

***Product Manual
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***Lucent Technologies
Lineage[®] 2000
ECS Battery Plant
(42-inch Framework)***

Notice:

Every effort was made to ensure that the information in this document was complete and accurate at the time of printing. However, information is subject to change.

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1 Introduction

General Information

The Lineage[®] 2000 family name of premier energy system products is globally recognized as the right choice for the ultimate in systems performance and reliability. Selecting this product brings the Lucent Technologies commitment to product and service excellence to your own telecommunications system. This long-standing Lucent Technologies commitment has been gained from years of worldwide telecommunications experience in the development, manufacturing, engineering, installation and servicing of leading edge energy systems, products and services.

This product manual (Select Code 167-790-028) is part of a set of product manuals which provide information on the Lineage[®] 2000 Evolutionary Control System (ECS) Battery Plant and its components, such as Controller, Rectifier, and Battery manuals. Each manual contains a technical description of the product, which is followed by detailed information on engineering, installation, operation and maintenance.

The complete set of documentation furnished with the Lineage[®] 2000 ECS Battery Plant consists of a plant manual, component manuals, and a set of related engineering drawings. The contents of the documentation package are identified for ordering and reference purposes in Section 3 of this manual.

Technical Support

Technical support for Lucent Technologies equipment is available to customers around the world.

***USA, Canada,
Puerto Rico, and
the US Virgin
Islands***

On a post-sale basis, **during the Product Warranty period**, our Technical Support telephone number 1-800-CAL RTAC (1-800-225-7822) provides coverage during normal business hours. Product Specialists are available to answer your technical questions and assist in troubleshooting problems. For out-of-hours EMERGENCIES, the 800 number will put you in touch with a Regional Technical Assistance Center Engineer via our 24 hour a day, 7 day per week Help Desk.

When Technical Support is required in **the Post-Warranty Period**, the service may be billable unless you hold an extended warranty or contractual agreement.

***Central and
South America***

If you need product technical support, contact your local Field Support/Regional Technical Assistance Center or contact your sales representative who will be happy to discuss your specific needs.

***Europe, Middle
East, and Africa***

If you need product technical support, contact your local Field Support/Regional Technical Assistance Center or contact your sales representative who will be happy to discuss your specific needs.

***Asia Pacific
Region***

If you need product technical support, contact your local Field Support/Regional Technical Assistance Center or contact your sales representative who will be happy to discuss your specific needs.

***Product Repair
and Return***

Repair and return service for Lucent Technologies equipment is available to customers around the world.

***USA, Canada,
Puerto Rico, and
the US Virgin
Islands***

For information on returning of products for repair, customers may call 1-800-255-1402 for assistance.

***Central and
South America***

If you need to return a product for repair, your sales representative will be happy to discuss your individual situation.

***Europe, Middle
East, and Africa***

If you need to return a product for repair, your sales representative will be happy to discuss your individual situation.

***Asia Pacific
Region***

If you need to return a product for repair, your sales representative will be happy to discuss your individual situation.

***Customer
Service***

For customer service, any other product or service information, or for additional copies of this manual or other Lucent Technologies documents, call 1-800-THE-1PWR (1-800-843-1797). Specify the select code number for manuals, or drawing number for drawings. Contact your regional customer service organization or sales representative for information regarding spare parts.

2 *Product Description*

Plant Specifications

**Table 2-A: Lineage[®] 2000 Battery Plant Specifications
(42-inch Framework)**

Input Voltage	180-264 Vac (208/240 Vac nominal)
Input Frequency	47-63 Hz (50/60 Hz nominal)
Operating Voltage	40-60.0 Vdc (48 Vdc nominal)
Float Voltage	47-58.5 Vdc (48 Vdc nominal)
Plant Current Rating	300 amperes
Plant Shunt	300 amperes maximum at 50 millivolts
LVD/R Voltage Settings	40.5 or 42.5 Vdc
Circuit Breakers	Type: KS23616 Available ratings: 10, 20, 30, 45, 60 amperes Interrupt capacity: 7000 amperes
Temperature	32-122°F (0-50°C)
Altitude	-200 to 13,000 feet (-61 to 3962 meters) For altitudes of 5000 to 13,000 feet, derate maximum temperature by 3.8°F per 1000 feet above 5000 feet. For altitudes of 1524 to 3962 meters, derate maximum temperature by 0.656°C per 100 feet above 1524 meters.

**Table 2-A: Lineage® 2000 Battery Plant Specifications
(42-inch Framework)**

Framework	Type: 3.5 foot frame (standard 23 inch relay rack) Horizontal mounting centers: 22.32 inches (567 mm)
Dimensions	Height: 42 inches (1067 mm) Width: 26 inches (660 mm) Depth: 18.5 inches (470 mm)
Weight	Bay: List 1 without rectifiers 120 pounds (54 kilograms) List 2 without rectifiers 140 pounds (63.6 kilograms) Rectifiers: 25 pounds (11.1 kilograms) each
Earthquake	Non-seismic
Heat Dissipation	Full load: 3080 watts (10,500 BTU/hr) Half load: 1680 watts (5730 BTU/hr) See Note 1
Humidity Rating	10% to 95% noncondensing
Audible Noise	65 dBA (See Note 2)
Electrostatic Discharge	IEC 801-2 Level 5 (15 KV) at 40% relative humidity
Radiated and Conducted Emissions	FCC Level A
Electromagnetic Immunity	10V/m over the range of 20 to 2000 MHz
Note 1: Specified at 54 Vdc, 300 amperes output, and nominal input voltages and frequencies.	
Note 2: Measured at 2 feet (0.6 meter) from the rectifiers installed in plant.	

Typical Battery Plant Description

A basic block diagram of a typical dc battery plant is shown in Figure 2-2. The battery plant accepts alternating current from the commercial utility or a standby ac power source and rectifies it to produce dc power for the using equipment. Control and alarm functions are provided by the plant to interact with the rectifiers and the office. In addition, the plant provides overcurrent protection, charge, discharge, and distribution facilities. Battery reserve automatically provides a source of dc power if the commercial or standby ac fails. This battery reserve is

engineered to supply dc power for a specific period of time. In normal practice, battery capacity is sized to provide 3 to 8 hours of reserve time.

Battery Plant Subsystems

Figure 2-2 illustrates the arrangement and interconnections of the typical dc battery plant subsystems from the ac input to the dc output. These subsystems are defined as follows:

AC Distribution: connects the commercial and/or standby ac power sources to the rectifiers within the plant and provides overcurrent protection. This subsystem is usually supplied by the customer.

Rectifiers: convert an ac source voltage into the dc voltage level required to charge and float the batteries and to power the using equipment.

Controller: provides the local and remote control, monitor and diagnostic functions required to administer the battery plant.

Batteries: provide energy storage for an uninterrupted power feed to the using equipment during loss of ac input or rectifier failure.

DC Distribution: provides overcurrent protection, connection points for the using equipment, and bus bars used to interconnect the rectifiers, batteries, plant shunt, and dc distribution.

ECS Battery Plant Physical Description

Introduction

The Lineage[®] 2000 Evolutionary Control System (ECS) Battery Plant is shown in Figure 2-1. The ECS battery plant provides power for the using equipment as well as float and recharge capability for the battery reserve. The plant operates from a nominal 208/240 Vac, 50/60 Hz source. It offers a 300 ampere total plant capacity with a nominal -48 Vdc output. The ECS battery plant is compatible with virtually all flooded and valve regulated batteries. In addition, the ECS plant is capable of operating in a batteryless mode, making it suitable for those applications where battery backup is not necessary or is

achieved through the use of an uninterruptible power supply (UPS).

The ECS battery plant uses state-of-the-art technology to achieve dramatic equipment size and weight reduction and to minimize maintenance. These advantages are realized by the application of Switch-Mode Rectifier (SR) technology and a unique plug-in rectifier design.

The ECS battery plant is designed as a totally integrated energy system package. It is a compact and complete system containing a controller, rectifiers, circuit breaker distribution panel and automatic battery disconnect/reconnect (LVD/R) feature, packaged in a 42-inch framework designed for mounting atop battery stands. The plant is a modular front-access design for ease of installation, growth and maintenance. This power system is ideal for use in confined areas and enables one to utilize valuable floor space in a more efficient manner.

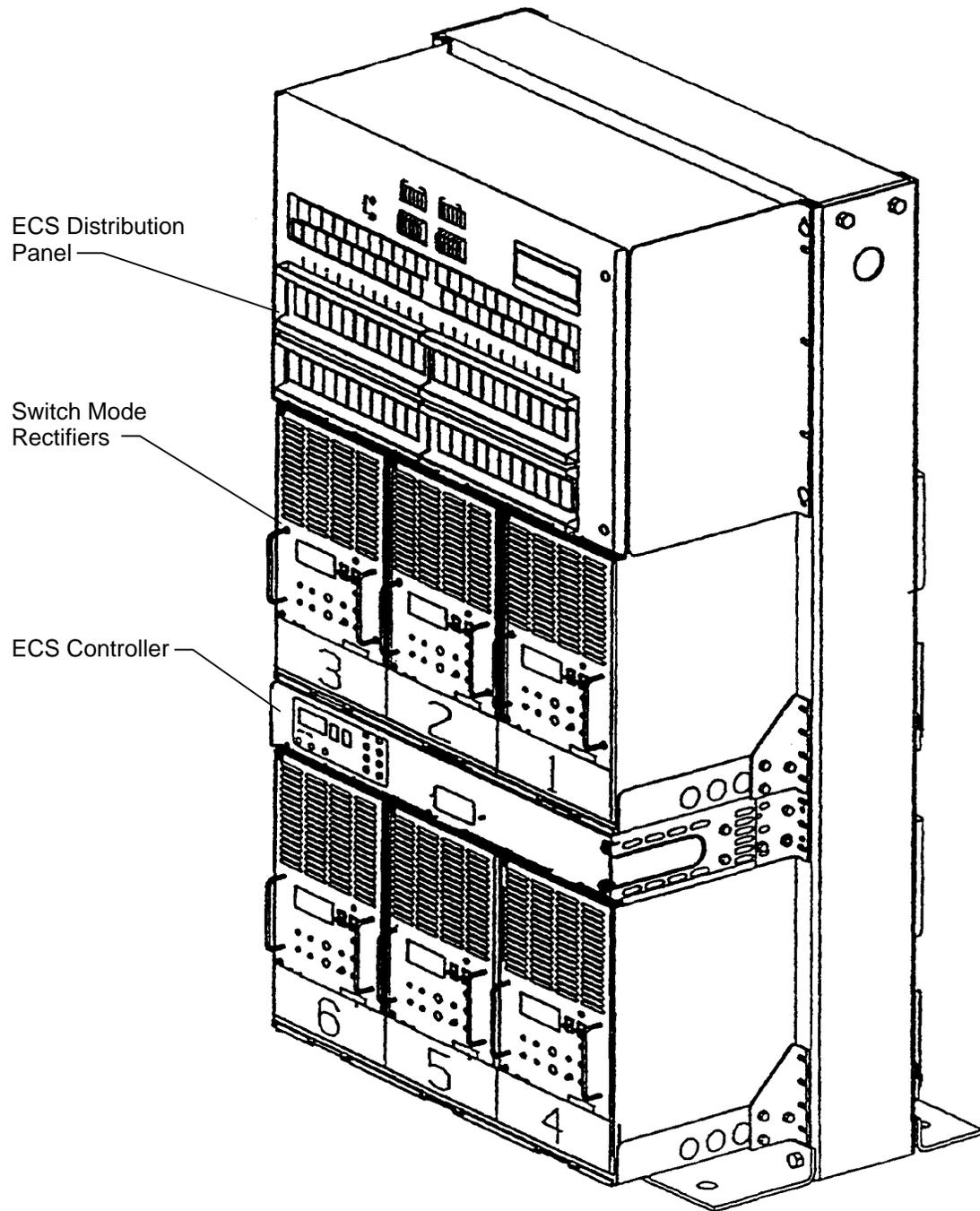


Figure 2-1: Lineage[®] 2000 ECS Battery Plant, 42-inch Framework

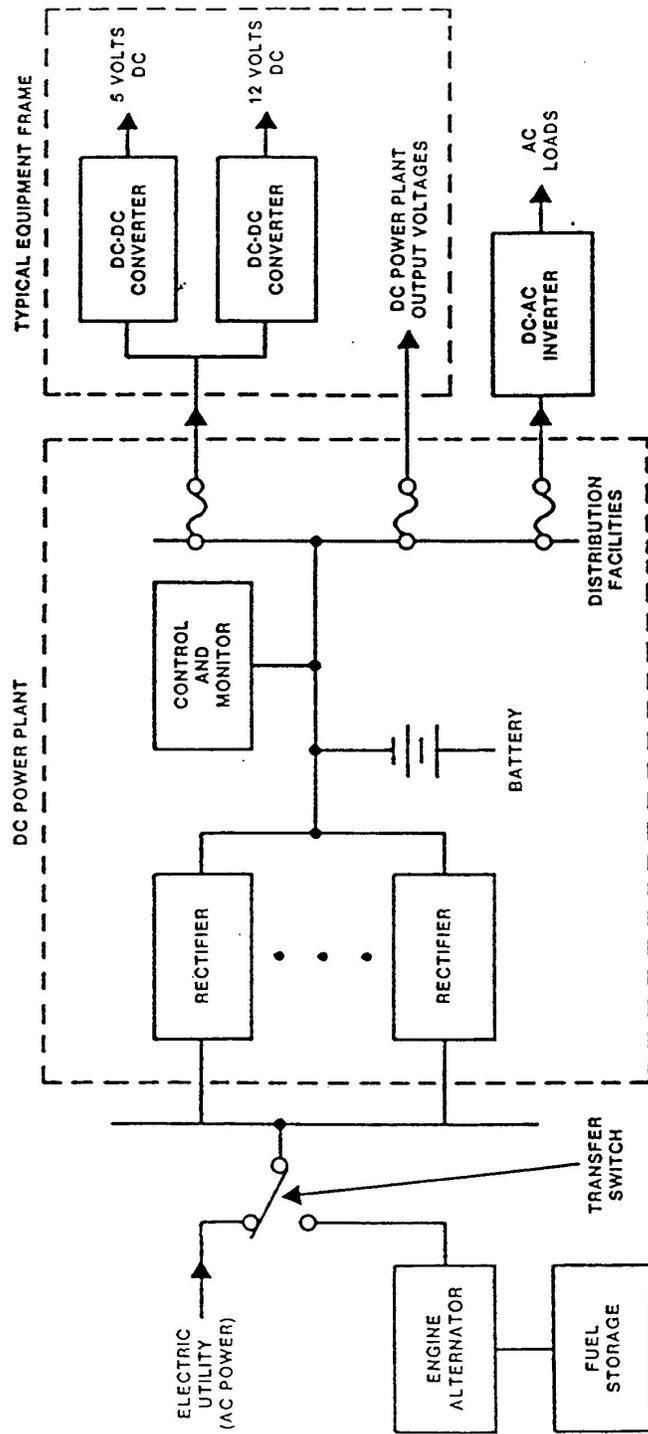


Figure 2-2: Block Diagram of Typical Battery Plant

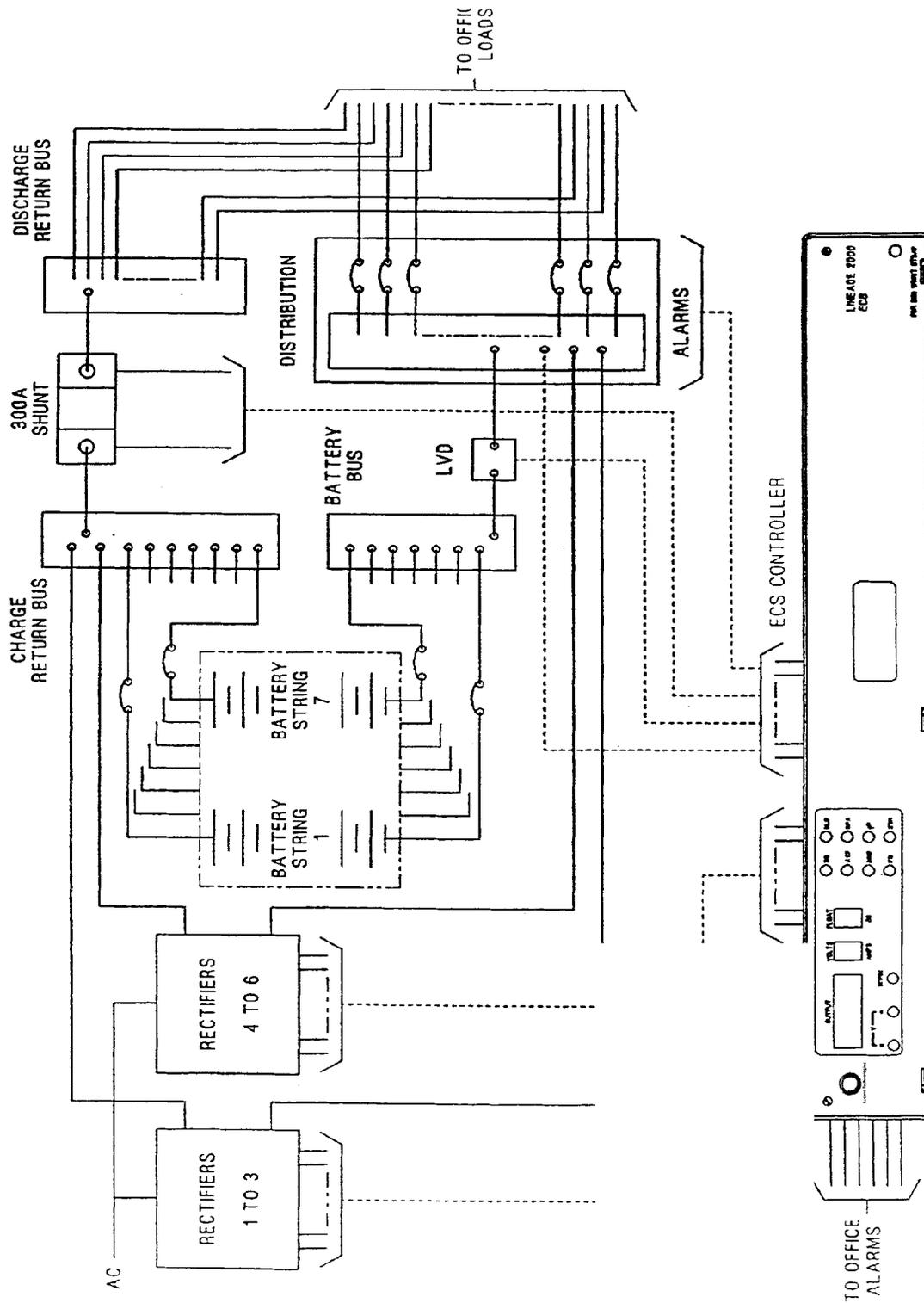


Figure 2-3: ECS Battery Plant Block Diagram

***Frame
Components***

The 42-inch framework will accommodate a maximum of six Lineage[®] 2000 SR Series 50 ampere rectifiers, a Lineage[®] 2000 ECS controller, a distribution panel capable of accepting a maximum of 42 circuit breakers of 10, 20, or 30 ampere capacity, or 20 circuit breakers of 45 and 60 ampere capacity and a low voltage battery disconnect/reconnect feature.

***ECS Battery
Plant
Subsystems***

Figure 2-3 illustrates the arrangement and interconnections of the ECS Battery Plant subsystems from the ac input to the dc output. These subsystems are described below:

Rectifier

The Lineage[®] 2000 SR Series rectifiers are designed specifically for applications where small size, low weight and ease of installation are of overriding importance. The rectifiers utilize a combination of switch-mode technology and forced air cooling to achieve a significant reduction in size and weight over conventional ferroresonant rectifiers. The plug in, connectorized design of the rectifiers reduces installation time to minutes, permitting easy growth and maintenance without service interruption.

The Lineage[®] 2000 SR Series 50 ampere rectifiers operate over 208/240 Vac 50/60 Hz nominal single phase input range without any necessary tap changes. A power factor correction circuit incorporated in the design insures a power factor of 90 percent or greater for loads above 50 percent of the full load rating. The rectifiers provide the ECS controller with a full complement of status and alarm signals. The SR Series 50 ampere rectifier is both UL recognized and CSA certified.

The rectifier status and alarm signals, ac input, and dc output are all connectorized. The rectifiers plug into a rectifier shelf assembly that accommodates a maximum of three individual 50 ampere rectifiers. The ECS plant may be equipped with two rectifier shelf assemblies for a total capacity of six SR Series 50 ampere rectifiers. (See the Lineage[®] 2000 SR Series rectifier product manual for further information.)

Batteries

The ECS battery plant is compatible with virtually all flooded and valve regulated batteries.

Controller The ECS controller performs the centralized monitoring, control and reporting functions for the ECS battery plant. The basic ECS controller can monitor and control up to six rectifiers. It also provides a single interface point for power alarm and status reporting.

Two optional expansion circuit packs are available to upgrade the ECS controller: a microcomputer board equipped with a powerful 16-bit microprocessor, and a datalogger board. The microcomputer board adds sophisticated firmware features such as remote communications, alarm history, and statistics. The datalogger board may be used in conjunction with the microcomputer option to provide general purpose ac and dc, voltage and current monitoring and control. (See the ECS controller manual for further information.)

DC Distribution The ECS dc distribution panel has a maximum of 42 circuit breaker positions. The circuit breakers are a plug-in style, available in 10, 20, 30, 45 and 60 ampere ratings. The 45 and 60 ampere circuit breakers require the utilization of two positions on the panel. The distribution panel contains the plant charge and discharge bus bars, plant shunt, LVD/R contactor and associated circuitry. A complete discussion of the ECS dc distribution is presented in paragraph "ECS DC Distribution Panel" of this manual.

ECS DC Distribution Panel

The ECS dc distribution elements are shown schematically in Figure 2-3 and pictorially in Figure 2-4. They are located behind the dc distribution cover panel which is displayed in Figure 2-6. These elements include the distribution bus bars, the plant shunt and the low-voltage battery disconnect/reconnect (LVD/R) feature.

Distribution Bus Bars The distribution or plant bus bars include the Charge Return Bus, Discharge Return Bus, Battery Bus 1 and Battery Bus 2 (see Figure 2-4). Battery strings are terminated to Battery Bus 1 and the Charge Return Bus. Rectifier output is terminated to Battery Bus 2 and the Charge Return Bus. Power conductors for load circuits are connected, through distribution circuit breakers, to Battery Bus 2. The return conductors for load circuits tie to the Discharge Return Bus. The Discharge and Charge Return Buses are joined via the Plant Shunt. Battery Buses 1 and 2 are interconnected by the LVD/R Contactor.

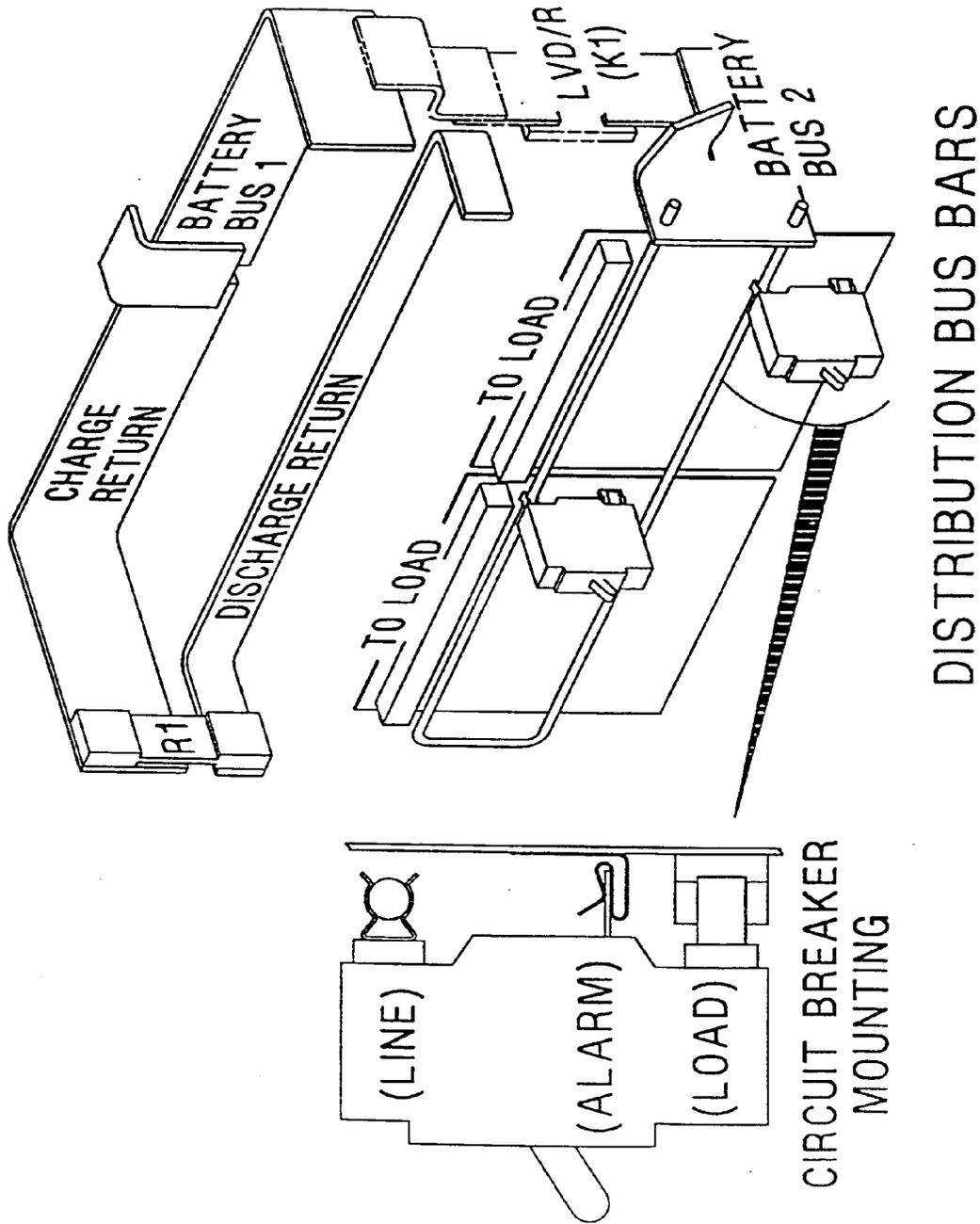


Figure 2-4: ECS Distribution Bus Bars

Plant Shunt

A current shunt is a sensing device which provides a millivolt signal proportional to the current flowing through it. The millivolt-to-ampere ratio of the shunt is the dc resistance of the shunt (in milliohms), which is thermally stable and accurately known.

The current shunt in the ECS Battery Plant is connected between the Charge Return Bus and the Discharge Return Bus (see Figure 2-4). It is used to measure the total current supplied to the load from the rectifiers and/or batteries. The shunt has a full scale rating of 50 millivolts at the maximum plant current of 300 amperes. The shunt millivolt signal is sent, via the CP5 Fuse Board, to the controller where it is translated back to amperes and displayed on the digital meter.

***Low Voltage
Battery
Disconnect/
Reconnect
(LVD/R) Feature***

In unattended battery plant locations, especially those without automatic back-up ac, batteries could be completely discharged during an ac power outage. The ECS Battery Plant is equipped with an automatic battery disconnect to prevent costly battery damage due to unforeseen deep discharge. This disconnect is designed to isolate batteries from the load when the plant voltage reaches the lowest usable battery voltage. The disconnect level is below the operating range of most load equipment, in which case service to the load would already have been lost. The disconnect does not separate the load circuits from the rectifiers, thus enabling the rectifiers to begin powering the load as soon as ac power is restored.

The LVD/R feature consists of the LVD/R Contactor, circuitry on the CP5 Fuse Board and associated wiring. As shown in Figures 2-3 and 2-4, the LVD/R Contactor (K1) is used either to connect or disconnect

Battery Bus 1 and Battery Bus 2. Figure 2-5 is a pictorial of the contactor (K1). The LVD circuit on CP5 monitors the plant charge bus (Battery Bus 2) voltage, designated RB.

When the RB voltage drops below a preset level, a comparator circuit on the CP5 Fuse Board senses the low voltage condition and removes power to the contactor. This opens the connection between Battery Buses 1 and 2, disconnecting the batteries from the rectifiers and the load. The user has a choice of disconnect threshold voltages (40.5 and 42.5 volts), as described in Section 3 of this manual.

When the contactor is open and the rectifiers are not delivering power, the controller is unpowered as well. In this state, the controller displays and LEDs are extinguished and various alarms are issued to the alarm reporting center. (See the Lineage® 2000 Controller manual for further details.)

The red “LVD OPEN” and yellow “LVD FAIL” LEDs are located on the dc distribution panel as shown in Figure 2-6. The red “LVD OPEN” LED on the CP5 Fuse Board is lit whenever the contactor is open, during a normal disconnect or in the unlikely event of a contactor failure. The LVD sensing circuitry on CP5 is redundant. A failure of either voltage detector circuit lights the yellow “LVD FAIL” LED, but the contactor will stay closed. A Fuse Alarm Minor (MNF) is issued when a LVD circuit fails, lighting a yellow LED on the controller front panel and sending Power Minor (PMN) alarms to the alarm reporting center.

Once the contactor opens it remains open until the RB voltage again exceeds the set threshold voltage. Voltage does not return until ac power is restored and the rectifiers restart and deliver power. The LVD circuit then restores power to the LVD/R contactor, which reconnects the batteries to the rectifiers and load. The batteries are then free to accept charging current from the rectifiers.

Circuit Breakers

The standard dc distribution panel (see Figure 2-6) can accommodate a maximum of 42 circuit breakers. The circuit breakers are plug-in style, KS-23616 (Heinemann AM series or equivalent) case size, and are available in 10, 20, 30, 45 and 60 ampere ratings. These breakers have the standard curve 2 trip characteristics and an interrupt capacity of 7000 amperes. The 45 and 60 ampere circuit breakers require the use of two positions on the panel. A two position load and return bus adapter terminal is included with the 45 and 60 ampere breakers.

The breakers are mounted vertically with actuators up in the ON position. Each circuit breaker is equipped with an auxiliary switch that indicates, with a closure, when the breaker has tripped due to overcurrent. The circuit breaker handle will move to a center trip position when tripped due to overcurrent. It should be noted here that customers who wish to prewire load circuits for future use may store the breaker in its installed position until service is actually required. Leaving the breaker in

the OFF position in an operating battery plant will not produce an alarm condition.

The circuit breaker panel consists of two identical printed wiring boards (PWBs), onto which the breakers plug (see Figures 2-4 and 2-7). The auxiliary contacts of all breakers are connected in parallel to create one common alarm signal designated CBA (Circuit Breaker Alarm). The CBA signal is sent to the CP5 Fuse Board where it is combined with other fuse alarm signals to produce a Fuse Alarm Major (MJF) signal used by the ECS Controller. (See the ECS Controller product manual for additional information.)

The individual load currents are conducted on the PWBs to individual positions of board-mounted barrier-type terminal blocks. Each PWB can accept 21 plug-in breakers and the 21 associated load connections. The plug-in circuit breaker connections are illustrated in Figure 2-7. The upper terminal of each breaker (line side) connects to a copper bus which distributes the total plant load current among the individual load circuits. The lower terminal of each breaker (load side) is connected to a terminal block position via a printed wiring path on one of the PWBs. The plug-in connectors, the printed wiring paths, and the terminal block itself are all rated at 30 amperes maximum in a 50°C ambient temperature.

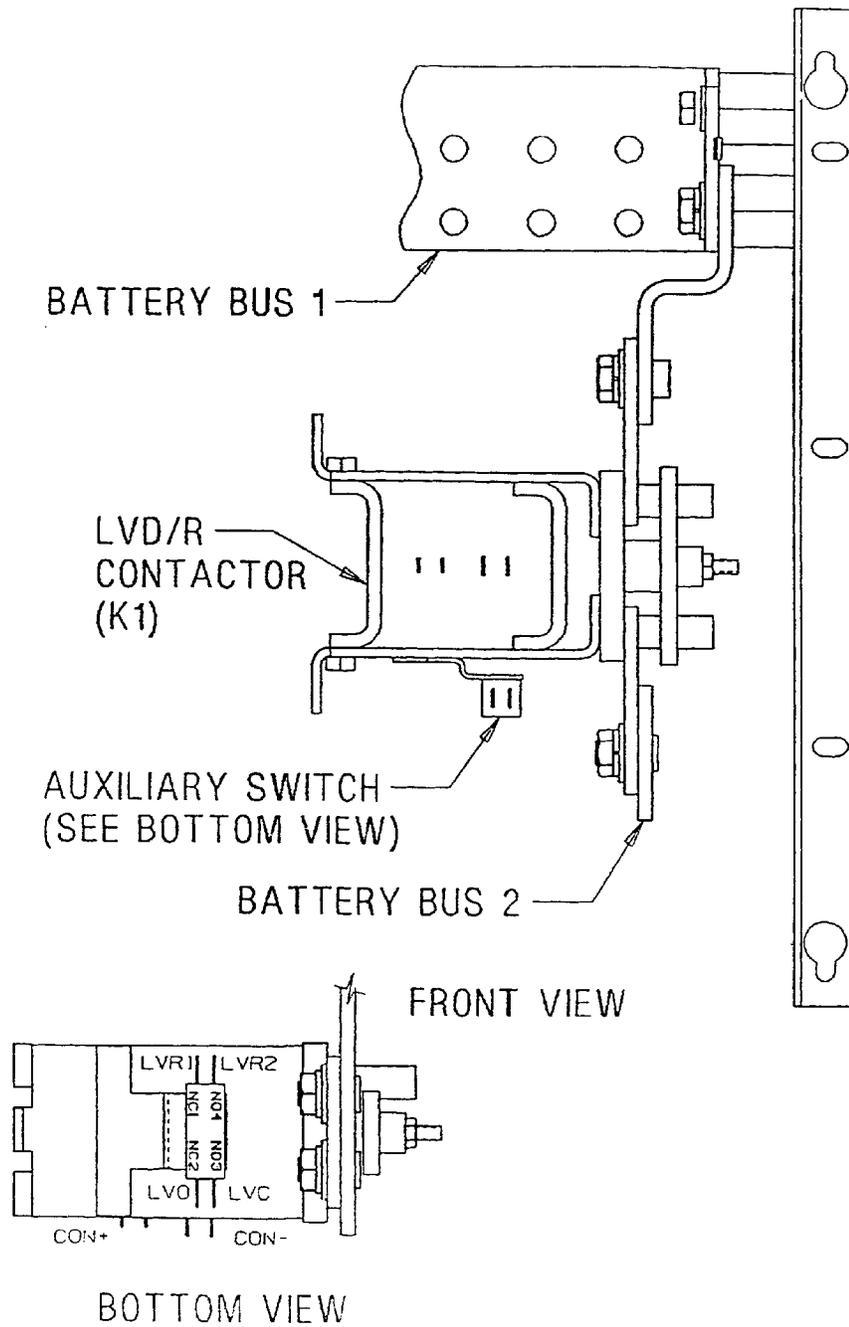


Figure 2-5: Low Voltage Disconnect/Reconnect Contactor (K1)

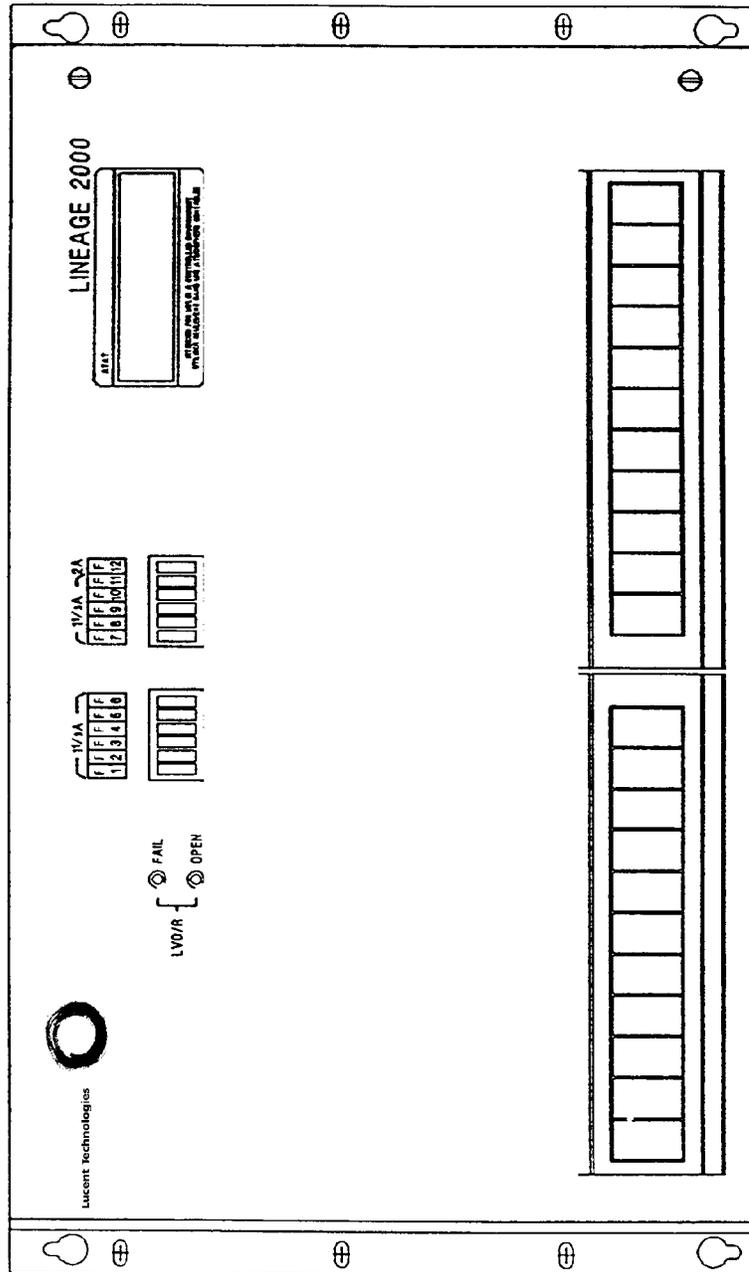
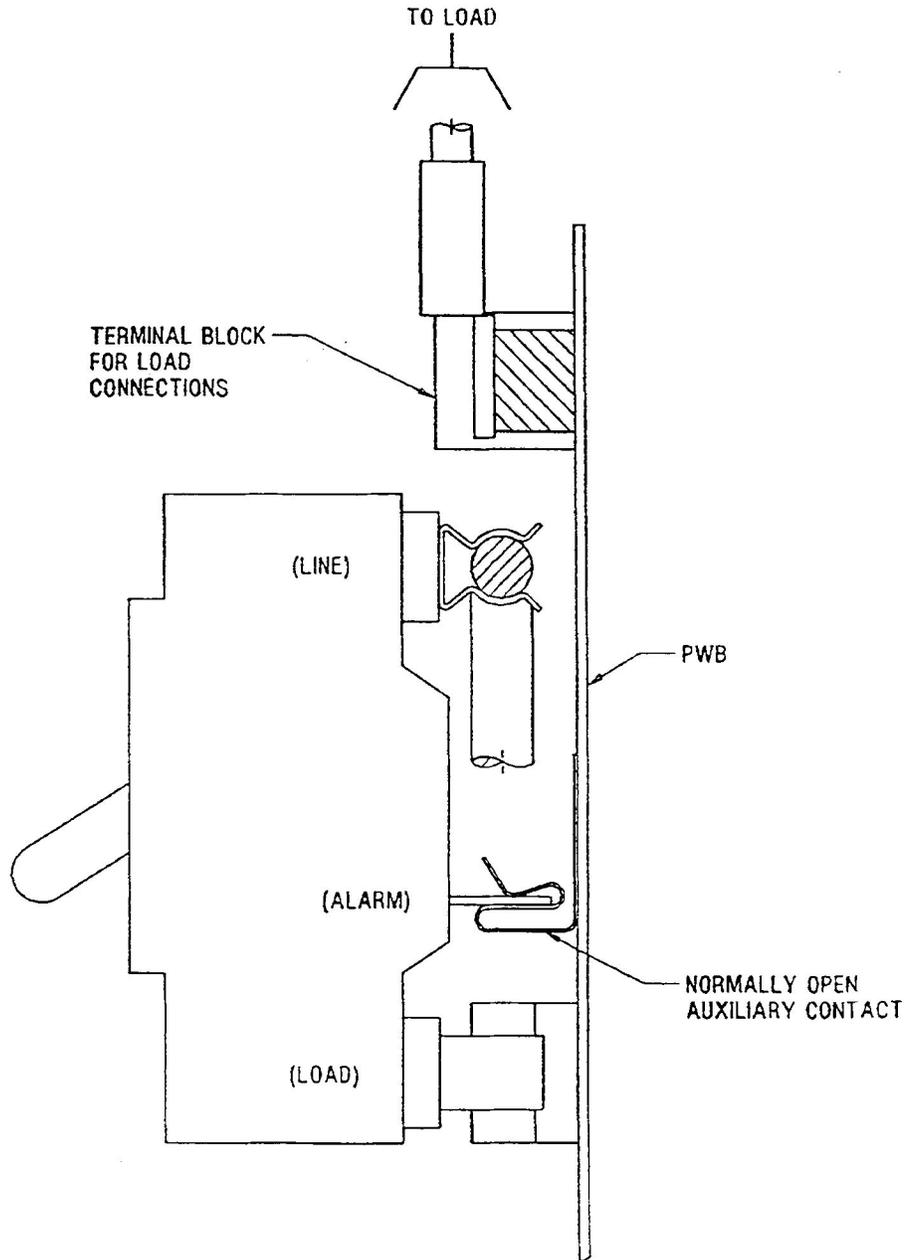


Figure 2-6: ECS DC Distribution Panel (Front View)

Circuit Breakers:
10, 20, 30, 45*, 60* Ampere Capacity
7000 Ampere Interrupt Rating



* 45 and 60 Ampere breakers require the use of two panel positions. A two position load and return bus adapter terminal is included with the 45 and 60 Ampere breakers.

Figure 2-7: Plug-In Circuit Breaker Mounting

General Engineering Calculations

The using system, also referred to as the LOAD EQUIPMENT, determines many characteristics of the power equipment. Service and maintenance strategies also affect the selection of power equipment. This paragraph describes, through the following topics, the types of basic power specifications and how they may be determined.

- load equipment voltage
- battery voltage
- load drain and growth
- reserve capacity
- charge capacity and recharge time
- battery string balancing
- voltage drop calculations
- conductor sizing
- overcurrent protection

Load Equipment Voltage

Determine the recommended operating voltage range of the using equipment. If the battery plant is used to power different types of equipment, it must meet the requirements of each. Fill in the load voltage information below. The answers to these questions will be used in engineering calculations and equipment selection in the following paragraphs.

- a. Recommended operating voltage: _____ volts
- b. Minimum steady-state voltage: _____ volts
- c. Maximum steady-state voltage: _____ volts
- d. Maximum high voltage transient: _____ volts
- e. Can the load be damaged by low input voltage?
____ (yes or no)

If the answer to (e) is yes, low-voltage LOAD disconnect provisions may be necessary. It is important to distinguish between low-voltage disconnects for BATTERIES and for LOADS.

Low-voltage battery disconnect does NOT protect load equipment from low input voltage. Load and battery disconnect features are not available on all types of battery plants.

Battery Voltage

Battery plant operating voltage is directly related to the recommendations of the battery manufacturer. These recommendations must include:

- the steady-state voltage for maximum life or FLOAT VOLTAGE,
- the END VOLTAGE after complete discharge,
- the maximum recharging voltage, and
- the initial charging method.

When the recommended recharging voltage is greater than the float voltage, this type of charging is called EQUALIZE or BOOST charging.

In batteryless applications, rectifier and load equipment voltage ranges are still tied to typical battery voltage ranges since the most common use of this equipment does involve batteries. Skip to paragraph “Load Drain and Growth” for batteryless plants.

A BATTERY STRING consists of a number of battery cells connected in series to provide the desired plant operating voltage. Although virtually any plant voltage is possible by varying the number of cells per string, this manual deals specifically with NOMINAL 48 VOLT systems.

The NOMINAL CELL VOLTAGE of lead-acid-type batteries is usually defined as 2 volts. The actual recommended float voltage of lead-acid batteries differs slightly among vendors and varies with chemistry. The most common float voltages are 2.17, 2.27 and 2.35 volts per cell.

Nominal 48 volt systems typically use 23 or 24 cell battery strings for float voltages that range from 52.08 to 56.40 volts per string. Standard arrangements are more commonly available for 24-cell strings than for 23-cell strings. The Lucent Technologies VR-series battery, for example, is designed to float at 2.27 volts per cell and is available in 24-cell arrangements for float voltage of 54.5 volts per string. Lucent Technologies KS-type flooded

lead-acid batteries float at 2.17 volts per cell (52.08 volts per string).

Customers should select a battery type and vendor based on their maintenance and replacement strategies, weighing initial cost, expected life, service requirements and replacement cost against each other. Once the battery is chosen, the following information is needed for the battery plant engineering process.

- f. Float voltage per cell: ____ volts
- g. Minimum cell voltage at end of discharge: ____ volts
- h. Is boost or equalize charging recommended? ____ (yes or no)
If yes, the maximum recharging voltage per cell:
____ volts
- i. Maximum initial charging voltage per cell: ____ volts
- j. Number of cells per string: ____

Multiply the number of cells per string (j) by the voltages (f), (g) and (h) to find the values for (k), (l) and (m), respectively.

- k. Float voltage per string: ____ volts
- l. Minimum string voltage at end of discharge: ____ volts
- m. Maximum charging voltage per string: ____ volts

Compare these three calculated voltages, (k), (l) and (m), against the steady-state load equipment voltages (a), (b) and (c).

If (l) is a higher voltage than (b), it may be desirable to provide the low-voltage battery disconnect/reconnect feature to prevent battery damage from deep discharge. A more complete comparison of battery and load voltage ranges, involving dc voltage drops in the cabling system, is provided in the following paragraphs.

Load Drain and Growth

Under normal conditions with a constant load, battery plant voltage to the load equipment is essentially constant. During an ac power outage, however, as the batteries deliver power, the voltage drops steadily. Most types of load equipment do not draw a constant current over their input voltage range. Therefore

the current drain on the plant may change as the batteries discharge.

Some types of load equipment are purely resistive, in that their current drain decreases as the plant voltage decreases. Other types of loads are characterized as constant power equipment, in that the current increases as the plant voltage drops. Load equipment may have a combination of resistive and constant power characteristics.

In the telecommunications industry, List 1 and List 2 are the designations of the load current drains which have historically been used to size various elements of the battery plant. These values are normally provided for each load circuit or group of load circuits through engineering of the load equipment, a topic not covered in this manual. These terms may be briefly defined as follows:

LIST 1 drain - the average busy-hour current during normal plant operation (i.e., at float voltage). This value is used to size batteries and rectifiers.

LIST 2 drain - the peak current under worst case conditions of voltage, traffic, etc. This current is used to size load feeder cables, plant discharge capacity and overcurrent protectors.

The summations of List 1 and List 2 drains for all the individual load circuits provide the List 1 and List 2 drains, respectively, for the entire battery plant.

Initial List 1 drains are used to size initial rectifiers and batteries since these components may be added relatively easily to operating plants. To determine the initial rectifier and battery needs, fill in the current drain information for all load circuits in the initial installation in Table 3-A. Use additional sheets, as needed.

As the customer's power needs evolve, however, load circuits may need to be added and traffic on existing circuits may increase. Ultimate List 2 drain should be used to select the initial sizes of load feeder cables and plant discharge capacity, since these cannot be readily increased once the plant is installed. In Table 3-B, fill in the anticipated future drains for the circuits listed in Table 3-A. Also include in Table 3-B any additional

Reserve Capacity

The customer's service and maintenance strategy are important in determining reserve time. The availability of back-up AC power and accessibility of the site are usually the determining factors in battery sizing. The risk and acceptability of loss of service is another factor which will vary from application to application.

Table 3-C lists reserve time practices which have been used in some telecommunications applications where maintaining power to the load is critical. The figures are not intended to be guidelines except in the absence of any specified customer practices.

Table 3-C: Reserve Capacity

Back-up Source	Typical Reserve Time	
	Attended Location	Unattended Location
Stationary Engine (automatic start)	3 hours	3 hours + travel time
Stationary Engine (manual start)	4 hours	4 hours + travel time
Portable Engine	4 hours + travel time	
Uninterruptible Power Supply	0 hours (batteryless)	

The noise and transient filtering capability of batteries, however, may also be considered in selecting the minimum battery capacity. Many using systems specify the maximum allowable input noise. Applications (such as UPS-supplied ac power) which do not require batteries for dc reserve purposes may require batteries or some other means for noise filtering. Compare the input noise requirements of the using system to the ECS Battery Plant specifications in Table 2-A.

Fill in the minimum reserve time below.

- n. Minimum battery reserve time: ____ hours

Battery capacity is usually specified in terms of AMPERE-HOURS, which is essentially a measure of energy. The ampere-hour rating is the product of a constant discharge current and the time to discharge a fully charged battery to a specified end voltage.

For comparison purposes, most vendors of telecommunications batteries specify ampere-hour ratings at the 8-HOUR RATE of discharge to an end voltage of 1.75 volts per cell. Many battery vendors also supply ratings at other discharge rates, such as 3, 5 and 24 hour rates.

Although ampere-hour ratings are useful for rough estimates of battery size, actual battery selection should be based on curves or tables of discharge current versus time.

***Charge Capacity
and Recharge
Time***

For all but batteryless applications, rectifier capacity must be provided specifically for the recharging of batteries. This rectifier capacity must be engineered into the plant in addition to that required to power the load under normal or float conditions. The sum of the normal and the recharge rectifier capacities is called the PLANT CHARGE CAPACITY.

The recharge current is a function of the recharge time and voltage. For example, increasing the plant voltage will, within limitations, decrease the necessary recharge time, but this calls for more current. Increasing the plant voltage after a discharge is also recommended by some battery vendors to assure that all cells charge equally for maximum life. Although these two charging methods are essentially the same, they are usually called by different names. The former process is usually called BOOST CHARGING, while the latter is called EQUALIZE CHARGING. For the purposes of this manual, the term Equalize is used to indicate boost- or equalize-charging. Refer to the battery manufacturer's recommendations on equalize charging.

The recharging requirement is determined by customer practices and is usually specified as a maximum time to reach a minimum percent of full capacity, for example, at least 90% capacity in no more than 24 hours.

- o. Maximum recharge time: ____ hours
- p. Percent of full-capacity after recharge time (o): ____%

Refer to the Battery manual or other documentation to calculate the required recharge current to meet the requirements of (o) and (p). The recharge voltage (m) will be needed for this calculation.

- q. Minimum recharge current: ____ amperes

RECHARGE FACTOR is a term that is sometimes used to describe available recharge capacity. The recharge factor is the total charge current divided by the List 1 drain. Typical recharge factors range from 1.20 to 1.50.

r. Minimum recharge factor: _____

The minimum initial rectifier requirement for float operation is derived from the Plant List 1 Drains calculated in Table 3-A.

Customer practices MAY dictate any combination of the following rectifier engineering conventions.

- At least one on-line spare rectifier must be included in the plant for increased reliability.
- Any on-line spares must be the same size as the largest rectifier size in the plant.
- At least 20 percent additional capacity must be included in the plant to provide recharge capacity and spares.

The actual selection of rectifiers depends on their sizes. In some types of battery plants, different sizes of rectifiers are available and, in some of those plants, rectifier sizes may be mixed within one plant. Refer to paragraph "Rectifier Sizing" for specifics on sizes and quantities of rectifiers for the ECS Battery Plant.

***Battery String
Voltage Drop
and Balancing***

The rectifiers, while recharging or floating the batteries, maintain a constant voltage at the battery plant bus bars. When batteries are accepting recharge current after a discharge, there is a finite voltage drop from the charge bus bars inside the ECS bay to the battery string terminals. This voltage drop is, of course, proportional to the magnitude of the recharge current. Any voltage drop from the battery plant bus bars to the terminals of each battery string will tend to slow the rate of battery recharge and delay their readiness for future discharges.

The same cable resistance responsible for voltage during recharge creates a voltage drop during discharge as well. Voltage drop during discharge can limit the effectiveness of the batteries in supplying the necessary reserve.

For these reasons, the engineer should minimize the voltage drop between bus bars and batteries by interconnecting them with the largest practical wire size.

In battery plants with multiple, parallel strings of batteries, the cable lengths from the DC distribution subsystem to each string will be different. It is as important to balance the strings as it is to minimize voltage drop. Multiple strings are balanced by sizing cables for equal resistance (and therefore equal voltage drop) between terminals and bus bars. If battery strings are unbalanced, the string with the least voltage drop to the DC distribution provides more than its share of current during each discharge. A battery string that sees excessive discharges may fail unexpectedly before its predicted end of life.

To both minimize and equalize voltage drops to parallel strings, the largest practical wire size should be selected for the most distant battery string. The cable sizes for the strings nearer to the DC distribution are then selected so that the drop in each is roughly the same as that for the most distant string.

Some using systems, such as electronic switching systems or transmission systems, dictate maximum allowable voltage drops. A common rule-of-thumb is a maximum drop of .25 volts in the leads from battery string terminals to the DC distribution. Voltage drop calculation methods are described in paragraph "Calculating Voltage Drop." For the calculation, use the plant List 2 drain divided by the number of parallel battery strings.

For extraordinarily long runs between batteries and DC distribution, wire gauges may be called for that cannot be conveniently terminated at the equipment at either end. In such cases, the necessary larger cables may usually be tapped down to smaller ones to make the actual connections to the bus bars and battery terminals.

***Battery Size
versus Voltage
Drop***

The critical requirement for a battery plant is that the input voltage to the load equipment remain within the proper operating range for the prescribed reserve time. Constants imposed by the typical 48-volt battery system are the normal battery float voltage and the minimum battery end voltage.

Note

Engineering of plants with end cell or counter-emf cell battery arrangements is not included in this discussion.

The variables that may be adjusted to ensure service for the specified time period are battery capacity and voltage drop from

batteries to the load. If the system is engineered with a relatively small voltage drop, large gauge cabling is required, but battery capacity can be minimized. If a large voltage drop exists between batteries and load, the minimum load voltage may be reached before the batteries reach their end voltage so that their rated capacity is only partially used. In this second case, additional battery capacity would be required.

The trade-off between battery size and wire size is an economic one. For systems with long cabling runs, the cost of large quantities of heavy wire should be balanced against the cost of additional batteries. Finding the exact optimum combination of cabling and batteries involves complex iterative calculations which are beyond the scope of this discussion. Some using systems, such as electronic switching systems or transmission systems, dictate maximum allowable voltage drops, thus simplifying the calculations. Lucent Technologies offers a computerized service to optimize the selection of cable sizes and battery capacity for any application. Contact your Lucent Technologies Energy Systems Account Executive for details on this service.

Alternatively, various rules-of-thumb are used to specify maximum voltage drops. During discharge, the critical voltage drop is the total drop from the battery terminals to the load equipment.

Increasing the voltage drop from dc distribution to load can potentially be compensated by decreasing the voltage drop from batteries to dc distribution.

The voltage drop from the batteries to the distribution has been covered above, in paragraph "Battery String Voltage Drop and Balancing." One rule-of-thumb specifies a maximum voltage drop of .75 volts in the feeder loop from the DC distribution to the load and back again, using the List 2 drain for that circuit as listed in Table 3-B. Voltage drop calculation methods are described in paragraph "Calculating Voltage Drop."

Fill in the selected or calculated system voltage drops below.

- s. Maximum drop (batteries to dc distribution): ____ volts
- t. Maximum drop (dc distribution to load): ____ volts
- u. Maximum drop (batteries to load): (v) + (w) =
____ volts

After the total drop from the batteries to the load is determined, the actual end voltage of the batteries can be derived from the minimum input voltage to the load (b).

v. Actual battery string end voltage: ____ volts

w. Actual battery cell end voltage: ____ volts

Since most battery vendors provide capacity information as a function of end voltage, item (z) is important in the selection of a specific battery. If (z) is below the manufacturer's recommended discharge voltage, low-voltage battery disconnect/reconnect may be helpful in preventing battery damage from deep discharge. In attended locations with back-up ac power, low-voltage disconnect/reconnect may not be necessary.

***Calculating
Voltage Drop***

A useful formula to relate voltage drop, cable length and cable size is:

$$VD = (K \times I \times L) / CM, \text{ or } CM = (K \times I \times L) / VD$$

where:

VD = allowable voltage drop, in volts

CM = conductor size in circular mils

K = 11.1 for copper at 78°F (25.5°C)

I = appropriate current drain, in amperes

L = conductor length, in feet

The formula may be applied to one-way conductors or to loop circuits (i.e., paired power and return conductors). The value of K in the above expression increases with increasing conductor temperature.

***Conductor
Ampacity***

Two criteria are used to select the actual wire gauge of a given conductor. These two criteria are ampacity and voltage drop. Ampacity is the current that may be carried safely without overheating. In relatively low voltage/high current systems, such as dc distribution, voltage drop limitations are often the

determining factors in sizing conductors. In systems, such as ac distribution, with relatively high voltage and low current, ampacity usually determines minimum conductor size. All conductors, however, must be large enough to safely carry the intended current.

Allowable ampacity is provided in Article 310 of the National Electrical Code (NEC), and it is a function of the following:

- wire size,
- ambient temperature,
- type of insulation, and
- proximity to other conductors.

The ampacity tables are given in the NEC, starting with Table 310-16. These tables, together with the appropriate notes, determine the current that will result in the maximum allowable operating temperature for each wiring method. For instance, for the maximum temperature for Type RHW wire is 75°C (167°F). The current that will result in that temperature (i.e., the ampacity) is less when the ambient air temperature is higher and also when conductors are bundled or side-by-side.

***Overcurrent
Protection***

The rating of an overcurrent protection device (fuse or circuit breaker) should not exceed the AMPACITY of the conductor it is intended to protect. The absolute maximum rating permitted by the NEC for an overcurrent protector is the next larger standard rating above the ampacity.

Overcurrent protectors may be sized smaller than this maximum rating. In general, however, protectors should be rated as high as allowable to avoid nuisance tripping due to high load conditions or inrush during start-up.

***Lineage[®] 2000
Engineering
Specifics***

The methods used in “General Engineering Calculations” are appropriate for the engineering of any battery plant. The specifications documented in “General Engineering Calculations” are used in this paragraph to select the specific types and quantities of equipment available with the Lineage[®] 2000 ECS battery plant.

The following topics are covered in this section:

- Rectifier Sizing
- Battery Sizing
- Cable and Load Breaker Sizing
- Low-voltage Disconnect/Reconnect
- Emergency Shutdown/Disconnect
- Controller Options
- Alarm System Interface

Rectifier Sizing

The Lineage[®] 2000 SR 50 ampere, -48 volt switched-mode rectifier is currently available with the Lineage[®] 2000 ECS Battery Plant. The maximum number of rectifiers per plant is six.

In the absence of specific customer practices, the following procedure is recommended:

- x. Determine the smallest whole number of rectifiers that will provide the normal (List 1) plant drain in Table 3-A: _____
- y. Determine the smallest whole number of rectifiers that will provide the normal plus recharge current from Table 3-A and (q): _____
- z. Provide the greater of (s)+1 or (t) rectifiers: _____

For batteryless plants, skip to paragraph “Cable and Load Breaker Sizing.”

Battery Sizing

The battery type and minimum size are determined in paragraphs “Battery Voltage” and “Reserve Capacity.” Many vendors offer families of batteries that cover a wide range of ampere-hour capacities. Ampere-hour capacities of parallel battery strings are added to provide the total reserve capacity of the battery plant. To supply the necessary reserve, several strings of small capacity batteries or one or two strings of large capacity batteries may be connected in parallel.

Several important considerations in the choice of battery size versus number of strings are:

- Cost
- Weight and Space Efficiency
- Anticipated Growth
- System Reliability

Cost: In general, for one vendor's family of batteries, the cost per ampere-hour decreases with increasing cell capacity. In other words, a battery that is twice as big, costs less than twice as much. On the basis of initial material cost, therefore, the number of strings should be minimized.

Weight and Space Efficiency: Weight density and space efficiency increase, in general, as battery capacity increases. There can be significant differences in space efficiency, however, between different vendors of the same capacity battery. Floor loading restrictions may limit the potential compactness of the battery arrangement. Such limitations of the building structure must be clearly understood before selecting a battery arrangement. Applications with space restrictions such as standard aisle depths may dictate the use of more strings of smaller batteries.

Anticipated Growth: The growth pattern for the battery plant may dictate the battery size to simplify expansion. It is usually easier to engineer and install additional strings of the same battery type and capacity as those already in place. The growth in battery capacity is tied to the growth in rectifier capacity, since both must increase with increasing load current. It is typically most economical to match an increase in charge capacity with an increase in battery capacity which can back up the load supported by the additional rectifiers. Since a fraction of any added rectifier capacity is needed for recharging added batteries, the matching incremental change in battery capacity depends on the desired recharge factor. (See paragraph "Charge Capacity and Recharge Time" for an explanation of charge capacity and recharge factor.)

Since the charge capacity of the Lineage® 2000 ECS battery plant grows in 50 ampere increments with the SR50A/48V rectifier, the optimum battery capacity increment may be approximated as follows:

$$\text{A-hr increment} = (50 \text{ A}) \times (\text{reserve time in hours}) / (\text{minimum recharge factor})$$

System Reliability: In most battery plants it is possible have an open circuit in the battery subsystem that could remain undetected until ac power is lost and battery power is required. Therefore, for applications where service reliability is critical, it is a good practice to select battery size such that at least two strings are required. Multiple strings allow for easier maintenance on the battery system without jeopardizing service to the load equipment.

***Cable and Load
Breaker Sizing***

In this paragraph, power cabling for the dc distribution and battery subsystems is covered, including the following subtopics:

- maximum and minimum wire gauges
- wire type
- crimp lugs
- circuit breaker selection

To determine actual wire sizes, equipment locations, cable rack and routing systems at the site must be known. Since the battery plant shares the cabling system with other building systems, cabling engineering is not completely defined by this paragraph of the product manual. In this paragraph, the basics are derived for the dc power cabling which will be required as part of a complete cable engineering process. Lucent Technologies offers cabling engineering services that are separate from battery plant engineering. Contact your Lucent Technologies Account Executive for more information on available services.

In general, wire type RHW or RHH should be used for dc power wiring. This type of wire is commonly available in American Wire Gauge (AWG) Stranded (e.g., KS-5482) and in a finer stranded welding type (e.g., KS-20921). Flexible or Welding Wire is slightly larger than AWG stranded wire of the same gauge, which may affect the selection of crimp lugs. For example, different crimp lugs are required for AWG and Weld wire of the same gauge, for 1/0 gauge and larger.

Flexible power wire (e.g., KS-20921) should be used for sizes 1/0 and larger in applications requiring tight bends, such as small battery plants in confined locations.

The wire sizes that may be readily terminated at the dc distribution subsystem are listed in Table 3-D. Wire sizes may be engineered which are larger than those indicated in Table 3-D. Larger wires, however, must be tapped down in the cabling system appropriately before entering the ECS distribution panel or a two position load and return terminal adapter can be used.

Table 3-D: Acceptable Wire Sizes

CIRCUIT	WIRE SIZE RANGE
Load Feeders	14 AWG to 10 AWG - one position 8 AWG to 2 AWG - two positions with adapter
Battery Feeders	1/0 Weld to 4/0 Weld 2/0 AWG to 250 AWG

Loose hardware, such as nuts and bolts, is provided with the ECS battery plant for the connections listed in Table 3-D. Crimp-type terminal lugs are provided with each load circuit breaker for a pair of 12 to 10 AWG load feeders. Lugs for battery feeders and for other size load feeders must be selected from tables on the H569-401 drawing and must be ordered separately from the battery plant.

Five sizes of plug-in circuit breakers are available for dc distribution overcurrent protection. The ratings of these circuit breakers are 10, 20, 30 45 and 60 amperes. The breaker rating for a given circuit is selected by the criteria covered in paragraph "Conductor Ampacity."

The lengths of all load and battery conductors must be known before proceeding with this paragraph. Use the following steps to record the wire and breaker sizes for each load feeder in Table 3-E. Use additional sheets as needed.

Step A: Copy List 2 drains for each load feeder from Table 3-B to Table 3-E.

Step B: Calculate the minimum wire size that meets the ampacity requirement based on the List 2 drain for each load feeder.

Step C: List the wire sizes based on ampacity in Table 3-E.

Step D: Calculate the minimum wire size for each load feeder in Table 3-B to meet the voltage drop requirements outlined in paragraph “Calculating Voltage Drop.”

Step E: List the sizes based on voltage drop in Table 3-E.

Step F: Indicate the larger size for each load feeder in the column marked Selected Wire Gauge.

Step G: Fill in the circuit breaker rating (10, 20 or 30 Amps) in Table 3-E for each feeder.

Step H: Record in Table 3-F the wire sizes for each battery feeder.

Step I: Calculate the minimum wire size that meets the ampacity requirement based on the total plant List 1 drain divided by the number of parallel battery strings.

Step J: Enter that wire size on the first line in Table 3-F.

Step K: Calculate the minimum wire size for each battery feeder in Table 3-B to meet the voltage drop requirements outlined in paragraphs “Battery Size versus Voltage Drop” and “Calculating Voltage Drop.”

Step L: List the sizes based on voltage drop in Table 3-F.

Step M: Indicate the larger size for each load feeder in the final column, “Selected Wire Gauge.”

Table 3-F: Minimum Wire Gauge (Ampacity) - All Strings

String Number	Minimum Wire Gauge	Selected Wire Gauge
1		
2		
3		
4		
5		
6		

Low-Voltage Disconnect/Reconnect Feature

Low-voltage BATTERY disconnect/reconnect contactor has two disconnect settings available: 40.5 and 42.5 volts. The tolerance on disconnect levels is +/- 0.5 volts. Based on the discussion in paragraph "Battery Voltage," specify the disconnect level ____ (40.5 or 42.5)

Note that Low-voltage LOAD disconnect is not currently an available feature of the ECS plant. Other Lineage[®] 2000 battery plant products do offer this capability, however. Contact your Lucent Technologies Energy Systems Account Executive for more information.

Emergency Disconnect

The Lineage[®] 2000 ECS battery plant may be equipped with a range of manual and automatic battery disconnect functions. These options are shown in Table 3-G as A through D and described in more detail below.

Option A: Of the three available combinations of battery disconnect features, the most basic one provides a two-pole circuit breaker for each battery string. This circuit breaker can isolate each battery string from all others and from the plant battery and ground bus bars. The breaker may be opened manually as a safety disconnect during battery maintenance.

The trip characteristics of the battery and dc distribution breakers are COORDINATED, which means that only the nearest upstream protector will open during a fault. In other words, a short circuit on a load feeder circuit will trip the associated dc distribution breaker and will NOT trip the battery string breaker. However, an internal short circuit within the string will cause the battery string circuit breaker to trip.

The battery string circuit breaker is rated at 100 amperes capacity. When this option is specified for a battery plant installation, care must be taken to insure that the battery plant is engineered correctly.

For plants utilizing a single battery string, excess rectifier capacity (total rectifier capacity less steady state load current) must not exceed 100 amperes. For plants utilizing multiple battery strings, excess capacity should not exceed 80 amperes per installed string. (For example, with three strings, excess capacity should be less than 240 amperes.)

When the battery string disconnect breaker is used in a battery plant installation where no external load is powered, excess capacity must not exceed 80 amperes times the number of installed battery strings. This is accomplished either by removing rectifiers or placing the appropriate number of rectifiers on standby.

The plant discharge current level for single battery string battery plants must be engineered for no more than 100 amperes with the battery disconnect breaker installed. For plants with multiple strings, the discharge current must be less than 80 amperes times the number of battery strings.

Option B: This option combines the features of option A with remote simultaneous disconnect of all battery strings. Some applications involving stringent building codes may require a disconnect for batteries located outside the battery room. This type of remote disconnect takes advantage of the relay-trip capability of the standard battery circuit breaker. By wiring all the battery string breakers to an emergency switch, such as a wall-mounted panic-button located outside the battery room, they may be remotely turned off. The emergency switch and associated wiring are not provided with the battery plant equipment since they are intimately related to the job application. Guidelines for selection of the emergency switch are provided in notes on the plant schematic SD-82670-01. This

emergency switch should be provided consistent with local and appropriate NEC requirements.

Option C: The most basic disconnect option is an emergency disconnect switch for ac power only. This would consist of a panic-button that would control a shunt-trip-type ac circuit breaker. Such a feature must be engineered as part of the building ac system and not part of the battery plant. A typical circuit, however, is provided on SD-82670-01.

Option D: The final and most comprehensive option is a combination of option B and option C, in which a single switch disconnects ac power and isolates each battery string. Again, the actual emergency switch and wiring are not provided with the battery plant equipment.

Table 3-G: Emergency Disconnect Options

Type of Disconnect		Allowable Combinations			
		A	B	C	D
Battery Disconnect	Overcurrent	X	X		X
	Maintenance	X	X		X
	Emergency	X	X		X
AC Shutdown	Emergency			X	X

Controller Options

The engineering of the ECS controller features involves orderable circuit packs and field-movable jumper straps.

Circuit Packs: Circuit pack options for the ECS controller are presented on the H569-401 battery plant drawing. Refer to that drawing and to the Controller manual for more information on the availability of optional circuit packs.

Jumper Straps: Certain controller features must be set during the installation process if requirements differ from the standard factory settings. The engineering process must provide the necessary instructions to the installer for the controller set-up. Refer to the H569-401 controller drawing and the Controller Manual for details.

Alarm System Interface

The standard ECS controller is equipped with connection points for a variety of battery plant alarms. The wiring from the controller alarm points to the local and remote reporting alarm

systems, however, is NOT provided with battery plant. Such wiring must be compatible in gauge and type with the terminal blocks provided on the controller circuit packs, as detailed in the Controller Manual.

Ordering

Coding and Terminology

The two main categories of Lucent Technologies hardware are called APPARATUS and EQUIPMENT. The battery plant ordering process primarily involves Equipment for the system and Apparatus for components and replacements.

An apparatus code identifies one specific arrangement of hardware. The product is available in one form only. Lucent Technologies Coded Apparatus is always specified by the code followed by the descriptor. For example,

- BAA1 Circuit Pack
- 364A Power Unit
- 113A Control Unit

The vintage or version of coded apparatus is controlled by a SERIES NUMBER. The series number may be appended to the apparatus code for a complete description of the product, but is not necessary because only the latest vintage is orderable at any given time. Apparatus-coded components for a battery plant are, typically, replacement parts and spares (see Section 5, “Spare Parts”).

Equipment-coded hardware is available in different configurations with combinations of optional features. The total number of combinations and permutations of the optional features on a given product may be in the hundreds or thousands. For this reason, a unique code is NOT assigned to each combination of options. Instead, a MAIN CODE is specified, which is followed by a list of identifiably separate options with the quantities for each option.

The main code number falls into one of three categories:

- J-code
- ED-code
- H-code

J-codes take the form JxxxxxA-y and are used to specify main assemblies, stand-alone products, and units that may have multiple applications.

ED-coding, of the form ED-xxxxx-yy, identifies subassemblies that are components of main equipment assemblies. For example, an ED-coded distribution panel assembly may be a component of a J-coded battery plant.

H-coding takes the form H-xxx-xxx and is used for a variety of special applications such as field installation kits, pre-assembled cables or custom configurations of options for a J-coded product.

The xxxxx part of an equipment code is called the **BASE NUMBER**. The y or yy, called the **DASH NUMBER**, is used to identify the vintage of the base number or to indicate a close relationship with products with the same base number.

A J-, ED- or H-coded piece of equipment is controlled by a standard drawing of the same number. This drawing contains the descriptions of the optional configurations, manufacturing assembly information and any additional details for engineering or field installation.

An equipment option is identified by a number or letter called a **LIST** or a **GROUP**. J- and H-coded equipment use Lists, while ED-coded products are equipped with Groups. For simplicity, the discussion that follows deals specifically with J-coded equipment. ED- and H-coded equipment, however, may be treated similarly.

The standard drawings for Lucent Technologies battery plants and their components are J-, T- and SD-drawings. Together these drawings provide the necessary details for engineering, planning, ordering, record-keeping, installation and repair. A thorough understanding of the construction and content of the standard drawings is, therefore, required for proper, error-free engineering and ordering of the battery plant. The drawings associated with this battery plant should be reviewed completely before preparing an order.

The generic features of J-, T- and SD-drawings are described in the following paragraphs.

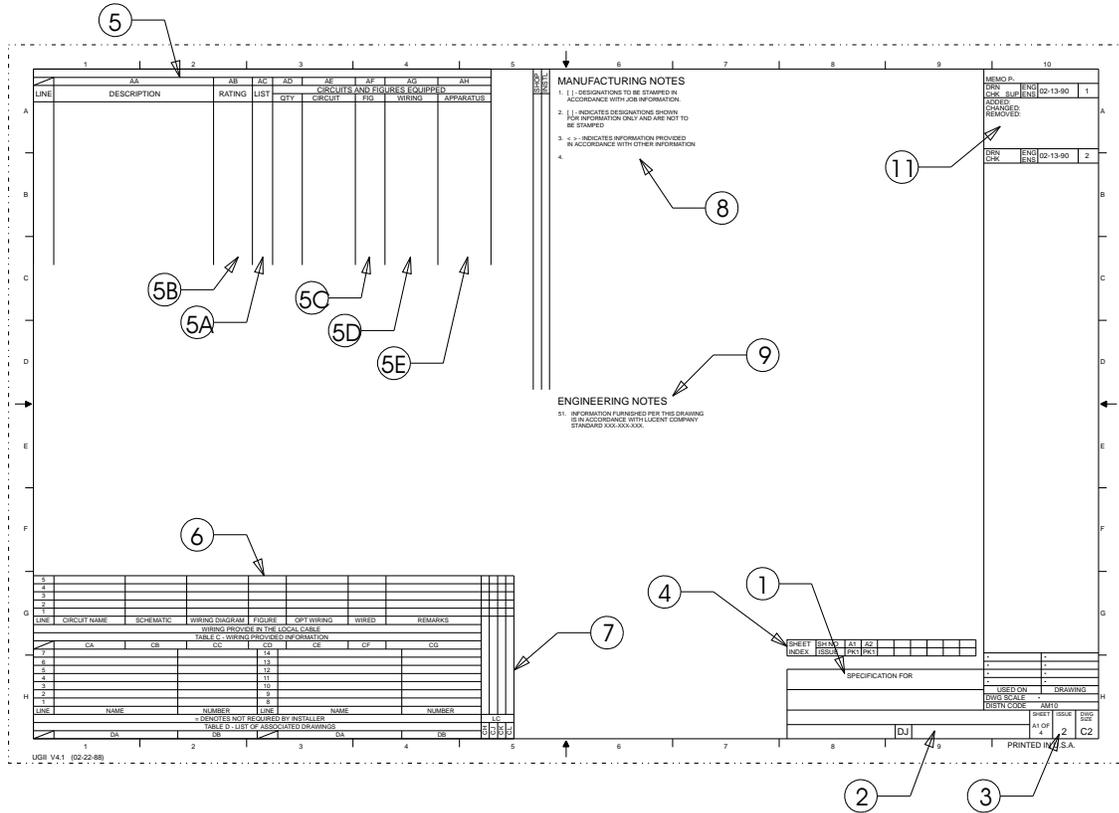


Figure 3-1: Typical J-Drawing A-Sheet

J-drawings A J-drawing consists of the following parts:

- Cover Sheet(s), containing ordering, engineering and issue information, as well as notes for manufacturing and installation.
- Assembly Views, showing details of shop and field assembly.
- Stocklist, listing the quantity and complete ordering code for each component part used in the assembly.

The cover sheets of a J-drawing contain a wide variety of important engineering and ordering information. The important parts of the cover sheet are described below. Item numbers, below, refer to those on the typical one page cover sheet displayed in Figure 3-1.

1. Title Block: This contains the official drawing title, including the input and output, if any. The title is NOT required for ordering purposes. Also included in the title block are the J-code and the issue number.

2. J-code: This number must be included in the order exactly as shown on the drawing. It is always followed by at least one List number when describing an orderable piece of equipment. On its own, the J-code refers to either the drawing itself or, in generic terms only, the product.

3. Issue number: Each sheet of a drawing has its own issue number, which changes whenever anything is changed on that sheet. The issue number of the first cover sheet changes whenever any sheet in the J-drawing is changed. The issue number of the cover sheet is called the DRAWING ISSUE.

The drawing issue number is one mechanism used to distinguish between vintages of the same product. Ordering information may or may not change when a J-drawing is reissued. The drawing issue must agree with the vintage of product available from Lucent Technologies. Reissued drawings are sometimes released prior to actual factory availability to provide time for engineering and order preparation. Consult your Lucent Technologies Account Executive for assistance with issue number coordination.

4. Sheet index: The index lists the numbers of all sheets in the drawing and their respective issue numbers. Some drawings have sheets numbered 1, 2, 3, etc. Many, including the example shown, are divided into A-, B-, C- and D-sheets. The A-sheets are the cover sheets and are numbered A1, A2, A3, etc. The B-sheets contain the main assembly views and are numbered similarly (B1, B2,...).

C-sheets are used to show assembly details and any other relevant graphical information. The stocklist is included on D-sheets.

5. Table A: Table A is the single most important entity on a J-drawing for engineering and ordering. It contains a description of each orderable feature, its ordering code, its availability and a cross-reference to the wiring diagram.

5.A List numbers: The ordering codes for product features are called Lists. They may be numbers, letters or combinations

thereof. A list describes a collection of parts which are: (1) assembled and packaged per the assembly views and stocklist of the J-drawing and (2) wired per the referenced figures of the T-drawing.

5.A-1 Main lists: The list number for a basic configuration of equipment is called a Main List. A Main List describes a set of features which is a lowest common denominator or a typical arrangement. There may be several Main Lists on a given J-drawing, that share, perhaps, common components or Supplementary Lists (see below). Only one Main List number is specified for one equipment assembly, and the quantity specified for that List is one.

5.A-2 Supplementary Lists: Features are added to or omitted from Main Lists by specifying Supplementary Lists. A Supplementary List is not orderable by itself but must be specified in addition to a main list. Different supplementary lists and multiples of individual supplementary lists may be specified for one main list. Restrictions on possible combinations of main and supplementary lists are described in the feature descriptions in Table A and/or in Engineering Notes (see below).

5.B Ratings: The availability for ordering of each List is controlled by the Rating, listed in Table A. Currently there are two Rating classifications: Available (AVAIL or no marking) and Discontinued Availability (DA). The conditions on discontinued availability, such as factory repair policy, vary from product to product and from List to List. Contact Lucent Technologies for information on specific products, as needed.

5.C Circuit Figures: There is often a Wiring Diagram (T-drawing) which is separate from the assembly drawing for equipment that incorporates factory wiring. If a List contains wiring, the associated Figure number of the T-drawing is indicated in Table A of the J-drawing. A quantity indicates the number of multiples of the wiring in the specified figure which are required for a List. When a T-drawing figure is not listed in parentheses, everything in the figure which is not indicated as optional is provided. (See below for a detailed discussion of T-drawing options.) When a T-drawing figure is listed in parentheses, only the indicated wiring or apparatus options are provided from that figure.

5.D Wiring Options: If portions of the wiring are connected differently among the Lists, those differences are indicated by T-drawing Wiring Options.

5.E Apparatus Options: When circuit components differ from one List to another, these differences are indicated by Apparatus Options on the T-drawing.

6. Table C: This table cross-references the schematic (SD) and wiring diagram (T).

7. Table D: This table provides a list of all associated drawings, such as other J-, ED- or H-coded equipment that must be ordered separately. Drawings which are required for engineering or manufacturing but are not necessary for installation are indicated by an equals-sign (=).

8. Manufacturing Notes and Symbols: Notes that apply to factory and/or field assembly are listed as Manufacturing Notes and are numbered from 1 to 50. The first several notes define standard symbols used on the assembly views and in the stocklist to indicate stamping and factory packaging methods. Additional manufacturing notes are specific to each J-drawing. All manufacturing notes should be read and understood by engineering, as well as installation, since they may include important installation details that the engineer must plan for.

9. Engineering Notes: For engineering, the second most important part of the J-drawing, after Table A, is the Engineering Notes section. These notes, starting at Note 51, provide such information as:

- Restrictions on List combination
- Additional job-specific hardware that must be ordered
- Product manual references
- Numbering conventions for panel positions

10. Other tables: Other non-standard tables may appear on the J-drawing to provide additional engineering, manufacturing and/or installation information. Each table should be referenced from an engineering or manufacturing note on the drawing.

11. Change Notes: Change or Revision Notes chronicle, in very abbreviated form, the history of drawing reissues and the

associated changes, such as additional Lists, modifications to assembly views, clerical error corrections and part number changes. The Issue number and date always FOLLOW the list of changes.

T-drawings T-drawings are used to show wiring details, such as wire colors, gauges, and routing, which cannot be conveniently shown in assembly views of the J-drawing. T-drawings are similar in format to J-drawings, with cover sheets and assembly sheets. There is no stocklist or Table A, however, on a T-drawing. The following T-drawing cover sheet features are essentially the same as those for J-drawings:

- Title Block
- Issue number
- Sheet Index
- Manufacturing Notes & Symbols
- Engineering Notes
- Change Notes

As with the J-drawing, all the notes on the T-drawing should be read completely when engineering a job. Other important features of the T-drawing cover sheet are Tables B, C and D. Table B of the T-drawing gives a historical record of the addition and elimination of options. This table corresponds to the Record of Change Table on the SD-drawing. (See below.)

As noted earlier, there is usually a close correspondence between options defined on the SD and those shown on the T-drawing. The exact correlation of options and figure numbers between the two drawings is given in Table C.

Table D gives is an index to the locations of T-drawing options on the various sheets of the drawing. There is a similar Option Index on the SD. (See below.)

The wiring information is shown graphically two ways: Shop Figures and Installer Figures. Shop figures are numbered 1, 2, 3, etc. for main figures and A, B, C, etc. for details. Installer figures are similarly numbered but with the prefix “H”. All connections and circuit components in a given figure, that are not indicated as optional, are provided when that figure is specified by the

J-drawing. Options are indicated on the figures by a letter or letters inside a double circle.

An option is defined when alternative connections or circuit components are possible. T-drawing options are called Wiring options for connection alternatives and Apparatus options for component differences. Where possible, T-drawing options are derived directly from those defined on the SD-drawing, using the same lettering scheme (see below). Options which are found on the T-drawing, but not on the SD, always include the prefix "H". Optional wiring and hardware is provided only when the associated options are specifically called for by Table A of the J-drawing.

SD-drawings

The SD-drawing is the source for the circuit information that describes a product. The connectivity and options shown on the T-drawing are based on the SD. The parts on the J-drawing stocklist which are circuit components are documented on the SD. Mechanical parts, wire colors, wire routing and cable harnesses, however, are not necessarily shown on the SD.

The SD-drawing package is usually sectionalized, similar to the J-drawing, as follows:

A-sheets are cover sheets including Title Block, Supporting Information, Sheet Index, Option Index. All of this information is similar in format to that on T- and J-drawings. B-sheets contain the Functional Schematics (FSs). C-sheets list the Apparatus Figures (APP FIGs) (i.e., circuit component lists). D-sheets contain drawing notes categorized as Circuit Notes (numbered 101 to 200), Equipment Notes (numbered 201 to 300) and Information Notes (301 to 400). Certain standard notes of particular interest are:

Note 102 - Feature & Option Table which describes each option letter, is often duplicated in the T-drawing engineering notes.

Note 103 -The Record of Change Table traces when options are added and discontinued on various drawing issues, as in Table C of the T-drawing.

SD notes often contain important details on applications of circuit features and options, so all notes should be read before completing the engineering process.

G-sheets show Cabling Diagrams (CADs), define terminal designations and wiring for installer connections. This information is duplicated in the Installer Figures of the T-drawing.

H-sheets are included in some SD-drawings to provide Block Diagrams (BDs) that are helpful in understanding complex circuits.

J-sheets are used for Circuit Pack Schematics (CPSs), if any are included in the SD. Most circuit packs, however, are documented on separate schematic drawings, some of which are proprietary and are not generally accessible.

***Documentation
References***

The following drawings, diagrams and manuals provide the engineering, ordering and installation information for the Lineage[®] 2000 ECS battery plant.

ECS Battery Plant

Assembly and Ordering Drawing: H569-401
Wiring Diagram: T-82670-30
Schematic Diagram: SD-82670-01
Product Manual: 167-790-128

Supplementary information on the ECS controller, Lineage[®] 2000 SR series rectifier and Rectifier Shelf Assembly (RSA), and the Lineage[®] 2000 VR series battery may be found on the following documents.

ECS Controller

Assembly and Ordering Drawing: J85501D-1
Wiring Diagram: None
Schematic Diagram: SD-82669-01
Product Manual: Select Code 167-790-031

SR Series Rectifiers and RSA

Assembly and Ordering Drawing: J85702B-
Wiring Diagram: None
Schematic Diagram: SD-82668-01
Product Manual: Select Code 169-790-117

4 ***Installation***

General

As mentioned at the beginning of Section 3, Lucent Technologies offers complete engineering and installation service that result in turn-key plant operation. Contact your Lucent Technologies Account Executive for further information on the complete range of installation services available from Lucent Technologies. Customers may, however, choose to make their own arrangements to fully or partially install the battery plant based on the information supplied here.

This section outlines an efficient sequence of battery plant installation steps that minimizes the installer's exposure to live circuits. A suggested test sequence is also provided to check the integrity of the installation effort. Upgrades, retrofits and replacement of equipment in the controller, rectifier and battery subsystems are covered in their respective manuals.

The framework, rectifier, controller and dc distribution subsystems, described in Section 2, are factory tested as a system. The controller and distribution subsystems are shipped assembled to the framework, ready for use. To improve shipping and handling, the rectifiers are packaged separately and must be plugged into their shelf assemblies during the plant installation process. The battery plant installation sequence that follows refers to the Rectifier and Controller manuals for details for those subsystems. Read this section and the referenced sections in other subsystem manuals completely before starting any work.

Installation Tools and Test Equipment

The following tools and test equipment are required for battery plant installation and testing.

- Equipment to handle shipping containers, remove framework from shipping containers, and erect framework into final position. Minimum lifting capacity: 250 lbs.
- Common electrician's hand tools.
- Proper crimping tools and dies for connectors used.
- Common mechanic's hand tools
- DMM (Digital Multimeter) with at least 0.05% accuracy on the dc scale.
- DC Dummy Load Bank rated for 75 amperes minimum at 60 volts dc.
- Power Supply, variable from zero to 60 volts dc at 2 amperes. Supply should have both coarse and fine output controls.
- Six clip leads each capable of carrying 3 amperes.

Suggested Installation Sequence

General Information

1. The plant may be wired with ac from the left side or the right side. Typical routing of ac, dc and control cabling is shown on the plant assembly drawing, H569-401. Connection points and wire types are indicated on the plant wiring diagram, T-82670-30.
2. When running dc cable, care should be taken to ensure that all non-protected leads are run in a separate cable rack from protected leads. (Protected, in this sense, refers to overcurrent protection by a fuse or circuit-breaker.) Battery leads are usually the only unprotected leads. When Lucent Technologies VR Batteries are used, the battery leads may be protected. Refer to the Battery Manual for more detail on this option.
3. All dc leads should be separated wherever possible from ac leads to minimize electrical noise transmitted to the load.
4. Pair the battery potential lead with the associated return lead of a given circuit for as much of the run as possible.

5. All control leads and other small gauge wiring should be separated from the ac and dc power leads to prevent physical damage. (Routing of control leads within the controller is described in the Controller manual.)
6. All bolts making electrical connections should be torqued per the values in Table 4-A; all bolts for mechanical connections should be torqued per values in Table 4-B.

***Sequence of
Tasks***

Table 4-C lists the drawings, manuals and other documentation that are necessary to complete the following Sequence of Tasks.

Step A - Unpacking, Handling & Frame Installation:

Before opening the packaging, carefully inspect the outside, in the presence of shipping personnel, for signs of damage. If damaged, follow the shipping carrier's procedure for filing a damage claim.

To ensure personnel safety and equipment protection use appropriate equipment during handling of crates and uncrated equipment. Use the equipment weights and dimensions, given in Section 2, as a guideline for choosing material handling tools. Move crated equipment to an area with adequate space and tools for unpacking and handling.

Carefully open the packaging to verify that the contents are complete and undamaged. If the equipment must be returned, it should be repacked in the original shipping crate.

Table 4-A: Minimum Torque for All Electrical Connections

Screw Size	Torque - lb-in or lb-ft					
	Wire Connections		Head Tightened		Nut Tightened	
	Slotted Machine	Hex or Socket Cap	Slotted Machine	Hex or Socket Cap	Slotted Machine	Hex or Socket Cap
8-32	15	15	19	19	19	23
10-24	21	21	27	27	27	33
1/4-20	50	50	65	65	65	80
5/16-18	-	100	-	135	135	165
3/8-16	-	180	-	240	240	290
7/16-14	-	280	-	385	385	465
1/2-13	-	500	-	585	585	710
5/8-11	-	(71)	-	(97)	(97)	(118)
3/4-10	-	(125)	-	(172)	(172)	(209)

Notes:

1. Slotted machine screws should be pan-head type.
2. Slotted machine and hex cap screws should be SAE Grade 2 steel or equivalent.
3. Socket cap screws should have 100,000 psi minimum tensile strength.
4. Steel flat washers should be furnished under heads of socket cap screws.
5. Ferrous screws and washers should have a corrosion protective finish.
6. Locking means is required only for connections subject to vibration. Belleville-type washers or jam nuts are the preferred means.
7. For less than 1/4 inch thick tapped copper bars, use No. 8, No. 10, or 1/4 inch machine screws to minimize applicable torque. When larger size screws are required, provide captive-type steel nuts or reduce torques.
8. Torque recommendations are also suitable for all non-ferrous fasteners, except aluminum.
9. Where application permits, hex cap screws should be used.

Table 4-B: Torque and Minimum Yield Strength for Mechanical Connections using Hex Head Cap Screws

Cap Screw Diameter	Minimum Yield Strength (PSI)	Torque (ft-lb) UNRC
1/4	57,000	6
3/16	57,000	12
3/8	57,000	22
7/16	57,000	35
1/2	57,000	54
9/16	57,000	77
5/8	57,000	107
3/4	57,000	190
7/8	36,000	193
1	36,000	290
R1-1/8	36,000	410
1-1/4	36,000	580
1-3/8	36,000	760
1-1/2	36,000	1010

Table 4-C: Installation Reference Documents

Step	Procedure	Reference Document (See Section 3)
A	Unpacking Handling and Frame Installation	H569-401 Drawing
B	Battery Stand Assembly	Battery Manual
C	Initial Battery Charge	Battery Manual Rectifier Manual
D	Cable Support and Ground System	Job Application Drawings
E	Controller Setup and LVD Test	Controller Manual
F	AC Wiring, Rectifier Installation and Rectifier Test	Rectifier Manual H569-401 Drawing T-82670-30 Drawing
G	Load Wiring	H569-401 Drawing T-82670-30 Drawing
H	Battery Connections	Battery Manual H569-401 Drawing T-82670-30 Drawing
I	Controller Test	Controller Manual
J	Load Turn Up	Load Equipment Documentation

Step B - Battery Stand Assembly:

Warning

Do not connect batteries to the system at this time.
--

Assemble battery stands per the battery manufacturer's documentation. Install the batteries onto their stands.

Step C - Initial Charge:

Batteries may undergo initial charging at this time, according to the manufacturer's recommendations. One of the rectifiers may be used for initial charging. Refer to the procedure given in the Rectifier manual.

Step D - Cable Support and Ground System:

Hang all cable support systems, as well as any auxiliary ground bus bars, as dictated by the job application drawings.

Step E - Controller and LVD Set-up:

Follow the controller set-up procedure given in the Controller manual to complete the steps below.

1. Enable/disable equalize charge set-up
2. Enable/disable rectifier restart set-up
3. Set HV shutdown level(s)
4. Set BD alarm level
5. Run office alarm wiring
6. Run other controller wiring
7. Set-up other optional circuit packs

Check and set the low-voltage disconnect/reconnect, if provided, at the desired voltage level. See Figure 4-3 for the location of the disconnect voltage select jumpers, J505.1 and J505.2 on CP5 Fuse Board. Plug these jumpers across pins 1 and 2 of their respective connectors to provide a disconnect voltage of 42.5 +/- 0.5 volts. To provide a disconnect voltage of 40.5 +/-

0.5 volts, plug the jumpers across pins 2 and 3 of their respective connectors. Refer to the ECS controller manual for acceptance testing procedures for the CP5 circuit pack and the associated LVD/R feature.

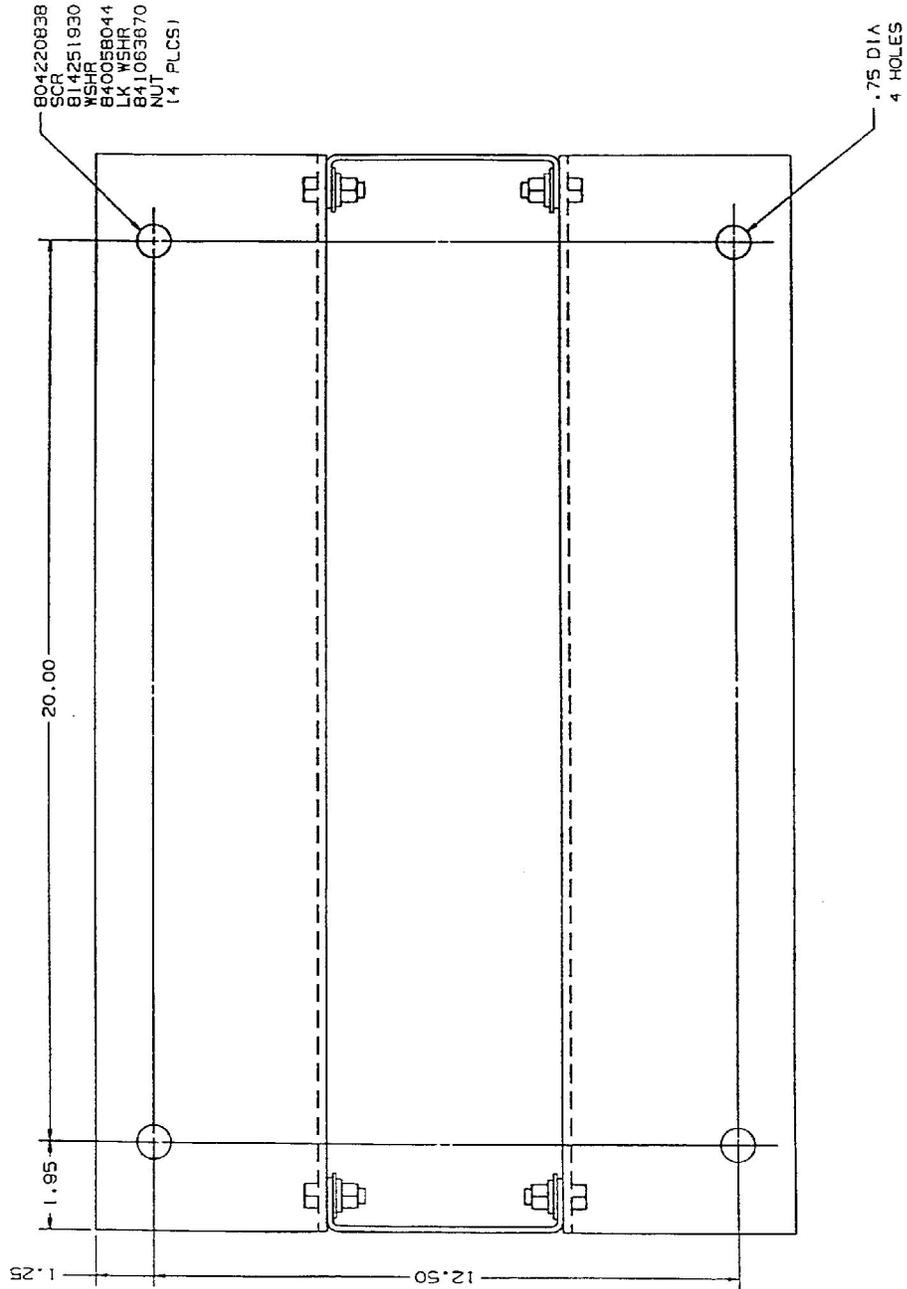


Figure 4-1: Frame Footprint

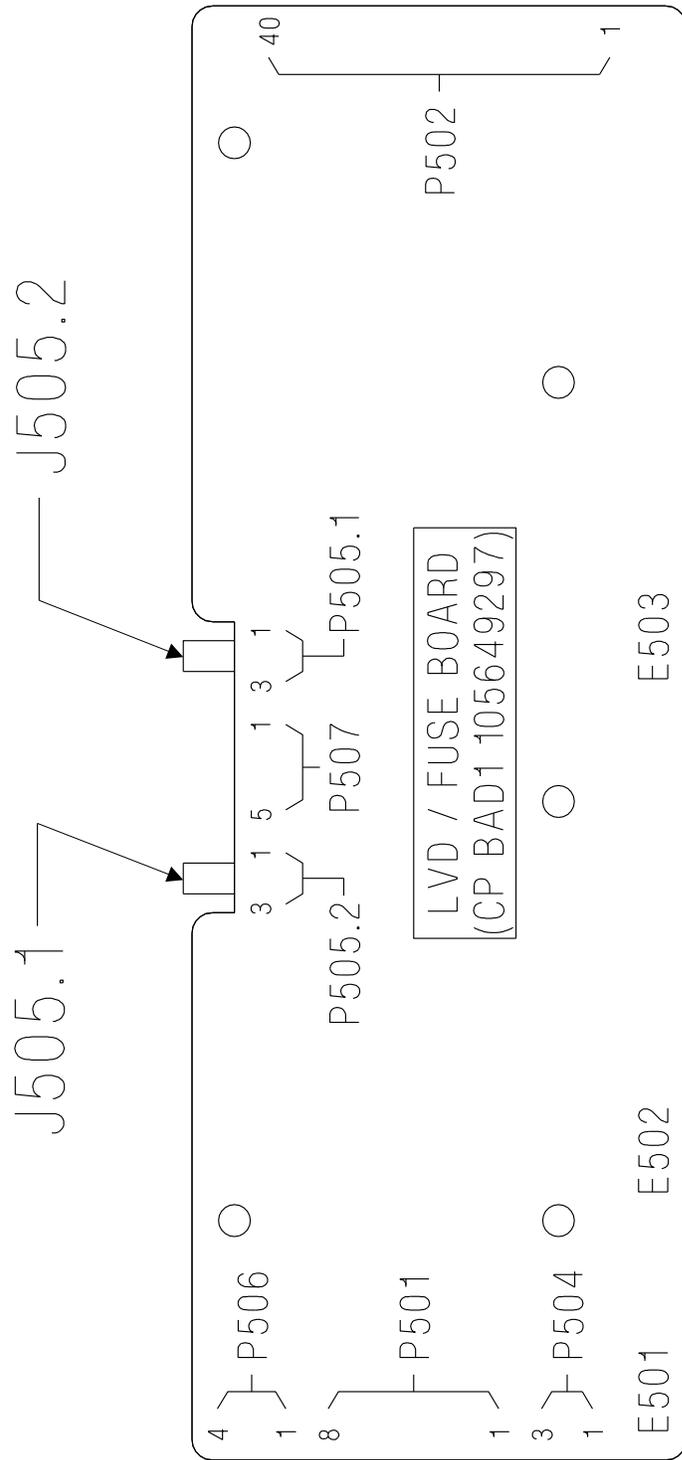


Figure 4-2: LVD/Fuse Board (CP5) Jumper Locations

Step F - AC Wiring, Rectifier Installation, and Test:

Refer to the installation and start-up procedure in the Rectifier manual for the following steps.

- Wire AC
- Set up
- Plug in
- Test

Note

It is recommended that ac be wired during the initial installation for all rectifier positions that may be used in the future. If ac is prewired in this way, growth in rectifier capacity is as simple as plugging in an additional rectifier.

Before proceeding, verify that all rectifier output circuit breakers are in the OFF position.

Step G - Load Wiring:

Open the dc distribution cover panel by turning the two 1/4 turn fasteners located on the front of the panel.

DANGER

Verify that no voltage is present on the dc distribution bus bars and that all dc circuit breakers are off before connecting any load leads.

Run paired leads (supply and return) to each load from a dc distribution circuit breaker and from the discharge return bus. The load supply leads are terminated at the battery plant end on terminal blocks TB701 on the distribution printed wiring boards. The load return leads are terminated at the battery plant end on the discharge return bus, directly above the load supply lead termination. The termination points for the load leads are numbered 1 to 42, from left to right. Distribution breaker positions are also numbered 1 to 42, from left to right.

To install a circuit breaker, first verify that the circuit breaker is in the OFF position. Plug in the circuit breaker and visually verify that the line, load, and alarm connections are properly

mated. (See Figure 2-7). Remove the plastic knockout from the associated position on the front cover. Mark the new circuit on the distribution front cover label. Spare circuit breakers may or may not be provided with the dc distribution panel, as ordered. Spare circuit breakers may be stored in distribution panel if in the OFF position. Leads may be run to spare circuit breaker positions in anticipation of future growth (similarly to prewiring rectifier ac input in Step D, above).

Recommendations for routing and dressing of load leads as they leave the battery plant and enter the cable rack system is shown on the plant assembly drawing, H569-401. Consult the job application drawings for the routing of these leads to the load equipment. A label is provided on the dc distribution cover that may be marked to indicate each load breaker's use.

Before proceeding, verify that all load circuit breakers are in the OFF position.

Step H - Battery Connections, Disconnect Installation, and Test:

Remove all fuses from CP5 Fuse Board. Confirm that the output circuit breakers of all rectifiers and that all distribution breakers are open.

DANGER

<p>The next step in this procedure will apply battery power to the battery plant. Before contacting any uninsulated conductor surfaces, always use a voltmeter to insure that no voltage, or the expected voltage, is present.</p>
--

Interconnect the battery strings and, if provided, the emergency disconnect circuit, as instructed by the battery manufacturer's documentation. The emergency disconnect circuit shown on the plant documentation (SD-82670-01 and T-82670-30), including the battery string disconnect and emergency plant shutdown switch, is designed for use with the Lucent Technologies VR battery. Other applications of the disconnect circuit must be specified on the job application drawings and are not described in this manual.

Run all cables from the battery and return bus bars to the battery strings by first connecting them to the bus bars in the dc distribution subsystem. For suggested cable routing within the

Important

Leave the disconnect breaker open or leave one intercell connection out so that there is an open circuit between the two terminals of each string before proceeding.

dc distribution see the H569-401 drawing. Replace the dc distribution cover panel on the plant framework after all connections have been made at the plant bus bars.

Terminate the cables from the dc distribution at each battery string according to the manufacturer's documentation. Measure the resistance between the two ends of any battery string to verify that the circuit is open. Close the last remaining part of the battery circuit on each string (either intercell connector or disconnect breaker).

Reinsert all fuses in CP5 Fuse Board. Match the fuse ratings and positions as indicated on the distribution cover panel.

Note

The white indicators on F1 through F11 represent a 1-1/3 amp rating and the orange indicator on F12 represents a 2 amp rating.

Step I - Controller Test:

Follow the controller test procedure given in the ECS controller manual to complete the steps below.

1. Test Enable/disable equalize charge feature.
2. Test Enable/disable rectifier restart feature.
3. Test HV shutdown level(s).
4. Test BD alarm levels.
5. Test other optional circuit packs.

Step J - Load Turn-up:

Turn on and adjust all rectifiers for normal operation according to the Rectifier manual.

Warning

Before applying power to any individual load, follow the powering up instructions as provided in the associated load equipment documentation.

Connect all loads, one at a time, by turning on the load circuit breakers. If a circuit breaker trips immediately when turned on, this may be due to inrush current and does not necessarily indicate a fault condition. Attempt to close the circuit breaker a second time. If the breaker trips again, check the wiring to the load circuit.

Installation Procedures for Plant Growth

As your power needs evolve, equipment may be readily added to the battery plant to provide any of the following.

- expanded controller features
- additional rectifier capacity
- increased battery capacity
- additional load circuits

Procedures for adding controller features, rectifiers and batteries to an operating plant are described in the installation sections of the associated subsystem manuals. The procedure to add load circuits, since they are part of the dc distribution subsystem, is described below.

Adding a Load Circuit

Warning

Procedures in this paragraph may cause power alarms to be issued temporarily. Notify the alarm reporting center before starting any installation procedure on an operating battery plant.

The following procedure provides the steps to add a new load circuit to an operating battery plant.

Step A - See Section 3 under Ordering for Growth, for details on sizing and obtaining additional circuit breakers.

Step B - Alarms may be issued during the installation process (e.g. by a new circuit breaker in the OFF position). Notify the alarm reporting center of that alarms may be received.

Step C - Open the dc distribution cover panel, taking care not to disturb any load-carrying circuit breakers.

DANGER

Battery voltage is present behind the distribution cover panel. Remove all jewelry before working in this area. Use insulated tools only.

Caution

Accidentally or intentionally turning a circuit breaker off may affect service to load equipment. Take care not to disturb load-carrying circuits.

Step D - Locate the intended new breaker position. Spare circuit breakers may or may not already be in place on the dc distribution panel, as ordered. Alternatively, spare distribution leads may or may not have been run to the new load location.

- a. If a spare circuit breaker is already plugged in the next available position, verify that the breaker is OFF.

DANGER

Do not plug a closed circuit breaker into a circuit which may be connected. Arcing may result in personnel injury and equipment damage.

- b. If a new breaker must be added, switch it to the OFF position. Plug in the new breaker. If possible, visually verify that line, load and alarm connectors are properly mated. (See Figure 2-7).

Step E - If leads have NOT already been run to the intended load from a spare circuit breaker position (e.g., during the initial plant installation), install these leads by following Installation Step G, "Load Wiring" above.

Step F - Mark the new circuit on the distribution cover panel label.

Step G - For safety, close the dc distribution front cover before proceeding to the next step.

Warning

<p>Before applying power to any individual load, follow the powering up instructions as provided in the associated load equipment documentation.</p>
--

Step H - Turn on the load circuit breaker. If the circuit breaker trips immediately when turned on, this may be due to inrush current and does not necessarily indicate a fault condition. Attempt to close the circuit breaker a second time. If the breaker trips again, check the wiring to the load circuit.

Step I - When all work on the dc distribution is complete, close the distribution cover and notify the alarm reporting center.

5 *Maintenance*

Controls and Indicators

Operating controls and indicators on the battery plant are listed below.

Controller LEDs and Switches

See Controller Manual.

Rectifier LEDs and Switches

See Rectifier Manual.

CP5 Fuse Board LEDs and Fuses

Two LEDs on the CP5 Fuse Board are used to indicate the status of the low-voltage disconnect/reconnect circuit.

- The red “LVD OPEN” LED indicates that the disconnect/reconnect contactor is open and, therefore, that batteries are disconnected from the rest of the battery plant.
- The yellow “LVD FAIL” LED indicates that only one of the two redundant low-voltage detectors has directed the contactor to open and that the disconnect circuit may have failed.

Fuses F1 through F12 are also located on the CP5 LVD/Fuse Board and provide power for controller functions and rectifier regulation. When a fuse blows the colored indicator (white or orange) pops up and an alarm signal is transmitted to the controller. The fault should be cleared before replacing a blown fuse. See “Troubleshooting,” below, for details on replacing blown fuses.

***DC Circuit
Breakers/Fuses***

Circuit breakers CB1 through CB42 are located in the DC distribution. Circuit breakers CB101 through CB107 are optional disconnects for Lucent Technologies VR battery strings. If equipped, the VR battery disconnect breaker is located on the side of each battery string.

Any circuit breaker in the battery plant is ON (or closed) when the handle is in the Up position, and OFF (or open) in the Down position. A circuit breaker which is supplying a load may be turned off manually, but this may affect service to the load. If a breaker has tripped off, the overcurrent problem should be cleared before restoring power to the load by resetting the breaker. See “Troubleshooting,” below, for information on tripped breakers.

Troubleshooting

Table 5-A provides a list of observable trouble conditions, their possible causes and the necessary corrective action for each cause. The table is organized by the subsystem in which the trouble is observed. Trouble indicated by the office alarm system is covered in the Table 5-A under the Controller subsystem.

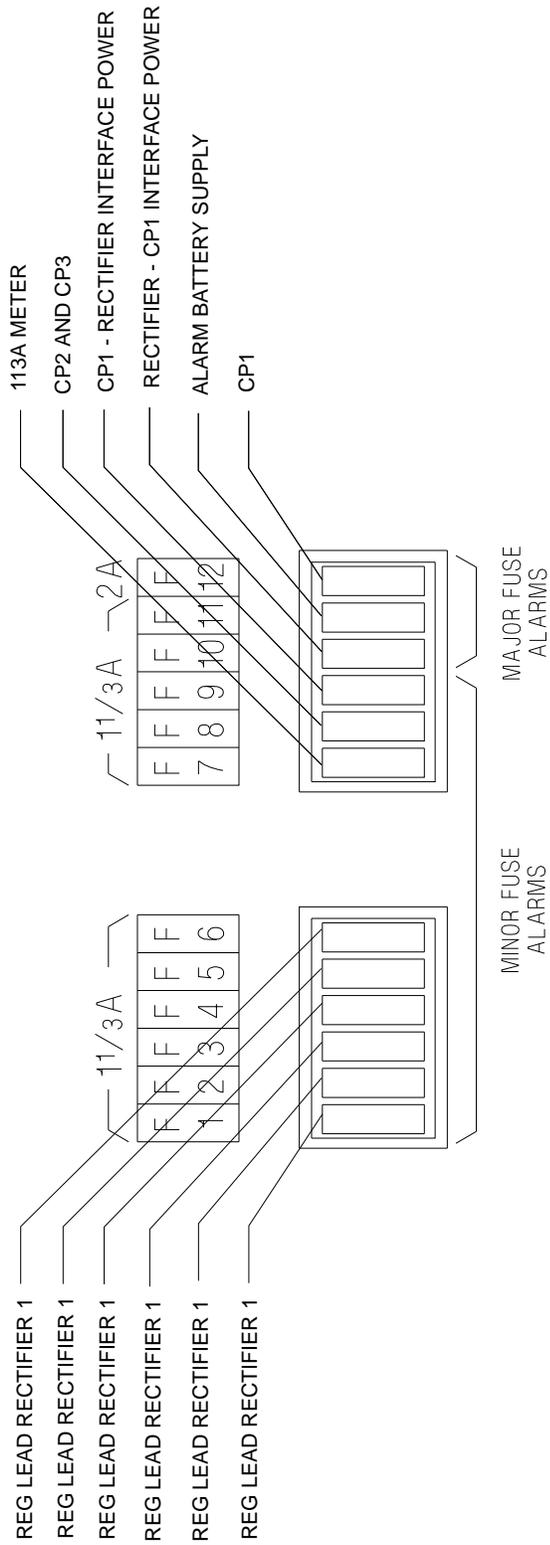


Figure 5-1: Fuse Designation and Function for LVD/Fuse Board (CP5)

Table 5-A: Troubleshooting

Observed Condition	Probable Cause	Procedure #
Controller		
Red or yellow LEDs lit No LEDs or Display lit Meter inaccuracy Office alarms issued False alarms issued Blown fuse on LVD/Fuse board	See “Troubleshooting” in Controller Manual	
Rectifier		
Red or yellow LEDs lit No LEDs or Display lit No output/low output Oscillation Open output breaker	See “Troubleshooting” in Rectifier Manual	
DC Distribution Subsystem		
Open distribution breaker or fuse	a. manually turned off b. overcurrent trip c. breaker failure	Open Distribution Breaker
“LVD OPEN” LED lit	a. failed LVD contactor b. low voltage c. faulty wiring d. LVD circuit failure	Red “LVD OPEN” LED Lit
“LVD FAIL” LED lit	a. low voltage b. LVD circuit failure	Yellow “LVD FAIL” LED Lit
Battery Subsystem		
Open disconnect breaker	a. manually turned off b. remote emergency trip c. overcurrent trip d. breaker failure	Open Battery Disconnect Breaker

***Open
Distribution
Breaker***

A distribution breaker which should be closed may be in the open position for one of the following reasons:

- A distribution breaker may have been inadvertently turned off manually. If this is the case, follow the proper procedure to restore power to the load equipment. If a distribution breaker is no longer needed, it may be unplugged from the panel or left in the OFF position.
- A distribution breaker or fuse may be open due to a short circuit in the load equipment or wiring. The fault must be cleared before resetting the breaker, except when the trip is suspected to be caused by inrush current during equipment start up.
- A circuit breaker may fail such that it cannot be reset. Replace a failed distribution breaker as described in paragraph “Load Circuit Breaker Replacement” below.

***Red LVD OPEN
LED Lit***

A lit red “LVD OPEN” LED indicates that the LVD Contactor is de-energized, i.e., open. The contactor may be open due to one of the following reasons:

- Plant voltage is below the disconnect threshold.
- The contactor has failed and must be replaced. See procedure “LVD/R Contactor Replacement” below.
- There is an open circuit in the wiring that powers the contactor. Check the cable assembly from CP5 to the contactor (see drawing T-82670-30).
- Both redundant LVD sensing circuits have failed. Replace the CP5 circuit pack per procedure “LVD/Fuse Board (CP5) Replacement” below.

***Yellow LVD
FAIL LED Lit***

A lit yellow “LVD FAIL” LED indicates that one or both of the LVD circuits has attempted to open the contactor, but the contactor is closed. This may occur due to one of the following reasons:

- The plant voltage is right at the disconnect level and is within tolerances of the redundant detector circuits, but only one detector has operated. No action is required.

- The LVD circuit has partially failed. Replace the CP5 circuit pack per procedure “LVD/Fuse Board (CP5) Replacement” below.

Blown Fuse on CP5

Refer to ECS controller manual for trouble shooting procedures.

Note

Replace with fuse of same rating only.

Open Battery Disconnect Breaker

The battery disconnect breaker may be open for one of the following reasons:

1. Manually turned off: breaker may be reset when verified that the string should be reconnected.
2. Remote emergency trip: when trouble is cleared, breakers may be reset.
3. Overcurrent trip: check for short circuit in string, replace batteries, as required, and reset breaker.
4. Breaker failure: replace breaker per VR battery manual.

Repair and Replacement

Note

Procedures in this paragraph may cause power alarms to be issued temporarily. Notify the alarm reporting center before starting any repair procedure.

Load Circuit Breaker Replacement

Step A. Obtain a replacement circuit breaker. See paragraph “Spare Parts.”

Step B. Verify that the faulty breaker is in the OFF position.

Step C. Loosen the 1/4 turn fasteners and open the dc distribution cover.

Step D. Measure the voltage on terminal block TB701 at the load connection associated with the faulty breaker, to verify that the breaker is truly open. The voltage on TB701 relative to the battery bus bars or circuit breaker bus bar should be approximately the float voltage of the plant.

If the faulty breaker is, in fact, still closed, the load equipment which it powers must be shut down so that no current flows through the breaker.

DANGER

Do not attempt to unplug a circuit breaker which may be carrying current. Arcing may result in personnel injury and equipment damage.

Step E. Unplug the faulty breaker from the printed wiring board.

Step F. Switch the new circuit breaker to the OFF position before plugging it in.

Step G. Plug in the new breaker, ensuring that line, load and alarm connectors are properly mated (see Figure 2-7).

Step H. Remove the plastic knockout from the associated position on the cover panel.

Step I. For safety, close the dc distribution door before proceeding to the next step.

Warning

Before applying power to any individual load, follow the powering up instructions as provided in the associated load equipment documentation.

Step J. Turn on the load circuit breaker. If the circuit breaker trips immediately when turned on, this may be due to inrush current and does not necessarily indicate a fault condition. Attempt to close the circuit breaker a second time. If the breaker trips again, check the wiring to the load circuit.

Step K. Note that Fuse Alarm Major (MJF) and its associated alarms retire.

Step L. When all work on the dc distribution is complete, refasten the cover panel.

***LVD/R
Contactor
Replacement***

The following assumptions are made:

- contactor coil has failed
- the contactor is open
- the rectifiers are carrying the load (off battery) with excess capacity available for charging the batteries.
- battery string(s) are at a voltage below the rectifier voltage in a state of partial or complete discharge.
- “LVD OPEN” LED is lit on the distribution front panel.

The following equipment is required:

- socket wrench with insulated handle
- 1/2 inch socket

Procedure: (Refer to Figure 2-5 and T-82670-30 drawing)

1. Remove rectifier in position directly beneath LVD/R contactor (position 1), if present.
2. Open distribution panel and unplug connector P501 from J501 on LVD/Fuse board (CP5). Leave cable dressed.
3. Disconnect and label the 5 quick connects from the contactor coil and auxiliary switch.
4. Unbolt and remove contactor.
5. Reconnect quick connect leads to new contactor and then mount new contactor using hardware from Step 4.
6. Plug P501 into J501 on LVD/Fuse board (CP5) and verify that contactor closes.
7. Replace rectifier and turn on.
8. Close distribution panel and verify that LVD FAIL and LVD OPEN lights are not lit.

***LVD/Fuse Board
(CP5)
Replacement***

The following equipment is required:

- standard screwdriver

Procedure: (Refer to Figure 4-3 and T-82670-30 drawing)

1. Open distribution panel.
2. Unplug the following connectors from the LVD/Fuse Board (CP5). Leave the cables dressed.
 - P502 from J502
 - P506 from J506
 - P501 from J501
 - P504 from J504
 - Quick Connect from E501
3. Remove the 5 mounting screws.
4. Set jumpers J505.1 and J505.2 on replacement LVD/Fuse Board (CP5) per H569-401 drawing for desired disconnect voltage.
5. Mount the replacement board to the distribution panel using the hardware from Step 3.
6. Reconnect the following connectors:
 - P502 to J502
 - P506 to J506
 - P501 to J501
 - P504 to J504
 - Quick Connect to E501
7. Close distribution panel.

Spare Parts

The following equipment may be ordered as spare parts. For exact ordering codes, refer to recommended spares information on the H569-401 drawing.

Rectifiers and fans

LVD/Fuse Board (CP5)

Fuses (F1 to F12)

Load Circuit Breakers (CB1 to CB42)

Controller Circuit Packs (e.g., 113A/CU)

(Refer to the Controller manual for details on spare controller circuit packs.)

In addition to these items, any piece part may be ordered that is identified in the assembly views and stocklist on the H569-401 drawing. When ordering, please specify the Description and Comcode as shown in the stocklist.

6 *Product Warranty*

A. Seller warrants to Customer only, that:

1. As of the date title to Products passes, Seller will have the right to sell, transfer, and assign such Products and the title conveyed by Seller shall be good;
2. Upon shipment, Seller's Manufactured Products will be free from defects in material and workmanship, and will conform to Seller's specifications or any other agreed-upon specification referenced in the order for such Product;
3. With respect to Vendor items, Seller, to the extent permitted, does hereby assign to Customer the warranties given to Seller by its Vendor of such Vendor Items, such assignment to be effective upon Customer's acceptance of such Vendor Items. With respect to Vendor items recommended by Seller in its specifications for which the Vendor's warranty cannot be assigned to Customer, or if assigned, less than Sixty (60) days remain of the Vendor's warranty or warranty period when the Vendor's items are shipped to Customer or when Seller submits its notice of completion of installation if installed by Seller, Seller warrants that such Vendor's items will be free from defects in material and workmanship on the date of shipment to Customer. In such an event, the applicable Warranty Period will be sixty (60) days.

B. The Warranty Period listed below is applicable to Seller's Manufactured Products furnished pursuant to this Agreement, unless otherwise stated:

Warranty Period

Product Type	New Product	Repaired Product or Part*
Central Office Power Equipment**	24 Months	6 Months
* The Warranty Period for a repaired Product or part thereof is as listed or, in the case of Products under Warranty, is the period listed or the unexpired term of the new Product Warranty Period, whichever is longer.		
** The Warranty Period for Products ordered for Use in Systems or equipment Manufactured by and furnished by Seller is that of the initial Systems or equipment.		

C. If, under normal and proper use during the applicable Warranty Period, a defect or nonconformity is identified in a Product and Customer notifies Seller in writing of such defect or nonconformity promptly after Customer discovers such defect or nonconformity, and follows Seller's instructions regarding return of defective or nonconforming Products, Seller shall, at its option attempt first to repair or replace such Product without charge at its facility or, if not feasible, provide a refund or credit based on the original purchase price and installation charges if installed by Seller. Where Seller has elected to repair a Seller's Manufactured Product (other than Cable and Wire Products) which has been installed by Seller and Seller ascertains that the Product is not readily returnable for repair, Seller will repair the Product at Customer's site.

With respect to Cable and Wire Products manufactured by Seller which Seller elects to repair but which are not readily returnable for repair, whether or not installed by Seller, Seller at its option, may repair the cable and Wire Products at Customer's site.

D. If Seller has elected to repair or replace a defective Product, Customer shall have the option of removing and reinstalling or having Seller remove and reinstall the defective or nonconforming Product. The cost of the removal and the reinstallation shall be borne by Customer. With respect to Cable and Wire Products, Customer has the further responsibility, at its expense, to make the Cable and Wire Products accessible for repair or replacement and to restore the site. Products returned for repair or replacement will be accepted by Seller only in accordance with its instructions and procedures for such returns. The transportation expense

associated with returning such Product to Seller shall be borne by Customer. Seller shall pay the cost of transportation of the repair or replacing Product to the destination designated by Customer within the Territory.

- E. The defective or nonconforming Products or parts which are replaced shall become Seller's property.
- F. If Seller determines that a Product for which warranty service is claimed is not defective or nonconforming, Customer shall pay Seller all costs of handling, inspecting, testing, and transportation and, if applicable, traveling and related expenses.
- G. Seller makes no warranty with respect to defective conditions or nonconformities resulting from actions of anyone other than Seller or its subcontractors, caused by any of the following: modifications, misuse, neglect, accident, or abuse; improper wiring, repairing, splicing, alteration, installation, storage, or maintenance; use in a manner not in accordance with Seller's or Vendor's specifications or operating instructions, or failure of Customer to apply previously applicable Seller modifications and corrections. In addition, Seller makes no warranty with respect to Products which have had their serial numbers or month and year of manufacture removed, altered, or with respect to expendable items, including, without limitation, fuses, light bulbs, motor brushes, and the like.

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