Batteries
Central Office and Remote Installation and Maintenance

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1. General

1.1 Purpose

This practice describes the:

- Requirements for maintaining Central Office (CO) and remote battery cells.
- Requirements for maintaining CO and remote lead-antimony battery cells.
- Exceptions for maintaining lead-calcium battery cells.
- Safety precautions to follow when working with or around CO and remote batteries.

1.2 Filing Instructions and Supersedures

Discard all previous issues and associated addenda of this practice and file this issue numerically in your GTE Telephone Operations practices set.

This practice supersedes and cancels:

- All policies, procedures, general instructions, letters, and memoranda which address this subject.
- Any document which provides information contrary to the information contained in this practice.

1.3 Reason for Reissuing

This practice has been reissued to:

- Add Battery Rundown Test.
- Eliminate the Check Charge.
- Modify battery routines.
- Add new Exhibit 3 - Continuity Test, Form 00-205-0002.

1.4 Responsibility

This practice was published by the GTE Telephone Operations Enterprise Services Department. For more information about this practice, contact Headquarters Central Office Construction Support.

1.5 Disclaimer

This practice was prepared solely for the use of GTE Telephone Operations. It must be used only by its employees, contractors, customers, and end users when installing, operating, maintaining, and repairing GTE Telephone Operations' equipment, facilities and services. Any other use of this practice is forbidden. The information contained in this practice may not be applicable in all circumstances and is subject to change without notice. By using this practice the user agrees that GTE Telephone Operations will have no liability (to the extent permitted by applicable law) for any consequential, incidental, special, or punitive damages that may result.

2. Overview

2.1 Definitions

The following chart provides definitions for the acronyms and terms used in this practice.

Acronym or Term	Definition
A	Ampere
Absorbed Electrolyte	Electrolyte that has been immobilized in an absorbent separator.
AC	Alternating Current
Acceptance Test	A constant-current (or constant-Watt) capacity test made on a new battery to determine if it meets specifications or manufacturer's ratings. See Capacity Test, Performance Test, Discharge Test, and Service Test.
Accumulator	See Secondary Cell, Secondary Battery, Storage Battery, and Storage Cell.

(continued)

2.1 Definitions, continued

Acronym or Term	Definition
Active Material	The material in the electrodes (plates) of the cell that reacts chemically to produce electric energy when the cell discharges and which is restored to its original composition during the charge process. The active material in the positive and negative plate of the lead-acid cell is lead dioxide PbO_2, and sponge lead Pb, respectively. The active material in the positive and negative plate of the nickel-cadmium cell is nickel-hydrate Ni (OH)s, and cadmium sponge Cd, respectively.
Activation Charge	The process of making a dry-charged cell functional by introducing electrolyte and charging.
Ah	Ampere-hour
Ambient Temperature	The average temperature of the surrounding air that comes into contact with the battery; e.g., the battery room air temperature.
Ampere-Hour Capacity	See Rated Capacity, Capacity, and Watt-Hour Capacity.
Ampere-Hour Efficiency	See Battery Efficiency, Efficiency, Ampere-Hour Capacity, and Oxygen Recombination Efficiency.
Anode	The electrode in an electrochemical cell where oxidation takes place. During discharge, the negative electrode of the cell is the anode. During charge, this reverses and the positive electrode of the cell is the anode.
As Found (Condition)	A term used to inform the person performing a capacity test that the battery should be tested without performing certain checks, so that the test results reflect the effect (i.e., good or bad) of the maintenance practice followed for the installation.
Bar	See Intercell Connector, Strap, Negative Strap, and Positive Strap.
Battery	Two or more cells connected electrically. Cells can be connected in series or parallel, or both, to provide the required operating voltage and current levels. (Note: common usage permits this designation to be applied to a single cell used independently.)

(continued)

2.1 Definitions, continued

Acronym or Term	Definition
Battery Charger	An apparatus that is capable of restoring the charge of a secondary battery.
Battery Duty Cycle	The load (in Amperes or Watts) a battery is expected to supply for a specified time period(s). See Duty Cycle, Profile, Battery Profile, and Load Profile.
Battery Efficiency	The electrochemical efficiency, expressed as a percent, of the ratio of the Ampere-hour (or Watt-hour) output of the battery, to the Ampere-hour (or Watt-hour) input required to restore the initial state of charge. See Ampere-l-tour Capacity, Capacity, and Watt-Hour Capacity.
Battery Nominal Voltage	The nominal voltage of one cell multiplied by the number of ceils in the battery. See Nominal Voltage.
Battery Profile	See Battery Duty Cycle, Duty Cycle, Profile, and Local Profile.
Battery Rack	A structure used to support a group of cells. The most common rack material is steel with a coating to resist the corrosive effects of the cell's electrolyte, although racks made of polyester-reinforced fiberglass, wood, and concrete are in use. See Earthquake Rack, Rack, Seismic Rack, Seismic Stand, and Earthquake Stand.
Battery Stand	See Battery Rack, Earthquake Rack, Rack, Seismic Rack, Seismic Stand, and Earthquake Stand.
Boost Charge	An overcharge of arbitrary length. See Quick Charge.
Capacity	See Rated Capacity, Ampere-Hour Capacity, and Watt-Hour Capacity.
Capacity Test	A discharge of a battery to a designated terminal voltage. See Acceptance Test, Performance Test, Service Test, and Discharge Test.
Carbonization	(Pocket-Plate Nickel-cadmium cells) A condition where the electrolyte becomes contaminated with potassium carbonate (k_2CO_3) to a point where it influences cell performance.

(continued)

2.1 Definitions, continued

Acronym or Term	Definition
Cathode	The electrode in an electrochemical cell where reduction takes place. During discharge, the positive electrode of the cell is the cathode. During charge, this reverses and the negative electrode of the cell is the cathode.
CCV	Closed-Circuit Voltage
Cell	The basic electrochemical unit, characterized by an anode and a cathode used to receive, store, and deliver electrical energy. The cell is characterized by a nominal potential which is 2.0 Vdc for a lead-acid cell and 1.2 Vdc for a nickel-cadmium cell. (Common usage permits the use of the word Battery when referring to a cell although it is technically incorrect.)
Cell Connector	See intercell Connector, Inter-Step Connector, Inter-Tier Connector, Inter-Rack Connector, and Terminal Connection Detail.
Cell Temperature	The temperature at which a cell is operating. In the US, the reference for cell temperature is 25°C (77OF). (For flooded cells cell temperature is also called the Electrolyte Temperature.)
CEMF	Counter Electromotive Force
Charge	The conversion of electrical energy into chemical energy within a secondary cell.
Charged and Dry	See Dry-Charged cell.
Charged and Wet	A cell that is filled with electrolyte and fully charged.
Closed-Circuit Voltage	The voltage of a cell when it is discharging. See Initial Voltage and Working Voltage.
CO	Central Off ice
COE	Central Off ice Equipment
COEC	Central Office Equipment Construction
Connector	See Intercell Connector, Inter-Step Connector, Inter-Tier Connector, Inter-Rack Connector, Terminal Connection Detail, and Cell Connector.

(continued)

2.1 Definitions, continued

Acronym or Term	Definition
Constant Current Charge	A charge in which the current output of the charger is maintained at a constant value. Sometimes this can be accomplished using two-rate charging.
Constant Voltage Charge	See Constant Potential Charge.
Constant Potential Charge	A charge in which the potential (or voltage) at the output terminals of the battery charger is maintained at a constant value. See Constant Voltage Charge.
Container	See Jar.
Counter Cell	See Counter Electromotive Force Cell and Counter EMF Cell.
Counter Electromotive Force Cell	A cell with essentially no capacity, used to oppose the battery voltage. (Note: these cells are rarely used in battery installations today.) See Counter EMF Cell and Counter Cell.
Counter EMF Cell	See Counter Electromotive Force Ceil and Counter Cell.
Cover	The lid of a cell jar or of a multi-cell container.
Cutoff Voltage	See End Voltage, Final Voltage, and End-of-Discharge Voltage.
Cycle	A discharge and subsequent charge of a cell. Sometimes additional modifiers are used to describe how much of the cell's capacity was removed during the discharge, e.g., shallow cycle or deep cycle. Normally, a deep cycle implies that at least 80% of the cell's rated capacity was removed during the discharge portion of the cycle. See Deep Cycle and Shallow Cycle.
Cycle Life	The number of cycles, under specified conditions, that a battery can undergo before failing to meet its specified end-of-life capacity.
DC	Direct Current
Deep Cycle	See Cycle and Shallow Cycle.
Deep Discharge	See Discharge.

(continued)

2.1 Definitions, continued

Acronym or Term	Definition
Depolarization	A reduction in the polarization of an electrode.
Depolarizer	A substance or means used to prevent or decrease polarization.
Depth of Discharge	The Ampere-hours (or Watt-hours) removed from a fully charged battery, expressed as a percentage of its rated capacity at the applicable discharge rate.
Discharge	The conversion of chemical energy into electrical energy within a cell. Sometimes additional modifiers are used to describe how much of the ceil's capacity was removed during the discharge, e.g., Shallow Discharge or Deep Discharge. Normally, a Deep Discharge would imply that at least 80% of the cell's rated capacity was removed during the discharge. See Deep Discharge.
Discharge Rate	The rate in Amperes (or Watts), at which current (or power) is delivered by the battery.
Discharge Test	See Capacity Test.
DMM	Digital Multimeter
DOD	Depth Of Discharge
DOT	Department of Transportation
Dry-Charged Cell	A cell that has been assembied with its plates dry, and in a charged state, ready to be activated by the addition of electrolyte. This is normally done for ease in shipping or storage, or both. See Charged and Dry.
Duty Cycle	See Battery Duty Cycle, Profile, Battery Profile, and Load Profile.
Earthquake Rack	A battery rack that is designed for use in a specific seismic (i.e., earthquake) zone. In the US, the seismic zones are normally found in the Uniform Building Code (UBC). The zones are designated 0 (no seismic activity) to 4 (high-seismic activity), These racks are provided with extra equipment e.g., side-rails, end-rails and spacers which restrain the cells during a seismic event. See Seismic Rack, Earthquake Stand, Seismic Stand, Rack, Battery Stand, and Battery Rack.

(continued)

2.1 Definitions, continued

Acronym or Term	Definition
Earthquake Stand	See Earthquake Rack, Seismic Rack, Rack, Battery Rack, and Battery Stand.
Efficiency	See Battery Efficiency, Oxygen Recombination Efficiency, and Ampere-Hour Capacity.
Electrode	The site, area or location at which the electrochemical reaction takes place. See Plate, Positive Plate, Negative Plate, and Positive Electrode.
Electrolyte	A conducting medium in which the flow of electric current takes place. The electrolyte in a lead-acid cell is a solution of sulfuric acid (H_2SO_4) in water. The electrolyte in a nickel-cadmium cell is a solution of potassium hydroxide (KOH) in water (small amounts of lithium hydroxide can sometimes be added as well).
Electrolyte Temperature	See Cell Temperature.
Element	The positive and negative plate groups with separators, or with separators and retainers, and so forth, assembled for one cell.
EMF	Electromotive Force
End Cell	A cell that can be added to, or removed from a battery circuit to adjust the battery voltage. (Note: the use of end cells is a practice followed almost exclusively by the telecommunications industry.)
End-Of-Discharge Voltage	See End Voltage, Final Voltage, and Cutoff Voltage.
End-Of-Life	See Service Life and Useful Life.
End Voltage	The cell voltage at which the discharge is terminated. (Note: apart from the users' requirements, the minimum end voltage, as a function of discharge rate, is normally provided by the cell manufacturer.) See Cutoff Voltage, End-Of-Discharge Voltage, and Final Voltage.
EPDG	Equipment Power Distribution and Grounding

(continued)

2.1 Definitions, continued

Acronym or Term	Definition
Equalize Charge	An extended charge to a measured end point that is given to a storage battery to ensure that the complete restoration of the active material in all the plates of the ceils.
Equalize Voltage	The voltage applied during an equalize charge. This voltage is sufficiently high to ensure the local action of all the cells is overcome.
Faure Plate	See Pasted Plate and Flat Plate.
FCR	Floor Plan Cable Runway
FGB	Floor Ground Bar
Fiber Plate	See Fiber-Structured Plate.
Fiber-Structured Plate	A plate made of a porous, conductive, fiber mass, in which the active material is impregnated. Usually used for nickel-cadmium cells. See Fiber Plate.
Final Voltage	See End Voltage, Cutoff Voltage, and End-Of Discharge Voltage.
Flame-Arrestor Vent	A cell-venting device that prevents the propagation of an external flame into the ceil. See Vent and Valve.
Flame-Retardant Material	A material capable of limiting the propagation of a fire beyond the area of influence of the energy source that initiated the fire.
Flat Plate	See Pasted Plate and Faure Plate.
Float	See Full-Float Operation, Float Charge, Floating, and Float Charging.
Float Charge	See Full-Float Operation, Float, Floating, and-Float Charging.
Float Charging	See Full-Float Operation, Float Charge, Float, and Floating.
Float Current	The current drawn by a cell that is being float charged. (Note: assuming the recommended float voltage is used, the ceil draws sufficient current to maintain itself fully charged.)

(continued)

2.1 Definitions, continued

Acronym or Term	Definition
Float Voltage	The voltage applied during full-float operation. This voltage is high enough to overcome local action of the cells and replace discharge losses caused by electrical load peaks, without overcharging the cells. See Normal Float and Normal Float Voltage.
Floating	See Full-Float Operation, Float, Float Charge, and Float Charging.
Flooded Cell	A cell design that is characterized by an excess of free electrolyte, and in which the products of electrolysis (i.e., gasses) and evaporation can freely exit the cell through a vent. See Wet Cell or Vented Cell.
FNC	Fiber Nickel-Cadmium
Formation	Electrochemical processing of a cell electrode (or plate) between manufacture and first discharge, which transforms the active material into its usable form.
Freshening Charge	A charge given to a battery following nonuse or storage. (Note: except for dry-charged cells, lead-acid cells in storage require freshening charges in accordance with the manufacturer's instructions.) See Initial Charge.
Full-Float Operation	Operation of a DC system with the battery, the battery charger, and the load all connected in parallel and with the battery charger supplying the normal DC load plus any self-discharge or charging current, or both, required by the battery. (The battery charger delivers current only when the load exceeds the charger output.) See Float, Floating, Float Charge and Float Charging.
Fully Charged (nickel-cadmium cells	The condition that exists following a long term constant current charge. (Note: constant potential charging might reduce capacity to some degree.)
Gassing	Evolution of gas by one or more of the plates in a cell. Gassing might result from electrolysis of water into hydrogen and oxygen within a cell during charging (normally near the end of a charge), from overcharging, or from local action.
Gelled Electrolyte	Electrolyte that has been immobilized by the addition of a gelling agent.

(continued)

2.1 Definitions, continued

Acronym or Term	Definition
Gravity	See Nominal Gravity and Specific Gravity.
Gravity Drop	The change in SG of the electrolyte for a lead-acid cell upon discharge of the cell.
Grid	A framework for a plate in a cell which supports or retains the active material and conducts the electric current.
Group	See Plate Group.
h	Hour
Hydration (lead-acid cell)	A condition caused by discharging a cell, and failing to recharge it in a timely manner. When this happens, the lead in the cell goes into solution forming lead-hydrate, rendering the cell useless.
ICV	Initial Cell Voltage or Individual Cell Voltage
Immobilized Electrolyte	Electrolyte that is retained by a gel or absorbent mat.
Initial Charge	The charge given to a new battery before placing the battery in service. See Freshening Charge.
Initial Voltage	The closed-circuit voltage at the beginning of a discharge. (Note: the value considered to be the initial voltage is that voltage measured after current has been flowing for a sufficient period of time so that the rate of change of voltage is essentially constant.) See Closed-Circuit Voltage and Working Voltage.
insulating Pin (pocket-plate type cells)	See Separator and Pin Insulator.
Integrity Test	A test used to detect conduction path problems (e.g., loose connections, high resistance connections).
Intercell Connection Resistance	The total electrical resistance of the connection between the terminals of two cells that are electrically connected to each other. It includes the resistance of the connector and the contact resistance at the point(s) of connection to the cell terminals.

(continued)

2.1 Definitions, continued

Acronym or Term	Definition
interceil Connector	An electrical conductor used to connect adjacent ceils on the same rack. Most often, the connector is copper bar which is lead-plated for lead-acid cells; however, for nickel-cadmium ceils the connector might be nickel- or cadmium-plated copper or steel bar. The connector might also be insulated copper wire, or may be lead for lead-acid ceils (where the manufacturer has made the connection between cells in the same multi-cell container). See Bar or Strap, although the word strap has another meaning related to a internal component of a ceil. See Also Positive Strap and Negative Strap.
Inter-Rack Connector	An electrical conductor used to connect ceils on two separate racks. Most often this connector is insulated copper wire. See Cell Connector, Inter-Step Connector, Interceil Connector, Inter-Tier Connector, and Terminal Connection Detail.
Inter-Step Connector	An electrical conductor used to connect two cells on different steps of the same rack. Most often this connector is insulated copper wire; however, in the past, plated copper bar was also used. See Cell Connector, inter-Rack Connector, lnterceil Connector, inter-Tier Connector, and Terminal Connection Detai l.
inter-Tier Connector	An electrical conductor used to connect two ceils on different tiers of the same rack. Most often this connector is insulated copper wire. See Cell Connector, Inter-Rack Connector, Inter-Step Connector, and Terminal Connection Detail.
Internal impedance	The resistance of a cell to an alternating current of a specific frequency.
internal Resistance	The resistance of a cell to an electric current, within a cell (i.e., the sum of the ionic and electronic resistances of the ceil components).

(continued)

2.1 Definitions, continued

Acronym or Term	Definition
Jar	The container which holds a cell or a group of cells. Common jar materials include thermoplastics; however, hard rubber is sometimes used as well and nickel-cadmium cells might even be in steel containers. Jars for flooded lead-acid cells are normally transparent to enable plate and sediment inspection. (See a container, particularly when it holds two or more cells in which case it is properly referred to as a multi-cell container.)
Jar-to-Cover Seal	The seal at the interface of the jar and cover.
k	Kilo (i.e., 10^3)
Lead-Acid Cell	A secondary cell in which the electrodes are made of lead and the electrolyte is a solution of sulfuric acid (H_2SO_4) in water. Lead-acid cells include pure lead cells (i.e., those with pure lead plates or grids) and lead alloy cells (i.e., those with lead alloy plates or grids) such as Lead-Antimony, Lead-Calcium, Lead-Selenium, and Lead Hybrids.
Lead-Antimony Cell	A lead-acid cell with plates or grids made from a lead-antimony alloy. See Lead-Acid Cell, Lead-Calcium Cell, Lead-Hybrid Cell, and Lead-Selenium.
Lead-Calcium Cell	A lead-acid cell with plates or grids made from a lead-calcium alloy. See Lead-Antimony Cell, Lead-Calcium Cell, Lead-Hybrid Cell, and Lead Selemium Cell.
Lead-Hybrid Cell	A lead-acid cell with plates or grids of one polarity (usually the positive) made from a lead-antimony alloy and plates or grids of the other polarity made from lead-calcium alloy. See Lead-Acid Cell, Lead-Antimony Cell, and Lead-Calcium Cell.
Lead-Selenium Cell	A lead-acid cell with plates or grids made from a lead-antimony alloy to which selenium has been added. Also see lead-acid cell.
load Profile	See Battery Duty Cycle, Duty Cycle, Profile, and Battery Profile.

(continued)

2.1 Definitions, continued

Acronym or Term	Definition
Local Action	The internal losses of a battery standing on open-circuit or on float charge, without considering any losses incidental to any discharge. See Self-Discharge and Standing Losses
LOI	Limiting Oxygen Index
M	Mega (i.e., 10^6)
m	Milli (i.e., 10^{-3}), minute
Maintenance-Free Cell	See valve-regulated sealed lead-acid cell. (Note: this term, although used frequently, is a misnomer.)
MGB	Master Ground Bar
Mixing Charge	A charge given after adding an appreciable amount of water, if reasonable mixing/diffusion is not expected under normal operation.
Modified-Plante Plate	A lead-alloy grid containing holes into which pure lead corrugated strip, which has been rolled into buttons (or rosettes), is placed.
Mossing (lead-acid cell)	The deposition of a sponge-like layer of lead on the negative plates or negative strap.
Multi-Cell Container	A multi-compartment container in which each compartment can contain an individual cell. See Jar.
Negative Electrode	See Negative Plate.
Negative Pillar	See Negative Terminal, Negative Pole, and Negative Post.
Negative Plate	The electrode to which current flows from the external circuit when the cell is discharging. See Negative Electrode.
Negative Pole	See Negative Terminal, Negative Pillar, and Negative Post.
Negative Post	See Negative Terminal, Negative Pillar, and Negative Pole.
Negative Strap	See Strap, Positive Strap, Bar, and Intercell Connector.

(continued)

2.1 Definitions, continued

Acronym or Term	Definition
Negative Terminal	The terminal toward which positive electric charge flows in the external circuit; i.e., from the positive terminal, when the cell discharges. See Negative Post, Negative Pillar, Negative Pole, and Positive Terminal. (Note: the flow of electrons in the external circuit is to the positive terminal and from the negative terminal.)
Nominal Gravity	The specific gravity of the electrolyte selected for the determination of the rated capacity of the cell when it is fully charged. (Note: this also implies that the cell temperature and the electrolyte level are at their respective reference points.) See Gravity and Specific Gravity.
Nominal Voltage	See Battery Nominal Voltage.
Normal Float	See Float Voltage and Normal Float Voltage.
Normal Float Voltage	See Float Voltage and Normal Float.
OCV	Open Circuit Voltage
OI	Oxygen Index
Open-Circuit Voltage	The voltage of a cell with no current flow in either direction after the cell has had time to stabilize. (Note: for a lead-acid cell this can be closely approximated by adding 0.84 to the nominal SG of the electrolyte of the cell.)
Overcharge	The forcing of current through a battery after it has been fully recharged.
Oxygen Cycle	See Oxygen Recombination.
Oxygen Index	The minimum concentration of oxygen, expressed as volume percent, in a mixture of oxygen and nitrogen that will just support flaming combustion of a material initially at room temperature. See Limiting Oxygen Index.
Oxygen Recombinant Cell	See Valve-Regulated Sealed Lead-Acid Cell and Oxygen Recombinant Cell.
Oxygen Recombination	A process whereby oxygen generated at the positive electrode recombines with hydrogen at the negative electrode to convert to water. See Oxygen Cycle.

(continued)

2.1 Definitions, continued

Acronym or Term	Definition
Oxygen Recombination Cell	See Valve-Regulated Sealed Lead-Acid Cell and Oxygen Recombinant Cell.
Oxygen Recombination Efficiency	A ratio of the quantity of oxygen recombined (at the negative electrode), to the total amount of oxygen generated (at the positive electrode), expressed as a percent.
PABX	Private Automatic Branch Exchange
Parallel	The term used to describe the interconnection of cells in which all the like terminals are connected together.
Pasted Plate	A grid (usually lead-alloy), filled with active material applied as a paste. See Flat Plate and Faure Plate.
PDU	Primary Distribution Unit
Performance Test	A constant-current (or constant-watt) capacity test made on a battery normally in the as-found condition, after being placed in service, to detect any change in the capacity determined by the acceptance test. See Capacity Test, Acceptance Test, Discharge Test, and Service Test.
Pillar	See Terminal, Positive Terminal, Negative Terminal, Post, and Pole.
Pilot Cell	A selected cell whose condition is assumed to indicate the condition of the entire battery.
Pin Insulator (pocket-plate type cells)	See Separator and Insulating Pin.
Plante Plate	A pure lead plate for a lead-acid cell in which the active material is formed directly from a lead substrate.
Plaque (pocket-plate type cells)	Individual pocket strips attached to one another and cut to the required plate height and width.
Plate	An assembly of active materials on a supporting framework grid, frame, or support strip. See Positive Plate, Negative Plate, and Positive Electrode.
Plate Group	An assembly of plates of the same polarity connected (usually in parallel). See Group.

(continued)

2.1 Definitions, continued

Acronym or Term	Definition
Pocket Plate	A plate in which the active material is held in perforated metal pockets on a support strip. Usually used for nickel-cadmium cells.
Point (of specific gravity)	One-thousandth (0.001) of SG; e.g., a 0.010 change in a SG would be a 10 point change.
Pole	See Terminal, Positive Terminal, Negative Terminal, Post, and Pillar.
Pole Bridge	See Strap, Bar, and Intercell Connector.
Positive Electrode	See Positive Plate, Negative Plate, and Electrode.
Positive Pillar	See Positive Terminal and Negative Terminal.
Positive Plate	The electrode from which current flows to the external circuit when the battery is discharging See Positive Electrode, Plate, Negative Plate, and Electrode.
Positive Pole	See Positive Terminal, Positive Post, and Positive Pillar.
Positive Post	See Positive Terminal, Positive Pole, and Positive Pillar.
Positive Strap	See Strap, Negative Strap, Bar, and Intercell Connector.
Positive Terminal	The terminal from which the positive electric charge flows through the external circuit to the negative terminal when the cell discharges. See Positive Post, Positive Pillar, Positive Pole, and Negative Terminal. (Note: the flow of electrons in the external circuit is to the positive terminal and from the negative terminal.)
Post	See Terminal, Positive Terminal, Negative Terminal, Pole, Pillar, Positive Pole, Positive Post, and Positive Pillar.
Post-to-Cover Seal	The seal between the post and the cover where the post penetrates the cover.
Profile	See Battery Duty Cycle, Duty Cycle, Battery Profile, and Load Profile.
PSB	Product Standardization Bulletin

(continued)

2.1 Definitions, continued

Acronym or Term	Definition
Quick Charge	See Boost Charge.
Rack	See Battery Rack, Earthquake Rack, Battery Stand, Seismic Rack, and Seismic Stand.
Rated Capacity (lead-acid cell)	The Ampere-hour (or Watt-hour) capacity assigned to a cell by its manufacturer for a given discharge time, at a specified electrolyte temperature and specific gravity to a given end-of-discharge voltage. See Capacity, Ampere-Hour Capacity, and Watt-Hour Capacity.
Rated Capacity (nickel-cadmium cell)	The Ampere-hour (or kilowatt-hour) capacity assigned to a cell by its manufacturer for a given discharge time, at a specified electrolyte temperature to a given end-of-discharge voltage. See Capacity, Ampere-Hour Capacity, and Watt-Hour Capacity.
Recombinant Cell	See Valve-Regulated Seated Lead-Acid Cell
Retainer	Any material which is used to prevent the loss of active material from the positive plate.
Reversal	A changing of the normal polarity of a cell.
Round Plate	A pure lead grid for a lead-acid cell which is filled with active material applied as a paste.
Rundown Test	A partial discharge test to a voltage other than the system designed end voltage. (Note: this type of test is frequently performed on UPS systems; however, it does not verify manufacturer's rated capacity nor does it guarantee the battery would be able to serve its load for the design duty cycle.)
s	Second
Sealed Cell	See Valve-Regulated Sealed Lead-Acid Cell, Recombinant Cell, Oxygen Recombinant Cell, Oxygen Recombination Cell, and Maintenance Free Cell.

(continued)

2.1 Definitions, continued

Acronym or Term	Definition
Secondary Battery	Two or more secondary cells connected electrically. Cells can be connected in series or parallel, or both, to provide the required operating voltage and current levels. (Note: common usage permits this designation to be applied to a single secondary cell used independently.)
Secondary Cell	An electrochemical cell that is capable of being discharged and then recharged. See Secondary Battery, Storage Cell, Storage Battery, and Accumulator.)
Sediment	The active material that separates from the battery plates and falls to the bottom of the jar.
Seismic Rack	See Earthquake Rack, Battery Rack, Rack, Seismic Stand, and Battery Stand.
Seismic Stand	See Earthquake Rack, Battery Rack, Rack, and Seismic Rack.
Self-Discharge	See Local Action and Standing Losses
Self-Discharge Rate	The amount of capacity reduction occurring per unit of time in a battery as a result of self-discharge.
Separator	An ionic permeable, nonconductive spacer used to prevent metallic contact between plates of opposite polarity within a cell. (Note: rather than a full separator, cells with pocket plates can use nonconductive insulating pins since the pocket plate surfaces do not have active material on them.)
Series	The interconnection of cells in such a manner that the positive terminal of the first is connected to the negative of the second, and so on.
Service Life	The period of time during which a fully charged battery is capable of delivering at least a specified percentage of its rated capacity. For most lead-acid battery designs this percentage is 80%. See End-of-Life and Useful Life.
Service Test	A special test of the battery's capability, as found, to satisfy the design requirements (battery duty cycle) of the DC system. See Duty Cycle Test and Profile Test.

(continued)

2.1 Definitions, continued

Acronym or Term	Definition
SG	Specific Gravity
Shallow Cycle	See Cycle and Deep Cycle.
Shallow Discharge	See Discharge.
Specific Gravity (SG)	The ratio of the weight of a given volume of electrolyte to the weight of an equal volume of water at a specified temperature. In the US, the specified temperature is 25°C (77°F). See Gravity and Nominal Gravity.
SSC	Siemens Stromberg Carlson
Stand	See Battery Rack, Earthquake Rack, Battery Stand, Rack, Seismic Rack, and Seismic Stand.
Standing Losses	See Local Action and Self-Discharge.
Stationary Battery	A secondary battery designed for service in a permanent location.
Storage Battery	See Secondary Battery, Secondary Cell, Storage Cell, and Accumulator.
Storage Cell	See Secondary Cell, Secondary Battery, Storage Battery, and Accumulator.
Strap	The component in a cell where all the plates of like polarity are joined. This term is sometimes used to refer to a plated copper bar type intercell connector. (For a nickel-cadmium cell this is often referred to as the pole bridge.) See Bar and Intercel I Connector.
sulfation (lead-acid cell)	A state where the battery has developed an abnormal amount of sulfate and its capacity is impaired. This is different from normal sulfate which occurs during discharge.
Taper Charge	A charge where both current and voltage decrease over the recharge period.
Terminal	The part of a cell to which the external circuit is connected. See Post, Pillar, Pole, Positive Terminal, and Negative Terminal.

(continued)

2.1 Definitions, continued

Acronym or Term	Definition
Terminal Connection Detail (lead-acid cell)	Connections made between rows of cells or at the positive and negative terminals of the battery, which might include lead-plated terminal plates, cables with lead-plated lugs, and lead-plated rigid copper connectors. See Cell Connector.
Terminal Connection Detail (nickel-cadmium cell)	Connections made between rows of cells or at the positive and negative terminals of the battery, which might include nickel- or cadmium-plated terminal plates, cables with nickel- or cadmium-plated lugs, and nickel- or cadmium-plated rigid copper or steel connectors.
Thermal Runaway	A condition whereby a cell on charge or discharge destroys itself through internal heat generation caused by high overcharge or over discharge current or other abusive condition.
Trickle Charge	A charge given to a battery with no external load connected to it, to maintain it in a fully charged condition.
Tubular Plate	A lead-alloy plate consisting of a top bar to which a set of spines (or core rods) are attached; a porous tube, which holds the active material, is fitted over each spine.
Two-Rate Charge	A charge in which two different charge rates are used, the first being higher than the second. The rate is usually changed from high to low when the battery starts gassing.
u	Micro (i.e., 10^{-6})
UPS	Uninterruptible Power Supply
Useful Life	See Service Life and End-of-Life.
V	Volt
Valve	A normally sealed mechanism which allows for the controlled escape of gasses from within a cell. See Flame-Arrestor Vent and Vent.

(continued)

2.1 Definitions, continued

Acronym or Term	Definition
Valve-Regulated Sealed Lead-Acid Cell	A cell that is sealed and fitted with a valve that opens to vent the cell whenever the internal pressure of the cell exceeds the pressure external to the cell by a set amount. See Sealed Cell, Recombinant Cell, Oxygen Recombinant Cell, Oxygen Recombination Cell, and Maintenance-Free Cell (although this is a misnomer).
Vdc	Volts Direct Current
Vent	A device that allows the escape of gasses from within a cell. See Flame-Arrestor Vent and Valve.
Vented Cel l	See Flooded Cell and Wet Cell.
Wet Cell	See Flooded Cell and Vent Cell.
Watt-Hour Capacity	See Rated Capacity.
Watt-Hour Efficiency	See Battery Efficiency.
Working Voltage	See Closed-Circuit Voltage.
VPC	Volts Per Cell
VRLA	Value-Regulated Sealed Lead-Acid Cell
VRSLA	Valve-Regulated Sealed Lead-Acid
W	Watt
Wh	Watt-hour

2.2 References

The following chart provides sources of supplementary information relating to this practice. The documents could be required for performing certain tasks.

See...	For Information About...
004-200-001	COE – Installation Quality
075-I 15-1 00	Central Office Chemical Bury Station, Description
082-302- 100	Crane, Floor, Hydraulic V-Master, Model VM-100, Description

(continued)

2.2 References, continued

See...	For Information About...
100-000-100	Test Equipment Calibration Guidelines
122-205-001	Battery Removal and Disposal
122-205-002	Lead-Acid Batteries – Spills and First Aid Procedures
200-001-000	Central and PABX Offices, Safety Precautions
200-001-004	Equipment Rooms, Housekeeping and Safeguards
200-002-700	Acceptance Test-Basic Equipment
205-005-l 00	Central Off ice Equipment, Battery Maintenance Safety Board
205-O 1 O-50 1	Telephone Storage Batteries, Discharge Tests for Ampere-Hour Capacity
205-O 1 O-502	CO and Remote Batteries, Method of Determining Reserve Capacity
205-l 01-701	CO and Remote Lead-Acid Batteries, Single Cell, Charging-Constant Current Method
244-25 1 -200	Numbering and Lettering for Power and Lighting
742-205-070	Battery Room or Area Ventilation Engineering Applications
795-805-071	Central Office Grounding System Engineering Applications
795-805-074	Central Office Grounding Inspections
342-205-500*	SSC Batteries Installation and Maintenance
PSB 3439**	Johnson Controls (JNCW) Batteries
PSB 3439.1**	Johnson Controis (JNCW) Battery Parts Miscellaneous
PSB 3439.2""	Johnson Controls (JNCW) Battery Racks
PSB 4754**	C&D (CDBT) Batteries
PSB 4754.0**	C&D (CDBT) Liberty 1000-2000 Battery

(continued)

2.2 References, continued

See...	For Information About...
PSB 4754.1**	C&D (CDBT) Battery Parts Miscellaneous
PSB 4754.2**	C&D (CDBT) Battery Parts Miscellaneous
PSB 4754.3**	C&D (CDBT) Racks Battery
PSB 4754.4**	C&D (CDBT) Racks Battery
PSB 4754.5**	C&D (CDBT) Rectifiers
PSB 4754.6**	C&D (CDBT) Miscellaneous
PSB 4754.7**	C&D (CDBT) System Distribution
PSB 4932**	Vallen (VENA) Safety Supply Battery Spill Kit
PSB 5145**	Exide (EXPI) Battery, Central Office
PSB 6734**	Battery Floor Mat

* Siemens Stromberg Carlson (SSC) is responsible for publishing this practice.

** Product Standardization Bulletins (PSBs) are published by the GTE Telephone Operations Standardization Management Department.

2.3 Forms for Acceptance and Maintenance

The following describes the forms and usage for battery plant installations and maintenance:

- Power Plant Hardware Acceptance Forms

  Power Battery plant acceptance is normally coordinated with acceptance of the switch/other hardware categories. The Basic Equipment form (Form 90002631) and the various parts relate to each core category requiring physical equipment acceptance. Form 90002631 is a dual-purpose form/checklist used for both quality reviews and acceptance. The forms are described in GTE Telephone Operations Practice 004-200-001, and the basic equipment acceptance test is described in GTE Telephone Operations Practice 200-002-700.

  The latest version of these forms can be obtained by accessing the Central Office Equipment Construction (COEC) Electronic Bulletin Board entitled HQ.COEI.NEWS Enter Scan *All* to review the bulletin board posting for:

  - Selecting and downloading the forms to a diskette to print later.

    OR

  - Selecting and printing the forms required.

  If PC or terminal access is not possible, order the forms from your local stationery storeroom.

2.3 Forms For Acceptance and Maintenance, continued

Form Number	Form Title
9000263 1	Acceptance CO Facilities – Basic Equipment (a seven-part form): A. Central Off ice Construction Quality Assurance or Equipment Acceptance COE Superstructure/Off ice Conditions B. Central Office Construction Quality Assurance or Equipment Acceptance COE Cable and Wire C. Central Office Construction Quality Assurance or Equipment Acceptance COE Power Installation D. Central Off ice Construction Quality Assurance or Equipment Acceptance Safety and Housekeeping E. Central Office Construction Quality Assurance or Equipment Acceptance Equipment Erection F. Central Off ice Construction Quality Assurance or Equipment Acceptance COE Administration G. Central Office Construction Quality Assurance or Equipment Acceptance COE Grounding, Isolation, and Protection

- Use the parts of Form 90002631 that apply to the particular work order-type equipment. At times, certain parts might not be required. When installed/completed, initial the applicable items in the space provided on the right-hand side of the forms. The individual items acceptance signoff on these forms can be optional for the COEC final inspection and Switching Service acceptance representatives, if mutually agreed. However, the individual items signoff provides for a more thorough audit trail if further investigation is required. The signoff on the Acceptance Formal Summary (Form 90002634) is the required controlling acceptance document.
- Record the initial installation and ongoing maintenance of battery and charger performance records on the Storage Battery/Charger Record (Form 90002456, Exhibit 2) described in this practice. Obtain this form from your local stationery storeroom.
- The Formal Summary for total work order/project acceptance is Form 90002634 described in GTE Telephone Operations Practice 200-002-700 and posted on the electronic bulletin board entitled HQ.COEI.NEWS.
- The power plant grounding and protection standards for new installation are shown in Form 90001528 in GTE Telephone Operations Practice 795805074. Obtain this form from your local stationery storeroom.
- The Continuity Test form (Exhibit 3) is not available online or from your local stationery storeroom. Obtain copies from the Central Office Construction Support group.

2.4 Manufacturer's Documentation

The requirements and specifications for installing, operating, and maintaining equipment differ among manufacturers. This practice is, therefore, intended to be generic. Always refer to the manufacturer's documentation for the equipment in question.

3. Battery Safety Precautions

3.1 Chemical Interaction

A lead-acid storage battery is an electrochemical device that produces direct current electricity through chemical interaction between:

- A clear liquid solution (electrolyte).
- Lead plates housed in the battery cell.

This chemical interaction also produces hydrogen gas, which might explode under certain circumstances. This practice provides specific steps for avoiding this hazard.

3.2 Potential Hazards

All batteries have four potential hazards:

- Voltage.
- Hydrogen gas emission.
- Body static.
- Battery acid (electrolyte).

To avoid injury, you must recognize and follow the guidelines presented in the following chart.

Potential Hazard	Prevention
Voltage	Take all necessary precautions to avoid contact with hazardous voltage. Some CO batteries carry voltages of up to 130 Vdc. Always wear rubber gloves when working with batteries.
Hydrogen gas emission	Provide adequate ventilation to prevent a potential explosion hazard that can occur when hydrogen gas accumulates near battery vents or ceilings. Refer to GTE Telephone Operations Practice 742-205-070.
Body static	Ensure that body static is not present before working on/maintaining batteries because the gases might trigger an explosion.

(continued)

3.2 Potential Hazards, continued

Potential Hazard	Prevention
Battery acid (electrolyte)	**WARNING: Avoid spilling or splashing electrolyte on skin or clothing or in eyes.** Electrolyte: • Burns skin. • Dissolves clothing. • Causes loss of eyesight.

IMPORTANT **Post the following in the battery area and in common locations, such as break rooms, bulletin boards, telephone stations, hallways, and entrances to the switching area:**

- **Address of the work location.**
- **Emergency telephone number to call for medical attention. (911 can be posted as an emergency telephone number.)**

3.3 Smoking Restrictions

Do not smoke in the following areas:

- Equipment rooms.
- Battery rooms.

Post NO SMOKING signs in all equipment and battery areas.

3.4 Precautions Before Installation and Maintenance

Before installing or maintaining batteries, read GTE Telephone Operations Practice 200-001-000 and observe the following precautions:

- Begin work on batteries only if the proper tools and safety equipment are available.
- Ensure that the battery's explosion-resistant venting devices are properly installed.
- Ensure that the metal racks are connected to the CO ground bar (Master Ground Bar [MGB] Floor Ground Bar [FGB]).

NOTE: **The battery rack ground (Lead 33) can be removed when installing/torquing battery connections. Verify ground potential, and do not leave the battery rack ungrounded.**

3.5 Precautions During Installation and Maintenance

When installing battery plants:

- Use only insulated tools and test products.
- Keep all unauthorized personnel outside the battery area.
- Strictly enforce no smoking regulations.
- Prohibit arcing and open flames in the battery area.
- Keep the tops of batteries clear of all tools and other foreign objects.
- Do not wear:
  - Rings.
  - Wrist watches.
  - Necklaces/chains.
  - Bracelets.
  - Large belt buckles.
  - Earrings.
  - Ties or loose-fitting clothes.
- Install earthquake bracing and protective insulation, as provided.
- Ensure that the procedures for freshening batteries have been performed.
- Ensure that the battery cell explosion-proof vents are installed.

Refer to Section 13 for precautions and procedures when maintaining batteries.

CAUTION: To eliminate the possibility of body static discharge before working on batteries that are on charge (equalize or float), touch the grounded battery rack. Touch the bolt at the battery rack grounding point to ensure proper discharge. After you have properly grounded yourself, put **on all required safety equipment, including rubber gloves, then start your work activity.**

When performing battery maintenance:

- Place a NO SMOKING sign in plain view on or near the battery rack.
- Have a supply of neutralizer readily available.
- Firmly seat and seal, at the base, any vents permanently cemented in place.
- Keep a container of soda and a bucket of water available for large acid splashes on the body, floor, or equipment.

NOTE: **Screw-type safety vents must be screwed down to a snug fit with no leakage through the seal.**

3.6 Lighting Requirements

Ensure that the lighting in the battery area is adequate when you perform battery maintenance. If necessary, use a flashlight with a plastic or rubber housing.

3.7 Ventilation Requirements

Be sure that the room is well ventilated when you install batteries. Refer to GTE Telephone Operations Practice 742205070 for guidelines on ventilating a battery room.

3.8 Charging Operations

Take frequent temperature readings during charging operations. Use the following procedure if the electrolyte temperature in the cells exceeds 110°F.

Step	Responding to Adverse Charging Operations
1	Discontinue charging operations immediately.
2	Notify your coach/coach/supervisor.
3	Continue charging later at a reduced rate. **NOTE: Do not allow cells to gas excessively during the charge. Excessive gassing is caused by charging too long or at too high a rate. Too much gassing breaks down the electrolyte and loosens active plate material.**

3.9 Power Board Meters

Use power board meters to check the voltage. When making float or equalizer adjustments, use calibrated Fluke 8060A or equivalent at battery terminals to make all voltage adjustments.

Power board meters must be adjusted yearly. To adjust a power board meter, compare it to a calibrated Fluke 8060A or equivalent, connected at the battery terminal.

NOTE: Send defective meters to the equipment shop or designated location for repair. Calibrate hand-held meters yearly by a qualified equipment center. Refer to GTE Telephone Operations Practice 100-000-l 00 for additional calibration procedures.

3.10 Battery Water

Store the water for battery maintenance only in nonmetal and nonconductive containers such as:

- Plastic.
- Rubber.
- Glass.

To bring the electrolyte to the required level, use only commercially available distilled/deionized water or water tested and approved by the battery manufacturer (see Section 4.1). Record all water added to each cell.

Impurity	Maximum Parts per 100,000	Maximum Parts per Million	Maximum Percent
Total Solids	35.0	350	0.035
Fixed Solids	20.0	200	0.020
Organic and Volatile	15.0	150	0.015
Calcium	4.0	40	0.004
Iron	0.4	4	0.0004
Nitrates	4.0	40	0.004
Chlorine and Bromine combined with Fluorine and Iodine -Total	4.0	40	0.004

NOTE: These figures apply to any distilled/deionized water used.

Exhibit 1 - Impurity Limits for Water Used to Replenish Electrolyte

3.11 Transferring and Mixing Acid

Never transfer acid from one cell to another to establish specific gravity in all cells. Notify your coach/supervisor if a wide variance in a specific gravity is present.

WARNING: **Observe these safety precautions when mixing electrolyte:**

- **Never place the electrolyte in a metal container or stir it with a metal object.**
- **Always pour the acid (sodium hydroxide) into the water gradually and stir gently to avoid splashing.**
- **Never pour the water into the acid because it will generate heat and can explode.**

Mix the electrolyte (acid and distilled water) or the sodium hydroxide for counter cells outdoors or in a welt-ventilated room.

3.12 Specific Gravity Readings

WARNING: Never remove the cell's explosion-resistant venting device to take SG or temperature readings.

When taking SG readings, place a gloved finger over the end of the hydrometer or refractometer dipstick when moving it from cell to cell to prevent the electrolyte from dripping on the batteries.

See Sections 4, 5, 10 and 13.

3.13 Sealed Batteries

During normal use, VRLA (sealed) batteries generally do not:

- Release hydrogen gas.
- Leak acid.

VRLA (sealed) batteries are:

- Safer than conventional lead-acid batteries.
- Designed to operate with less maintenance.

However, under abnormal operating conditions such as overcharging, damage, or high ambient temperature, the potentially hazardous conditions of hydrogen gassing or leaking electrolytes can occur.

3.14 Personal Protective Equipment

To ensure safe handling of batteries and to protect employees, the following protective equipment is required in all CO and remote battery areas.

Item	Type
Chemical burn neutralizer (three bottles)	ID 680918
Bicarbonate soda (one pound)	Baking soda (purchase locally)
Chemical (indirectly ventilated) goggles	ID 589367
Acid-resistant gloves	ID 589622
Protective apron	ID 589620
Acid gas respirator	ID 352775

Place these items near the batteries for quick access.

WARNING: Always wear goggles, gloves, and a protective apron (as described in the preceding chart) when working with batteries or electrolyte.

3.15 Battery Maintenance Safety Board

Keep an approved Battery Maintenance Safety Board at each battery maintenance location (refer to GTE Telephone Operations Practice 205-005-l 00). These boards allow easy access and convenient storage of:

- Chemical burn neutralizer.
- Personal protective equipment.
- Maintenance records.

CAUTION: Replace a bottle of neutralizer after it is opened. Replace the neutralizer before its expiration date, even if it was not opened.

3.16 Chemical Burn Stations

Chemical Burn Stations or a Battery Maintenance Safety Board must be available for emergency first aid at all battery locations and areas where cells or electrolyte are handled. Refer to GTE Telephone Operations Practice 075-l 15-100.

3.17 Emergency Spill Kits

CAUTION: The Emergency Spill Kit does not contain eye wash. Arrange to have three bottles of eye wash available at all times by ensuring that the Battery Maintenance Safety Board is also on-site.

Establish and maintain an Emergency Spill Kit (ID 345042, PSB 4932) at each Supply and Transportation location. Refer to GTE Telephone Operations Practice 122-205-002 for specific contents of the spill kit and instructions for using it.

The clean-up kit must be on-site when wet cell, DC-type batteries are:

- Warehoused.
- Transported.
- Installed.
- Removed.

Label the Emergency Spill Kits and attach a list that describes the contents. Refer to PSB 4932 and GTE Telephone Operations Practice 122-205-002.

3.18 First Aid for Battery Acid Splashes

CAUTION: Large skin burns and all eye injuries must be flushed with water or an approved chemical solution. See a physician for additional treatment as soon as the flushing is completed.

Electrolyte is corrosive and can destroy clothing and human tissue. When handling electrolyte, do **not:**

- Splash or spill electrolyte in your eyes.
- Splash or spill electrolyte on your skin or clothing.
- Take internally.

3.18 First Aid for Battery Acid Splashes, continued

If Electrolyte Is...	Then...
Splashed in the eyes	1. Start first aid immediately. 2. Flush the eyes with large amounts of tap water for 15 minutes. 3. if using chemical burn neutralizer, slowly flush the eyes with three bottles of neutralizer. 4. See a physician. **Note: Hold the eyelids apart to make sure the water or neutralizer washes all surfaces of the eyes and eyelids.**
Splashed on the skin or clothing	1. Remove all contaminated clothing immediately. 2. Flush the affected area with a large amount of water or chemical burn neutralizer until all traces of electrolyte are removed. 3. If large skin burns are present, see a physician.
Inadvertently taken internally	1. Call an emergency medical service immediately. 2. Do not induce vomiting. 3. Do not try to give anything by mouth to an unconscious person.

3.19 Shock Symptoms

WARNING: In cases of severe shock or extensive burns, the following shock symptoms might appear:

- **Rapid pulse.**
- **Sweating.**
- **Collapse.**

If shock symptoms occur:

1. Place the person on his or her back.
2. Elevate the person's feet.
3. Keep the person warm until emergency medical help arrives.

3.20 Leaking or Broken Cells

When a cell is leaking or broken, follow the instructions in GTE Telephone Operations Practice 122-205-002. The following steps, which are a shortened version of the procedures found in GTE Telephone Operations Practice 122-205-002 can be used in the absence of that practice.

Step	Handling Leaking or Broken Cells
1	Notify your coach/supervisor immediately.
2	Put on all the personal protective safety equipment provided.
3	Dam the spilled electrolyte with Technical Grade Soda Ash to: • Prevent damage to surrounding equipment. • Protect personnel.
4	Warn others of the hazard by putting out a barricade warning tape.
5	Neutralize the spilled electrolyte by continually adding Technical Grade Soda Ash until the fizzing stops. **NOTE: If possible, open doors and windows to increase ventilation when neutralizing. If ventilation is a problem, wear an Acid Gas Respirator (ID 352775).**
6	Use bicarbonate of soda to clean up small areas.
7	Clean up and place all contaminated material into plastic bags.
8	Contact the Safety Department's Area Environmental Compliance Staff to arrange for: • Replacing cells. • Disposing of hazardous materials. **NOTE: Keep a copy of GTE Telephone Operations Practice 122-205-002 inside the Emergency Spill Kit container for reference purposes (see Section 3.17).**

3.21 Transporting CO Batteries

When transporting CO batteries:

- Ensure that environmentally approved contractors are used.
- Perform the procedure in the following chart.

Step	Transporting CO Batteries
1	Check your state and Department of Transportation (DOT) regulations. **CAUTION: Do not transport damaged batteries that contain electrolyte. Contact the Safety Department's Area Environmental Compliance Staff for instructions on proper disposal procedures.**
2	Place batteries on cardboard-covered pallets.
3	Place cardboard or bubble-wrap packaging material between and on top of battery cells.
4	Use plastic banding and cardboard as reinforcement to band the batteries together, forming one unit.
5	Band the batteries to the pallet. **CAUTION: Ensure that the banding material does not prevent using a forklift to pick up the pallet.**

NOTE: Keep an Emergency Spill Kit on the vehicle when transporting CO batteries (see Section 3.17).

4. Tools and Materials

4.1 Requirements

Use the following tools and materials to install, remove, and maintain a set(s) of batteries.

Tools and Materials	Item ID	Notes
Hydraulic floor crane	ID 630930	
Steel strap cutter	ID 580980	
Movable battery hoist:		24" x 24" platform 1000-lb capacity lifts to 66" high. Overall size: 26" wide 80" high 38" long
• Manually operated	ID 862612	
OR		
• Approved for restricted access areas		Use standard equipment.
Digital Multimeter	Fluke 8060A or equivalent ID 631425	The meter must be able to display a typical 52.08 volt reading.
Hydrometer syringe	ID 880287	
Refractometer	ID 337718 (MISCO #7084VP	A quicker, efficient, and more accurate tool/method for taking specific gravity readings.
Thermometer for each set of batteries	ID 881199 or equivalent	The scale must have a correction for gravity from 77°F.
Battery/charger history form	Form 90002546, Storage Battery/ Charger Record (Exhibit 2).	
Type A No-Oxide Battery Terminal Grease	Quart-ID 881183 5 Gallon-ID 881185	
Battery filler		Use standard equipment.
Battery terminal wrench	ID 579385	
Torque wrenches (s" drive, inch pounds)	ID 579347	

(continued)

4.1 Requirements, continued

Tool and Materials	Explanation	Notes
Battery cleaning solution bucket	Use 1 lb of baking soda to 1 gallon of water (obtain locally).	
Neutralizer solution	ID 680918 or ID 589621	
Allen set screw wrenches, socket wrenches open, or box-end wrenches	ID 327551 ID 589628	1/2" x 9/16" 3/4" 17/32"
Acid-resistant gloves	ID 589622	
Protective apron	ID 589620	
Safety goggles	ID 881231	
Battery Maintenance Safety Board	ID 580345 (standard) ID 327542 (small) ID 327545 (portable)	
Battery floor mat	ID 314549 vinyl ¼" x 3' x L' ID 372172 vinyl x 4' x L' Refer to PSB 6734.	
Approved water	Water tested and approved by the battery manufacturer, or bottled distilled water that contains less impurities than the maximum limits shown in Exhibit .	See Section 3.10.
Midtronics Celltron Plus	ID 493981	Model CTP-M500
Alber Cell Corder	ID 450238	Model CLC-100

CAUTION: Do not use tap water.

4.2 Mounting Hardware

All mounting hardware (bolts, washers, and nuts) that connects to the battery post or connection plates on the battery post must be one of the following:

- Stainless steel.
- Bronze-lead plated.
- Brass stud/cast-lead cap.

5.1 Locating and Using the Hydrometer

Locate the hydrometer in the holder (if ordered separately by Engineering) and mount the hydrometer holder in one of the following locations:

- Near either end of the battery rack.

  OR
- On the Battery Maintenance Safety Board.

CAUTION: Do **not use the same hydrometer to check lead-antimony and lead-calcium cells. This can destroy the lead-calcium cells.**

NOTES:

- **Individual hydrometers must be dedicated to one battery string. Contamination can occur if hydrometers are shared among different battery types.**
- **Most cells have an electrolyte withdrawal tube in the corner of the cell. Use a hydrometer with a stem long enough to reach the bottom of this tube. Use the second sample taken from the withdrawal tube because the electrolyte in the tube is not representative of the electrolyte in the entire cell. For calcium cells, take SG readings 1/3 down from the top of the plates.**

When using a hydrometer, perform the procedure in the following chart.

Step	Using a Hydrometer
1	Because of slow electrolyte mixing, extend the hydrometer draw tube down to the last 1/3 of the distance below the top of the plates when you read specific gravity in a lead-calcium battery.
2	Fill and empty the hydrometer a few times.
3	Gently shake the hydrometer to free any gas bubbles from the surface of the float. NOTE: **Make sure that the float does not touch the barrel.**
4	Place the hydrometer at eye level.
5	Sight along the lower edge of the concave surface at the top of the electrolyte in the barrel. If possible, leave the hydrometer tube in the cell while reading it. Refer to Section 12.3 when recording the SG readings. **NOTE: If you must remove the hydrometer, cover the tip with a gloved finger to prevent a siphon effect from spilling electrolyte.**

5.2 Using a Refractomer

When using a refractometer, perform the procedure in the following char-t. Refer to the manufacturer's documentation provided with the unit.

Step	Using a Refractometer
1	Slide out dipstick in refractometer and insert it in battery cell.
2	Transfer drop of battery acid on refractometer prism.
3	Wipe dipstick clean with a rag.
4	Look into refractometer eyepiece and take reading with the attached View Point, a pushbutton-activated light source. Record the reading on Form 90002546 (Exhibit 2).
5	Wipe the refractometer prism clean with a rag.

5.3 Cleaning a Hydrometer or Refractometer

CAUTION: Rinse the hydrometer after use when the next reading will be more than a day later. Clean a hydrometer frequently according to the instructions in the following chart.

When cleaning a hydrometer or refractometer, perform the procedure in the following chart.

Step	Cleaning a Hydrometer or Refractometer
1	Disassemble the hydrometer.
2	Wash all parts with soap and water.
3	Rinse all parts thoroughly.
4	Use paper towels to dry all parts. **NOTE: To obtain accurate cell readings with the hydrometer, the inside of the barrel must be completely clean and dry.**

5.4 Using a Thermometer

When using a thermometer, perform the procedure in the following chart.

Step	Using a Thermometer
1	Allow approximately five minutes for the thermometer to adjust and register the electrolyte temperature accurately.
2	Read the temperature to the nearest degree.
3	Return the thermometer to the pilot cell (the cell with the lowest specific gravity).

5.5 Reading a Voltmeter

When reading a voltmeter, perform the procedure in the following chart.

Step	Reading a Voltmeter
1	Ensure that the meter has been calibrated per Section 5.6.
2	Ensure that there are good connections between the voltmeter and the cell terminals, including both of the following: • Test lead to the voltmeter. • Clip or test probe to the cell terminal connections. NOTE: **Do not deface the shipping date on the cell terminal posts with the test probes.**

6. Assembling and Installing the Battery Rack

6.1 Assembly and Installation

Assemble and install the battery rack according to the manufacturer's instructions packaged with the material and the site-specific floor plan drawing provided by Engineering. Perform the procedure in the following chart.

NOTE: **Before installing the battery rack, become familiar with:**

- **Section** 3 **of this practice.**
- GTE **Telephone Operations Practice 200-001-000.**

6. Assembling and Installing the Battery Rack

6.1 Assembly and Installation, continued

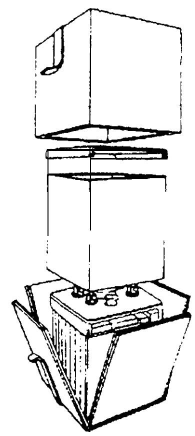
Step	Assembling and Installing the Battery Rack
1	To verify that the dimensions in the site-specific floor plan drawing can be met: A. Obtain the dimensions of the battery rack, cells, and other power room equipment from the manufacturer's manual. B. Verify the dimensions of the room and the location and size of any columns, bus ducts, or other structural components.
2	Assemble the battery rack according to the manufacturer's instructions.
3	Position the battery rack(s) as shown in the site-specific floor plan job drawing provided by Engineering.
4	Using a level, level the battery rack from end-to-end and from front-to-back. Shim as required (use steel shims 2½" x 2½" with diameter hole 1/16" larger than bolt size). You do not have to isolate the battery racks.
5	Anchor the battery rack to the floor through predrilled holes in the base of the rack in accordance with the battery rack manufacturer's instructions. **NOTE: In nonearthquake zones, it is acceptable to use two anchors (3/8" [I 0 mm] or ½" [12 mm]) at each end of the rack and stagger the anchors in the middle verticals. In earthquake zones, use at least 5/8" (16 mm) bolts in all mounting holes.**
6	Torque bolts (minimum SAE Grade 5) without lubrication as follows: • 3/8" – 20 ft-lbs. • ½" – 75 ft-lbs. • 5/8" – 150 ft-lbs. **NOTE: When channel or I-beam floor supports are used on sealed cells, use at least four floor anchors, one at each corner of the stack or string.**
7	Cover all stains, scratches, or bare metal on the battery rack with acid-resistant paint.
8	Glue or tie the rubber or plastic insulating strips (when provided) into the channels of the battery rack.
9	Install the provided earthquake bracing when required.
10	Ground metal battery racks in accordance with GTE Telephone Operations Practice 795-805-071. **NOTE: You can remove the battery rack ground (Lead 33) when you torque the battery connections.**

7. Unpacking and Inspecting Battery Cells

7.1 Unpacking Battery Cells

CAUTION: Do not tilt the batteries more than 15 degrees from the vertical position.

When unpacking battery cells, perform the procedure in the following chart.

Step	Unpacking Battery Cells
1	If battery cells are shipped in pallets, use steel strap cutters to cut the strapping bands that hold the cartons and pallets together.
2	Remove the tops and sides from the packing cases. **CAUTION: Always set the batteries down gently to avoid a shock to the ceil plates.** **Use caution to not crack the ceil covers or jars.** 
3	Cover all vents to prevent foreign matter from falling into the cells.

7.2 Inspecting Battery Cells

NOTE: Have the following items on hand when you inspect batteries:

- **Thermometer.**
- **Voltmeter.**
- **Hydrometer.**

7.2 Inspecting Battery Cells, continued

When inspecting battery cells, perform the procedure in the following chart.

Step	Inspecting Battery Ceils
1	Inspect the battery cells before and after unpacking to reveal any damage that might have occurred during shipment. **NOTE: If you notice any damage, notify your coach/supervisor.**
2	Inspect the battery cells for: • Cracks and/or leaks. • Buckled or warped plates. • Fallen separators. • Corroded terminals. • Broken or loose seal nuts around the positive and negative terminals. • Loss of electrolyte. (Observe indicator on jar.) **NOTE: A battery cell is considered damaged if the electrolyte level is more than ½" below the plates.** **NOTE: Do not place the cell in service. Notify the vendor, and file a Concealed Damage Report with the carrier.**
3	If a cell has a low electrolyte level and less than ½" of the plate is exposed, have the manufacturer add sulfuric acid of the proper specific gravity to produce approximately the same electrolyte level as in the other cells. **NOTE: If the electrolyte level is <u>above</u> the plates, do not add sulfuric acid or water.** **Add water only after:** • **The freshening charge has been applied (Section 10.4).** **OR** • **The required SG reading has been reached (Section 9.1, Step 4 and Sections 12.3 and 12.4).**
4	Check the seal between the jar and the top of the battery. If the seal is broken, contact the battery vendor for repair or replacement.
5	To reseal broken battery cells, follow the manufacturer-approved procedure.
6	Ensure that the voltage and specific gravity are not so low that the cell cannot be properly charged. Consult the battery manual or contact the manufacturer for more detailed information. **NOTE: If a cell is questionable, apply a trickle charge and retest it before placing the battery rack.**

8. Positioning the Battery Cells

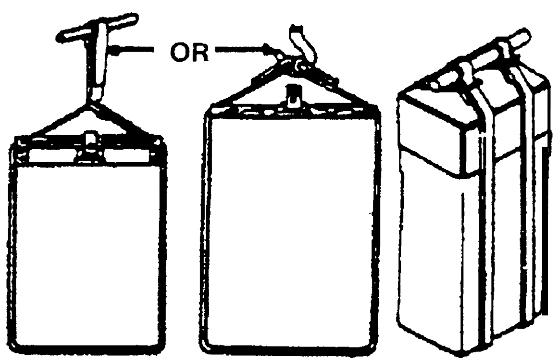
8.1 Lifting Battery Cells – Strap Method

CAUTION: Never lift a battery cell by its terminals. Always use straps with a hoist for batteries in a normal 24-cell or larger 26-cell office. To avoid spilling or dropping, do not lift the battery by hand.

Battery cells that weigh more than 50 pounds must always be moved by two people.

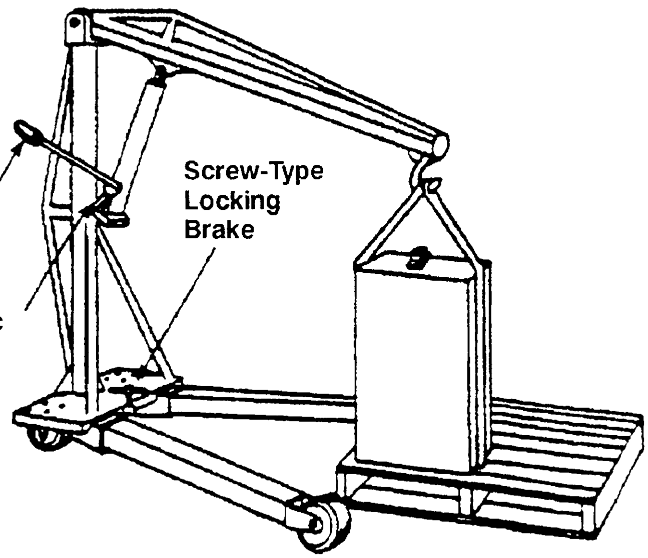
Check each battery cell for cracks and spilled electrolyte before removing the battery from the pallet. If any sign of damage is visible, notify your coach/supervisor.

When straps are available, follow either the manufacturer's instructions or perform the procedure in the following chart.

Step	Lifting Battery Cells – Strap Method
1	Place the straps under the battery cell according to the manufacturer's instructions.
2	Place the wood spreader on top of the battery cell with the beveled side up, as shown in this step. 
3	Follow the manufacturer's instructions to lift the battery cell by bar or hoist. **NOTE: One person must hold the battery cell to balance it during lifting.**
4	Remove the lifting straps when the battery cell is in place.

8.2 Using a Crane to lift Heavy Battery Cells

If the battery cells are heavy, lift them with a portable hydraulic crane according to the instructions in the following chart. Refer to GTE Telephone Operations Practice 082-302-l 00 for more detail.

Step	Using a Crane to Lift Heavy Battery Cells
1	Place the crane with the hook directly over the battery cell to be lifted.
2	Tighten the screw-type locking brake on the crane, as shown in this step. 
3	lower the boom to the correct level by slowly opening the hydraulic release valve.
4	Tighten the valve until snug.
5	Attach the hook to the battery cell strap as shown in Step 2.
6	Raise the battery cell to the required height by moving the pump handle up and down.
7	Release the screw-type locking brake on the crane, as shown in Step 2.
8	Roll the entire assembly to the battery rack.
9	Position the cell as indicated: A. Raise the cell to the required height. B. Move it into position.

(continued)

8.2 Using a Crane to Lift Heavy Battery Cells, continued

Step	Using a Crane to Lift Heavy Battery Cells
10	When the cell is directly over its position on the rack, lower it by slowly opening the hydraulic release valve.
11	When the battery cell is resting on the battery rack or floor, tighten the hydraulic release valve.
12	Detach the hook.
13	Remove the strap and wood spreader placed in Section 8.1, Step 2.

8.3 Using a Movable Battery Hoist to Lift and Move Battery Cells

CAUTION: Before using a movable battery hoist, ensure that it moves easily and that all controls are in proper working condition.

When you use a movable battery hoist to lift and move battery cells, perform the procedure in the following chart.

Step	Using a Movable Battery Hoist to Lift and Move Battery Cells
1	Always lower the hoist platform to its lowest position. Do **not** try to move the batteries onto the hoist if the platform is raised.
2	Place the cell in the center and to the rear of the hoist platform.
3	Position the hoist next to the battery rack, as near to the permanent position of the battery as possible, and slide the cell into place. NOTE: Use **a lubricant, such as soap flakes or baby powder, to help move the cells from the platform onto the battery rack.**

8.4 Placing Battery Cells on the Battery Rack

To place the battery cells on the battery rack, perform the procedure in the following chart.

Step	Placing Battery Cells on the Battery Rack
1	Place the battery cells on the battery rack. Refer to both the Floor Plan (FCR) and Equipment Power Distribution and Grounding (EPDG) job drawing (or equivalent) for cell locations, labeling, and cable information.
2	Place the battery cells in the center position **on** each tier of the battery rack.
3	Dust the rubber insulating strips with baking soda and glue them on the battery rack channels.

(continued)

8.4 Placing Battery Cells on the Battery Rack

Step	Placing Battery Cells on the Battery Rack
4	Space the battery cells properly on both sides. In earthquake configurations, do not forget to insert the foam plastic spacers between ceils. **NOTE: The spacing must conform to the length of the battery interconnecting straps furnished by the manufacturer.**
5	Center the first and last battery cell, from front to back, on each tier.
6	Stretch a piece of lacing twine tightly between the posts on the first and last cells for site alignment.
7	Align all intermediate battery cells (sighting) with the lacing twine.
8	Prepare a bicarbonate of soda solution in the proportion of one pound of soda to one gallon of water.
9	Wipe the battery cells with a cloth that has been dipped in the soda solution and partially wrung out.
10	Wipe the soda solution from the jars with a cloth that has been dipped in clear water and partially wrung out. **CAUTION: Do not allow the soda solution to enter a battery cell through the vent plug.**
11	In accordance with the numbering scheme shown on the site-particular EPDG and Floor Plan Cable Runway (FCR) drawings (see GTE Telephone Operations Practice 244-251-200): • Label each battery string (e.g., BATT-1, BATT-2, etc.). • Label each battery with the numbers provided by the manufacturer. • Use the labeling tool and ½" black labels to label Cell 1 with the battery number and initial freshening charge date. • Apply the factory-supplied negative (-) decals to Ceils 23 and 26. **NOTE: In a 24-cell system, apply the negative decal (-) only to Cell 24 and the positive decal (+) only to Cell 1.** • Using ½" labels, label Cell 1 with the in-service and the initial._- charge date. Battery cell numbers vary for each installation depending on: • The location of the charges. • The length of the battery string. • Other site-dependent requirements. When conditions permit, locate Cells 1 and 24 on the top tier. Position the cells so that the cables leaving the battery (positive and negative) are both on the side against the wall or nearest the splice plates. Follow the existing battery locations when adding to installations that were completed before 1966. Cell 1 is on the end of the bottom step or tier of the battery rack.

8.5 Floor-Mounted Batteries

Follow the existing battery locations when adding to installations that were completed before 1966. Cell 1 is on the end of the bottom step or tier of the battery rack. Set the floor-mounted batteries on the floor. To level them, use shims as required.

NOTE: Do **not fasten floor-mounted batteries to the floor.**

9. Intercell/Intertier Connections

9.1 Preconnection Process

Before interconnecting battery cells, perform the following preconnection process.

Step	Before Interconnecting Battery Cells
1	Remove the shipping plugs.
2	Install the explosion-proof vents. **NOTE: If battery cells are shipped with the vents in place, remove the tape and packing material.**
3	Install the filling funnels and dust caps.
4	Perform the following steps: A. Take a voltage and SG reading of each cell. • The open circuit voltage of the battery should be at least 2.0 Vdc per cell. • Batteries with an open circuit voltage of less than 2.0 Vdc per cell are **NOT** acceptable and should be referred to manufacturer's specifications. • Batteries with an open circuit voltage of less than 1 .O Vdc must not be recharged. 6. Record the readings. See Section 12.4. C. Note the correct polarity of each cell.
5	Perform the following steps: A. Identify the pilot cell with the lowest SG reading. B. Place the thermometer in the pilot cell. See Section 13.9.

9.2 Cleaning Battery Terminals and Straps

Battery terminals and straps must be:

1. Cleaned.
2. Moderately coated with Type A, No-Oxide Battery Terminal Grease.

All electrical contact surfaces must have a clean, bright finish protected by Type A, No-Oxide Battery Terminal Grease.

To clean battery terminals and straps, perform the procedure in the following chart.

Step	Cleaning Battery Terminals and Cells
1	Inspect the sides of each battery post if it contacts an intercell connector: • If discoloration or tarnishing is visible, remove the No-Oxide Grease with paper towels. • Clean the battery post surface with a plastic bristle brush or Scotch Brite® scouring pad to obtain a clean, bright surface.
2	Inspect both sides of the intercell connector straps where they contact a post.
3	If discoloration or tarnishing is visible, remove it with a plastic bristle brush. NOTE: Do **not use a wire brush, steel woof, or emery cloth to clean the connectors because they will damage the lead plating on the connector straps.**
4	Coat both sides of the contact points of the battery interconnect straps and all four sides of the battery post with a moderate coating of No-Oxide Grease. NOTE: **Heat No-Oxide Grease (if a hot plate is available) to about 160°F. Use a plastic bristle brush to apply a fight coat of grease to the contact points of the straps and to all sides of the battery terminal.**

9.3 Installing Battery Straps

To install battery straps between the battery cells, perform the procedure in the following chart.

Step	Installing Battery Straps
1	Do not close the last strap until you perform the proper tests to verify that: • All straps are properly connected. • There are no shorts or grounds. • All cells are connected with the proper polarity (see Section IO). • All filter capacitors in the chargers are fully charged if you are installing a new, off-line office with no old string.
2	Use an insulated torque wrench to torque the strap bolts and nuts to the manufacturer's specification. Refer to GTE Telephone Operations Practice 200-001-000. **NOTE: Torquing must be done on a dry bolt. If grease is present on the threads, wipe the bolt clean before you install the nut. Do <u>not</u> reduce the torque value to compensate for grease on the threads. Wipe *all* grease *off.*** **Within one month, perform a second torque of the connections using the initial torque value. All torque activity after the second torque is to be at a retorque value (maintenance).**
3	Remove any excess grease between the posts and straps. If the proper amount of grease was used, only a small bead of grease should remain at the edge of the strap against the post.
4	**WARNING: Insulate the battery terminal wrench to prevent possible injury when tightening terminal bolts. Do not overtighten and damage the threads in the nut or the lead plating on the strap. lighten the battery terminal bolts to the manufacturer's recommendations.** Perform subsequent torques yearly at 10 inch-pounds <u>less</u> than the original torque value. Refer to the battery manufacturer's instructions. **NOTE: For safety, the battery rack ground (Lead 33) can be removed while torquing battery connections. Remember to reconnect Lead 33 following the procedure.**

9.4 Performing Prepower Checks

When performing prepower checks, perform the procedure in the following chart.

Step	Performing Prepower Checks
1	After the straps have been installed, read the open circuit voltage of a few cells to get a representative reading.

If the Voltage Reading...	Then...
Adds up to 24 times (or 23, if it is a 23-cell system) the voltage of one cell (e.g., 2.05 x 24 cells= 49.2 volts)	The straps are correctly installed.
Is less than 24 times (or 23, if it is a 23-cell system) the voltage of one cell	A cell is strapped wrong and the condition must be corrected before power is applied.

Step	Performing Prepower Checks
2	Verify the electrolyte level. Refer to Section 7.2, Steps 2 and 3. **NOTE: The electrolyte should be above the plates and above the bottom of the explosion proof cap funnel system. To prevent overfilling, do NOT fill the cells with distilled water before the freshening charge because the level will rise during the charge.** **The batteries should be "topped off" with water near the end of the freshening charge and left on charge for a minimum of eight hours to accelerate the mixing. The gassing action helps mix the electrolyte.**

10. Voltages, Specific Gravity, and Records

10.1 Matching Voltages

The voltage of all cells must be matched after battery straps are installed, Perform the procedure in the following chat-t to match the voltage.

<table>
<tr><th>If...</th><th>Then...</th></tr>
<tr><td>The power plant and switch is new, off-line office with no old string</td><td>Perform the following:
Cable the chargers to the battery.
Install the last battery straps as described in Section 9.3.
Apply the charger power to the battery.
Charge the filter capacitors in the chargers according to the manufacturer's specifications.
NOTE: Charge the filter capacitors to prevent explosion or equipment damage due to differences in voltage potentials when installing battery straps.</td></tr>
<tr><td>Replacing or adding a single battery string to an existing battery plant</td><td>Perform the following:
Match the voltage of the new battery to the office voltage. This can be accomplished in one of two ways:
Raise the voltage on the new battery to match the office voltage.
OR
Lower the office voltage by reducing the charger voltage to match the voltage of the new office.
NOTE: Reduce the voltage on only as many chargers as needed to carry the office load. Turn off the remaining chargers during the transfer.
Use a portable charger to raise the voltage of the new string or take one of the on-line chargers off-line and use it for that purpose.
NOTE: Taking an on-line charger off-line is time-consuming and should be done only if no other alternative is available. This work must be performed during the maintenance window.</td></tr>
</table>

10.2 Testing Strap Conductivity/ Resistance

On additions or for maintenance, the strap conductivity test determines whether a connection is properly cleaned and torqued or if corrosion is present. Before conducting a strap conductivity test, the connections must be cleaned, greased, and torqued.

The strap conductivity test supplements the Torquing Tests process, and can be performed in one of two ways:

- Read the strap resistance (typically 50 micro-ohms, depending on the size of the battery plant), using a micro-ohm meter, with little or no current flowing through the strap.
- Take intercell and interior strap readings with a micro-ohm meter (such as Bittle 247000'").

  A typical intercell strap reading can be 50 micro-ohms depending on the size of the battery.

  OR

- Read the cell resistance with the Alber Cell or the cell conductance using the Midtronics Celltron Plus™

Convert intercell strap readings that were taken as a voltage drop to ohms (R=E/1) so they conform to subsequent readings (such as more current, more voltage drop):

- The first intercell strap readings are very important because they set the benchmark for future strap readings.
- The first readings are "best case" readings because the posts have just been cleaned and greased. Take a benchmark reading also for the inter-tier cables and power connections.
- The individual post-to-post intercell strap readings must not be more than 20% higher than the average reading of all straps. Place the probe in the center of each post.
- The intertier strap readings must not exceed four times the average intercell strap readings.

Take intercell and inter-tier strap readings with a micro-ohm meter (such as Bittle 247000).

A typical intercell strap reading can be 50 micro-ohms, depending on the size of the battery.

10.3 Checking Voltage Drop

When checking the intercell voltage drop, perform the procedure in the following chart.

NOTE: **Best results are obtained during battery discharge.**

Step	Checking Voltage Drop
1	When a micro-ohm meter is not available, take a voltage drop for each strap.
2	With the probes on the center of the battery posts, take voltage drop readings across each battery strap while equalizing the initial charge or under discharge conditions.
3	**The** voltage drop must not exceed 20 millivolts for straps and 80 millivolts for inter-tier cables during "full load" conditions. This is an ultimate maximum and generally reads much lower. It is critical that the strap readings do not vary more than 20%. NOTE: "Full **load" of a battery is calculated at the eight-hour rate. For example, a 1600-amp hour battery has a full load of 200 amps (1600/8).**
4	A linear scale can be used if a full load is not possible. If a full load is 200 amps and the actual load is 100 amps, reduce the allowable voltage drops by the same amount. In this case, the amount is 50%, or 10 millivolts for straps and 40 millivolts for inter-tier cables. **NOTE: A low reading indicates a good connection with minimum resistance.**

10.4 Freshening Charge Process

Battery ceils that are received from the manufacturer are full and charged.

CAUTION: **Do not allow antimony battery cells to remain dormant for more than 60 days without being charged. Calcium batteries must not go uncharged for more than 90 days and VRLA (sealed) must not go uncharged for more than 6 months. Give the battery cells a freshening charge as soon as possible with either a regular office charger or a portable charger.**

A freshening charge is needed because:

- Some of the charge is lost in storage.
- More of the charge is lost due to vibration during transport to the site.

10.4 Freshening Charge Process, continued

When applying a fresh charge, perform the procedure in the following chart.

Step	Applying a Freshening Charge
1	If possible to allow for a higher voltage, apply the freshening charge before the battery is placed on-line. **NOTE: Voltages of 0.05 above or below the average battery cell voitage during the freshening charge should level off within six months after the batteries are placed on float charge.**
2	Use the scale of voltage and time for the proper freshening charge voltage and duration shown in the chart in Sections 13.10 and 13.14: • Do not exceed 2.38 Volts per Cell o/PC). OR • Do not exceed 2.30 VPC for VRLA (sealed) cells. • Because power plants are normally set to shut down at 55 volts, temporarily adjust the high-voltage shutdown in the rectifier and/or smart power system higher when the charge voltage exceeds 55 volts.
3	Monitor the cell temperature continuously at the off-line, higher voltages, and do not let the temperature rise above 110°F.
4	If it is not possible or practical to do the freshening charge before the battery is placed into service, equalize the voltage so that it does not exceed the limits of the switch. **NOTE: Equalization takes much longer, but the cell temperature will not be as much of a problem as with the higher voltage.**
5	The freshening charge is complete when the: • Specified time has elapsed. OR • Cell readings have not changed on two consecutive intervals. Start the cell readings near the end of the specified freshening charge time.
6	Read the lead-antimony cells every two hours.
7	Read the lead-calcium cells every eight hours.

(continued)

10.4 Freshening Charge Process, continued

Step	Applying a Freshening Charge
8	Read the sealed cells every three hours NOTE: A sealed cell is considered fully charged when one of the following occurs: • The charge current remains constant for three consecutive hours. • The pilot cell voltage remains constant for six consecutive hours or two readings.
9	Keep the freshening charge readings on-site with the office battery records. NOTE: Always use the highest practical voltage rate to reduce the charging time.

10.5 Recording Initial Cell Readings

Record the cell voltage and SG readings as shown in the following chart.

Reading	When to Read
All cells	Before applying power to the battery.
The pilot cell	During the first 90% of the freshening charge.
All cells	During the last 10% of the freshening charge (at the end of the freshening charge while the battery is still on the freshening charge).
All cells	After the battery has been on float voltage for three days for lead-antimony and seven days for lead-calcium and sealed cells (voltage only on sealed cells).

CAUTION: Do not locate pilot cells:

- Near a window.
- Near a radiator.
- At the end of a row of ceils.

NOTE: Designate a new pilot cell, based on the cell with the lowest SG reading. For sealed cells, the ceil with the lowest voltage reading is the pilot cell. See Section 13.9 for information on pilot cell designation.

10.5 Recording Initial Cell Readings, continued

When charging batteries, perform the procedure in the following chart.

Step	Charging Batteries
1	Double the charging time if the temperature is 55 to 69°F.
2	Quadruple the charging time if the temperature is 40 to 54°F.
3	Apply the freshening charge at the maximum voltage that can be tolerated: • The voltage cannot be greater than 2.38 VPC average or 2.30 VPC for VRLA batteries. • The temperature of the battery must not exceed 1 10°F. Apply this charge for the period indicated in Section 13.14. Note the different constant charging time periods for lead-antimony compared to lead-calcium. Make voltage readings with an approved digital meter. **NOTE: All new batteries show deviations in cell voltage during a freshening charge. This condition, however, is normal as long as the specific gravity is between 1.200 and 1.220 after the charge is completed.**
4	After charging is completed, select the battery ceil with the lowest specific gravity for the pilot cell. This is not necessarily the same cell that had the lowest specific gravity before the freshening charge. If the selected cell is not the cell designated as the pilot cell before charging: • Update the battery record to reflect the new pilot cell. • Move the thermometer to the new pilot cell (see Section 13.9).

11. Power Equipment Threshold Values

11.1 Switch Operating Limit and Battery Type Reference Table

The following chart lists switch operating limits and battery types.

Switch Operating Limits	Lower	Upper	Calcium 12	Calcium 23	Calcium 24	Calcium 70	Antimony 12	Antimony 23	Antimony 24	Antimony 70	VRLA 12	VRLA 23	VRLA 24
SXS	44.0	54.0			X				X				X
1EAX	44.0	54.0			X				X				X
2EAX	44.0	54.0			X				X				X
GTD3	44.0	54.0			X				X				X
GTD5	43.0	56.0			X				X				X
4600	44.0	54.0			X				X				X
1AESS -24	20.8	26.5	X				X					X	
1AESS 48	44.0	52.5		X				X				X	
5ESS (Prior 10/94)	43.5	53.5		X				X				X	
5ESS (After 10/94)	40.5	55.0			X				X				X
DMS	43.8	55.8			X				X				X
DCO	44.0	56.0			X				X				X
4ESS -24	20.8	26.3	X				X					X	
4ESS 48	42.8	52.3		X								X	
4ESS -150V	144.0	755.0				X				X			
PAD MOUNT (NOTES 1, 2 & 4)													
(NOTE 3 - 5ESS)													

11.2 Battery Plant Dependent Threshold Values Table

The following chart lists battery plant dependent threshold values.

Battery Type	Rectifier Adjustments (NOTES 5,7 & 8) Float	Rectifier Adjustments Equal.	Controller Adjustments (NOTE 9) HV Sel. Shut.	Controller LV1 BoD (F1-1)	Controller LV2 Fl(If eqpd) (LV1-2)	Controller (NOTE 5) Float HV Shut. (FL+1)	Controller (NOTE 5) Equal. HV Shut. (Eq+1)	Power Bd Adjustments W.O. LV (Fl-1)	Power Bd Adjustments Contr HV (-.5HV Sel)
Calcium 12	26.5	26.5	27.5	25.5	23.5	27.5	27.5	25.5	27.0
Calcium 23	50.6	50.6	51.6	49.5	47.5	51.5	51.5	49.5	51.0
Calcium 24	52.8	52.8	54.0	52.0	50.0	54.0	54.0	52.0	53.5
Calcium 70	154.0	N/A	N/A	152.0	N/A	N/A	N/A	152.0	154.5
Antimony 12	26.0	26.3	27.0	25.0	23.0	27.0	27.0	25.0	26.8
Antimony 23	49.9	53.0	54.0	49.0	47.0	51.0	54.0	49.0	53.5
Antimony 24	52.1	54.0	55.0	51.0	49.0	53.0	55.0	51.0	54.5
Antimony 70	151.9	154.0	N/A	150.0	N/A	N/A	N/A	150.0	152.5
VRLA 12	27.0	27.0	28.0	26.0	24.0	28.0	28.0	26.0	27.3
VRLA 23	51.8	51.8	53.0	51.0	49.0	53.0	53.0	51.0	52.5
VRLA 24	54.0	54.0	55.0	53.0	51.0	55.0	55.0	53.0	54.5
(NOTES 3 & 4)									
Bell Cells 23	50.0	N/A	N/A	49.0	47.0	N/A	N/A	49.0	50.5
Bell Cells 24	52.1	N/A	N/A	51.0	49.0	N/A	N/A	51.0	52.5

11.3 Notes

The following notes apply to the tables in Sections 11.1 and 11.2:

1. The 914A will have a nonadjustable rectifier that will not adjust to meet these values.
2. The DMS OPM with the 8X02 autoboost unit will add 5 Vdc to the batteries. Sites with this feature will be floated at 52.5 Vdc until the feature is disabled.
3. The 5ESS switches and 5ESS remote equipment (normally engineered with 23-cell VRLA or 24-cell lead-calcium batteries) can be engineered to 23-cell battery strings for antimony-type batteries, including those locations sharing the battery plant with other switch types or technologies. Notify Engineering if the battery plant must be modified to meet this standard.

   NOTE: **Any 5ESS shipped before October 1994 has a voltage operating range of** 43.5 **minimum voltage and a maximum voltage of 53.0V at the PDCF. This requirement is based on the line card. 5ESS switches shipped October 1994 or later, voltage limits should be 40.5V minimum and 55.0V maximum at the PDCF. If using the VRLA batteries, 24 cells are valid for switches shipped after September 1994, but 23 cells are recommended for switches shipped before October 1994.**
4. Pad mount sites will have a 23- or 24-cell VR battery plant that will be floated at 54.0 Vdc (24 cell) or 51.8 Vdc (23 cell), except as stated in Notes 1 and 2. If gates batteries (no longer standard) have been issued, 24-cell plants require a float of 56 Vdc.
5. Under normal operating conditions, and with correct float voltages, lead-calcium or VRLA batteries do not need to be equalized. Normally, settings do not exceed the switch operating limit. See the manufacturer's documentation if equalization is required on these types of batteries normally set to the float value.
6. Some power equipment might allow only incremental voltage adjustments (either ½ or 1 volt). Settings should be made to the closest possible voltage in the preceding tables.
7. When rectifiers are used with a controller, the primary threshold settings for the rectifier HV shutdown are set and overridden by the controller. When this occurs, leave the rectifier backup HV threshold setting as set by the manufacturer.
8. When rectifiers are used without a controller, the same rectifier HV shutdown thresholds should be used for the selectable setting as were used for the controller equalize HV shutdown setting.
9. LV2 in a Smart Power System is the "Switch Disconnect Pending" alarm threshold. Adjust per LV2 threshold.
10. LVD for is 45 Vdc and the re-connect voltage is 50.5 Vdc.

12. Considerations for Maintaining Batteries

12.1 Floated Batteries Defined

Floated batteries are continuously connected to the charger system with which they are used. Except for momentary or emergency discharge, these batteries are normally kept fully charged by maintaining a constant voltage that results in a small net charge.

The float charge voltage is needed to:

- Replace internal cell losses
- Maintain the cells at full charge.

The float charge voltage is always the same for no-load or full-load conditions.

12.2 Trickle Rate

The trickle rate is the amount of current, generally less than one amp, that is siphoned off by the battery to maintain a full charge. This is determined by the cell voltage (e.g., 2.17 VPC for lead-antimony). If the load is 0, the required trickle rate becomes the total load for the charger.

The required trickle current is automatically provided when the proper voltage is maintained across the battery.

12.3 Specific Gravity Corrections

Maintain an adjusted specific gravity for each lead-antimony or lead-calcium battery, as shown in the following chart.

Battery Type	Charge Voltage	Specific Gravity (Adjusted)
Lead-antimony	2.17V	1.200 - 1.215
Lead-calcium	2.20V	1.210 - 1.215
VRLA	2.25V	N/A

NOTE: Because of slow electrolyte mixing, extend the hydrometer draw tube down to the last ⅓ of the distance below the top of the plates when you read specific gravity in a lead-calcium battery.

When using the hydrometer and thermometer (Sections 5.1 and 5.4, respectively), for each three degrees difference in electrolyte temperature, add or subtract .001, as follows:

- Subtract 0.001 for each three degrees below 77°F.
- Add 0.001 for each three degrees above 77°F.

For example, at 75°F the specific gravity for lead-antimony is 1.199; it is 1.219 for lead-calcium. At 80°F the specific gravity for lead-antimony is 1.201; it is 1.221 for lead-calcium.

For level correction, subtract 0.006 for each ¼" the level is below the top line, or the designated "full charge" line, if they are different.

NOTE: **The specific gravity corrections are not required when using the refractometer.**

12.4 Taking Cell Voltage Readings

Refer to Section 4 to determine the standard equipment for taking cell voltage readings.

Qualified personnel must calibrate the meters yearly (see Section 3.9).

With the proper voltage across its terminals, the actual charging current taken by the battery depends on the:

- Earlier load conditions that the battery had to meet.
- Temperature of the battery.
- Age of the battery.

If any unusual or unexplainable performance occurs:

- Report it to the coach/supervisor.
- Record it on the proper battery record sheet.

In most cases, battery trouble does not suddenly appear. Compare records periodically to locate battery problems before serious trouble develops. High or low cell voltage deviations are usually the first indications of trouble.

12.5 Voltages Below and Above Average

If voltages are continuously below or above average, the following conditions might develop. (Refer to Section 13.10 for recommended values.)

If Voltage Is Continuously...	Then...
Below recommended value	• Charging might be insufficient. • Low-voltage cells might develop. • Battery life is shortened. • Battery plates might sulfate (indicated by tiny sparkling spots on the plates).
Above recommended value	• Charging might be excessive. • Battery life is shortened. • Frequent additions of water might be required.

13. Procedures for Maintaining Batteries

13.1 Safety Guidelines

When performing battery maintenance, refer to Section 3.

13.2 Corrosion

Keep the battery racks and the cell terminals clean and free of corrosion.

Ensure that the battery rack(s) is grounded properly and check the grounding connections for corrosion. If the terminals become corroded, clean and coat them with Type A No-Oxide Battery Terminal Grease, as described in Section 13.3.

13.3 Cleaning Batteries, Cell Jars, and Covers

Keep the batteries free of dust and dirt. Keep all outside surfaces of the cells dry.

CAUTION: Do not clean plastic cell jars or covers with solvent, detergents, oils, or spray-type cleaners because these solutions might cause plastic material to craze and crack.

NOTE: Moisture tends to collect on the cell tops, causing a slight current flow between cell terminals. This robs the cells of their maximum float current.

Clean cell jars and covers periodically, according to the directions in the following chart.

Step	Cleaning Cell Jars and Covers
1	Use a water-dampened cloth to remove accumulated dust.
2	**CAUTION: Do not allow any of the solution to enter the cell.** Dampen a cloth with a solution of water and baking soda and apply it to the damp cell parts to neutralize the electrolyte. Use a mixture of one pound of baking soda and one gallon of water.
3	Continue to neutralize the electrolyte with the baking soda solution until the fizzing stops.
4	Wipe and dry the areas with a water-dampened cloth to remove the baking soda solution.
5	Wipe the cell parts dry with a clean cloth. **NOTE: When available, an approved battery-cleaning agent __ provided by the battery vendor can be used.**

13.4 Subsequent Strap Conductivity Tests

Conduct strap conductivity tests regularly. Perform the procedure in the following chart to ensure that the test results are accurate.

Step	Conducting Strap Conductivity Tests
1	Take intercell strap readings at least once a year, as directed in Section 10.
2	If a reading is more than 20% higher than the benchmark reading, check the connection for corrosion. If there is corrosion: WARNING: **Removing a battery strap is a high-risk activity and must be done during the maintenance window. The Maintenance coach/supervisor must consider the level of risk. When determining the precautions required before opening a battery strap, consider the following items:** • **A standby cell or string of batteries might be needed.** • **Bridging cables might be need to bridge around the cell being opened.** • **Use a standby generator to ensure that an AC interruption does not drop the office when running off the chargers.** • **The chargers must be on float and optioned for "battery eliminator" before the strap is removed.** A. Remove the strap. B. Clean, grease, and retorque the post and the strap.
3	If there is no sign of corrosion: A. Retorque the connections. B. Reread the intercell strap. **NOTE: If the connection is still bad, remove and clean the contacts as described in Section 9.2.**
4	If there is no record of a benchmark reading, take the average of three strap sets to establish a benchmark reading. Use this reading as a base for all subsequent readings.

13.5 Terminal (Post) Bolts

Check the terminal bolts yearly for tightness. Battery terminal bolts are often made of brass with hexagonal lead covers over the bolt heads to protect the brass from corrosion. The nuts might have similar covers.

Use the following guidelines when tightening the terminal bolts:

- Use nonconductive terminal wrenches to tighten the terminal bolts.
- Do not overtighten the bolts.
- Periodically check the torque values to maintain connection integrity. This requires a slightly lower value (IO inch-pounds less than the original torque value).

  NOTE: Continued overtorquing causes cold flow of the lead posts and distortion of the post.

- Refer to the manufacturer's specifications for subsequent torque values.

13.6 Low Electrolyte Level

Make sure that the electrolyte level is:

- Clearly visible.
- Within the required range.

Do not allow the electrolyte level to go below midrange. Refer to Exhibit 1 for the approved water used to fill the cells. Record all amounts of distilled water that you add to a cell.

NOTE: A low electrolyte level is usually caused by electrolysis and evaporation.

Refer to the following chart when correcting the electrolyte level:

If the Electrolyte Level is...	Then...
Low	Add commercially available distilled or deionized water (see Exhibit 1).
Consistently low	The cell is possibly being overcharged. Check and adjust the battery charger.

NOTE: If the electrolyte level is consistently low in all cells, the battery might be showing signs of age.

13.7 Voltage Deviations

Check the battery records for voltage deviations between cells. Voltage differences indicate damaged separators or other problems.

If...	Then the...
The record indicates that: • The battery is not fully charged • Other irregularities exist	coach/supervisor must take appropriate action to eliminate the problems with new or reused batteries.
A set of batteries is being reused	Old records must accompany the battery cells. **NOTE: Keep the old numbering scheme in the new installation.**

13.8 Gassing Cells

If the cells are old and gassing heavily on the float charge, ask for help with special capacity testing techniques to determine the live expectancy of the cells.

NOTE: If you suspect an abnormal condition, contact a qualified battery inspector from the battery manufacturer to inspect the battery.

13.9 Designating the Pilot Cell

The pilot cell is the one cell in each string of batteries:

- That has the lowest specific gravity.
- With the lowest voltage reading in a string of sealed cells.

To identify a pilot cell:

1. Assume that any cell whose specific gravity is too low to read on a standard hydrometer has the lowest specific gravity.
2. Identify the pilot cell on the battery record form. The pilot cell need not be labeled.

NOTE: The initial pilot cell is not necessarily the permanent pilot cell.

Take and record the voltage and specific gravity for the pilot cells each month.

CAUTION: Do not locate pilot cells:

- **Near a window.**
- **Near a radiator.**
- **At the end of a row of cells.**

13.10 Cell Voltage Table

Some cells might be above or below average. Use the following cell voltage table as a reference when adjusting the equipment to float or charge at the indicated levels.

CELL VOLT.	2 CELLS	3 CELLS	12 CELLS	23 CELLS	24 CELLS	26 CELLS	27 CELLS	66 CELLS	REMARKS
2.50	5.00	7.50	30.00	57.50	60.00	65.00	67.50	165.00	Note 5
2.45	4.90	7.35	29.40	56.35	58.80	63.70	66.15	161.70	Note 5
2.44	4.88	7.32	29.28	56.12	58.56	63.44	65.88	161.04	Note 5
2.43	4.86	7.29	29.16	55.89	58.32	63.18	65.61	160.38	Note 5
2.42	4.84	7.26	29.04	55.66	58.08	62.92	65.34	159.72	Note 5
2.41	4.82	7.32	28.92	55.43	57.84	62.66	65.07	159.06	Note 5
2.40	4.80	7.20	28.80	55.20	57.60	62.40	64.80	158.40	Note 5
2.38	4.76	7.14	28.56	54.74	57.12	61.88	64.26	157.08	Note 5
2.37	4.74	7.11	28.44	54.51	56.88	61.62	63.99	156.42	Note 5
2.36	4.72	7.08	28.32	54.28	56.64	61.36	63.72	155.76	Note 5
2.35 (Note1)	4.70	7.05	28.20	54.05	56.40	61.10	63.45	155.10	Equalize (Note 2)
2.34	4.68	7.02	28.08	53.82	56.16	60.84	63.18	154.44	Equalize for EC rectifier (Note 3)
2.33	4.66	6.99	27.96	53.59	55.92	60.58	62.91	153.78	Equalize for EC rectifier (Note 3)
2.32	4.64	6.96	27.84	53.36	55.68	60.32	62.64	153.12	
2.31	4.62	6.93	27.72	53.13	55.44	60.06	62.37	152.46	
2.30	4.60	6.90	27.60	52.90	55.20	59.80	62.10	151.80	
2.28	4.56	6.84	27.36	52.44	54.72	59.28	61.56	150.48	
2.28	4.52	6.78	27.12	51.98	54.24	58.76	61.02	149.16	
2.25	4.50	6.75	27.00	51.75	54.00	58.50	60.75	148.50	
2.20	4.40	6.60	26.40	50.60	5280	57.20	59.40	145.20	
2.17	4.34	6.51	26.04	49.91	52.08	56.42	58.59	143.22	Float Avg. (Note 4)

NOTES:

1. **In some COs, high voltage limits must be observed during battery equalization. These values can be too high, as in cases where 24 cells are used with no Counter electromotive Force (CEMF) cell in the discharge circuit.**

2. **Use this table when you apply check and equalizing charges to cells.**

3. **Use this table as a reference in COs where the rectifier cannot be raised to 2.35 VPC.**

4. **Use this table to check for a continuous float charge. These readings should appear across the battery terminals or on a standard voltmeter.**

5. **Use this table when applying a freshening charge to new or reused batteries.**

13.11 Float Charge

Floated batteries are continuously connected to the electrical system with which they are used. The batteries are normally kept fully charged (except for momentary or emergency discharge) by being constantly maintained at a voltage that results in a small net charge.

The float charge voltage is required to:

- Replace internal cell losses.
- Maintain the cells at full charge.

The voltage remains the same for no-load and full-load conditions. The chargers supply the load current, and the battery siphons off only the current needed to maintain a full charge.

Lead-calcium batteries require an average of 2.20 to 2.25 VPC to maintain a fully charged battery.

After prolonged discharge, lead-calcium cells require a longer restoration period to charge full than do other types of cells. The low gassing rate of lead-calcium cells prevents rapid mixing of the acid that is driven from the plates into the solution during cell charging.

Give a continuous float charge to batteries per the manufacturer's instructions.

The following chart shows the types of batteries and their respective float voltage.

Type of Battery	Float Voltage
Lead-antimony	2.17 Vdc times the number of cells.
Lead-calcium	2.20 Vdc times the number of cells.
VRLA (sealed)	2.25 Vdc times the number of cells.

Maintain this float voltage continuously across the batteries. Check the cell float voltage and corrected specific gravity quarterly

NOTE: Refer to GTE Telephone Operations Practice 205-001-500 for additional voltage and alarm threshold settings.

13.12 When to Apply an Equalizing Charge

CAUTION: Always check the voltage limits of the equipment before using a voltage that is higher than "float."

To determine when to apply an equalizing charge, follow the check charge parameters and guidelines in the following chart:

Type of Battery	Normal Requirements
Lead-antimony	• An equalizing charge once every month for 4 hours. • After known discharge, equalize for 2 hours. **NOTE: As the battery ages, it requires longer and more frequent equalizing charges.**
Lead-calcium	• An equalizing charge normally not required, batteries floated at the recommended nominal voltage (2.20-2.25 VPC). • Equalize when the lowest cell in the string drops more than 0.04 Vdc below the average float voltage. **CAUTION: For accuracy, do not take voltage readings of individual cells for at least 72 hours after completing an equalizing charge.**
VRLA (sealed)	• An equalizing charge when any cell voltage drops below 2.20 Vdc when floated at 2.25 VPC. A single cell charger adjusted to 2.30 Vdc. can be used to recharge the cell. • An equalizing charge after a known discharge reading.

An equalizing charge is required on antimony and calcium cells when:

- The corrected specific gravity of any cell is more than 0.010 below its full charge value. The nominal specific gravity is 1.215 at full charge unless otherwise indicated on the battery label. See the freshening charge record to determine the "full charge" specific gravity for each cell.
- Quarterly records show an increase in the spread between individual cell voltage and SG readings.

13.12 When to Apply an Equalizing Charge, continued

Sulfation, indicated by tiny particles of sulfur on the lead plates, appears if the battery has gone uncharged or low-charged for an extended time. If sulfation occurs, equalize until all signs of sulfation are gone.

NOTE: See **Section 13.11 for additional information.**

The following example illustrates the equalizing charge requirements for lead-calcium batteries:

- A C&D lead-calcium battery with a specific gravity of 1.210 has a minimum float voltage of 2.17 VPC.
- When floated at the minimum and when the voltage of any cell falls below 2.13 VPC, an equalizing charge is required.
- The nominal float voltage is 2.20 VPC.

NOTES:

- **Lead-calcium batteries might require a 2.30 VPC or higher equalized voltage for proper charging. When this voltage is used on a 24-cell system, however, it shuts down the chargers that are set to shut down at 55V, or it might be too high for connected equipment.**
- **Do not equalize a 24-cell system at 2.30V or higher, especially on-line systems, unless special precautions are taken.**

When floated at the nominal voltage, the battery probably will not need an equalizing charge.

Floating lead-calcium batteries at the nominal voltage IS advantageous. The required equalized voltage is usually higher than:

- Some connected equipment can tolerate.
- The voltage at which most battery chargers are set to shut down.

In addition to the guidelines shown earlier in this section, apply an equalizing charge as instructed in the following chart.

If the Voltage Across Any...	Is...
One-cell unit	0.05 Vdc or more below the average voltage of the cells.
Two-cell unit	0.10 Vdc or more below the average voltage of the cells.
Three-cell unit	0.15 Vdc or more below the average voltage of the cells.

If you must use a charge-limited voltage, raise the voltage to the maximum permitted to reduce the length of time on charge.

NOTE: **An equalizing charge may be recommended by the coach/supervisor when cell conditions show irregularities.**

13.13 Applying an Equalizing Charge to Lead-Antimony

Lead-calcium cells are constructed like lead-antimony cells. The grid structure for the plates in lead-calcium cells, however, is composed of lead and calcium. Calcium is the hardening agent for the lead grid that supports the active material of the plate.

To apply an equalizing charge to lead-antimony or lead-calcium batteries, perform the procedure in the following chart.

Step	Applying an Equalizing Charge to Lead-Antimony Batteries
1	Increase the voltage across the battery to a typical 54.00 Vdc, or 2.25 VPC for 24 cells and 2.35 VPC for 23 cells (refer to GTE Telephone Operations Practice 205-001-500). **NOTE: Ensure that the connected equipment is not voltage limited below the equalized voltage level.** A step-by-step CO might experience a slight change in timing and pulsing characteristics because of the higher equalized voltage.
2	Charge the batteries (1.215 SG) as indicated in the battery manufacturer's instructions, which are similar to the following chart.

Battery Type	Minimum Charge Time	Record Cell Voltage
Lead-antimony	48 hours at 2.25 Vdc	Every 2 hours

NOTE: Lead-antimony batteries are charged for 48 hours during a 1 -year period (see section 14.2).

Step	Applying an Equalizing Charge to Lead-Antimony Batteries
2 (cont.)	Record the cell voltage and the corrected specific gravity as indicated until the ceil with the lowest specific gravity maintains the same voltage and specific gravity for two consecutive readings.
3	Ensure that the corrected SG readings fall between 1.200 and 1.220 during the final portion of the charging process.
4	If necessary, return to float voltage during the charge if the office is unattended. This might require a longer equalizing charge time.
5	Monitor the battery temperature and discontinue the charge if the temperature rises to 110°F or higher, or if excessive gassing occurs. **NOTE: Ensure that there is adequate exhaust ventilation during the entire equalizing charge period.**

13.14 Applying an Equalizing Charge to Sealed Cells

Because the sealed cell is floated at 2.25 VPC, a higher charge can be applied only in a 23-cell system (2.35 VPC and so forth).

After the current has stabilized, equalize for a minimum of 12 hours. Equalization is complete when the lowest cell (pilot cell) voltage ceases to rise for either:

- Two consecutive readings.

  OR
- A period of six hours.

13.15 Applying an Equalizing Charge to End Cells

The equalizing voltage is divided by the number of cells to obtain the VPC reading. Three end cells, therefore, should be equalized at approximately 3 x 2.35-7.05 VPC.

NOTE: **It might not be possible to increase the voltage to 2.35 VPC. In this case, increase the voltage level as high as possible and continue the charge for as long as needed, until there is no increase in voltage or specific gravity for two consecutive readings.**

13.16 Setting the Float Voltage

Use a digital voltmeter (4½ digit Fluke 8060A or equivalent) to:

- Check or set the battery voltages.
- Set the float voltage.

NOTE: **Measure the voltage at the battery terminals to eliminate line loss to the power board.**

If evidence of an incorrect float voltage setting occurs (e.g., sulfation, gassing, or excessive use of water), perform the procedure in the following chart.

Step	Setting the Float Voltage
1	Check the battery voltage with a different meter.
2	Check the calibration of the original meter.
3	Notify your coach/coach/supervisor. NOTE: **Accurate float voltage is possible only if:** • **The voltmeters are correctly calibrated.** • **The voltage regulating equipment (rectifiers) is accurate.**

14. Routine Maintenance and Records

14.1 Instructions

Accurate battery records must be kept to:

- Compare the performance of batteries.
- Reduce the loss of batteries.

True battery conditions cannot be determined if any readings on these records are omitted.

Use a separate copy of the Storage Battery/Charger Record (Form 90002546, Exhibit 2) for each single cell measurement under the following charging methods:

- Float, specific gravity, and strap resistance readings.
- Freshening.
- Equalizing.

Use the back of Form 90002546 for:

- Battery string records.
- Pilot cell records.
- CEMF cell records.
- Battery charger records.
- Noise readings.

14.2 Battery Routines and Records

Keep the copies of battery records in the CO file until the battery is retired.

CAUTION: If a problem cannot be solved at the CO, follow the local telephone company procedures and seek assistance at once. Do not wait until the battery has a serious problem before reporting unusual conditions.

Refer to Section 10.5 for initial cell reading requirements. After the batteries are installed, maintain Form 90002546 as described in the following chart.

When	What to Do
Monthly	• Add approved water if needed. **NOTE: To ensure proper mixing of the electrolyte, do not add water to any cell for a period of 72 hours before taking SG readings.** **Individual hydrometers must be dedicated to one battery string. Contamination can occur if hydrometers are shared among different battery types.** • Clean the battery (see Section 13.3). • Record the amps per charger (see Area C on Exhibit 2). • Ensure that the proper load sharing exists between chargers (refer to GTE Telephone Operations Practice 795205075). • Record the total office current on the back of the form (see Area C on Exhibit 2). • Record the office float voltage on the back of the form (see Area A on Exhibit 2). – Water level (in inches from top line). – Temperature.

(continued)

14.2 Battery Routines and Records, continued

When	What to Do
Monthly, continued	• Perform monthly routines and readings. • Lead-Antimony 4 hours equalize charge routine. • Inspect the battery rack for corrosion, level, and grounding. • Inspect the cell flame arresters, seals, and jars for tightness, leaks, cracks corrosion, moisture, etc. • Inspect the cell plates for sulfation (sparkling spots on plates), buckling, plate growth, etc. • If the office has end cells, adjust the float voltage as follows. **NOTE: This routine should be performed only during hours of light traffic.** Turn off the chargers Observe the voltmeter and adjust the end cell switch to operate at 46 volts. Turn on the chargers. When the voltage returns to approximately 53.5 volts, the end cell switch and voltage should return to normal. Adjust if needed. • For all cells: Record the float voltage on the float voltage log (Form 90002546) (see Area A on Exhibit 2). **NOTE: When individual cell readings cannot be taken, as in the case of two- or three-cell units, enter the total voltage reading across these cells on Form 90002546. The cell numbers for the two- or three-cell units must be bracketed on Form 90002546 to enter the total voltage reading.**

(continued)

14.2 Battery Routines and Records, continued

When	What To Do
Yearly	• Record the battery string on the back of Form 90002546 in the month in which the measurement was made (see Area D on Exhibit 2): 1. Record the office battery noise while on float voltage. 2. Record the office equalizing voltage. • Complete all monthly routines. • Check intercell and intertier strap continuity, according to Section 13.4. Record the readings on Form 90002546 in the appropriate quarter in which the measurements were made (see Area F on Exhibit 2). • Retorque all battery connections to the retorque value or 10 inch-pounds less than the original torque value, regardless of the strap readings. • Equalize all antimony batteries for the minimum time, as stated in Section 13.13.

Maintain the following miscellaneous records and follow these directions:

- Maintain a record for each emergency or test discharge and each equalizing charge. Record the voltage approximately 72 hours after terminating the equalizing charge.

15. Procedures for Battery Rundown Test

15.1 Battery Rundown Test

The following chart describes the Battery Rundown Test.

CAUTION: **Do not perform this test if battery chargers have been off-line for any reason during the 48 hours before this test.**

NOTE: **Perform a Battery Rundown Test on all switching sites. Perform this test on an annual basis during the Maintenance Window. Fax a copy of the Continuity Test Form (See Exhibit 3) to the NOC-OLS Power at 972/615-3834. Perform this test only after all other routines have passed.**

Step	Action
1	Review the battery plant records for indications of a bad battery cell.
2	Inspect the batteries for loose cell strap connections or cable connections. Visually inspect cells for leakage or damage.
3	Place a DMM across the battery set closest to the PDU or battery distribution board. Place lead on positive post of cell #1 and negative post of cell #24 (#23 in a 23-cell system). Verify correct float voltage.
4	If there is a battery test gear such as an Alber Cellcorder™ or a Midtronics Celltron Plus ™ you should test the batteries before the Rundown Test.

Battery Type	Cells	Float Voltage	Equalize Voltage
Lead-antimony	23	49.91	54.00
Lead-antimony	24	52.08	54.00
Lead-calcium	23	50.60	Do Not Equalize Lead calcium or Valve Regulated Cells without Consulting NOC-OLS Power Group
Lead-calcium	24	52.80	
Valve Regulated	23	51.75	
Valve Regulated	24	54.00	

Step	Action
5	Turn off all battery plant rectifiers (chargers) and monitor the battery voltage as it drops. **Note:** **Do Not Allow Voltage To Drop Below** 46 **Vdc...Turn On Rectifiers At 46 Vdc.**

(continued)

15.1 Battery Rundown Test, continued

Step	Action
6	When the voltage drops from float voltage to approximately 48V and then builds up to approximately 49V and holds there (stabilized reference point), record this voltage activity on the Continuity Test Form (see Exhibit 3). NOTE: The time to reach the voltage stabilized referenced point may take anywhere from a few seconds to several minutes depending on office load and battery size.
7	Monitor the voltage for the recommended time periods on the Continuity Test Form and observe the voltage for 20 minutes beyond the stabilized reference point. Subtract this amount from the initial stabilized reference voltage. There should not be a difference greater than -0.1V. If there is, the discharge period probably will not last the calculated reserve time.
8	Turn on rectifiers and switch them to equalize mode for 24 hours so that the battery plant is restored to full charge. (Lead-antimony ONLY.)
9	Contact GTE Engineering for an evaluation of battery plant reserve capacity.

NOTES:

Sizing calculations (refer to GTE Telephone Operations Practice 795-000-073 for reserve time standards).

- Automatic start standby generator on premise = 3 hours battery reserve.
- Standby generator not on premise = 5 hours battery reserve.
- Remote/Inaccessible sites without standby generator = 8 hours or more battery reserve.

This calculation tells how long the battery should last at the load of the device if the batteries are in good health.

GIVEN:

- End cell voltage is 1.75 Vdc per cell.
- 77" F.

ASSUME:

- 1680 Ah battery.
- Actual load current drain is 210 amps.
- 0.80 represents 80% of battery capacity according to manufacturer specifications_

CALCULATION EXAMPLE:

- (1680x0.80)/210 = 6.4 hours expected reserve.

Battery life in pair gain sites is probably from three to five years due to weather conditions.

STORAGE BATTERY/CHARGER RECORD
FORM 90002546
REF 205-005-200
REF 795-205-075

SITE ______________________ STATE ______________________ YEAR ______________

		BATTERY DATA	
Battery string No.		Area/Op. Unit	
Manufacturer		Division/District	
Battery Part #		Initial Charge Date	
A. H. CAP (8 Hr.)		Installation Date	
Type (Ant., etc.)			

Type of Charge: ❒ Float ❒ Freshening ❒ Equalizing ❒ Check

E Quart

F Yearly

DATE / CELL NO.	Voltage								Specific Gravity (Corrected) *				Strap Reading (Vt. Res., etc.)			
	1st Quarter		2nd Quarter		3rd Quarter		4th Quarter		1 st Qtr	2nd Qtr	3rd Qtr	4th Qtr	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr
1																
2																
3																
4																
5																
6																
7																
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32																
33																

* **CORRECTION FACTORS:**

- **Correction for Electrolyte Level**

  Subtract .006 from the specific gravity reading for each 1/4" the electrolyte is below the high level line (or the designated 1.215 sg line if different) on the battery.

- **Correction for Temperature**

  Add .001 to the specific gravity reading for each 3 degrees Fahrenheit the electrolyte is above 77 degrees Fahrenheit.

  Subtract .001 from the specific gravity reading for each 3 degrees Fahrenheit the electrolyte is below 77 degrees Fahrenheit.

Exhibit 2 - Storage Battery/Charger Record, Form 90002546 (Front)

FORM 90002546

Monthly

D Quarterly

BATTERY STRING RECORD

MONTH	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
DATE												
Float Voltage												
Equalized Voltage												
Noise Reading												
Initials												

B Monthly

PILOT CELL FLOAT RECORD

MONTH	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
DATE												
Cell No.												
[redacted]												
Sp. Gr.												
W. Lev.												
Temp.												
Initials												

CEMF CELL RECORD (Wet Types Only)

Cell No.	1	2	3	4	5	6	7	8	9	10	11	12
1st Period Volts Drop												
2nd Period Volts Drop												

BATTERY CHARGER RECORD

nthly

INSTALL DATE	DATE → / Total Office Current / Charger # & Size												
		AMPS	AMPS	AMPS	AMPS	AMPS	AMPS	AMPS	AMPS	AMPS	AMPS	AMPS	AMPS
	1												
	2												
	3												
	4												
	5												
	6												
	7												

Readings By ____________________ Date ____________

Reviewed By ____________________ Date ____________

Readings By ____________________ Date ____________

Reviewed By ____________________ Date ____________

Readings By ____________________ Date ____________

Reviewed By ____________________ Date ____________

Readings By ____________________ Date ____________

Reviewed By ____________________ Date ____________

REMARKS

Exhibit 2 - Storage Battery/Charger Record, Form 90002546 (Back)

Continuity Test

form 00-205-0002 (2/97)

Site: ____________ **Exch:** ____________ Date: ________

Batt Manu: ________ Model: ________ # Cells: ______ Batt Type: ______

Batt A.H.: ________ Office Load; ________

(A.H. x .8) / Office Load = Reserve- ______ Hr.

Batt Date: ____________ String #: ____________ Float Volt: _

Start / V.D.C. ____________ **Stab - 20 =** ________ (Target **is** - .1 volt)

5 sec: ________ 20 sec: ________ 3 min: ________ 10 min: ________

10 sec: ________ Low Point: ________ 4 min: ________ 15 min: ________

15 sec: ________ 2 min: ________ 5 min: ________ 20 min: ________

Stab: ________

Warning - Do Not Allow Voltage to Drop Below 46 VDC

	5	10	15	20	LP	STAB	2	3	4	5	10	15	20
54 vdc													
53 vdc													
52 vdc													
51 vdc													
50 vdc													
49 vdc													
48 vdc													
47 vdc													
46 vdc													

Exhibit 3 - Continuity Test