C&D TECHNOLOGIES, INC.
Power Solutions

POWER SYSTEMS DIVISION

AGM 60
–48 VDC, 60A
POWER PLANT

PRODUCT MANUAL FOR
P/N 110-4202

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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) ALTERED	DESCRIPTION	REVISOR/ DATE
A		Preliminary issue	
1	ALL	Initial Release per ECN# 12118	GFV/07-28-99
2	8	ECN #12140 (SW2-7 CORRECTED & BAT. SWITCH)	GFV/10-01-99
3	ALL	Ensured new company name/logo throughout manual and drawings; Added new website address and correct field service numbers to the cover; added updated ENF0005 sheets. Incorporated Addendum 1 concerning undocumented alarm feature. See ECN 12733	MCM 01/07/00
4	ALL	Clarified dip switch settings. Changed HVSD minimum set points from 56.0 to 57.0 SEE ECN 13494	MCM 05/18/01
5	ALL	SEE ECN 15561	MCM 5/30/06

DOCUMENT SUMMARY

This document is the User Product Manual for AGM 60 Power Plants.

SCOPE

This manual applies to all AGM 60 Power Plants, Part Number 110-4202-L.XA,
and each of the FIVE option configurations they can be ordered in:

Shelf size	C&D Ordering Part #	Plant Option/Features
23 inch	J110-4202 List 1	AGM 60, w/o LVD
23 inch	J110-4202 List 2	AGM 60, w/LVBD
23 inch	J110-4202 List 3	AGM 60, w/LVD LOAD “A” ONLY
23 inch	J110-4202 List 4	AGM 60, w/LVD LOAD “B” ONLY
23 inch	J110-4202 List 5	AGM 60, w/LVD LOAD “A” & “B"

PURPOSE

This manual includes instructions for installing, operating, maintaining and provisioning the Plant.

LEGAL DISCLAIMER

C&D Technologies, Inc., believes that all information contained in this manual is accurate and reliable. However, this information does not constitute any guaranty or warranty by C&D, nor does it make C&D responsible for any damage that might occur during the installation, use or maintenance of the equipment described in this manual.

C&D Technologies, Inc., also does not guarantee that the suggested equipment uses given in this manual will not infringe upon any existing or pending patents.

Those who install, use, and maintain this equipment, should not assume that all possible safety measures that should be taken with this equipment are mentioned in this manual. Furthermore, no one should assume that no other precautionary measures may be required for safe installation, use and maintenance of this equipment, where unusual environmental conditions or circumstances dictate otherwise.

TABLE OF ABBREVIATIONS

ABBREVIATION, ACRONYM OR SYMBOL	MEANING
AH	Ampere Hours
ANSI	American National Standards Institute
ATC	Automatic temperature compensation (or BTC)
AWG	American wire gauge
BTC	Battery temperature compensation (or ATC)
CCW	Counter clockwise
CEV	Controlled environment vault
CO	Central Office
CM	Circular mils
CW	Clockwise
DIP	Dual in-line package
DVM	Digital voltmeter
EMI	Electromagnetic interference
ESD	Electrostatic discharge
FA	Fuse Alarm (-48v)
HVA	High voltage Alarm (normally energized)
HVSD	High Voltage Shut Down
IEC	International Electrical Commission
IEEE	Institute of Electrical and Electronic Engineers
LED	Light Emitting Diode
LSD	Least Significant Digit
LVA	Low Voltage Alarm
LVBD	Low Voltage Battery Disconnect
LVD	Low Voltage Disconnect
NEC	National Electric Code
NEMA	National Electrical Manufacturers Association
PWB	Printed Wire Board
PDR	Power distribution rack
RBOC	Regional Bell Operating Company
RFA	Rectifier Failure Alarm
SD	Schematic Diagram
UL	Underwriters Laboratories
Vdc	Volts direct current
VRLA	Valve Regulated Lead Acid

TABLE OF REFERENCES

DOCUMENT NUMBER	TITLE
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 edition, 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 5, July 1991
TR-TSY-000078	Bellcore Generic Physical Design Requirements for Telecommunication Products and Equipment
UL489	UL Molded Case Circuit Breaker Enclosures, May 1984

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CHAPTER ONE: INTRODUCTION

1.0 GENERAL DESCRIPTION

The AGM 60 Power Plant is a –48Vdc source that supplies redundant load currents of 52.5 amps DC and comes in a standard 23" rack mount-able cabinet. The AGM 60 was designed for applications such as customer premises and outdoor installations, where space is at a premium. The Plant supports A & B distribution with 10 GMT fuse positions each standard, and can be ordered in five different list number configurations: without LVD, with LVBD, LVD load "A", LVD load "B" and with LVD load "A & B". Based on modular switched-mode rectifier technology, the Plant supports up to eight –48 Vdc, 7.5A plug-in rectifier modules which are easily accessed behind the front panel door. The AC and DC connections as well as the trip breakers are all easily accessed from the front making the AGM 60 a front accessible plant. The AC connections feature the capability of one AC feed or two thereby providing plant redundancy from an AC dropout standpoint. Either AC feed can be fed from the top or bottom of the rack. The DC load connector blocks and load disconnect breakers as well as the battery disconnect switches are all accessible via the pull out distribution tray which makes it easier for the installer to make load connections (See DWG J110-4202 sheet B1 and DWG SD110-4202 sheet B1-FS1 & B2, FS2).

The rectifiers have all of the operation, alarm, and control features that are normally required of a Telecom compliant rectifier. State of the art switched-mode technology has allowed us to produce a compact 450 watt –48 Vdc rectifier, which made a 5 rack space power plant possible. Typically a plant of this size would have occupied 1 complete bay by itself. Each rectifier has its own set of current test jacks rated 10A @ 50 mv to monitor individual output currents (See J110-4202 sheet B3 fig 4). All rectifiers provide coded status and alarm messages via the green "NORM" led located on the rectifier face plate and remote control operation is indicated via the yellow "REM" led also located on the face plate(See J110-4202 sheet B3 fig 4).

The AGM 60 is a fully integrated system primarily consisting of a RECTIFIER INTERFACE BOARD (A1), MAIN DISTRBUTION BOARD (A2) and a CONTROLLER BOARD (A3). This makes field upgrading and servicing, a quick and easy process. A more complete description of the system boards is given in the following paragraphs.

The Rectifier Interface PWB (A1) allows the AC to be fed from a single source or two separate sources and is configured at the factory prior to shipment. Feed "A" powers rectifier slots 1, 3, 5 and 7, while Feed "B" powers slots 2, 4, 6 and 8 (See SD110-4202 sheet B2 – FS2). This backplane allows for complete system signal integration via rectifier output connectors J1 – J8, J9 completes the signal connections to the distribution pwb (A2) while J10 and J11 complete the signal connections between the controller pwb (A3) and the system (See SD110-4202 sheet B2 – FS2).

The Distribution PWB (A2) is mounted to a slide out tray which enables the installer to make load and battery connections in one location. It has a 70A contactor (available on List 2 – 5 only), which can be used as either a load or battery disconnect depending on how jumper straps are placed (See J110-4202 sheet B4 – fig. 5).

Load distribution is provided through 20 GMT fuses and options for up to 4 snap-in breakers rated 5 to 50A. The load breakers are designed for two separate feeds, “Load A” and “ Load B” thereby providing load shedding capabilities. The terminal blocks for all load and return wires are lug-less, compression clamp type connectors, while connections to the load breakers are made via bus bars designed for 2 hole anti-rotational lugs on 5/8” centers. Buss bars on the Distribution PWB also provide a solid and convenient tie point to connect up to two battery strings to the battery service disconnect switches. Load breakers and battery switches snap in and are easily changed out without having to disconnect the cables (See J110-4202 sheet B3 – fig. 3). Battery and Plant current shunts are also provided on the Dist. PWB and are monitored by test jacks on the Control PWB (A3) rated at 10mv per ampere. Temperature sensor inputs (J1) as well as alarm monitoring connections for Major, Minor, RFA, FA, LVDA and AC Fail (J2 and J3) are located on the distribution board also (See J110-4202 sheet B4 – fig. 5 and SD110-4202 sheet B1 – FS1).

The Control PWB (A3) was designed utilizing SMT technology enabling the controller to be compact in size and unobtrusive in the system design (See J110-4202 sheet B4 – fig. 6). The versatility of the controller card is realized by the numerous control functions provided, as well as the monitoring capabilities of critical system parameters via test jacks located on the front of the pcb. Visual indications of plant status as well is given through the use of led indications and coded diagnostics which alert the user to system status (green led) and temperature status of battery strings (yellow led). On board dip switches allow the plant to be configured for customer requirements pertaining to disconnect functions, battery temperature compensation, rectifier control functions, and advanced alarm functions (See J110-4202 sheet B4 – fig. 6). S1 pos. 1 – 4 configure the LVD trip point, factory default setting is -42 vdc. S1 pos. 5 – 7 configure the HVSD trip point, factory default is –57.5 vdc. S1 pos. 8 configures the TEMP ALARM (2 modes offered Delta or Absolute). S2 pos. 1 & 2 set the BATTERY TEMP COMP (BTC) span, factory default is ± 4 volts. S2 pos. 3 & 4 control the operation of the LVD contactor, which can be in auto mode, fixed on or fixed off. S2 pos. 5 turns AUTO EQUALIZE on or off, this feature can extend battery life and will be explained in the operation section of the manual. S2 pos. 6 turns on the TEST MODE of the controller which is primarily used for check-out purposes in verifying alarm set points and proper operation of the LVD disconnect. S2 pos. 7 will disable the open sensor alarm so the temperature probe can be replaced and does not affect ATC ‘s continued operation or alarm status. S2 pos. 8 is not used. S3 pos. 1 turns BATTERY TEMPERATURE COMPENSATION on or off (also referred to as ATC , automatic temp comp). S3 pos. 2 turns the REMOTE function on or off, when enabled single point voltage control is possible by adjusting the on board pot located on the front of the pwb. S3 pos. 3 turns MANUAL EQUALIZE on or off and allows the user to charge batteries at his own discretion (plant should not be left unattended while in equalize, however the cycle will drop out after a 10 hour charging time should someone forget to turn it off). S3 pos. 4 turns the SLEEP MODE on or off and studies have shown that battery life can be extended by as much as 20%. All of the functions and features described above are explained in further detail in the manual.

2.0 SPECIFICATIONS

2.1 Physical Specifications

	Plant Cabinet	**Rectifiers (ea.)**	**Combined**
Width	21.0" (53.35 cm)	4.0" (10 cm)	NA
Depth	12.0" (30.50 cm)	11.0" (28 cm)	NA
Height	8.562" (21.7 cm)	2.5" (6.4 cm)	NA
Weight	44 lbs. (20 kgms)	3 lbs. (1.4 kgms)	68 lbs. (31 kgms)

2.2 Environmental Specifications

Operating temperature	–40°C to +65°C (–40°F to +149°F)
Storage temperature	–40°C to +85°C (–40°F to +185°F)
Shipping and handling	**Plant:** shipped fully assembled, in packaging designed to withstand normal shipping & handling **rectifier modules:** each in its own protected box
Humidity	0 to 95 %, non-condensing
Altitude	13,858 ft (4,224 meters) Power Plants only. Rectifiers de-rate above 3,281 ft (1 kilometer) see rectifier manual for derating spec.'s
Heat dissipation	2,776 BTU/hour maximum, fully loaded to 60.0 Adc; approximately 347 BTU/hr/rectifier
Cooling	**distribution:** natural convection **rectifiers** forced air convection, w/ built-in over-temp. protection & automatic recovery
Seismic	Designed to comply with Bellcore seismic zone 4

2.3 Electrical I/O Specifications

Input	110/208/240 Vac, single phase, 45 – 65 Hz, 18 Aac per feed @ 110 (w/4 rect. @ 54 Vdc) 16.5 Aac, @ 240 Vac (w/ 8 rect. @ 54 Vdc)	**Output**	Max: 60.0 Adc at –60 Vdc Temp. Coef. = ≤ 0.01 % / °C Voltage Stabilization < 1 min. Max. charge buss Vdrop < 0.5 Vdc Max. discharge Vdrop < 0.25 Vdc

2.4 Factory Settings

Electrical Parameter	Set Point Value
Float voltage	**–54.26** Vdc, ± 0.1 Vdc
Equalize voltage	**–55.9** Vdc, ± 0.1 Vdc
HVSD	**–57.5** Vdc, ± 0.1 Vdc
LVD (disconnect, adjustable if equipped)	**–42** Vdc, ± 0.1 Vdc
LVD (reconnect, not adjustable if equipped)	**–49.5** Vdc, ± 0.1 Vdc

S1

LVD TRIP: 1 ON, 2 ON, 3 ON, 4 OFF
HVSD TRIP: 5 ON, 6 ON, 7 OFF
TEMP MODE - 8 ON
DELTA/**ABSOLUTE**

S2

BTC SPAN: 1 ON, 2 OFF
LVD OPERATION: 3 OFF, 4 OFF
AUTO EQ. — 5 OFF
TEST MODE — 6 OFF
TEMP SENSOR BAD - 7 OFF (ALARM CUTOFF ONLY)
DEFAULT IS **OFF**
NOT USED — 8 OFF

S3

TEMP COMP - 1 ON
REM CNTRL - 2 ON
MAN EQ. - 3 OFF
SLEEP MODE - 4 OFF

When viewing the control pwb while installed in the system the dip switches operate from left to right with the LEFT POSITION being OFF and the RIGHT POSITION being ON.

2.5 Noise Specifications

"Voice Band" electrical noise	Does not exceed **32 dBrnC**, when operating with or without batteries; @ 208/240 Vac in
"Wide band" electrical noise	Does not exceed **40 millivolts rms** in any 3 kHz freq. range, between 10 kHz & 20 MHz
"Peak-to-peak" electrical noise	Does not exceed **250 millivolts pk–pk**, at 20 MHz bandwidth
"Audible Noise"	Does not exceed **60 dB** with 8 rectifiers fully loaded.

2.6 Susceptibility Specifications

- Meets ESD requirements per IEC specs on Electromagnetic Compatibility (IEC 801-2, Section 4.11).
- Meets Class A EMI requirements of CFR 47, parts 15C and 15J.
- Withstands lightning surges (without damage) between the battery charge buss or ground return buss and the equipment frame/Safety ground with minimum impedance of .025 ohms, per ANSI/IEEE C62.41.

2.7 Rectifier Specifications

Efficiency	≥ 82 % when supplying full load current at 54 volts out, with 240 Vac in, at 25°C. ≥50 %, when supplying 10% of full load, at 54 volts out, with 240 Vac in, at 25°C.
Power factor	greater than 0.99 at rated full power out
Protection	Internally fused
Service	Rectifiers may be installed or removed without affecting Plant operation

2.8 Safety Specifications

Unit is Underwriters Laboratory Standards of Safety for Information Technology Equipment (UL 1950), CSA and VDE compliant.
Bellcore Network Equipment-Building System Generic Equipment Requirements (TR-EOP-000063) was used as guidelines in the specifications of all components and wiring. Particular attention was paid to Safety ratings and OI-28 flammability requirements.

2.9 Monitoring & Alarm Specifications

- Test jack for Plant voltage — All models
- Test jacks for Plant and Battery current shunts — All models
  (current shunts read 10 mV per Amp)
- Test jacks on the rectifier for individual rectifier output currents
  (current shunt reads 50 mV @ 10A)

ALARM INDICATIONS (Visual/Local & Electrical/Remote)	
FA (Open Fuse Alarm)	Front panel red LED indicator. Each open GMT fuse or tripped Breaker causes an FA. Removing a fuse or turning breaker off will not cause an FA.
Battery or Load LVD	Front panel red LED indicator. Indicates Plant voltage below the LVD trip point, & that the contactor is disconnected. Dip Switch 2 pos. 3 & 4 set LVD for fixed on or fixed off operation when fixed on the red led indicator will still give an alarm in the event of contactor failure. When fixed off the LVD led remains illuminated.
Major Alarm	Front panel red LED indicator. A Major Alarm is generated by an FA, Controller failure, AC FAIL, LVD, >1 RFA, HVA, LVA and HVSD.
Minor Alarm	Front panel yellow LED indicator. A Minor Alarm is generated by 1 RFA, Test mode, plant voltage limited to prevent HVSD, HVSD set too low, temp sensor missing or out of range and a high temperature alarm. The Minor led will operate in conjunction with the Temp Alarm led.

ALARM INDICATIONS (Visual/Local & Electrical/Remote)	
Temp Alarm LED	Yellow led designated for temperature alarms only, located adjacent to system green led behind system LED's and test jacks. Temp sensor missing or out of range, ATC required greater than selected span, Delta alarm true, Absolute alarm true and Battery over-heated during equalize. A more detailed description of alarms is given later in this section of the manual.
ALL Plants	• Each rectifier's own RFA Alarm. • Form C relays for Major, Minor, RFA, FA, LVDA and AC FAIL

3.0 FEATURES

3.1 Overview of List 1 Power Plant Features

- 52.5 Adc redundant load current, 60.0 Adc Max.
- Supports 8 switch mode rectifiers rated 7.5A @ -60Vdc, featuring a pull out tray with A & B load distribution with each load consisting of 10 GMT fuse positions and 2 optional AM1 snap in breaker positions rated 5 – 50A.
- Supports 2 battery strings with options for two snap-in 100A rated battery service disconnect switches.
- Dual AC power feeds, power 4 rectifiers each, with an option for a single feed.
- Automatic Controller service by-pass.
- Controller features support:
  - ❖ Standard alarms with form C alarm output relays including AC FAIL, LVDA, FA, RFA, MIN & MAJOR ALARMS.
  - ❖ Battery temperature compensation.
  - ❖ Single point voltage control
  - ❖ High temperature alarms
  - ❖ HVSD with adjustable set points
  - ❖ Manual and automatic equalize modes
  - ❖ Sleep mode
  - ❖ Battery and Plant shunt test jacks
  - ❖ Led indicators with coded alarm and status outputs
- Front access to all connections
- Terminal Blocks that allow temperature sensor connections to be easily made.

3.2 Overview of List 2 Power Plant Features

- Same features as a List 1 Plant
- Low voltage battery disconnect is added
- Adjustable trip point
- Auto or Manual operation with led indicator and alarm output relay
- Automatic Controller service by-pass

3.3 Overview of List 3 Power Plant Features

- Same features as a List 1 Plant
- Load A low voltage disconnect is supported
- Adjustable trip point
- Auto or Manual operation with led indicator
- Automatic Controller service by-pass

3.4 Overview of List 4 Power Plant Features

- Same features as a List 1 Plant
- Load B low voltage disconnect is supported
- Adjustable trip point
- Auto or Manual operation with led indicator
- Automatic Controller service by-pass

3.5 Overview of List 5 Power Plant Features

- Same features as a List 1 Plant
- Load A & B low voltage disconnect is supported
- Adjustable trip point
- Auto or Manual operation with led indicator
- Automatic Controller service by-pass

3.6 Detail Listing of LIST 1,2,3,4 & 5 Power Plant Features

3.6.1 Load or Battery Low Voltage Disconnect

The LVD function comes from the factory already configured per the ordered LIST #. Should a different need arise for a battery disconnect rather than a load disconnect the change is easily accomplished with 3 jumper straps located on the DIST BRD. A2 (See SD110-4202 sheet B1 – FS1 & J110-4202 sheet B4 fig. 5). The LVD trip point is set by dip switch S1 positions 1 – 4 between -38.5 and -46.0 volts in 0.5v increments (See sheet B3 – FS4 for settings). The factory setting is -42.0 volts. The reconnect voltage is fixed via the controller at –49.5 volts.

3.6.2 AC Line options

Two line cords can be wired for 110 Vac, dual A & B feeds or 208/240 Vac dual A & B feeds. There is also the option for 208/240 Vac single feed prewired at the factory. Feed A supplies power to rectifier slots 1,3,5 & 7 while Feed B powers slots 2,4,6 & 8. Should the AC requirements change refer to SD110-4202 sheet B2 – FS 2 for the necessary strapping diagram. True front AC access is accomplished via an access box on the front left side of the chassis. The box provides top or bottom access to a front accessible terminal block.

3.6.3 Terminal Blocks for accessing temp sensor connections and alarm relay outputs

Three mini-terminal blocks provide access to TEMP SENSOR CONNECTIONS & ALARM RELAY FORM C OUTPUTS (See SD110-4202 sheet B2 – FS 3). J1 allows for three temp sensors, 1 ambient and 2 battery string connections. J2 allows for MAJ, MIN and RFA outputs to be monitored. J3 allows for FA, LVDA and ACF outputs to be monitored.

3.6.4 Load “A” breaker, Load “B” breaker and Battery switch bus bar connections

Convenient bus bars and return landings on the Dist. Brd. A2 allow for field connections with 2-hole anti-rotational lugs on 5/8” c.c. with #10 studs (See J110-4202 sheet B4 fig. 5).

3.6.5 Optional Load Breakers and Battery Service Disconnect Switches

A unique bussing architecture supports the use of 2 easily changeable snap-in type breakers for load A and 2 for load B, rated @ 5-50 amps. Battery disconnect switches are rated at 100A each and are snap-in type also (See J110-4202 sheet B3 fig. 3).

3.6.6 Standard GMT distribution fuse blocks

Load A and load B have 10 GMT fuse positions each to accommodate current carrying loads. Fuses range from 0.5A to 10A (See J110-4202 sheet B4 fig. 5). Included is a fuse extraction tool mounted to a clip on the cable guide bracket.
CAUTION: Fuses >3A should be distributed evenly across fuse block

3.6.7 Test jacks for Plant Voltage, Plant Current and Battery Current

The test jacks are located on the Controller Brd. A3 and are accessible through the front panel door. The respective signals are bussed from the Distribution Brd. A2 via the 26 pin ribbon cable. The plant voltage is a direct reading while the plant current and battery current read across series shunts scaled at 10mv per amp (See J110-4202 sheet B4 fig. 6).

3.6.8 Single-point Plant Voltage Control

Remote control of the plant voltage is located on the front of Control Brd. A3 and is enabled by dip switch S3 position 2. When remote control is enabled the output voltage adjustment pot on the rectifiers are disabled. The Controller then assumes control of the output voltage, which can be adjusted with pot R85 which is also located on the front of the control board (See J110-4202 sheet B4 fig. 6).

3.6.9 Battery Temperature Compensation

Three sensors come with each plant, 1 for ambient and 2 for battery measurements. Both battery sensors must be used, either both on the same battery string or 1 each on 2 separate strings (Avoids missing sensor alarm). If one battery sensor fails the missing sensor alarm can be disabled with dip switch S2 position 7 (This is an alarm cut off for open sensors only) until the temperature sensor can be replaced. Remember to turn off SW2-7 after replacing the probe. The plant float voltage will continue to automatically compensate for temperature variations (See SD110-4202 sheet B2 – FS3 & sheet A3 notes 85 & 86). If the Ambient sensor opens the Differential temp alarm reverts to Absolute.

3.6.10 High Temperature Alarms (Absolute or Delta)

Based on the data from the ambient and battery temp sensors, two different high temp alarms can be generated: Delta or Absolute. Dip switch S1 position 8 located behind float voltage pot R85 selects which mode is desired. In the Delta mode the ambient temperature is subtracted from the highest battery temperature and an alarm is generated when the difference is greater than 36° F. Delta mode takes ambient temperature changes into account. The Absolute mode simply compares the highest battery temperature reading against a fixed alarm trip point of 145° F. In either case a minor alarm is generated (See SD110-4202 sheet A2 note 77 & sheets B3 and B4).

3.6.11 Automatic & Manual Equalize Charge Modes

The Automatic Equalize Charge mode is dip switch select-able with S2 position 5. During a battery discharge, the Control PWB A3 records the discharge AHs of the batteries. Ten seconds after AC power returns the Controller measures the plants output voltage. The Controller compares that measurement against a reference point (1/2 of the difference between the plant's remote float voltage set point and –42 volts). Usually, the "ten seconds after the ac power returns" measurement will be higher than the reference point, unless the batteries have been deeply discharged. If the "ten seconds after" measurement is lower than the reference point, the Controller waits until the battery recharge current drops to less than 75% of the initial recharge value, and then begins the Automatic Equalize Charge cycle. Once begun, the Plant voltage is raised 2 volts above the Plant's remote Float voltage set point, and a 10 hour timer is started. The cycle ends by battery recharge current dropping below 1.5 amps, another incident of ac power loss, or after the 10 hour timer has timed out. Battery temperature is also monitored with an unexpected high temperature resulting in emergency equalize shutdown. (See SD110-4202 sheet A3 note 81 & sheet B3 & B4 – FS7)

The Manual Equalize Charge mode is dip switch selectable with S3 position 3 and places the rectifiers into Equalize mode (as opposed to the Automatic mode, which only raises the Remote Control Set-point voltage of the rectifiers). A ten hour timer is also started when the Plant is put into the Manual Equalize Charge mode (via a dip switch). The Manual Equalize Charge mode is either software terminated at the end of ten hours, or if battery temperature rises more than 30°C; or hardware terminated by moving the dip switch back DOWN, into the OFF state.

3.6.12 Battery Fail Alarm (part of Auto Equalize Mode)

Deserving of special mention is the Battery Fail Alarm which is an integral feature of the Auto Equalize Mode. When a power outage occurs and AC is subsequently restored the Controller records both the discharge AHs and the recharge AHs of the batteries. It then compares the two, to determine the state of the batteries. If the recharge AHs are more than 40% greater than the discharge AHs, a **"Battery Fail" Alarm** is activated and displayed through coded flashes of the PWB's [CNTLR OK] LED (see Chapter 3; Section 9.0, Control PWB [CNTLR OK] LED Status…).

3.6.13 Battery Sleep Mode

Sleep Mode provides another level of VRLA battery life enhancement. Periodically taking batteries to open circuit voltage has shown evidence of increasing battery life expectancy by as much as 20%. Sleep mode is dip switch select-able (SW3 position 4). When selected, the Control PWB will reduce the Float voltage to –52.0 volts (± ATC), for 2 days per week. Should a battery discharge occur or any alarm minor or major, the periodic Sleep mode function is disabled until the batteries have fully recovered their charge (See SD110-4202 sheet B3 – FS4 for switch setting & B4 for functional diagram).

3.6.14 HVSD & Automatic Restart Functions

The Plant's HVSD trip point is adjustable in ½ volt steps, from –57.0 Vdc to –59.5 Vdc, by SW1 position 5,6 & 7 on the Control PWB A3. A rectifier SHUTDOWN command is generated if the plant voltage reaches this HVSD trip point. A rectifier RESTART command is also generated when the plant voltage drops below –52 Vdc. (See SD110-4202 sheet B3 – FS4)

3.6.15 Green CNTLR OK LED flashes Status, Trouble & Warning Information

Steadily lit means normal Float mode Plant operation; various short and long flash combinations indicate a status other than normal; i.e., Equalize mode or some kind of trouble (see Chapter 3; Section 9.0, Control PWB Green [CNTLR OK] LED Status & Trouble Codes, for a table of flashing LED codes).

3.6.16 Yellow TEMPERATURE LED flashes Status, Trouble & Warning Information

Sensor status and battery status are indicated by various short and long flash combinations. (see Chapter 3; Section 9.0, Temperature Status & Trouble Codes, for a table of flashing LED codes).

3.6.17 Over Current Alarm

AGM 60 power systems shipped after December 5, 1999 as Issue 2 have an undocumented alarm feature that could be confusing to the user.

An over current alarm was added to warn user's when their load current has exceeded the N + 1 redundancy requirement and another rectifier should be added.

The AGM 60 can detect the number of installed rectifiers. The controller calculates the total available load current as:

Rectifiers (7.5A) – (7.5A)* = Total Available Current
*Redundancy Factor

The over current alarm utilizes the yellow temperature alarm LED as two short flashes. The alarm also generates a minor alarm output.

This alarm will always occur when a single rectifier is installed since there is no redundancy. The maximum load without generating the over current alarm in a full eight-rectifier power system is 52.5A.

CHAPTER TWO: POWER PLANT INSTALLATION

1.0 INTRODUCTION

1.1 General Information

This chapter contains procedures with step by step instructions for a complete Plant installation. This includes making all of the necessary wiring connections to the Plant. A complete Drawing set (J Drawings and Schematic Diagram Drawings) of the Plant can be found in the back of this manual.

1.2 Field Service Assistance

Installation questions are handled primarily by authorized C&D agents, however our dedicated Field Service Representatives may also be utilized. They can be reached at:

1-800-299-3907

Between the hours of 8:00am to 4:00pm, Eastern Standard Time, this phone number reaches an answering service. That service then transfers you to the correct C&D Field Service Department.

1.3 Equipment ID Numbers

Each Plant has an identification label on the side of it. Have the part number 110-4202 List X from that label ready to give to the Field Service Representative that is helping you. This will enable them to serve you more efficiently.

1.4 Recommended Installation Tools & Test Equipment

The following tools and test equipment are recommended for a typical Plant installation:

NOTE: Adequately insulated tools help prevent accidental electrical short circuits.

- Screwdriver: Cabinet tipped, 1/8" (tip width) by 3" to 4" (shaft length) straight slot
- Screwdriver: Standard, # 2 Phillips tip
- Nut Driver: 3/8", hex
- Wire Strippers: Standard, 24 AWG to 10 AWG
- Long Nose Pliers (for inserting wires into the Load Distribution Terminal Blocks)
- Lug Crimpers: Up to 6 AWG (for Battery Lugs)
- Volt Meter: Hand held DMM, with MIN/MAX Peak Detect Function

1.5 Load Distribution and Battery Buss Bar Access

The removal of 2 safety screws beneath the thumb latches is required to gain access to the Distribution tray, with the front panel door open depress the latch located in the middle of the shelf and pull the tray out until it latches in its extended position exposing Load Breaker and Battery Switch buss bars as well as GMT fused distribution blocks.

<u>Lug-less Terminal Block Wire Preparation</u>
Each wire that is to be connected to a lug-less terminal block in the Plant, should have ¼ inch of exposed bare wire at it's end, to ensure good electrical contact to the wire clamp in the block.

<u>WARNING</u>: Prevent loose wire strands from shorting to adjacent terminal block positions. Ensure that all strands of each wire go into the receptacle hole of that block position.

Testing Lug-less Terminal Block Wire Connections
Verify the mechanical soundness of each wire that you clamp into a lug-less terminal block position, by gently pulling on it to make sure that it is securely clamped within the block. Use a pull test force of no greater than 8 inch pounds.

2.0 LOCATION SELECTION CRITERIA

WARNING: Do not expose the AGM 60 Power Plant to extreme environmental conditions.

The PLANT installation location must meet the following criteria:

- Dry (protected from direct precipitation)
- Free of pests and vermin
- Well ventilated & unobstructed to forced air flow (air flows in the front & out the rear)

3.0 DC POWER WIRE SIZE SELECTION

3.1 Safety, Performance & Reliability

Safety, overall system performance, and the reliability of circuit protection devices depend on the size of the DC load and return wires installed. It is the responsibility of the equipment installer to install adequately sized wire at each site. The following procedure gives a formula for calculating wire size, and a wire size table to help determine the proper wire size needed for a particular site.

3.2 Select Wire Size

PROCEDURE

1. Calculate the circular mils [CM] of (copper) wire required for installation at this site:

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

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

Example.: I out max. = 5 amps, tolerable loop voltage drop = 0.25 volts, and Plant is 10 feet from the load:
CM = 4,500

2. Select the proper sized copper wire (based on your calculated CM) from the table below.
If the calculated CM falls in between that of two standard wire sizes, choose the larger size wire.

Table: Cross Sectional Area of Wire Sizes

AWG wire size number	cross sect. area, CM	Current carrying capacity	dia (ins.) bare conductor	RHW (ins.) dia, with insulation	RHW bend radius, in inches	RHW net weight in lbs., per 1000 feet	RHW max length/reel in feet
14	4110	15	0.064	0.19	0.955	26	5000
12	6530	20	0.081	0.21	1.05	35	3000
10	10380	30	0.102	0.24	1.20	49	3000
8	16510	45	0.146	0.31	1.55	84	3000
6	26250	70	0.184	0.40	2.00	126	2000

NOTE: Data based on NEC Handbook 1993, Table 310-17; adjusted for 50°C ambient temperature.

3. Find the wire size required by the local wiring codes, for the number of Amps the wire is to conduct.

4. If the two wire sizes are not the same, use the larger wire size for your installation.

4.0 INSTALLATION & WIRE HOOK-UP

4.1 Cabinet Installation

PROCEDURE

1. Remove the AC input cover and set the cabinet into place within the rack or enclosure that you are installing it in.

2. Start one 12-24 panel mounting screw into the top mounting hole on each side of the cabinet.

3. Put paint breaking washers under each of the bottom mounting screws, and tighten all four screws.

4. Perform a chassis ground TEST. Using an Ohmmeter, verify that there is less than one Ohm of resistance between the ground stud, located beneath the AC terminal block, and the screws that hold the Plant in place.

4.2 Connecting & Verifying AC Input Power (All Models)

The AC cover has provisions for top or bottom entry of the AC feeds and the appropriate strain relief should be used (See J110-4202 sheet B1). Adhere to the requirements of the governing local Electrical Codes, when making the AC power connection to the Plant. There should be an adequately rated delayed-trip circuit breaker at the source of the AC feed to the Plant (See SD drawing sheet A1, Table C).

<u>AC service run length & minimum gauge recommendations</u>: < 25 Feet, 12 gauge; > 25 Feet, 10 gauge. <u>Expected current draw over the AC input voltage range</u>: 18 Aac per feed @ 110 Vac; 18 Aac @ 240 Vac. <u>Absolute maximum worst case current draw:</u> 20 Aac @ 106 Vac, with 30 Adc out, @ –58 Vdc out (per feed w/4 rectifiers). (See SD drawings, sheet A1, Table C, for AC circuit breaker ratings).

1. Run the wiring to the Plant, as required by the governing local Electrical Codes for this installation site. If a single 208/240 AC feed is utilized the connection to the AC terminal block should be made on feed “A” only (unit must be strapped for this application, see J110-4202 sheet B1). Dual AC feeds can be utilized from 110/208/240 Vac by wiring to “A” and “B” feeds on the AC terminal block (See SD110-4202 sheet B2 – FS2).

2. Connect the wiring to the circuit breaker protected AC source and strain relieve it as necessary. With all rectifiers disengaged apply AC power and verify connectivity at AC terminal block.

3. Leave AC power to the Plant turned off until after the rectifiers are installed.

4.3 Connecting Battery Wires & the Main Ground Buss Wire

<u>4.3.1 Battery & MGB Wires, General Information</u>

Telecom cabling regulations require that an adequately sized direct Main Ground Buss [MGB] connection be made from the Plant ground return to a valid MGB point. A properly made MGB connection bonds the DC output to earth ground, eliminating potential ground loops, and provides a safe path for potentially dangerous lightning induced voltages and currents. The two following documents define what an adequately sized direct MGB connection is:

- Central Office Telecommunications Equipment Engineering Standards, 1984
- TRP-EOP-000154 Bellcore Generic Req.’s for …CO Power Plant Control & Distribution, 1985

Recommended MGB connection point:
The MGB should be connected to the +48V, with the AGM 60 this would be a 10/32 stud located in the upper left corner of the distribution board. The stud is marked as “MGB” (Max wire size = 6 awg).

4.3.2 Connect Battery & MGB Wires

WARNING: Battery cables should have fuses installed in series with them.

1. Remove the series battery fuses, so that battery power is not connected to the plant.

2. With the Distribution tray pulled out connect –48v battery leads to Bat 1 or Bat 2 bus bars with the MAX Torque set @ 18 in/lbs. Connect the +48v battery leads to Bat 1 or Bat 2 return landings on the distribution board. Be sure to use 2-hole anti-rotational lugs and torque to a MAX of 18 in/lbs. (See SD110-4202 sheet B2 – FS3).

3. Connect the MGB wire to the “MGB” stud and torque to a MAX of 18 in/lbs.

4.4 Connecting Distribution Wires

4.4.1 Distribution Wires, General Information

Distribution Terminal Blocks, their location and maximum AWG capacity: Load distribution and return wires can be connected to lug-less terminal blocks J4, J5, J6 and J7, terminal blocks J5 & J7 are the fused load blocks. (See J Drawing, Sheet B 2, Figure 2 and SD Drawing sheet B1 – FS1 & B2 – FS3). These blocks accept wires of up to 12 AWG.

4.4.2 Connect Distribution Wires

PROCEDURE

1. Size wires per section 3.2 of this chapter.

2. After all Load Distribution connections have been made record the information on the Distribution log located on the AGM 60 door panel.

3. Routing of all Load and Alarm wires is important and should follow the pictorial diagrams shown on dwg. J110-4202 Sheet B2 Figure 2.

4. Utilizing dwg. J110-4202 sheet B2 – fig. 2 all cabling should be tie-wrapped at critical tie points indicated.

5. To allow for proper cable travel as the tray is moved in and out, do not tie cabling to rack closer than 8” to 10” above or below cable entrance on the AGM 60 (See J110-4202 sheet B2 – fig. 2).

6. Ensure the Distribution tray slides in and out easily without pinching or kinking the load wires.

4.5 Connecting Temp Sensors and Alarm & Control Wires

4.5.1 Temp Sensors and Alarm & Control Wires, General Information

Depending on the Plant configuration, there is additional wiring that must be completed, and some optional wiring that should be completed before power is connected to the Plant. Review these connections before you start wiring. It will simplify the process and prevent you from having to add connections to the Plant after it is in operation. Below are listed the required **(Req)** and optional **(Opt)** connections:

(Req) All Plants need all temperature sensors attached (for battery temp comp operation).

(Opt) All Plants provide the option for external monitoring of MAJ, MIN, RFA, FA, LVDA and ACF signals on terminal blocks J2 & J3 located on the Distribution Brd.
(See SD Drawing, sheet B2, FS 3, for more on these terminal blocks).

Control & Alarm Terminal Blocks; their max AWG capacity & making connections to them:
The control, alarm and temp. sensor terminal blocks are all lugless one piece connectors. The connectors are soldered into the PWBs and accept up to **18 AWG** wires.

4.5.1.1 Connecting wires to Terminal Blocks

NOTE: A very small straight slot screw driver or pot adjustment tool, such as a BOURNS #60, is required for clamping wires into these blocks.

PROCEDURE

1. Clamp the stripped ends of the wires into the connector. Pull test each wire (<8 lbs.) to ensure it's clamped.
   CAUTION: Temp sensors are solid strand wire and can be easily damaged.

4.5.2 Temperature Sensors

Three temperature sensors come with each system. Each one has 30 feet of hook-up wire connected and is packaged in its own bag. Each sensor has three wires that must be connected. They connect to terminal block J1 (See SD Drawing sheet B2, FS 3, for wiring detail). The sensors are embedded in plated ring lugs, designed to be connected directly to a battery terminal. Both battery temp sensors must be used (both on the same string, or one each on two separate strings).

4.5.2.1 Connecting Temp Sensors to Terminal Blocks

PROCEDURE

1. Mount the 2 battery temp. sensors directly to battery terminals (1/string, if more than 1 batt. string).

2. Identify each wire set and then route them all back into the Plant.

3. Find a mounting location for the ambient sensor, that has enough thermal mass to prevent temperature reading fluctuations due to quick changes in the room or enclosure temperature.
   The sensor can be mounted to the rack or enclosure itself.

4. Mount the ambient sensor identify its wire set and route it into the Plant.

5. Trim the excess wire from each temperature sensor wire set, and **follow Procedure:**
   4.5.1.1 Procedure: Connecting wires to Plug in Terminal Blocks; to connect them to the Plant.
   RED wire to (+) BLUE wire to (IN) BLACK wire to (-)

WARNING: Mis-wiring of a temperature sensor may damage it!

4.5.3 Alarm Wires

When connecting alarm wires to the plant the contact rating of the alarm relays need to be observed.
at 120 Vac contacts are rated @ .500 A and @ 24 Vdc contacts are rated for 1.0 A.

4.5.3.1 Connecting Alarm Wires to Terminal Blocks

These signal lines are accessible at the J2 & J3 connectors located on the right side of the Distribution Board A2. The pin-outs of the two terminal blocks are listed in the next table. (See SD Drawing, sheet B2, FS 3)

As an added feature 6 mini-jump headers with jumpers are provided should a GND closure configuration be required. JP1 configures K1 (MAJOR), JP2 configures K2 (MINOR), JP3 configures K3 (RFA), JP4 configures K4 (FA), JP5 configures K5 (LVDA) and JP6 configures K6 (ACF). Each jumper is located directly beneath its respective relay and when shipped from the factory it is placed on the right two pins of the header away from the GND. To enable the GND closure feature simply move the jumper to the left next to the GND words in silkscreen on the board.

Table: List 1 Alarm and Control Signal Interface

Term Blk # pin #	**J2 MAJ**	**J3 FA**
1	C	C
2	NC	NC
3	NO	NO
Term Blk # pin #	**J2 MIN**	**J3 LVDA**
4	C	C
5	NC	NC
6	NO	NO
Term Blk # pin #	**J2 RFA**	**J3 ACF**
7	C	C
8	NC	NC
9	NO	NO

Legend: LT = switch to the LEFT position (OFF); RT = switch to the RIGHT position (ON);
When viewed with control PWB installed in system

MAJOR ALARM RELAY: Normally energized relay for fail safe alarm indications include Fuse Alarms, 2 or more RFA's, High Voltage Shutdown, Low Voltage Alarm, High Voltage Alarm, Controller Failure. Red LED indication on the Controller Brd A3.

MINOR ALARM RELAY: Normally de-energized relay for standard alarm indications include Single RFA, HVSD set too low, High Temp, Test Mode. Yellow LED indication on Controller Brd A3.

RECTIFIER FAIL RELAY: Normally de-energized relay for standard alarm indication of any RFA. Red LED indication on individual rectifiers.

FUSE ALARM RELAY: Normally de-energized relay for standard alarm indication of any GMT fuse failure or any Breaker Trip indication. Red LED indication on Controller Brd A3. Breakers in the off position will not cause an FA alarm.

LOW VOLTAGE DISCONNECT ALARM RELAY: Normally de-energized relay for standard alarm indication of an LVD Contactor open condition, trips @ -42Vdc.

AC FAIL ALARM RELAY: Normally de-energized relay for standard alarm indication of an AC Fail condition of all rectifiers on a single AC Feeder. If the condition exists where all RFA's occur on both AC feeders then the Controller looks for current being drawn from the batteries or negative battery current. The Controller also looks at Plant current and if the draw is more than 2A then an AC Fail alarm will be generated.

5.0 RECTIFIER INSTALLATION, POWER-UP & VERIFICATION

5.1 Rectifier Installation

Each rectifier monitors it's performance, and reports rectifier status and problem information through the green NORM LED on the front of the rectifier. A series of short and long light pulses are used to convey any state other than normal operation. A label on the inside of the Plant's front door describes what each pulse pattern means (See SD Drawing sheet A2, Note 66, for more details).
The rectifier manual also provides more details about these light pulse codes. The most common status code likely to be seen under normal operation is the single long pulse for "Low Current".
(See the following Table for a legend of rectifier "NORM" LED coded "flash" messages)

<u>WARNING</u>: The rectifiers are open frame units that slide into the cabinet on card guides. Excess force or rough handling can mechanically damage the rectifiers or the card guides.

NOTE: Rectifiers are designed to be installed "Hot", without interrupting normal Plant operation. When removing a rectifier, handle by the face plate cover only to avoid HOT SINKS AND COMPONENTS located behind the cover.

Table: Rectifier [NORM] LED Coded Flash Message Legend

Flashes		**Coded Flash Messages & Their Problem or Status Indication Descriptions**	
Long	**Short**	**Coded Flash Message**	**Problem or Status Indication Description**
	1	Low Output Current	Output Current below 0.375 Adc
	2	Internal HVSD	Occurs if V dc out > –61 Vdc, or 3 Vdc > set point
	3	AC Line Sag	When line should be 208–240 Vac, shows line is < 187 Vac
	4	Over Temperature	Occurs when internal heat sink temp > 110 °C
1	**1**	Rem. Control "out of range"	Voltage across REM. CNTRL. inputs > ± 2 Vdc (The rectifier's FLOAT pot is setting it's output voltage)
1	**2**	Load Share "out of range"	Voltage across LS inputs > ± 2 Vdc; Load Sharing inactive
1	**3**	Over Temp./ Iout derated	Ambient Temperature > +65 °C; rectifier Iout limit derated
1		Low Air Flow	Occurs when heat sink to ambient Δ > 30% over normal
2		External HVSD	The Plant has placed the rectifier into HVSD mode

<u>5.1.1 Installing Rectifiers</u>

<u>WARNING</u>: Keep rectifiers in their shipping containers, until you are ready to insert them into the cabinet. Being open framed units, they can sustain ESD damage if they are not kept protected.

NOTE: Although not critical, it is best to have each rectifier switched OFF during insertion and removal.

PROCEDURE

1. Align the front edges of the rectifier's bottom PWB with the card guides in the cabinet.

2. Slide the rectifier into the cabinet, until it touches the edge connector on the backplane pcb.

3. Press on the bottom corners of the rectifier's front plate until the unit "seats" into place.

4. Install the remaining rectifiers the same way, leaving all switches OFF until initial power up.

5.2 Initial Rectifier Power-Up

5.2.1 Required Equipment for Initial Rectifier Power Up

- A Variable Load, capable of handling at least 60 amps
- GMT fuses rated for proper current draw
- A DVM, with a millivolt scale that is accurate to at least 0.5%
- A Potentiometer adjustment tool

5.2.2 Pre Power Up Steps

1. Connect the variable load to the plant via the load distribution breakers or the GMT fuse blocks which ever is applicable. Depending on the number of rectifiers ordered set the load to approximately ½ of its rated capacity i.e.: 4 rectifiers = 30 A, set load to 15 A. For all tests that follow loading capacity will be determined by Breaker size ordered or GMT fuses available.

2. Connect the DVM to the Plant (to monitor the output voltage).
   Across the "BAT VOLTS" and "COMMON" test jacks (Controller PWB A3)
   (See J110-4202 sheet B4 – fig. 6, for "BAT VOLTAGE" and "COMMON" test jack locations)

5.2.3 Initial Rectifier Power Up

NOTE: Batteries should not be connected to the Plant during this procedure. Ignore the "one short flash" [NORM] Rectifier LED code when the Plant is not loaded.

PROCEDURE

1. Apply AC service power to the Plant (Rectifier fans will start turning).

2. Put dip switch S3, positions 1 & 2 to the LEFT, into the OFF state. S3 – 1 disables ATC while S3 – 2 disables REMOTE CONTROL. (See SD110-4202 sheet B3 – FS4)

3. Flip the toggle switch on a rectifier to the LEFT into the ON state. When turning rectifiers on 1 at a time be sure to adjust the variable load accordingly.

4. Verify and adjust the rectifier float adjustment pot as required so that the Plant output [BAT VOLTS] to [COMMON] is –54.25 Vdc, ± 0.1 Vdc.

5. Flip the toggle switch on that rectifier to the RIGHT, into the OFF state.

6. Repeat steps 3 – 5, on each rectifier, until you have verified that each one is working OK. (Green NORM LED shows one short flash, and REM, EQL & RFA LEDs are all not lit)

7. Flip the toggle switches on all rectifiers to the LEFT, into the ON state, and Verify that the Plant output voltage is –54.2 Vdc, ± 0.25 Vdc.

8. Put dip switch S3 position 2 to the right into the ON state and Verify that the Plant output voltage is –54.2 Vdc ± 0.25 Vdc. (if it is not ≅ –54.2 Vdc adjust it to that value using the pot R85 on the Control PWB [A3] See J Drawing, sheet B4, Figure 6, for the location of pot R85 "Remote Voltage Adjust").

Optional Tests:

9. Set the variable load so that each rectifier is delivering approx. 3.75 Adc. (18.75 mVdc, ± 2.5 mVdc across the two rectifier "I+" and "I–" test jacks). Again Breaker size ordered and GMT fuses available will determine loading capacity.

NOTE: All rectifiers should load share, and be operating normally within 30 seconds (all rectifier "NORM" LEDs should be lit continuously, with no flashing codes displayed, and the EQL and RFA LEDs are all not lit).

10. Set the variable load so that each rectifier is delivering approx. 7.0 Adc (from 32.5 mVdc to 37.5 mVdc {35 mVdc, ± 2.5 mVdc} across the two rectifier "I+" and "I–" test jacks).

NOTE: Plant voltage should not change more than ±0.5 %, and there should be no alarms or flashing rectifier LEDs.

11. Set the variable load so that each rectifier is delivering approx. 3.75 Adc. (18.75 mVdc, ± 2.5 mVdc across the two rectifier "I+" and "I–" test jacks).

12. Perform the next two steps on each rectifier, one rectifier at a time.

13. Flip a rectifier's toggle switch to the RIGHT, into the OFF state (it's green NORM LED will flash 1 short flash for low current, and it's red RFA LED will be lit continuously while the MINOR LED on the Controller pwb A3 will give an indication also).

14. Verify that the other rectifiers pick up the load and continue load sharing equally, and that the Plant output voltage does not change > ± 250 mVdc.

15. **Initial test completed!** Flip all rectifier toggle switches to the right, into the OFF state. The ATC, SW3 pos. 1, can remain in the off state.

6.0 LVD SET-UP & OPERATION VERIFICATION

6.1 LVD Op Verification, Gen. Info.

Correct LVD operation should be verified. The Plant must be put in the TEST mode to verify correct operation. With LVD in the TEST mode, a trip point –48 Vdc is forced on the plant. Also, the adjustment range of the Plant's remote control Float voltage adjust pot (R85) is increased (and it's adjustment sensitivity is decreased). The adjustment range (and sensitivity) returns to normal when the Plant function is taken out of the TEST mode. To verify the correct operation of the LVD function, perform the following Procedure. Depending on Breaker size and GMT fuse availability apply 3.5 A to plant (Only use one rectifier for the LVD TEST).

WARNING: If an on-line Plant is placed in the TEST mode, either Load service or battery back-up capacity will be interrupted if the LVD function is actuated.

6.2 Verify LVD Operation

PROCEDURE

1. Put the Plant function in TEST mode: Move dip switch S2 position 6 to the right. The Plant operation mode must also be in REMOTE, dip switch S3 position 2 to the right (See SD110-4202 sheet B3 FS4).

NOTE: In TEST mode, the Minor Alarm LED will be lit, and the Green [CNTLR OK] LED will flash 2 long and 2 short flashes, indicating that the Plant is in the TEST mode.

2. Flip the toggle switch on all rectifiers except one, to the LEFT, into the OFF position; then stick the leads of a DVM into the "BAT VOLTS" & "COMMON" test jacks.

3. Verify that the DVM reads ≅ –54 Vdc, and that the red LVD LED is not lit.

4. Use a pot adjustment tool to turn the Plant's remote control Float voltage adjust pot (R85) counter clockwise, as you observe the red LVD DISCONNECT LED on the controller, and watch for it to become lit. Adjust to –49V and then slowly turn the pot gradually ¼ turn at a time, this is to compensate for the slow response of the voltage out.

5. When the red LVD LED lights, stop turning R85 counter clockwise, observe the reading on the DVM and verify that the DVM reading is approximately –48 Vdc, ± 250 mVdc. The LVD contactor should drop out also.

6. Use a pot adjustment tool to turn the Plant's remote control Float voltage adjust pot (R85) clockwise as you observe the red LVD LED and watch for it to go out (the TEST mode reconnect point is –52 Vdc).

7. When the red LVD LED goes out, stop turning R85 clockwise, observe the reading on the DVM, and verify that the DVM reading is approximately –52 Vdc, ± 250 mVdc. The LVD contactor should pick back up.

8. Set dip switch S2 position 6 to the LEFT, taking the plant out of the TEST mode. Leave SW3 position 2 to the RIGHT (remote control mode)

9. Adjust the Plant's remote control Float voltage adjust pot (R85) to the correct setting.
   This completes the LVD test.

6.3 Select an LVD Trip Point

Dip switch S1 positions 1, 2, 3 & 4 set the LVD trip point in ½ volt steps from –38.5 to –46.0 Vdc. To change the LVD trip point voltage set the switches according to the following table or the label on the inside of the front door of the Plant.

PROCEDURE

1. Select the desired LVD trip voltage and set the dip switches accordingly.

Table: Dip Switch S1, Positions 1, 2, 3, & 4 and LVD Trip Point Voltages

LVD Voltage	**38.5**	**39**	**39.5**	**40**	**40.5**	**41**	**41.5**	**42**	**42.5**	**43**	**43.5**	**44**	**44.5**	**45**	**45.5**	**46**
S1, Pos. 1	LT	RT	LT	RT	LT	RT	LT	**RT**	LT	RT	LT	RT	LT	RT	LT	RT
S1, Pos. 2	LT	LT	RT	RT	LT	LT	RT	**RT**	LT	LT	RT	RT	LT	LT	RT	RT
S1, Pos. 3	LT	LT	LT	LT	RT	RT	RT	**RT**	LT	LT	LT	LT	RT	RT	RT	RT
S1, Pos. 4	LT	LT	LT	LT	LT	LT	LT	**LT**	RT	RT	RT	RT	RT	RT	RT	RT

Legend: LT = switch toggle in the LEFT position (OFF); RT = switch toggle in the RIGHT position (ON);
When viewed with control PWB installed in system

The factory setting is at 42 volts for the LVD trip point.

7.0 AUTOMATIC TEMPERATURE COMPENSATION (ATC) SET-UP & OPERATION VERIFICATION

7.1 ATC Operation Verification Overview

Battery temperature compensation can be easily verified. Simply heat one of the battery temp. sensors while monitoring the Plant's Float voltage, and see that the Float voltage drops accordingly.

7.2 Verify ATC Operation

NOTE: The Plant must be powered and operating, but without any load on it.

PROCEDURE

1. Plug DVM leads into the "BAT VOLTS" & "COMMON" test jacks on the front of the Plant.
2. Move dip switch S3, position 1 to the RIGHT (ATC MODE ON), and wait for the reading on the DVM to stop changing.
3. Record the reading on the DVM (the Plant's compensated Float voltage with ATC on).
4. Pick a Battery Temp. Sensor, and unbolt it from the battery connection that it is mounted to.
5. Heat the sensor by holding it tightly in your hand, or by using a convenient heat source.
6. Check the reading on the DVM and verify that the Plant Voltage has decreased.

7.3 ATC Offset Span Selection Criteria

In order to select the best ATC offset voltage span, consider the following:

- The temperature extremes of the location where the Plant is installed
- Temperature effects on battery reserve capacity and battery life expectancy
- The input voltage variance range that the load equipment can tolerate
- The costs of responding to nuisance alarms (caused by too wide of a Battery Temperature Compensation span)

7.4 Select ATC Offset Span

The span of the ATC offset voltage is selected by changing the settings of dip switch S2, positions 1 & 2. The following table lists the four offset voltage span ranges, the temperature ranges that each covers, and the dip switch settings for each offset span range (also, see SD110-4202 sheet A2 note 78) (Also SD110-4202 sheet B3 – FS4).

PROCEDURE

1. Select the ATC offset voltage span that you wish to have the Plant's ATC function operate in.

Table: Dip Switch S2, Positions 1 & 2, and ATC Offset Voltage Span Ranges

BTC	Temperature Range Spanned		Dip Switch S2	
Span	**Min Temp**	**Max Temp**	**Pos 1**	**Pos 2**
±1 Vdc	58°F (14.4°C)	98°F (36.6°C)	LT	LT
±2 Vdc	38°F (3.3°C)	118°F (47.7°C)	**RT**	**LT**
±3 Vdc	18°F (–7.7°C)	138°F (58.8°C)	LT	RT
±4 Vdc	-4°F (–20°C)	158°F (70°C)	RT	RT

Legend: LT = switch toggle LEFT (OFF); RT = switch toggle RIGHT (ON);
When viewed with control PWB installed in system
The Factory setting is ±2 Vdc.

8.0 LVA, HVA & HVSD OPERATION VERIFICATION

8.1 Verifying LVA, HVA & HVSD Trip Points

In order to verify the correct operation of the LVA, HVA & HVSD Trip Points a temporary HVSD trip point must be selected, that is within the Float voltage adjustment range of the Plant's remotely controlled Float voltage potentiometer R85 located on the Control PWB A3. The LVA trip point is fixed at –51.5 Vdc, ±0.25 Vdc. The HVA trip point, is set by the Control PWB, at 1 Vdc less than the HVSD trip point, ± the Battery Temperature Compensation offset voltage. The LVA trip point is not user alterable. The HVA trip point is user alterable, to the extent that the user can select the HVSD trip point. The 1 Vdc margin of the HVA trip point, below the HVSD trip point, is not user alterable. Both LVA and HVA are indicated by different coded flashes of the Green [CNTLR OK] LED. A Major Alarm also accompanies both an LVA or an HVA.

8.1.1 HVSD Trip Point Selection

The Plant HVSD trip point is selected using dip switch S1, positions 5, 6, and 7. The following table lists the Plant's HVSD trip points, and the dip switch settings for each.

Table: Dip Switch S1, Positions 5, 6, & 7 and HVSD Trip Point Voltages

HVSD Voltage	57	57	57	57.5	58	58.5	59	59.5
S1, Position 5	LT	RT	LT	**RT**	LT	RT	LT	RT
S1, Position 6	LT	LT	RT	**RT**	LT	LT	RT	RT
S1, Position 7	LT	LT	LT	**LT**	RT	RT	RT	RT

Legend: LT = switch in the LEFT position (OFF); RT = switch in the RIGHT position (ON);
When viewed with control PWB installed in system
FACTORY SETTING IS 57.5 Vdc

8.2 Verify LVA, HVA & HVSD Trip Points

PROCEDURE

1. Operate the Plant normally, with at least two rectifiers installed and working, and enough load so that there are no rectifier or Plant alarms.

2. Place the Plant into the TEST mode: move dip switch S2, position 6 to the RIGHT (the Minor Alarm LED will light, & the Green [CNTLR OK] LED will flash the TEST mode code).

3. Turn Battery Temperature Compensation OFF (dip switch S3 position 1 to the LEFT) and Plant voltage remote control ON (dip switch S3 position 2 to the RIGHT).

4. Select the –57.0 Vdc HVSD trip point: Move dip switch S1 positions 5,6, and 7 to the LEFT.

5. Insert the probes of a DVM into the "BAT VOLTS" & "COMMON" test jacks on the Plant.

6. Watch the Major Alarm LED, as you slowly turn the remote control FLOAT voltage adjust pot (R85 on the Control PWB) CCW, and stop turning the pot as soon as the Major Alarm LED lights.

7. Verify the following: the DVM reads –51.5 Vdc, ±0.25 Vdc, and the Green [CNTLR OK] LED flashes the code for an LVA (1 short flash).

8. Watch the Major Alarm LED, as you slowly turn the remote control FLOAT voltage adjust pot (R85 on the control PWB) CW and stop turning the pot when the Alarm LED goes out.

9. Verify that the DVM reads from **–51.5 to –52.5 Vdc**, and the Green [CNTLR OK] LED is steadily lit.

10. Connect the batteries to the Plant (install the series battery fuses).

11. Watch the Major Alarm LED, as you continue turning the remote control FLOAT voltage adjust pot (R85 on the Control PWB) CW, and stop turning the pot as soon as the Major Alarm LED lights.

12. Verify that the DVM reads from **–55.5 to –56.5 Vdc**, and the Green [CNTLR OK] LED flashes the code for an HVA (2 short flashes).

13. Place the DVM into the Peak Detect mode of operation, and set it to catch Maximum value.

14. Watch a rectifier NORM LED, as you continue to slowly turn the remote control FLOAT voltage adjust pot (R85 on the Control PWB) CW, and stop turning the pot as soon as the rectifier NORM LED goes out and the rectifier RFA LED lights.

15. Verify that the following criteria are all true: The DVM reads from **–55.5 to –56.5 Vdc**, the Green [CNTLR OK] LED flashes the code for the HVSD trip point set too low (4 short flashes), and that all rectifier NORM LEDs are flashing an external HVSD code (2 long flashes).

NOTE: With all working rectifiers shut down, the Plant is on battery back-up.

16. Turn the remote control FLOAT voltage adjust pot (R85 on the Control PWB) CCW 3 full turns.

17. If you need to verify the Plant's HVSD/ReStart function, do not change any Plant settings and go to 8.3: Procedure Verify HVSD/ ReStart Function. If not, perform the next step.

18. Remove the Plant from the TEST mode: move dip switch S2, position 6 to the left,
    put the Plant's HVSD trip point back where it should be set at (57.5 v).
    ReStart all rectifiers by cycling the AC power to the Plant OFF, and then back ON again
    (the Minor Alarm LED will go out, & the Green [CNTLR OK] LED will become steadily lit)
    and readjust the remote control FLOAT voltage adjust pot R85 to the desired Plant voltage value.

8.3 Verify HVSD/ ReStart Function

<u>WARNING</u>: Do not draw more than twice the AH rating out of the batteries, in discharging them!

PROCEDURE

1. Connect a load to the Plant's batteries, and monitor the battery voltage on the DVM (leave the probes of the DVM in the "BAT VOLTS" & "COMMON" test jacks on the Plant, and put the DVM in the Peak Detect mode of operation, and set it to catch a Minimum value).

2. When the rectifiers ReStart and the Plant resumes normal operation (with no alarm indications), verify that the DVM Peak Detect function captured –52.0 Vdc, ±0.25 Vdc.

3. This completes the testing of the Plant's HVSD/ ReStart Function.
   Disconnect the batteries from the Plant (remove the series fuses).
   Remove the Plant from the TEST mode: move dip switch S2, position 6 to the LEFT,
   and put the Plant's HVSD trip point back where it should be set at, then readjust the remote control FLOAT voltage adjust pot R85 to the desired Plant voltage value.

9.0 FINAL RECTIFIER SET-UP & VERIFICATION

Final adjustment and verification, before the Plant is brought on-line, involves the following:
Setting the Float and Equalize voltages of each Rectifier, verify proper load sharing at these settings; and adjusting the remote control voltage set point.

NOTE: Batteries should be disconnected from the Plant for this last procedure.

PROCEDURE

1. Reconnect the variable load and the DVM to the Plant (as in the last procedure).

2. Flip all rectifier toggle switches to the RIGHT, into the OFF state; and then apply AC.

3. Put dip switch S3, positions 1 & 2 to the LEFT , into the OFF state. (REM off & ATC off)

4. Perform the next five steps (5 – 9) on each rectifier, one rectifier at a time.

5. Flip a rectifier's toggle switch to the LEFT, into the ON state.

6. Adjust the rectifier's Float [FLT] voltage Pot until the DVM reads the desired value.

NOTE: Allow 15 seconds, after each adjustment, for the unit to adjust it's output voltage.

7. Manually place the Rectifiers into their Equalize mode: Move dip switch S3 position 3 to the RIGHT into the ON state (See SD110-4202 sheet B3 – FS4, for location).

8. Adjust the rectifier's Equalize [EQL] voltage Pot until the DVM reads the desired value.

NOTE: Allow 15 seconds, after each adjustment, for the unit to adjust it's output voltage.

9. Flip the rectifier's toggle switches to the RIGHT, into the OFF state, and adjust the remaining rectifiers.

10. Move dip switch S3 position 2 to the RIGHT (ON) and flip all rectifier toggle switches to the LEFT (ON), (See J110-4202 sheet B4 Figure 6 and SD110-4202 sheet B3 – FS4 for dip switch locations).

11. Adjust the "Remote Control Float Voltage Adjust Pot" [called "ADJ FLOAT VOTLAGE" on the door label] (R85 located on the front edge of the Control PWB A3) until the DVM reads the desired "Remotely Controlled" Float Voltage value.

12. Set the variable load so that the rectifiers are each delivering approximately 3.5 Adc. Depending on load capability of Plant ordered.

13. Using the DVM, on the millivolt range, check the current sense jacks ("I+" and "I–") of each rectifier. Verify that each rectifier is load sharing within 1 Adc (±5 mVdc) of each other.

14. **Procedure complete!** Flip all rectifier toggle switches OFF & disconnect the variable load.

End of Installation: Install the GMT fuses, and the series Battery fuses and put the Plant into service.

10.0 ADDING LOADS TO AN ON-LINE PLANT

Adding loads to an on-line Plant should be done at a time when the Plant can be temporarily removed from service. Down time can be limited to a few minutes if properly planned. If removing the Plant from service is not an option use the following guidelines to minimize difficulty and potential problems.

CAUTION: Using insulated tools should minimize the likelihood of accidentally causing short circuits.

PROCEDURE

1. Slide the distribution tray out and pick the available fuse location(s) you wish to add a load to.

WARNING: Do not install GMT fuses until all load wires are connected. Installed fuses put the terminal block screws at battery potential. Do not let loose wire strands short to adjacent positions.

2. Run the wires from the load to the Plant (leaving the load unterminated until the Plant is connected).
3. Route the wires up to J4, J5, J6 & J7 with enough slack to create a reasonable service loop.
4. Turn the terminal block clamping screws counter clockwise, to ensure that the wire entrance is open.
5. Remove ¼” of insulation and ensure that the wire strands are tightly bundled (to prevent shorts).
6. Pull test each wire (with ≤ 8 inch pounds) after tightening it's terminal block clamp screw.
7. Repeat steps 5 & 6 for each wire you install.
8. Create a service loop in the wires, bundle them together, and terminate them to the load.
9. Identify the load on the Distribution Log sheet label, which is located on the inside of the front door.
10. Insert a GMT fuse into the correct fuse holder slot.
11. Turn ON the new load and ensure that it is operating correctly.
12. Verify that the Plant is operating normally, and close it up.

CHAPTER THREE: PLANT OPERATION

1.0 LOW VOLTAGE DISCONNECT (LVD) OPERATION

1.1 LVD Normal Operation Overview

During a power outage, when service to the loads is being supplied by the batteries, The Plant Control PWB causes the LVD relay to disconnect the load or the batteries from the Plant, when the battery voltage drops below a user select-able trip point. The battery voltage must remain below the trip point for more than 2 seconds, before the relay will disconnect. This delay prevents transients from causing unnecessary disconnects. The Plant Control PWB automatically reconnects the LVD relay when the Plant voltage rises above a fixed reconnect trip point of –49.5 Vdc (usually right after power returns). The LVD function can protect batteries from deep discharge damage, or protect load equipment from unacceptable low input voltage. The LVD operation mode and the disconnect voltage trip point are selected by dip switches, located on the front of the Control PWB. Dip switch settings are monitored by the Control PWB, and changes are implemented immediately. The Factory setting is –42.0 volts.

1.2 LVD Hardware and By-pass Operation

The LVD relay is located on the Distribution PWB. A unique and helpful feature is the "automatic by-pass" function which allows the Controller to be removed without the LVD Contactor dropping out. The LVD relay control is by-passed and the relay contacts stay closed. In this mode the Control PWB can be removed for service without taking the Plant off-line. When the Control PWB is plugged back in normal LVD operation is restored. There is no warning indication or alarm to alert a user that the Control PWB has been removed should the front panel be closed. The user must remember to reinstall the Controller to resume normal operation.

1.3 LVD Function & Plant Alarm Status

The Distribution PWB has a form C alarm output relay on it which reports when the LVD relay contacts are open. The Control PWB has a red LVD LED on it which lights when the LVD relay contacts are open. Whenever the LVD relay contacts are open the Plant is in a Major Alarm state; the red Major Alarm LED is lit and the Major Alarm output relay is reporting the Major Alarm state, it's N.O. contacts are closed and it's N.C. contacts are open.

1.4 LVD Trip Point Setting

Dip switch S1, positions 1, 2, 3 & 4 set the LVD trip point, in ½ volt steps, from –38.5 to –46.0 volts. To change the LVD trip point voltage, set the switches according to the following table or the label on the inside of the front door of the Plant.

Table: Dip Switch S1, Positions 1, 2, 3, & 4 and LVD Trip Point Voltages

LVD Voltage	**38.5**	**39**	**39.5**	**40**	**40.5**	**41**	**41.5**	**42**	**42.5**	**43**	**43.5**	**44**	**44.5**	**45**	**45.5**	**46**
S1, Pos. 1	LT	RT	LT	RT	LT	RT	LT	**RT**	LT	RT	LT	RT	LT	RT	LT	RT
S1, Pos. 2	LT	LT	RT	RT	LT	LT	RT	**RT**	LT	LT	RT	RT	LT	LT	RT	RT
S1, Pos. 3	LT	LT	LT	LT	RT	RT	RT	**RT**	LT	LT	LT	LT	RT	RT	RT	RT
S1, Pos. 4	LT	LT	LT	LT	LT	LT	LT	**LT**	RT	RT	RT	RT	RT	RT	RT	RT

<u>Legend</u>: LT = switch in the LEFT position (OFF); RT = switch in the RIGHT position (ON);
When viewed with control PWB installed in system

FACTORY SETTING IS 42 Vdc

1.5 LVD Operation mode Selection

Dip switch S2 position 3 (fixed on) and 4 (fixed off) select the LVD operation mode. If the LVD function is being used, the Automatic mode will usually be active. The manual modes (fixed ON & fixed OFF) are available for emergency and service use (See SD110-4202 sheet B3 – FS4).

1.5.1 Automatic mode

In this mode, the LVD relay contacts are closed, while the Plant or battery voltage is above the selected LVD trip point. If the battery or Plant voltage drops below the LVD trip point for more than two seconds, the LVD relay contacts open, disconnecting the Load or Batteries from the Plant. The LVD relay contacts remain open until the battery or Plant voltage rises above –49.5 Vdc for more than two seconds. Then the LVD relay contacts close again, reconnecting the Load or Batteries to the Plant. S2 positions 3 and 4 must both be to the LEFT or RIGHT to select the Automatic mode (See SD110-4202 sheet B3 – FS4).

1.5.2 The Fixed ON mode

The Fixed ON mode makes the LVD relay contacts stay closed, regardless of Plant or battery voltage. This mode could be used to maintain service during an extended power outage. The Fixed ON mode is selected by moving S2 position 3 to the RIGHT and leaving S2, position 4 to the LEFT.

1.5.3 The Fixed OFF mode

The Fixed OFF mode makes the LVD relay contacts remain open, regardless of Plant or battery voltage. This mode could be used to take the batteries off-line for servicing. The Fixed OFF mode is selected by leaving S2 position 3 to the LEFT and moving S2 position 4 to the RIGHT. The red LVD Disconnect LED will be lit when the Plant is in the Fixed OFF mode, indicating that the LVD relay is open.

1.5.4 The TEST mode

In the TEST mode, the LVD relay disconnects at –48 Vdc, and reconnects at –51 Vdc, so that it's operation can be easily verified. The TEST mode is for operation verification and troubleshooting only. Testing the LVD on a live Plant will disconnect the load or battery resulting in a loss of load service or battery reserves. The TEST mode is selected by moving S2 position 6 to the RIGHT.
See Chapter TWO Installation Section 6.0 for Instructions on using the TEST mode to verify LVD operation or to troubleshoot an LVD problem.

2.0 AUTOMATIC TEMPERATURE COMPENSATION (ATC) OPERATION

2.1 ATC Normal Operation Overview

ATC adjusts Plant voltage according to changes in battery temperature. The Plant monitors two battery temp. sensors and one ambient temp. sensor. The higher reading of the two battery temp. sensors is used to calculate the ATC offset voltage.

2.2 Turning ATC ON or OFF

Dip switch S3 position 1 on the front of the Control PWB turns ATC on or off. When S3 position 1 is to the right ATC is ON when S3 position 1 is to the LEFT, ATC is OFF.
ATC must be turned OFF to perform the following tasks:

- To verify or set the Plant Float voltage (OFF removes the ATC offset from the Plant voltage)
- Calculating battery temperature using the difference between comp'd & un-comp'd Plant voltage

2.3 Why a Variable ATC Offset Span

The ATC generated offset voltage can put the Plant into an alarm condition. The added or subtracted offset voltage can cause the Plant Float voltage to trip a High Voltage Alarm [HVA]or a Low Voltage Alarm [LVA]. Load equipment may also require a tighter regulation of the Plant Float voltage than can be maintained at the widest ATC span. To prevent meaningless HVAs & LVAs from occurring the span of the ATC offset can be reduced or increased from the Factory setting of ±2 Vdc, to ±4, ±3, or ±1 Vdc.

<u>2.3.1 ATC Offset Span & HVSD Conflicts</u>

If remote control of the Plant's Float voltage is ON and the Plant's Float voltage is being driven towards the Plant's HVSD trip point, the Control PWB will stop the ATC's offsetting of the Float voltage at 1 Vdc below the Plant's HVSD trip point and thus prevent the ATC offset from causing an HVSD. When the Plant's Float voltage is so clamped the Green [CNTLR OK] LED will flash a code. Also if the Plant's remotely set Float voltage is within 2.5 Vdc of the Plant's HVSD trip point the Green [CNTLR OK] LED will flash a code indicating that there is an inadequate safety margin between the two set points. Both of the above describe conditions which cause the Control PWB to generate a Minor Alarm.

2.4 ATC Offset Span Selection Criteria

In order to select the best ATC offset voltage span, consider the following:

- The temperature extremes of the location where the Plant is installed
- Temperature effects on battery reserve capacity and battery life expectancy
- The input voltage variance range that the load equipment can tolerate
- The costs of responding to nuisance alarms (caused by too wide of a ATC span)

2.5 ATC Offset Span Selection

The span of the ATC offset voltage is selected by changing the settings of dip switch S2, positions 1 & 2. The following table lists the four offset voltage span ranges, the temperature ranges that each covers, and the dip switch settings for each offset span range.

Table: Dip Switch S2, Positions 1 & 2, and BTC Offset Voltage Span Ranges

BTC	Temperature Range Spanned		Dip Switch S2	
Span	**Min Temp**	**Max Temp**	**Pos 1**	**Pos 2**
±1 Vdc	58°F (14.4°C)	98°F (36.6°C)	LT	LT
±2 Vdc	38°F (3.3°C)	118°F (47.7°C)	**RT**	**LT**
±3 Vdc	18°F (–7.7°C)	138°F (58.8°C)	LT	RT
±4 Vdc	-4°F (–20°C)	158°F (70°C)	RT	RT

Legend: LT = switch toggle LEFT (OFF); RT = switch toggle RIGHT (ON);
When viewed with control PWB installed in system
FACTORY SETTING IS ± 2 Vdc

3.0 BATTERY TEMPERATURE ALARM (BTA) OPERATION

The BTA function is only active when ATC is turned ON. When ATC is ON, the higher reading of the two battery temp. sensors, and the reading from the ambient temp. sensor are used to trigger a BTA. Whenever battery temp. or the difference between battery temp. and ambient temp. exceed the trip point of the currently active Battery Temp. Alarm mode, the following three actions occur: A Battery Temp. Alarm and a Minor Alarm are generated and the YELLOW [TEMP ERROR] LED flashes a temperature alarm code (See Chapter 3 Section 9.0 or SD Drawing sheet A2 for a Table of [TEMP ERROR] LED flash codes). Plants normally leave the factory with the BTA function in the Absolute mode (SW1 position 8 to the RIGHT).

3.1 BTA Operation Requirements

All three temp. sensors must be correctly connected to their terminal blocks on the Distribution PWB and operating normally for the High Temp. Alarm to function properly. The Control PWB detects open or out of range temperature sensors. Should a temp. sensor become open circuited or it's reading be out of range a Minor Alarm will be generated and the YELLOW [TEMP ERROR] LED will flash a code indicating a temperature sensor problem (See Chapter 3 Section 9.0 or SD Drawing, sheet A2 for a Table of [TEMP ERROR] LED flash codes).

3.2 BTA Mode Selection

The BTA mode is changed by dip switch S1, position 8. With dip switch S1, position 8 to the RIGHT, the BTA is in the Absolute mode (a BTA will occur only if a Battery Temp. Sensor's reading is greater than 145°F). With dip switch S1, position 8 to the LEFT, the BTA is in the Delta mode (a BTA will occur only if a Battery Temp. Sensor's reading is greater than 36°F above that of the Ambient Temp. Sensor).

4.0 EQUALIZE CHARGE MODE OPERATION

The Plant has two Equalize Charge modes; Automatic and Manual. Both modes raise the Plant output voltage above the (Plant or individual rectifier) normal "Float" voltage. Both modes also run for a duration of no longer than 10 hours at a time, due to a timer function on the Control PWB.

4.1 Manual Equalize Charge Mode Operation

Moving dip switch S3 position 3 to the RIGHT manually places the Plant's rectifiers into their Equalize voltage mode. Manual Equalize puts the rectifiers into Equalize mode as opposed to Automatic Equalize which merely increases the set point of the Plant's remote voltage control signal raising rectifier output voltage 2 volts. When Manual Equalize is enabled a 10 hour count-down timer starts. After 10 hours, the Control PWB puts the rectifiers back into Float mode. Manual Equalize mode is also terminated if the reading of a battery temperature sensor rises more than 30°F during the charge cycle. Moving dip switch S3 position 3 to the LEFT also terminates the Manual Equalize Charge mode.

4.2 Automatic Equalize Charge Mode Operation

Moving dip switch S2 position 5 to the RIGHT places the Plant in Automatic Equalize mode. The Control PWB only initiates an Equalize charge cycle if the batteries become deeply discharged during a power outage. The following sequence of events occurs when the Control PWB is in the process of determining if an Equalize charge cycle is necessary or not (See SD110-4202 sheet B4 – FS7).

State 0:
The Plant confirms an ac power outage by detecting an RFA from each installed rectifier. During the resulting battery discharge cycle the Control PWB monitors the discharge AHs of the batteries.

State 1:
Ten seconds after AC power returns the Control PWB measures the Plant Float voltage and compares it against a trip point calculated as: (Original Plant Float voltage + 46.0 v)/2. Usually the "Ten seconds after AC power returns" measurement will be higher than the calculated trip point unless very deep discharge has occurred.

State 2:
If the "Ten seconds after" measurement is lower than the calculated reference point the Control PWB waits until the battery recharge current drops below 75% of the initial recharge value and then begins the Equalize Charge cycle. The Control PWB then puts the Equalize Charge mode into state 4. If the "Ten seconds after" measurement is higher than the calculated reference point the Control PWB puts the Equalize Charge mode into state 3.

State 3:
Normal Float mode. The Plant remains in this mode until another ac power outage starts the sequence all over again.

State 4:
A Ten hour Equalize charge cycle is started and the Plant's output voltage is raised 2 Vdc above the normal remotely set Plant Float voltage. The cycle ends by battery recharge current dropping below 1.5 Adc, the batteries over heating, another incident of ac power loss, or after ten hours has elapsed.

5.0 PLANT VOLTAGE REMOTE CONTROL OPERATION

Moving dip switch S3 position 2 to the RIGHT into the ON state puts the output voltage of all rectifiers installed in the Plant under the control of the Remote Control pot (R85) located on the Control PWB. Moving dip switch S3 position 2 to the LEFT into the OFF state puts the output voltage of all rectifiers installed in the Plant under the control of their own FLT control pots.

6.0 BATTERY SLEEP MODE OPERATION

Moving dip switch S3 position 4 UP into the ON state puts the Plant into "Sleep Mode". When active the Control PWB reduces the remotely set Plant Float voltage to –52.0 volts (± ATC) for 2 days per week. Should a battery discharge occur the periodic Sleep mode function is disabled until the batteries have fully recovered their charge. An additional safeguard puts the batteries into Sleep Mode whenever the battery temperature rises above 95°F.

7.0 MISCELLANEOUS FUNCTIONS OPERATION

7.1 LVA & HVA Trip Points

The Low Voltage Alarm (LVA) trip point is fixed at –51.5 Vdc, ±0.25 Vdc. The high Voltage Alarm (HVA) trip point, is set by the Control PWB, at 1 Vdc less than the HVSD trip point, plus the ATC offset voltage. These trip points are not user alterable. Both alarm conditions are indicated by coded flashes of the Green [CNTLR OK] LED. A Major Alarm also accompanies an LVA or an HVA.

7.2 HVSD Trip Point

If the Plant voltage exceeds the HVSD trip point, an HVSD command is sent to the rectifiers.

7.2.1 HVSD Trip Point Selection

The Plant HVSD trip point is selected using dip switch S1 positions 5, 6, and 7. It can be set in ½ volt steps from a low of –57 Vdc to a high of –59.5 Vdc. The following table lists the Plant's HVSD trip points and the dip switch settings for each.

Table: Dip Switch S1, Positions 5, 6, & 7 and HVSD Trip Point Voltages

HVSD Voltage	**57**	**57**	**57**	**57.5**	**58**	**58.5**	**59**	**59.5**
S1, Position 5	LT	RT	LT	**RT**	LT	RT	LT	RT
S1, Position 6	LT	LT	RT	**RT**	LT	LT	RT	RT
S1, Position 7	LT	LT	LT	**LT**	RT	RT	RT	RT

Legend: LT = switch to the LEFT position (OFF); RT = switch to the RIGHT position (ON);

When viewed with control PWB installed in system

The Factory set HVSD trip point is –57.5 Vdc

7.2.2 HVSD & Float Voltage Proximity Conflicts

If a Plant HVSD trip point is selected that is within 2.5 Vdc of the remotely set Plant Float voltage the Green [CNTLR OK] LED will flash a code indicating an inadequate safety margin between the two points. The currently selected ATC span is used to determine if the safety margin is adequate. (See SD110-4202 sheet A2 note 72)

7.2.3 Effects of an HVSD Occurrence

If an HVSD event occurs only rectifiers delivering more than 0.75 Adc will be shut down. The Control PWB will also generate a Restart (RS) when the Plant voltage drops below –52.0 volts. The Restart is given for one reason: To put all functional rectifiers back into service. Good, working rectifiers will be shut down by a Plant generated HVSD if they are sourcing more than 0.75 Adc. This can occur if the source of the high voltage was external to the Plant. A rectifier in HVSD will have it's red RFA LED lit and will have a code flashing on it's green "NORM" LED indicating the type (internal or external) of HVSD. The Plant also generates a Major Alarm when an HVSD occurs.

7.2.4 Restarting Shut-Down Rectifiers

Rectifiers of revision 4 and lower can only be revived from an HVSD by cycling the AC power to them OFF and then ON again or by disconnecting each rectifier from the Plant's backplane momentarily and then plugging it back in. A rectifier, of revision 5 and higher can also be revived from an HVSD by flipping it's toggle switch to the RIGHT into the OFF position and leaving it OFF for at least ten seconds and then flipping it back to the LEFT into the ON position.

7.3 Battery FAIL Alarm Operation

The control PWB uses the actual discharge and recharge AHs to determine the state of the batteries. The recharge AHs are compared to the discharge AHs + 40% (of the discharge AHs). If the recharge AHs are more than 40% above the discharge AHs, a BATTERY FAIL Alarm is generated, and displayed as a series of coded flashes on the Green [CNTLR OK] LED. This only occurs if AUTO EQUALIZE is enabled.

7.4 Alarm Operation Overview

Alarms only serve to communicate trouble information. No alarm affects Plant operation. Following are lists of what criteria cause the various alarms to be generated.

7.4.1 Major Alarm Criteria

- > one rectifier fails [RFA] (If only one rectifier is installed, a single RFA causes a Major Alarm)
- Plant voltage drops below the LVA trip point, –51.5 Vdc
- Plant voltage rises above the HVA trip point, (1 Vdc < the Plant HVSD trip point)
- A GMT (Distribution) fuse opens [FA]
- A low voltage disconnect [LVD] occurs
- The Plant Control PWB fails

7.4.2 Minor Alarm Criteria

- A single rectifier fails [RFA]
- A high battery temperature [HIGH TEMP] Alarm occurs
- The Plant's LVD function is in the TEST mode
- Plant voltage is clamped to prevent an HVSD
- HVSD is set too low, & is within the ATC offset's voltage span
- A temperature sensor is open or out of range

7.4.3 Other Alarm Criteria

- LVD — Plant Voltage is < LVD trip point, or LVD is in FIXED OFF mode
- High Temp. — Battery Temp. has exceeded 145°F, or is > 36°F over ambient
- Fuse [FA] — A GMT (distribution) fuse has opened
- RFA — A rectifier is not working properly, and has generated an RFA

7.5 Alarm Remote Reporting Hardware

All alarm relay pin-outs for Common (C), Normally Closed (NC), and Normally Open (NO) reflect the normal non-alarmed state. As a fail safe precaution the normally energized Major and Battery Disconnect Alarm relays will still generate an alarm in the event of a total power loss.

8.0 CIRCUIT BOARD (PWB) LOCATIONS WITHIN THE PLANT

8.1 The Control PWB, A3

The Control PWB A3 slides into a pair of card guides located on the top left side of the Plant's Distribution Bay. It seats into a 50 pin edge connector mounted on the chassis back panel.

The user interface dip switches S1, S2 & S3, the remote Float voltage adjust pot (R85), and the Green [CNTLR OK] LED are located on the front edge of this PWB.

8.2 The Distribution PWB, A2

The Distribution PWB A2 is mounted to the distribution tray which slides out for front access.

8.3 The Rectifier Interface PWB, A1

The Rectifier Interface PWB A1 is mounted across the back of the cabinet. It connects the rectifiers, the Distribution PWB, and the Control PWB. The AC input power connection comes factory terminated to the Interface board.

9.0 PLANT PERFORMANCE MONITORING, STATUS INDICATION, AND DEFAULT SETTINGS

9.1 Plant Voltage and Current Monitoring

All plants have front accessible test jacks, which are mounted on the Control PWB. Plant voltage is measured across the battery input buss on the Distribution PWB; accuracy = ±0.5%.
The Plant and battery shunts read 10 mV per Amp. Plant and battery current measurements are direct readings across PWB mounted shunts which are located on the Distribution PWB; accuracy = ±1%. Each rectifier has a pair of test jacks that monitor it's output current [10A @ 50 mV]; accuracy = ±1%.

9.2 Control PWB Green [CNTLR OK] LED Status & Trouble Codes

The Green [CNTLR OK] LED displays a number of alarm and status codes using short and long flash combinations. The coded flashes are arranged in priority of display. The highest priority code will always be displayed continuously until the event that triggered that code is no longer true. Once the highest priority code is cleared, the next highest priority code will be displayed, and so on. Using a single GREEN LED for Plant issues and a single YELLOW LED for Temperature issues the codes have been arranged into related groups.

Table: Green [CNTLR OK] LED Status & Trouble Codes

Grouping	Priority	Flashes		Status or Trouble CODE Description
		Long	Short	
Plant Issue	1	2		Plant is in a Manual or Automatic Equalize charge cycle
Plant Issue	2		3	The Plant's sleep mode is active
Plant Issue	3		1	Low Voltage Alarm: (LVA) Plant voltage < –51.5 volts
Plant Issue	4		2	High Voltage Alarm: (HVA) Plant voltage > HVSD trip pt, –1 Vdc
Plant Issue	5		4	HVSD set too low: Plant voltage within 2.5 volts of HVSD trip pt.
Plant Issue	6		5	Plant Voltage Clamped to avoid Temp. Comp. caused HVSD
Plant Issue	7	2	1	Battery fail: Recharge AH > 140% of Discharge AH
Plant Issue	8	2	2	Test mode: Test mode selected with dip switch S2–8 ON

Table: Yellow [TEMP OK] LED Status & Trouble Codes

Grouping	Priority	Flashes		Status or Trouble CODE Description
		Long	Short	
Temp. condition	1	1		Temperature sensor missing or out of range
Temp. condition	2	1	1	Temperature compensation requires a range > selected span
Temp. condition	3	1	2	Temperature Delta > 36°F
Temp. condition	4	1	3	Battery temperature > 145°F
Temp. condition	5	1	4	Battery over-heated during Equalize (>20°F over ambient)
Over Current			2	Load current exceeded N + 1 redundancy

9.3 Dip Switch Default Settings

The following table shows the dip switches on the Control PWB, A3, as they are set when shipped from the factory. The default switch settings are also depicted on a label, located on the inside of the Plant's front door.

Table: Dip Switch S1, S2 & S3 Default Settings

ON	ON	OFF	OFF		ON	OFF	OFF	OFF	OFF	OFF	OFF	OFF		ON	ON	ON	OFF	ON	ON	OFF	ON
1	2	3	4		1	2	3	4	5	6	7	8		1	2	3	4	5	6	7	8
DIP SW S3					**DIP SWITCH (BANK) S2**									**DIP SWITCH (BANK) S1**							

Legend: LT = switch to the LEFT position (OFF); RT = switch to the RIGHT position (ON);
When viewed with control PWB installed in system

The majority of dip switch changes will not immediately affect Plant operation. Changing from local to remote Float voltage adjustment (S3-2) could cause a large immediate change in the Float voltage, depending on the setting of the remote voltage adjustment potentiometer.

WARNING: Moving dip switch S2 position 4 to the RIGHT to the ON state will immediately disconnect the LVD relay resulting in a load or battery disconnect.

NOTE: Always verify you are flipping the correct switch position before changing a dip switch setting.

9.4 Verifying Temperature Sensors and Alarms

To verify a High temperature Alarm trip point and the correct operation of the temperature sensors, one sensor will be removed from the battery bank and heated until an over temperature alarm is generated. Then one sensor will be unplugged to verify that an open sensor can be detected.

9.4.1 Temperature Sensor Operation Verification

PROCEDURE

1. Ensure that all three sensors are properly connected to the Plant (see Chapter 2, section 4.5.2, Temperature Sensors), and that the Plant is operating normally (no load is necessary for this test).

WARNING: Shorting a sensor's blue and red leads may damage it!

2. Measure (with a DVM on mV range) across the blue and black wires of each sensor, and record it's reading.

NOTE: The reading for each sensor should be within a reasonable range (10 mV/°F), considering the temperature of the site (the sensors have an accuracy of ± 2 °F, and a slow thermal response).

3. Put the Plant into the Delta temperature Alarm mode; move dip switch S1, position 8 to the LEFT.

WARNING: Do NOT heat the temperature sensor with a flame!

4. Remove a battery temperature sensor from the battery bank, start heating it, and watch for the Plant's Minor Alarm LED to light up.

5. When the Minor Alarm LED lights, stop heating the sensor, and measure across it's blue and black wires.

NOTE: The reading should be within 250 to 550 mV higher than that of the ambient temperature sensor, and the Yellow [TEMP STATUS] LED should flash a Delta High Temp. Alarm (1 Long & 2 short flashes).

6. Set the sensor down on a cool surface. When the Minor Alarm LED goes out and the Yellow [TEMP STATUS] LED stops flashing the Delta code, take another measurement across the sensor's blue and black wires.

NOTE: The reading should be less than 250 mV higher than that of the ambient temperature sensor.

7. Reconnect the sensor to the battery bank, and then disconnect it at the terminal block.

8. Verify that the Yellow [TEMP STATUS] LED flashes a temp. sensor missing code (1 long flash).

9. Reconnect the sensor, end of procedure.

CHAPTER FOUR: TROUBLESHOOTING

Most of the Plant problems that may occur, will be detected by the microcontroller on the Control PWB, A3, and reported by the boards' green [CNTLR OK] LED or the boards' yellow [TEMP STATUS] LED. It displays a number of alarm and status codes using short and long flash combinations. The coded flashes are arranged in priority of display. The highest priority code will always be displayed continuously until the event that triggered that code is no longer true. Once the highest priority code is cleared, the next highest priority code will display, and so on, until all codes are cleared.

Table: Green [CNTLR OK] LED Status & Trouble Codes

Grouping	Priority	Flashes		Status or Trouble CODE Description
		Long	Short	
Plant Issue	1	2		Plant is in a Manual or Automatic Equalize charge cycle
Plant Issue	2		3	The Plant's sleep mode is active
Plant Issue	3		1	Low Voltage Alarm: (LVA) Plant voltage < –51.5 volts
Plant Issue	4		2	High Voltage Alarm: (HVA) Plant voltage > HVSD trip pt, –1 Vdc
Plant Issue	5		4	HVSD set too low: Plant voltage within 2.5 volts of HVSD trip pt.
Plant Issue	6		5	Plant Voltage Clamped to avoid Temp. Comp. caused HVSD
Plant Issue	7	2	1	Battery fail: Recharge AH > 140% of Discharge AH
Plant Issue	8	2	2	Test mode: Test mode selected with dip switch S2–8 ON

Table: Yellow [TEMP OK] LED Status & Trouble Codes

Grouping	Priority	Flashes		Status or Trouble CODE Description
		Long	Short	
Temp. condition	1	1		Temperature sensor missing or out of range
Temp. condition	2	1	1	Temperature compensation requires a range > selected span
Temp. condition	3	1	2	Temperature Delta > 36°F
Temp. condition	4	1	3	Battery temperature > 145°F
Temp. condition	5	1	4	Battery over-heated during Equalize (>20°F over ambient)
Over Current			2	Load current exceeded N + 1 redundancy

Most of the rectifier problems that may occur, will be detected by the microcontroller in the rectifier, and reported through the unit's green [NORM] LED. The green [NORM] LED conveys the nature of the problem, using short and long flash combinations. The coded flashes are arranged in priority of display. The highest priority code is displayed continuously until the event that triggered that code is no longer true. Once the highest priority code is cleared, the next highest priority code will be displayed, and so on.

Table: Rectifier [NORM] LED Coded Flash Message Legend

Flashes		Coded Flash Messages & Their Problem or Status Indication Descriptions	
Long	**Short**	**Coded Flash Message**	**Problem or Status Indication Description**
	1	Low Output Current	Output Current below 0.375 Adc
	2	Internal HVSD	Occurs if V dc out > –61 Vdc, or 3 Vdc > set point
	3	AC Line Sag	When line should be 208–240 Vac, shows line is < 187 Vac
	4	Over Temperature	Occurs when internal heat sink temp > 110 °C
1	**1**	Rem. Control "out of range"	Voltage across REM. CNTRL. inputs > ± 2 Vdc (The rectifier's FLOAT pot is setting it's output voltage)
1	**2**	Load Share "out of range"	Voltage across LS inputs > ± 2 Vdc; Load Sharing inactive
1	**3**	Over Temp./ Iout derated	Ambient Temperature > +65 °C; rectifier Iout limit derated
1		Low Air Flow	Occurs when heat sink to ambient Δ > 30% over normal
2		External HVSD	The Plant has placed the rectifier into HVSD mode

The following table shows the dip switches on the Control PWB, A3, as they are set when shipped from the factory. The default switch settings are also depicted on a label, located on the inside of the Plant's front door.

Table: Dip Switch S1, S2 & S3 Default Settings

ON	ON	OFF	OFF		ON	OFF	OFF	OFF	OFF	OFF	OFF	OFF		ON	ON	ON	OFF	ON	ON	OFF	ON
1	2	3	4		1	2	3	4	5	6	7	8		1	2	3	4	5	6	7	8
DIP SW S3					**DIP SWITCH (BANK) S2**									**DIP SWITCH (BANK) S1**							

<u>Legend</u>: LT = switch to the LEFT position (OFF); RT = switch to the RIGHT position (ON);
When viewed with control PWB installed in system

CHAPTER FIVE: MAINTENANCE

Perform the following maintenance procedure twice a year:

PROCEDURE

1. Open the front door of the Plant and visually inspect for signs of overheating or arcing.

2. Check all mechanical connections, and tighten any that are noticeably loose.

3. Verify that all rectifiers are on-line and operating normally with no alarms indicated.

4. Verify that the Plant voltage is set correctly.

5. Measure the current shunts (at the test jacks on each rectifier) and divide each one by 5.

NOTE: Each rectifier's current reading should be within ± 5mv (or ±1Adc) of each other.

6. If the load on the Plant allows, remove each rectifier one at a time, and use low pressure air to remove all accumulated dust and debris from the rectifiers.

7. Check all Control PWB dip switch settings, and verify that they are correctly set.

8. Swap all spare rectifiers into service, taking out those that have been in service the longest.

CHAPTER SIX: SPARE PARTS

1.0 We recommend that a Control PWB be stocked as a spare: P/N 306-2947-04

2.0 We recommend that at least one modular rectifier be stocked as a spare:

–48v/7.5A	P/N 100-7507-48

3.0 We recommend that various GMT fuses be stocked as spares:

0.50A	P/N 280-0700-00
1.0A	P/N 280-0710-00
2.0A	P/N 280-0735-00
3.0A	P/N 280-0760-00
5.0A	P/N 280-0740-00
7.5A	P/N 280-0750-00
10A	P/N 280-0770-00
Dummy	P/N 276-0001-00

4.0 We recommend that an LVD relay be stocked as a spare: P/N 246-0022-00