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Lucent Technologies Lineage® 2000 600-Ampere, +24-Volt ECS Battery Plant

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

This product manual (Select Code 167-790-041) describes the H569-403 ECS Battery Plant, which is shown in Figure 1-1. This member of the ECS family of battery plants operates from a nominal 208/240 volt ac, 50/60 Hz source. It offers a 600-ampere total plant capacity with a nominal 24-volt dc output in a totally integrated energy system.

The basic plant consists of charge and discharge bus bars with optional low voltage disconnect, a circuit breaker panel for 24-volt distribution requirements, an ECS controller, two rectifier shelf assemblies which can connect up to six Lineage® 2000 SR Series +24-volt, 100-ampere rectifiers, and space for four 24-volt to 48-volt, 10-ampere dc to dc converters and a fuse panel for 48-volt distribution needs.

The plant's modular front-access design facilitates installation and growth. Growth in plant output current capacity is achieved by adding Lineage® 2000 100-ampere, +24-volt rectifiers to rectifier shelf assemblies. Adding functionality to the basic controller is achieved through two optional circuit packs, one to add microprocessor-based features and the second to add a datalogger.

The ECS Battery Plant is compatible with virtually all valve-regulated batteries that float within the range of 24 through 29 volts. 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 uninterrupted power supply (UPS).

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.

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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.

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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.

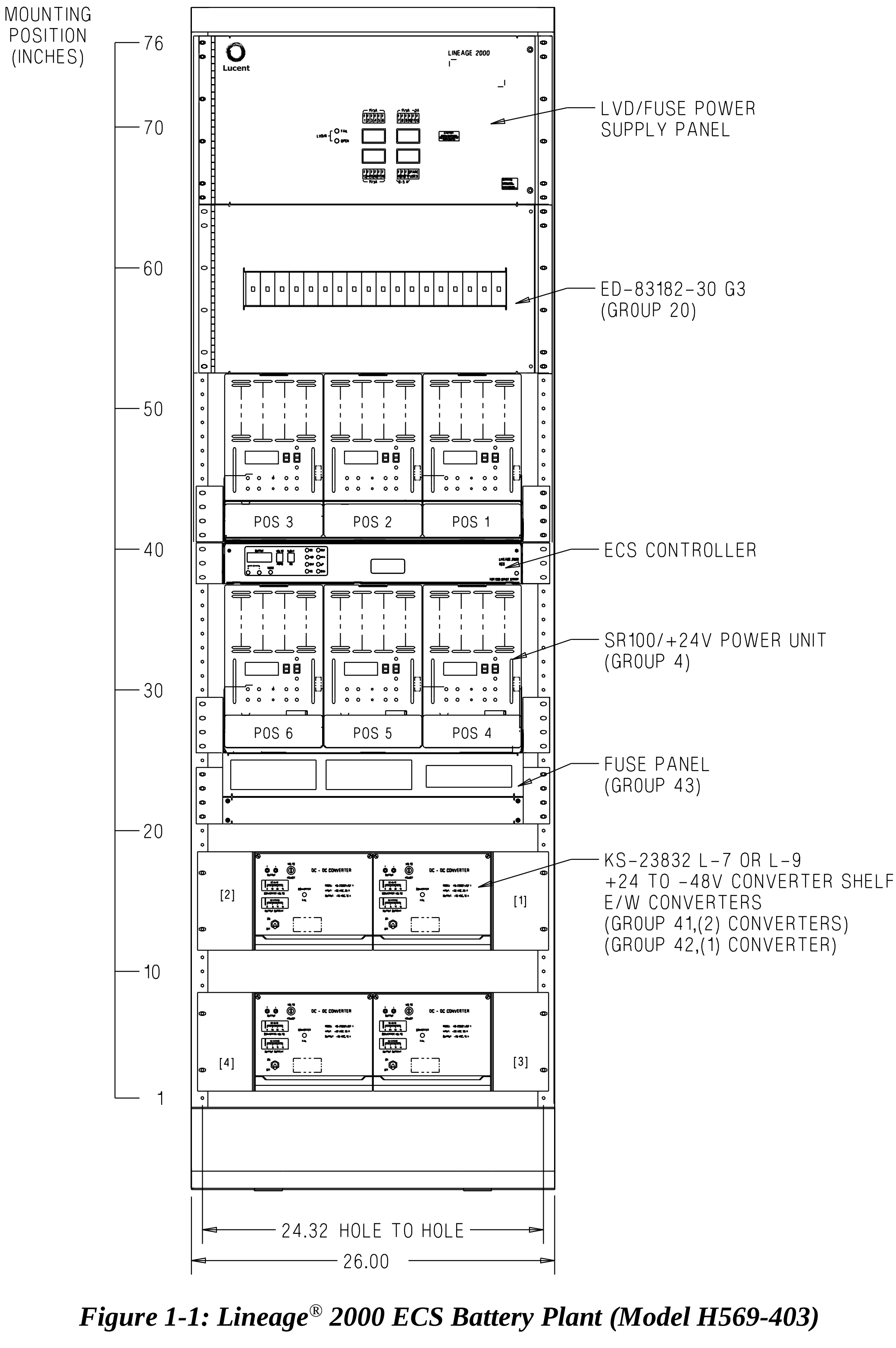

Figure 1-1: Lineage® 2000 ECS Battery Plant (Model H569-403)

2 Product Description

Plant Specifications

Table 2-A: Lineage® 2000 Battery Plant Specifications (Model H569-403)

Input Voltage	180-264 Vac (208/240 Vac nominal)
Input Frequency	47-63 Hz (50/60 Hz nominal)
Operating Voltage	20-30 Vdc (24 Vdc nominal)
Float Voltage	24-29 Vdc (24 Vdc nominal)
Plant Current Rating	600 amperes
Plant Shunt	600 amperes maximum at 50 millivolts
LVD/R Voltage Settings	20.25 or 21.25 Vdc
Controller	Basic: 113B Microprocessor option circuit pack: CP2 Datalogger option circuit pack: CP3
Rectifier Shelf Assembly	2 maximum, each mounts 3 rectifiers
Rectifiers	Type: Lineage® 2000 SR100/+24 Rating: +24 volts nominal, 100 amperes 6 maximum
Converter Shelf Assembly	2 maximum, each mounts 2 converters
Converters	Type: KS23832 Rating: -48 volts, 10 amperes 4 maximum

Table 2-A: Lineage® 2000 Battery Plant Specifications (Model H569-403)

Circuit Breakers	Type: KS22010 Available ratings: 10, 20, 30, 45, 60, 100 amperes 18 maximum
Fuses	Type: 74, KS-19870 Available ratings: 1-30 amperes 8 maximum
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 3.6°F per 1000 feet above 5000 feet. For altitudes of 1524 to 3962 meters, derate maximum temperature by 0.656°C per 100 meters above 1524 meters.
Framework	Type: 7-foot Central Office Framework (standard 26-inch width) Vertical mounting centers:1.00 inch (25 mm) Horizontal mounting centers: 24.32 inches (618 mm)
Dimensions	Height: 84 inches (2134 mm) Width: 26 inches (660 mm) Depth: 18.0 inches (457 mm)
Weight	(Includes 6 rectifiers): 450 pounds (204 kilograms)
Earthquake	(See Note 1)
Heat Dissipation	Full load: 3254 watts (11,093 BTU/hr)(See Note 2) Half load: 1640 watts (5590 BTU/hr) Rectifier, full load: 538 watts (1834 BTU/hr) Controller, basic and options: 26 watts (89 BTU/hr) Converter, full load: 135 watts (460 BTU/hr)
Humidity rating	10% to 95% noncondensing

Table 2-A: Lineage® 2000 Battery Plant Specifications (Model H569-403)

Audible noise	68 dBa (See Note 3)
Electrostatic discharge	IEC 801-2 Level 5 (15 KV) at 40% relative humidity
Electromagnetic immunity	10V/m over the range of 20 to 2000MHz

Note 1: Earthquake testing has not been conducted on this bay. However, the bay's components and architecture are very similar to J85500G-2, which has passed Zone 4.

Note 2: Specified at 27.25 Vdc, 600 amperes output, and nominal input voltages and frequencies.

Note 3: Measured at 2 feet (0.6 meter) from the rectifiers installed in plant (six rectifiers in initial bay).

Typical Battery Plant Description

A basic block diagram of a typical dc battery plant is shown in Figure 2-1. 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 three to eight hours of reserve time.

Battery Plant Subsystems

Figure 2-2 illustrates the arrangement and interconnections of the typical ECS 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.

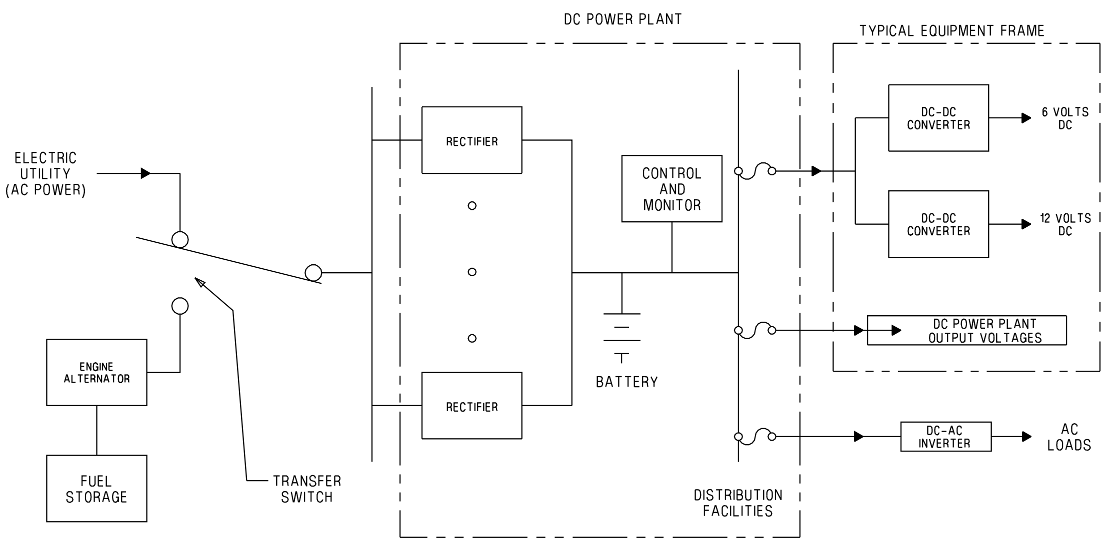

Figure 2-1: Block Diagram of Typical Battery Plant

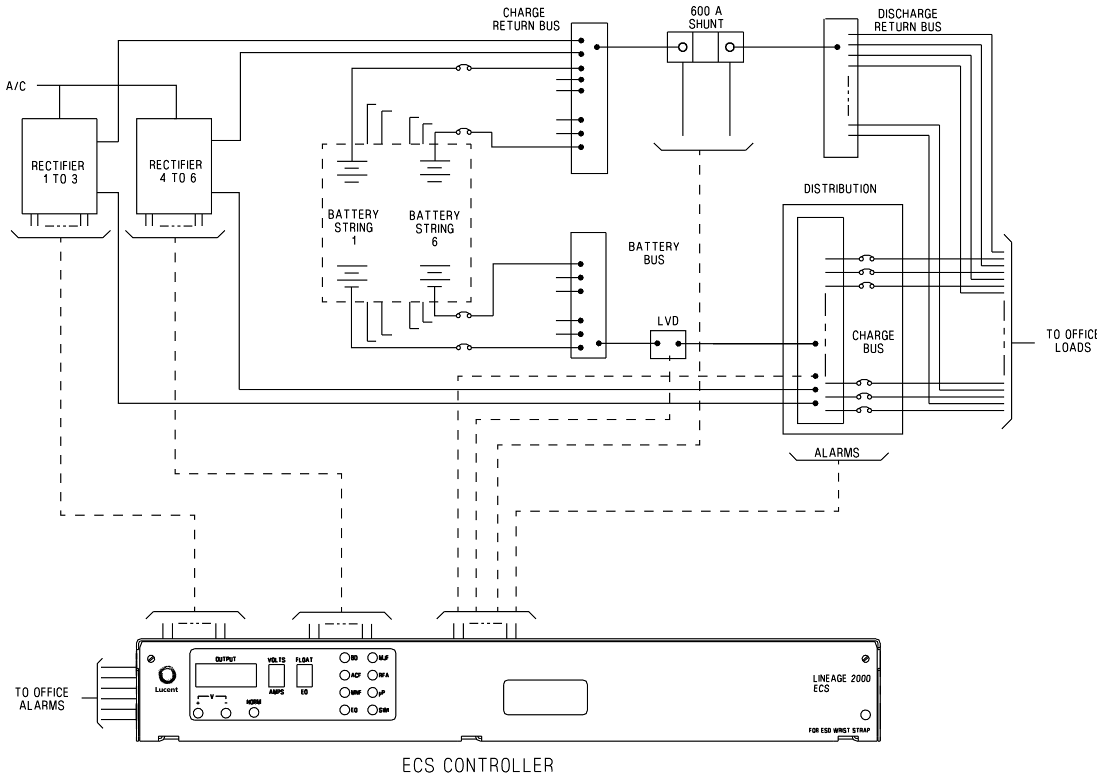

Figure 2-2: ECS Battery Plant Block Diagram

ECS Battery Plant Physical Description

Introduction

The Lineage® 2000 Evolutionary Control System (ECS) Battery Plant Model H569-403 is shown in Figure 1-1. 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 600-ampere total plant capacity with a nominal +24 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 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 an automatic battery disconnect/reconnect (LVD/R) feature that can all be configured in one standard equipment bay. 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 allows efficient use of valuable floor space.

Initial Bay

The initial bay will accommodate up to six Lineage® 2000 SR Series +24-volt, 100-ampere rectifiers, a Lineage® 2000 ECS controller, a distribution panel accepting breakers from 10-100 amperes, a low voltage battery disconnect/reconnect feature, and space for four +24-volt to -48-volt dc-dc 10-ampere converters and an associated meter and fuse panel for 48-volt distribution.

ECS Battery Plant Subsystems

Figure 2-2 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 switchmode 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 100-ampere rectifiers operate over 208/220/240 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 100-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

100-ampere rectifiers. The ECS plant is equipped with two rectifier shelf assemblies for a total capacity of six SR Series 100 ampere rectifiers. (See the rectifier product manual for additional information on the shelf and rectifier.)

Batteries

The ECS battery plant is compatible with virtually all flooded and valve regulated batteries. The Lineage® 2000 VR Series battery is designed specifically for use in the ECS battery plant. Selection of the VR Series battery enables one to maximize space efficiency and fully realize the benefits of front access, modular growth, and ease of installation and maintenance offered by the ECS battery plant system design.

The Lineage® 2000 VR Series battery is a valve-regulated design incorporating many of the same technologically advanced features as the highly acclaimed Lineage® 2000 Round Cell battery. It is a compact, totally front access, modular battery based on a unit cell architecture. The VR Series battery is currently available in a 2 volt, 375 ampere-hour configuration for use in the ECS plant. The compact physical dimensions of the VR battery permit the installation of up to 1500 ampere-hours of 24-volt battery reserve in a single framework space. (See the battery product manual for additional information.)

Controller

The ECS controller performs the centralized monitoring, control, and reporting functions for the ECS battery plant. In the H569-403, the basic ECS controller monitors and controls a maximum of six SR 100/+24V rectifiers. The controller, however, is capable of monitoring up to twelve 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. This board is available as Group 5 or 7 on H569-403. Group 7 is the same as Group 5, with the addition of a voice response feature. 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. This board is available as Group 8 or 9 on H569-403. Group 9 is the same as

Group 8, with the addition of a remote termination panel allowing external connection to the board from outside the controller. (See the ECS controller manual for further information.)

DC-DC Converter

The Lineage® 2000 KS23832 24-volt to -48-volt dc-dc converter system utilizes 50KHz technology to provide a reliable and economical means of obtaining closely regulated and filtered -48-volt dc power when only one primary source of +24-volt dc power is available.

The dc-dc converter system consists of KS23832 converter shelf assemblies equipped with one or two KS23832 10-ampere +24-volt to -48-volt converters. A maximum of two shelves with four converters may be equipped per bay. Group 41 provides a converter shelf equipped with two converters and Group 42 provides a converter shelf equipped with one converter. Converters should be sized with n+1 redundancy. This extra reserve not only provides backup to your operating converter but also provides the necessary energy required to operate fuses. Distribution to the -48-volt load is provided via a meter and fuse panel.

The converter shelf assembly has mounting brackets for standard 26-inch relay rack mounting. Each converter module contains a blocking diode, low input voltage shutdown, current limiting, and high voltage shutdown with automatic restart. The converter shelf assembly is equipped with major and minor alarms. The converter shelf assembly has two Form C contacts, one for converter major and one for converter minor. When one converter fails, the converter minor relay will operate and when two converters fail, the converter major relay will operate. For more details, refer to the KS23832 converter product manual.

DC Distribution

The ECS H569-403 distribution includes the plant charge and discharge bus bars, plant shunt, LVD/R contactor, and associated circuitry. Space below these items accommodates circuit breaker panel for 24-volt distribution. A meter and fuse panel is also available for 48-volt loads when the plant is equipped with 24-volt to -48-volt converters. A complete discussion of the ECS dc distribution is presented in the following section of this manual.

ECS DC Distribution Panel

Both circuit breaker and fuse protected distribution panels are available with the ECS Battery Plant. They are orderable as Group 20 and Group 43, respectively. An alarm connection is provided with each panel to indicate an open fuse or tripped circuit breaker and is transmitted to the ECS Controller as a Major Fuse Alarm, MJF (FAJ).

Circuit Breaker Panel (Group 20)

Distribution to the +24-volt loads is provided with the ED83182-30 G7 circuit breaker panel. This panel accommodates up to eighteen 10- to 100-ampere circuit breakers. A hinged front cover panel allows easy access to the breakers for connecting load leads or adding circuit breakers. When dc-dc converters are required, the first four mounting positions should be reserved for 45-ampere circuit breakers (one for each converter). Figure 2-3 shows the circuit breaker panel and Table 2-B describes the circuit breaker options and ordering information.

Table 2-B: H569-403, Group 20 Lineage® 2000 ECS Battery Plant Breaker Panel

Circuit breakers operate and provide an alarm during electrical or manual trip. The Group 20 panel contains 18 positions for circuit breakers. The panel bus bar is sized for 600-ampere capacity.		
Circuit Breaker Specifications		
Capacity (Amps)	**Type Heinemann**	**Order Information H569-403, G20***
10	KS22010	G-AA
20		G-AB
30		G-AC
45		G-AD
60		G-AE
100		G-AF
* One breaker provided per lettered group. Specify breaker positions 1 to 18, left to right.		

Meter and Fuse Panel (Group 43)

Distribution to the -48-volt loads is provided with the J85501C-1 L5 meter and fuse panel. This panel includes a fuse block that accommodates eight 1- to 30-ampere distribution fuses and associated alarm fuses, an ammeter (0-50A), voltmeter (0-60V) and distribution bus bars. The analog meters monitor the total current and voltage delivered by the converters. Load lead connections to the fuse block and discharge return are front accessible via a removable 3-inch cover panel. Figure 2-4 shows the meter and fuse panel and Table 2-C describes the load fuse options.

Table 2-C: H569-403 Group 43 Fuse Options

The Group 43 panel contains a fuse block which accommodates 8 load fuses. Refer below for fuse specifications. *Load fuses are ordered on a job basis, separately from the battery plant order.*			
Load Fuse			
Size	**Type**	**Range (Amps)**	**Order Information for a Fuse Panel**
9/32 x 1-1/4 inch	74 KS-19870	1.25-20 2-30	H569-403, G-43

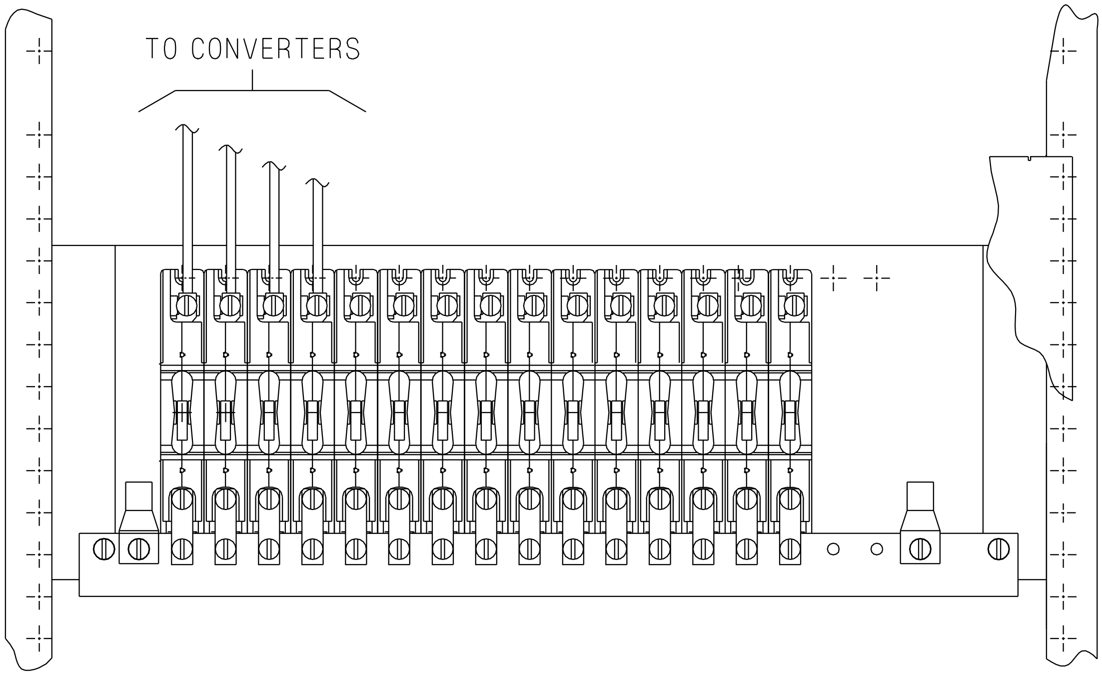

Figure 2-3: Group 20 (10 to 100A) Circuit Breaker Panel

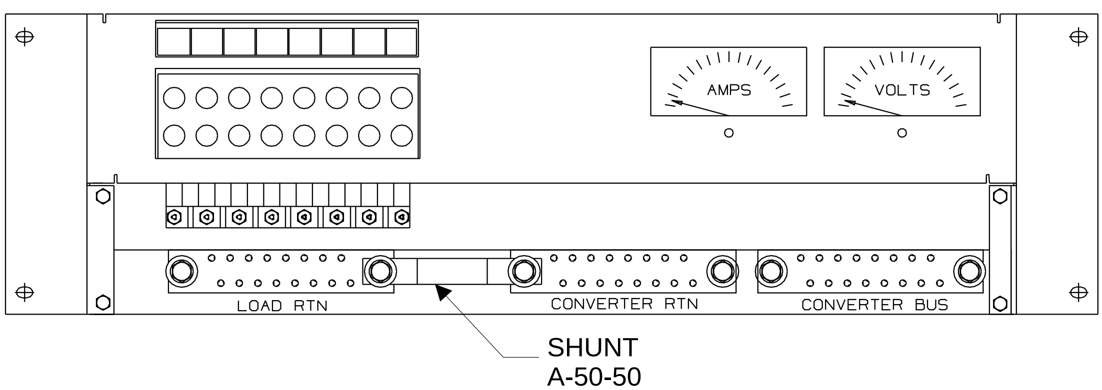

Figure 2-4: Group 43 Meter and Fuse Panel (3-Inch Cover Removed)

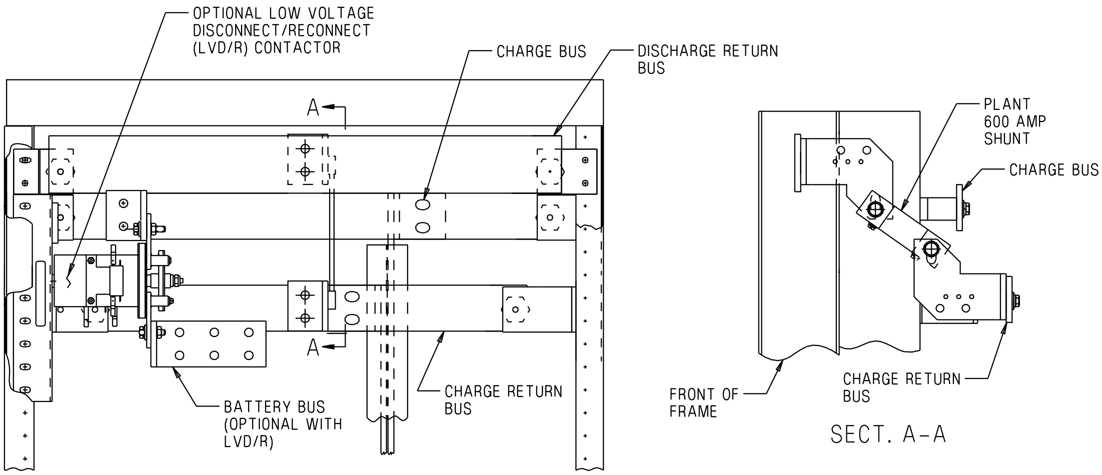

Figure 2-5: Plant Bus Bars with Optional Group 2 Low Voltage Disconnect

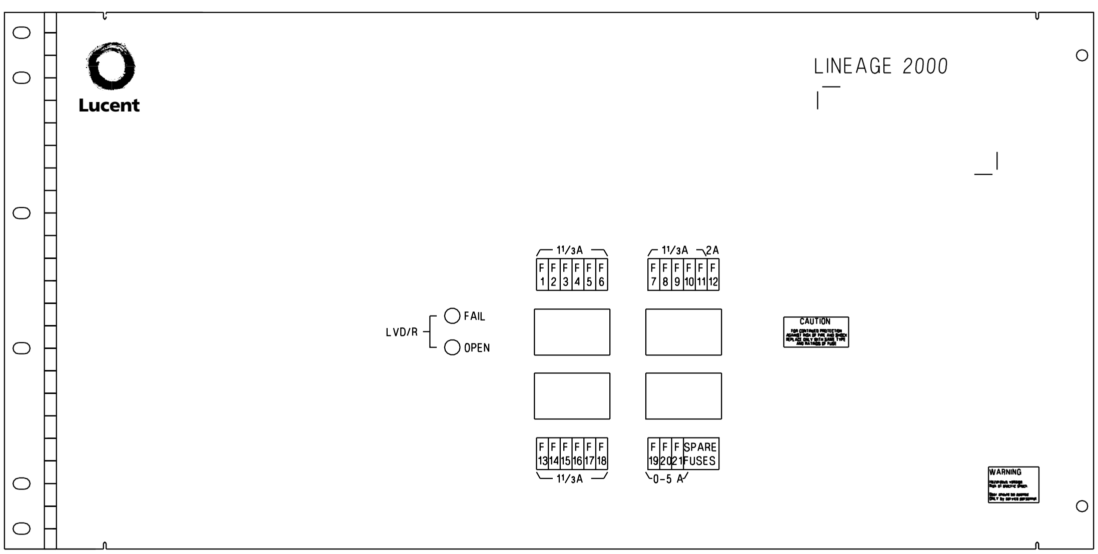

Figure 2-6: ECS DC Distribution Panel (Front View)

Plant Bus Bars

The Plant Bus Bars are mounted in three tiers on insulating standoffs at the top of the ECS plant. These copper bus bars (plated with a solder finish) are designed to accommodate one- or two-hole copper crimp lug connectors in many sizes up to 350MCM. Refer to Tables 3-D and Table 3-E for details.

The middle bus bar serves as the Charge Bus for both charge and discharge circuits. The lowermost bus bar serves as the Charge RTN Bus, which is connected via the plant shunt to the uppermost Discharge RTN Bus Bar. Refer to Figure 2-5.

A hinged panel covers the front of the bus bars and includes a mounting space for a LVD/Fuse Power Board (see Figure 2-6). The LVD/Fuse Board (CP5) provides circuitry for the LVD sensing (see Section 2.5.3) and regulation fuses to protect the ECS controller from overcurrent in the sense leads.

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 2-6). 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 600 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 may be equipped with an optional 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 option consists of the LVD/R Contactor, circuitry on the CP5 Fuse Board and associated wiring (see Figure 2-5). The LVD/R Contactor is used either to connect or disconnect Charge Bus and Battery Bus. The LVD circuit on CP5 monitors the battery bus 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 Charge Bus and Battery Bus, disconnecting the batteries from the rectifiers and the load. The user has a choice of disconnect threshold voltages.

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.

3 Engineering, Planning, and Ordering

Lucent offers a wide variety of engineering services that range from complete telecommunications installations to custom modifications of in-place equipment. For more information on the type of services that best meet your engineering needs, contact your Lucent account executive.

This section of the manual is intended to provide guidance for those customers who wish to engineer their battery plant completely or partially. The detailed process of engineering a battery plant is described as it progresses through four stages. This process is essentially the same for the field modification of an existing battery plant as it is for a new installation.

The four stages are:

1. characterizing the basic power requirements,
2. determining the power equipment that satisfies those needs,
3. determining the impact on the various building systems, and
4. preparing the order using the engineering drawings.

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 section 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 sections.

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 available on this ECS 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.

EQUALIZE or BOOST charging is recharge capacity greater than the float voltage.

Rectifier and load equipment voltage ranges are associated with typical battery voltage ranges. For batteryless plants, skip to paragraph "Load Drain and Growth."

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 24 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 24 volt systems typically use 12 cell battery strings for float voltages that range from 26.04 to 28.20 volts per string. Lucent KS-type flooded lead-acid batteries float at 2.17 volts per cell (26.04 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; boost or equalize charging is not recommended for the Lucent VR Series battery)

   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 sections.

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 circuits that may be added and their drains. Recalculate the total battery plant drains.

Table 3-A: Initial Load Drain Information

Load Circuit	List 1 (Amps)	List 2 (Amps)
1		
Battery Plant Total		

Table 3-B: Anticipated Future Load Drain Information

Load Circuit	List 1 (Amps)	List 2 (Amps)	NC, C, or A*
1			
Battery Plant Total			
* NC = No Change; C = Changed; A = Added			

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 in the plant.
- At least 20 percent additional capacity must be included in the plant to provide recharge capacity and spares.

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 drop 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 undergoes 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 0.25 volts in the leads from battery string terminals to the dc distribution. Voltage drop calculation methods are described in the 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 24-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 offers a computerized service to optimize the selection of cable sizes and battery capacity for any application. Contact your Lucent 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 (0.25 volts) has been covered above, in the paragraph “Battery String Voltage Drop and Balancing.” One rule-of-thumb specifies a maximum voltage drop of 0.75 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 the 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 x I x L) / CM, or CM = (K x I x 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.

General Guidelines

The peak current drain (List 2) is used to size the circuit protection for each individual load. The fuse or circuit breaker must also protect the wire connecting to it in accordance with NEC and local code regulations.

Fuses

Load fuses are not provided with the fuse panels that are supplied with the ECS power plant. The individual fuse size should be 150% of the List 2 current drain for the load that the fuse is protecting.

Circuit Breakers

All circuit breakers supplied with the ECS power plant can be loaded up to 100% of their rating only if the job engineer can determine that the user load has no short term peaks greater than 150% of its rating and not exceeding 10 milliseconds in duration. If the characteristics of the load cannot be determined, apply a factor of 125% instead of 100%.

Lineage® 2000 Engineering Specifics

The methods used in the previous section, “General Engineering Calculations,” are appropriate for the engineering of any battery plant. The specifications documented in that section are used in this section 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
- Controller options
- Alarm system interface

Rectifier Sizing

The H569-403 Battery Plant uses the Lineage® 2000 SR 100 ampere, +24 volt switched-mode rectifier. A maximum of six rectifiers may be ordered per plant for a total of 600 amperes maximum capacity.

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 “Cable and Load Breaker Sizing.”

Battery Sizing

The battery type and minimum size are determined in paragraphs “Battery Sizing” and “Battery Voltage.” 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.

There are several important considerations in the choice of battery size versus number of strings, namely,

- 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.

See paragraph “Floor Plan Data” for more information on floor loading. 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 100 ampere increments with the SR100/+24V rectifier, the optimum battery capacity increment may be approximated as follows.

A-hr increment = (100 A) x (reserve time in hours) / (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 section, 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 section of the product manual. In this section, the basics are derived for the dc power cabling which will be required as part of a complete cable engineering process. Lucent offers cabling engineering services that are separate from battery plant engineering. Contact your Lucent 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 terminal lugs that may readily be attached at the dc distribution subsystem are listed in Tables 3-D and 3-E.

A wide range of circuit breakers and fuses is available for dc distribution overcurrent protection. The ratings of these circuit breakers are from 10-100 and the ratings of the fuses are from 1-30 amperes. The breaker or fuse rating for a given circuit is selected by the criteria covered in paragraph “Overcurrent Protection.”

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

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

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-F.

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-F.

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, 30, 45 or 60 amperes) in Table 3-F for each feeder.

Step H: Record in Table 3-G 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-G.

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-G.

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

Table 3-D: Double Hole Terminal Lugs

KS-5482 Wire	KS-20921 Wire	WP-91412 List	Comcode	Bolt Size	Centers	Die
10	10	73	405356171	10	0.625	R5473
8	8	52	405348178	10	0.625	Red
8	8	75	406216626	0.250	0.625	Red
6	6	3	405347519	0.250	0.625	Blue
4	4	5	405347576	0.250	0.625	Grey
2	-	54	40 5348202	0.250	0.625	Brown
-	2	8	405347683	0.250	0.625	Green
1/0	-	56	405348228	0.375	1.0	Pink
-	1/0	57	405348236	0.375	1.0	Black
2/0	-	57	405348236	0.375	1.0	Black
-	2/0	77	4060 21725	0.375	1.0	Orange
4/0	-	59	405348251	0.375	1.0	Purple
-	4/0	27	405347923	0.375	1.0	Yellow
350MCM	-	61	405348277	0.375	1.0	Red
-	350MCM	56	405348228	0.375	1.0	Red

Table 3-E: Single Hole Terminal Lugs

KS-5482 Wire	KS-20921 Wire	WP-91412 List	Comcode	Bolt Size	Die
10	10	93	406338145	10	R5473
8	8	1	405474402	10	Red
8	8	74	405356189	0.250	Red
6	6	2	405474436	0.250	Blue
4	4	4	405347543	0.250	Grey
2	-	53	40 5348186	0.250	Brown
-	2	7	405347659	0.250	Green
1/0	-	55	405348210	0.375	Pink
-	1/0	10	405477717	0.375	Black
2/0	-	10	405477717	0.375	Black
-	2/0	17	4053 47790	0.375	Orange
4/0	-	58	405348244	0.375	Purple
-	4/0	78	406021741	0.375	Yellow

Table 3-F: Load Feeder Wire and Fuse/Breaker Size

CIRCUIT NUMBER	LIST 2 DRAIN	MINIMUM WIRE GAUGE		SELECTED WIRE GAUGE	BREAKER RATING
		(AMPACITY)	(VOLTAGE DROP)		
1					

Table 3-G: 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 is available as an option on the ECS plant. For this feature, two disconnect levels are available: 20.25 and 21.25 volts. The tolerance on disconnect levels is +/-0.5 volts. Based on the discussion in paragraphs "Battery Sizing" and "Battery Voltage," fill in the following information.

Is Low-Voltage BATTERY Disconnect/Reconnect required? _____(yes or no)

If yes, specify the disconnect level _____(20.25 or 21.25)

Controller Options

The engineering of the ECS controller features involves orderable circuit packs and DIP switch settings.

Circuit Packs: Circuit pack options for the ECS controller are presented on the H569-403 battery plant drawing. Refer to that drawing and to the Controller manual for more information on the availability of optional circuit packs.

DIP Switch Settings: 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 H569-403 drawing, Table R for controller default settings and Table V for available alternative settings.

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 the 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.

Planning

The equipment specified in the previous section will affect various other systems within the building that serve more than just the battery plant. Some of these common systems are ac distribution, cabling, air conditioning and ventilation and the building structure itself. For example, the ac distribution system for a building or room is not completely defined by the power equipment needs alone, but clearly the number and type of rectifiers have a direct impact.

The following topics are covered in this section:

- Floor Plan Data: Floor Space, Floor Load, Heat Load, AC Service
- Grounding
- Growth

Floor Plan Data

There are several types of information that are collectively called Floor Plan Data. This information is sometimes published on Floor Plan Data Sheets. For the Lineage® 2000 ECS Battery Plant, Floor Plan Data are given in Figures 3-1 and 4-2. This battery plant information must be combined with the corresponding data for all other equipment in the office to engineer the appropriate aspects of the building.

The four categories of floor plan data relevant to battery plants are listed below.

Floor Space: Adequate space must be allocated for the battery plant footprint and for aisles.

Floor Load: The building structure must support the intended weight per unit floor area, and equipment must be spaced out to distribute the load, as necessary.

Heat Load: The air conditioning and ventilation systems are sized to maintain the environment given the heat dissipation of the equipment.

AC Service: The ac distribution system is sized to accommodate the current requirements of the powered equipment.

Grounding

The ECS battery plant is designed for compatibility with most grounding systems. The standard dc discharge return bus is located in the initial bay. Alternatively, the battery plant return bus system may be mounted in the overhead cable rack.

When the discharge return bus is in the initial bay, a connection point is provided on it specifically for grounding. This point may be used to tie the battery plant to the building grounding electrode. Two holes for .250-20 self tap screws are provided at the rear of the top crossmember of the bay uniframe to accommodate a two-hole cable lug on .62" centers. If the frame ground lead is calculated to be larger than 2 AWG, the corresponding lug has 3/8" diameter holes on 1" centers. In this case, the adapter that is always provided with the bay should always be used. Refer to Figure 3-2.

Growth

As in the selection of protector and wire sizes for load feeders, building systems should be designed for ultimate growth. Cable rack support and ac distribution cabinets should be sized for the maximum anticipated battery plant capacity. Floor space and weight capacity should also account for any increase in battery reserve.

Ordering Reference Material

Coding and Terminology

The two main categories of Lucent 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 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 "Spare Parts" in Section 5.)

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 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 sections.

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 3-3.

(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. Reissued drawings are sometimes released prior to actual factory availability to provide time for engineering and order preparation. Consult your Lucent 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.

(5A) 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.

(5A-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.

(5A-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 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).

(5B) 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 for information on specific products, as needed.

(5C) 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.

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

(5E) 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 & 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 combinations

- 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 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 documents provide the engineering, ordering and installation information for the Lineage® 2000 ECS battery plant.

ECS Battery Plant

Assembly and Ordering Drawing:	H569-403
Wiring Diagram:	T-83118-30
Schematic Diagram:	SD-83118-01
Product Manual:	167-790-041

Supplementary information on the ECS controller, Lineage® 2000 SR series rectifier and Rectifier Shelf Assembly (RSA), the Lineage® 2000 VR series battery and the KS23832 converter may be found on the following documents.

ECS Controller

Assembly and Ordering Drawing:	J85501D-2
Wiring Diagram:	None
Schematic Diagram:	SD-82669-02
Product Manual:	167-790-033
Optional Circuit Pack Product Manual:	167-790-109

SR Series Rectifiers and RSA

Assembly and Ordering Drawing:	J85702C-1
Wiring Diagram:	T-82668-30
Schematic Diagram:	SD-82668-01
Product Manual:	169-790-115

VR Series Battery

Assembly and Ordering Drawing:	ED83242-31
Wiring Diagram:	T-82671-30
Schematic Diagram:	SD-82671-01
Product Manual:	157-622-010

KS23832 Converter

Product Manual	161-200-101

Ordering Information

The H569-403 battery plant is ordered with Group (G) numbers and Equipped With (E/W) items. The following is an example of an order.

A sample order for an H569-403 plant containing a low voltage disconnect, (3) 100-ampere rectifiers, a CP2 microprocessor pack, (7) 100-ampere breakers, (4) 45-ampere breakers, (3) +24- to -48-volt converters and (1) -48-volt meter and fuse distribution panel would look like the following:

Item	Qty.	Description
1	1	H569-403 G-2 +24V, 600A ECS Plant E/W
	3	G-4
	1	G-5
	1	G-41
	1	G-42
	1	G-43 Fuse Panel
	1	G-20 Circuit Breaker Panel
	7	G-AF Circuit Breaker Pos 5 thru 11
	4	G-AD Circuit Breaker Pos 1 thru 4

Table 3-H: Ordering Guide, H569-403 ECS 600-Ampere +24-Volt Battery Plant

Group No.	Equipment/Features
1	Provides a battery plant, 208/220/240 volt input, +24-volt, 600-ampere maximum output (includes controller, two rectifier shelves and charge & discharge bus bars).
2	Same as Group 1, with a low voltage battery disconnect feature.
4	Provides 100-ampere +24-volt SR rectifier.
5	Provides optional microprocessor circuit pack (CP2) for plant controller. CP2 provides remote/local monitoring and control functions.
7	Same as Group 5 (CP2), with voice response feature.
8	Provides optional datalogger circuit pack (CP3) for plant controller. CP3 is a data acquisition pack that always requires a CP2 circuit pack.
9	Same as Group 8, with remote termination panel. The remote termination panel allows external connection to the CP3 circuit pack from outside the controller.
20	Circuit breaker panel for 10A to 100A breakers.
	Items AA-AF Provide Circuit Breakers For Group 20 With These Ampere Capacities:
AA	10-ampere breaker
AB	20-ampere breaker
AC	30-ampere breaker
AD	45-ampere breaker
AE	60-ampere breaker
AF	100-ampere breaker
41	Provides optional converter shelf assembly equipped with two +24- to -48-volt dc, 10-ampere converters.
42	Provides optional converter shelf assembly equipped with one +24- to -48-volt dc, 10-ampere converter.
43	Provides optional meter and fuse panel equipped with (8) 1-30 ampere load fuses for -48-volt distribution and analog meters for monitoring the total current and voltage delivered by the converters.
K1	Upgrade kit to add one +24- to -48-volt dc, 10 ampere converter in the field.

Table 3-H: Ordering Guide, H569-403 ECS 600-Ampere +24-Volt Battery Plant

K2	Upgrade kit to add a Group 42 converter shelf equipped with one converter in the field.
K3	Upgrade kit to add a 100-ampere circuit breaker in the field.
K10	Upgrade kit to add voice response feature to a plant controller in the field.

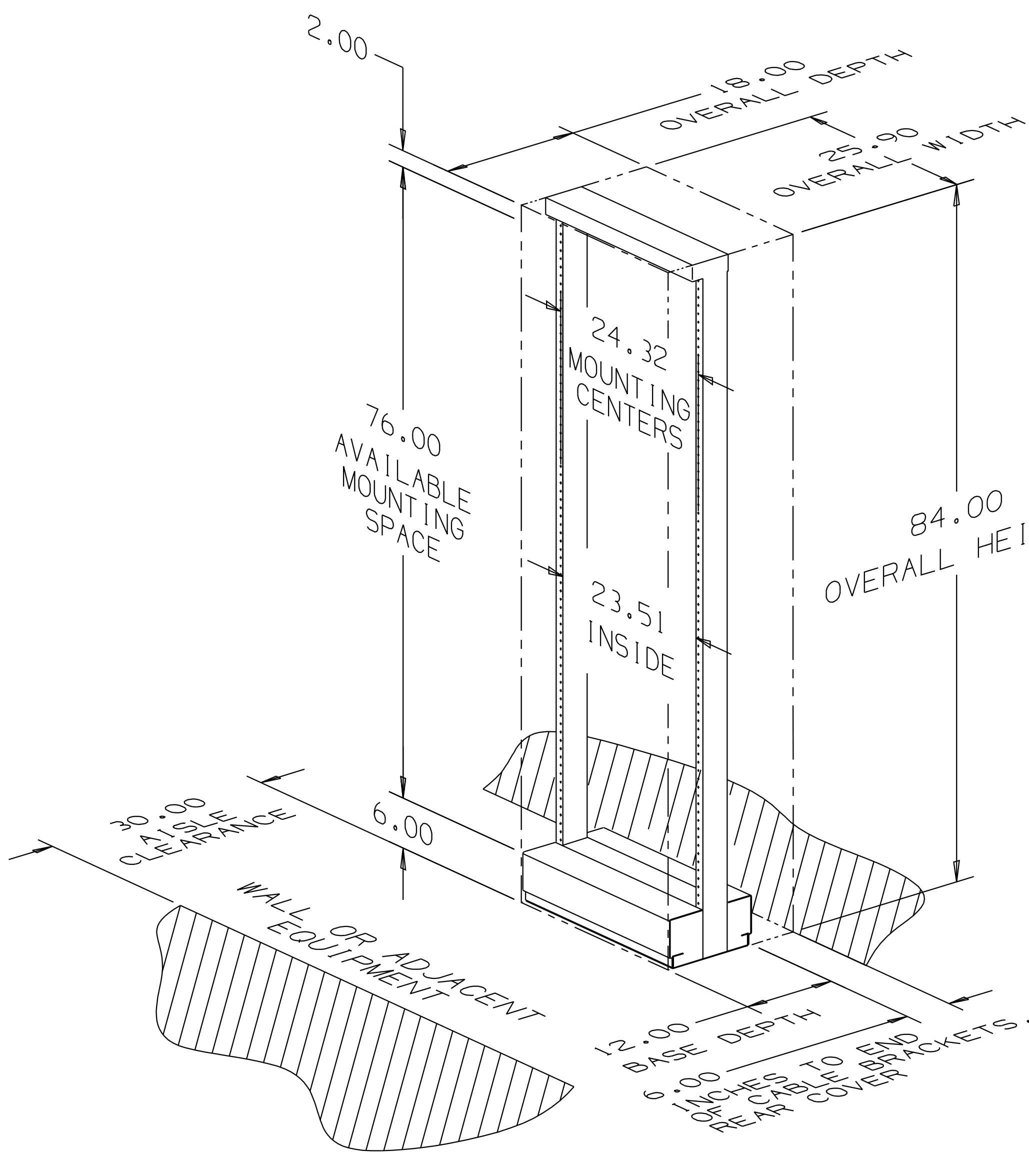

Figure 3-1: Bay Dimensions and Clearances

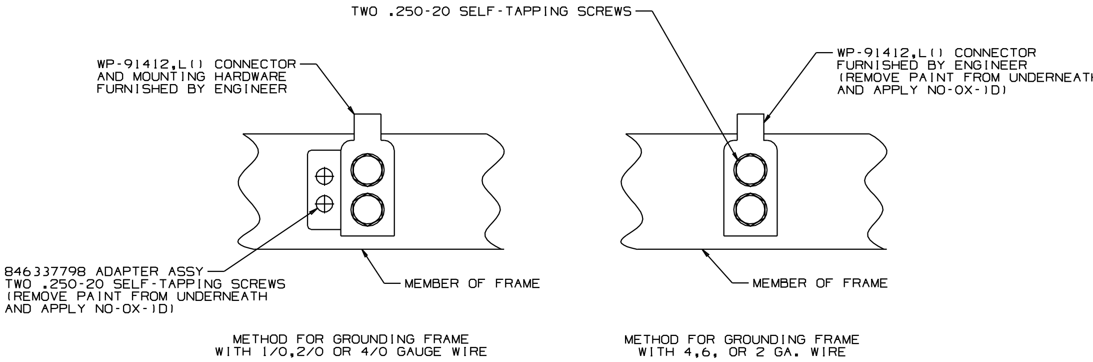

Figure 3-2: Frame Ground Adapter Assembly

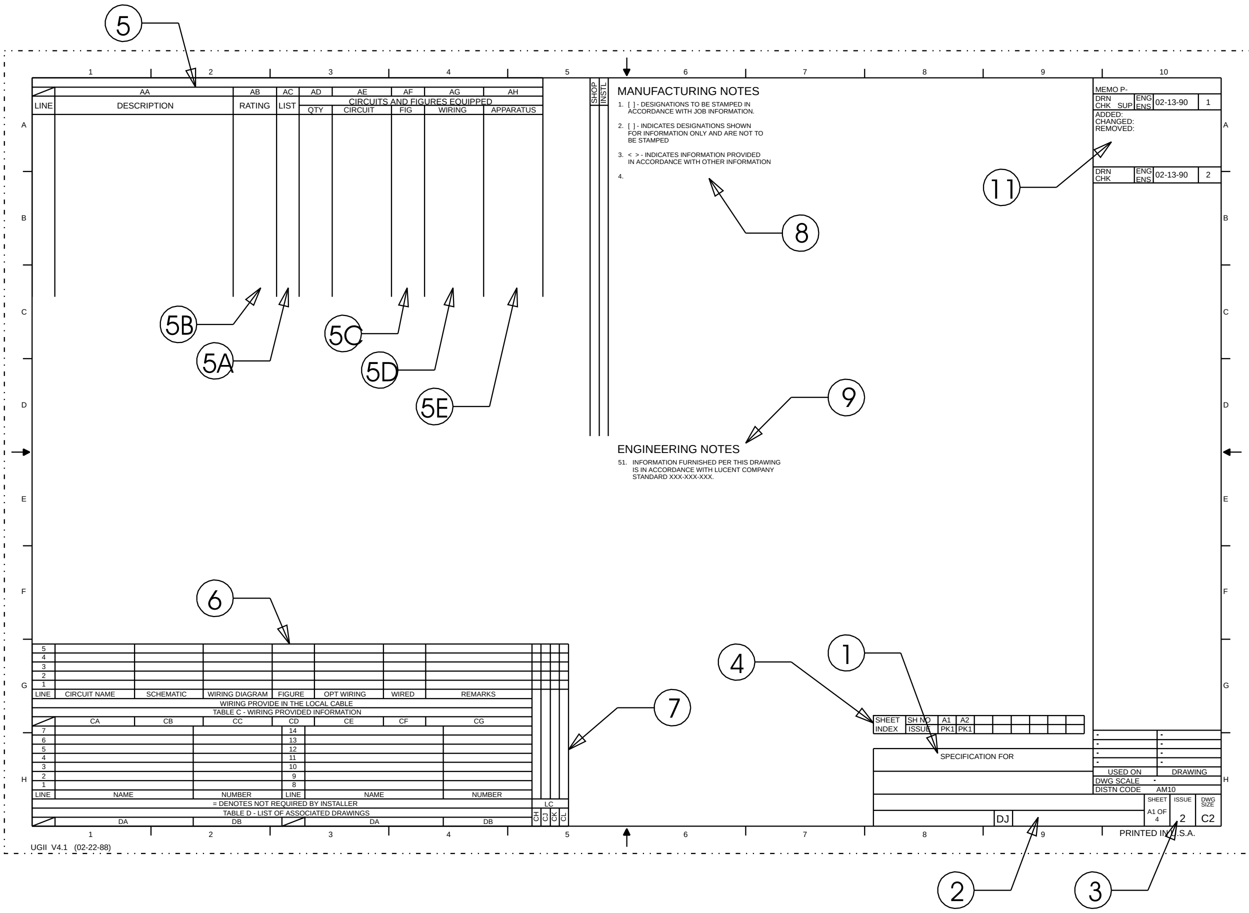

Figure 3-3: Typical J-Drawing A-Sheet

4 Installation

General

As mentioned at the beginning of Section 3, Lucent offers complete engineering and installation service that result in turn-key plant operation. Contact your Lucent Power Systems Account Executive for further information on the complete range of installation services available from Lucent. 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. 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 subsystem must also be assembled by the installer. The battery plant installation sequence that follows refers to the Rectifier, Controller and Battery 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: 450 lbs.
- Common electrician's hand tools.
- Proper crimping tools and dies for connectors used.
- Common mechanic's hand tools.
- 18mm or 3/4-inch drill to bore holes for floor anchors.
- 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. For LVD/R option only: Power supply, variable from 0 to 60 volts dc at 2 amperes. Supply should have both coarse and fine output controls.
- For LVD/R option only: Six clip leads each capable of carrying 3 amperes.

Suggested Installation Sequence

General Information

1. The plant is wired with ac from the right side. Typical routing of ac, dc and control cabling is shown on the plant assembly drawing, H569-403. Connection points and wire types are indicated on the plant wiring diagram, T-83118-30.
2. When running dc cable, 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.
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 to the values in Table 4-A; all bolts for mechanical connections should be torqued to values in Table 4-B.

Sequence of Tasks

To install the H569-403 ECS Battery Plant, complete the following sequence of tasks.

Unpacking, Handling, and 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 2.1, 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, repack it in the original shipping crate.

Locate, shim and anchor the framework. Figure 4-1 shows typical floor mounting details for concrete floors. Other types of floor construction may require other mounting methods. Holes can be located using Figure 4-2. Note that primary mounting locations are at the outermost corners of each set of four holes (four anchoring devices per bay). Select alternate locations if primary locations would interfere with floor reinforcing bars. For multi-bay plants and for plants in aisle line-ups with compatible framework, frames may be tied together for extra rigidity.)

Table 4-A: Minimum Torque for All Electrical Connections (e.g., Bus Bars)

Screw Size	Torques - Lb-In or (Lb-Ft	
	Wire Connectors	Mechanical Connectors
8-32	15	19
10-24	21	27
1/4-20	50	65
5/16-18	100	135
3/8-16	180	240
7/16-14	280	385
1/2-13	(42)	(49)
5/8 -11	(71)	(97)
3/4-10	(125)	(172)

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 torque.
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 for All Non-Electrical Connections (e.g., Floor Anchors)

Cap Screw Diameter	Torque (Ft-Lb) UNRC
1/4	6
3/16	12
3/8	22
7/16	35
1/2	54
9/16	77
5/8	107
3/4	190
1	290
1-1/4	580
1- 1/2	1010

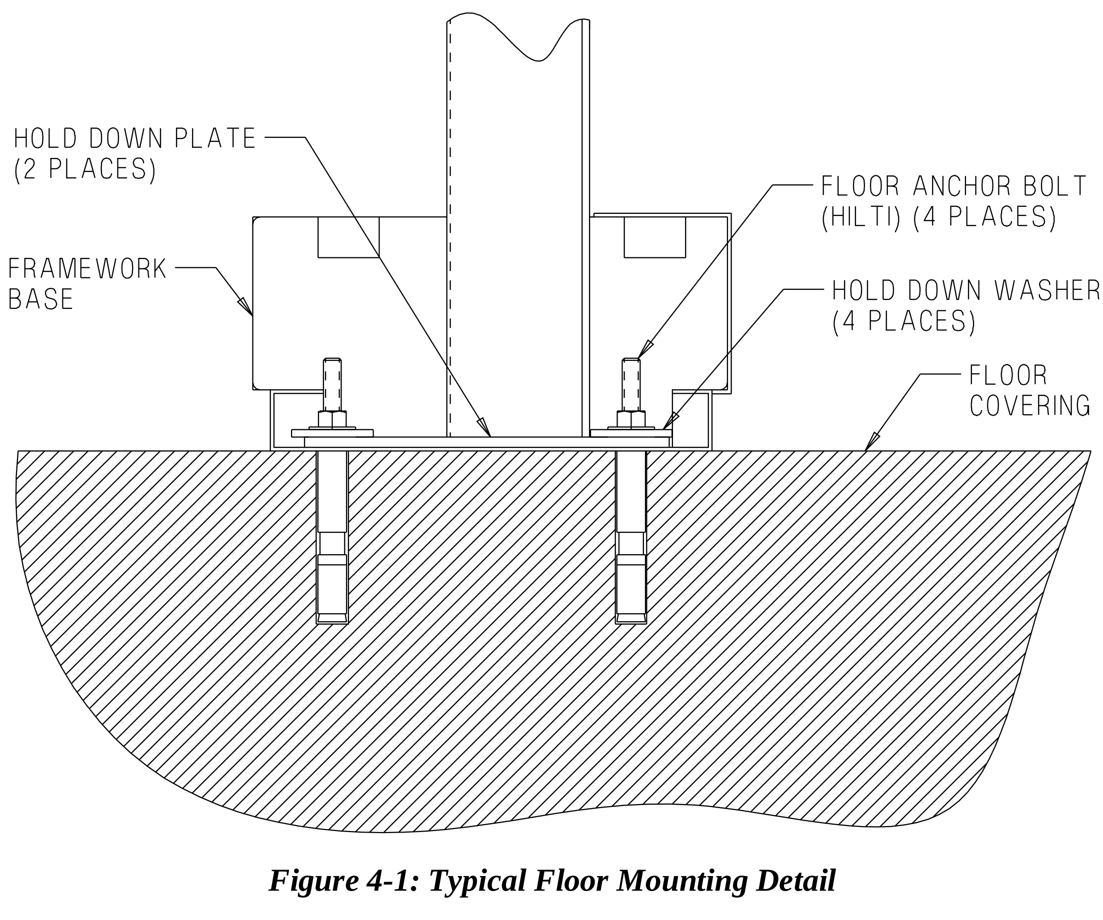

Figure 4-1: Typical Floor Mounting Detail

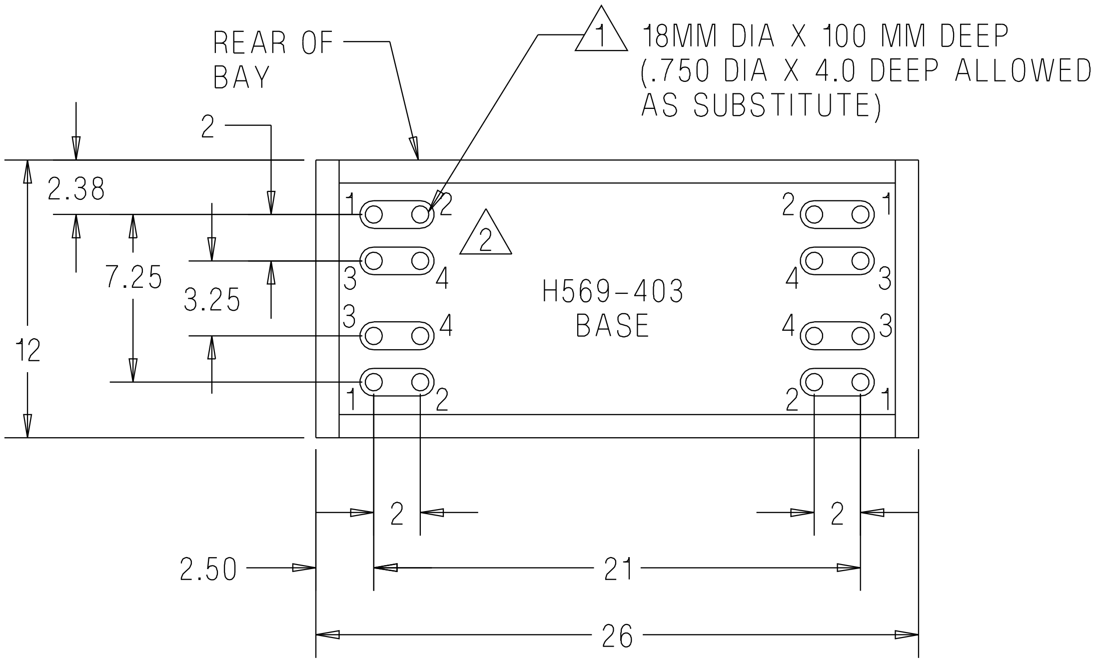

Figure 4-2: Floor Mounting Template (All Dimensions Are Given in Inches)

Battery Stand Assembly

Warning

Do not connect batteries to the system at this time.

Assemble battery stands or shelves as instructed in the battery manufacturer's documentation. Install the batteries onto their stands or into their shelves.

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.

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.

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 21.25 +/-0.5 volts. To provide a disconnect voltage of 20.25 +/-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 option.

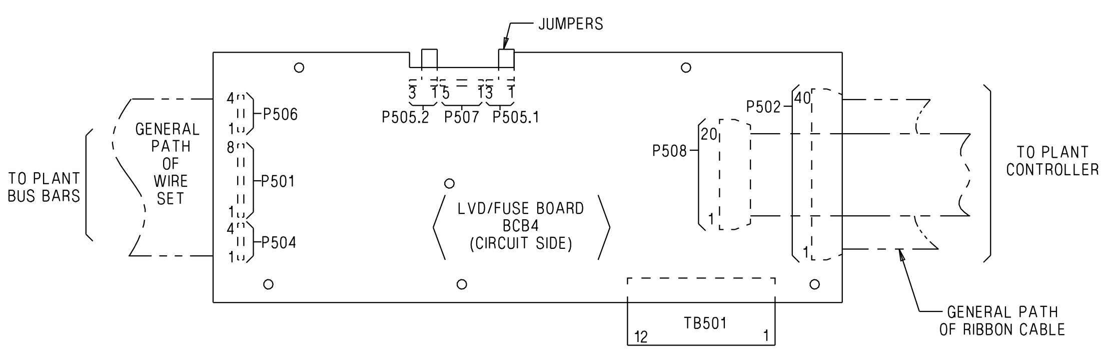

Figure 4-3: LVD/Fuse Board (CP5) Jumper Locations

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

> AC wiring should be completed 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. It will also be possible to add a rectifier without shutting down adjacent rectifiers to gain access to space for additional ac wiring.

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

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 or fuse and from the discharge return bus. The load supply leads are terminated at the breaker and fuse panels (directly to the breaker or fuse terminal end). The load return leads are terminated at the battery plant end on the discharge return bus, located at the top front of the bus bar arrangement.

Recommendations for routing and dressing of load leads as they leave the battery plant and enter the cable rack system are shown on the plant assembly drawing, H569-403 or in Figure 3-4. Consult the job application drawings for the routing of these leads to the load equipment.

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

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

> 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.

Interconnect the battery strings and, if provided, the emergency disconnect circuit, as instructed by the battery manual or other manufacturer's documentation.

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 dc distribution see the H569-403 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 and F13 represent a 1-1/3 ampere rating, the orange indicator on F12 represents a 2 ampere rating and the green indicator on F19 through F21 represents a 5 ampere rating.

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.

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 (associated with additional rectifier 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.

1. See Section 3 for details on sizing additional circuit breakers.
2. 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.

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.

3. Locate the intended new breaker or fuse. Ensure that breakers are switched to the OFF position or that fuses are not loaded.
4. Install the load leads by following paragraph “Load Wiring” above.
5. Mark the new circuit on the distribution cover panel label.
6. For safety, mount the dc distribution front cover 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.

7. Turn on the load circuit breaker or install the fuses. If the circuit breaker trips or the fuse blows 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 or add another fuse. If the breaker trips or the fuse blows again, check the wiring to the load circuit.
8. 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 F21 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. Refer to the ECS Controller manual for troubleshooting procedures.

DC Circuit Breakers/Fuses

Any circuit breaker mounted in the List 20 panel 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. All fuse blocks in the battery plant have indicating fuses that allow a red element to pop out when a fuse blows (opens). If a breaker has tripped off or a fuse blows, the overcurrent problem should be cleared before restoring power to the load by resetting the breaker or replacing the fuse. See "Troubleshooting," below, for information on tripped breakers or blown fuses.

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.

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 or Fuse
“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

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 or Fuse 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-83118-30).
- 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.

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 or Fuse Replacement

Procedure: (Refer to Figures 2-3 and 2-4 and T-83118-30 drawing)

1. Obtain a replacement circuit breaker. See paragraph “Spare Parts.”
2. Verify that the faulty breaker is in the OFF position or that a blown fuse is actually in the fuse block.
3. Open the hinged panel cover.
4. Measure the voltage at the load connection associated with the faulty breaker or fuse, to verify that the breaker or fuse is truly open. The voltage relative to the battery bus bars or distribution panel bus bar should be approximately the float voltage of the plant. With a blown fuse, the indicating fuse can be replaced to verify that the fuse is truly open. If the faulty breaker or fuse is, in fact, still closed, the load equipment which it powers must be shut down so that no current flows through the breaker/fuse arrangement during the following replacement steps.

DANGER

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

5. Disassemble the faulty breaker from the panel or remove the load fuse and indicating fuse from the fuse block.
6. Switch the new circuit breaker, if applicable, to the OFF position before plugging it in.
7. Assemble the new breaker or fuse, ensuring that line, load and alarm connectors are properly mated.

Warning

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

8. Turn on the load circuit breaker, if applicable. If the circuit breaker trips immediately when turned on, or the fuse blows when installed, this may be due to inrush current and does not necessarily indicate a fault condition. Attempt to close the circuit breaker or add another fuse a second time. If the breaker trips again, check the wiring to the load circuit.
9. Note that Fuse Alarm Major, FAJ (MJF) and its associated alarms retire.

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-83118-30 drawing)

1. Remove rectifier in position directly beneath LVD/R contactor (position 1), if present.
2. Open LVD/fuse panel door 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 LVD/fuse panel door 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-83118-30 drawing)

1. Open distribution panel.
2. Unplug the following connectors from the LVD/Fuse Board (CP5). Leave the cables dressed.
   - J502 from P502
   - J508 from P508
   - J506 from P506
   - J501 from P501
   - J504 from P504
   - Wires from TB501
3. Remove the 6 mounting screws.
4. Set jumpers J505.1 and J505.2 on replacement LVD/Fuse Board (CP5). See H569-403 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:
   - J502 to P502
   - J508 to 508
   - J506 to P506
   - J501 to P501
   - J504 to P504

- Wires to TB501

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 Table T of the H569-403 drawing.

- Rectifiers and fans
- Circuit Breakers (10-100 ampere)
- Fuses (1-30 ampere)
- LVD/Fuse Board (CP5)
- Fuses (F1 to F21)
- Controller Circuit Packs (Refer to the Controller manual)

In addition to these items, any piece part may be ordered that is identified in the assembly views and stocklist on the H569-403 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.

THE FOREGOING WARRANTIES ARE EXCLUSIVE AND ARE IN LIEU OF ALL OTHER EXPRESS AND IMPLIED WARRANTIES, INCLUDING BUT NOT LIMITED TO WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. CUSTOMER'S SOLE AND EXCLUSIVE REMEDY SHALL BE SELLER'S OBLIGATION TO REPAIR, REPLACE, CREDIT, OR REFUND AS SET FORTH ABOVE IN THIS WARRANTY.

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