

KS-21520 RECTIFIER
48 VOLTS, 400 AMPERES
LORAIN PRODUCTS CORPORATION
OPERATING METHODS

CONTENTS	PAGE
1. GENERAL	1
2. TOOLS AND TEST APPARATUS	1
3. OPERATION	3
4. ROUTINE CHECKS	7
5. TROUBLES	12

1. GENERAL

1.01 The KS-21520 rectifiers, Fig. 1, are rated at 48 volts at 400 amperes. They provide an isolated, filtered, constant negative dc voltage for automatically charging and floating 23 or 24 cells of lead acid battery. In addition, L11 and L12 rectifiers are equipped with end cell charging capacity allowing 25 or 27 cells to be floated or charged at voltages up to 2.3 volts per cell. The L11 and L12 rectifiers are primarily intended for use in the 301C, 302A, and 302B while the L21 and L22 rectifiers are intended for use in the 303A, 326A, 326B, and 111A power plants. However, they may be used whenever the voltage, current capacities, and regulation characteristics meet the requirements with which they will be associated. These rectifiers are designed for continuous operation, and during normal operation are energized and connected to the load. The input power is 3-phase, 3-wire, 60±3 Hz ac within the limits of 184 to 254 volts for List 11 and List 21 or 424 to 508 volts for L12 and L22. The L11 and L21 rectifiers are provided with taps on the main transformers for 208/240 volt operation.

1.02 Whenever this section is reissued, the reason for reissue will be listed in this paragraph. This issue does affect the Equipment Test List.

1.03 The KS-21520 rectifier is intended to replace the KS-20489 and KS-20490 rectifiers.

1.04 This issue of the section is based on the following drawing.

SD-82409-01, Issue 1.

For a detailed description of circuit operation, see the corresponding circuit description. If this section is to be used with equipment or apparatus that is associated with a later issue of the drawing, reference should be made to the SDs and CDs to determine the extent of the changes and the manner in which the section may be affected.

1.05 For more detailed information on the operation and maintenance of individual apparatus, refer to the appropriate Bell System Practices.

1.06 The abbreviations cw and ccw refer to clockwise and counterclockwise, respectively.

2. LIST OF TOOLS AND TEST EQUIPMENT

CODE OR SPEC NO.	DESCRIPTION
TOOLS	
—	3-Inch C Screwdriver
TEST APPARATUS	
KS-20599 L4	Digital volt-ohm-milliammeter or equivalent

NOTICE

Not for use or disclosure outside the
Bell System except under written agreement

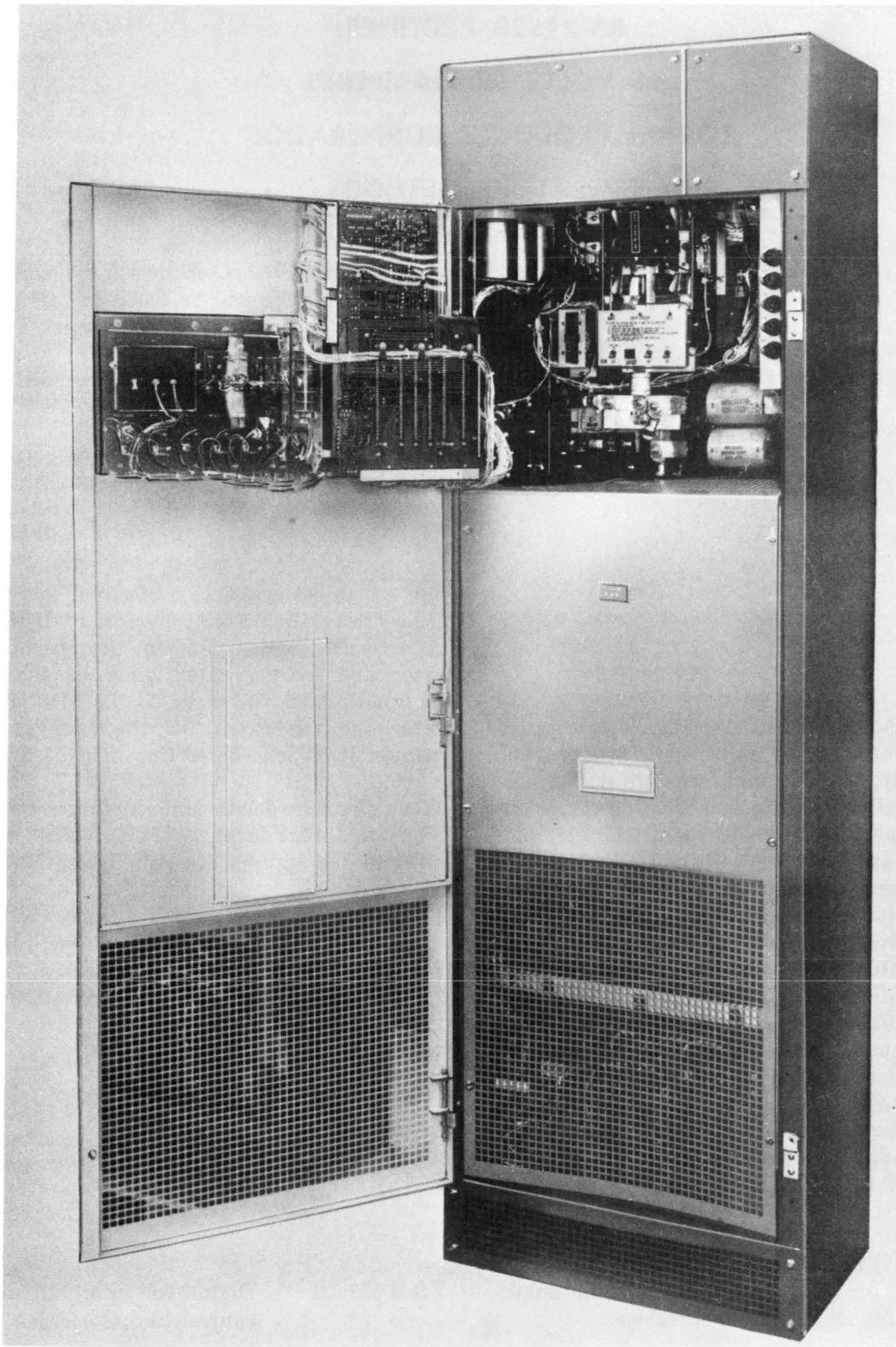


Fig. 1—KS-21520 L11 and L12 Rectifier—Lorain Products Corporation

Dummy Load—ITE 5317, 30-Kilowatt or equivalent

FUSE

DC OUTPUT
(F7.1)

DC OUTPUT ALM
(F7.2)

OUTPUT CAPACITOR
(F6.1)

OUTPUT CAPACITOR
ALM(F6.2)

OUTPUT VOLTS ALM
(F8)

RELAY AND ALM
(F9)

F1, F2, F3

F4 and F5
(KS21520 L11, L21)

F4 and F5
(KS21520 L12, L22)

3. OPERATION

3.01 Enclosure: The rectifier is enclosed in a cabinet structure having front access only. The entire control panel is visible from the exterior through a recess in the front door. All of the adjustable controls are accessible without opening the front door.

3.02 Preparing to Start

(a) When preparing to put the rectifier into service, the controls should be initially positioned as follows.

Danger 1: Voltages inside the rectifier cabinet are over 150 volts to ground. Avoid all contact with terminals. Do not allow a test pick to touch two metal parts at the same time or destructive and dangerous short circuits may occur. Always disconnect the ac supply before working on the rectifier except when it is necessary to make tests.

Danger 2: To avoid electrical shock and possible damage, do not remove any plug-in circuit packs while the rectifier is in operation.

POSITION	CONTROL
OFF	POWER ON/OFF switch
Fully ccw	SIMULATED OUTPUT CURRENT potentiometer
OFF-TEST	DC OUTPUT switch

(b) Make certain that the following fuses have been properly installed.

(c) On rectifiers KS-21520 L11 and L21 only, check to be sure that the input voltage taps on the power transformer (T1) and input inductor (L1), as well as the 208- or 240-volt voltage select plug associated with power supply transformers, have been selected to match the ac input voltage (See 3.03).

Note: If either of the two input taps are satisfactory for the prevailing ac line voltage, it is preferable to use the higher voltage tap.

(d) Make certain that the six plug-in circuit packs, CP1-CP6, are installed in their proper locations.

3.03 Input Voltage Tap Adjustment (L11 and L21 only): The Model KS-21520 L11 and L21 rectifiers operate from nominal 208/240V ac input. Input voltage tap adjustments on the power transformer (T1), the line inductor (L1), the power supply transformers (T3-T5), and autotransformer (T6) are required to adapt these rectifiers for nominal 208 or 240V ac input.

Note 1: L11 and L21 rectifiers are shipped from the factory connected for 240-volt input.

SECTION 169-748-301

For 208-volt input connections, see note 105 on SD-82409-01.

Note 2: Access to the T1 transformer terminals requires removal of the front guard.

Danger: Make certain that all input power has been removed before removing the front guard.

3.04 Charging Output Filter Capacitors:

Follow the procedure below for charging the output filter capacitors. This will prevent arcing when the DC OUTPUT switch, Fig. 2, is operated from the OFF-TEST position to the BAT or EC position.

- (1) Turn the rectifier off by placing the POWER switch to the OFF position.
- (2) On L11 and L12 rectifiers equipped with an (S6) PRE-CHG EC/BAT switch, place the toggle of the switch to the desired position.

Note: This will connect the DC filter capacitors to the BAT or EC bus respectively.

- (3) Place the toggle of the CAP CHG switch to the ON position.

Requirement: The indicator lamp CAPACITOR CHARGING will illuminate while the capacitors are being charged.

- (4) Wait until the CAPACITOR CHARGING lamp has extinguished, then close the DC OUTPUT switch to the BAT position or EC position (EC on L11 or L12 only).
- (5) Return the toggle of the CAP CHG switch to the OFF position.
- (6) The rectifier can now be started by placing the POWER switch, Fig. 3, to the ON position.

3.05 Connection to Plant

Warning: If improper indications are noted, do not proceed further but refer to Trouble Locating Section 169-748-311.

To connect the rectifier to the plant, proceed as follows.

- (1) Perform the steps of 3.02.
- (2) Make the input voltage tap adjustments in accordance with 3.03 (L11 and L21 only).
- (3) Perform the voltage regulation adjustment in accordance with 4.05.
- (4) Perform the current limiting checks and adjustments—full load in accordance with 4.06.
- (5) Perform the current limiting checks and adjustments—partial load in accordance with 4.07.
- (6) Operate the POWER switch to the OFF position.
- (7) Place the plant connector J1 firmly into the P1 connector making sure that the locking clips engage properly with the mounting bracket.

Note: No plant alarms should be indicated but if any do appear, refer to the appropriate plant trouble locating practice.

- (8) Open the front access door and place the toggle of the TEST/OFF switch to the OFF position.
- (9) Charge the output filter capacitors in accordance with 3.04.
- (10) Operate the DC OUTPUT (S1) switch to the BAT or EC position.
- (11) Operate the POWER switch to the ON position.

Requirement 1: The rectifier starts and runs.

Requirement 2: The POWER ON indicator lights.

Requirement 3: If operating in the EC position, the EC indicator lights.

- (12) Using the plant voltmeter, verify that the battery voltage is within proper limits.

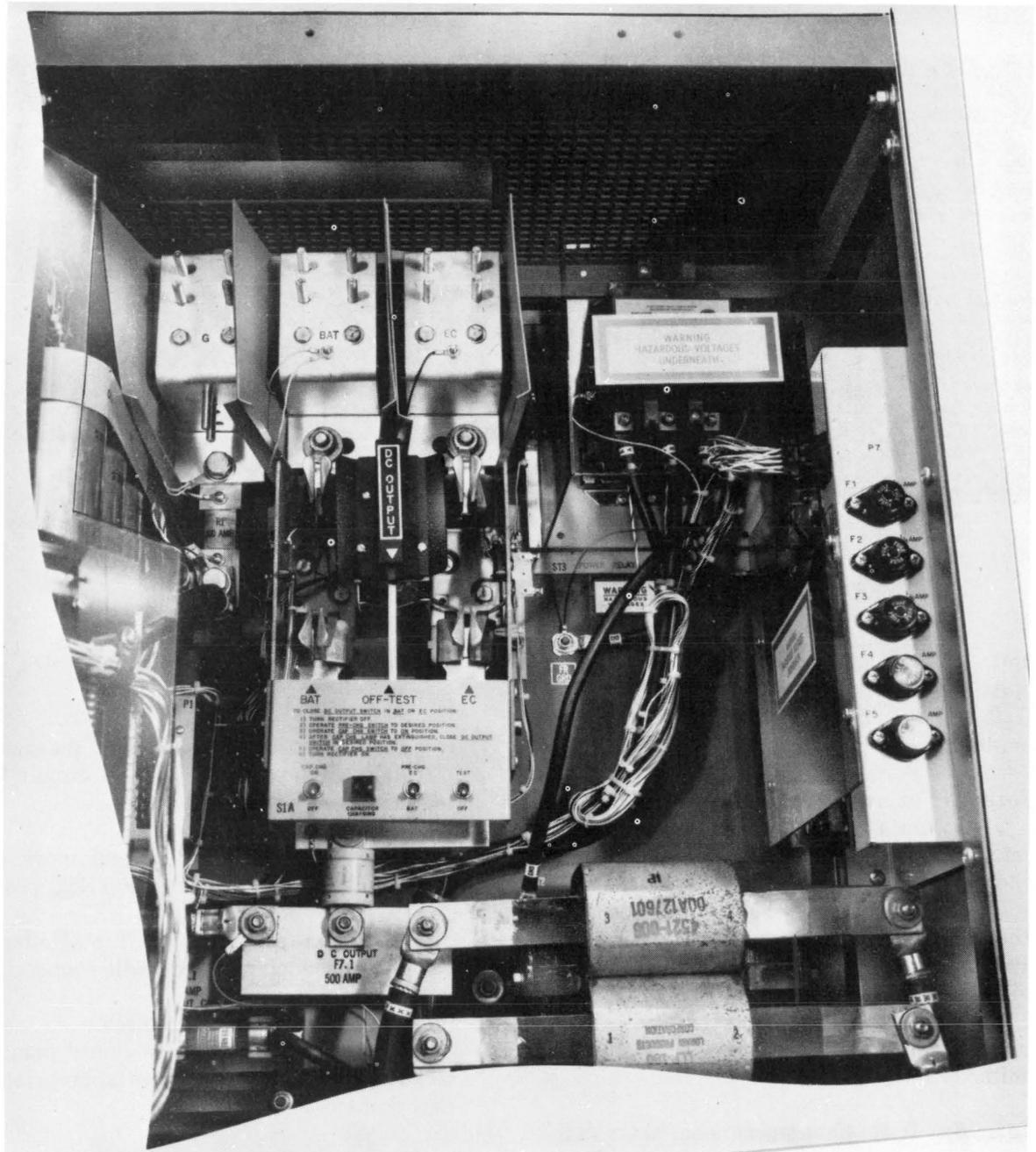


Fig. 2—KS-21520 L11 and L12 DC OUTPUT Switch—Lorain Products Corporation

Note 1: Adjust the output voltage in accordance with the appropriate Bell System plant practice. In the absence of a practice, adjust the OUTPUT VOLTAGE ADJUST control for 2.17 volts per cell across the battery.

Note 2: If the rectifier does not deliver current after turnon, its voltage may be set

below the voltage of the other rectifiers operating in parallel. SLOWLY rotate the OUTPUT VOLTAGE ADJUST control cw until load current is indicated on the rectifier's output current ammeter.

Note 3: If the rectifier current increases to near or in excess of 400 amperes when turned on, the unit may be operating in current

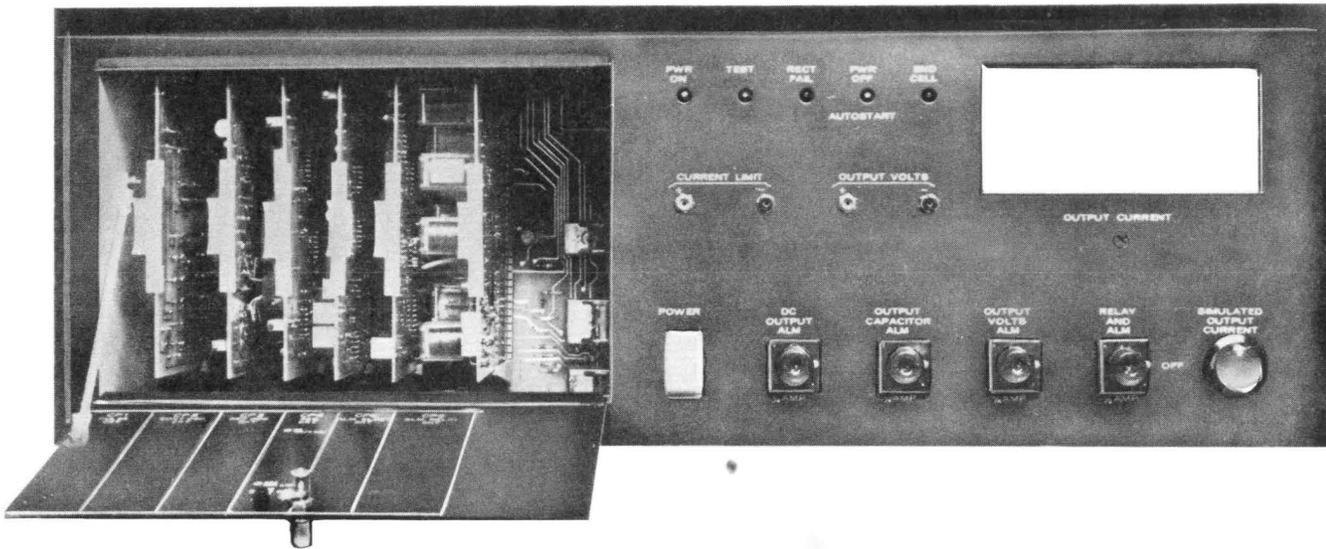


Fig. 3—KS-21520 Rectifier Control Panel—Lorain Products Corporation

limit. If plant voltage is at or above proper limits, slowly rotate the OUTPUT VOLTAGE ADJUST potentiometer ccw until the load current falls below 400 amperes.

Note 4: It is never necessary to attempt to adjust units to share load. The suggested method to set the rectifier voltage is as follows. Select a period when plant load is less than the rating of the rectifier such that other paralleled units can be shut down. In this way current limiting or the other chargers will not affect the plant voltage. Each unit of a paralleled set should be individually adjusted for output voltage within specified limits.

Note 5: With 400-ampere load, the voltage difference between the plant voltage and the value at the output voltage test jacks should not exceed 2 volts.

No other adjustments should be necessary.

3.06 Stopping and Removing From Service

- (1) To stop the rectifier, operate the POWER switch to OFF.

Requirement: No rectifier indicators are lighted.

- (2) To remove the rectifier from service, proceed as follows:

- (a) Stop the rectifier and open the associated AC switch and fuse unit or circuit breaker in the power service cabinet.
- (b) Open the rectifier door and move the DC output switch to the OFF-TEST position.

Requirement: The RECT FAIL lamp will light and a plant alarm will sound.

- (c) Remove the plant connector J1 and take other necessary steps to cancel plant alarm conditions in accordance with appropriate plant Bell System Practices.

Danger: The capacitors in the rectifier require several seconds to discharge. With the rectifier OFF, wait 1 minute before removing shields and 5 minutes before working near the DC capacitor bank with metallic tools.

Warning: If the rectifier will be out of service for an extended period, connect the electrolytic capacitors of the output filter to a source of direct current of suitable voltage and polarity in accordance with Section 032-110-701.

3.07 Restoring to Service: To restore the rectifier to service, reconnect the ac service and follow the procedure in 3.05.

4. ROUTINE CHECKS

4.01 The following checks should be made annually or more often if experience indicates that it is required. The rectifier may be tested with its output disconnected from the battery by operating the DC OUTPUT (S1) switch to the OFF-TEST position.

4.02 All relays and other components are coded as shown on the circuit schematic drawing SD-82409-01.

4.03 Clean, test, and adjust the DC OUTPUT (S1) switch in accordance with Section 169-748-501.

4.04 Prepare the rectifier for testing by following this procedure.

- (1) Turn the rectifier off by placing the POWER switch to the OFF position.
- (2) Open the front access door and place the toggle of the TEST/OFF switch to the TEST position.
- (3) Place the DC OUTPUT switch to the OFF-TEST position.
- (4) Unplug the plant control socket (J1).
- (5) Place the POWER switch to the ON position.

Requirement: The rectifier starts and the POWER ON indicator lights.

- (6) Proceed with routine checks and adjustments.

A. Voltage Regulation and Current Limit Adjustments

4.05 Output Voltage Adjustment

- (1) Prepare the rectifier for testing in accordance with 4.04.
- (2) Connect a KS-20599 L4 voltmeter, set to the 100-volt dc scale, to the OUTPUT VOLTS (+) and (-) pin jacks to read the rectifier output voltage.

- (3) Operate the POWER switch to the ON position.

- (4) Adjust the rectifier output voltage by adjusting the OUTPUT VOLTS ADJUST potentiometer on CP4 cw to increase output voltage and ccw to decrease output voltage.

Note: Access to the OUTPUT VOLTS ADJUST potentiometer is made through a hole in the hinged cover of the circuit pack assembly.

- (5) Adjust the output voltage for 2.17 volts per cell.

Note: If the plant is equipped with diodes in the regulation (sense) leads, readjustment of the output voltage will be required when connected to plant.

- (6) After the adjustment is complete, remove the dc voltmeter and return the rectifier to service using the capacitor charging and rectifier startup procedure.

4.06 Current Limiting Checks and Adjustments—Full Load: The FULL LOAD CURRENT LIMIT is factory set for 400 amperes output. To check the current limit setting, follow the procedure below.

- (1) Prepare the rectifier for testing in accordance with 4.04.
- (2) Connect a KS-20599 L4 voltmeter, set to the 100-volt dc scale, to the OUTPUT VOLTS test jacks on the front of the meter panel.
- (3) Turn on the simulated output current by turning the SIMULATED OUTPUT CURRENT switch-potentiometer slightly cw.
- (4) Slowly adjust the SIMULATED OUTPUT CURRENT switch-potentiometer cw.

Requirement: The current indication on the OUTPUT CURRENT ammeter slowly starts to rise.

- (5) Observe the output voltage and output current while adjusting the SIMULATED OUTPUT CURRENT switch-potentiometer.

Note 1: When the current limit setting is reached, the rectifier output voltage starts to decrease.

Requirement: The point at which current limit occurs is approximately 400 amperes.

Note 2: If the output voltage starts to decrease when the OUTPUT CURRENT ammeter indicates approximately 400 amperes, this is an indication that current limiting full load adjustment is properly set.

- (6) If the current limit setting is correct, turn the SIMULATED OUTPUT CURRENT switch-potentiometer fully ccw and remove the voltmeter.
- (7) If the output current is not limited at approximately 400 amperes, proceed as follows.
- (8) Operate the rectifier POWER switch to OFF.
- (9) Turn the SIMULATED OUTPUT CURRENT switch-potentiometer fully ccw.
- (10) Open the circuit pack access door on the meter panel and locate potentiometer CUR LIM (R24) on circuit pack CP4.
- (11) Adjust this potentiometer fully cw.
- (12) Operate the POWER switch to the ON position.

Requirement: The rectifier starts.

- (13) Turn on the simulated output current by adjusting the SIMULATED OUTPUT CURRENT switch-potentiometer cw and adjust the simulated output current for an OUTPUT CURRENT ammeter indication of approximately 20 amperes more than the desired current limit point, 420 amperes.
- (14) Slowly adjust the CUR LIM (R24) potentiometer ccw until the current indication on the OUTPUT CURRENT ammeter reaches the desired current limit setting.

Requirement: The output voltage, as measured on the KS-20599 L4 voltmeter, starts to decrease at the current limit point.

Note: Some minor adjustment of the CUR LIM (R24) and SIMULATED OUTPUT CURRENT switch-potentiometers may be required to reach the desired setting.

- (15) Adjust the SIMULATED OUTPUT CURRENT switch-potentiometer fully ccw.
- (16) Remove the KS-20599 L4 voltmeter.

4.07 Current Limiting Checks and Adjustments—Partial Load (L11 and L12 only): The recommended PARTIAL LOAD CURRENT LIMIT setting is 200 amperes unless otherwise specified by the appropriate plant practice. To check the current limit setting, follow the procedure below.

- (1) Prepare the rectifier for testing in accordance with 4.04.
- (2) Connect clip cord jumper wire between terminal 4 of the plant control plug P1 and the ground output bus.

Note: This grounds the PL plant control lead.
- (3) Connect a KS-20599 L4 voltmeter, set to the 100-volt dc scale, to the OUTPUT VOLTS test jacks on the front of the unit.
- (4) Turn on the simulated output current by turning the SIMULATED OUTPUT CURRENT switch-potentiometer slightly cw.

- (5) Slowly adjust the SIMULATED OUTPUT CURRENT switch-potentiometer cw.

Requirement: The current indication on the OUTPUT CURRENT ammeter slowly starts to rise.

- (5) Observe the output voltage and output current while adjusting the SIMULATED OUTPUT CURRENT switch-potentiometer.

Note 1: When the current limit setting is reached, the rectifier output voltage will start to decrease.

Requirement: The point at which current limit occurs is approximately 200 amperes.

Note 2: If the output voltage starts to decrease when the OUTPUT CURRENT ammeter indicates 200 amperes, this is an indication that the current limiting partial load adjustment is properly set.

- (7) If the current limit setting is correct, turn the SIMULATED OUTPUT CURRENT switch-potentiometer fully ccw and remove the clip card jumper wire and voltmeter.
 - (8) If the output current is not limited at approximately 200 amperes, proceed as follows.
 - (9) Open the circuit pack access door on the meter panel and locate potentiometer PAR CUR LIM (R25) on circuit pack CP4.
 - (10) Adjust this potentiometer fully cw.
 - (11) Operate the rectifier POWER switch to OFF.
 - (12) Turn the SIMULATED OUTPUT CURRENT switch-potentiometer fully ccw.
 - (13) Connect a clip cord jumper between terminal 4 of the plant control plug (P1) and the ground output bus.
- Note:** This simulates a partial load command from the plant control circuit by placing ground on the PL plant control lead.
- (14) Operate the POWER switch to the ON position.

Requirement: The rectifier starts.

- (15) Turn on the simulated output current by adjusting the SIMULATED OUTPUT CURRENT switch-potentiometer cw and adjust the simulated output current for an OUTPUT CURRENT ammeter indication of approximately 20 amperes more than the desired current limit point, 220 amperes normally.
- (16) Slowly adjust the PAR CUR LIM (R25) potentiometer ccw until the current indication

on the OUTPUT CURRENT ammeter reaches the desired current limit setting.

Requirement: The output voltage, as measured on the KS-20599 L4 voltmeter, starts to decrease at the current limit point.

Note: The adjustment is now complete.

- (17) Adjust the SIMULATED OUTPUT CURRENT switch-potentiometer fully ccw.
- (18) Disconnect the test equipment.

4.08 Internal High Voltage Monitor Checks and Adjustments: An internal high voltage shutdown circuit is factory adjusted to shut down and lock out the rectifier when the rectifier output voltage reaches the values given below for the specific rectifier.

MODEL	SHUTDOWN VOLTAGE
KS-21520 L11 & L12 (23 Cells)	51 . 6 ± 0 . 1V DC
KS-21520 L21 & L22 (24 Cells)	53 . 8 ± 0 . 1V DC

- (1) To check this adjustment setting, open the circuit pack access door and connect a clip cord jumper between test point minipins TP21 and TP22 on circuit pack CP5.

Note: This will prevent an actual rectifier shutdown.

- (2) Connect the probes of a KS-20599 L4 voltmeter, set to the 100-volt dc scale, to the OUTPUT VOLTS test jacks on the meter panel, observing proper polarity.
- (3) Insert the probes of another KS-20599 L4 voltmeter, set to the 100-volt dc scale, into test jacks J1 and J2 on circuit pack CP5 observing the color coded polarity.
- (4) Slowly increase the rectifier output voltage, using the OUTPUT VOLTS ADJUST potentiometer, until the voltage being monitored

SECTION 169-748-301

at CP5 jacks J1 and J2 goes positive to between 7 and 13V DC.

(5) Observe the voltage indicated on the voltmeter connected to the OUTPUT VOLTS test jacks on the meter panel.

Note: The voltage indicated on this meter is the shutdown voltage setting.

(6) If the shutdown setting is correct, readjust the OUTPUT VOLTS ADJUST control to the required output voltage for the plant per 4.05; operate the POWER switch to OFF and remove the clip cord and voltmeters.

(7) If a readjustment is necessary, proceed as follows.

(8) Maintain the clip cord jumper between test points TP21 and TP22 on circuit pack CP5.

(9) Adjust the HVSD ADJ (R10) potentiometer on circuit pack CP5 fully cw, then turn on the rectifier.

(10) Adjust the rectifier output voltage, using the OUTPUT VOLTS ADJUST potentiometer, to the desired high voltage shutdown level.

(11) Adjust the HVSD ADJ (R10) potentiometer ccw very slowly until the voltage being monitored at test jacks J1 and J2 swings positive to 7-13V DC.

Note 1: This indicates that the high voltage shutdown circuit has been activated.

Note 2: The adjustment is now complete.

(12) Turn off the rectifier and remove the test equipment.

B. Rectifier Shutdown in the Test Mode

4.09 The rectifier may be tested with its output disconnected from the battery. The following procedure is to be used for all subsequent simulated shutdown tests.

(1) Turn the rectifier off by operating the POWER switch to the OFF position.

(2) Open rectifier access door and operate the TEST/OFF toggle switch (located on DC OUTPUT switch assembly) to the TEST position.

(3) Open the DC OUTPUT switch and place the switch in the OFF-TEST position.

(4) Unplug plant control socket J1.

(5) Operate the POWER switch to the ON position.

4.10 Simulated TR Shutdown and Alarm Check: This test checks the remote TR shutdown and corresponding alarm indications.

(1) Connect ground to the TR lead (pin 7 of plant control plug P1).

Requirement 1: The rectifier will shut down and the following indicators will be illuminated:

(a) PWR OFF/AUTOSTART

(b) PWR ON

(c) TEST.

Requirement 2: In addition to the local indicators, the following alarms will be extended to the plant:

(a) Status C Alarm

(b) Status G Alarm.

(2) Remove the ground on pin 7 of plant control plug P1.

Requirement 1: The rectifier will restart.

Requirement 2: The PWROFF/AUTOSTART indicator extinguishes.

Requirement 3: The plant alarms extinguish.

4.11 Simulated Plant HV Shutdown and Remote Recycle Check: This test checks the remote HV shutdown and corresponding alarm indications.

(1) Connect ground to the HV lead (pin 6 of plant control plug P1).

- (2) Slowly adjust the SIMULATED OUTPUT CURRENT switch-potentiometer cw.

Requirement 1: The rectifier shuts down and locks out at approximately 45 amperes.

Requirement 2: The following indicator lamps light.

- (a) RECT FAIL
- (b) PWR ON
- (c) PWR OFF/AUTOSTART
- (d) TEST.

Requirement 3: In addition to the local indicators, the following alarms are extended to the plant:

- (a) Rectifier Fail Alarm
- (b) Status D Alarm
- (c) Status G Alarm.

- (3) Remove the ground from pin 6 of plant control plug P1 and restart the rectifier by using one of the two methods given below.

- (a) Manually operate the POWER switch to the OFF position, then back to the ON position.
- (b) To check the remote recycle function of the rectifier, connect a clip cord jumper between pins 14 and 15 of plant control plug P1.

- (4) After the rectifier has restarted, observe the rectifier control panel.

Requirement 1: Indicator lamps RECT FAIL and PWR OFF/AUTOSTART extinguish.

Requirement 2: All plant alarms extinguish.

- (5) Adjust the SIMULATED OUTPUT CURRENT switch-potentiometer fully ccw and, if necessary, remove the clip cord jumper between pins 14 and 15 of plant control plug P1.

4.12 Fuse Alarm Checks: Any open fuse in the rectifier will cause identical alarm indications. To check the alarm circuit, open the front access door and locate fuses F1 through F5 on the right side of the unit and follow the procedure below.

Danger: AC voltage is always present on the F1—F5 fuses unless the ac input circuit breaker or the switch in the power service cabinet or bus duct is turned off. Removal and reinsertion should be done carefully.

- (1) Simulate a fuse failure by removing fuses F1—F5, one at a time.

Requirement 1: The rectifier shuts down and the following alarm indicators illuminate.

- (a) RECT FAIL
- (b) PWR ON
- (c) PWR OFF/AUTOSTART
- (d) TEST.

Requirement 2: In addition to the local indicators, the following alarms are extended to the plant:

- (a) Rectifier Fail Alarm
- (b) Status F Alarm
- (c) Status G Alarm.

- (2) Replace the fuse and restart the rectifier.

Requirement: Indicators RECT FAIL and PWR OFF/AUTOSTART extinguish and all plant alarms extinguish.

- (3) The above test shall be repeated for fuses DC OUTPUT ALM, OUTPUT CAPACITOR ALM, and RELAY AND ALM, one at a time, by substituting blown fuses in the respective fuseholders.

Requirement 1: The rectifier shuts down and locks out and the following alarm indicators light.

SECTION 169-748-301

- (a) RECT FAIL
- (b) PWR ON.

Requirement 2: In addition to the local indicators, the following alarm is extended to the plant:

Rectifier Fail Alarm.

- (4) Turn the rectifier OFF, reinsert a good fuse, and restart the rectifier.

Requirement: Indicator RECT FAIL extinguishes and the plant alarm extinguishes.

4.13 Operation Under Load With the Rectifier Disconnected From Battery:

If it is desired to artificially load the rectifier with the output of the rectifier not connected to battery, follow the procedure below.

- (a) Turn the rectifier off and place the DC OUTPUT switch to the OFF-TEST position.
- (b) Loosen (but do not remove) the two screws securing the test load cable entrance cover

plate at the top of the rectifier and insert the test load cables through the entrance hole.

- (c) Connect the test load cables to the appropriate TEST (+) and TEST (-) bus.
- (d) The rectifier may now be turned on and any tests may be made.
- (e) Upon completing the tests with load; turn the rectifier off, remove the test load, and restart the rectifier using the capacitor charging and rectifier startup procedure.

4.14 Load Carrying Bolts Check: To assure that bolted connections remain tight, on a 12-month interval, retighten all bolted connections.¶

5. TROUBLES

5.01 Whenever a trouble condition is encountered in the operation of the rectifier, refer to Section 169-748-311, Trouble Locating.