SECTION M -- POWER

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1. GENERAL

1.1. Introduction

1.1.1 The Installation Supplier shall ensure, as part of the evaluation of the installation, that all equipment added, rearranged, or modified is properly installed and in conformance with AT&T installation specifications.

1.1.2 The Installation Supplier shall ensure, as part of the evaluation of the installation, that all work has been done in accordance with the detail specifications or approved changes to the detail specifications.

1.1.3 Changes in this issue of Section M are summarized in Table M-1.

1.1.4 ATT-TP-76400, Section 12 and ATT-TP-76300, Section M are an engineering and installation pair. To minimize redundancy, many common requirements are listed in ATT-TP-76400, Section 12 and the reader of Section M is referred back to Section 12. A few requirements are duplicated in both sections. The lack of duplicating a requirement in Section M does not relieve the Installation Supplier from Compliance. The Installation Supplier shall adhere to all the requirements documented in ATT-TP-76400, Section 12.

1.1.5 Additional power wiring and connecting requirements can be found in ATT-TP-76300, Section K.

1.2. Definitions

1.2.1 Advanced Technical Support (ATS): Local GNFO technical support for power issues, aka Maintenance Engineer.

1.2.2 Alternating Current (AC): A form of electric power where the electric charge periodically reverses direction. Typical waveform is sinusoidal with a frequency of 60 Hz in the U.S.

1.2.3 Authority Having Jurisdiction (AHJ): As defined in the NEC, typically local government Electrical Inspector or Fire Marshal.

1.2.4 AT&T Engineer: The term “AT&T Engineer” will be used in this section to refer to the AT&T representative who is responsible for approving the order to engineer and install the equipment, regardless of organizational structure and job titles - aka, MEI.

1.2.5 AT&T Standard Drawings are equipment bay layout, wiring and Power drawings that are maintained on the TDocs website.

1.2.6 American Wire Gauge (AWG): Wire size standard commonly used in the U.S.

1.2.7 Central Office (CO): Carrier Communications Space containing switching and transport equipment.

1.2.8 Direct Current (DC): A form of electric power where the electric charge flows in one direction only.

1.2.9 DESP: Detail Engineering Service Provider. In this section, DESP refers to the provider of power detail engineering services, including DC power plant, UPS, inverter, and standby generator detail engineering service providers.
1.2.10 **Emergency Power Off (EPO):** EPO is a means to disconnect power to all electronic equipment, HVAC systems, batteries, and shall cause all required fire/smoke dampers to close in Non-Network Space under certain conditions by the AHJ.

1.2.11 **GES** – Global Engineering Support

1.2.12 **Global Network Field Operations (GNFO):** Local Electronic Technicians, Supervisors, etc.

1.2.13 **IDC** – Internet Data Center

1.2.14 **Information and Communications Technology (ICT)** - is an umbrella term that includes any communication device or application, encompassing: radio, television, cellular phones, computer and network hardware and software, satellite systems and so on, as well as the various services and applications associated with them, such as videoconferencing and distance learning.

1.2.15 **Installation Supplier** – provider of equipment installation services.

1.2.16 **IS** – Internet Services

1.2.17 **IS POP** is an Internet Services POP. Primary distinction between an IS POP and a general POP is that typically an IS POP is AT&T Partitioned Network Space located in a facility controlled by AT&T that is predominantly used for Carrier Communications Space. See also **POP**.

1.2.18 **Listed:** Per the NEC, “Listed” refers to equipment, materials, or services included in a list published by an organization – typically a Nationally Recognized Testing Laboratory (NRTL) - that is acceptable to the Authority Having Jurisdiction (AHJ) and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that the equipment, material, or services either meets appropriate designated standards or has been tested and found suitable for a specified purpose. The means for identifying listed equipment may vary for each organization concerned with product evaluation, some of which do not recognize equipment as listed unless it is also labeled. In this section, “listed on the MML” will also be used to refer to AT&T approved minor materials.

1.2.19 **Manager – Engineering Implementation (MEI):** AT&T Engineer, aka Engineer.

1.2.20 **Minor Materials List (MML):** Minor material approved products list found on the TDocs website. There are two lists applicable to power: AC Power MML, and DC Power and Grounding MML. The term MML will be used in this section to apply to both lists.

1.2.21 **Mobile Telephony Switching Office (MTSO):** Traditional wireless telecommunications equipment building containing switching and transport equipment.

1.2.22 **Nationally Recognized Testing Laboratory (NRTL):** Evaluates products or services and states that the equipment, material, or service either meets appropriate designated standards or has been tested and found suitable for a specified purpose. Underwriters Laboratory (UL) is an example of a NRTL.

1.2.23 **NEC:** National Electric Code, aka NFPA 70.

1.2.24 **NiCad:** Nickel – Cadmium, a type of battery technology.
1.2.25 **NTC** – National Technology Center.

1.2.26 **PBD** – Power Board. The Power Board is the primary distribution point of a DC power plant.

1.2.27 **POP** – Point of Presence. A point-of-presence (POP) is an artificial demarcation point or interface point between communications entities. The term, as used in this section, typically refers to AT&T Network Equipment Space in a facility controlled by another communications provider. It can also refer to AT&T Network Equipment Space in a facility controlled by a different legacy AT&T affiliate. See also **IS POP**.

1.2.28 **Secondary Power Distribution Unit (SPDU)**: SPDU includes Battery Distribution Fuse Board (BDFB), Battery Distribution Circuit Breaker Board (BDCBB), mini-BDFB, micro-BDFB, Power Distribution Cabinet (commonly found in switching systems), Power Distribution Unit (PDU), and Fuse and Alarm Panel (FAP). In this section, “BDFB” will be used to refer to SPDUs that are designed to serve multiple bays of equipment and are typically sourced at a Power Board. “Bay mounted SPDU” will be used to refer to SPDUs typically designed to serve a single bay of equipment and are typically sourced from a BDFB.

1.2.29 **Uninterrupted Power Supply (UPS)**: A standby plant typically consisting of rectifier(s), battery, inverter(s), isolation transformer, and AC distribution used to serve AC powered equipment.

1.2.30 **VHO**: Video Hub Office is a building containing video services equipment in Non-Network Space.

1.2.31 **VRLA**: Valve Regulated Lead Acid, a type of battery technology.

1.2.32 **TDocs**: AT&T server that is accessible to approved DESPs that houses AT&T Standard Drawings, Job Aids and Approved Product Minor Material Lists.

### 1.3. General Requirements

1.3.1 The Installation Supplier shall ensure that manufacturer’s equipment specifications and documentation provided by the DESP are turned over to local maintenance forces.

1.3.2 The Installation Supplier shall ensure that manufacturer’s recommended spare parts provided by the DESP are turned over to local maintenance forces.

1.3.3 The Installation Supplier shall ensure all remote alarms (and local alarms where applicable) are wired in accordance with ATT-P-05100-E “Power Equipment Alarm Standards” drawing, and tested in accordance with ATT-TP-76900.

1.3.4 When adding equipment on waterproof floors, the Installation Supplier shall secure equipment frames to the floor in accordance with ATT-TP-76300, Section B: sub-section “Penetrating Waterproof Environments”.

1.3.5 The Installation Supplier can reference the specific installation requirements for battery, return, and busbar hardware connections that are listed in ATT-P-05100-E.

1.3.6 The Installation Supplier shall verify (with a multi-meter) the absence of voltage on the battery and battery return leads before connecting the leads. That is, when two conducting parts are to be landed, there shall be less than or equal to 0.05V between them.
1.3.7 The Installation Supplier shall verify (with a clamp-on ammeter) the absence of current for each power lead to be removed.

1.3.8 Power equipment and busbars shall be protected any time there is installation activity in the immediate vicinity. See ATT-TP-76300 Section B.

1.3.9 Installation Supplier shall ensure BDFB/SPDU Load Demand Worksheet (LDW) requirements detailed in ATT-TP-76300 section E are met.

1.3.10 The fuse assignment record for a new BDFB/SPDU shall be completed by the DESP or Installation Supplier per local practice (either direct in the database or completed form sent to the appropriate AT&T contact) prior to Installation Complete Date.

1.3.11 See ATT-TP-76400 section 12 and Table 12-2 for Working Space requirements.

1.4. DC Power Cable Reuse

1.4.1 See ATT-TP-76400 section 12 subsection 3.5 for requirements governing reuse of DC power cable.

1.5. Power Cables Passing Through a Cable Rack

1.5.1 Power cables passing through a cable rack are limited to the following cases:

   a) Unfused power cables (all cases).

   b) Existing primary or secondary distribution bays (Power Board or BDFB) where the power distribution bay was originally installed with either primary or secondary cable rack installed directly overhead, requiring primary or secondary power cables to pass thru cable rack rungs.

1.6. Removal Of DC Fuses Or Opening DC Circuit Breakers

1.6.1 Unless stated otherwise in the MOP, the Supplier shall not remove a fuse or open a circuit breaker serving energized equipment. The AT&T GNFO / Operations representative is responsible for opening the circuit on energized equipment.

1.6.2 The Installation Supplier shall ensure that all circuit breakers that are spare, unassigned, or reserved for future equipment are in the "Off" position.

1.7. DC Protection Devices

1.7.1 Fuses and circuit breakers shall be of the type and capacity as indicated in the job documentation. Under no circumstances shall circuit protection devices (fuses or circuit breakers) be placed in parallel in order to increase circuit capacity.

1.7.2 Dummy fuses shall be installed at all open faced and GMT type vacant fuse positions.

1.7.3 Cartridge, knife, and blade type fuses and disconnect switches shall be coated with a thin film of NO-OX-ID "A" anti-corrosive compound prior to fuse installation (on contact surfaces only).

1.7.4 The use of any fuse reducer shall require the authorization of the AT&T Engineer.

1.7.5 Spare circuit protection devices shall be placed in a designated location or turned over to the AT&T Representative at job completion if a spare fuse holder is not provided.
1.7.6 When provided by the DESP, connecting hardware shall be installed on all BDFB/SPDU fuse posts.

1.7.7 Circuit Protection devices shall not be installed or activated on unterminated leads.

1.7.8 The Installation Supplier shall verify that all electrical contact surfaces are not damaged.

1.8. Battery Post

1.8.1 The Installation Supplier shall refer to the job documentation and cell manufacturer's documentation for specific requirements and precautions for cleaning and treating cell posts. If the cell manufacturer's recommended procedures for cell post cleaning and preparation differ from those specified in this section, then the Installation Supplier shall contact ATS for direction.

1.8.2 All contact surfaces of flooded lead acid and VRLA battery posts and contact areas of intercell connectors shall be cleaned and coated with a thin film of NO-OX-ID "A" anti-corrosive compound.

1.8.3 All cell post connections shall be made with the proper tools and shall be tightened to the manufacturer’s torque requirements.

1.8.4 When lead-plated details and/or details with elongated holes are used, flat lead-plated or stainless steel washers shall be used under the nut and under the bolt head.

1.8.5 Tin-Zinc coated connectors shall be used when connecting to lead acid-type batteries or battery post terminal adapter plates. Existing stock of lead coated connectors may be used until exhausted.

1.8.6 On new battery string installations, all nuts, bolts and washers shall be stainless steel, unless specified otherwise by the manufacturer. Stainless steel (316 or better grade) is required, and the flat washer shall be 1/8 inch thick. The smooth (rounded) side of the flat washer shall be placed against and not overhang the battery strap or connector lug. Where lock washers are provided by the battery manufacturer, they shall be assembled on top of the flat washer as shown in the ATT-P-05100-E drawing.

1.8.7 The threaded portion of bolts on intercell connectors shall not be installed to have exposed threads past the nut more than the equivalent diameter of the bolt.

2. DC BUSBARS

2.1. Assembly

2.1.1 The Installation Supplier shall use zinc-chromium plated SAE J429 ASTM B117 & B633 specifications or ASTM B99 silicon bronze finished busbar joint, fastening and support bolts, nuts, washers, etc. as listed on the Minor Material List. The hardware shall be American National Coarse with a Class #2 Fit. Busbar runs shall be supported on a maximum of 6 feet centers. Each length between joints shall be supported on both sides of a mechanical splice. Typical supports are within 6 inches of the end of the busbar. The unsupported length of a busbar section cantilevered beyond the last support shall not exceed the lesser of 18 inches or 25% of the length of the busbar section. E.g., for a 3 foot busbar, then the maximum cantilever is 25% of 3 feet, or 9 inches. Reference Figure M-5 – Busbar Support Distances.
2.1.2. Busbar runs supported by ceiling inserts, threaded rod and/or auxiliary framing channels shall be braced, both side and lengthwise, according to AT&T seismic requirements.

2.1.3. Except for the auxiliary framing bar supporting the red insulator, busbars shall be installed at least one foot from metal pipes, cable racks, conduit, auxiliary framing, etc., unless approved by the AT&T Engineer or Power ATS representative. In no case shall this distance be less than three (3) inches.

2.1.4. New busbar installations shall be a minimum of 7’3” and a maximum of 9’3” above finished floor (AFF), as measured from the bottom of the bar. Additions to existing busbars outside these limits may continue at the current height of the existing busbar.

2.1.5. The busbar shall be insulated from all supporting ironwork with approved (DC Minor Material List) insulators.

2.1.6. Exposed busbar splice plates with plant voltage potential, located outside the power plant environment, (e.g. above or below secondary power distribution frames, cable rack, auxiliary framing, etc.,) shall be protected, in order of preference:
   a) With non-combustible covers (V-1 or better rating), or
   b) Have each busbar and its associated cable connectors wrapped with two half-lapped layers of plastic insulating tape.

2.2. Connecting Busbars Together

2.2.1. Existing aluminum busbars or details shall not be connected directly to heat producing devices. Examples are:
   a) Fuse terminals
   b) Switch terminals
   c) End cells

2.2.2. Aluminum busbars shall not be tapped for fastening terminal lugs or for fastening bar to bar. Use through-bolts or clamp joints.

2.2.3. Only American Standard Unified Course (UNC) Grade 5 threads and hardware shall be used on all external power plant and busbar connections (internal manufacturer power plant connections may be metric as long as there are no requirements for field installation interaction).

2.2.4. High spots, sharp edges and burrs shall be removed from all electrical contact areas, before assembly, to maximize continuity. Contact surfaces shall be flat.

2.2.5. Plated contact surfaces shall be cleaned without using abrasives coated with a thin film of NO-OX-ID “A” anti-corrosive compound and then assembled in a timely manner.

2.2.6. All non-plated contact surfaces shall be cleaned with a fine abrasive material coated with a thin film of NO-OX-ID “A” anti-corrosive compound and then assembled in a timely manner.

2.2.7. Joints between laminated busbar sections shall be made with square clamps. At such busbar joints, the busbar laminations shall overlap each other not less than the width of the busbar. At such busbar joints, a busbar section ending at the clamp shall not extend farther than 2 inches
beyond the nominal square dimensions of the clamp. For example, a 6”x6” clamp must have at
least 6” of material in the clamp and can have up to 2” of material protruding beyond the clamp
where the busbar section is ending. See Figure M-4.

a) Busbar terminations for single lamination battery and rectifier connections shall be permitted
to be made with rectangular clamps having their long nominal dimension equal to the width
of the main busbar run and their short nominal dimension equal to the width of the busbar
termination (drop). For example, in a 6” main busbar run, terminations using a single
lamination to connect a battery string or rectifiers may be made using a rectangular clamp
such as a 3”x6” where the termination (drop) is 3” wide. See Figure M-4.

b) Note: This requirement does not apply to BDFB external return busbars or CO ground bars,
which are not laminated busbars. BDFB manufacturer recommendations shall be followed
for BDFB external return busbar extensions.

2.2.8. For through-bolt connections on busbars, flat washers shall be used under the nut and under
the bolt head. In addition, a lock-washer shall be used under the nut. (See AT&T Drawing
ATT-P-05100-E for assembly details.)

2.3. Busbar Clamps

2.3.1. Clamps that have a busbar contact surface concave in shape are defective and shall not be
used.

2.3.2. Busbar clamp bolts shall be equipped with self-locking pal nuts. Non-self-locking nuts shall be
torqued per the manufacturer’s specifications before applying a pal nut. The pal nut shall be
applied with the smooth (flat) side in, open side out, run up to the regular nut, tightened and
taken up only one quarter turn with an insulated wrench. On larger clamps, lock nuts may be
provided instead of pal nuts. The lock nuts shall be tightened until tension is snug against the
regular nut.

2.4. Taping

2.4.1. Two overlapping wraps of plastic electrical insulating tape, (e.g., Scotch 33 or Scotch 88) shall
be applied when taping busbars with battery potential.

2.4.2. The Installation Supplier shall tape the portion of the battery return bar in close proximity to live
exposed terminals, studs, etc. In power rooms or in power board lineups containing power
exclusively, taping is not required.

2.4.3. Busbars, studs, nuts and details having 150 volts or more to ground shall be taped with two
layers of friction tape, unless protected by enclosures or barriers.

2.4.4. Power panels and power boards having 150 volts or less shall have exposed details taped
when located in open type frames, racks, boards and bays. In power rooms or in power board
lineups containing power exclusively, taping is not required.

3. FLOODED LEAD-ACID STORAGE BATTERIES

3.1. General
3.1.1 Batteries shall not be unpacked until the battery stand installation is complete and the Installation Supplier is ready to install the batteries.

3.1.2 The Installation Supplier shall not place cells of different manufacturers in the same string.

3.1.3 When cells in a string are replaced, the replacement cells shall have the same constant current discharge rating (aka ampere hour) or constant power discharge rating (aka watts per cell), the same number of plates and shall have the same manufacturer. KS20472 L1 round cells can be replaced by LS20472 L1S cells.

3.1.4 Battery cells shall not be lifted or moved using the intercell connectors, cell posts or covers; with the exception of the KS20472 round cell battery which is designed to be lifted by the jar cover lip.

3.1.5 The battery marked as the pilot cell shall have a thermometer installed.

3.2. Cautions

3.2.1 While batteries are being charged, the Installation Supplier shall post temporary warning signs in conspicuous locations near the batteries as follows:

**Warning:** BATTERY GASES ARE FLAMMABLE. NO SPARKS OR OPEN FLAME NEAR CELLS.

3.2.2 While batteries are being charged, the following precautions shall be observed:

a) Provide maximum ventilation (at least 2 air changes per hour).

b) Before charging, allow the cell to stand at least 1/2 hour on open circuit or on float voltage.

c) Install explosion vent caps before charging

3.3. Shipping Batteries for Removal or Reuse

3.3.1 When batteries are removed for non-reuse, procedures described in Section V shall be followed.

3.3.2 Batteries scheduled for reuse shall be inspected by the ATS (or their designees) to determine battery string condition; pressure testing as required (before and/or after redeployment); estimated time for relocation; and pre-determination of expected length of a boost charge where required for input to the engineering cost estimate. The batteries shall be prepared for shipment as follows:

a) All cells shall be individually marked with the original string cell position number.

b) All battery records shall be packed with the batteries in a plastic sleeve, taped to cell #1 in each string. Where battery records are not available, a written statement regarding this shall be placed in the plastic sleeve. The date and time the string is removed from float shall also be placed in the plastic sleeve.

c) Batteries relocated as a complete string shall be reinstalled in the same order as placed in the original installation.

d) If a string is removed and cells are shipped to different locations for reuse, a copy of the complete battery string record shall be included with each shipment.
e) Miscellaneous battery items such as spark arrestors and thermometers shall be packed and stay with the cell in which they were originally installed.

f) Shipping plugs and filling tube caps shall be firmly installed to prevent electrolyte spillage.

g) Battery terminals shall be protected against short circuits with tape, caps or protective packaging.

h) Battery intercell connectors and associated hardware shall be inspected and replaced as necessary; non-stainless steel hardware shall be replaced regardless of condition.

i) Perform a complete review of batteries at new location(s) as required in ATT TP 76300 Section M, Paragraph 3.4.5.

j) Pressure testing shall be required where specified by the ATT Engineer in the TEO, ATS, or GNFO based on the condition of the batteries prior to shipment and/or when received at the installation site. Jar pressure tests when taken before relocation shall be compared to pressure testing results after the battery relocation and installation. Jar pressure testing at a minimum shall always be done after the batteries are installed on the battery rack.

k) After relocation and installation, the ATS shall verify estimated charge testing requirements for the re-used batteries are sufficient for the condition of the batteries. If additional charging is required over the initial job estimate, the ATS will notify the ATT Implementation Engineering and the Installation Supplier. Boost charging where specified by ATS shall at a minimum meet or exceed manufacturer requirements to maintain the battery warrant.

3.3.3 Batteries shall be packaged and shipped per AT&T EH&S guidelines (contact AT&T Engineer for further information if necessary).

3.4. Cell Unpacking, Cleaning And Inspection

3.4.1 Flooded battery cells shall remain in their protective packaging or be protected from damage until commencement of battery installation.

3.4.2 All cells shall be cleaned and neutralized thoroughly as soon as practical after they arrive on the job. Use a wet cloth in a 5% - 10% baking soda or soda ash solution, squeeze out sufficiently, and wipe thoroughly to neutralize cell top and sides. Ensure that posts, post holes and post seals are thoroughly cleaned.

3.4.3 After neutralization has been completed, the Installation Supplier shall remove salts and residue with water, wet cloth and frequent rinsing. Batteries and/or jars shall be wiped clean until dry to be sure all soda residues have been removed.

3.4.4 Solvents, mineral spirits, commercial detergents, ammonia, or other cleaning compounds or oils, waxes or polishes shall never be applied to the cell jar or lid. When such information is not provided in the job documentation (e.g., cell manufacturer's documentation) only water and baking soda or soda ash may be used.

3.4.5 The Installation Supplier shall make a visual inspection of all batteries shipped to the job site (prior to installation) to identify any physical damage, defects or problems that may prevent their proper installation, maintenance and/or operation.

The Installation Supplier shall inspect for the following defects:
• Breaks in the jar to cover seal.
• Crooked posts.
• Plates improperly supported on the bottom bridge.
• Loose paste material between the jar wall and interior.
• Bent or broken internal parts.
• Cracked jar or cover.
• Scratched, gouged, or chipped jar or cover. Indentations of more than 1/64 of an inch should be reported.
• Hairline cracks around the cell and post.
• Small dots on the post or early signs of post porosity.
• Uneven gaps or flaws in the cover.
• Crystals on plates.
• Low (touching plates) or high (at or above upper level mark) electrolyte level.
• Presence of sprues (raised areas) on the jar

3.4.6 When uncrating cells, the Installation Supplier shall check for stains or discoloration in the packing material to locate damaged or defective cells.

3.4.7 The Installation Supplier shall install explosion proof vents when cells are first unpacked.

3.4.8 In all geographic areas, batteries awaiting installation shall be secured (strapped together in groups of four or more with non-metallic straps).

3.4.9 Unpacked batteries awaiting installation shall not be covered with a tarp.

3.4.10 Upon installation of a new battery string, the Installation Supplier shall inspect and verify that all voltage-matching stickers are of like color prior to their initial charge. The exceptions being round cell and UPS batteries, which do not supply the stickers.

3.5 Pressure Testing

3.5.1 The following testing requirements apply only when ordered by the AT&T Engineer, or if any battery leakage is found in any of the cells during unpacking:

   a) The Installation Supplier shall pressure test all cells. The cells shall be pressure tested after placement onto the stand to assure that they were not damaged during placement. The Installation Supplier may choose to perform an additional pressure test prior to placing cells on the rack (to avoid placing a “leaker”). This, however, does not replace the “on the rack” test.

   b) Cells, posts and cover seals shall withstand a pressure of 1/2 pound per square inch for one minute without any noticeable loss in pressure. Do not over pressurize the cells.

   c) Document the results of the pressure test on the Pressure Test Record (Figure M-1).

3.5.2 Pressure Test Records shall be turned over to the AT&T Engineer at the completion of the job.
3.5.3 The Installation Supplier shall notify the AT&T Engineer, as soon as practical, if a cell does not pass pressure tests.

3.5.4 Cells that do not pass the pressure test shall not be connected until the cell has been fixed and passed a retest, or is replaced.

3.6. **Electrolyte Spills**

3.6.1 All spills shall be contained and reported to:

AT&T Environmental Health & Safety at 1-800 KNOW EHS or for Legacy-B locations, 1-888-330-CRES. Refer to Section V, ATT-TP-76300 for additional requirements concerning Electrolyte spills.

3.7. **Battery Water**

3.7.1 Prior to initial charging, if the electrolyte level is below the bottom fill line, the Installation Supplier shall adjust the electrolyte level to the bottom fill line. No adjustment shall be made if the electrolyte level is above the bottom fill line.

3.8. **Battery Preparation**

3.8.1 The Installation Supplier shall notify the AT&T Engineer if the electrolyte is above the upper level line when the cells are received at the job site. The Installation Supplier shall NOT remove excess electrolyte for any reason.

3.8.2 A Storage Battery Charge Report (see Figure M-2) shall be maintained on each battery throughout the installing and charging phases of battery installation. A completed copy of the Storage Battery Charge Report shall be provided to the AT&T Representative at job completion.

3.8.3 The Installation Supplier shall check the installed batteries for the presence of crystals. If crystals or other defects are detected, notify the AT&T Engineer. The Installation Supplier shall note the presence or absence of crystals on the Storage Battery Charge Report.

4. **BATTERY RACKS**

4.1. **General**

4.1.1 Battery racks shall be positioned, assembled, aligned, grounded, designated and installed as specified in the job documentation, ATT-TP-76300, and the rack manufacturer's documentation.

4.1.2 For personnel protection, creating sparks while working with batteries shall be avoided. To avoid Electrostatic Discharge (ESD), the Installation Supplier shall perform one of the following steps prior to beginning each work operation involving battery work:

a) Firmly touch a grounded metal rack/object or battery termination plate near the return (grounded) end of the battery for the removal of static electricity.

b) If the battery stand is equipped with an ESD ground termination, an ESD wrist/ankle strap may be used for self-discharge. However, it is not the intent to require the technician to wear the device while working on the batteries.
4.1.3 On a two-tier, two string, rectangular, flooded lead-acid battery rack each of the battery strings shall have cell 1 on the bottom tier.

4.1.4 In seismic zones 3 and above, cell separators shall be installed between battery cells. Manufacturer supplied battery container support cradles may be used instead of cell separators if they minimize battery movement.

4.1.5 In seismic zones 2 and below, cell separators or container support cradles shall be installed between battery cells if shipped by the battery manufacturer.

4.1.6 Only materials that meet a limiting oxygen index (LOI) of 28 or higher shall be used as cell separators. (Styrofoam packing material shall not be used as separators.)

4.1.7 When tie rods are required for seismic protection on a battery stand installation, it is permissible to double nut the battery stand tie rod on both ends.

4.1.8 Battery cells shall not touch each other or adjacent framework.
   a) The spacing between the cells in a row shall match the battery manufacturer’s recommended spacing (as specified in the battery manufacturer’s installation documentation). If not specified in the battery manufacturer’s installation documentation, the spacing between the cells in a row should be in the range of 3/8” to 5/8”.
   b) The spacing between the rows of cells shall match the battery manufacturer’s recommended spacing (as specified in the battery manufacturer’s installation documentation). If not specified in the battery manufacturer’s documentation, the spacing between the rows of cells should be greater than ¾”.
   c) Side and end-rail clearance to the battery jar shall match the battery manufacturer’s recommended spacing (as specified in the battery manufacturer’s installation documentation). If not specified in the battery manufacturer’s documentation, side and end-rail clearance should be in the range of 1/32” to 1/8”.

4.1.9 In DC power plant applications, cell/jar number 1 shall be the grounded end of the battery string and cell/jar number 1 shall be installed on the bottom tier when using a two tier battery stand. Battery strings used in UPS applications are ungrounded. In UPS battery applications, cell/jar number 1 shall be the positive end of the battery string and cell/jar number 1 should be installed on the bottom tier when using a two tier battery stand. Reference AT&T standard drawing Battery String Numbering, ATT-P-05322-E.

4.2. Battery Cabling (Unfused)

4.2.1 In DC Power Plant applications,
   a) #4/0 AWG flexible type power cable shall be the standard size and type to be used on 201Ah to 1900Ah battery tier-to-tier or tier-to-termination bar applications.
   b) Size 350 MCM flexible type power cable shall be used on 1901Ah to 4000Ah cells.
   c) #2 AWG flex power cable shall be used on 200Ah and smaller individual strings (typically NiCad, VRLA or Sodium Nickel Chloride).
d) Battery racks that contain multiple strings of batteries (typically 200Ah or smaller), shall use one of the following options to size the cable from the rack collection bar to the termination bar:

1. Use the row in Table M-3 that matches the aggregate Ah of the strings contained in the rack. E.g., a battery rack that contains six (6) strings of nominal 200Ah batteries (aggregate Ah of 1200Ah) may use four (4) #4/0 AWG flexible power cables.

2. When battery discharge and recharge current is limited by either an overcurrent protection device or battery management system (BMS), then the aggregate maximum ampacity may be used with ATT-TP-76400 section 12 Table 12-3 to determine cable size, provided at least two (2) cables per battery rack are provided. E.g., a battery rack that contains six (6) strings of batteries current limited by a 100A breaker per string (600A aggregate) may use two (2) 350MCM flexible power cables. E.g., a battery rack that contains five (5) strings of batteries current limited by a 200A breaker per string (1000A aggregate) may use two (2) 750MCM flexible power cables.

4.2.2 In DC Power Plant applications, cables between the battery posts and battery busbar shall be installed as shown in Table M-3.

Exception: Factory cabling harnesses provided with a battery rack to aggregate multiple strings in a rack shall be as provided by the manufacturer.

Note: Table M-3 is based on 1 to 8 hour discharge rate and standard voltage drop scenarios for DC Power Plants.

UPS battery string cabling shall be sized to meet the UPS manufacturer’s specifications for ampacity (based on the appropriate battery discharge rate) and a 2 volt loop maximum voltage drop.

4.2.3 Cable runs, from busbar drop plates to cell posts shall have sufficient slack to allow 6 inches of movement.

4.2.4 Multi-conductor connections between inter-tier and inter-row battery posts shall be of the same size and length.

5. CHARGING STORAGE BATTERIES

5.1. Introduction

5.1.1 Subsection Subsections 5.2 and 5.6 are applicable to all battery technologies.

Subsections 5.3 through 5.5 apply specifically to flooded lead acid batteries.

Subsections 5.7 through 5.11 are specific to VRLA, Ni-Cad and alternative battery technologies.

5.2. Float, Equalize, and Initial Freshening Charge Voltages

5.2.1 Float, Equalize, and Initial Freshening Charge Voltages shall be per Table M-2:
### Table M-2 – Float, Equalize, and Initial Freshening Charge Voltages per Battery Technology

<table>
<thead>
<tr>
<th>Battery Type</th>
<th>Cell Voltage (V / cell)</th>
<th>24V System</th>
<th>48V System</th>
<th>240 Cell UPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Float</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flooded Lead Acid – 1.215 SG, Standard</td>
<td>2.20V</td>
<td>26.40V</td>
<td>52.80V</td>
<td>N/A</td>
</tr>
<tr>
<td>Flooded Lead Acid – 1.215 SG, Legacy</td>
<td>2.17V</td>
<td>26.04V</td>
<td>52.08V</td>
<td>N/A</td>
</tr>
<tr>
<td>Flooded Lead Acid – 1.250 SG, UPS</td>
<td>2.25</td>
<td>N/A</td>
<td>N/A</td>
<td>540.00V</td>
</tr>
<tr>
<td>VRLA – 1.250 SG, ATL Series</td>
<td>2.20V</td>
<td>26.40V</td>
<td>52.80V</td>
<td>528.00V</td>
</tr>
<tr>
<td>VRLA – 1.300 SG</td>
<td>2.25V</td>
<td>27.00V</td>
<td>54.00V</td>
<td>540.00V</td>
</tr>
<tr>
<td>Ni-Cad - Standard</td>
<td>1.43V</td>
<td>27.17V</td>
<td>54.34V</td>
<td>N/A</td>
</tr>
<tr>
<td>Li-ion</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Molten Salt (NaMx or NaNiCl)</td>
<td>Follow manufacturer recommendations</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equalize</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flooded Lead Acid – 1.215 SG, Standard</td>
<td>2.24 - 2.39V</td>
<td>26.88 - 28.68V</td>
<td>53.76 - 57.36V</td>
<td>N/A</td>
</tr>
<tr>
<td>Flooded Lead Acid – 1.215 SG, Legacy</td>
<td>2.24 - 2.39V</td>
<td>26.88 - 28.68V</td>
<td>53.76 - 57.36V</td>
<td>N/A</td>
</tr>
<tr>
<td>Flooded Lead Acid – 1.250 SG, UPS</td>
<td>2.38 - 2.43V</td>
<td>N/A</td>
<td>N/A</td>
<td>571.2 - 583.2V</td>
</tr>
<tr>
<td>VRLA – 1.250 SG, ATL Series</td>
<td>2.29V</td>
<td>27.48V</td>
<td>54.96V</td>
<td>549.60V</td>
</tr>
<tr>
<td>VRLA – 1.300 SG, Use only when recommended by the manufacturer</td>
<td>2.35V</td>
<td>28.20V</td>
<td>56.40V</td>
<td>564.00V</td>
</tr>
<tr>
<td>Li-ion</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Molten Salt (NaMx or NaNiCl)</td>
<td>Follow manufacturer recommendations</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial Freshening Charge</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flooded Lead Acid – 1.215 SG, Standard</td>
<td>2.50V</td>
<td>30.00V</td>
<td>60.00V</td>
<td>N/A</td>
</tr>
<tr>
<td>Flooded Lead Acid – 1.215 SG, Legacy</td>
<td>2.50V</td>
<td>30.00V</td>
<td>60.00V</td>
<td>N/A</td>
</tr>
<tr>
<td>Flooded Lead Acid – 1.250 SG, UPS</td>
<td>2.50V</td>
<td>N/A</td>
<td>N/A</td>
<td>600.00V</td>
</tr>
<tr>
<td>VRLA – ATL Series</td>
<td>Same as Equalize Voltage</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VRLA – 1.300 SG</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ni-Cad</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lithium-ion</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Molten Salt (NaMx or NaNiCl)</td>
<td>Follow manufacturer recommendations</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5.2.2 The Installation Supplier shall provide its own portable battery charger equipped with overcurrent protection and the following specifications:

a) Capable of producing a charge rate of at least:
   
   i. 25A for 3900 Ah (6.5kW) batteries and larger.
   
   ii. 20A for 2000 Ah to 3899 Ah (3.4kW to 6.5kW) batteries and larger.
iii. 12A for 1200 Ah to 1999 Ah (2.0Kw to 3.3Kw) batteries.

iv. 10A for smaller than 1200 Ah batteries (< 2.0Kw).

b) For VRLA batteries, the charger must be current limited per battery manufacturer requirements.

c) Constant DC voltage regulation with maximum AC ripple voltage output of 0.5%.

5.3. Initial Charging of Flooded Lead Acid Batteries

5.3.1 Initial charging may be performed off-site so long as charging records are kept appropriately and are available for inspection by AT&T at any time.

5.3.2 Flooded lead acid batteries shall be given an initial freshening charge. Initial freshening charge begins when the batteries are placed on the charger and is complete when all of the following conditions are met:

a) Minimum of 100 hours for all new batteries and batteries stored up to 6 months. For cells stored over 6 months but less than one year, the minimum initial freshening charge time is 225 hours. Cells stored more than one year shall not be installed. If the manufacturer “Charge By” date has been exceeded, contact the local AT&T ATS – Power representative for resolution.

b) Charge voltage and current reach steady state plus 72 additional hours. Steady state is defined as charge voltage and current having little or no appreciable change for at least three consecutive readings.

c) Visual inspection indicates every cell is gassing freely and equally (applicable only to cells that have transparent or clear translucent containers).

d) Visual inspection indicates no crystals present on the plates when examined with a flashlight (applicable only to cells that have transparent or clear translucent containers). Cells with crystals after the initial charge may contain an internal short.

e) Maximum of 250 hours. If a battery string fails to reach steady state or fails to gas freely and equally within 200 hours, contact the local AT&T ATS – Power representative for resolution. If crystals are still present after 250 hours, the cells shall be referred to the local AT&T ATS-Power representative for resolution.

5.3.3 Just before the initial freshening charge is complete, record the parameters specified on the Storage Battery Charge Report (Figure M-2) and the Pilot Cell Charge Report (Figure M-3). Then reduce the charge voltage to normal float voltage and allow the cells to stabilize for 72 hours. After the batteries have completed the initial freshening charge and have been at float voltage for 72 hours, then the Charge Reports can be completed and the batteries are ready to be turned over for service.

Example: Assume that after 60 hours, steady state voltage and charge current have been reached. After 132 hours (60 hours to achieve steady state + 72 additional hours), visual inspection indicates every cell is gassing freely and equally and no crystals are present on the cell plates. Thus at 132 hours, the initial freshening charge is complete and the charge voltage can be reduced to normal float voltage for 72 hours. After 72 hours at float voltage (204 hours total), then the batteries are ready for turnover to AT&T.
5.3.4 Before the initial freshening charge is started, the Installation Supplier shall designate the cell with the lowest specific gravity as the Pilot Cell (aka Temperature Reference Cell). The Pilot Cell shall be located on the lower shelf of the stand. Do not place the Pilot Cell on the end of a stand, near a window, or near a heating/cooling vent.

5.3.5 When more than one string is charged in parallel, the Installation Supplier shall select a separate Pilot Cell for each string.

5.3.6 The Installation Supplier shall record the Pilot Cell number in the appropriate box on the Storage Battery Charge Report (Figure M-2).

5.3.7 The Installation Supplier shall insert a thermometer in the Pilot Cell so the temperature reading can be taken without touching the thermometer. The Pilot Cell is used for the purpose of temperature measurement for the hours of charge.

5.3.8 Just before the start of initial charge, the Installation Supplier shall measure and record on the Pilot Cell Charge Report (Figure M-3) the cell temperature of the pilot cell and ensure it is a minimum of 65°F (18.3°C). If pilot cell temperature is below 65°F, ambient temperature of the site/room shall be increased until the pilot cell temperature reaches this threshold.

5.3.9 The Installation Supplier shall ensure that adequate ventilation is present to prevent the hydrogen concentration from reaching the 1 percent level at any time during the charging process. Warning signs shall be placed near the charge area. For information regarding ventilation requirements, refer to Section 6 of ATT-TP-76400.

5.3.10 Explosion proof vent caps and shipping plugs (for the electrolyte draw-off tubes) shall be firmly in place on each cell during cell charging activities.

5.3.11 Before performing any work functions, the Installation Supplier shall touch any bare metal grounded part of the battery rack to avoid ESD to the batteries.

5.4. Charging Records

5.4.1 The Installation Supplier shall complete the Pressure Test Record (Figure M-1) if a Pressure Test is requested by the AT&T Engineer in the TEO. The Pressure Test is generally reserved for existing strings that may have developed cracks while in service. It is no longer a requirement for new battery installations.

5.4.2 The Installation Supplier shall complete the Storage Battery Charge Report (Figure M-2). This report shall record the voltage, specific gravity, and temperature of each cell at the following intervals:

a) Prior to start of initial freshening charge,

b) At end of initial freshening charge, prior to turn-down to float voltage,

c) After 72 hours at float voltage, and

d) At turnover to AT&T.

5.4.3 The Installation Supplier shall complete the Pilot Cell Charge Report (Figure M-3). This report shall record the time, charge current, voltage, and temperature of the pilot cell at the following intervals:

a) At the start of initial freshening charge.
b) Once each hour for the first eight hours of charge.

c) Three times a day after the first eight hours of charge.

d) Just before initial freshening charging is completed or temporarily discontinued if necessary.

e) When charging is restarted (if initial freshening charge is interrupted).

5.4.4 Pressure Test Record, Storage Battery Charge Report, and Pilot Cell Charge Report per ATT-TP-76300 Figures M-1, M-2, and M-3, shall be included in the paper records left on-site, in the email to the AT&T Representative, and uploaded to EJF. Output reports from logging meters are an acceptable reference attachment.

5.5. Electrolyte Level

5.5.1 While batteries are on initial charge, the electrolyte level may rise above the maximum level line. If it should become necessary to remove electrolyte to prevent overflow, the Installation Supplier shall make note of removals on the battery initial charge records. Retain electrolyte for possible reuse at the cell level.

5.5.2 Electrolyte not reused shall be disposed of in accordance with Section V, Hazardous Material and Waste Management of ATT-TP-76300.

5.5.3 After the initial charge, distilled water shall be added to bring the electrolyte midway between the lower and upper level lines. If the electrolyte level exceeds the high mark, the Installation Supplier shall note the high level on the initial Storage Battery Charge Report in the comment section, but shall not make any adjustment in the electrolyte.

5.5.4 The Installation Supplier shall ensure that the full-charge specific gravity of each cell meets the manufacturer’s documentation and does not vary by more than 0.015 (15 points) per cell.

5.6. Turnover

5.6.1 The initial charge shall be approved by the AT&T Representative prior to placing the string online.

5.6.2 Individual cell voltages shall have a measurement within ± 0.05V of the float voltage listed in Table M-2.

5.6.3 All charged strings shall only be allowed to be removed from float for a period of ≤ 72 hours prior to being placed in service.

5.7. Valve Regulated Cells

5.7.1 The manufacturer’s installation instructions and forms shall be utilized for installation of VRLA cells.

5.7.2 Battery cabling between the battery strings and the bay collection bars shall be continuous; the use of quick-connectors is prohibited.

a) Exception: See ATT-TP-76400 section 12 subsection 2.11 for customer premise application.

b) Exception: The use of a battery quick disconnect is permissible in outside plant configurations.
i. Quick Disconnect devices shall be properly secured in a manner which provides clearance from moisture/groundwater which may accumulate on the floor of a cabinet's battery compartment.

5.8. Initial Charging of VRLA Batteries

5.8.1 New VRLA batteries are shipped fully charged and do not require an initial charge unless recommended by the manufacturer. However, if VRLA batteries have been stored for 3 months or more, they shall be given an initial charge before being placed in service. The initial charge shall consist of an initial freshening charge plus 72 hours at float voltage. Initial freshening charge begins when the batteries are placed on the charger and is complete when all of the following conditions are met:

a) Charge voltage and current reach steady state. Steady state is defined as charge voltage and current having little or no appreciable change for at least three consecutive readings. Note that steady state will typically be achieved in 12 to 16 hours @ 77°F (25°C) and it is critical not to overcharge VRLA batteries.

b) Maximum of 24 hours @ 77°F (25°C), 32 hours @ 65°F (18.3°C). If a VRLA battery string fails to reach steady state within this time, contact the local AT&T ATS – Power representative for resolution.

5.8.2 When steady state is achieved, reduce the charge voltage to normal float voltage and allow the cells to stabilize for 72 hours. After the batteries have completed the initial freshening charge and have been at float voltage for 72 hours, then the initial charge is complete.

Example: After 12 hours, steady state voltage and charge current have been reached, the initial freshening charge is complete, and the charge voltage can be reduced to normal float voltage for 72 hours. After 72 hours at float voltage (84 hours total initial charge), then the initial charge is complete and the VRLA batteries are ready for turnover to AT&T.

5.8.3 Minimum battery temperature shall be 65°F (18.3°C). If cell temperature is below 65°F, ambient temperature of the site / room shall be increased until cell temperature reaches this threshold.

5.8.4 The Installation Supplier shall record individual battery jar and strap conductance values before battery charge.

5.8.5 Before any VRLA battery string can be accepted, the resistance or conductance of all cells and inter-cell connectors shall be read and recorded by the supplier's installer. This record becomes part of the battery records turned over to the AT&T Representative and must remain with the battery string. These records are used as a baseline for future readings. The test shall meet the following requirement.

a) Supplier shall use a test set approved by ATS.

b) No reading (conductance or intercell connector resistance) shall be more than 20% above or below the average for the string.

c) Both a paper and electronic copy of the test results shall be left on site. Electronic test results shall include a spreadsheet and graph of the cell conductance and intercell connector measurements.
5.8.6 After string has settled at proper float voltage, the Float Current shall be recorded and preserved as a baseline.

5.9. Thermal Runaway Protection for VRLA Batteries

5.9.1 Thermal runaway monitor and control features per Telcordia GR-1515-CORE built into the power plant controller shall be used to ensure that thermal runaway does not occur. Manufacturer recommendations shall be followed for placement and wiring of sensors.

a) Monitor feature typically measures variance of battery cell temperature from ambient. A shorted cell is a typical root cause of thermal runaway. A shorted cell does not produce a temperature rise. To ensure the shorted cell is not also the only measured cell, the temperature of two cells in every string shall be measured.

Exception: 12V VRLA jars contain six cells; thus, only one jar per string is required to be monitored.

b) When a potential thermal runaway event is detected, the control feature typically lowers rectifier float voltage to limit current flow into the batteries, or to force a limited battery on discharge condition. Manufacturer recommended / factory default settings shall be used.

c) Exception “Monitor Only”: When an existing power plant controller is not capable of providing monitor features in compliance with GR-1515-CORE, then a separate thermal runaway monitor shall be provided. When an existing power plant controller is capable of monitor, but not capable of control features in compliance with GR-1515-CORE, then a separate thermal runaway monitor is not required, but implementation of the monitor feature in the controller is required.

i. “Monitor only” sites shall have the detection of a thermal runaway event alarmed. When the variance between battery cell temperature and ambient exceeds 10°C ± 1°C (18°F ± 2°F), a remote Power Major alarm shall be provided.

d) Exception UPS systems: Many modern UPS systems mitigate thermal runaway by limiting recharge current to a value at or below that recommended by the VRLA battery manufacturer, in lieu of GR-1515-CORE methodology

5.10. NiCad Cells

5.10.1 The manufacturer recommendations and forms shall be utilized for the installation of NiCad cells.

5.10.2 The Installation Supplier shall perform and record an Open Circuit Voltage (OCV) for each cell before installation. Any cell with less than 1.10 volts shall be replaced.

5.10.3 -48V NiCad battery strings for Central Office applications contain 38 cells with a standard float voltage per Table M-2. The float voltage can be reduced to the “optional” level shown in Table M-2 if there is an adjustment issue with high voltage alarms.

5.10.4 The higher than normal float voltage requires that a power plant be entirely supported by NiCad batteries. Strings of flooded lead acid batteries or VRLA batteries shall not be mixed with NiCad battery strings.

5.10.5 Battery cabling between the battery strings and the bay collection bars shall be continuous; the use of quick-connectors is prohibited.
a) **Exception:** The use of a battery quick disconnect is permissible in outside plant configurations.
   
   i. Quick Disconnect devices shall be properly secured in a manner which provides clearance from moisture/groundwater which may accumulate on the floor of a cabinet’s battery compartment.

5.10.6 Battery collection bars shall be installed at the top of the NiCad stand(s).

5.10.7 Nickel plated copper lugs without inspection holes and nickel plated steel hardware shall be used for NiCad battery terminal connections (e.g., -48V, 0V). Nickel plated copper lugs with inspection holes are permitted for inter-block connector cables.

5.10.8 NiCad battery hardware shall be supplied by the manufacturer.

5.10.9 NiCad battery connections shall be torqued to 50 inch-pounds for NCX product line and 96 inch pounds for the Tel.X product line.

5.10.10 A thin film of NO-OX-ID “A” anti-corrosive compound shall be used on all external battery connections.

5.10.11 NiCad batteries contain a corrosive alkaline electrolyte solution that shall be neutralized with a special NiCad spill kit (which is labeled in bright orange). Spill kits for flooded lead acid batteries do not contain the correct neutralizing absorbent for NiCad batteries, and the lead acid battery safety equipment shall not be used when cleaning up a NiCad electrolyte spill due to the potential of a dangerous chemical reaction.

5.10.12 NiCad batteries can release hydrogen gas, and the same safety precautions regarding gassing and explosion hazard apply to NiCad as flooded lead acid battery installations (see 3.2.2).

5.10.13 NiCad batteries shall use constant voltage charging to maintain float voltage. Temperature compensated voltage control is not required.

5.10.14 High float current on a NiCad battery string is an indication of state of charge and state of health. Continuously high float current (8 to 10 times normal) may reflect that the battery is reaching end-of-life.

5.10.15 NiCad batteries shall only be recycled through the manufacturer.

5.11. **Alternative Battery Technologies**

5.11.1 Alternative battery technologies deployed in trial applications shall be installed with charge records per the manufacturer’s documentation.

6. **FLOODED LEAD-ACID STRING TRANSITIONS**

6.1. **General**

6.1.1 Prior to and during battery transition work, air flow in the battery area shall be at least two air changes per hour to eliminate the buildup of hydrogen gas.

6.1.2 The Installation Supplier shall ensure that temporary wiring for transition batteries is never less than two (2) # 4/0 AWG or one (1) 500 MCM for 1680 AH and smaller or two (2) 500 MCM for strings larger than 1680 AH.
6.1.3 The Installation Supplier shall ensure that the battery string to be transitioned has been on a stable float charge for at least 48 - 72 hours so that hydrogen gas release is minimal. Only one string shall be taken off-line at a time. When opening a string, the installation supplier shall cover cable ends by taping on a heat shrink cap after removing bolt assemblies.

6.1.4 When necessary, the transition string voltage shall be raised to adjust voltage differences to 0.05 volts or less. The AT&T ATS or GNFO representative must approve any decision to lower the plant voltage for a battery transition. The plant voltage shall never be lowered more than 2.0 volts from the normal float voltage for a -48 volt plant.

6.1.5 In all cases, the plant voltage shall be kept within the operating limits of the equipment served by the battery plant.

7. UPS SYSTEMS

7.1. General

7.1.1 See ATT-TP-76400 Section 12 for UPS requirements.

7.1.2 See sub-sections 3 through 6 for flooded lead acid and VRLA installation requirements that are applicable in UPS applications.

7.2. UPS EPO Switches

7.2.1 Where required, UPS EPO switches may be placed at the exits of the equipment rooms and at the exit or entrance of the UPS equipment rooms. Switches shall be adequately labeled, covered and protected from accidental activation. The EPO switches must lock in place to identify activation when depressed.

8. AC POWER DISTRIBUTION (DUPLICATE OF ATT-TP-76400 SECTION 12-8)

8.1. General

8.1.1 All AC wiring, conduit, power strips, and duplex receptacles shall be listed on the AT&T AC Power Distribution Minor Material List, meet the requirements of the National Electric Code (NEC), and be listed by a Nationally Recognized Testing Laboratory (NRTL).

8.2. AC Panels

8.2.1 A Power Service Cabinet (PSC) distributes AC power to non-essential loads such as computer terminals, comfort lighting, and general purpose duplex appliance outlets. It is powered from a House Service Board or larger capacity PSC. Depending on their purpose and building electrical system, PSCs may or may not be served via the essential bus.

8.2.2 A Power Distribution Service Cabinet (PDSC) distributes AC power to essential loads such as DC Power Plants, Inverters or UPSs. It is powered from the essential bus protected by the standby AC plant. PDSCs exclusively serve essential loads.

8.2.3 A Protected Power Service Cabinet (PPSC) distributes AC power to protected AC loads such as AC powered equipment and revenue producing billing / accounting systems. It is powered from AC Power Plants such as Inverters or UPSs.
PPSC is an AT&T defined term. These AC panel boards are given a variety of names by manufacturers such as Power Distribution Unit (PDU), Remote Power Panel (RPP) and Computer Load Switchboard.

8.2.4 AC test receptacle and equipment aisle lighting branch circuits shall be provided from a PSC that is served via the essential bus (i.e., protected by the standby AC plant).

8.2.5 Circuit Breaker additions to an existing PDSC shall be validated for the existence of available capacity. Additional distribution circuit breakers shall not be added to a PDSC where measured demand exceeds 80% of the primary supply circuit breaker. Installation Suppliers shall notify the responsible AT&T representative when the 80% levels have been met or exceeded.

8.2.6 The term “PPSC” shall be included in the labeled identification of all PPSCs located on the load distribution side of a UPS or inverter.

8.2.7 All distribution panel types shall have a nameplate that includes the distribution panel designation, input power source (supply panel designation), supply panel protection device rating, voltage and phases. (Reference Section L)

8.2.8 When a new distribution panel is installed in the PPSC architecture, the existing single line drawing shall be modified or created to reflect the changes and provided during the installation/completion of the job. (Reference Section L)

8.2.9 Work on AC circuits shall be performed de-energized whenever it is possible to do so without causing a service interruption. De-energizing a redundant circuit as part of an approved, planned SMOP during the maintenance window to perform work safely is not considered a service interruption. Work on energized circuits must be performed in compliance with Section B Protective Personnel Clothing and Equipment (PPE) requirements.

8.2.10 When work is being performed that requires removing the electrical potential from an operating circuit, the circuit shall be identified with a "Warning - Working on Circuit" tag at the AC source. The tag shall only be removed by the person performing the work. (a.k.a. "Lock-out, Tag-out").

8.3. **AC Cable and Power Cords**

8.3.1 AC power cords shall be used to extend power from AC outlets located under raised floors to AC powered equipment, outlet strips or PDUs. The data processing system shall be permitted to be connected to a branch circuit by the following listed means:

a) Flexible cord and attachment plug cap not to exceed 80 feet (24.4 m) in AT&T Controlled Environment locations.

   In AT&T Controlled Environment locations, when run on dedicated horizontal raceways, flexible cords and cables are limited to a maximum 50 ft. distance within the raceway. The vertical portion of the flexible cord or cable may be 15 ft. on either end, for a maximum flexible cord or cable length of 80 ft.

   Flexible cord and attachment plug cap shall not exceed 20 feet (6.0 m) for Outside Plant (OSP) and Customer Premise applications.

b) Cord set assembly. Where run on concrete deck below a raised floor or in dedicated overhead raceway designed for AC power use, cord set assembly shall be supported and
secured within 18 inches of terminations. Cords shall be secured at intervals not to exceed 4 1/2 feet and protected against physical damage. Where securing is not practical, cord set assemblies may be bundled and tethered.

8.3.2 All AC conductors, except AC power cords or Metallic Clad (MC) cable, shall be enclosed in a metal conduit, metal raceway or metal trough.

8.3.3 Metallic Clad (Type MC) cable is strictly limited to the following AC branch circuit applications:
   a) Factory installed within bay end guards.
   b) Within bay end-guards and bases to connect light switches or bay test receptacles. MC cable does not have a distance limitation in this application, but shall not have excessive slack or be coiled within the bay end-guard or base.
      1. Type MC cable shall not be installed within a cable rack or raceway containing any other cable.
      2. Where Type MC cable exits the end guard, it shall be limited to up to 3 feet maximum vertically and/or up to 3 feet maximum horizontally to the conduit junction box or panel.
      3. Where Type MC cable is secured horizontally under a cable rack, it shall be sewn to the cable rack at every cross strap.

Factory connectorized Type MC whips using snap on style compression fittings included in the AT&T AC Power MML are approved for use in these applications.

8.3.4 Type MC cable is prohibited for use in all other Network applications (feeder and branch circuit) not explicitly described above. e.g.,
   a) It is prohibited for use between a PDSC and a rectifier or rectifier shelf or bay.
   b) It is prohibited for use between a UPS or inverter fed PPSC and an AC powered network element, regardless of overhead distribution or under a raised floor.

8.3.5 Type MC cable may be used for certain building support applications outside the scope of ATT-TP-76300 (e.g., elevators, pumps, and motors).

8.3.6 Type AC cable is not approved in AT&T and is prohibited for all applications.

8.3.7 AC wire and cable shall be exclusively copper conductors.

8.3.8 A wire nut shall be used to cover the exposed end of all un-terminated AC conductors.

8.3.9 Wire nuts shall meet UL-94 V-1 oxygen index rating or better.

8.4. Conduit

8.4.1 Conduit shall be supported with material designed for the support of conduit, such as U-bolts, conduit clamps, conduit straps, etc. Hose clamps, cord, nylon tie wraps, and other similar material shall not be used to support conduit.

8.4.2 AC conduit troughs shall be mounted and secured per the NEC and local municipality.

8.4.3 Rigid Metal Conduit (RMC), Intermediate Metal Conduit (IMC), Electrical Metallic Tubing (EMT), Liquidtight Flexible Metal Conduit (LFMC), or Metallic Clad (MC) Cable shall be utilized for all AC circuits.
8.4.4 Non-metallic materials shall not be used as AC raceways.

8.4.5 RMC, IMC, and EMT shall be supported at intervals not to exceed 10 feet and shall be secured within 3 feet of each outlet box, junction box, device box, cabinet, conduit body, or other termination. Securely fastened outlet boxes, junction boxes, device boxes, and cabinets are considered supports.

8.4.6 Standard compression fittings are required. “Rain-tight” or “wet location” (per UL 514B, typically designated “RT”) compression fittings are not required. Set screw fittings are prohibited.

8.4.7 LFMC is permitted where flexibility is necessary after installation. LFMC shall be supported and secured at intervals not to exceed 4½ feet and shall be securely fastened within 1 foot of each box, cabinet, conduit body, or other termination. Securely fastened boxes, cabinets, and conduit bodies are considered supports. Specific applications where LFMC is permitted:

a) All final AC powered equipment connections (LFMC whips are 6 feet maximum).

b) At a rectifier bay (6 feet maximum).

c) Conduit transitions from walls or columns in Seismic Zones 3 & 4 (3 feet maximum).

d) All final AC lighting fixture connections (6 feet maximum).

e) Within bay end-guards and bases to connect light switches or bay test receptacles. LFMC does not have a distance limitation in this application, but shall not have excessive slack or be coiled within the bay end-guard or base.

f) Between the power trough and the power strip or between the PDU and the AC powered equipment being served (6 feet maximum whip).

g) Between the junction box and engine/alternator set.

h) Under a raised floor, directly on the concrete deck in an established engineered pathway, or off the floor secured to the pedestals. In an existing line-up where existing LFMC is run unsecured and securing new runs is not practical, then bundling or tethering new runs may be permitted.

i) In dedicated overhead raceway designed for AC power use.

8.4.8 When conduit (including LFMC) must be secured over equipment areas, it may be secured to cable rack stringers or auxiliary framing using conduit mounting brackets designed for this purpose. No conduit shall be run on cable racks with other cable.

8.4.9 All conduit raceways, regardless of type, shall have an Equipment Grounding conductor installed with the feeder or branch circuit conductors, sized in accordance with Table 250.122 in the NEC.

8.4.10 The entire length of the metallic raceway, conduit or trough shall provide a continuous conductive path for grounding.

8.4.11 The Installation Supplier shall install bushings, nipples or connectors to protect wiring. Exposed AC conductors shall not be in contact with edges of metal frameworks, boxes or raceways (e.g. running through a knockout).

8.4.12 Enclosure support shall be as follows:
a) Enclosures without devices or luminaires may be supported by RMC, IMC, or EMT if the conduit is connected to the enclosure by threaded hubs, the threaded conduits enter the box on two or more sides, and are supported within 3 ft of the enclosure.

b) Enclosures with devices or luminaires may be supported by RMC, IMC, or EMT if the conduit is connected to the enclosure by threaded hubs, the threaded conduits enter the box on two or more sides, and are supported within 1½ feet of the enclosure.

c) Enclosures with threaded entries supported by only one RMC, IMC, or EMT raceway shall be secured to building structure or framing.

d) Enclosures with knock outs shall be secured to building structure or framing.

e) Enclosures shall not be supported by LFMC.

8.5. Appliance Outlets/ AC Test Receptacles

8.5.1 AC duplex test receptacles shall be provided in equipment line-ups in AT&T Technical Space. This includes Carrier Communications Space as well as Global Technical Space. Permitted exceptions where ac test receptacles are not required within the equipment line-up include:

a) In non-AT&T controlled facilities where the facility owner provides the test receptacles (e.g., POPs, collocation cages, customer premises).

b) In facilities or equipment rooms < 500 sq ft that are equipped with existing test receptacles in the walls, spaced a maximum of 12 feet apart.

8.5.2 In Stored Program Control System (SPCS) equipment, the duplex test receptacles will be provided as an integral part of the switching system in the maintenance area (e.g., MAP, MCC) only. Any appliance outlets added to any SPCS equipment shall meet all interface and grounding requirements of that SPCS equipment.

8.5.3 New equipment lineups outside of a SPCS shall utilize the Overhead Design in the front aisle, as shown in Figure #12-9. The Overhead Design provides for a single branch circuit using standard ½” EMT conduit and metal outlet boxes installed in the middle 2/3rd’s of the center of the front aisle, to serve both equipment line-ups.

8.5.4 EMT conduit and outlet boxes shall be secured mechanically (e.g., supported from below aux framing) in accordance with NEC Articles 314 and 358, and ATT-TP-76400 section 12 paragraph 8.4.5. ATT-TP-76400 Figure #12-9 summarizes NEC Article 310 and 358 distance requirements for securing EMT conduit and outlet boxes.

8.5.5 The first outlet box shall be required when the first relay rack / equipment bay / cabinet is installed in either of the two facing equipment line-ups. The first outlet box shall be located within 6 feet of the first bay or cabinet, measured from the center of the first bay or cabinet to the closest edge of the outlet box, linearly along the length of the aisle. The intent is to allow flexibility for use of existing aux framing for support of conduit and outlet boxes.

8.5.6 Spacing of outlet boxes shall be at approximately 10 feet intervals, corresponding to the use of standard 10 ft sections of EMT conduit between outlet boxes. The intent is to not cut a standard 10 ft section of EMT conduit to extend the Overhead Design, unless site conditions dictate, such as the need to change the elevation of the conduit run, or to avoid an obstruction. Where
obstructions occur, the maximum distance allowed between outlet boxes (edge to edge, measured linearly along the length of the aisle) shall be 12 feet.

8.5.7 Extensions of the Overhead Design shall be required when an equipment bay or cabinet is added - in either of the two facing aisles - where the center of the bay or cabinet is more than 6 feet from the edge of the closest existing outlet box, measured linearly along the length of the aisle.

8.5.8 When positioning aisle lighting with the Overhead Design for ac test receptacles, the position of the aisle lighting takes precedence. Conduit and outlet boxes shall be located to one side or the other of the aisle lighting, and not interfere with extension and placement of future aisle lighting fixtures.

8.5.9 In the Overhead Design, test receptacles and outlet boxes shall face down toward the floor, and be accessible.

8.5.10 Test receptacles shall not be deployed in the rear aisles of equipment line-ups.

8.5.11 Extensions of existing legacy overhead designs shall follow ATT-TP-76400 Figure #12-9 and paragraphs 8.5.3 through 8.5.10. If two overhead conduit runs exist (one for each equipment line-up), then only one shall be extended, transitioning to the center 2/3rds of the front aisle, to serve the growth of both line-ups.

8.5.12 Extensions of existing legacy Bottom of the Bay Designs shall transition to the Overhead Design, as shown in Figure #12-10. The transition riser shall utilize either LFMC or a Jacketed Type MC whip, and can be routed using the cable duct of the last equipped bay in the line-up. While vertical in the bay cable duct, nine cord may be used to tether the LFMC or Jacketed Type MC whip, if no means of securing is available. At the overhead junction box, transition riser must be secured per paragraph 8.4.7 (within 1 ft of the box). If two branch circuits exist (one for each equipment line-up), then only one shall be extended, transitioning to the center 2/3rds of the front aisle, to serve the growth of both line-ups.

Exceptions:

a) In 9' and 11’6” line-ups, the Bottom of the Bay Design shown in Figure #12-6 shall be followed, pursuant to paragraph 8.5.12 (c).

b) Where obstructions do not allow for transition to the Overhead Design, the Bottom of the Bay Design shown in Figure #12-6 shall be followed, pursuant to paragraph 8.5.12(c).

c) When only one (1) duplex test receptacle is required to finish the line-up, transition to the Overhead Design is not required, and the last duplex test receptacle shall be omitted, even if the 12 ft maximum distance limitation will be exceeded.

8.5.13 AC test receptacles shall be mounted flush and equipped with a metal cover plate.

8.5.14 The Installation Supplier shall ensure that the grounding and polarity of AC test receptacles are correct, verified and recorded on the test record.

8.5.15 The DESP shall provide the installer specific work items for placement of appliance outlets, outlet boxes, conduit, J-boxes, and risers.

8.5.16 Isolated ground receptacles (orange) shall not be installed.
8.5.17 Appliance outlets shall be NEMA rated per ATT-TP-76400 Table 12-10.

8.5.18 New 120Vac test receptacle branch circuits shall be 20A circuits using NEMA 5-20R duplex receptacles and #12 AWG wiring. Extensions of existing 120Vac test receptacle branch circuits shall utilize #12 AWG wiring and NEMA 5-20R receptacles, unless it can be verified that the branch circuit is protected by a 15A overcurrent protection device (where #14 AWG wire and NEMA 5-15R receptacles can be used).

8.5.19 The maximum number of duplex appliance outlets allowed on a general purpose / AC test receptacle branch circuit shall not exceed the number specified in ATT-TP-76400 Table 12-11.

8.6. Multi-outlet Power Strips

8.6.1 Multi-outlet Power Strips serve as the final point of AC distribution typically found in the corded AC powered equipment cabinet/bay.

8.6.2 Power strip shall be securely fastened to the cabinet/bay structure.

8.6.3 Depending on the configuration the protected power strip may be specified as horizontal or vertical mounting.

8.6.4 Separate A&B protected power strips shall be provided.

8.6.5 Each power strip shall be engineered with a dedicated branch supply circuit sourced from a PPSC and load managed, not to exceed 80% of the supply circuit breaker.

8.7. Branch Circuits

8.7.1 An Alternating Current Equipment Ground (ACEG) lead shall be provided with each AC branch circuit. When a conduit contains more than one AC branch circuit, one ACEG lead may be used if properly sized per the NEC.

8.7.2 AC test receptacles and equipment aisle lighting shall be placed on separate branch circuits.

8.7.3 When adding new branch circuits, or extending existing circuits, the Installation Supplier shall verify that no additional connection is made between the grounded conductor neutral (white wire) and the required green wire grounding conductor (ACEG).

8.7.4 Branch circuit conductors serving appliance outlets shall be sized per ATT-TP-76400 Table 12-12.

8.7.5 From the panel source to the end appliance outlet, the length of the branch circuit shall not exceed the limits specified in ATT-TP-76400 Table 12-13.

8.8. AC Circuit Protection Devices

8.8.1 Circuit breakers shall be sized and coordinated with system components to ensure proper isolation of feeders due to faults or overloads. Breakers shall be sized to allow all charge units to operate at full output during battery recharge.

8.8.2 Thermal breakers are acceptable for most applications and may be used unless prohibited by the equipment manufacturer’s documentation.
8.8.3 For equipment loads having start surges (such as those using large capacitors), it is recommended that thermal-magnetic circuit breakers be specified.

8.8.4 Circuit design shall not include circuit protection devices engineered in parallel.

8.8.5 Circuit Protection devices shall be engineered based on an 80% rating unless the circuit protector is rated at 100%. Therefore, the continuous load on a circuit breaker should not exceed 80% of its listed capacity. The circuit protection device shall be sized at 125% of the maximum equipment connected load.

8.8.6 Circuit protection devices installed in PPSC distribution cabinets shall be specified as bolt-on type rather than the clip-on type.
FIGURES M-1, M-2 AND M-3

A reproducible copy of a Pressure Test Record (Figure M-1), Storage Battery Charge Report (Figure M-2) and Pilot Cell Charge Report (Figure M-3) are provided on the following pages.
## PRESSURE TEST RECORD

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**Installation Supplier:**

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<td>Prior to initial Charge</td>
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M-32
## STORAGE BATTERY CHARGE REPORT

(Note: Refer to Pilot Cell Charge Report to complete charge interval readings)

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### Reading 72 Hours after end of initial charge

- **Date:**
- **Cell Number and Serial Number**
  - Crystal Cells (Round Cells: Y=Yes, N=No)
  - Volts In Excess Of 2.000
  - Temp in degrees °F.
  - S. G. In Excess Of 1.000 Corrected

### Float Reading at end of Charge

- **Date:**
- **Volts In Excess Of 2.000**
- **S. G. In Excess Of 1.000 Corrected**
- **Temp in degrees °F.**

### Initial Charge

- **Date:**
- **Hour of Charge**
- **Charge in Amps**
- **Cell Voltage**
- **S. G. Corrected**
- **Temp in degrees °F.**

### Average Cell Voltage

### Total Hours Of Charge

### Comments:

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<tr>
<td>6</td>
<td>5 hours</td>
</tr>
<tr>
<td>7</td>
<td>6 hours</td>
</tr>
<tr>
<td>8</td>
<td>7 hours</td>
</tr>
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<td>9</td>
<td>8 hours</td>
</tr>
<tr>
<td>10</td>
<td>Day 1 #1</td>
</tr>
<tr>
<td>11</td>
<td>Day 1 #2</td>
</tr>
<tr>
<td>12</td>
<td>Day 1 #3</td>
</tr>
<tr>
<td>13</td>
<td>Day 2 #1</td>
</tr>
<tr>
<td>14</td>
<td>Day 2 #2</td>
</tr>
<tr>
<td>15</td>
<td>Day 2 #3</td>
</tr>
<tr>
<td>16</td>
<td>Day 3 #1</td>
</tr>
<tr>
<td>17</td>
<td>Day 3 #2</td>
</tr>
<tr>
<td>18</td>
<td>Day 3 #3</td>
</tr>
<tr>
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</tr>
<tr>
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<td>22</td>
<td>Day 4 #3</td>
</tr>
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<td>23</td>
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<td>24</td>
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</tr>
<tr>
<td>25</td>
<td>Day 5 #3</td>
</tr>
<tr>
<td>26</td>
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</tr>
<tr>
<td>27</td>
<td>Day 6 #2</td>
</tr>
<tr>
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<td>29</td>
<td>Day 6 #3</td>
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<td>Day 7 #1</td>
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<td>31</td>
<td>Day 7 #2</td>
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<tr>
<td>32</td>
<td>Day 7 #3</td>
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<tr>
<td>33</td>
<td>Day 8 #1</td>
</tr>
<tr>
<td>34</td>
<td>Day 8 #2</td>
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<tr>
<td>35</td>
<td>200 hours</td>
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<tr>
<td>36</td>
<td>Day 9 #1</td>
</tr>
<tr>
<td>37</td>
<td>Day 9 #2</td>
</tr>
<tr>
<td>38</td>
<td>Day 9 #3</td>
</tr>
<tr>
<td>39</td>
<td>Day 10 #1</td>
</tr>
<tr>
<td>40</td>
<td>Day 10 #2</td>
</tr>
<tr>
<td>41</td>
<td>Day 10 #3</td>
</tr>
<tr>
<td>42</td>
<td>250 hours</td>
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**Installation Vendor Contact**  
**Telephone No.:**

<table>
<thead>
<tr>
<th>Person(s) making measurements:</th>
<th>Name</th>
<th>Initials</th>
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FIGURE M-4 – CONNECTING LAMINATED BUSBAR

EXAMPLE 6 INCH BAR – LAMINATED

EXAMPLE 6 INCH BAR – SINGLE LAMINATED
**FIGURE M-5 – BUSBAR SUPPORT DISTANCES**

**Typical 8 foot busbar support spacing**

- 3-½ to 4 feet

**Typical 8 foot busbar support spacing**

- 6 Feet Max

8 foot busbar support max spacing and cantilever

- 6 Feet Max

3 foot busbar

- 9" Max

- Insulators
- Aux Framing Channel
- Threaded Rod and hardware not shown
### TABLE M-3--CONDUCTORS FOR BUS DROP TO CELL POSTS

<table>
<thead>
<tr>
<th>Cells AMP HR Capacity</th>
<th>Conductors</th>
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<tbody>
<tr>
<td>8 HR Rate</td>
<td>Number</td>
</tr>
<tr>
<td>≤ 200Ah</td>
<td>1</td>
</tr>
<tr>
<td>&gt; 200Ah ≤ 420Ah</td>
<td>1</td>
</tr>
<tr>
<td>&gt;420Ah ≤ 840Ah</td>
<td>2</td>
</tr>
<tr>
<td>&gt;840Ah ≤ 1900Ah</td>
<td>4</td>
</tr>
<tr>
<td>&gt;1900Ah ≤ 4000Ah</td>
<td>4</td>
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</tbody>
</table>

**Note:** Table M-3 is based on one (1) hour and longer discharge rate and standard voltage drop scenarios for DC Power Plants.

UPS battery string cabling shall be sized to meet the UPS manufacturer’s specifications for ampacity (based on the appropriate battery discharge rate) and 2 volt loop maximum voltage drop.