C&D TECHNOLOGIES, INC.
Power Solutions

POWER SYSTEMS DIVISION

ACM-600
+24/-48 VDC, 600A
POWER PLANT
PDS 4100

PRODUCT MANUAL
P/N 110-4100

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Power Systems Division
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RECEIVING INSTRUCTIONS
&
GENERAL EQUIPMENT INFORMATION

Please Note: For your protection, the following information and the product manual should be read and thoroughly understood before unpacking, installing, or using the equipment.

C & D Technologies presents all equipment to the delivering carrier securely packed and in perfect condition. Upon acceptance of the package from us, the delivering carrier assumed responsibility for its safe arrival to you. Once you receive the equipment, it is your responsibility to document any damage the carrier may have inflicted, and to file your claim promptly and accurately.

1. PACKAGE INSPECTION

1.1 Examine the shipping crate or carton for any visible damage: punctures, dents, and any other signs of possible internal damage.

1.2 Describe any damage or shortage on the receiving documents, and have the carrier sign their full name.

1.3 If your receiving freight bill notes that a Tip-N-Tell is attached to your freight, locate it. If the Tip-N-Tell arrow has turned even partially blue, this means the freight has been tipped in transport. Make sure the carrier notes this on your receipt before you sign for the freight.

2. EQUIPMENT INSPECTION

2.1 Within fifteen days, open the crate and inspect the contents for damages. While unpacking, be careful not to discard any equipment, parts, or manuals. If any damage is detected, call the delivering carrier to determine appropriate action. They may require an inspection.

***SAVE ALL SHIPPING MATERIAL FOR THE INSPECTOR TO SEE!**

2.2 After the inspection has been made, call C & D Technologies. We will determine if the equipment should be returned to our plant for repair, or if some other method would be more expeditious. If it is determined that the equipment should be returned to C & D Technologies, ask the delivering carrier to send the packages back to C & D Technologies at the delivering carrier's expense.

2.3 If repair is necessary, we will invoice you for the repair so that you may submit the bill to the delivering carrier with your claim form.

2.4 It is your responsibility to file a claim with the delivering carrier. Failure to properly file a claim for shipping damages may void warranty service for any physical damages later reported for repair.

3. HANDLING

Equipment can be universally heavy or top-heavy. Use adequate humanpower or equipment for handling. Until the equipment is securely mounted, be careful to prevent the equipment from being accidentally tipped over.

4. NAMEPLATE

Each piece of C & D Technologies equipment is identified by a part number on the nameplate. Please refer to this number in all correspondence with C & D Technologies.

5. INITIAL SETTINGS

All equipment is shipped from our production area *fully checked and adjusted*. Do not make any adjustments until you have referred to the technical reference or product manual.

6. SPARE PARTS

To minimize downtime during installation or operation, we suggest you purchase spare fuses, circuit boards and other recommended components as listed on the Recommended Spare Parts List in the back of the product manual. If nothing else, we strongly recommend stocking spare fuses for all systems.

ISSUE HISTORY

ISSUE	PAGE(S)	DESCRIPTION	DATE
A		Preliminary Issue	
1	ALL	Initial Release	
2	?	? Address change on cover	
3	ALL	Updated cover to read "C & D Technologies, Inc. Power Solutions" with Dunlap Plant address, phone #'s, fax #'s, and website address. Added updated Receiving Instructions & General Equipment Info. Sheet, Issue 7 Changed "Ratelco" to "C & D Technologies, Inc." throughout document Added updated drawings. SEE ECN 12186	MCM 2/11/99
4		Added references for LVD by-pass switch and remote disconnect terminal block	JSN 9/24/99
5	ALL	SEE ECN 15562	MCM 6/6/06

DOCUMENT SUMMARY

This document explains the installation, operational, maintenance and troubleshooting methods for the C & D Technologies, Inc. ACM-600 Power Plant.

Thank you for purchasing the Liberty ACM-600 Power Plant. We at C & D Technologies, Inc. are proud of the quality of our products and welcome any suggestions to further improve our design to fit your needs.

All statements, information and data given herein are believed to be accurate and reliable but are presented without guarantee, warranty or responsibility of any kind, express or implied. Statements or suggestions concerning possible use of the product are made without representation or warranty any such use if free of patent infringement and are not recommendations to infringe any patent. The user should not assume all safety measures are indicated or other measures may not be required.

TABLE OF CONTENTS

TABLE OF ABBREVIATIONS

ABBREVIATION, ACRONYM OR SYMBOL	MEANING
ANSI	American National Standards Institute
AWG	American wire gauge
CEV	controlled environment vault
CFA	converter failure alarm
CM	circular mils
DIP	dual in-line package
EMI	electromagnetic interference
ESD	electrostatic discharge
FA	fuse and breaker alarm
FA1	+24-volt fuse and breaker alarm
FA2	48-volt fuse and breaker alarm
HVA	normally energized high voltage alarm
HVA**not**	normally de-energized high voltage alarm
IEC	International Electrical Commission
IEEE	Institute of Electrical and Electronic Engineers
LED	light emitting diode
LSD	least significant digit
LVA	low voltage alarm
LVD	low voltage disconnect
PCB	printed circuit board
PDR	power distribution rack
RBOC	Regional Bell Operating Company
RFA	rectifier failure alarm
Vdc	volts direct current
NEMA	National Electrical Manufacturers Association
ANSI	American National Standards Institute
NEC	National Electric Code
UL	Underwriters Laboratory
UBC	Uniform Building Code

TABLE OF REFERENCES

DOCUMENT NUMBER	TITLE
ANSI C 39.1	Requirements for Electrical Analog Indicating Instruments
ANSI T1.311-1991	DC Power Systems – Telecommunications Environment Protection
ANSI/IEEE C 62.41-1980	IEEE Guide for Surge Voltages in Low-Voltage AC Power Circuits, ANSI
IEC 801-2	IEC Electromagnetic Compatibility for Industrial-Process Measurement and Control Equipment October 1987
NEC 1993	NEC Handbook 1993, National Fire Protection Association
No Number	OI-28 Standards
No Number	Central Office Telecommunications Equipment Engineering Standards December 1984
PUB 77350	U S West Telecommunications Equipment Installation & Removal Guidelines June 1990
PE-7-1985	Communications Type Battery Chargers, NEMA/ANSI
STD 487-1980	IEEE Guide For The Protection of Wire-Line Communications Facilities Serving Electrical Power Stations
TR-EOP-000151	Bellcore Generic Requirements for 24-, 48-, 130-, & 140-Volt Central Office Power Plant Rectifiers May 1985
TR-EOP-000154	Bellcore Generic Requirements for 24-, 48-, 130-, & 140-Volt Central Office Power Plant Control and Distribution May 1985
TR-NWT-000063	Bellcore Network Equipment-Building System Generic Equipment Requirements Issue 4, July 1991
TR-TSY-000078	Bellcore Generic Physical Design Requirements for Telecommunication Products and Equipment
UL489	UL Molded Case Circuit Breaker Enclosures May 1984

CHAPTER ONE INTRODUCTION

1.0 GENERAL DESCRIPTION

The ACM-600 Power Plant provides a +24 vdc power with either 600 or 360 ampere maximum distribution in a variety of rack combinations for standard floor mounting or direct mounting on battery stacks. Based on modular switched-mode rectifier technology, the plant allows custom configurations in multiples of 150 amperes or 60 amperes with plug-in +24 vdc rectifier modules. Plant options include 48 Vdc distribution with five 3-ampere dc-dc converters. The -48-volt distribution option includes a maximum of ten GMT fuse positions. Rectifier modules, dc-dc converters, and distribution breakers and fuses must be ordered separately.

The 24-volt distribution section provides positions for up to 24 plug-in, AM1-type 5 to 100-ampere breakers. Circuit breakers 50 amperes and under require one breaker position while breakers 60 amperes and over take up two breaker positions. Circuit breakers must be ordered separately.

The distribution cabinet buss work provides landings for two strings of battery cables. A ground return is also provided for +24 and -48-volt load returns.

Basic list numbers allow for plant configurations that support 600A distribution with 24v 150A rectifiers (List1) or 360A distribution with 24v, 60A rectifiers (List3). Each of these plants is available with the low-voltage disconnect feature (LVD) in List 2 or List 4 configurations, respectively. All plant configurations include a high-resolution digital meter for monitoring voltage and current for the +24-volt plant and -48-volt converter section.

A System board provides detection and front-panel light-emitting diode (LED) displays for:

- **RFAs** rectifier failure alarms
- **+24V FA** fuse alarm for +24 volt distribution
- **-48V FA**. 48 volt alarm
- **CFA** converter failure alarms
- **HVA** high voltage alarm
- **LVA** low voltage alarm
- **MAJOR** alarms
- **MINOR** alarms
- **HIGH TEMP** high temperature alarm (optional)

The digital meter, calibration, HVA and LVA alarm circuits can be adjusted and tested from the front panel door. The List 2 and List 4 power plants provide a low voltage disconnect (LVD) alarm. HVA, LVA, LVD, and FA alarms generate a major alarm.
A single RFA generates a minor alarm that will automatically upgrade to a major alarm if a second rectifier failure occurs. An adjustable High Temperature alarm is included with the Battery Temperature Compensation option.

Nine form-C normally energized relays and one normally de-energized relay (HVA) provide remote alarm monitoring capability with (2) major, minor, LVD, HVA, LVA, RFA, or +24-volt FA and -48-volt FA alarms. The ninth relay is for the optional high temperature output.

The LVD trip settings can be adjusted and tested on the front door of the distribution panel without a service interruption. The LVD control circuit has manual or automatic operation, adjustable delays before disconnect, and a two-switch press manual safe disconnect feature. Additional features provide a contactor service by-pass switch to allow controller servicing without a service interruption and a connection for an emergency remote disconnect switch. Disconnecting the LVD relay automatically generates a major alarm.

2.0 FEATURES

2.1 Standard Plant Features

The following list of features are standard with all ACM 600 list number configurations:

- 600-ampere, +24 volt maximum distribution
- 150A or 60A switch-mode rectifiers for optimal modularity
- Front access to all distribution and customer wiring.
- 4½-digit, high-resolution digital meter for monitoring voltage and current
- LED alarm indications for major, minor, HVA, LVA, RFA, +24-volt (FA1) and -48 volt (FA2) alarm
- Nine form-C contacts for remote alarm monitoring
- Customer-adjustable set points for HVA, LVA, and LVD trip points Calculated for UBC seismic zone four installations
- Two battery strings and buss work supporting ground return terminations for forty-six double-sided 5/8-inch cc, ¼-inch diameter 2-hole lugs and ten, ¼-inch diameter and four, □-inch diameter single lugs.
- 600-ampere shunt for +24-volt section
- 20-ampere shunt for 48-volt section
- 24 plug-in , AM1-type breaker positions
- Built-in monitoring for the +24 Vdc and -48 Vdc battery and current

2.2 Optional Plant Features

- Optional Low Voltage Disconnect with service by-pass switch and remote disconnect capability.
- An option for battery temperature compensation which includes customer adjustable trip point for high temperature alarm.
- Front access AC wiring for List 1 and List 2 power plants
- DC to DC converter option consisting of a cardcage and motherboard with 10-position GMT fuse block and all necessary hardware to support five, 3-ampere, 24-volt to 48-volt DC to DC converters
- Additional -48v distribution with 10 GMT fuse positions.

2.3 Rectifier Features

- Hot-swappable and lightweight modules allow a low mean-time-to-repair without plant shutdown

- Active power factor correction greater than 0.98 and efficiency of 85 percent means low operating costs
- Individual AC input terminals for each rectifier for failsafe operation
- No tools are necessary for rectifier installation
- Cooling fans are field-replaceable without plant shutdown

2.31 24v, 150A Rectifier Features

- Front panel AC and DC circuit breakers
- Three front panel selectable load share modes: active, passive or off
- Front panel rectifier failure (RFA), fan failure (FF), and ac failure (ACF) LED's

2.32 24v, 60A Rectifier Features

- Front panel switch
- Three front panel selectable load share modes: active, passive or off
- Front panel rectifier failure (RFA), fan failure (FF), and ac failure (ACF) LED's

2.4 DC to DC Converter Features

- Plant supports up to five 3-ampere modular, convection cooled converters
- Distribution with 0.50 to 10-ampere GMT-type fuses.
- Converters easily plug-in without the need for tools.

2.5 +24v Distribution Features

- AM1-type circuit breakers of 5 to 125-amperes are available
- All breakers snap-in to facilitate installation and field expansion

3.0 SPECIFICATIONS

3.1 Physical Specifications*

	Power Shelf	Rectifiers	Distribution Cabinet	Modular Converter 3 Ampere
Width	21.5" (55 cm)	5" (13 cm)	21.5" (55 cm)	10.21" (25.96 cm)
Depth	14.5" (37 cm)	14.5" (37 cm)	16" (40.7 cm)	1.665"(4.23 cm)
Hght.	See below	See below	12"(30 cm)	3" (7.6 cm)
24150	7" (18 cm)	12" (30 cm)		
2460	8.75"(22.2cm)	8.63"(21.9cm)		
Wt.	See below	See below	40 lbs. (18.2 kgs)	3 lbs. (1.36 kgs)
24150	18 lbs. (8.2 kgs)	18 lbs. (8.2 kgs)		
2460		13.5 lbs.(6.1kgs)		

***NOTE:** Refer to drawing J110-4100, Sheet A3 for specific relay rack dimensions and part numbers. Rack options add from 25 to 75 lbs. to overall weight depending on the rack type ordered.

3.2 Environmental Specifications

Operating temperature	0 to 50C (32 to 122F)
Storage temperature	-40 to +85C (-40 to +185F)
Shipping and handling	**plant** shipped fully assembled in packing crates designed to withstand the shock and vibration normally encountered in shipping and handling
	rectifier and converter modules encased in protective foam and shipped in individual boxes
Humidity	0 to 95 percent non-condensing
Altitude	10,000 feet (3,048 meters)*
Heat dissipation	19,500 BTU/hour maximum, fully loaded
Cooling	**distribution** convection cooling
	rectifiers fan cooling with built-in over-temperature protection with automatic recovery
	converters fan cooled, thermally protected
Seismic	UBC seismic zone 4**

* Plant derating will be required above 7,000 feet. Consult factory.

** Application should include overhead or wall bracing. Seismic mounting kits with Hilti anchors are available.

3.3 Electrical Specifications

Input **24150**	Rectifier shelves require 176 to 264 Vac, single phase, 45 to 65 hertz input power 40-ampere delayed-trip circuit breaker is recommended for each rectifier for single ac input applications. 80-ampere circuit breaker is recommended for each shelf for dual AC input applications.
2460	Rectifier shelves require 110/208/240 Vac, single phase, 45 to 60 hertz input power 20-ampere delayed-trip circuit breaker is recommended for each rectifier for single ac input applications.
Battery	Two-hole 3/8-inch diameter 1-inch cc lug connections are provided for connection of up to two battery strings
DC/DC	The plant supports up to 5 three-ampere DC to DC converters. The DC to DC converter option provides positions of 10 GMT fuses from 0.5 to 10 amperes.

Output	**plant** maximum plant output is 600 amperes at 27.10 ±0.5 Vdc **converters** maximum dc-dc converter output with five converters is 15 amperes at 51±0.05 Vdc

3.4 General Plant Performance Specifications

- The plant will float and recharge low specific gravity lead-calcium battery cells at 2.26 volts per cell ±0.5 percent times the number of cells while maintaining full load. Refer to SD 110-4100, Engineering notes 59 and 61 for specific settings.
- The plant temperature coefficient will not exceed 0.01 percent per degree Celsius.
- Plant voltage will be stable within regulation set value one minute after turn on.

3.5 Bus Specifications

- Bus structure ampere ratings are less than those listed in American National Standards Institute's Telecommunications Environment Protection Specifications (ANSI T1.311-1991) ampere tables.
- Charge bus maximum voltage drop will not exceed 0.5 volts.
- The discharge maximum voltage drop will not exceed 0.25 volts.

3.6 Noise Specifications

Electrical noise	will not exceed 32 dBrnC for battery or battery-less operation
Wide-band noise	will not exceed 40 milli-volts in any 3 KHz band between 10 KHz and 20 MHZ
Peak-to-peak ripple	will not exceed 350 milli-volts over 20 MHZ bandwidth

3.7 Susceptibility Specifications

- Designed to meet ESD requirements per International Electrical Commission Specifications on Electromagnetic Compatibility (IEC 801-2, Section 4.11).
- Designed to meet Class "A" EMI requirements of CFR 47, part 15C and J.
- Designed to withstand, without damage, a lightning surge between battery return bus and frame ground per ANSI/IEEE C62.41.

3.8 Rectifier Specifications

Efficiency	greater than 85 percent, outputting maximum current rating at 28 volts from a 240 Vac input at 25°C. greater than 50 percent, outputting 10% of maximum current rating at 28 volts from a 240 Vac input at 28°C.
Power factor	greater than 0.98 at rated output
Protection	DC circuit breaker on 24150 rectifier Internally fused on 2460 rectifier
Service	rectifiers may be installed or removed without affecting plant operation

3.9 Safety Specifications

Underwriters Laboratory Standards of Safety for Information Technology Equipment (UL 1950) and the Bellcore Network Equipment-Building System Generic Equipment Requirements (TR-EOP-000063) were used as guidelines in the specifications of all components and wiring, with particular attention to safety ratings and OI-28 flammability requirements.

3.10 Low Voltage Disconnect Feature Specifications (List 2 only)

* See Drawing J110-4100 for LVD board details

- The low voltage disconnect feature is factory-set to disconnect at 21 Vdc ±0.5 percent and reconnect at 25 Vdc ± 0.5 percent.
- On-line calibration and operation verification without service interruption.
- Manual disconnect requires two switch operation
- Manual or automatic reconnect
- Disconnect/inhibit switch is provided
- Disconnect delay from 2 to 375 seconds set with dual in-line package (DIP) switch. Factory setting is 2 seconds.
- An LVD By-pass switch allows for service on the LVD control without a service interruption.
- A terminal block is provided for the addition of an LVD emergency disconnect switch

3.11 Monitoring Specifications*

* See Drawing J110-4100, Sheet B3, Figure 5 for System board details

- The metering and alarm board's front panel meter provides 4½-digit resolution with 0.05 percent accuracy ± least significant digit (LSD) on voltage readings and 1.0 percent accuracy on current readings.
- The default reading on the metering and alarm board's meter is plant voltage.
- Front panel switches are available for displaying the following on the metering and alarm board's digital meter:
  - plant battery voltage
  - converter load voltage
  - plant load current
  - converter load current
- The rectifier's 3½-digit meter continually displays rectifier current.
- Both meters can be calibrated for voltage and current accuracy through front panel test jacks and adjustment potentiometer.

3.12 Control Specifications

~ A front panel switch selects the Equalize function. All rectifiers will indicate the equalize mode when selected. The equalize voltage is customer adjustable when selected by separate potentiometers on each rectifier.

~ The 24150 rectifiers provide a customer adjustable HVSD trip point with a front panel potentiometer. The 2460 rectifiers have an internally set HVSD trip point with no adjustment. See SD 110-4100 for specific factory settings.

~ The system board provides an automatic rectifier restart signal when battery voltage drops below the low voltage trip point.

~ The battery temperature compensation option automatically adjusts plant float voltage with respect to battery temperature to provide battery protection and prolong battery life.

3.13 Alarm Specifications*

- See Drawing J110-4100, Sheet B3, Figure 5, for System board details

The following charts list the various alarm indications and outputs available on the ACM 600 power Plant. Each alarm is listed with its' location and indication color, specific operation and/or factory trip setting, and major and minor alarm implications.

FRONT PANEL ALARM INDICATIONS	
RFA **rectifier failure alarm**	front panel red LED RFA indication the plant monitors each individual rectifier's RFA alarm one RFA causes a minor alarm signal two or more RFAs cause a major alarm signal individual rectifiers have their own red LED to indicate where the failure has occurred
HVA **high voltage alarm**	front panel red LED HVA indication HVA is factory-set to signal an alarm at 28.5 Vdc. HVA hystresis is approximately 1.0 volts. HVA trip point can be adjusted and tested from the front panel HVA causes a major alarm signal
LVA **low voltage alarm**	front panel red LED LVA indication LVA is factory-set to signal an alarm at 24.2 Vdc. LVA hystresis is approximately 1.0 volts. LVA trip point can be adjusted and tested from the front panel LVA causes a major alarm signal
FA1 **+24-volt fuse and breaker alarm**	front panel red LED FA1 indication all +24-volt fuses and circuit breakers send individual fuse alarms (FAs) when tripped or open manually turning a breaker off or

FRONT PANEL ALARM INDICATIONS

	removing a fuse will not generate an FA1 signal FA1 causes a major alarm signal
FA2 **48-volt fuse and breaker alarm**	front panel red LED -48-volt alarm indication all 48-volt fuses and circuit breakers send individual fuse alarms (FAs) when tripped or open manually removing a fuse will not generate a -48-volt fuse alarm signal
CFA **LED indicator converter fail alarm**	All converters provide individual converter fail alarm indications (CFA) and output relays. A CFA alarm indicates a failure due to over-current, over-temperature, input power failure, or internal circuit failure
LVD **low voltage disconnect alarm** **list 2 only** **(See Chapter 1, Section 3.10 for more low voltage disconnect specifications)**	front panel red LED to signal load disconnect and green LED to signal load connect a major alarm will be generated any time the LVD contactor is disconnected manually disconnecting the LVD connector will generate a major alarm
Major alarm	front panel red LED indication major alarms are generated simultaneously with HVA, LVA, FA1, LVD, two or more RFAs, CFA, FA2, and HIGH TEMP (optional)
Minor alarm	front panel yellow LED indication a minor alarm is generated when a single RFA occurs

FRONT PANEL ALARM INDICATIONS	
Rectifier ac failure	rectifier front panel red AC LED indication
Rectifier fan failure	rectifier front panel red FF LED indication

REMOTE ALARM INDICATIONS	
Form-C contacts	the alarm interface board provides 9 form-C alarm relay outputs; all relays except HVA are normally energized
standard	seven form-C contacts are factory-wired for minor, major (2), LVD, HVA and FA1 alarm indication
optional **(See Drawing J110-4100, Figure 11 Sheet B6 for more information)**	one set of form-C contacts are factory-wired for a high temperature alarm based on the differential between ambient and battery temperature sensors. The set point is customer adjustable, factory default is 20F.
converters	a -48V major form-C relay contact monitors both the -48V FA and converter CFA alarms

CHAPTER TWO POWER PLANT INSTALLATION

1.0 INTRODUCTION

1.1 These instructions provide general information about installing the ACM-600 Power Plant. They are meant to be used with Drawings J110-4100 and SD110-4100. If the appropriate drawings are not included in this manual, contact Customer Service at 1-423-949-4135.

1.2 If questions or problems arise during installation, please call one of our technicians at 1-800-869-7130 for assistance. A nameplate on the front of the distribution cabinet gives the part number for the ACM-600 Power Plant. Reference this number when requesting service.

1.4 To install the ACM-600 Power Plant you will need:

- Standard installation tools
- Cables and lugs
- J110-4100 drawing set
- SD110-4100 drawing set

1.5 Rectifiers and modular converters are shipped in separate, protected packages. They are ready to plug into the shelves. Only AC power connections to power shelves are required.

1.6 A label on the inside of the distribution cabinet door lists circuit breaker/fuse position and amperage information. Space has been left for customer-entry of information.

1.7 Factory Settings: The plant voltage, low voltage disconnects and low voltage alarms are factory-set. Below are the settings and trigger points for each. Each rectifier and converter is individually adjusted before shipment.

Plant voltage	Set at 27.1 volts dc ± 0.5 volt
Low voltage alarms	Set to trigger at 24.2 volts dc
High voltage alarm	Set to trigger at 28.5 volts dc
Low voltage disconnect option	Set to disconnect at 21 volts dc
(If ordered)	Set to reconnect at 25 volts dc

WARNING: Plant voltage will regulate to the voltage present at the rectifier with the highest voltage adjustment setting. The plant voltage setting must be changed with care to avoid disrupting the load sharing between rectifiers.

2.0 SELECTING A LOCATION

2.1 Equipment will last longer if it is kept in a non-harmful environment. The power plant must be permanently secured in a location that is:

- DRY
- WELL VENTILATED
- MODERATE IN TEMPERATURE (4 TO 38 C)
- FREE OF OBSTRUCTIONS
- PEST FREE

2.2 Mark and drill floor-mounting holes as shown on Drawing J110-4100, Sheet A3.

2.3 Additional wall or overhead bracing may be required for seismic zone 4 compliance.

3.0 SELECTING POWER CABLES

3.1 Protective circuits, overall system performance, and safety depend on the proper sizing of DC cables for ampere ranges and acceptable DC voltage drop.

3.2 Perform the following procedure to determine wire size.

PROCEDURE

1. Calculate the minimum number of circular mils (CM) required for copper wire using the following formula:

$$CM = \frac{22.2 \times I \times L}{V}$$

where:

CM = minimum area of circular mils in the cable
I = maximum current (in amperes)
L = one-way cable length (in feet)
V = allowable loop voltage drop (in volts)

i.e.: If you have a maximum output current of 100 amperes, and an allowable loop voltage drop of 0.25 volts, and your ACM-600 Power Plant is 50 feet from the load:

I = 100 amperes
L = 50 feet
V = 0.25 volts

$$CM = \frac{(22.2)(100)(50)}{(0.25)}$$

$$CM = 440{,}000$$

2. After calculating the minimum number of circular mils, select the proper copper wire size from Table 2-A, always choosing the larger wire if the resistance rating falls between values. (i.e., for the example in the previous step, 500 MCM wire size would be selected.)

3. Determine the minimum wire size for ampacity according to the code authority having jurisdiction over you location.

4. Select the larger of the sizes calculated for voltage drop or ampacity.

SIZE AWG NO.	AREA IN CM	CURRENT CARRYING CAPACITY*		DIA BARE COND INCHES	RHW DIA OVER INS INCHES	RHW BEND RADIUS INCHES	RHW NET WEIGHT PER 1000 FT IN POUNDS	RHW MAX SHIP LENGTHS PER REEL IN FEET
		Open Air	Enclosed					
14	4,110	15	15	0.064	0.19	0.95	26	5,000
12	6,530	20	20	0.081	0.21	1.05	35	3,000
10	10,380	30	30	0.102	0.24	1.20	49	3,000
8	16,510	45	45	0.146	0.31	1.55	84	3,000
6	26,250	70	65	0.184	0.40	2.00	126	2,000
4	41,740	100	85	0.232	0.45	2.25	190	1,500
2	66,370	135	115	0.292	0.51	2.55	278	1,000
1/0	105,500	185	150	0.373	0.63	3.15	443	1,000
2/0	133,100	210	175	0.418	0.68	3.40	540	1,000
4/0	211,600	300	230	0.528	0.78	3.90	814	1,000
350 MCM	350,000	425	310	0.681	0.98	4.90	1,310	750
500 MCM	500,000	525	380	0.814	1.12	5.60	1,815	500
750 MCM	750,000	660	475	0.998	1.34	6.70	2,700	360

Table 2-A: Wire Sizing

* Data based on NEC Handbook 1993, Table 310-17 adjusted for 50C ambient temperature.

4.0 INSTALLATION PROCEDURE OUTLINE

WARNING: The ACM-600 Power Plant has a center of gravity that is slightly higher than a typical rack power board. Personal injury could result if it were to tip and fall. Do not leave the power board unsecured in the upright position.

Note: Installation in a seismic zone 4 location should include either wall or overhead bracing.

GENERAL PROCEDURE OUTLINE

1. Install floor anchors and secure framework.
2. Assemble overhead ironwork as required.
3. Provide AC power and ground to the power shelf.
4. Run and secure battery cabling.
5. Run and secure distribution cabling.
6. Verify correct AC power to the modules.
7. Install rectifier modules.
8. Install converter modules (if ordered).
9. Power-up plant.
10. Verify proper installation and operation.

5.0 AC POWER CONNECTIONS

5.1 Direct Wiring to Power Shelf*

*Refer to drawing J110-4100, Sheet B2, Figure 3, and SD110-4100, Sheet B1, FS 1 and Table D for List 1 and 2 power plants with 24v 150A rectifiers.
**Refer to drawing J110-4100, Sheet B6, Figure 16, and SD110-4100, Sheet B1, FS 1 and Table D for List 3 and 4 power plants with 24v 60A rectifiers.

WARNING: Hazardous voltage exists on the shelf interior. Use extreme caution. Do not insert arms or tools. Do not install rectifiers until just before the plant is ready to be powered-up.

NOTE: Separate protected AC power circuits must be provided for each power shelf slot to prevent single point failures.

NOTE: Access holes for conduit connections are provided in the rear of the power shelves for each rectifier slot. Refer to Drawing SD110-4100 for specific AC wiring information.

PROCEDURE

1. Protect input cables by installing the proper delayed-trip circuit breaker specified in SD 110-4100 Table D on each input cable.

2. Run individually protected AC power-cabling feeds from the ac cabinet to each rectifier slot position via the 1.25" conduit holes at the rear of the shelf. Each rectifier slot provides an interface with a compression terminal block for AC power connections.

3. Carefully insert stripped leads into the access holes.

4. Tighten the clamp with a screwdriver.

   NOTE: Keep wire lengths to a minimum. Long leads may interfere with proper rectifier operation.

5. Pull on the leads to check that the connections are tight.

6. Test each AC power connection by turning the breakers ON at the AC cabinet, and applying a meter to individual terminal blocks.

7. Verify that the AC input voltage is between 176 and 264 volts AC at each rectifier slot for 24150 rectifier applications and 110/208/240 volts AC for the 2460 rectifiers.

8. Turn breakers in the AC cabinet OFF. Verify that AC power is disconnected. Power should remain disconnected from the shelf until rectifiers are installed.

5.2 Front Access AC Power Wiring

AC front access wiring is available only with List 1 and 2 power plants utilizing 24150 rectifiers.

PROCEDURE

Refer to drawing J110-4100, Sheet B6, Figure 13.

1. The front access AC wiring option provides terminal blocks and conduit connections in the left rear of the distribution cabinet. The terminal blocks are factory wired to the power shelf.

2. Route AC power to single 1.75-inch conduit or individual 1.25-inch conduit holes at the top left of the cabinet and secure.

3. Refer to SD110-4100 Figure 5 for terminal block connection diagram and secure wires using the tie wrap holes in the chassis. No lugs required.

4. Pull on the leads to check that the connections are tight.

.

5. Turn AC power on at mains. Verify proper voltage: 176-264 Vac single phase.

6. Turn breakers in the AC cabinet OFF. Verify that ac power is disconnected. Power should remain disconnected from the shelf until rectifiers are installed.

6.0 CONNECTING BATTERY CABLES

WARNING: Dense distribution, confined working space, and close proximity between battery and ground bus work present shorting hazards. Working on a live plant without exercising caution could result in arcing, equipment damage, load interruptions, and personal injury. Installers and maintenance personnel should use insulated tools and extreme caution when working inside a live distribution cabinet.

6.1 The battery charge bus and ground charge bus provides 2-hole lug landings with □-inch holes on 1-inch centers for connecting up to two battery strings. Battery cable landings were designed for vertical side-by-side cable entry from the overhead cable rack. Back-to-back lug connections can be supported if more than two battery strings are required. (Refer to drawing J110-4100, Sheet B4, Figure 8).

PROCEDURE

1. Determine correct battery cabling size and routing.

2. Terminate cables using installer provided hardware.

7.0 CONNECTING DISTRIBUTION

READ BEFORE STARTING:

Breakers, 60 amperes and over require two breaker positions. An adapter bus bar that comes with the breaker supports a single 3/8" stud for cabling lug connections (hardware not provided).

All other breakers provide 5/8" cc two-hole #10 clearance holes for cabling lug connections.

All AM1 breakers utilize snap-in clips requiring no hardware for installation.

The ground return bus bar behind and below the breaker distribution section provides 46 back to back two-hole lug landings with ¼-inch clearance holes on 5/8" centers, and 8 back-to-back 3/8" clearance holes for larger breakers. Additional 1/4" single lugholes are provided for -48-volt distribution return leads.

NOTE: Circuit breakers are factory-installed as ordered with largest ratings mounted from left to right.

PROCEDURE

1. Breakers snap into place. Snap the topside of the breaker in first, pivot the breaker down and snap in the bottom side.

2a. For **5 -50 ampere breaker installation**, wiring must be terminated with two-hole lugs with ¼-inch clearance holes on 5/8" centers. Hardware must be provided by installer.

2b. For **60 -100 ampere breaker installation**, wiring must be terminated with single 3/8" hole lugs. Install the adapter bus bar and place the load wiring lug on the 3/8" stud with hardware and tighten.

3. Leave the circuit breakers in the OFF position until load connections are desired.

8.0 INSTALLING 24150 RECTIFIER MODULES

WARNING: The rectifier modules provide a simple locking handle that cams the module into the installed position. Excessive force is unnecessary, and could result in mechanical damage to the rectifier module.
WARNING: All shelf slots must contain a rectifier or a protective cover. Do not insert arm or tools into powered shelves.

NOTE: The rectifier modules are designed to be installed hot with no plant service interruption. Rectifiers are shipped separately in padded boxes. Blank covers have been installed in all power shelf slots.

PROCEDURE

1. Remove rectifiers from shipping containers. Remove all packaging materials.

2. Remove blank covers from power shelf slots.

3. Pull AC and DC breaker handles on the front of the rectifiers OUT.

4. Open the locking handle into the horizontal position.

5. Slide a rectifier slowly into the far left, slot 1 position, of the power shelf until the locking handle engages. The rectifier will come into its operating position as the handle is moved into its locking position.

6. Install rectifiers from left to right, leaving the blank covers in place over any unused slots. The removed covers can be stored for possible maintenance use.

8.1 INSTALLING 2460 RECTIFIER MODULES

NOTE: The rectifier modules are designed to be installed hot with no plant service interruption. Rectifiers are shipped separately in padded boxes. Blank covers have been installed in all power shelf slots.

WARNING: The use of excessive force when installing rectifiers could damage the power shelf and/or rectifier. Read and follow installation procedure.

PROCEDURE

1. Remove rectifiers from shipping containers. Remove all packaging materials.
2. Remove blank covers from power shelf slots.
3. Make sure power switch is in the OFF position..
4. Slide a rectifier slowly into the far left, slot 1 position, of the power shelf until contact with the power shelf mating connectors is felt. Apply steady firm pressure to seat card edge connectors. Continue pressing on rectifier until the front snap catch latches into place. The Rectifiers faceplate should be even with the power shelf top and up against the bottom.
5. Install rectifiers from left to right, leaving the blank covers in place over any unused slots. The removed covers can be stored for possible maintenance use.

9.0 INSTALLING CONVERTER MODULES

NOTE: The following instructions were written to be used in conjunction with the appropriate drawings. Please reference Drawing J110-4100, Sheet B5 and Drawing SD110-4100, Sheet B1, Figure 1 when performing this installation. Converter modules need to be installed by the customer.

WARNING: If the plant is live during installation of modules, exercise extreme caution to avoid equipment damage or personal injury.

WARNING: Ensure that converters' power slide switch is in the OFF (down) position. Installing converters in a live plant with the power switch ON can damage the converters.

9.1 The DC to DC converter module option includes a motherboard with a ten-position GMT fuse block and all necessary hardware to support five, 3-ampere converters.
NOTE: The converter modules are designed to be installed hot with no plant service interruption. Converters are shipped separately in padded boxes.

PROCEDURE

1. Remove converter module from shipping container. Remove all packaging materials.

2. Verify that the power slide switch is in the OFF (down) position.

   NOTE: Converter modules require only slight pressure to fully insert. Excessive force could damage the converter motherboard and/or converter modules.

3. Remove the DC to DC converter retainer by sliding the retainer latches inward.

4. Factory conventions assign slot numbers from left to right, with the far left slot designated as slot #1.

5. Carefully slide the module into the shelf. As the module comes into contact with the shelf connectors, a gentle rocking motion can be used to begin seating the module into the connectors.

6. Once aligned, apply firm pressure to fully seat the module into the shelf. The module will bottom-out against the connector when fully seated.

7. Repeat this procedure for each converter module to be installed.

8. Put the converter retainer back on the converter shelf.

9. Leave converter switches in the OFF (down) position until needed on.

9.2 Installation of GMT fuses: The GMT fuse block provides positions for ten GMT fuses ranging from 0.5 to 10 amperes. Factory installed fuses are positioned from left to right with the largest values on the left and smaller values on the right. Fuse installation for the standard GMT distribution and extended GMT distribution option is the same except for the load return wire termination.

PROCEDURE

1. Install the GMT fuse in the proper position.

2. Bring the load wire to the corresponding terminal block, TB1, using a maximum of 12 Ga wire. No lugs are required. Refer to J 110-4100 Figures 11 and 12, and SD 110-4100 FS 1 for wiring details.

3. Load returns from the primary -48v distribution on the dc/dc Motherboard are terminated directly to the Ground Return bus. Single 1/4" dia. holes are provided Load returns from the optional Extended GMT Distribution pcb are terminated to the ground return pins on the pcb's terminal block, TB1.

10.0 POWERING-UP 24150 RECTIFIERS

WARNING: Adjusting a plant with battery temperature compensation option connected will result in erroneous plant voltage settings due to compensation offset. Move temperature compensation jumpers on alarm interface board, A2, to the DISABLE position before adjusting plant voltage. Return jumpers to ENABLE position after plant voltage has been set. Plant voltage will immediately shift due to temperature compensation offset.

PROCEDURE

1. Pull OUT the AC and DC breakers on each rectifier to be activated. Be sure the temperature compensation is disabled. See warning note.

2. Turn on the power at the AC cabinet.

3. Close the AC breaker, allow thirty seconds for power-up, and then close the DC breaker on one of the rectifiers.

4. Adjust the float voltage and load bank as required until the rectifier takes load and is set to 27.1 Vdc ±½ volt. It may be necessary to connect the load by pushing the NORMAL or RECONNECT/INHIBIT switches on the low voltage disconnect board, if present.

5. Repeat Steps 3 and 4 until all rectifiers are on line and taking load.

6. Adjust rectifier float voltage settings as necessary until the rectifiers are sharing current (±1 ampere) and the plant voltage is 27.1 Vdc.

7. This same procedure can be followed to set the Equalize voltage. Select the Equalize voltage mode on the front panel. Verify the equalize mode is indicated on each rectifier when powered and adjust as for float using the equalize adjustment pot on each rectifier.

WARNING Leaving rectifiers in the equalize mode for extended periods can overcharge and damage the batteries.

At this point, the rectifier ammeters should show current delivery and all rectifier LED's except NORMAL should be off.

Be sure to re-enable temperature compensation after all the rectifiers are properly adjusted.

10.1 POWERING-UP 2460 RECTIFIERS

WARNING: Adjusting a plant with battery temperature compensation option connected will result in erroneous plant voltage settings due to compensation offset. Move temperature compensation jumpers on alarm interface board, A2, to the DISABLE position before adjusting plant voltage. Return jumpers to ENABLE position after plant voltage has been set. Plant voltage will immediately shift due to temperature compensation offset.

PROCEDURE

1. Make sure the power switch is in the "Off" position and that the temperature compensation is disabled. See warning note.

2. Turn on the power at the AC cabinet.

3. Turn the power switch to the "On" position

4. Adjust the float voltage and load bank as required until the rectifier takes load and is set to 27.1 Vdc ±½ volt. It may be necessary to connect the load by pushing the NORMAL or RECONNECT/INHIBIT switches on the low voltage disconnect board, if present.

5. The 2460 rectifiers are designed to lock load sharing within ~ ±0.75 vdc of the current float voltage. Once in the locking range the rectifiers will automatically average the voltage and equalize load sharing in about 6 seconds. Too simplify the adjustment and minimize the locking voltage range deviation for the next step for all subsequent rectifiers.

6. Be sure the float voltage adjustment pot is turned down well below the desired float voltage before starting. Power the rectifier and **very slowly** adjust the voltage up watching the current bar graph. As the rectifier begins to take load and approaches balanced loading with the other rectifier(s) go even slow the adjustment down even slower. Stop when the loads appear balanced and wait 6 seconds for the locking circuitry to take affect. Verify the displayed voltage has not changed. Adjust the rectifier voltage up or down slightly if necessary to maintain the desired float voltage. This process should result in rectifier to rectifier actual voltage deviations no greater than ± 0.20 volts

7. This same procedure can be followed to set the Equalize voltage. Select the Equalize voltage mode on the distribution front panel. Verify the equalize mode is indicated on each rectifier when powered and adjust as for float using the equalize adjustment pot on each rectifier.

WARNING Leaving rectifiers in the equalize mode for extended periods can overcharge and damage the batteries.

At this point, the rectifier ammeters should show current delivery and all rectifier LED's except NORMAL should be off.

✽Be sure to re-enable temperature compensation after all the rectifiers are properly adjusted.

11.0 VERIFYING PROPER 24150 RECTIFIER INSTALLATION

WARNING: Adjusting a plant with battery temperature compensation option connected will result in erroneous plant voltage settings due to compensation offset. Move temperature compensation jumpers on alarm interface board, A2, to the DISABLE position before adjusting plant voltage. Return jumpers to ENABLE position after plant voltage has been set. Plant voltage will immediately shift due to temperature compensation offset.

NOTE: These tests require an adjustable load be attached to the battery charge and ground charge bus bars.

PROCEDURE

1. Adjust the plant current to approximately 75 amperes.

2. Pull OUT the AC and DC breakers on one rectifier.

3. Push IN the AC breaker after the rectifier display goes out.

4. Monitor the rectifier output voltage (independent of the charge bus) at the rectifier voltage test jacks.

5. Confirm the internal high voltage shutdown occurs at the proper DC voltage value by gradually increasing the rectifier float voltage until the rectifier shuts down.

6. Restart the rectifier by reducing float voltage slightly and pulling OUT the AC breaker until the rectifier display goes out.

7. Push ON the AC breaker, allowing thirty seconds to power-up, and then push ON the DC breaker.

8. Readjust the float voltage until the rectifiers share current.

9. Perform Steps 2 through 8 for each rectifier in the plant.

10. Confirm and, if necessary, calibrate the digital meter. The voltage at the current test jacks (in milli-volts) multiplied by 4.0 should equal the current displayed by the meter. Calibration will be most accurate when done at full load.

    NOTE: All rectifiers load share switches must be in the same mode; ACTIVE, OFF or PASSIVE.

11. Push the load share switch into the OFF position on all rectifiers.

12. Finely adjust the float voltage on each rectifier as required to achieve current balance between rectifiers and maintain correct float voltage.

13. Vary the output load to confirm load share and accurate output voltage regulation.

14. Push the load share switch into the ACTIVE position on all rectifiers.

15. Finely adjust the float voltage on each rectifier as required to achieve current balance between rectifiers and maintain correct float voltage.

16. Vary the output load to confirm loadshare and accurate output voltage regulation.

17. Increase the plant load too more than 150 amperes.

18. Confirm the current limit setting of each rectifier by pushing the rectifier test switch into the FL position and holding it there for a few seconds. The instantaneous current limit is displayed first, followed by the average current limit. The instantaneous current limit is set at approximately 165 amperes and is not adjustable. The average current limit is adjustable up to 150 amperes.

19. If necessary, adjust the average current limit by adjusting the current limit potentiometer while holding the rectifier test switch in the FL position.

20. Press the NL switch on each rectifier in turn. Verify RFA LED comes on and a minor alarm is generated.

11.1 VERIFYING PROPER 2460 RECTIFIER INSTALLATION

WARNING: Adjusting a plant with battery temperature compensation option connected will result in erroneous plant voltage settings due to compensation offset. Move temperature compensation jumpers on alarm interface board, A2, to the DISABLE position before adjusting plant voltage. Return jumpers to ENABLE position after plant voltage has been set. Plant voltage will immediately shift due to temperature compensation offset.

NOTE: These tests require an adjustable load be attached to the battery charge and ground charge bus bars.

1. Adjust the plant current to approx. 50% of maximum load. For instance assume 4 rectifiers: 4 x 60A max = 240A x .3 = 72A load

2. Wait 6 seconds and verify all rectifiers are current sharing within one segment of the current bar graph on each rectifier.

3. Lower load current to approx. 50 amps.

4. Slowly adjust the float voltage on the first rectifier up to verify a high voltage shutdown occurs at 30.0 ± 0.5 vdc

5. Verify the load is immediately picked up by the remaining rectifiers with no droop in plant voltage or service interruption.

6. Turn the voltage adjustment pot on the rectifier in HVSD down well below the trip point, then turn the unit off momentary to reset the HVSD.

7. Turn the unit back on and adjust the float voltage so all the rectifiers are load sharing normally.

8. Repeat the HVSD test for each rectifier.

9. Select the "equalize" mode on the plant system mode, verify the correct voltage is displayed and rectifiers are load sharing normally.

10. Select the "normal" float mode again and adjust the load as in step one. Then switch the load to provide large step changes above and below that point. Verify the rectifiers maintain load share with no variation in float voltage.

11. Check for rectifier failure alarms by adjusting the float voltage down on each rectifier in turn until no load current is indicated. The power good LED should go "Off" and the fail LED should go "On". An RFA alarm and minor alarm should be indicated on the plant System board.

12. Leave the first the fail condition and adjust the next rectifier down until it also indicates a failed condition. Adjust the load as necessary so the remaining rectifiers are not in current limit. With two rectifiers in the failed condition the plant system board should upgrade to a major alarm condition.

13. Adjust the rectifiers back to the float voltage so they are sharing the load and all alarms are cleared. Perform the same initial test on any remaining rectifiers to verify a rectifier alarm occurs along with a plant RFA and minor alarm.

14. Adjust all rectifiers for proper float voltage and load sharing.

12.0 POWERING-UP CONVERTER MODULES

NOTE: This procedure assumes the -48V loads have been cabled and all the GMT fuses have been installed.

PROCEDURE

1. Turn on the power at the AC cabinet, if it is not already on.

2. With the modules OFF, verify that each module's green POWER GOOD LED is OFF.

3. A single adjustment potentiometer, located on the back of the motherboard, controls the output voltage for all modules. It is factory set at 50.0 volts.

4. Turn all of the converter modules ON. The green LED's should illuminate.

5. Set the front panel voltage switch to -48V, press the CURRENT select switch to verify the load current is within the capacity range or the number of converters installed (three amperes per converter).

6. Measure the -48V shunt output across the test points on the front panel. Calculate the actual current based on 20A = 50mV. Adjust the display to match the calculated value if necessary.

7. Measure the output voltage on TP3 of the motherboard with a digital voltmeter with at least three-digit accuracy.

8. Release the CURRENT select switch. Verify the accuracy of the display value against the measured voltage reading.
9. If desired, adjust the potentiometer on the DC to DC motherboard A4 for the desired -48V output voltage.

10. Verify that voltage remains constant and that each converter module POWER GOOD LED is illuminated. Converter modules adjusted in this manner will proportionally share the shelf load current.

CHAPTER THREE LOW-VOLTAGE DISCONNECT ADJUSTMENT AND OPERATION*

* this chapter only applies to List 2 ACM-600 Power Plants.

1.0 INTRODUCTION

1.1 General Description: The C & D Technologies, Inc. low voltage disconnect (LVD) circuitry located on the system board provides protection for stationary battery systems and the loads they support. When battery voltage drops below a user-defined level, the LVD disconnects all loads from the batteries by disengaging the 600-ampere contactor. This prevents batteries from becoming discharged and protects the connected system from low voltages. The system board is located on the back of the distribution panel. See Drawing J110-4100, Sheet B1.

1.2 Factory Settings: The LVD is pre-set to disconnect the load two seconds after battery voltage dips to 21Vdc, and to automatically reconnect the load when the battery voltage rises to 25 Vdc. Different voltage thresholds and time delay periods as well as a manual reconnect mode may be selected to fit varying needs. See Section 3.0: Adjustments of this chapter.

1.3 Features:

- On-line calibration without load disturbance
- On-line verification of proper operation without load disturbance
- User-defined manual or automatic disconnect and reconnect
- Disconnect-inhibit push button
- User-defined disconnect delay period
- Integrated with plant system board for local and remote indication of disconnect.
- LED status indicators
- LED test push button

1.3.1 User-defined disconnect delay: The time lapse between detection of an automatic disconnect condition and disconnection of the load is adjustable from two to 375 seconds. This time lapse is pre-set at two seconds. To adjust, see Section 3.1 of this chapter.

1.3.2 Integrated alarm circuit: An alarm circuit built into the system board allows the LVD condition to be monitored on the ACM-600 Power Plant. This enables major alarm indications on the front panel and remote monitoring of disconnections.

2.0 OPERATION

2.1 Five push buttons on the front panel are used to select the operating mode of the LVD circuit and three additional push buttons on the front panel are used to adjust or test the LVD circuit. See Table 3-1.

2.2 Manual-disconnect mode: To manually disconnect the load, press the ENABLE push button and hold it in while pushing the DISCONNECT button. If ENABLE and DISCONNECT are not pressed together, with ENABLE pressed first, the LVD will not enter the manual-disconnect mode. The manual-disconnect mode is indicated by the flashing red DISCONNECT LED and flashing red LOAD DISC LED.

2.3 Normal mode: Press the NORMAL button to remove the LVD from the manual disconnect, reconnect/inhibit, or calibration mode. In the normal mode, the LVD disconnects and reconnects the system automatically.

2.4 The normal mode is indicated by the steady green NORMAL LED. Load status is indicated by the steady green LOAD CONN and flashing red LOAD DISC LED's.

CAUTION: When the reconnect/inhibit mode is activated with the RECONNECT push button on the LVD, the load will be connected indefinitely without protection.

Note: Verify Contactor By-Pass Switch is in the off (not-lighted) position before proceeding with LVD check-out. Remote disconnect terminal block must have short installed across contacts when not used to allow normal operation.

2.5 Reconnect/inhibit mode: If automatic reconnection is disabled, the reconnect/inhibit mode can be activated momentarily to reconnect the load. The Reconnect/Inhibit mode is indicated by the flashing red RECONNECT and steady green LOAD CONN LED's.

CAUTION: When the calibration mode is activated with the CALIBRATE push button, the load will be connected indefinitely without protection.

2.6 Calibration mode: Press the calibrate button to enter calibration mode to allow verification and adjustment of high voltage, low voltage, high temperature, load connect and load disconnect alarm threshold settings through the front digital meter. Also, a synthesized test voltage controlled by the TEST VOLT ADJ adjustment can be directed to the detection circuitry to allow verification of plant functions. Pressing the CALIBRATE button will prevent the load from being disconnected while the operator performs the adjustment procedures described in Section 3.0 of this chapter. The calibration mode is indicated by the flashing red CALIBRATE and steady green LOAD CONN LED's, or a flashing LOAD DISC LED. The calibration mode can be turned off by pressing the NORMAL button.

2.7 LED test: Press the LED TEST button to verify LED operation. When the button is pressed down, all operable LED's should illuminate.

PUSH BUTTON OPERATION

Button	Function
TEST LED	Pressing the TEST LED button will cause LED's to light.
CALIBRATE	Pressing the CALIBRATE button will allow adjustment of voltage settings without disturbing the load.
RECONNECT	Pressing the RECONNECT button will reconnect the load to the batteries. Leaving the LVD in RECONNECT mode will disable automatic operation.
ENABLE & DISCONNECT	Pressing and holding the ENABLE button while pressing the DISCONNECT button will disconnect the load from the batteries.
LOAD CONN VOLT ADJ	Pressing the VOLT ADJ button located directly below the LOAD CONN LED and potentiometer, while in calibration mode, will allow adjustment of load disconnect voltage.
LOAD DISC VOLT ADJ	Pressing the VOLT ADJ button located directly below the LOAD DISC LED and potentiometer, while in calibration mode, will allow adjustment of load disconnect voltage.
TEST VOLT ADJ	Pressing the VOLT ADJ button located directly below the TEST potentiometer while in calibration mode will allow adjustment of synthesized test voltage.

Table 3-1

WHAT LED's INDICATE

LED	Indicated condition
CALIBRATE	Flashing red CALIBRATE LED indicates that the LVD is in the calibration mode. Load will not disconnect. To end mode, press the NORMAL button.
RECONNECT	Flashing red RECONNECT LED in conjunction with a steady green LOAD CONN LED indicates that the LVD is in the reconnect/inhibit mode. Load will not disconnect. To end mode, press NORMAL button.
NORMAL	Steady green NORMAL LED indicates normal automatic operation.
DISCONNECT	Flashing red DISCONNECT LED in conjunction with a flashing red LOAD DISC LED indicates that the LVD is in the manual disconnect mode. To end mode, press NORMAL button.
LOAD CONN	Steady green LED indicates load is connected to the batteries.*
LOAD DISC	Flashing red LED indicates load is disconnected from the batteries.*

Table 3-2

***NOTE:** In CALIBRATE mode the LOAD CONN and LOAD DISC LED's indicate synthesized conditions controlled by the TEST VOLT ADJ adjustment. In all other LVD modes LOAD CONN and LOAD DISC indicate contactor conditions.

LVD VOLTAGE ADJUSTMENT AND VERIFICATION

BUTTON/METER	Function
Digital meter	The digital meter located on the center of the panel displays the TEST, LOAD CONN, and LOAD DISC voltages when the respective VOLT ADJ buttons are pushed in calibration mode.
LOAD CONN VOLT ADJ	The VOLT ADJ potentiometer located directly below the LOAD CONN LED is the control used to adjust the load connect threshold.
LOAD DISC VOLT ADJ	The VOLT ADJ potentiometer located directly below the LOAD DISC LED is the control used to adjust the load disconnect voltage.
TEST VOLT ADJ	The VOLT ADJ potentiometer located directly above the TEST LED is the control used to adjust the test voltage.

Table 3-3

3.0 ADJUSTMENTS

3.1 Adjust time delay proceeding disconnection of load: (Optional) The LVD is pre-set to disconnect the load two seconds after a disconnect condition is recognized. If battery-voltage fluctuations frequently occur, you may choose to increase this time period.

PROCEDURE

1. Open the front door of the distribution panel.

2. Locate the system board on the back of the distribution panel door.
   (See on Drawing J110-4100-00, Sheet B6, Figure 11)

3. Locate the dual, in-line package (DIP) switches on the lower left edge of the system board. Switches 3, 4, 5, and 6 have time values associated with them of 25, 50, 100 and 200 seconds respectively. The time values are additive; if DIP switches 3 and 5 are turned on, the disconnect time delay will be 125 seconds.

4. Calculate which DIP switches should be turned on for your application.

5. Push selected DIP switches into the ON position.

6. Close front door of the distribution panel.

3.2 Set the LVD to manual-reconnect mode: (Optional) The LVD is pre-set to automatically reconnect loads to the batteries once the desired battery voltage is obtained. If you would rather use a push button to reconnect the loads to the batteries, follow the below procedure to set the LVD into the manual-reconnect mode.

PROCEDURE

1. Open the front door of the distribution panel.

2. Locate the system board on the back of the distribution panel door.
(See Drawing J110-4100, Sheet B6, Figure 11)

3. Locate the DIP switches on the lower left edge of the system board.

4. Push switch 2 into the ON position.

5. Close the front door of the distribution panel.

3.3 Adjust disconnect and reconnect voltages: The LVD is pre-set to disconnect at 21 Vdc ±1% and reconnect at 25 Vdc ±1%. These voltage levels may be verified and adjusted.

3.4 Verification and adjustment of reconnect voltage setting:

PROCEDURE

1. Push the CALIBRATE button to activate the calibration mode. This will prevent the load from being disconnected and to allow the voltage to be adjusted.

2. Note that the red CALIBRATE LED is flashing.

3. While pressing the LOAD CONN button, adjust the LOAD CONNECT VOLT ADJ control with a small screwdriver until the front digital meter displays the desired voltage.

4. Remove screwdriver.

5. Push the NORMAL button to de-activate the calibration mode.

3.5 Verification and adjustment of disconnect voltage setting:

PROCEDURE

1. Push the CALIBRATE button to activate the calibration mode. This will prevent the load from being disconnected and allow the voltage to be adjusted.

2. Note that the red CALIBRATE LED is flashing.

3. While pressing the LOAD DISC button, adjust the LOAD DISC VOLT ADJ control with a small screwdriver until the front digital meter displays the desired voltage.

4. Remove screwdriver.

5. Push the NORMAL button to de-activate the calibration mode.

3.6 Verification of connect and disconnect setting through a test voltage:

PROCEDURE

1. Push the CALIBRATE button to activate the calibration mode. This will prevent the load from being disconnected and allow verification of voltage settings.

2. Note that the red CALIBRATE LED is flashing.

3. While pressing the test button, slowly rotate the TEST VOLT ADJ control with a small screwdriver. The synthesized test voltage will be displayed on the front digital meter.

4. Note the voltages at which the LOAD DISC and LOAD CONN LED's illuminate.

5. Push the NORMAL button to de-activate the calibration mode.

3.7 Verification of Contactor Service By-pass Switch Operation

1. With the LVD in the normal non-calibrate mode press the enable and disconnect switches so that the contactor is left disconnected.

2. Press the service by-pass switch so that the switch is lighted. The contactor contacts should immediately close.

3. Turn the by-pass switch off and the contactor contacts should immediately open. Press the reconnect switch on the LVD control to resume normal operation.

CHAPTER FOUR METERING AND ALARM ADJUSTMENTS AND OPERATION

1.0 INTRODUCTION

1.1 General Description: The meter and alarm functions, integrated into the system board, are used to monitor the ACM-600 Power Plant. The meter and alarm has a high resolution 4½-digit meter that displays the voltage and current measurements of the plant. Ten front-panel LED's and nine form-C contacts are provided for local and remote alarm indications. One 3-ampere GMT-type fuses is provided for circuit protection. Push buttons are provided to display voltage and temperature alarm thresholds on the front digital meter for adjustment and verification.

1.2 Factory Settings:

1.2.1 Low and high voltage alarm trip points: A low voltage alarm is preset to trigger at 24.2 ±0.2Vdc and a high voltage alarm is preset to trigger at 28.5 ±0.2 Vdc. These trigger voltages may be changed to fit specific customer needs. See Sections 3.1 and 3.2 of this chapter.

1.2.2 Relay contacts: Nine form-C contacts are provided for remote monitoring of the following alarm conditions:

- (2) major alarms
- minor alarm
- low-voltage disconnect alarm (LVDA)
- high voltage alarm (HVA)
- low voltage alarm (LVA)
- +24 volt fuse or circuit breaker failure (FA1)
- -48 volt major alarm
- battery high temperature alarm

1.3 Position: The system board is mounted on the distribution panel door. See Drawing J110-4100, Sheets B3, Figure 5 and B6, Figure 11. Board A1 is the system board. No customer wiring is required to this board. The output contacts are tied via a ribbon cable to the alarm interface board on the bottom of the distribution cabinet just inside the door (see Sheet B1). One 3-ampere GMT-type fuse on the front of Board A1 provides circuit protection.

1.4 Voltage/current display: The high-resolution, front-panel, digital meter continuously displays plant voltage. The meter can also display plant and converter current, converter voltage, alarm threshold voltages and temperature and synthesized test voltage. See Section 2.1 of this chapter and Drawing J110-4100, B3 Figure 5.

1.5 Alarm LED's: Major alarm, rectifier failure alarm (RFA), +24 volt fuse alarm (FA1), -48-volt fuse alarm (FA2), converter failure alarm (CFA), low voltage alarm (LVA), high voltage alarm (HVA), battery high temperature alarm, and low voltage disconnect alarm (LVDA) alarm conditions are indicated with individual red LED's. Minor alarm and equalize conditions are indicated by individual yellow LED's. Load connect is indicated with a green LED.

1.6 Major alarm conditions occur when:

- More than one rectifier fails (RFA).
- Plant voltage drops below a preset level (LVA).
- Plant voltage rises above a preset level (HVA).
- A +24 volt fuse or circuit breaker opens or trips (FA1).
- A low voltage disconnect occurs (List 2 only).
- A converter fails (CFA).
- Battery temperature rises above a preset level.

1.7 Minor alarm conditions occur when:

- A single rectifier fails (RFA).

1.8 -48-volt major alarm condition occurs when:

- one or more converters fail (CFA).
- -48-volt fuse or circuit breaker opens or trips (FA2).

1.9 Remote alarm contacts: Nine remote alarm contacts are provided for remote monitoring of alarms. The system board is configured for remote monitoring of (2) major, minor, LVDA, HVA, LVA, FA1, -48V major and battery high temperature alarms.

1.10 All relays excluding the HVA provide normally energized contacts that ensure an alarm even if power fails. The HVA output is normally de-energized to avoid the triggering of an HVA alarm if the alarm board loses power. All output relay contacts are rated for one ampere at 24 volts and for ½ ampere at 48 volts.

1.11 Battery and Ambient Temperature Measurement (Plant with battery temperature option): Test points TP1 and TP2 are used for ambient temperature monitoring (1/10th of the actual value in F). Test points TP3 and TP2 are used for battery temperature monitoring (1/10th of the actual value in F). TP1, TP2, and TP3 are located on the left edge of the system board (below the JP2 jumper).

WHAT LIT LED's INDICATE

LED	LIT INDICATION
-48 V (FA2)	Flashing red LED indicates a -48 volt fuse or circuit breaker failure.
+24 V (FA1)	Flashing red LED indicates a +24 volt fuse or circuit breaker failure.
RFA	Flashing red LED indicates one or more rectifier failures.
MAJOR ALARM	Flashing red LED indicates a major alarm. See other LED's to find cause.
MINOR ALARM	Flashing red LED indicates a single rectifier failure.
HIGH VOLTAGE	Flashing red LED indicates voltage is higher than allowable threshold.
LOW VOLTAGE	Flashing red LED indicates voltage is lower than allowable threshold.
HIGH TEMP	Flashing red LED indicates battery temperature is higher than allowable threshold.
CFA	Flashing red LED indicates one or more converter failures.
EQUALIZE	Steady yellow LED indicates rectifiers are in equalize mode.
LOAD DISC	Flashing red LED indicates load is disconnected from the batteries.

Table 4-1

2.0 OPERATION

2.1 Front Panel Controls and Indicators: Refer to drawing J110-4100 for the front panel location of the various controls and indicators associated with metering and alarm.

Control or Indicator	Function
Display	Digital meter with 4½-digit resolution displays plant voltage, load current, converter voltage and converter current. Default display is plant voltage.
Current/Voltage Meter Display Switch	Momentary switch is used to select monitoring of current. Default display is voltage.
-48V/+24V Meter Display Switch	A switch is used to select monitoring of the converter. Default display is plant.
Test Jacks I+ & I-	I+ & I-Monitors 50 mV full scale shunt current for conversion to amperes in calibrating meter display.
I ADJ -48V/+24V Potentiometer	Used in conjunction with ±I test jacks to calibrate meter current display.
Test Jacks V+ & V-	Monitors plant or converter voltage directly for use in calibrating meter voltage display.
V ADJ Potentiometer	Used in conjunction with ±V test jacks to calibrate meter voltage display.
EQUALIZE/FLOAT switch	Used to set rectifier in equalize mode.
CALIBRATE Push button	Used to set plant in calibrate mode to display and test alarm thresholds without affecting the load.
TEST Push button & VOLT ADJ Potentiometer	The VOLT ADJ potentiometer is used in conjunction with the TEST push button to adjust the synthesized test voltage to verify low voltage, high voltage, and LVD operation during calibration mode.
NORMAL push button	Used to return the plant to normal mode from calibration mode.

LOW VOLTAGE LED	The LOW VOLTAGE potentiometer is used to adjust the LVA trip point and is accessible through the front panel using a small insulated screwdriver.
Low Voltage VOLT ADJ Potentiometer	The red LOW VOLTAGE ALARM LED illuminates when the battery voltage drops below the predetermined trip point.
Low Voltage VOLT ADJ Push button	The LOW VOLTAGE VOLT ADJ push button is used during calibration mode to display the low voltage alarm threshold on the front digital meter.
HIGH VOLTAGE LED	The red HIGH VOLTAGE ALARM LED illuminates when the battery voltage rises above the preset trip point.
High Voltage VOLT ADJ Potentiometer	The HIGH VOLTAGE potentiometer is used to adjust the HVA trip point and is accessible through the front panel using a small insulated screwdriver.
High Voltage VOLT ADJ Push button	The HIGH VOLTAGE VOLT ADJ push button is used during calibration mode to display the high voltage alarm threshold on the front digital meter.
HIGH TEMP. LED	The HIGH TEMP. LED illuminates when the battery temperature rises above the preset differential to ambient trip point.
High temp. TEMP ADJ Potentiometer	The high temperature TEMP ADJ potentiometer is used to adjust the differential trip point and is accessible through the front panel using a small insulated screwdriver.
High Temp. TEMP ADJ Push button	The high temperature TEMP ADJ push button is used during calibration mode to display the high temperature alarm threshold on the front digital meter.
MINOR ALARM LED (yellow)	Illuminates during a single rectifier failure.
MAJOR ALARM LED (red)	Illuminates when any alarm condition is detected (except the single RFA fault condition described above). A major alarm is always accompanied by at least one other front panel indicator that identifies the fault condition.
TEST LED Push button	Pressing the TEST LED push button will cause all operable LED's to light.

RFA LED (red)	Illuminates to indicate a fault condition in one or more rectifiers. If the RFA LED and the MINOR ALARM LED are both illuminated, a single rectifier has failed. If the RFA LED and the MAJOR ALARM LED are both illuminated, two or more rectifiers have failed.
FA1 + 24 V LED (red)	Illuminates when a +24 volt fuse or circuit breaker is open.
FA2 -48 V LED (red)	Illuminates when ą 48 volt fuse or circuit breaker is open.
CFA LED (red)	Illuminates to indicate a fault condition in a converter.

2.2 One protection fuse is located on the front panel:

- POWER FUSE: 3 ampere GMT-type (C & D Technologies, Inc. P/N 280-0760-00)

3.0 ADJUSTMENTS

3.1 Resetting low voltage alarm threshold: The system board is pre-set to trigger a low voltage alarm at 24.2 Vdc ±1% . This alarm threshold can be changed through front-panel adjustments.

PROCEDURE

1. Push the CALIBRATE button to activate the calibration mode.
2. While pressing the low voltage VOLT ADJ button, adjust the low voltage VOLT ADJ control with a small screwdriver until the front digital meter displays the desired voltage. Adjusting the control counterclockwise will decrease the voltage; adjusting the control clockwise will increase the voltage. The low voltage threshold must be at least 1.0 volts lower than the float voltage.
3. Push the NORMAL button to de-activate the calibration mode.

3.2 Resetting high voltage alarm threshold: The system board is pre-set to trigger a high voltage alarm at 28.5 Vdc ±1%. This alarm threshold can be changed through front panel adjustments.

PROCEDURE

1. Push the CALIBRATE button to activate the calibration mode.

2. While pressing the high voltage VOLT ADJ button, adjust the high voltage VOLT ADJ control with a small screwdriver until the front digital meter displays the desired voltage. Adjusting the control counterclockwise will decrease the voltage; adjusting the control clockwise will increase the voltage. The high voltage threshold must be at least 1.0 volts higher than the float voltage.

3. Push the NORMAL button to de-activate the calibration mode.

3.3 Resetting high temperature alarm threshold: The system board is pre-set to trigger a high-temperature alarm when a battery temperature sensor is 20 ±1F higher than the ambient temperature when the temperature compensation option is purchased. This alarm threshold can be changed through front panel adjustments.

PROCEDURE

1. Push the CALIBRATE button to activate the calibration mode.

2 While pressing the high temperature VOLT ADJ button, adjust the high temperature VOLT ADJ control with a small screwdriver until the front digital meter displays the desired temperature. Adjusting the control counterclockwise will decrease the temperature; adjusting the control clockwise will increase the temperature.

3. Push the NORMAL button to de-activate the calibration mode.

4.0 VERIFICATION

4.1 The following procedures can be performed on a live plant to verify proper metering and alarm operation. Relay operation can be verified on the Alarm Interface Board A2.

NOTE: All verification measurements should be made with a high-quality, external, 4½-digit voltmeter with at least 10 megohms of input impedance, and 0.08-inch test probes.

4.2 Verification of basic plant operation: The following procedure can be performed on a live plant to verify proper operation.

PROCEDURE

1. Verify the digital meter is displaying either plant voltage or current voltage depending on the 24V/48V meter display switch position. If the meter does not illuminate, check the GMT-type power fuse.

2. Move and hold the current/voltage momentary switch to the current position and verify that plant current is displayed.

3. Move the 48V/24V switch to the 48V position and verify that 48V voltage is displayed.

4. Move and hold the current/voltage switch into the current position. Verify that the 48V current is displayed.

4.3 Verification of digital meter calibration: Verify display meter current and voltage calibration as follows:

PROCEDURE

1. Insert test probes of voltmeter into the V+ and V- voltage test jacks below the digital meter on the metering and alarm display.

2. Compare voltmeter reading with the display meter reading. If displayed voltage is not within 0.05 percent of the voltmeter reading, adjust V ADJ potentiometer to match displayed value to voltmeter.

3. Alternate the voltmeter switch between +24V and -48V to verify both readings are within specified 0.05 percent accuracy limit.

4. Move voltmeter test probes to I+ and I- current test jacks, set voltmeter to read milli-volts. The current test jacks are monitoring the shunt output directly and should read between 0 and 50 milli-volts depending on the load current being drawn at the time.

5. Convert the shunt milli-volt reading to amperes in order to verify the displayed current accuracy.

   a. Divide the voltmeter milli-volts reading by 50.

   b. Multiply the result by the shunt full-scale rating.
      Ex. Voltmeter reading = 32.5 mV
      Shunt rating = 600 amps
      $32.5 \div 50 = 0.65 \times 600 = 390$ amps

6. Push the voltage/current meter display switch to the CURRENT position and hold it there. Compare the calculated current value to the display meter reading. If the meter display is not within one percent of the calculated value, adjust the I-ADJ potentiometer to match the calculated value.

7. Move and hold the 48V/24V switch in the 48V position.

8. Repeat steps 2 through 6 with the 48V/24V switch in the 48V position.

4.4 Low voltage alarm verification:

PROCEDURE

1. Push the CALIBRATE button to activate the calibration mode.

2. While pressing the TEST button slowly rotate the TEST VOLT ADJ control counterclockwise with a small screwdriver until the LVA LED illuminates.

3. The LVA LED should illuminate at the low voltage alarm threshold ±1%.

4. Verify that the LOW VOLTAGE alarm relay activates and the red LOW VOLTAGE LED illuminates.

5. Slowly rotate the TEST VOLT ADJ control clockwise until the red low voltage LED goes out. The low voltage alarm has approximately 1.0 volt hystresis.

4.5 High voltage alarm verification:

PROCEDURE

1. Push the calibrate button to activate the calibrate mode.

2. While pressing the TEST button slowly rotate the TEST VOLT ADJ control clockwise with a small screwdriver until the HVA LED illuminates.

3. The HVA LED should illuminate at the high voltage alarm threshold ±1%.

4. Verify that the HIGH VOLTAGE alarm relay activates and the red HIGH VOLTAGE LED illuminates.

5. Rotate the TEST VOLT ADJ control counterclockwise until the red high voltage LED goes out. The high voltage alarm circuit has approximately 1.0 volts hystresis.

4.6 High temperature alarm verification:

NOTE: Functional only when the temperature compensation option is purchased.

PROCEDURE

1. Place a battery sensor near a temperature source that is greater than the high temperature alarm threshold, factory-set at 20F, than the ambient temperature.

2. Verify the HIGH TEMPERATURE alarm relay activates and the red HIGH TEMPERATURE LED illuminates.

3. Repeat steps 1 and 2 for the other two battery temperature sensors.

4.7 Verification of RFA and minor alarm:

PROCEDURE

1. Turn off AC circuit breaker to one of the rectifiers. After a few seconds, the yellow MINOR ALARM LED and the red RFA LED should illuminate.

2. Verify that the MINOR ALARM relay activates.

3. Turn off a second rectifier. After a few seconds, the yellow MINOR ALARM LED should turn off, the red MAJOR ALARM LED should illuminate, and the red RFA LED should stay lit.

4. Turn on both rectifiers. The RFA and the MAJOR ALARM LED's should both turn off.

4.8 Verification of major alarm: The major alarm LED will illuminate whenever there is a low voltage alarm, a high voltage alarm, battery high temperature alarm, a +24-volt fuse or circuit breaker alarm (FA1), a low voltage disconnect or two or more rectifier failure alarms (RFA). Use the following procedure to check the major alarm is operating properly.

PROCEDURE

1. Simulate a major alarm situation.

2. Verify the red MAJOR ALARM LED is lit.

3. Using an ohmmeter, check the Major Alarm Relay terminals on TB1 on the interface board. The circuit between relay contact "C" and "NC" should be closed and the circuit between "C" and "NO" should be open.

4.9 Verification of CFA and -48 V major alarm

PROCEDURE

1. Turn off the input circuit breaker of a converter.

2. Observe that the red CFA LED flashes.

3. Using an ohmmeter, check the -48V major alarm relay terminals on TB1 on the interface board. The circuit between relay contact "C" and "NC" should be closed and the circuit between "C" and "NO" should be open.

4. Turn on the input circuit breaker of the converter. The CFA LED should turn off.

4.10 Verification of FA2 and -48V major alarm

PROCEDURE

1. Install a blown GMT fuse.

2. Observe that the red FA2 LED flashes.

3. Using an ohmmeter, check the -48 V major alarm relay terminals on TB1 on the interface board. The circuit between relay contact "C" and "NC" should be closed and the circuit between "C" and "NO" should be open.

4. Turn on the input circuit breaker of the converter. The FA2 LED should turn off.

CHAPTER FIVE OPTIONAL BATTERY TEMPERATURE COMPENSATION

1.0 INSTALLING BATTERY TEMPERATURE COMPENSATION/ALARM CIRCUIT BOARD

If the temperature compensation/alarm option is ordered with the plant, the temperature compensation/alarm circuit board A3 will be installed at the factory. Also, the temperature sensors will be connected to circuit board A3 and routed to the top of the relay rack. To complete the installation, the battery temperature sensors must be routed and connected to the batteries by the installer (see Section 2).

PROCEDURE

1. Install circuit board A3 in the ACM distribution box. Refer to drawing J110-3780 for specific location.

2. Connect ribbon cable between circuit board A2, customer alarm interface board and circuit board A3, temperature compensation/alarm board.

3. Connect the ambient temperature sensor to J1 and the battery temperature sensor to TB2 on circuit board A3. Refer to WD110-3780 and J110-3780 drawing for wire colors and terminal pin numbers.

2.0 CONNECTION TEMPERATURE SENSORS TO BATTERIES

The Liberty ACM temperature compensation/alarm option comes with three battery temperature sensors and one ambient temperature sensor. When the option is ordered, temperature sensors are bundled to the top of the relay rack.

NOTE: For fail-safe operation at least two temperature sensors must be connected to the batteries. If no sensors are connected and the option is enabled, plant voltage will be forced high, due to the automatic temperature compensation circuits.

The highest temperature of the three sensors is used for that battery string temperature alarms and for battery temperature compensation calculations.

PROCEDURE

1. Unbundle the temperature sensors from their shipping location on the top of the relay rack.

2. Determine which battery posts to apply the sensors to. Suggested temperature sensing locations are diagramed in drawing J110-3780.

CAUTION: Temperature sensor installation may result in a momentary battery string open circuit condition when the terminal bolts are removed. DO NOT perform this procedure if the battery string is in a high charge or discharge condition.

3. Remove the bolt holding the intercel battery strap in place and apply the ringed-lug temperature sensing lead to the appropriate battery post.

4. Replace the bolt over the temperature's ringed-lug.

5. Repeat this procedure until all temperature sensors are attached.

6. Bundle and secure excess wiring.

3.0 ENABLE/DISABLE BATTERY TEMPERATURE COMPENSATION ALARM

After the battery temperature compensation alarm option is installed, see Section 1.0 through 12.0. JP1 on the customer alarm interface board A2 must be set to the enable position for battery temperature compensation or battery temperature alarm to operate. Refer to J110-3780- drawing for board and jumper locations. Setting jumper JP1 to the disable position will disable both the battery temperature compensation and temperature alarm.

4.0 ADJUSTING THE RANGE OF TEMPERATURE COMPENSATION

The plant is factory-set to assure a high voltage alarm at 28.5 volts and to assure a low voltage alarm at 25.0 volts. It may be necessary to adjust the range of allowable temperature compensation to avoid triggering a high voltage or a low voltage alarm due to temperature compensation voltage fluctuations.

PROCEDURE

1. Determine the desired allowable voltage range.

2. Use Table 8-1 to determine which positions to jumper on the system board A1. Voltage settings have a ±0.25 volt accuracy setting.

3. Access the system board A1.

4. Move the jumpers to the appropriate positions. Putting the jumpers in jumper position 5 will allow the plant to operate with no compensation cutoffs.

Jumper Position	Compensation Cutoff Point (Volts)	Battery Temperature F
JP2 Pos 5*	No cutoff point	
JP2 Pos 4	29.5 V	-27 F
JP2 Pos 3	29.0 V	-6 F
JP2 Pos 2	28.5 V	15 F
JP2 Pos 1	28.0 V	35 F
Note 1	27.0 V	77 F
JP1 Pos 1	26.75 V	87 F
JP1 Pos 2	26.50 V	98 F
JP1 Pos 3	26.25 V	108 F
JP1 Pos 4	26.00 V	119 F
JP1 Pos 5*	No cutoff point	

Table 8-1

***Notes:**

1. Table is based on nominal 27.0 Vdc battery voltage with zero temperature compensation at 77F.
2. Voltage clamp points may vary by ±0.5V Max.
3. Asterisks denote JP1 and JP2 factory settings.
4. There is no cutoff point when *factory settings are JP1-4 and JP2-1.

CHAPTER SIX MAINTENANCE

Cycle spare rectifiers and perform the following maintenance procedure twice a year.

PROCEDURE

1. Check mechanical connections. Tighten as required while looking for signs of overheating, arcing, and dirt accumulation.

2. Verify digital meter calibration for voltage and current.

3. Verify proper alarm settings for HVA, LVA and TEMP (if installed).

4. Verify all alarms are functional.

5. Verify LVD settings (List 2 only).

6. (24150 only) Verify all rectifiers are on-line with their DC breakers pushed ON. Compare the plant controller's reading for battery voltage to the reading gained from the rectifier voltage test jacks. Calibrate the controller if necessary.

7. (24150 only) Compare each individual rectifier current readings displayed against the internal shunt reading. Calibrate the rectifiers display if necessary.

8. (2460 only) Compare individual current bar graphs for equal load sharing, ± 1 segment, adjust float voltage if necessary.

9 If load requirements allow, remove rectifier modules one at a time. Use low-pressure air to clean modules.

9. Verify proper load sharing between all rectifiers and adjust if necessary.

10. Clean dust and lint, especially from rectifier fans or air intakes.

CHAPTER SEVEN SPARING

1.1 It is recommended that the system board be stocked for depot spares. P/N 301-2795-01

1.2 It is recommended that spare 150-ampere modular rectifiers are stocked. P/N 100-7520-00

1.3 It is recommended that spare rectifier fans are stocked. P/N 151-0051-00

1.4 It is recommended that various breakers and GMT-type fuses are ordered from Drawing J110-4100, Sheet A2, Tables D and E and stocked as spares.

1.5 It is recommended that the contactor for the low voltage disconnect (LVD) be stocked for depot spares. P/N 246-0625-02