RECTIFIERS
KS-20493 L21 AND L22
48 VOLTS, 100 AMPERES
LORAIN PRODUCTS CORPORATION
OPERATING METHODS

CONTENTS PAGE

1. GENERAL

1.01 This rectifier provides regulated dc power from a single-phase ac power source to charge and float a 23- or 24-cell battery at full load, or to charge a 25- or 27-cell battery at 80 percent of rated full load. This rectifier is primarily intended for use in the 110A, 111A, 151A, 303A, 301C, and 302A power plants. This rectifier is of the ferroresonant type. This type rectifier can provide a relatively constant dc output voltage, and may be used wherever the voltage, current capacities, and regulation characteristics meet the requirement with which they will be associated.

1.02 This section is reissued to:

(a) Provide information on options ZK, ZL, ZN, and ZP

(b) Update admonishments to the latest standards

(c) Make other minor corrections.

Revision arrows are used to emphasize the more important changes. This reissue does affect the Equipment Test List.

1.03 The rectifier is arranged for single-phase, 60 ±3 Hz, ac input and is suitable for use with battery power plants where 3-phase service is not available. The rectifier is adaptable for the following variations.

KS-20493 RECTIFIER

LIST NO.	INPUT	OUTPUT
L21	208/240V	−48V
L22	480V	−48V

The rated current output is 0 to 100 amperes.

Note: From 48.00 Vdc to 56.20 Vdc the rated output current is 100 amperes. Beyond 57.20 Vdc, up to 61.40 Vdc, the rated output current is 80 amperes.

1.04 The rectifier will operate with a permissible input voltage variation of -10 percent to +5 percent about the nominal values. The rectifier is equipped with a low ac input voltage monitor to shut down but not lock out the unit in the event of low ac input voltage. When the voltage restores to an acceptable level, the rectifier will automatically restart. ◗For those rectifiers that are provided with ZL option, an overvoltage shutdown circuit is included that will shut down and lock out the rectifier and activate its failure alarms when the

output terminal voltage exceeds a preset level. This level is to be set at 57.5 ±0.2 volts.

1.05 Rectifiers provided with ZK option have a fast walk-in reset circuit to minimize transient voltage overshoot when the ac service restores after a service outage.

1.06 Rectifiers provided with ZN option have an automatic restart circuit which will restart the rectifier upon receiving a loop closure signal from the plant if the rectifier has been shut down and locked out by a temporary fault such as transient high voltage.

1.07 Rectifiers provided with ZP option include a modified failure alarm circuit to prevent an RFA alarm and lamp indication when the rectifier is manually turned off.◀

1.08 The rectifier utilizes back-to-back thyristors and a KS-20618 regulator to electronically control a ferroresonant transformer for control of the output voltage. The output voltage is protected by the external charge fuse (external to the rectifier), and by the current limit feature.

Warning: Voltages inside the rectifier case are over 150 volts to ground. Do not allow a test pick to touch two metal parts at the same time as destructive and dangerous short circuits may occur. Disconnect the alternating current supply before working on the rectifier except when necessary to make tests.

1.09 This rectifier is designed to mount on a 23-inch relay rack framework or in a cabinet with similar mounting arrangements and can be serviced and maintained from the front only. All electrical connections can be made with the front cover removed. The meter, controls, and fuses are mounted on a hinged panel for access, maintenance, or replacement.

1.10 ▶When the rectifier is used in the 151A power plant for No. 3 ESS, it is required that ZK, ZL, and ZN options be furnished.◀

1.11 This issue of the section is based on the following drawings:

SD-81999-01, Issue ▶8D◀

SD-82030-01, Issue ▶6D◀

For a detailed description of the operation, see the corresponding circuit description. If this section is to be used with equipment that is associated with an earlier or later issue of the drawings, 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.

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

2. LIST OF TOOLS AND TEST APPARATUS

CODE OR SPEC NO.	DESCRIPTION
TOOLS	
—	3-Inch C Screwdriver
TEST APPARATUS	
▶KS-20538◀	Volt-Ohm-Milliammeter (or equivalent)
KS-8039	DC Volt-Milliammeter

3. OPERATION

3.01 The rectifier is completely automatic in the regulation of float voltage and should require no day-to-day routine adjustments. Normally it remains energized and connected. In addition to manual turnoff, it may be stopped and started by signals from the plant, and will shut down automatically upon occurrence of certain conditions.

3.02 If the load exceeds the safe capacity of the rectifier, the regulating circuit switches to constant current regulation. As the load diminishes, the rectifier brings the voltage to float value and returns to voltage regulation. The voltage at which the rectifier will regulate is determined by the setting of the OUTPUT VOLTS ADJUST (R8) rheostat.

Note: Because some difficulty may be encountered when attempting to adjust the output to the precise FLOAT voltage setting of 2.17 volts per cell, the R8 rheostat is changed from a 5K ohms, 2-watt, single-turn type (E option) to a 10K ohms, 2-watt, 10-turn

type (D option) and the value or resistor R9 is changed from 16.2K ohms (P option) to 12.7K ohms (B option) with B and D options, the range of adjustment is 48.00 Vdc to 61.40 Vdc. The B and D options must be intalled at the same time.

3.03 If it is desirable to CHARGE the battery, the OUTPUT VOLTS ADJUST (R8) rheostat must be rotated cw to shift the operating point of the rectifier from 2.17 volts per cell to 2.20 volts per cell. The office load will then be subjected to the CHARGE voltage.

3.04 The rectifier will provide on OVERCHARGE voltage up to 2.30 volts per cell for 23- or 24-cell batteries at rated full load or will provide up to 2.20 volts per cell for 25- or 27-cell batteries at 80 percent of rated full load. If it is necessary to OVERCHARGE the battery, the OUTPUT VOLTS ADJUST (R8) rheostat must be rotated cw to shift the operating point of the rectifier from 2.17 volts per cell to the required OVERCHARGE voltage (up to 2.30 volts per cell). The office load will then be subjected to the OVERCHARGE voltage.

Note: The rectifier will provide a maximum of 2.30 volts per cell only when the ac input voltage is equal to or greater than the value shown below.

RECTIFIER CONNECTED FOR	AC INPUT VOLTAGE
208V -	200V (L21)
240V	230V (L21)
480V	460V (L22)

3.05 The rectifier can be tested without disturbing the office load by removing the external charge and charge alarm fuses and disconnecting the plant control cable. It can then be operated in the FLOAT, CHARGE and OVERCHARGE conditions from no load to full load by adding an external resistance load across the BAT and GRD output terminals.

Note: On rectifiers equipped with ZB wiring, the RECT FAIL lamp does not light if the external charge fuse operates. On rectifiers equipped with ZC option wiring, if the external charge fuse operates, the RECT FAIL lamp lights. With ZC option, power to operate the RECT FAIL lamp circuit and the HV relay circuit is continuously provided by the plant CBS signal via terminal 15 on the PLANT CONTROL DISCONNECT, J1 connector.

3.06 A circuit is provided to simulate an adjustable load up to 125 percent of the output current rating of the rectifier. The simulated output current circuit is enabled only when the SIMULATED OUTPUT CURRENT pushbutton is maintained depressed.

3.07 ***Preparing to Start:*** When putting the rectifier in service, check that:

(a) The POWER ON-POWER OFF (S1) switch is in the OFF position.

Requirement 1: The POWER OFF lamp is lighted.

Requirement 2: ▶The RECT FAIL lamp is lighted (option ZP not provided).◀

(b) The plant control cable is connected to the rectifier.

(c) The ac service fuses are installed.

(d) The external charge and charge alarm fuses of the proper size and type are in place.

3.08 ***Starting:*** To start the rectifier, proceed as follows.

(1) Depress the POWER ON-POWER OFF (S1) switch.

Requirement 1: The POWER ON lamp lights.

Requirement 2: ▶The RECT FAIL lamp extinguishes (option ZP not provided).◀

(2) Loosen the locking device and rotate the OUTPUT VOLTS ADJUST (R8) rheostat cw to increase or ccw to decrease the output voltage of the rectifier until the voltage at the battery (as indicated on the plant voltmeter) is the required value. Tighten the locking device for the OUTPUT VOLTS ADJUST (R8) rheostat being careful not to disturb the setting.

Requirement: The voltage at the battery should meet the voltage values specified in the appropriate plant Bell System Practice.

(3) Observe the OUTPUT CURRENT (M1) ammeter to make sure the rectifier accepts its portion of the load (see the appropriate plant Bell System Practice for voltage and current adjustment of the rectifier).

Note: The CP2 circuit has been modified to improve possible unstable operation when rectifiers are operated in parallel. CP2 per KS-20618, L2 (A option) is replaced by CP2 per KS-20618, L7 (ZA option).

3.09 ***Stopping:*** To stop the rectifier, proceed as follows.

(1) Depress the POWER ON-POWER OFF (S1) switch.

Requirement 1: The POWER OFF lamp lights.

Requirement 2: ▶The RECT FAIL lamp lights (option ZP not provided).◀

(2) If the rectifier is to be left out of service for an extended period of time, remove the ac service fuses, external charge and charge alarm fuses and disconnect the plant control cable.

Danger: All power should be disconnected before attempting maintenance in the power sections of the rectifier. The battery should be disconnected when the rectifier is shut down for extended periods or for maintenance. Be careful not to short circuit the battery or sensing terminals.

4. ROUTINE CHECKS AND ADJUSTMENTS

4.01 Routine checks are intended to detect defects particularly in infrequently operating parts of the equipment and, insofar as possible, to guard against circuit failures which interfere with service. Checks and adjustments, other than those required by trouble conditions, should be performed during a period when there will be a minimum interference to service.

4.02 Periodically check the output float voltage on the associated power plant voltmeter when the unit is operating on voltage control. If the voltage is not correct, readjust the rectifier float voltage as outlined in 4.06.

4.03 Electrolytic capacitors should be maintained in accordance with Section 032-110-701.

4.04 If the relays are mounted on circuit boards, they can be checked by use of the extender circuit board furnished with the rectifier, and must be replaced in case of malfunction. If possible, periodically check all other relays for condition of contacts, making sure that they are in accordance with the circuit requirements table and Bell System Practices which apply.

Warning: When using a portable instrument, the leads should be carefully examined to make sure the insulation is undamaged. The leads should be properly connected to the instrument before making any contact with the circuit to be tested. If connections are to be changed from one instrument range to another, the power should first be disconnected from equipment being tested or, if test picks are being used, they should be removed from the equipment under test.

4.05 ***Placing the Rectifier in the Test Mode:*** The rectifier should be tested and adjusted in the TEST mode, and disconnected from the office load. To place the rectifier in the TEST mode, use the following procedure.

(1) Turn the rectifier off by operating the POWER ON/POWER OFF (S1) switch to OFF.

(2) Remove the external charge and charge alarm fuses or operate the external charge circuit breaker to OFF.

(3) Disconnect the PLANT CONTROL DISCONNECT (J1) connector from the rectifier.

(4) Connect a jumper between the BAT output terminal and the CBS lead (terminal 15 of the PLANT CONTROL DISCONNECT, P1 connector).

(5) The rectifier is now in the TEST mode and may be turned on without disturbing the office load.

4.06 ***Output Voltage Adjustment:***

(1) Depress the POWER ON-POWER OFF (S1) switch.

Requirement 1: The POWER ON lamp lights.

Requirement 2: ▶The RECT FAIL lamp extinguishes (option ZP not provided).◀

(2) Connect the KS-8039 volt-milliammeter, set to the 75-volt scale, to the OUTPUT VOLTS, J2(+) and J3(-) jacks.

(3) Loosen the locking device and slowly rotate the OUTPUT VOLTS ADJUST (R8) rheostat until the reading on the KS-8039 volt-milliammeter is equal to the battery float voltage requirements at the associated power plant or 2.17 volts per cell if no battery float requirement is given. Tighten the locking device for the OUTPUT VOLTS ADJUST (R8) rheostat being careful not to disturb the setting.

▶***Note:*** When end cell and 2.30 volts per cell charging is required, disconnect the jumper from TP2 and connect to TP1. Restore to TP2 when charging is completed.◀

4.07 ***Current Limiting Adjustment:***

Note: The CURRENT LIMIT ADJUST (R10) rheostat is factory set for 100 amperes. If it is necessary to readjust the current limit point, proceed as follows.

(1) Turn off the rectifier by depressing the POWER ON-POWER OFF (S1) switch.

Requirement 1: The POWER OFF lamp is lighted.

Requirement 2: ▶The RECT FAIL lamp is lighted (option ZP not provided).◀

(2) Loosen the locking device and rotate the CURRENT LIMIT ADJUST (R10) rheostat fully cw.

(3) Observing ▶proper◀ polarity, connect the ▶KS-20538◀ volt-ohm-milliammeter, set to the 60-volt dc scale, to the CURRENT LIMIT test jacks (J4 and J5) located on the control panel of the rectifier.

(4) Depress the POWER ON-POWER OFF (S1) switch to start the rectifier.

Warning: Make sure the external charge and charge alarm fuses are removed ▶or external charge circuit breaker is OFF◀ before operating the SIMULATED OUTPUT CURRENT feature.

(5) Depress and hold the SIMULATED OUTPUT CURRENT (S2) switch.

Requirement: The SIMULATED OUTPUT CURRENT lamp is lighted.

(6) Rotate the SIMULATED OUTPUT CURRENT (R12) rheostat cw until the OUTPUT CURRENT (M1) ammeter indicates the desired maximum output current.

(7) Rotate the CURRENT LIMIT ADJUST (R10) rheostat slowly until the ▶KS-20538◀ volt-ohm-milliammeter indicates 1.25-1.5 volts dc on the 3-volt scale.

(8) Tighten the locking device for the CURRENT LIMIT ADJUST (R10) rheostat being careful not to disturb the setting.

(9) Release the SIMULATED OUTPUT CURRENT (S2) switch.

Requirement: The SIMULATED OUTPUT CURRENT lamp extinguishes.

(10) Rotate the SIMULATED OUTPUT CURRENT (R12) rheostat fully cw.

(11) Remove the ▶KS-20538◀ volt-ohm-milliammeter.

4.08 ▶***Overvoltage Shutdown Adjustment:***

Note 1: The OV ADJUST (R67) potentiometer is factory set to shut down and lock out the rectifier if the output voltage exceeds 57.5 ±0.2 volts. If it is necessary to readjust the

overvoltage shutdown setting, proceed as follows.

Note 2: For this test, the jumper on the CMI circuit assembly must be connected to TP2.

(1) Turn the rectifier off by depressing the POWER ON-POWER OFF (S1) switch.

Requirement: The POWER OFF lamp is lighted.

(2) Connect the KS-8039 meter, set to the 75-volt scale, to the J2(+) and J3(-) OUTPUT VOLTS jacks.

(3) Adjust the OV ADJUST (R67) rheostat on CM1 to its full cw rotation.

(4) Turn the rectifier on by operating the POWER ON-POWER OFF (S1) switch.

(5) Set the voltage, by means of the OUTPUT VOLTS ADJUST (R8) control, to 57.5 volts.

(6) Slowly rotate the OV ADJUST (R67) rheostat ccw until the rectifier shuts down and locks out.

(7) To restore the rectifier, rotate the OUTPUT VOLTS ADJUST (R8) rheostat ccw several turns.

(8) Depress the POWER ON-POWER OFF (S1) switch twice and reset the voltage per 4.06.

(9) Disconnect the KS-8039 meter from the J2 and J3 jacks.◀

4.09 ***TR Shutdown Check:***

(1) Using a suitable jumper, connect ground to terminal 7 of the P1 plug.

Requirement: The rectifier shuts down.

(2) Remove the jumper.

Requirement: The rectifier restarts.

4.10 ***HV Shutdown Check:***

(1) Using a suitable jumper, connect ground to pin 6 of the P1 plug.

(2) Depress and hold the SIMULATED OUTPUT CURRENT (S2) switch.

(3) Rotate the SIMULATED OUTPUT CURRENT (R12) rheostat cw.

Requirement: The rectifier shuts down when the OUTPUT CURRENT (M1) ammeter indicates about 5 amperes.

(4) Release the SIMULATED OUTPUT CURRENT (S2) switch.

(5) Remove the jumper.

(6) Depress the POWER ON-POWER OFF (S1) switch twice to release the relays and restart the rectifier.

(7) Rotate the SIMULATED OUTPUT CURRENT (R12) rheostat fully ccw.

4.11 ▶***Overvoltage Shutdown and Lockout:***

(1) Connect the KS-8039 meter, set to the 75-volt scale, to the J2(+) and J3(-) rectifier jacks.

(2) Using the OUTPUT VOLTS ADJUST (R8) rheostat, slowly increase the voltage.

Requirement: The rectifier shuts down and locks out when the voltage is between 57.3 and 57.7 volts.

Note: If shutdown occurs below or above these limits, adjust the shutdown voltage in accordance with 4.08.

(3) Disconnect the KS-8039 meter from the J2 and J3 rectifier jacks.

4.12 ***Automatic Restart Check:***

(1) Provide a connection between the RS and RSR leads (terminals 4 and 5) of the PLANT CONTROL DISCONNECT connector P1.

(2) Simulate an HV shutdown in accordance with 4.07 except that the SIMULATED OUTPUT CURRENT switch should be released immediately after shutdown occurs.

Requirement: The rectifier automatically restarts approximately 2 seconds after shutdown and lockout.

(3) Simulate a second HV shutdown in accordance with 4.10.

Requirement: The rectifier does not restart until the POWER ON-POWER OFF (S1) switch is depressed twice.

(4) If the rectifier is provided with ZL option, simulate an overvoltage shutdown and lockout in accordance with 4.11.

Requirement: The rectifier automatically restarts approximately 2 seconds after shutdown and immediately shuts down again.

(5) Operate POWER ON-POWER OFF (S1) switch to OFF.

(6) Remove connection between RS and RSR leads (terminals 4 and 5) of P1.

(7) To restore the rectifier, adjust the output voltage in accordance with 4.06.

(8) Reconnect plant control disconnect plug, P1.

5. TROUBLES

5.01 Refer to Section 169-745-311 for trouble-locating information for the KS-20493 rectifiers manufactured by Lorain Products Corporation.