RECTIFIERS
KS-20489 L11, L12, L21, AND L22
48 VOLTS, 400 AMPERES
TROUBLE LOCATING

1. GENERAL

1.01 The KS-20489 rectifiers provide an isolated, filtered, and regulated dc voltage for automatically floating and charging battery plants. The KS-20489 L11 and L12 rectifiers are used for floating and charging 23-cell battery plants, with manual switching for additionally charging either 2- or 4- end cells. The KS-20489 L21 and L22 rectifiers are used for floating and charging 24-cell battery plants without end-cells and 23- cell 303A plants with automatic switching for additionally charging either 2- or 4- end cells. The KS-20489 rectifiers are initially intended for use in the 300-type power plants but may be used wherever their characteristics and design apply. The rectifiers operate on a 3-phase, 3-wire, 57- to 63-Hz alternating current. The L11 and L21 rectifiers operate on an ac input voltage of 186 to 253 volts (depending on tap settings) and the L12 and L22 rectifiers on an ac input voltage of 430 to 506 volts. The nominal output of these rectifiers is 48 volts, 400 amperes.

1.02 The issue does not affect the Equipment Test List.

Warning: The voltages in this unit exceed 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. Do not apply AC power to rectifier except when checking voltages, currents, or waveforms.

1.03 This section is based on drawing SD-81995-01, Issue 2A. If this section is to be used with equipment or apparatus reflecting later issue(s) of the drawing(s) 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.

1.04 For more detailed information on the operation of the KS-20489 rectifier, refer to Section 169-741-301. Procedures for maintaining the input and output switches of the KS-20489 rectifier are contained in Section 169-741-701.

2. LIST OF TEST APPARATUS

CODE OR SPEC NO.	DESCRIPTION
TEST APPARATUS	
KS-14510	Volt-Ohm Milliammeter
KS-8039	DC Volt-Milliammeter
-	Weston Model 904 AC Voltmeter
-	Oscilloscope, Tektronix 545B (or equivalent)

3. OPERATION

3.01 Normal operation of the KS-20489 L11, L12, L21, and L22 rectifiers shall be in accordance with Section 169-741-301. In the event of a trouble condition, the rectifier should be removed from service and restored to service in accordance with Section 169-741-301 or the section on the power plant in which the rectifier is installed. Before restoring the rectifier to service, it should be checked in accordance with 3.02.

3.02 ***Restoring the Rectifier to Service After a Trouble Condition:*** Under all trouble conditions, before placing the rectifier back in service, proceed as follows.

(1) Operate the associated switch and fuse unit in the duct or in the power service cabinet to the ON position.

(2) Operate the DC OUTPUT (S3) switch to the TEST position.

(3) Operate the POWER ON/OFF (S1) switch to the POWER ON position.

(4) Check Full Load Current Limit as follows.

(a) Verify that the SIMULATED OUTPUT CURRENT (R25) potentiometer is rotated fully ccw.

(b) Connect the KS-14510 volt-ohm-milliammeter, set on the 3 DC volts scale, to the rectifier + CURRENT LIMIT (TP3) and – CURRENT LIMIT (TP4) test jacks.

Note: Allow the rectifier to operate for at least 15 seconds before operating the SIMULATED OUTPUT CURRENT (S2) switch to the ON position.

(c) Operate the SIMULATED OUTPUT CURRENT (S2) switch to the ON position.

Requirement: The SIMULATED OUTPUT CURRENT ON (white) lamp lights and the SIMULATED OUTPUT CURRENT OFF (white) lamp extinguishes.

(d) Rotate the SIMULATED OUTPUT CURRENT (R25) potentiometer cw until the rectifier OUTPUT CURRENT (M1) ammeter indicates 400 amperes.

Requirement: The KS-14510 meter indicates between 0 and 0.5 volt.

(e) If requirement is not met, refer to 4.08 in Section 169-741-301, to adjust full load current limit.

(5) Rotate the SIMULATED OUTPUT CURRENT (R259) potentiometer fully ccw.

(6) Restore rectifier to service per Section 169-741-301 or the section on the power plant in which the rectifier is installed.

4. TROUBLESHOOTING PROCEDURES

4.01 Failure of the KS-20489 rectifier will usually be characterized by one of three conditions.

- Operated fuses and consequent loss of output
- Loss of output without operated fuses
- Incorrect output

The trouble flow chart in Fig. 1 is designed to analyze troubles in the rectifier from the standpoint of these three symptoms. The flow chart should be utilized in the following manner.

(a) When using the trouble flow chart, after a rectifier trouble has occurred, it must be determined whether the rectifier has no output or an incorrect output.

(b) If the rectifier has no output, it must be determined if the rectifier has operated fuses.

(c) If fuses are operated, the operated fuse should be located on the flow chart and reference should be made to the trouble chart indicated.

(d) If no fuses are operated, the cause of no output should be located on the flow chart and reference should be made to the trouble chart indicated.

(e) If the rectifier has an incorrect output, the characteristic of the output should be located on the flow chart and reference should be made to the trouble chart indicated.

(f) The steps in the trouble charts should be followed in the order given to determine the rectifier trouble or defective component. Reference will be made in the trouble charts to the test charts which give further tests of circuit packs and aid in isolating defective components.

4.02 When the rectifier fails, try to locate the trouble before subjecting the rectifier to restart attempts. Repeated attempts to restart the rectifier before correcting the trouble condition may damage other rectifier components.

4.03 As a general troubleshooting procedure, check for faulty connections, broken, burned or shorted wires. Inspect the harness wiring and leads from all components for possible breaks and shorts. Check that no adjacent terminals or lugs

touch together. Check that all solder and pressure points make good electrical contact using a volt-ohmmeter. Inspect for evidence of poor connections at switch and bus joints. The main load-carrying bolted connections should be tightened (including squeeze-connected lugs) about six weeks after installation cutover and once each year thereafter.

4.04 When a trouble is traced to a circuit pack, replace it with the proper new or repaired circuit pack. ***Do not attempt to repair defective circuit packs unless personnel are equipped and trained to repair circuit packs.*** Return the defective circuit pack to the authorized repair facility in accordance with local instructions.

4.05 The following precautions should be observed prior to and during the interval of detecting and clearing troubles in the rectifier.

(a) ***Do not apply AC power to rectifier except when checking voltages, currents, or waveforms. To completely isolate the rectifier from the AC line, the branch circuit AC disconnect must be open.***

(b) ***Plus of battery is grounded. When using an oscilloscope or any other test equipment powered from the AC line which has one probe connected to the chassis, that probe must always be connected to ground potential when troubleshooting the rectifier.***

(c) ***Under no circumstances should fuses of higher rating than those specified be used.***

(d) ***Use extreme caution when handling wrenches to prevent any inadvertent shorts of the DC voltage. The same caution should be used with test leads.***

(e) ***If rectifier is faulty and high voltage is experienced in the TEST position, do not operate rectifier with outputs above 75 volts DC since this exceeds ratings of output capacitors.***

(f) ***If rectifier is faulty and operates at currents in excess of 420 amperes in BAT position, do not operate rectifier for extended periods since this load exceeds rating of the rectifier.***

TROUBLE CHARTS AND TESTS

4.06 TROUBLE CHARTS 1 through 7 refer to operated fuses, TROUBLE CHARTS 8 and 9 refer to shutdown or rectifier failure in which no fuses are operated, and TROUBLE CHARTS 10 and 11 refer to an incorrect output.

4.07 ***Test Point Symbols:*** The test point symbols are stamped on circuit packs. Test points and component designations are used for troubleshooting orientation. Voltages and waveforms are included in the schematic drawings.

Note 1: Whenever a test procedure requires testing a circuit pack, and components or test points are not accessible, the circuit pack board extender (CP10) furnished with the rectifier should be used.

Note 2: When checking the possible cause of trouble, a (+) or (−) symbol after the component or test point indicates the polarity of the terminal. This should always be considered when connecting any test apparatus.

4.08 The following cautions should be observed while operating or performing maintenance on the rectifier.

Warning: Voltages inside the rectifier are over 150 volts to ground. Avoid all contact with terminals.

Caution 1: Do not remove any plug-in circuit pack while rectifier is in operation. Remove power from the circuit before removing and replacing circuit packs.

Caution 2: The POWER ON/OFF (S1) switch must be operated to the POWER OFF position to shut down the rectifier before the DC OUTPUT (S3) switch is operated from one position to another.

Caution 3: With the rectifier shut down and disconnected from the battery [DC OUTPUT S3 switch in the OFF position], the filter capacitors in the rectifier will discharge in approximately 1 minute. The output capacitors should be charged in accordance with 169-741-301 prior to operation of the DC OUTPUT (S3) switch to the battery or EC position.

Caution 4: Operation of the rectifier while a trouble exists may cause additional failures of some components. It is essential, while testing, to be alert to the need of quickly shutting down the rectifier until the trouble is localized and corrected.

Caution 5: The SIMULATED OUTPUT CURRENT R25 rheostat should always be returned to the fully ccw position when not in use.

Caution 6: The simulated output current circuit should be disabled when an external resistive load is connected to the + TEST and – TEST lugs and the DC OUTPUT switch is in the TEST position. This circuit is disabled if the SIMULATED OUTPUT CURRENT S2 pushbutton is in the OFF position.

Caution 7: When making the current limit adjustments, especially when R23 and R34 are fully cw, the rectifier is subject to excessive damage if a fault which draws excessive overload current were to develop.

Caution 8: Make certain circuit packs are correctly inserted into circuit board extender. The connector on the circuit board extender is for universal fit and will accept a circuit pack inserted upside down. If circuit packs are incorrectly inserted, damage may occur by incorrect voltage application.

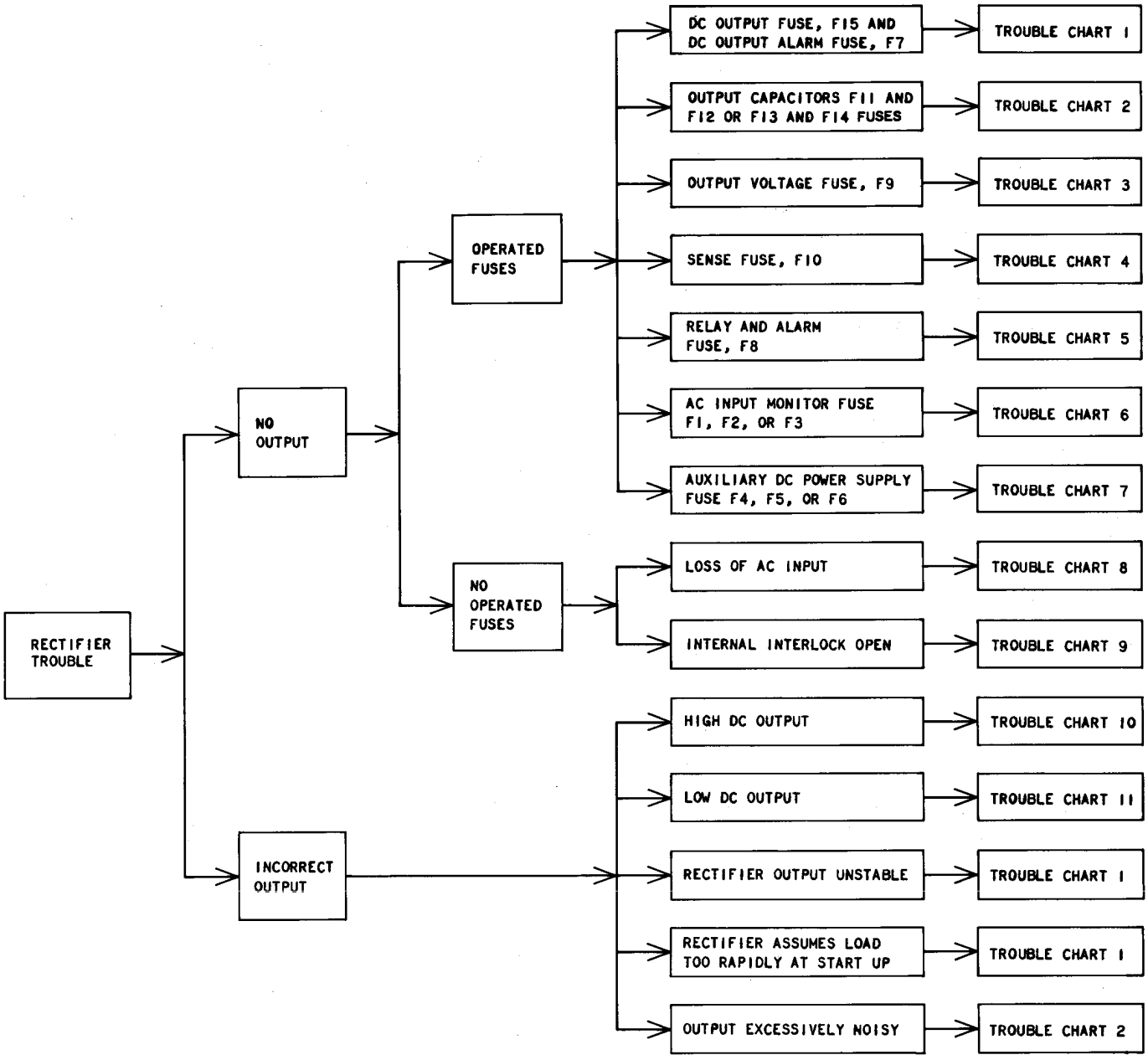

Fig. 1—Trouble Flow Chart

TROUBLE CHART 1

NO DC OUTPUT (DC Output Fuse, F15 and DC Output Alarm Fuse, F7 Operated)

LAMP INDICATION	METER INDICATION	PLANT SIGNALS
POWER ON	OUTPUT VOLTAGE — Battery Voltage	RFA
POWER OFF	OUTPUT CURRENT — 0	Open circuit on leads CA and CB (L11 and L12)
RECT FAIL		

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
A. Shorted power thyristor Q1-Q6 or shorted power thyristor anode cable.	1. Operate POWER ON/OFF (S1) switch to POWER OFF. 2. Operate DC OUTPUT (S3) switch to OFF. 3. Operate switch and fuse unit in bus duct or power service cabinet to OFF. 4. Remove RELAY AND ALARM fuse, F8. 5. Disconnect plant circuit connection, J10 from PLANT CONTROL DISCONNECT plug, P10. *Note:* If fuses F15 and F7 operated when rectifier was in test mode of operation and supplying power to an external test load, turn rectifier off and disconnect external test load before proceeding with any trouble shooting tests. 6. Measure anode to cathode resistance of power thyristors by connecting KS-14510 meter, set on X1 ohm scale, across anode to cathode terminals (3 to 1) of power thyristor Q1. 7. Meter should indicate approximately 12 ohms. 8. If meter indicates high resistance, reverse meter lead connections. 9. If requirement is met, proceed to B.	

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
	10. If meter indicates approximately zero ohms, one or more of power thyristors are shorted, one of their anode cables are shorted to ground, or one of the secondary windings of MAIN TRANSFORMER, T1 is shorted to ground. Proceed to 13.	
	Note: Note method of anode cable connections at time of disconnect. At completion of tests or repairs, reconnect anode cables in same manner. Use same hardware to make connections, do not use substitutes for required hardware as this may effect rectifier operation.	
	11. Disconnect anode cables from power thyristors Q1-Q6.	
	12. Check for shorted thyristor, grounded anode cable or grounded transformer winding.	Replace shorted thyristor, unground anode cable, unground transformer winding, or replace transformer if short is internal.
	Note: A good thyristor will measure high resistance (open circuit) between anode to cathode, and cathode to anode.	
	14. At completion of troubleshooting tests for A, install fuse F8 and reconnect J10 to P10.	
B. Faulty operation of the DC output fuse, F15.	1. Check for defective fuses and connections.	Replace fuses or repair connections as necessary.
	2. Turn on AC input service.	
	3. Start rectifier in accordance with Section 169-741-301.	
	4. If fuses F15 and F7 are again operated, proceed to C.	Replace fuses F15 and F7.
C. Faulty operation of CURRENT LIMIT AND SIMULATED OUTPUT CURRENT (CP6) circuit. (Excessive output current.)	1. Turn rectifier off per A (1) (2).	
	2. Replace fuses F15 and F7.	

TROUBLE CHART 1 (CONT)

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
	3. Place rectifier in test mode of operation in accordance with Section 169-741-301.	
	4. If output voltage is high, proceed to D.	
	5. Perform Full Load Current Limit Check in accordance with Section 169-741-301.	
	Note: A fault in voltage regulating circuit may mask operation of the CP6 circuit pack.	
	6. To verify operation, turn rectifier off.	
	7. Remove CP6 circuit pack.	
	8. Install printed board extender and CP6 in the rectifier.	
	9. Connect the KS-14510 meter, set on 60 DC volt scale, between TP10 (—) [CLS] and TP21 (+) [GRD] on extender.	
	10. Turn rectifier on per Section 169-741-301.	
	11. If CP6 is not defective, meter will indicate negative going CLS voltage.	
	12. If check indicates proper operation, remove printed board extender, replace CP6, and proceed to E.	
	13. If check indicates faulty operation of the circuit, CP6 is defective.	Replace CP6 with a factory tested circuit pack.
	Note: See Test Chart 6 on CP6 for locating defective components.	

TROUBLE CHART 1 (CONT)

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
D. Faulty operation of VOLTAGE REGULATOR (CP5) circuit.	1. Perform Output Voltage Check per Section 169-741-301.	
	2. If Output Voltage Check indicates a fault in voltage regulating circuitry, turn rectifier off before proceeding with step 3 of D.	
	3. Remove VOLTAGE REGULATOR (CP5) circuit pack from rectifier.	
	4. Install printed board extender in CP5 position in rectifier.	
	5. Connect a jumper from TP8 to TP9 on extender to close interlock path.	
	6. Connect a jumper from TP2 (FAC) to TP28 (+14) on extender.	
	7. Place rectifier in test mode of operation in accordance with Section 169-741-301.	
	8. If OUTPUT VOLTAGE (M2) voltmeter indicates zero volts, CP5 is defective.	Replace CP5 with a factory tested circuit pack.
	9. If output voltage is above zero volts, turn rectifier off, remove extender board, and install CP5. Proceed to E.	
	Note: See Test Chart 5 on CP5 for locating defective components.	
E. Faulty operation of PULSE (CP2) circuit. (Excessive output current.)	1. Turn rectifier off per A (1) (2).	
	2. Remove PULSE (CP2) circuit pack from rectifier and in its place install printed board extender.	
	3. Connect a jumper from TP22 to TP23 on extender board to close the interlock path.	

TROUBLE CHART 1 (CONT)

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
	4. Place rectifier in test mode of operation in accordance with Section 169-741-301.	
	5. If OUTPUT VOLTAGE (M2) voltmeter indicates a voltage greater than zero volts, turn off rectifier, remove printed board extender and install CP2 in rectifier. Then proceed to F.	
	6. If indicated voltage is zero volts, CP2 is defective.	Replace CP2 with a factory tested circuit pack.
	Note: See Test Chart 2 on CP2 for locating defective components.	
F. Faulty operation of PULSE BOOST (CP3) circuit. (Excessive output current.)	1. Turn rectifier off per A (1) (2).	
	2. Remove PULSE BOOST (CP3) circuit pack from rectifier and in its place install printed board extender.	
	3. Connect a jumper from TP15 to TP16 on extender board to close interlock path.	
	4. Place rectifier in test mode of operation in accordance with Section 169-741-301.	
	5. If OUTPUT VOLTAGE (M2) voltmeter indicates a voltage greater than zero volts, turn off rectifier, remove printed board extender and install CP3 in rectifier. Than proceed to G.	
	6. If indicated voltage is zero volts, CP3 is defective.	Replace CP3 with a factory tested circuit pack.
	Note: See Test Chart 3 on CP3 for locating defective components.	

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
G. Defective DC OUTPUT (S3) switch	1. Look for indications of excessive heat (discoloration). 2. Check clips for contact closure visually. 3. Check for loose connections on switch. 4. Check for blown AC fuse.	Refer to Section 169-741-701 for switch maintenance.

TROUBLE CHART 2

NO DC OUTPUT (Output capacitors [A] fuses, F11 and F12 or Output Capacitors [B] fuses F13 and F14 Operated)

LAMP INDICATION	METER INDICATION	PLANT SIGNALS
POWER ON	OUTPUT VOLTAGE — Battery Voltage	RAF
POWER OFF	OUTPUT CURRENT — 0	Open circuit on leads CA and CB (L11 and L12)
RECT FAIL		

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
A. Shorted output filter capacitor C1-C8 (for fuses F11 and F12).	1. Operate POWER ON/OFF (S1) switch to POWER OFF. 2. Operate DC OUTPUT (S3) switch to OFF. 3. If fuses operated when rectifier was in test mode of operation and supplying power to an external test load, disconnect external test load before proceeding with step 4 of A. 4. Determine if there is any voltage left on capacitors associated with operated fuses by connecting KS-14510 meter, set on 60 volt DC scale, across capacitor bank's bus bars (observe correct meter lead polarities). 5. If meter indicates zero volts, proceed to 6. *Note:* The 300-ohm discharge resistors, R7 and R8, should have completely discharged the capacitors (banks [A] and [B]) within 1.5 minutes after operation of the fuses. 6. Connect KS-14510 meter, set on the X1 ohm scale, across capacitor bank's plus (+) and minus (—) bus bars for at least 1 minute. 7. If meter indicates greater than zero ohms, proceed to B.	

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
	8. If meter indicates zero ohms, disconnect bus bars from capacitors and check each capacitor for shorted condition.	Replace capacitors as necessary.
	Note: Note method of bus bar connections to capacitors at time of disconnect. At completion of repairs, reconnect in same manner using same hardware. Do not substitute for required hardware as this may effect rectifier operation. Use approved antiseize compound on screw threads when reconnecting capacitors to bus bars.	
B. Faulty operation of fuse F11 and F12 or F13 and F14.	1. Replace operated fuses F11 and F12 or F13 and F14.	
	2. Start rectifier in accordance with test mode procedure in Section 169-741-301.	
	3. If fuses are again operated, proceed to C.	
C. Excessive output ripple current caused by loss of power thyristor gate pulses.	1. Operate POWER ON/OFF (S1) switch to POWER OFF.	
	2. Operate DC OUTPUT (S3) switch to OFF.	
	3. Replace operated fuses F11 and F12 or F13 and F14.	
	Note: Set controls on Tektronix 545B oscilloscope for dual-trace display. Use external triggering. Set Time Base for 2 mSec/CM and voltage attenuators for 1 volt/CM display. Connect External Trigger input terminal to input terminal of CHANNEL 1 of 1A2 plug-in. Set INPUT SELECTORS to AC.	
	Caution: Before connecting oscilloscope ground to rectifier ground, make certain these two grounds are at the same electrical potential. Use KS-14510 meter set on the 60 volt DC scale, to make this check. If meter indicates greater than zero volts, isolate the oscilloscope's AC input ground,	

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
	using an AC isolation plug, in accordance with procedures in appropriate Bell System Practice.	
	4. To determine if required gate to ground pulses are present on power thyristors, Q1-Q6, connect gate (terminal 2) of power thyristor Q3 to the input of Channel 1 of 1A2 plug-in.	
	5. Connect gate (terminal 2) of power thyristor Q6 to the input of Channel 2 of 1A2 plug-in.	
	6. Connect oscilloscope ground to cathode (terminal 1) of either power thyristor.	
	Note: This is the common GRD 1 bus bar.	
	7. Place rectifier in the test mode of operation in accordance with Section 169-741-301.	
	Note: The observed waveforms should compare with those shown in FS2 of SD-81995-01.	
	8. At completion of test, operate POWER ON/OFF (S1) switch to POWER OFF.	
	9. Repeat gate to ground waveform checks for power thyristor pairs Q1 and Q4, then Q2 and Q5.	
	10. If any of the gate pulses are missing in waveforms observed in step 7 and 9, operate POWER ON/OFF (S1) switch to POWER OFF.	
	11. Operate DC OUTPUT (S3) switch to OFF.	
	12. Check PULSE (CP2), PULSE BOOST (CP3) as in E and F of Trouble Chart 1.	Replace CP2 and CP3, if necessary, with a factory tested circuit pack.

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
	13. If CP2 and CP3 are not defective, PULSE LOGIC (CP4) is defective.	Replace CP4 with a factory tested circuit pack.
	Note: See Test Chart 2 on CP2, Test Chart 3 on CP3, and Test Chart 4 on CP4 for locating defective components.	

TROUBLE CHART 3

NO DC OUTPUT (Output Voltage Fuse, F9 Operated)

LAMP INDICATION	METER INDICATION	PLANT SIGNALS
POWER ON	OUTPUT VOLTAGE — 0	RFA
POWER OFF	OUTPUT CURRENT — 0	Open circuit on leads CA and CB (L11 and L12)
RECT FAIL		

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
A. Shorted OUTPUT VOLTAGE (M2) voltmeter.	1. Operate POWER ON/OFF (S1) switch to POWER OFF.	
	2. Operate DC OUTPUT (S3) switch to OFF.	
	3. Remove operated OUTPUT VOLTAGE fuse, F9.	
	4. Check resistance of OUTPUT VOLTAGE (M2) voltmeter by connecting KS-14510 meter, set on X10,000 ohm scale, across M2 voltmeter terminals.	
	Note: A nonshorted meter will indicate approximately 75,000 ohms on KS-14510 meter.	
	5. If meter measurement is zero ohms, M2 voltmeter is defective.	Replace M2 voltmeter as necessary. Check for loose test meter lead causing inadvertant short.
	6. At completion of repairs or meter replacement, install a nonoperated OUTPUT VOLTAGE fuse, F9 of required type in appropriate fuse holder before restoring rectifier to service in accordance with Section 169-741-301.	

TROUBLE CHART 4

NO DC OUTPUT (Sense Fuse, F10 Operated)

LAMP INDICATION	METER INDICATION	PLANT SIGNALS
POWER ON	OUTPUT VOLTAGE — Battery Voltage	RFA
POWER OFF RECT FAIL	OUTPUT CURRENT — 0	Open circuit on leads CA and CB (L11 and L12)

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
A. Shorted or accidental grounding of- SENSE TEST JACK, TP2.	1. Operate POWER ON/OFF (S1) switch to POWER OFF.	
	2. Operate DC OUTPUT (S3) switch to OFF.	
	3. Remove operated — SENSE fuse, F10.	
	4. Check for a ground short between terminal C of — SENSE test jack, TP2 and ground using KS-14510 meter, set on the X1 ohm scale.	Repair as necessary
	5. If meter indicates zero ohms, inspect lead from — SENSE test jack, TP2 and terminal C of the — SENSE fuse, F10 fuseholder for a short to ground.	Repair or replace lead as necessary.
	Note: If a ground short is not detected, it is possible that an external meter lead was inadvertently grounded during testing which operated — SENSE fuse F10.	Install a nonoperated F10 fuse of required type.
	6. Restore rectifier to service accordance with procedures in Section 169-741-301.	

TROUBLE CHART 5

NO DC OUTPUT (Relay and Alarm Fuse, F8 Operated)

LAMP INDICATION	METER INDICATION	PLANT SIGNALS
RECT FAIL	OUTPUT VOLTAGE — Battery Voltage	RFA
	OUTPUT CURRENT — 0	Open circuit on leads CA and CB (L11 and L12)

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
A. —48 lead shorted to ground or excessive current due to defective circuit pack component.	1. Operate POWER ON/OFF (S1) switch to POWER OFF. 2. Operate DC OUTPUT (S3) switch to OFF. 3. Remove operated RELAY AND ALARM fuse, F8. 4. Check total parallel resistance of loads on —48 lead using KS-14510 meter, set on X10 ohm scale. 5. Connect meter between terminal C of RELAY AND ALARM fuse, F8 fuse holder and ground. 6. Meter should indicate approximately 250 ohms if all —48 lead loads are not defective. 7. If meter indicates low resistance or zero ohms, one of —48 lead loads is defective. 8. To locate defective component, connect KS-14510 meter, set on the X10 ohm scale, between terminal C of fuse F8 fuse holder and ground. 9. Remove following circuit packs from rectifier, one at a time: PULSE (CP2), CURRENT LIMIT AND SIMULATED OUTPUT CURRENT (CP6), RELAY AND ALARM (CP7), HIGH VOLTAGE MONITOR (CP8), and AC INPUT VOLTAGE MONITOR CIRCUIT (CP9).	

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
	10. If meter indicates removal of short when a particular circuit pack is removed, that circuit pack is defective.	Replace with a factory tested circuit pack.
	11. If short indication remains after all above circuit packs have been tried, proceed to B.	
	Note: See associated Test Chart for any defective circuit pack to locate defective components.	
B. AC INPUT CONTACTOR (ST2) coil is shorted.	1. Operate switch and fuse unit in bus duct or power service cabinet to OFF.	
	Note: This will remove AC input voltage from contacts of AC INPUT CONTACTOR (ST2).	
	2. Check resistance of AC INPUT CONTACTOR (ST2) coil by connecting KS-14510 meter, set on X10 ohm scale, between terminals C3 (GND) ohm and C4 of ST2 coil.	Replace ST2 coil if shorted.
	Note: If coil is not shorted meter will indicate approximately 125 ohms.	
	3. If ST2 coil does not appear to be shorted, check all wiring associated with —48, terminal C of F8 fuse holder.	Repair or replace wiring as necessary.

TROUBLE CHART 6

NO DC OUTPUT (AC Input Voltage Monitor Fuse F1, F2, or F3 Operated)

LAMP INDICATION	METER INDICATION	PLANT SIGNALS
POWER ON	OUTPUT VOLTAGE — Battery Voltage	Open circuit on leads CA and CB (L11 and L12)
POWER OFF	OUTPUT CURRENT — 0	

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
A. Ground short on the AC input voltage monitor transformer, T5 wiring.	1. Operate POWER ON/OFF (S1) switch to POWER OFF.	
	2. Operate DC OUTPUT (S3) switch to OFF.	
	3. Operate switch and fuse unit in bus duct or power service cabinet to OFF to remove AC input to the rectifier.	
	4. Remove AC INPUT VOLTAGE MONITOR fuses F1, F2, and F3 and AC INPUT VOLTAGE MONITOR CIRCUIT (CP9) from the rectifier.	
	5. Check for ground shorts on AC INPUT VOLTAGE MONITOR TRANSFORMER (T5) primary and secondary wiring by connecting KS-14510 meter, set on X1 ohm scale, between each transformer, T5 terminal and ground.	Repair or replace T5 transformer as necessary.
	6. If a ground short is not detected, proceed to B.	
B. Defective AC input voltage monitor transformer T5.	1. Measure cold dc resistance of T5 transformer's primary windings using KS-14510 meter, set on X1000 ohms scale.	
	Note: Winding resistance values given are with fuses F1, F2, and F3 removed and AC INPUT VOLTAGE MONITOR CIRCUIT (CP9) pack removed.	
	2. Windings 1 to 2, 1 to 3, and 2 to 3 shall each measure approximately 6,000 ohms.	Replace T5 transformer if defective.

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
	3. Measure secondary windings with KS-14510 meter, set on the X10 ohm scale.	
	4. Each secondary winding 4 to 7, 5 to 7, and 6 to 7 shall measure approximately 120 ohms.	
	5. If windings do not appear defective, proceed to 6.	
	6. Install nonoperated fuses F1, F2, and F3 of required type in their respective fuse holders.	
	7. With CP9 circuit pack removed from rectifier, operate switch and fuse unit in the bus duct or power service cabinet to ON.	
	8. If fuses F1, F2, or F3 operate when AC input service is turned on, T5 transformer is defective.	Replace T5 transformer.
	9. Measure and record the AC voltages across each of primary windings of T5 transformer using Weston Model 904, AC voltmeter, connected for 300 volt scale for List 11 and List 21 rectifiers or connected for 750 volt scale for List 12 and List 22 rectifiers.	
	10. Record each winding measurement separately.	
	Note: Each winding measurement will be used to calculate voltage ratio of each phase for comparision with ratio appearing in Information Note 305 on SD-81995-01.	
	11. Measure and record voltages across each of the secondary windings of T5 transformer using Weston Model 904 AC voltmeter, connected for appropriate voltage scale.	
	12. Calculate voltage ratio for each phase by dividing measured primary winding voltage by measured secondary winding voltage.	

TROUBLE CHART 6 (CONT)

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
	Note: Voltage ratios of measured values should not differ from ratio requirements appearing in Information Note 305 on SD-81995-01.	
	13. If voltage ratio requirements are met, proceed to C.	
	14. If voltage ratio requirements are not met, transformer T5 is defective.	Replace T5 transformer.
C. Faulty AC INPUT VOLTAGE MONITOR Circuit (CP9).	1. AC INPUT VOLTAGE MONITOR Circuit (CP9) is defective.	Replace CP9 with a factory tested circuit pack.
	Note: See Test Chart 9 on CP9 for locating defective components.	

TROUBLE CHART 7

NO DC OUTPUT (Auxiliary DC Power Supply Fuse F4, F5, or F6 Operated)

LAMP INDICATION	METER INDICATION	PLANT SIGNALS
POWER ON	OUTPUT VOLTAGE — Battery Voltage	RFA
POWER OFF	OUTPUT CURRENT — 0	Open circuit on leads CA and CB (L11 and L12)
RECT FAIL		

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
A. Shorted primary winding on the PULSE CIRCUIT TRANSFORMER (T2), AUX DC POWER SUPPLY TRANSFORMER (T4), or AC FUSE MONITOR TRANSFORMER (T6).	1. Operate POWER ON/OFF switch (S1) to POWER OFF. 2. Operate DC OUTPUT (S3) switch to OFF. 3. Remove AC input to rectifier by operating switch and fuse unit in bus duct or power service cabinet to OFF. 4. Remove AUX DC POWER SUPPLY fuses F4, F5, and F6. 5. Allow T2, T4, and T6 transformers to cool. 6. Measure parallel primary winding resistance across following points using KS-14510 meter set on X10 ohm scale: Terminal 2 of F4 fuse holder to terminal 2 of F5 fuse holder, terminal 2 of F5 fuse holder to terminal 2 of F6 fuse holder, and terminal 2 of F6 fuse holder to terminal 2 of F4 fuse holder. *Note:* Meter should indicate approximately 210 ohms when transformers are cold. 7. If requirement is met, proceed to B. 8. If requirement is not met and meter indicates low resistance, proceed to step 9. 9. Disconnect primary wiring from the T2, T4, and T6 transformer terminals.	

TROUBLE CHART 7 (CONT)

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
	Note: For ease of reconnection, tag each disconnected wire as it is removed from the transformer terminal.	
	10. Check for shorted wiring using KS-14510 meter, set on X1 ohm scale.	
	11. Check primary winding resistances of each transformer using KS-14510 meter.	
	12. If primary winding resistance of any transformer is very low or zero, that transformer is defective.	Replace defective transformers.
B. Shorted secondary winding on the PULSE CIRCUIT TRANSFORMER (T2). (See E.)	1. Remove AUX DC POWER SUPPLY (CP1), PULSE (CP2), PULSE BOOST (CP3), and PULSE LOGIC (CP4) circuit packs from rectifier.	
	2. Install printed board extender in CP2 position on rectifier.	
	3. Measure resistance between following points on printed board extender using KS-14510 meter, set on X1000 ohm scale: TP3 to TP2, TP4 to TP2, and TP5 to TP2 for secondary No. 2 of transformer T2.	
	Note: Meter should indicate approximately 8,000 ohms for each measurement.	
	4. This measurement includes a 7,500 ohm resistor in series with each winding of secondary No. 2 of T2 transformer.	
	5. To check the transformer winding resistances, measure across T2 transformer terminals only with meter set on X100 ohm scale.	
	Note: Each winding shall measure approximately 500 ohms.	
	6. If the 8000 ohms resistance is met, proceed to step 8.	

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
	7. If it is not, transformer T2 is defective.	Replace T2 transformer.
	8. Remove printed board extender from CP2 position and install it in CP3 position.	
	9. Measure winding resistances of secondary No. 3 of T2 transformer by connecting KS-14510 meter, set on X10 ohm scale, between following points on printed board extender: TP5 to TP6, TP9 to TP10, and TP21 to TP22.	
	Note: Meter should indicate approximately 100 ohms for each winding.	
	10. If requirement is met, proceed to step 12.	
	11. If it is not, T2 transformer is defective.	Replace T2 transformer.
	12. Remove printed board extender from CP3 position and install it in CP4 position.	
	13. Measure winding resistances of secondary No. 1 of the T2 transformer by connecting KS-14510 meter, set on the X1 ohm scale, between following points on the printed board extender: TP2 to TP3, TP3 to TP10, and TP10 to TP2.	
	Note: Meter should indicate approximately 2.5 ohms for each winding.	
	14. If the requirement is met, proceed to C.	
	15. If the requirement is not met, transformer T2 is defective.	Replace T2 transformer.

TROUBLE CHART 7 (CONT)

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
C. Shorted secondary winding on the AUXILIARY DC POWER SUPPLY TRANSFORMER (T4). (See E.)	1. Remove printed board extender from CP4 position and install it in CP1 position.	
	2. Measure winding resistances of secondary No. 3 of T4 transformer by connecting KS-14510 meter, set on X10 ohm scale, across following points on the printed board extender: TP4 to TP5, TP5 to TP6, and TP6 to TP4.	
	Note: Meter should indicate approximately 40 ohms for each winding.	
	3. If requirement is met, proceed to step 5.	
	4. If the requirement is not met, transformer T4 is defective.	Replace T4 transformer.
	5. Measure winding resistances of secondaries No. 2 and No. 1 of T4 transformer by connecting KS-14510 meter, set on X1 ohm scale, across following points on printed board extender: TP15 to TP16, TP16 to TP17, and TP17 to TP15 for secondary No. 2; TP20 to TP21, TP21 to TP22, and TP22 to TP20 for secondary No. 1.	
	Note: Meter should indicate approximately 9 ohms for each winding.	
	6. If requirement is met, proceed to D.	
	7. If requirement is not met, transformer T4 is defective.	Replace T4 transformer.
D. Shorted secondary winding on the AC FUSE MONITOR TRANSFORMER (T6). (See E.)	1. Remove printed board extender from CP1 position and AC INPUT VOLTAGE MONITOR (CP9) circuit pack from rectifier.	
	2. Install printed board extender in CP9 position in rectifier.	

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
	3. Measure secondary winding resistances of T6 transformer by connecting KS-14510 meter, set on X10 ohm scale, across the following points on printed board extender: TP1 to TP2, TP23 to TP2, and TP28 to TP2.	
	Note: Meter should indicate approximately 120 ohms for each winding.	
	4. If requirement is met, proceed to F.	
	5. If requirement is not met, transformer T6 is defective.	Replace T6 transformer.
E. Additional check for shorted T2, T4, or T6 transformer.	*Note:* It is possible that transformer T2, T4, or T6 is shorted (defective) even though winding resistances measured appear to be correct. To verify that transformers are not defective, proceed as follows.	
	Caution: Remove all AC input voltage before removing circuit packs.	
	1. Remove all circuit packs from rectifier except RELAY AND ALARM (CP7) circuit pack.	
	2. Connect a jumper from common side of DC OUTPUT (S3) switch, section 1 (S 3-1) to ground to bypass all circuit pack interlocks and associated relay contacts.	
	Caution: Before making this connection, remove all AC input voltage to rectifier.	
	3. Connect a jumper from terminal 28 of connector J7 to normally open contact of POWER ON/OFF (S1) switch to bypass AC1 relay contacts.	

TROUBLE CHART 7 (CONT)

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
	4. Install nonoperated fuses F4, F5, and F6 in their respective fuse holders in rectifier.	
	5. Operate switch and fuse unit in bus duct or power service cabinet to ON.	
	6. Operate POWER ON/OFF (S1) switch to POWER ON.	
	7. If fuse F4, F5, or F6 operates, turn rectifier off by operating POWER ON/OFF (S1) switch to POWER OFF, if not, proceed to F.	
	8. Operate switch and fuse unit in bus duct or power service cabinet to OFF.	
	9. Disconnect primary winding to one transformer, either T2, T4, or T6 and maintain wiring on remaining transformers.	
	10. Insulate open ends of removed wires.	
	11. Replace operated fuses F4, F5, or F6.	
	12. Energize remaining transformers as in step 5 and 6.	
	13. Repeat process until defective transformer is located.	Replace defective transformer
	14. At completion of tests, turn off rectifier and AC input service.	
	15. Remove jumpers called for in steps 2 and 3.	
	16. Proceed to F.	
F. Faulty CP1, CP2, CP3, CP4, or CP9 circuit pack.	1. Turn rectifier off per A (1)(2).	

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
	2. Operate switch and fuse unit in bus duct or power service cabinet to OFF.	
	3. Remove all circuit packs from rectifier except RELAY AND ALARM (CP7) circuit pack.	
	4. Connect a jumper from common side of DC OUTPUT (S3) switch, section 1 (S3-1) to ground to bypass interlocks.	
	Caution: Before making this connection, remove all AC input voltage to rectifier.	
	5. Connect a jumper from terminal 28 of connector J7 to normally open contact of POWER ON/OFF (S1) switch to bypass the AC1 relay.	
	6. Install nonoperated fuses F4, F5, and F6.	
	7. Operate switch and fuse unit in bus duct or power service cabinet to ON.	
	8. Install CP1 circuit pack in rectifier.	
	9. Operate POWER ON/OFF (S1) switch to POWER ON.	
	10. If fuses F4, F5, or F6 do not operate, turn rectifier off.	
	11. Repeat procedure in steps 8, 9, and 10 for remaining circuit packs until a fuse is operated.	
	12. The circuit pack which caused fuse to operate is defective.	Replace defective circuit pack with factory tested circuit pack.
	13. If no fuse is operated or no circuit pack is defective, proceed to G.	
	Note: See associated Test Chart for any defective circuit pack to locate defective components.	

TROUBLE CHART 7 (CONT)

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
G. No load voltage ratios for transformers T2, T4, and T6.	1. Prepare rectifier as indicated in step 1 through 4 of E. 2. Operate switch and fuse unit bus duct or power service cabinet to ON. 3. Energize transformers by operating POWER ON/OFF (S1) switch to POWER ON. 4. Measure and record primary winding voltages of transformers using Weston, Model 904 AC voltmeter, connected for 300-volt scale for List 11 and List 21 rectifiers or for 750-volt scales for List 12 and List 22 rectifiers. 5. Measure and record secondary winding voltages of transformers using Weston, Model 904 AC voltmeter connected for scale indicated in table below.	

TRANSFORMER	SECTION	FOR TERMINALS	VOLTMETER SCALE
T2	No. 1	14 to 15 15 to 16 16 to 14	15 VOLT
	No. 2	10 to 13 11 to 13 12 to 13	150 VOLT
	No. 3	17 to 19 20 to 21 12 to 13	75 VOLT
T4	No. 1	4 to 5 5 to 6 6 to 4	30 VOLT
	No. 2	7 to 8 8 to 9 9 to 7	30 VOLT

PROBABLE CAUSE	TEST PROCEDURE			CORRECTIVE ACTION
	TRANSFORMER	SECTION	FOR TERMINALS / VOLTMETER SCALE	
		No. 3	10 to 11 11 to 12 12 to 10 30 VOLT	
	T6		4 to 7 5 to 7 6 to 7 15 VOLT	

6. Calculate primary to secondary voltage ratios of each phase by dividing primary voltage of a phase by secondary voltage of same phase.

7. Compare ratios obtained from measured values with values appearing in Information Note 305 on SD-81995-01 for T2, T4, and T6 transformers.

8. If measured ratios differ from those specified in Information Note 305 per that transformer, that transformer is defective. — Replace transformers as necessary.

9. At completion of tests, turn off rectifier and the AC input service.

10. Remove jumpers called for in step 1.

11. Install all circuit packs in the rectifier.

12. Restore rectifier to service in accordance with Section 169-741-301.

TROUBLE CHART 8

NO DC OUTPUT (No visual Fuse Operated)

LAMP INDICATION	METER INDICATION	PLANT SIGNALS
POWER ON	OUTPUT VOLTAGE — Battery Voltage	
POWER OFF	OUTPUT CURRENT — 0	Open circuit on leads CA and CB (L11 and L12)

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
A. Loss of AC input or low AC input voltage.	1. Measure three (3) line to line AC input voltages by connecting Weston, Model 904 AC voltmeter, connected for 300 volt scale for List 11 and List 21 rectifiers or connected for 750-volt scale for the List 12 and List 22 rectifiers, across input terminals L1 to L2, L2 to L3, and L3 to L1 of the AC INPUT CONTACTOR (ST2). *Note:* Voltmeter should indicate each line to line voltage to be within voltage range specified in Section III, Working Limits, of CD-81995-01. 2. Choose correct voltage range corresponding to this installations nominal AC service voltage (208, 240, or 480 volts). 3. If requirements are met, proceed to D. 4. If any of line to line voltages are below required minimum level but not zero, rectifier is operating normally and is in Temporary Shutdown mode. *Note:* In plants where several 48-volt, 400-ampere rectifiers are powered by a common AC input service, it is possible for some rectifiers to continue operating, delivering power to load, when AC service voltage is somewhat lower than required minimum level. This is due to the normal operating tolerances of each rectifier. 5. If any of line voltages measure zero volts, proceed to B.	

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
B. Loss of one of the AC input phase voltages.	1. Operate POWER ON/OFF (S1) switch to POWER OFF.	
	2. Operate DC OUTPUT (S3) switch to OFF.	
	3. Operate switch and fuse unit in bus duct or power service cabinet to OFF.	
	4. Remove AC INPUT fuses [A], [B], and [C] and inspect for possible operated condition.	
	5. If none of fuses are operated, inspect the AC input service cables for an open circuit in accordance with appropriate Power Plant Bell System Practice.	Repair open circuit as necessary
	6. If one of fuses operated, replace it and restart the rectifier in accordance with Section 169-741-301.	
	7. If a fuse is again operated, proceed to C.	Replace operated fuse.
C. Shorted power-primary cable or defective main transformer (T1).	1. Turn rectifier off per B (1)(2).	
	2. Operate switch and fuse unit in bus duct or power service cabinet to OFF.	
	3. Check power-primary cabling for a short to ground using KS-14510 meter set on the X1 ohm scale.	
	4. If a ground short appears in AC service cabling, repair the fault in accordance with procedures in appropriate power plant Bell System Practices.	Repair short as necessary.
	5. Visually inspect power commutating contacts of AC INPUT CONTACTOR (ST2).	
	6. If they appear discolored and require cleaning, refer to appropriate power plant Bell System Practice for maintenance of this contactor.	Clean contacts of ST2.

TROUBLE CHART 8 (CONT)

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
	7. If cleaning does not restore contacts to a usable condition, ST2 contactor is defective.	Replace ST2 contactor.
	8. If a grounding of cabling or defective AC INPUT CONTACTOR (ST2) is not cause of AC input fuse operation, trouble may be due to a power primary line to line short or a shorted winding on MAIN TRANSFORMER (T1).	
	9. To determine which is cause, remove AC INPUT VOLTAGE MONITOR fuses F1, F2, and F3 and AUX DC POWER SUPPLY fuses F4, F5, and F6.	
	10. Operate POWER FACTOR CORRECTION (CB1) circuit breaker to OFF position or remove three (3) power factor fuses.	
	11. Disconnect following power-primary cables from MAIN TRANSFORMER (T1) terminals.	
	Note 1: Check AC input service cabling for line-to-line shorts before disconnecting cables from T1 transformer. Fuses F1, F2, and F3 must be removed from their respective fuse holders and ST2 contactor's power commutating contacts must be in the normally open position before making this check. Use KS-14510 meter, set on X1 ohm scale, to make this check.	
	Note 2: Note method in which these cables are connected to T1 transformer terminals at time of disconnect. At completion of tests and repairs, reconnect cables in same manner. Use same hardware to make the connections. Never substitute for original hardware as this may affect proper rectifier operation.	
	12. For List 11 and List 12 rectifiers, disconnect black color-coded voltage selecting jumpers from terminals 37, 40, and 43.	

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
	13. Tag cable ends for ease of identification and connection.	
	14. Insulate open cable ends.	
	15. For List 21 and List 22 rectifiers, disconnect slate, violet, and white color-coded jumpers from their respective terminals.	
	16. Tag cables for ease of identification and reconnection.	
	17. Insulate open cable ends.	
	18. Check for line to line shorts by connecting KS-14510 meter, set on X1 ohm scale, across terminals T1 to T2, T2 to T3, and T3 to T1 of AC INPUT CONTACTOR (ST2).	Repair shorts as necessary.
	19. If line to line shorts are not detected, reconnect cables removed in 12 or 15.	
	20. Replace fuses removed in 9.	
	21. Operate POWER FACTOR CORRECTION (CB1) circuit breaker to ON or replace fuses, then proceed to step 22.	
	22. To test T1 transformer under no load conditions, remove PULSE LOGIC (CP4) circuit pack from rectifier.	
	23. Install printed board extender in its place.	
	24. Connect a jumper from TP18 to TP19 on printed board extender to close interlock path.	
	25. Disconnect plant circuit connector, J10 from PLANT CONTROL DISCONNECT plug, P10.	
	26. Operate DC OUTPUT (S3) switch to TEST.	

TROUBLE CHART 8 (CONT)

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
	27. Operate switch and fuse unit in bus duct or power service cabinet to ON.	
	28. Energize T1 transformer by operating POWER ON/OFF (S1) switch to POWER ON.	
	29. If any of AC input fuses are operated when MAIN TRANSFORMER (T1) is energized with no load, T1 transformer is defective.	Replace T1 transformer.
	30. Measure and record the MAIN TRANSFORMER (T1) primary and secondary winding voltages using Weston, Model 904 AC voltmeter connected for voltage scale shown in table below.	

FOR RECTIFIER LIST NO.	VOLTMETER CONNECTED FOR (SCALE) PRIMARY WINDINGS	SECONDARY WINDINGS
L11 and L21	300 Volt	150 Volt
L12 and L22	750 Volt	

	31. For each winding measurement, record winding and phase with value for future calculations.	
	32. Calculate primary to secondary voltage ratios by dividing primary voltage for a phase by the secondary voltage for same phase.	
	33. Compare ratios of the measured values with those appearing in Information Note 305 on SD-81995-01.	
	34. The ratios obtained from measured values must agree with those specified in Information Note 305.	
	35. If ratios do not agree, transformer T1 is defective.	Replace T1 transformer.

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
	36. At completion of tests, turn rectifier off and remove AC input from rectifier before starting any repairs.	
	37. Remove printed circuit board extender.	
	38. Install PULSE LOGIC (CP4) circuit pack in rectifier.	
	39. Disconnect jumper from TP18 to TP19 on printed board extender and proceed to D.	
D. Ground on the transfer shutdown (TR) lead.	1. Disconnect plant circuit connector, J10 from PLANT CONTROL DISCONNECT plug, P10.	
	2. Connect KS-14510 meter, set on 60 DC VOLT scale, between terminal G (TR) of PLANT CONTROL DISCONNECT plug, P10 and ground.	
	3. If meter indicates zero volts, internal TR lead from P10 to J7 is shorted to ground.	Repair or replace TR leads as necessary.
	4. If meter indicates battery voltage (approximately 50 volts), plant circuit connector, J10 has ground on TR lead.	Repair or replace as necessary.
	5. Verify operation of Transfer Shutdown per Section 169-741-301.	
	6. If rectifier will not start in test mode, proceed to E.	
E. AC INPUT VOLTAGE MONITOR fuse F1, F2, or F3 operated.	1. Remove AC INPUT MONITOR fuses F1, F2, and F3 from rectifier and check for operated condition.	
	2. If fuse F1, F2, or F3 is operated, refer to Trouble Chart 6 to find cause of trouble.	
	3. If fuses are not operated, proceed to F.	

TROUBLE CHART 8 (CONT)

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
F. Faulty operation of the AC INPUT VOLTAGE MONITOR CIRCUIT (CP9).	1. Turn rectifier off per B (1)(2).	
	2. Remove AC INPUT VOLTAGE MONITOR CIRCUIT (CP9) from rectifier.	
	3. Install printed board extender and CP9 in rectifier.	
	4. Verify that POWER OFF lamp and RECT FAIL lamps are lighted.	
	5. Connect KS-14510 meter, set on X1 ohm scale, across TP4 and TP5 of printed board extender.	
	6. If meter indicates zero ohms, the CP9 circuit pack is not defective.	
	7. If an open circuit is indicated, CP9 is defective.	Replace CP9 with a factory tested circuit pack.
	Note: See Test Chart 9 on CP9 for locating defective components.	

TROUBLE CHART 9

NO DC OUTPUT (No Visual Fuse Operated)

LAMP INDICATION	METER INDICATION	PLANT SIGNALS
POWER ON	OUTPUT VOLTAGE — Battery Voltage	RFA
POWER OFF	OUTPUT CURRENT — 0	Open circuit on leads CA and CB (L11 and L12)
RECT FAIL		

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
A. Internal interlock loop open.	1. Operate POWER ON/OFF (S1) switch to POWER OFF.	
	2. Check to see that all circuit packs, CP1-CP9, are installed properly in rectifier.	Install correctly if necessary.
	3. Check if DC OUTPUT (S3) switch is properly engaged in BAT, EC, or TEST.	Reposition switch if necessary.
	4. Proceed to B.	
B. Defective auxiliary contacts on DC OUTPUT (S3) switch.	1. Remove RELAY AND ALARM (CP7) circuit pack from rectifier.	
	2. Check for proper closure of auxiliary switch S3-1 on DC OUTPUT (S3) switch by connecting KS-14510 meter, set on 60 DC VOLT scale, between terminal 12 of connector J7 and terminal 19 of connector J1.	
	3. Meter should indicate zero volts when DC OUTPUT (S3) switch is in BAT, EC, or TEST.	
	4. If zero volts is not indicated, DC OUTPUT (S3) switch is defective.	Repair or replace DC OUTPUT (S3) switch per Section 169-741-701
	5. If the switch is not defective, install CP7 circuit pack and proceed to C.	

TROUBLE CHART 9 (CONT)

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
C. AUX DC POWER SUPPLY fuse F4, F5, or F6 operated.	1. Remove AUX DC POWER SUPPLY fuses F4, F5, and F6 from rectifier. 2. Inspect each fuse for operated condition. 3. If one of fuses is operated, refer to Trouble Chart 7 to find cause of trouble. 4. If none of fuses are operated, install them in rectifier and proceed to D.	
D. Faulty operation of AC INPUT VOLTAGE MONITOR CIRCUIT (CP9). AC2 relay circuit defective.	1. Remove AC INPUT VOLTAGE MONITOR CIRCUIT (CP9) circuit pack from rectifier. 2. Install printed board extender and CP9 circuit pack in CP9 position in rectifier. 3. Check operation of AC2 relay circuit by operating POWER ON/OFF (S1) switch to POWER ON position and then to POWER OFF position. *Note:* POWER ON and RECT FAIL lamps should extinguish. 4. Operate POWER ON/OFF (S1) switch to POWER ON. 5. If fault still exists, AC INPUT CONTACTOR (ST2) will momentarily operate and rectifier will again go into shut-down and lockout. *Note:* POWER ON, POWER OFF, and RECT FAIL lamps will light. 6. If OUTPUT VOLTAGE (M2) voltmeter indicates high voltage before lockout, proceed to F. 7. Verify closure of AC2-6 make contacts by connecting KS-14510 meter, set on X1 ohm scale, between TP16 and TP17 of printed board extender.	

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
	8. If meter indicates zero ohms, CP9 is not defective.	
	9. If meter does not indicate zero ohms, CP9 is defective.	Replace CP9 with a factory tested circuit pack.
	Note: See Test Chart 9 on CP9 for locating defective components.	
E. Defective AC INPUT CONTACTOR (ST2).	1. Operate POWER ON/OFF (S1) switch to POWER OFF.	
	2. Operate DC OUTPUT (S3) switch to OFF.	
	3. Operate switch and fuse unit in bus duct or power service cabinet to OFF to remove AC input to rectifier.	
	4. Manually operate AC INPUT CONTACTOR (ST2) and check each set of ST2 contacts using KS-14510 meter, set on X1 ohm scale.	
	5. If all contacts are not defective, proceed to F.	
	6. If any contacts are defective, ST2 is defective.	Clean or replace ST2 contactor as necessary.
F. HIGH VOLTAGE MONITOR CIRCUIT (CP8) operated.	1. Operate switch and fuse unit in bus duct or power service cabinet to ON.	
	2. Perform High Voltage Monitor Check per Section 169-741-301.	
	3. If CP8 fails to operate correctly, it is defective.	Replace CP8 with a factory tested circuit pack.
	4. If CP8 performs properly, proceed to G.	
	Note: See Test Chart 8 on CP8 for locating defective components.	

TROUBLE CHART 9 (CONT)

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
G. FUSE ALARM RELAY FA defective or operated.	1. Turn rectifier off per E (1)(2).	
	2. Remove RELAY AND ALARM (CP7) circuit pack from rectifier.	
	3. Install printed board extender and CP7 circuit pack in CP7 position in rectifier.	
	4. Connect KS-14510 meter, set on 60 DC VOLT scale, between TP20(—) and TP21 (+, GRD) on printed board extender.	
	5. Place rectifier in test mode of operation in accordance with Section 169-741-301.	
	Note: KS-14510 meter should indicate zero volts.	
	6. If no voltage is present, proceed to step 8.	
	7. If voltage is present, inspect for operated alarm fuse.	Replace alarm fuse if necessary.
	8. Disconnect KS-14510 meter and connect it, set on X1 ohm scale, between solder type terminals NC (normally closed) and C (Common) for the spare FA-6 contacts in CP7.	
	Note: KS-14510 meter should indicate zero ohms.	
	9. If meter indicates zero ohms, proceed to H.	
	10. If meter does not indicate a short circuit (zero ohms), CP7 is defective.	Replace CP7 with a factory tested circuit pack.
	Note: See Test Chart 7 on CP7 for locating defective components.	

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
H. RECTIFIER FAIL RELAY, RF defective.	1. Disconnect KS-14510 meter.	
	2. Connect meter, set on 60 DC VOLT scale, between TP26 (+, GRD) and TP9 (—) on printed board extender.	
	3. If KS-14510 meter indicates zero volts, CP7 is not defective.	
	4. If meter does not indicate zero, CP7 is defective.	Replace CP7 with a factory test-circuit pack.
	Note: See Test Chart 7 on CP7 for locating defective components.	

TROUBLE CHART 10

HIGH DC OUTPUT (Fuses not Operated)

LAMP INDICATION	METER INDICATION	PLANT SIGNALS
POWER ON	OUTPUT VOLATAGE — Battery Voltage	RFA
POWER OFF	OUTPUT CURRENT — 0	Closed circuit on leads CA and CB (L11 and L12)
RECT FAIL		

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
A. Faulty HIGH VOLTAGE MONITOR CIRCUIT (CP8).	1. Check adjustment of HIGH VOLTAGE MONITOR ADJUST (R24) POTENTIOMETER per Section 169-741-301.	
	2. Operate DC OUTPUT (S3) switch to TEST.	
	3. Energize rectifier by operating POWER ON/OFF (S1) switch to POWER OFF and then to POWER ON.	
	4. If OUTPUT VOLTAGE (M2) voltmeter indicates that rectifier is operating at correct voltage, HIGH VOLTAGE MONITOR CIRCUIT (CP8) may be faulty.	
	5. Check CP8 per Trouble Chart 9 (F).	Replace CP8 with factory tested circuit pack if necessary.
	6. If OUTPUT VOLTAGE (M2) voltmeter indicates high output, proceed to B.	
	Note: See Test Chart 8 on CP8 for locating defective components.	
B. Faulty VOLTAGE REGULATOR circuit (CP5).	1. Operate DC OUTPUT (S3) switch to TEST.	
	Caution: Remove all AC input voltage before removing circuit packs.	
	2. Remove VOLTAGE REGULATOR CIRCUIT (CP5) from rectifier.	

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
	3. Install printed board extender and CP5 circuit pack in CP5 position in rectifier.	
	4. Connect a jumper from TP8 to TP9 and from TP2 to TP28 on printed board extender.	
	5. Energize rectifier by operating POWER ON/OFF (S1) switch to POWER ON.	
	6. If OUTPUT VOLTAGE (M2) voltmeter indicates zero volts, CP5 is defective.	Replace CP5 with a factory tested circuit pack.
	7. If the output voltage remains high, remove the printed board extender and install CP5 in the rectifier. Then proceed to C.	
	Note: See Test Chart 5 on CP5 for locating defective components.	
C. Faulty PULSE CIRCUIT (CP2).	1. Operate DC OUTPUT (S3) switch to OFF.	
	Caution: ***Remove all AC input voltage before removing circuit packs.***	
	2. Remove PULSE CIRCUIT (CP2) from rectifier.	
	3. Install printed board extender and CP2 circuit pack in CP2 position in rectifier.	
	4. Connect a jumper from TP22 to TP23 on printed board extender.	
	5. Operate DC OUTPUT (S3) switch to TEST.	
	6. Energize rectifier by operating POWER ON/OFF (S1) switch to POWER ON.	
	7. If OUTPUT VOLTAGE (M2) voltmeter indicates zero volts, CP2 is defective.	

TROUBLE CHART 10 (CONT)

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
	8. If output voltage remains high, remove printed board extender and install CP2 in rectifier. Then proceed to D.	
	Note: See Test Chart 2 on CP2 for locating defective components.	
D. Faulty PULSE BOOST CIRCUIT (CP3).	1. Operate DC OUTPUT (S3) switch to OFF.	
	Caution: Remove all AC input voltage before removing circuit packs.	
	2. Remove PULSE BOOST CIRCUIT (CP3) from rectifier.	
	3. Install printed board extender in CP3 position in rectifier.	
	4. Connect a jumper from TP15 to TP16 on printed board extender.	
	5. Operate DC OUTPUT (S3) switch to TEST.	
	6. Energize rectifier by operating POWER ON/OFF (S1) switch to POWER ON.	
	7. If OUTPUT VOLTAGE (M2) voltmeter indicates zero volts, CP3 is defective.	Replace CP3 with a factory tested circuit pack.
	Note: See Test Chart 3 on CP3 for locating defective components.	

TROUBLE CHART 11

LOW DC OUTPUT (Fuses Not Operated)

LAMP INDICATION	METER INDICATION	PLANT SIGNALS
POWER ON	OUTPUT VOLTAGE — Battery Voltage OUTPUT CURRENT — 0	Open circuit on leads CA and CB (L11 and L12)

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
A. Parallel rectifier carrying load.	1. Operate DC OUTPUT (S3) switch TEST. 2. Energize rectifier by operating POWER ON/OFF (S1) switch to POWER ON. 3. Check output voltage on M2 against battery voltage. 4. If rectifier operates very near battery voltage with DC OUTPUT (S3) switch in TEST position, rectifier operation is correct. 5. If output voltage is not very near battery voltage, proceed to B.	
B. OUTPUT VOLTS ADJUST not properly set.	1. Adjust output voltage per Section 169-741-301. 2. If output voltage will not adjust correctly, proceed to C.	
C. Faulty CURRENT LIMIT CIRCUIT (CP6).	1. Check adjustment of CURRENT LIMIT (FULL LOAD) (R23) POTENTIOMETER and CURRENT LIMIT (Partial Load) (R34) RHEOSTAT per Section 169-741-301. 2. Operate DC OUTPUT (S3) switch to TEST. 3. Connect KS-14510 meter, set on 12 DC VOLT scale, to CURRENT LIMIT test jacks.	

TROUBLE CHART 11 (CONT)

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
	4. Energize rectifier by operating POWER ON/OFF (S1) switch to POWER ON.	
	5. If KS-14510 meter indicates zero volts but output voltage is low proceed to D.	
	6. If meter does not indicate zero volts, CP6 is defective.	Replace CP6 with a factory tested circuit pack.
	Note: See Test Chart 6 on CP6 for locating defective components.	
D. Faulity VOLTAGE REGULATOR CIRCUIT (CP5).	1. Operate DC OUTPUT (S3) switch to TEST.	
	Caution: ***Remove all AC input voltage before removing circuit packs.***	
	2. Remove VOLTAGE REGULATOR CIRCUIT (CP5) from rectifier.	
	3. Install printed board extender and CP5 circuit pack in CP5 position in rectifier.	
	4. Connect KS-14510 meter, set on the 12 DC VOLT scale from TP26 (+) to TP2 (—) on printed board extender.	
	5. If meter voltage shows negative needle deflection and output voltage is low, CP5 is defective.	Replace CP5 with a factory tested circuit pack.
	6. If meter voltage is zero or positive, and output voltage is low, proceed to E.	
	Note: See Test Chart 5 on CP5 for locating defective components.	
E. Faulty PULSE CIRCUIT (CP2).	1. Test PULSE CIRCUIT (CP2) per Trouble Chart 1 (E).	Replace CP2 with a factory tested circuit pack if necessary.
	2. If CP2 is not defective, proceed to F.	

PROBABLE CAUSE	TEST PROCEDURE	CORRECTIVE ACTION
	Note: See Test Chart 2 on CP2 for locating defective components.	
F. Faulty PULSE BOOST CIRCUIT (CP3).	1. Test PULSE BOOST CIRCUIT (CP3) per Trouble Chart 1 (F).	Replace CP3 with a factory tested circuit pack if necessary.
	2. If CP3 is not defective, proceed to G.	
	Note: See Test Chart 3 on CP3 for locating defective components.	
G. Faulty PULSE LOGIC CIRCUIT (CP4).	1. If CP2 and CP3 are not defective PULSE LOGIC CIRCUIT (CP4) is defective.	Replace CP4 with a factory tested circuit pack.
	Note: See Test Chart 4 on CP4 for locating defective components.	

TEST CHART 1

CIRCUIT PACK CP1 AUXILIARY D. C. POWER SUPPLY

To test AUXILIARY D.C. POWER SUPPLY CIRCUIT, proceed as follows:

Caution: Remove all AC input voltage before removing circuit packs.

1. Remove circuit packs CP2, CP5, CP6, and CP8 to prevent damage to their components from excessive voltage.
2. Place printed board extender in CP1 position and connect a jumper from TP2 to TP19 of extender.
3. Place CP1 circuit pack into extender.
4. Operate DC OUTPUT (S3) switch to TEST.
5. Energize rectifier by operating POWER ON/OFF (S1) switch to POWER ON.

Perform all of following tests with rectifier operating as described above.

1. Connect KS-14510 meter to measure output voltage from TP3 (+) to TP4 (—) and from TP4 (+) to TP7 (—).
2. These voltages should read 14.0 volts DC.
3. If these voltages are incorrect, refer to proper section of following chart.

Note 1: All measurements will be made with KS-14510 meter unless otherwise specified.

Note 2: All resistance measurements are made with circuit component removed.

POSSIBLE CAUSE	TEST PROCEDURE	REASON FOR INCORRECT INDICATION
LOW DC OUTPUT OF CP1		
A. Loss of auxiliary DC power supply transformer voltage.	1. Remove CP1 from circuit pack extender. 2. Energize rectifier by operating POWER ON/OFF (S1) switch to POWER ON. 3. Read following voltages to see if they conform with proper values	If readings are not correct, check wiring from transformer to circuit pack socket. Wiring may be open or shorted. Transformer T4 may have open circuited secondary. If readings are correct, proceed to B.

POSSIBLE CAUSE	TEST PROCEDURE		REASON FOR INCORRECT INDICATION
	TP4-TP5 TP5-TP6 TP6-TP4	25 Vdc	
	TP15-TP16 TP16-TP17 TP17-TP15	19 Vdc	
	TP22-TP21 TP21-TP20 TP20-TP22	19 Vdc	
	Note: Readings are for nominal AC input		
B. Loss of Bias Voltage.	1. Place CP1 in printed board extender.		If voltage is not correct check diodes CR1-CR6, Capacitor C1, Resistor R24 and Zener Diode CR26. Replace faulty components. If Requirement is met, proceed to C.
	2. Energize rectifier by operating POWER ON/OFF (S1) switch to POWER ON.		
	3. Measure DC Voltage from TP1 (+) to TP3 (—).		
	Requirement: This voltage should read 9.1 ± .5 Vdc.		
C. Loss of +14 VDC Bulk Voltage.	1. With rectifier operating as in B, check voltage from TP2 (+) to TP4 (—).		If voltage is not correct, check diodes CR7-CR12 and Capacitor C2. Replace faulty components. If requirement is met, proceed to D.
	Requirement: This voltage should read 22.7 ± 1 Vdc.		
D. Loss of —14 VDC Bulk Voltage.	1. With rectifier operating as in B, check voltage from TP6 (+) to TP7 (—).		If voltage is not correct, check diodes CR13-CR18 and Capacitor C3. If Requirement is met, proceed to E.
	Requirement: This voltage should read 22.7 ± 1 Vdc.		

TEST CHART 1 (CONT)

POSSIBLE CAUSE	TEST PROCEDURE	REASON FOR INCORRECT INDICATION
E. +14 VDC open pass or driver transistor.	1. With rectifier operating as in B, check voltage from TP8 (+) to TP3 (—). *Requirement:* This voltage should read 1.2 ± .4 Vdc	If voltage is higher than correct range, check base to emitter resistance of Q1 and Q5 for open circuit. If low voltage, check for shorted Q3 emitter collector or open CR19. If no defects are found, proceed to F.
F. —14 VDC open pass or driver transistor.	1. With rectifier operating as in B, check voltage from TP9 (+) to TP4 (—). *Requirement:* This voltage should read 1.2 ± .4 Vdc.	If voltage is higher than correct range, check the base to emitter resistance of Q2 and Q6 for open circuits. If low voltage check for shorted Q4 emitter collector or open CR20. If no defects are found, proceed to G.
G. Shorted reference zener.	1. Check resistance from cathode (+) to anode (—) of zener diode CR28 with meter set on X100 ohm scale. *Requirement:* This resistance should read 1200 ohms.	Replace if faulty. If not defective, proceed to H. If CR28 is replaced, refer to procedure at end of Test Chart 1 to adjust output voltage.
H. Shorted output capacitor.	1. Check resistance from (+) to (—) of capacitors C12 and C13 with meter set on X100 ohm scale. *Requirement:* This resistance should read 500 ohms.	If defective, replace capacitor. If not defective, proceed to I.
I. Faulty +14 VDC Operational Amplifier.	1. If voltage from TP8 (+) to TP3 (—) was low for E and no Reason for Incorrect Indication indicates failure; and if G is disproved, A1 amplifier may be faulty.	If defective, replace A1. If not defective, proceed to J.

POSSIBLE CAUSE	TEST PROCEDURE	REASON FOR INCORRECT INDICATION
J. Faulty −14 VDC Operational Amplifier.	1. If voltage from TP9 (+) to TP4 (−) was low for F, an no Reasons For Incorrect Indication indicates failure, A2 Amplifier may be faulty.	If defective, replace A2.
HIGH DC OUTPUT OF CP1		
K. Short circuited pass transistor or driver transistor.	1. Check resistance of following transistors from collector to emitter with meter set on X100 ohm scale. Q1 and Q2 approximately 2 K ohms. Q5 and Q6 approximately 2.5 K ohms.	If any of listed transistors read short circuit, replace. If not, proceed to L.
L. Open circuited reference zener CR28.	1. Energize rectifier by operating POWER ON/OFF (S1) switch to POWER ON. 2. Measure voltage from TP4 (+) to TP5 (−). *Requirement:* This voltage should read 9.0 ± .5 Vdc.	If this voltage is high, replace CR28. If CR28 is replaced, adjust output voltage as described at end of Test Chart 1.
M. Open sense resistor.	1. Measurement resistance of R15, R16, and R17. *Requirement:* This resistance should read 15K ohm ±1%.	If defective, replace resistors. If not defective, proceed to N.
N. Faulty +14 VDC regulator.	1. Energize rectifier by operating POWER ON/OFF (S1) switch to POWER ON. 2. Measure voltage from TP8 (+) to TP3 (−).	If this voltage is positive, check zener CR27. If CR27 is not defective, replace A1. If this voltage is negative, proceed to O.
O. Faulty −14 VDC regulator.	1. Energize rectifier by operating POWER ON/OFF (S1) switch to POWER ON. 2. Measure voltage from TP9 (+) to TP4 (−).	If this voltage is positive, check diode CR21. If CR21 is not defective, replace A2.

TEST CHART 1 (CONT)

If zener diode CR28 is replaced, output voltage of CP1 will require adjustment. To adjust output voltage of CP1, proceed as follows:

1. Remove selected resistors R19 and R20.
2. Energize rectifier as described at beginning of Test Chart 1.
3. Measure voltage from TP3 (+) to TP4 (—) on CP1.
4. This voltage should read 14.0 ± .15 Vdc.
5. If this voltage is higher than required value, place a zero to 1 meg ohm decade box set at 300K ohms in parallel with R17.
6. Adjust value of the decade box until proper output voltage is obtained from CP1.
7. Place a carbon, 1/2 watt, 5% resistor of this value in position R19 on CP1.
8. If this voltage is lower than required value, place a zero to 1 meg ohm decade box set at 300K ohms in parallel with R18.
9. Adjust value of the decade box until proper output voltage is obtained from CP1.
10. Place a carbon 1/2 watt, 5% resistor of this value in position R20 on CP1.
11. Check voltage from TP4 (+) to TP7 (—).
12. This voltage should read 14.0 ± .3 Vdc.

TEST CHART 2

CIRCUIT PACK CP2 PULSE CIRCUIT

To test the PULSE CIRCUIT, proceed as follows:

1. Operate DC OUTPUT switch to TEST position.

Caution: Remove all AC input voltage before removing circuit packs.

2. Remove CP4, PULSE LOGIC circuit pack, and CP5, VOLTAGE REGULATOR circuit pack.
3. Place CP2, PULSE CIRCUIT, on circuit pack extender.
4. Connect a clip lead from Ground Output terminal to DC OUTPUT switch S3-1 Common.
5. Place a zero to 100K Ohm decade resistance box set at 20K Ohms from TP8 to TP24 of circuit pack extender.
6. It is important to note that if components are replaced on CP2, a realignment per end of Test Chart 2 will be needed.

Note: All measurements will be made with a KS-14510 meter, unless otherwise specified.

POSSIBLE CAUSE	TEST PROCEDURE	REASON FOR INCORRECT INDICATION
LOW DC OUTPUT VOLTAGE		
A. Loss of (+) and (—) 14 VDC voltage from CP1.	1. Measure voltage from TP1 (+) to TP2 (—) and from TP2 (+) to TP3 (—) on CP2. *Requirement:* These voltages should read 14 ± .3 VDC.	If proper voltage is not present, check wiring from CP1 to CP2. If wiring is not faulty, refer to beginning of Test Chart 1. If proper voltage is present, proceed to B.
B. Faulty ramp circuit.	1. Check waveshapes from TP8 to TP2 and from TP9 to TP2 and compare them to correct waveshapes in FS4 of SD-81995-01. 2. If proper waveshapes are not present, check voltage from TP2(+) to CR19 anode (—). *Requirement:* This voltage should read 27.3 ± 1.5 VDC.	If voltage in Test 2 is not present, CR17, CR18 or CR19 may be open-circuited. If voltage in Test 2 is present, check Q1, Q2, Q3, C10, C13, and C14 to find which component is short-circuited. If correct waveshape is found in Test 1, proceed to C.

TEST CHART 2 (CONT)

POSSIBLE CAUSE	TEST PROCEDURE	REASON FOR INCORRECT INDICATION
C. Faulty level detector.	1. Check waveshapes from TP10 to TP2 and from TP11 to TP2 and compare them to correct waveshapes in FS4 of SD-81995-01.	If correct voltage is not present from TP10 to TP2, check CR25, R18, R25, and A4. If correct voltage is not present from TP11 to TP2, check CR24, R17, R26, and A3. If correct voltages are present, proceed to D.
D. Faulty output amplifier stage.	1. Check waveshapes from TP6 to TP2 and from TP7 to TP2 of the extender, and compare them to correct waveshape in Fig. 2.	If correct voltage is not present from TP6 to TP2 of extender, check transistors Q4, Q6, and resistors R30, R32, and R23. If correct voltage is not present from TP7 to TP2 of extender, check transistors Q5, Q7, and resistors R31, R33, and R29.
HIGH DC OUTPUT VOLTAGE		
E. Loss of AC input from T2 PULSE transformer.	1. Measure following AC voltages on T2 PULSE transformer using Weston Model 904 AC voltmeter: Terminal 10 to 13 Terminal 11 to 13 115 ± 5 VAC Terminal 12 to 13	If correct voltage is not present: A) Check input wires to T2. B) T2 may be faulty. If correct voltage is present, proceed to F.
F. Faulty input clipper circuit on CP2.	1. Check waveshapes from TP3 to TP2, from TP4 to TP2, and from TP5 to TP2 and compare them to correct waveshapes in FS4 of SD-81995-01.	If voltages are not correct, check CR1-CR8. If correct voltages are present, proceed to G.
G. Loss of A1 amplifier output.	1. Check waveshapes from TP6 to TP2 and compare it to correct waveshape in FS4 of SD-81995-01.	If voltage is not present, R4, R5, R6, R35, C2 or A1 may be faulty. If correct voltage is present, proceed to H.

TEST CHART 2 (CONT)

POSSIBLE CAUSE	TEST PROCEDURE	REASON FOR INCORRECT INDICATION
H. Loss of A2 amplifier output.	1. Check waveshape from TP7 to TP2 and compare it to correct waveshape in FS4 of SD-81995-01.	If voltage is not present, R7, R8, CR11-CR14, or A2 may be faulty. If correct voltage is present, proceed to I.
I. Faulty ramp circuit.	1. Check waveshapes from TP8 to TP2 and from TP9 to TP2 and compare them to correct waveshapes in FS4 of SD-81995-01.	If both voltages are not correct, check CR17, CR18, CR19, R11, and C10. If correct voltage is not present from TP8 to TP2 check Q2, C13, and R28. If correct voltage is not present from TP9 to TP2, check Q1, Q3, R10, R14, R19, R34, and C14. If correct voltages are present, proceed to J.
J. Faulty level detector.	1. Check waveshapes from TP10 to TP2 and from TP11 to TP2 and compare them to correct waveshapes in FS4 of SD-81995-01.	If correct voltage is not present from TP10 to TP2, check CR25, R18, R25, and A4. If correct voltage is not present from TP11 to TP2, check CR24, R17, R26, and A3. If correct voltages are present, proceed to K.
K. Faulty output amplifier stage.	1. Check waveshapes from TP6 to TP2 and from TP7 to TP2 of the extender, and compare them to correct waveshape in Fig. 2.	If correct voltage is not present from TP6 to TP2 of extender, check transistors Q4, Q6 and resistors R30, R32, and R23. If correct voltage is not present from TP7 to TP2 of extender, check transistors Q5, Q7, and resistors R31, R33, and R29.

TEST CHART 2 (CONT)

For aligning PULSE CIRCUIT CP2, set up rectifier as described at beginning of Test Chart 2 and perform following steps:

1. Remove present 1/2 watt carbon resistors in R28 and R34 positions of CP2.
2. Decrease variable decade box in step 5 at beginning of Test Chart 2 until pulses shown in Fig. 3 just disappear.
3. Place a 1-megohm resistor decade box set at 1 megohm, in parallel with R15 on CP2. Decrease resistance value until pulses from TP6 to TP2 (Fig. 2) of extender just appear.
4. Remove decade box in parallel with R15 and place a 1/2 watt 5% carbon resistor of this value in Position R28 on CP2.
5. Place a 1-megohm resistor decade box set at 1-megohm in parallel with R16 on CP2. Decrease resistance value until pulses from TP7 to TP2 (Fig. 2) of extender just appear.
6. Remove decade box in parallel with R16 and place a 1/2 watt 5% resistor of this value in position R34 on CP2.
7. If decade box from TP8 to TP24 is now varied, the pulses (Fig. 3) should appear and disappear together.

TEST CHART 3

CIRCUIT PACK CP3 PULSE BOOST CIRCUIT

To test the PULSE BOOST CIRCUIT, proceed as follows:

1. Operate DC OUTPUT switch to TEST position.

Caution: Remove all AC input voltage before removing circuit packs.

2. Place CP3, PULSE BOOST CIRCUIT, on circuit pack extender.

3. Place a clip lead from Ground Output terminal to DC OUTPUT switch S3-1 Common.

Note: All readings will be taken with KS-14510 meter unless otherwise specified.

POSSIBLE CAUSE	TEST PROCEDURE	REASON FOR INCORRECT INDICATION
LOW DC OUTPUT VOLTAGE		
A. Loss of signal from CP2.	1. Operate DC OUTPUT switch to OFF position. 2. Remove CP3 and with a multimeter on X1 Ohm scale, check wiring from terminals 6 and 7 of CP2 to 2 and 1 of CP3.	Lead may be open from CP2. If lead is not open, proceed to B.
B. Loss of Pulse Bulk Supply.	1. Measure voltage from TP3(+) to TP26(—) of circuit pack extender. *Requirement:* This voltage should read 23.5 ± 1 VDC.	If voltage is not present, check wiring from terminal 26 of CP3 to ground and terminal 3 of CP3 to terminal 1 of CP4. If wiring is not defective, proceed to C.
C. Loss of synch signals from T5 PULSE TRANSFORMER.	1. Check to see if waveshapes shown in FS5 of SD-81995-01 are present at following test points on CP3: TP9 and TP10 to TP15 TP11 and TP12 to TP15 TP13 and TP14 to TP15.	If signal is not present, check associated circuitry, that is, if signal is not correct for TP9 and TP10 to TP15, check Q1, Q2, CR7, CR8, R19 and the wiring from terminals 5 and 6 of CP3 to T2. If circuitry is not defective, but signal is not present, proceed to

TEST CHART 3 (CONT)

POSSIBLE CAUSE	TEST PROCEDURE	REASON FOR INCORRECTION INDICATION
		D. If signals are all correct, proceed to E.
D. Loss of T2 secondary #2 voltage.	1. Energize rectifier. 2. Using Weston Model 904 AC voltmeter, check to see that 28 ± 1.5 VAC is present at following points on extender. TP5 to TP6 TP9 to TP10 TP21 to TP22	If voltages are not present, T2 transformer may be faulty. If voltages are present, proceed to E.
E. Faulty Pulse Transformer for T1, T2, or T3 of CP3.	1. With a multimeter set at 1 Ohm scale, measure resistance of T1, T2, and T3 windings. *Requirement:* All windings should read 4.5 ohms.	If winding reads "open" replace transformer. If transformer is not defective, proceed to F.
F. Faulty Pulse Transformer secondary circuit.	1. Check to see if waveshapes shown in FS5 of SD-81995-01 are present at following test points on extender: TP4 and TP7 to TP26 TP8 and TP19 to TP26 TP20 and TP28 to TP26.	If any of the signals are not present, check associated circuitry; that is, if the signal is not present at TP4 to TP26, check components Q7, S1, R1, R2, C1, and CR1. If no defects are found, proceed to G.
HIGH DC OUTPUT VOLTAGE		
G. Shorted Pulse Transistor.	1. Remove CP3 from circuit and check transistors Q1 through Q12 with a multimeter, from emitter to collector for a short circuit.	Transistor failure. If transistor has not failed, proceed to H.

POSSIBLE CAUSE	TEST PROCEDURE	REASON FOR INCORRECT INDICATION
H. Shorted Pulse Transistor.	1. Replace faulty transistors. 2. Energize rectifier. 3. Check to see that correct waveshapes shown in FS5 of SD-81995-01 are present at following points on extender: TP4 and TP7 to TP26 TP8 and TP19 to TP26 TP20 and TP28 to TP26	Transistor failure.

CIRCUIT PACK CP4 PULSE LOGIC CIRCUIT

To test PULSE LOGIC CIRCUIT, proceed as follows:

1. Operate DC OUTPUT switch to TEST.

Caution: Remove all AC input voltage before removing circuit packs.

2. Place CP4, PULSE LOGIC CIRCUIT, on circuit pack extender.

Note: All measurements will be made with KS-14510 meter unless otherwise specified.

POSSIBLE CAUSE	TEST PROCEDURE	REASON FOR INCORRECT INDICATION
LOW OR LOSS OF DC OUTPUT		
A. Loss of PULSE CIRCUIT Bulk Voltage.	1. Energize rectifier. 2. Measure the voltage from TP1(+) to TP2(—). *Requirement:* This voltage should read 23.5 ± 2.5 VDC. 3. If correct voltage is not present check CR1-CR6 and C1 on CP4. 4. Check waveshape from TP1 and TP2 and compare it to correct waveshape in FS6 of SD-81995-01. 5. Check to see that 19 VAC is present at following points on circuit pack extender: TP2 to TP3 TP3 to TP10 TP10 to TP2.	CR1-CR6 or C1 may be faulty. Wiring from CP4 terminals 2, 3, and 10 to T2 Sec. No. 1 may be open. T2 may be faulty. If no defects are found, proceed to B.
B. Loss of input signal from CP3.	1. Check input signals on CP4, TP3 and TP4 to TP2 TP5 and TP6 to TP2	Open wiring from CP3 to CP4. If there is no open wiring, proceed to C.

POSSIBLE CAUSE	TEST PROCEDURE	REASON FOR INCORRECT INDICATION
	TP7 and TP8 to TP2, compare with the correct waveshape shown in FS5 of SD-81995-01. 2. If they do not match, check wiring.	
C. Faulty Pulse Logic Component.	1. Check to see that output signals shown in FS6 of SD-81995-01 are present at the following points: TP9 and TP10 to TP2 TP11 and TP12 to TP2 TP13 and TP14 to TP2 2. If signal is missing, check associated circuitry. That is, if waveshape is not correct from TP9 to TP2, check components R1, R12, R13, R14, CR7, CR18 and C2. 3. If waveshape is not correct for TP10 to TP2, check components R3, R10, R15, R16, CR9, CR16 and C3.	Open circuit component. Test components with multimeter, and replace faulty components.

TEST CHART 5

CIRCUIT PACK CP5 VOLTAGE REGULATOR CIRCUIT

To test VOLTAGE REGULATOR CIRCUIT, proceed as follows.

1. Operate DC OUTPUT switch to TEST.
2. Connect a jumper from ground output to DC OUTPUT switch S3-1 common.

Caution: Remove all AC input voltage before removing circuit packs.

3. Place CP5 on circuit pack extender.

Note: All measurements are made with KS-14510 meter unless otherwise specified.

POSSIBLE CAUSE	TEST PROCEDURE	REASON FOR INCORRECT INDICATION
LOW DC OUTPUT VOLTAGE, TEST LAMP ENERGIZED IN BAT POSITION		
A. Faulty Q2 transistor or open sense lead.	1. Remove CP5 from circuit and, with multimeter, measure resistance from collector to emitter of Q2. 2. Check resistor R9 and wiring from CP5 terminals 4 and 13 to CP7. 3. Refer to Test Chart 7 (Faulty TEST Relay).	Q2 transistor may be shorted. R9 resistor may be open. If no defects are found, refer to Test Chart 7 (Faulty test relay), then proceed to B.
LOW DC OUTPUT VOLTAGE		
B. Loss of plus or minus 14 VDC bias.	1. Energize rectifier. 2. Measure voltage from TP3 (+) to TP4 (—) of CP5 and from TP4 (+) of CP5 to TP3 (—) of extender. *Requirement:* This voltage should read 14 ± .3 VDC.	Wiring to CP1 may be faulty. CP1 may be faulty. If no defects are detected, proceed to C.
C. Faulty reference zener diode.	1. Energize rectifier	Shorted CR9 zener.

POSSIBLE CAUSE	TEST PROCEDURE	REASON FOR INCORRECT INDICATION
	2. Measure voltage from TP1(+) to TP2(—) on CP5. *Requirement:* This voltage should measure 9.0 ± .5 VDC.	If CR9 is replaced, refer to Section 169-741-301 to check output voltage. Proceed to D.
D. Faulty output regulator stage.	1. Energize rectifier 2. Measure voltage from TP4(+) to TP5(—). *Requirement:* This voltage should read 10 VDC or greater if the output voltage is low.	Capacitors C6 or C13 may be short circuited. R10 may be open-circuited. A2 amplifier may be faulty. If not defects are found, proceed to E.
E. Faulty input regulator stage.	1. Energize rectifier. 2. Measure voltage from TP4(+) to TP7(—). *Requirement:* This voltage should read 10 VDC or greater if the output voltage is low.	Capacitor C1 may be short circuited. A1 amplifier may be faulty. If no defects are found, proceed to F.
F. Faulty CP5 wiring.	1. Check wires from CP5 terminals 2 and 26.	Wiring may be open circuited. If wiring is not open, proceed to G.
HIGH DC OUTPUT VOLTAGE		
G. Loss of plus or minus 14 VDC bias.	1. Energize rectifier with CP4 removed 2. Measure voltage from TP3(+) to TP4(—) of CP5 and from TP4(+) of CP5 to TP3(—) of the extender. *Requirement:* This voltage should read 14 ± .3 VDC.	Wiring to CP1 may be faulty. CP1 may be faulty. If no defects are found, replace CP4 and proceed to H.

TEST CHART 5 (CONT)

POSSIBLE CAUSE	TEST PROCEDURE	REASON FOR INCORRECT INDICATION
H. Faulty output or input regulator stage.	1. Place a clip lead from TP5 to TP4 on CP5. 2. Energize rectifier momentarily to see if output is still high.	If output voltage remains high A1 or C1 may be faulty. If output voltages goes to zero after step (B) of test procedure, A2, CR9, or R9 may be faulty. If CR9 is replaced, refer to Section 169-741-301 to check output voltage.

TEST CHART 6

CIRCUIT PACK CP6 CURRENT LIMIT AND SIMULATED OUTPUT CURRENT

To test CURRENT LIMIT AND SIMULATED OUTPUT CURRENT circuit, proceed as follows:

1. Operate DC OUTPUT (S3) switch to TEST.

Caution: Remove all AC input voltage before removing circuit packs.

2. Place CP6 on the circuit pack extender.

Note 1: After a failure has been corrected within CP6, the CURRENT LIMIT FULL LOAD and CURRENT LIMIT PARTIAL LOAD (Lists 11 and 12 only) should be reset per Section 169-741-301.

Note 2: All measurements are made with KS-14510 meter unless otherwise specified.

POSSIBLE CAUSE	TEST PROCEDURE	REASON FOR INCORRECT INDICATION
LOW DC OUTPUT VOLTAGE		
A. Loss of (+) and (—) bias voltage.	1. Check voltage from TP6 (+) to TP5 (—) and from TP5(+) to TP7(—) on CP6. *Requirement:* This voltage should read 14 ± .3 VDC.	Wiring to CP6 terminals 26, 16 or 27 may be faulty. If no faults are found, proceed to B.
B. Faulty shunt current amplifier.	1. Place meter set on 12 VDC scale from TP1(+) to TP5(—). 2. Energize rectifier 3. Depress SIMULATED OUTPUT CURRENT ON/OFF switch. 4. Adjust R25, SIMULATED OUTPUT CURRENT ADJUST, until OUTPUT CURRENT meter reads 200 amps. *Requirement:* This voltage should read 4.0 ± .1 VDC.	A2 amplifier may be faulty. SIM relay may be faulty. R16 or R19 may be faulty. If no defects are found, proceed to C.

TEST CHART 6 (CONT)

POSSIBLE CAUSE	TEST PROCEDURE	REASON FOR INCORRECT INDICATION
C. Faulty current limit reference circuit.	1. Place a Tektronix 545B scope from TP5(+) to TP2(—).	C7 may be shorted. A3 may be faulty. Q1 may be faulty. CR4 zener may be faulty. If no defects are found, proceed to D.
	2. Energize rectifier.	
	3. Check the waveshape from TP2 to TP5 and compare it to correct waveshape in FS8 of SD-81995-01.	
	Requirement: Final value should be 9.0 ± .5 VDC.	
D. CURRENT LIMIT ADJUST Full Load Faulty.	1. Check wiring from terminal 20 of CP6 to the CURRENT LIMIT FULL LOAD ADJUST, and from this potentiometer to CP6 terminal 5.	Wiring or potentiometer may be open circuited. If no defects are found, proceed to E.
E. Current Limit Adjust Partial Load faulty (List 11 and 12 ONLY).	1. Check wiring from terminal 20 of CP6 to the CURRENT LIMIT PARTIAL LOAD ADJUST and from this potentiomenter to CP6 terminal 6.	Wiring of potentiometer may be open circuited. If no defects are found, proceed to F.
F. Faulty Current Limit Comparitor stage.	1. Energize rectifier.	A1 amplifier may be faulty.
	2. Measure voltage from TP3 (+) to TP5 (—).	
	Requirement: This voltage should read approximately .6 VDC positive.	
HIGH DC OUTPUT CURRENT		
G. Loss of (+) and (—) bias voltage.	1. Check voltage from TP6(+) to TP5(—) and from TP5(+) to TP7(—) on CP6.	Wiring to CP6 terminals 26, 16, or 27 may be faulty. If no defects are found, proceed to H.
	Requirement: This voltage should read 14 ± .3 VDC.	

POSSIBLE CAUSE	TEST PROCEDURE	REASON FOR INCORRECT INDICATION
H. Faulty shunt current amplifier.	1. Place meter set on the 12 VDC scale from TP1(+) to TP5(—). 2. Energize rectifier. 3. Depress SIMULATED OUTPUT CURRENT ON/OFF switch. 4. Adjust R25 (SIMULATED OUTPUT CURRENT ADJUST) until the OUTPUT CURRENT meter reads 200 Amps. *Requirement:* This voltage should read 4.0 ± .1 VDC.	A2 amplifier may be faulty. The SIM relay may be faulty R16 or R19 may be faulty. If no defects are found, proceed to I.
I. Faulty current limit reference.	1. Place a Tektronix 545B scope from TP5 (+) to TP2(—). 2. Energize rectifier. 3. Check waveshape from TP2 to TP5 and compare it to correct waveshape in FS8 of SD-81995-01. *Requirement:* Final value should be 9.0 ± .5 VDC.	C7 may be shorted. A3 may be faulty. Q1 may be faulty. CR4 zener may be faulty. If no defects are found, proceed to J.
J. Faulty current limit comparitor stage.	1. Energize rectifier. 2. Measure voltage from TP3(+) to TP5(—). *Requirement:* This voltage should read approximately .6 VDC positive. 3. Depress SIMULATED OUTPUT CURRENT ON/OFF (S2) switch. 4. Adjust SIMULATED OUTPUT CURRENT (R25) potentiometer until the output current exceeds maximum rating.	Faulty A1 amplifier. If signal is correct, proceed to K.

TEST CHART 6 (CONT)

POSSIBLE CAUSE	TEST PROCEDURE	REASON FOR INCORRECT INDICATION
	5. Voltage from TP3 (+) to TP5 (—) should reverse at current limit setting of output current.	
K. Open leads to CP5.	1. Check wire from terminal 10 of CP6 to terminal 10 of CP5.	Lead may be broken.
SIMULATED OUTPUT CURRENT CIRCUIT NOT FUNCTIONAL		
L. Faulty simulated Output Current ON/OFF switch.	1. Check to see that (BAT) voltage is applied from TP1(+) to TP8(—) on circuit pack extender when the SIMULATED OUTPUT CURRENT ON/OFF switch is energized.	Switch may be faulty or wiring to switch may be open circuited. If no defects are found, proceed to M.
M. SIM relay on CP6 faulty.	1. Check to see that zero volts appear from TP2 to TP3 of extender when the SIMULATED OUTPUT ON/OFF switch is energized.	SIM relay may have open coil or faulty contacts. If no defects are found, proceed to N.
N. Faulty SIMULATED OUTPUT CURRENT ADJUST potentiometer.	1. Energize rectifier with SIMULATED OUTPUT CURRENT ON/OFF switch in OFF position. 2. Measure voltage from TP16 (+) to TP3 (—) of circuit pack extender. *Requirement:* This voltage should read 14 ± .3 VDC.	R25 potentiometer or R20 may be open-circuited.
LOSS OF LO AND HV FUNCTIONS OF PLANT CONTROL		
O. Faulty 10% Current Circuit.	1. Energize rectifier in TEST position and apply greater that 10% TEST LOAD current. 2. Measure voltage from TP4 (+) to TP5 (—) and measure for continuity from auxiliary LO-N/0 to LO-C contacts to see if (LO) relay is picked.	If voltage reads approx. 13.5 VDC and LO relay does not pick, replace relay. If voltage is not present, Q2, Q3, or A2 may be faulty. Check A2 per B under LOW DC OUTPUT VOLTAGE.

POSSIBLE CAUSE	TEST PROCEDURE	REASON FOR INCORRECT INDICATION
LO AND HV FUNCTIONS OPERATE AT NO-LOAD		
P. Faulty 10% current circuit.	1. Energize rectifier in TEST position (at NO-LOAD). 2. Measure voltage from TP4(+) to TP5(—) and measure for continuity from auxiliary LO-N/O and LO-C contacts to see if LO relay is picked.	If voltage is not present but LO relay appears picked (replace LO relay). If voltage is present at approx. 13.5 VDC, Q2, Q3, or A2 may be faulty. Check A2 per B of LOW DC OUTPUT VOLTAGE.
PL FUNCTION DOES NOT OPERATE (LISTS 11 and 12 ONLY)		
Q. Faulty PL relay.	1. Ground PL lead of PLANT CONTROL point (D) on J10 and check PL aux. contacts to see if PL relay operates.	Wires from CP6 terminals 7 or 8 may be faulty. PL relay may be faulty. If no defects are found, proceed to R.
R. Faulty CURRENT LIMIT PARTIAL LOAD potentiometer.	1. Check wiring from CP6 terminals 20 and 6 to the CURRENT LIMIT PARTIAL LOAD potentiometer.	Wiring or potentiometer may be open-circuited.

TEST CHART 7

CIRCUIT PACK CP7 RELAY AND ALARM CIRCUIT

The CP7 RELAY AND ALARM CIRCUIT PACK contains five relays that perform (RF) rectifier failure shutdown, (ST1) rectifier start, (TEST) test sense transfer, (FA) fuse failure alarm, and (TR) temporary shutdown functions. To test this circuit, proceed as follows:

1. Operate DC OUTPUT (S3) switch to TEST.

Caution: Remove all AC input voltage before removing circuit packs.

2. Place CP7 on circuit pack extender.

Note: All measurements are made with KS-14510 meter unless otherwise specified.

POSSIBLE CAUSE	TEST PROCEDURE	REASON FOR INCORRECT INDICATION
RECTIFIER WILL NOT ENERGIZE. POWER OFF LAMP STAYS ENERGIZED		
A. Faulty ST1 relay.	1. Check resistance of ST1 coil. 2. This should read 2100 ohms, C1 to C2, and should appear as a forward biased diode from C2 to C1.	CR3 may be shorted, or ST1 coil may be open. If no defects are found, proceed to B.
B. Faulty TR-1 or RF-3 contacts.	1. Measure resistance across TR-1 N/C contacts to insure continuity. 2. Place circuit pack CP7 in extender and measure resistance across RF-3 N/O contacts with RF relay picked to insure that RF-3 N/O contacts close.	TR-1 N/C contacts may be failed open. RF-3 N/O contacts may not be closing.
RECTIFIER WILL NOT ENERGIZE. POWER OFF AND RECT FAIL LAMPS STAY ENERGIZED		
C. Faulty RF relay.	1. Measure resistance of RF coil. 2. This should read 2100 Ohms C1 to C2 and should appear as a forward biased diode from C2 to C1.	CR2 may be shorted or RF coil may be open. If no defects are found, proceed to D.

POSSIBLE CAUSE	TEST PROCEDURE	REASON FOR INCORRECT INDICATION
D. Faulty FA-4 contacts.	1. Measure resistance across FA-4 N/C contacts to insure contacts close.	Replace (FA) if contacts are faulty.
TEST LAMP DOES NOT ENERGIZE WITH RECTIFIER IN TEST POSITION		
E. Faulty TEST relay.	1. Check resistance of TEST coil. 2. This should read 2100 Ohms C2 to C1 and should appear as a forward biased diode from C1 to C2. 3. If coil is not defective, measure resistance of all TEST N/C contacts. 4. Energize TEST relay by placing CP7 in extender with the DC OUTPUT switch in TEST position and measure resistance of all TEST N/O contacts.	Replace TEST relay if faulty.
RECTIFIER DOES NOT SHUTDOWN WHEN TR LEAD IS GROUNDED		
F. Faulty (TR) relay.	1. Check resistance of the (TR) coil. 2. This should read 2100 Ohms C1 to C2 and should appear as a forward biased diode from C2 to C1.	CR5 may be shorted. (TR) relay may be faulty.
RECTIFIER DOES NOT SHUTDOWN AND LOCK OUT WITH RFA ALARM WHEN FUSES INTERRUPT		
G. Faulty (FA) relay.	1. Check resistance of the (FA) coil. 2. This should read 2100 Ohms C1 to C2 and should appear as a forward biased diode from C2 to C1.	CR4 may be shorted. (FA) relay may be faulty.

TEST CHART 8

CIRCUIT PACK CP8 HIGH VOLTAGE MONITOR CIRCUIT

To test HIGH VOLTAGE MONITOR CIRCUIT, proceed as follows.

1. Disconnect Plant Control Plug P10.
2. Operate DC OUTPUT (S3) switch to TEST.

Caution: Remove all AC input voltage before removing circuit packs.

3. Place CP8 in circuit pack extender.
4. Place an adjustable voltage (50 to 54 VDC @ 1 MA) (+) on terminal TP19 of circuit pack extender and (—) on terminal #2 (slider) of R24, HV monitor adjust potentiometer.
5. Place a resistive load of at least 10% of full load on (+) and (—) TEST lugs.

Note: All measurements are made with KS-14510 meter unless otherwise specified.

POSSIBLE CAUSE	TEST PROCEDURE	REASON FOR INCORRECT INDICATION
LOW DC OUTPUT VOLTAGE		
A. Loss of (+) and (—) bias from CP1.	1. Energize rectifier. 2. Measure voltage from TP15 (+) to TP28 (—) and from TP28 (+) to TP23 (—) on circuit pack extender. *Requirement:* This voltage should read 14 ± .3 VDC.	Wiring from CP1 to CP8 may be faulty or CP1 may be faulty. If no defects are found, proceed to B.
B. Loss of (HV) reference zener.	1. Energize rectifier. 2. Measure the voltage from TP1(+) to TP2(—). *Requirement:* This voltage should read 9.0 ± .5 VDC.	CR12 zener may be faulty. If no defects are found, proceed to C.

POSSIBLE CAUSE	TEST PROCEDURE	REASON FOR INCORRECT INDICATION
C. Faulty (HV) comparitor amplifier.	1. Energize the rectifier. 2. Lower the adjustable voltage described at the beginning of Test Chart 8 to 50 VDC. 3. Measure the voltage from TP2 (+) to TP6 (—). *Requirement:* This voltage should read approximately .6 VDC. 4. Raise the voltage to 54 VDC. *Requirement:* The voltage from TP6 (+) to TP2 (—) should be approximately 9.6 VDC.	R18 may be open; CR6, CR7, or CR18 may be shorted; Q5 transistor may be shorted emitter to collector; A1 amplifier may be faulty.
HV CIRCUIT PRODUCING RF SHUTDOWN LOCKOUT WITH PROPER BAT VOLTAGE		
D. Faulty Q1, Q2, Q3, or Q4 transistors.	1. Check Q1, Q2, Q3, and Q4 transistors to insure that they are not shorted collector to emitter.	Q1, Q2, Q3, or Q4 transistors may be shorted. If no shorts are indicated, proceed to E.
E. Open back bias resistor.	1. Check resistive values of R10, R7, R5 and R2.	R10, R7, R5, or R2 may be open-circuited.
HV FUNCTION OF PLANT CONTROL WILL NOT OPERATE		
F. Open HV relay circuit.	1. Energize rectifier. 2. Place ground on TP12 of extender. 3. The rectifier should shut down and lock out and give an RF alarm.	HV coil may be open-circuited. CR3, CR4, or CR13 may be faulty.
HVB AND HVG FUNCTION OF PLANT CONTROL WILL NOT OPERATE		

TEST CHART 8 (CONT)

POSSIBLE CAUSE	TEST PROCEDURE	REASON FOR INCORRECT INDICATION
G. Loss of (+) and (—) bias from CP1.	1. Energize rectifier.	Wiring from CP1 to CP8 may be faulty or CP1 may be faulty.
	2. Measure voltage from TP15 (+) to TP28 (—) and from TP28 (+) to TP23 (—) on circuit pack extender.	If no defects are found, proceed to H.
	Requirement: This voltage should read 14 ± .3 VDC.	
H. Loss of (HV) reference zener.	1. Energize rectifier.	CR12 zener may be faulty.
	2. Measure voltage from TP1 (+) to TP2 (—).	If zener is not faulty, proceed to I.
	Requirement: This voltage should read 9.0 ± .5 VDC.	
I. Faulty (HV) comparitor amplifier.	1. Energize rectifier.	R16 may be open; CR6, CR7, or CR8 may be shorted; Q5 transistor may be open. A1 amplifier may be faulty. If no defects are found, proceed to J.
	2. Lower adjustable voltage described at beginning of Test Chart 8 to 50 VDC.	
	3. Measure voltage from TP2 (+) to TP6 (—).	
	Requirement: This voltage should read approximately .6 VDC.	
	4. Raise voltage to 54 VDC.	
	Requirement: The voltage from TP6 (+) to TP2 (—) should be approximately 9.6 VDC.	
J. Faulty Q1, Q2, Q3 or Q4 transistor.	1. Check transistors Q1, Q2, Q3 and Q4 transistors to insure that they are not open-circuited.	Q1, Q2, Q3, or Q4 transistors may be open. If no transistors are open, proceed to K.

POSSIBLE CAUSE	TEST PROCEDURE	REASON FOR INCORRECT INDICATION
K. Faulty time delay circuit.	1. Energize rectifier. 2. Adjust variable voltage described at beginning of Test Chart 8 to 54 VDC. 3. Place meter from TP5 (+) to TP4 (—) set on 12 VDC scale (at least 20K ohm/volt). 4. Ground TP7 of CP8. 5. When TP7 is grounded, meter should rise to approximately 9.0 VDC in .5 to 1 second and then drop to 2 VDC. 6. When voltage drops, rectifier should shutdown and RF alarms should be given.	C2 may be shorted; S1 may be open; HV coil may be open circuited; CR3 or CR4 may be open-circuited.

TEST CHART 9

CIRCUIT PACK CP9 AC INPUT VOLTAGE MONITOR CIRCUIT

To test AC INPUT VOLTAGE MONITOR CIRCUIT, proceed as follows:

1. Operate DC OUTPUT (S3) switch to TEST.

Note: All measurements are made with KS-14510 meter unless otherwise specified.

Caution: Remove all AC input voltage before removing circuit packs.

2. Place CP9 on circuit pack extender.

POSSIBLE CAUSE	TEST PROCEDURE	REASON FOR INCORRECT INDICATION
RECTIFIER SHUTDOWN. POWER OFF AND POWER ON LAMPS ENERGIZED		
A. Faulty AC1 relay circuit.	1. Place clip lead from TP8 on CP9 to TP10 of extender. 2. Depress POWER ON/OFF switch to ON position. 3. Rectifier should energize and POWER OFF lamp should be de-energized.	If rectifier will not energize AC1, CR10, or CR11 may be faulty. If no defects are found, proceed to B.
B. Faulty Q1 or Q2 transistor.	1. Check resistance of Q1 and Q2.	Q1 may be shorted emitter to collector. Q2 may be open-circuited. If no defects are found, proceed to C.
C. T5 secondary voltage not present at CP9.	1. Measure following voltages on circuit pack extender using Weston Model 904 AC voltmeter: TP24 — TP26 TP25 — TP26 TP27 — TP26 *Requirement:* These points should read 9.8 ± 1 VAC.	Wiring from T5 to CP9 may be faulty. If wiring is not faulty, proceed to D.

POSSIBLE CAUSE	TEST PROCEDURE	REASON FOR INCORRECT INDICATION
D. Faulty sense supplies.	1. Measure voltages from: TP4 (+) to TP7 (—) TP5 (+) to TP7 (—) TP6 (+) to TP7 (—)	If correct voltage and waveshape are not present at TP4 to TP7; CR3, CR4, C1, or R1 may be faulty.
	Requirement: These points should read 9.8 ± 1 VDC.	If correct voltage and waveshape are not present at TP5 to TP7; CR2, CR5, C2, or R2 may be faulty.
	2. Check waveshapes at these points with a scope to see if they conform with those shown in Fig. 4.	If correct voltages and waveshapes are not present at TP6 to TP7; CR1, CR6, C3 or R3 may be faulty. If no defects are detected, proceed to E.
E. Loss of reference voltage.	1. Measure voltage from TP10 (+) on extender to TP7 (—) on CP9.	CR9 or R13 may be faulty.
	Requirement: This voltage should read 9.0 ± .5 VDC.	
RECTIFIER SHUTDOWN. POWER OFF POWER ON AND RECT FAIL LAMPS ENERGIZED		
F. Faulty AC2 relay.	1. Place a clip lead from TP9 on CP9 to TP10 of extender.	If rectifier will not energize and RECT FAIL lamp energizes, AC2, CR11, or CR12 may be faulty. If no defects are found, proceed to G.
	2. Operate POWER ON/OFF switch to POWER ON.	
	3. Rectifier should energize and POWER OFF lamp should de-energize.	
G. Faulty Q3 or Q4 transistor.	1. Check resistances of Q3 and Q4.	Q3 may be open-circuited. Q4 may be short-circuited. If no defects are found, proceed to H.

TEST CHART 9 (CONT)

POSSIBLE CAUSE	TEST PROCEDURE	REASON FOR INCORRECT INDICATION
H. Loss of reference voltage.	1. Measure voltage from TP10 (+) on extender to TP7 (—) on CP9.	CR9 or R13 may be faulty.
	Requirement: This voltage should read 9.0 ± .5 VDC.	If no defects are found, proceed to I.
I. T6 secondary voltage not present at CP9.	1. Measure following voltages on circuit pack extender using Weston Model 904 AC voltmeter: TP1 to TP2 TP28 to TP2 TP23 to TP2	Wiring from TP6 to CP9 may be faulty. If no defects are found, proceed to J.
	Requirement: These points should all read 9.8 ± 1 VAC.	
J. Faulty sense supplies.	1. Measure the voltage from: TP1(+) to TP7(—) TP2(+) to TP7(—) TP3(+) to TP7(—)	If correct voltage and waveshape are not present at TP1 to TP7; CR17, CR22, C6 or R12 may be faulty. If correct voltage and waveshape are not present at TP2 to TP7, CR18, CR21, C5, or R11 may be faulty. If correct voltage and waveshape are not present at TP3 to TP7, CR19, CR20, C4, or R10 may be faulty. If no defects are found, proceed to K.
	Requirement: These points should read 9.8 ± 1 VDC.	
	2. Check waveshapes at these points with a scope to see if they conform with those shown in Fig. 5.	
K. Loss of signal from ST2.	1. With rectifier de-energized, measure resistance from TP10 to TP22 on extender.	Wires from ST2 auxiliary may be faulty. ST2 may be faulty.
	Requirement: This resistance should read zero ohms.	

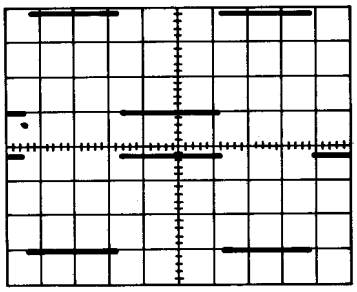

FIGURE 2
5 VOLTS/CM VERT.; 1 MILLISECOND/CM HORIZ.
TOP TRACE: TP6 TO TP2 OF EXTENDER
BOTTOM TRACE: TP7 TO TP2 OF EXTENDER

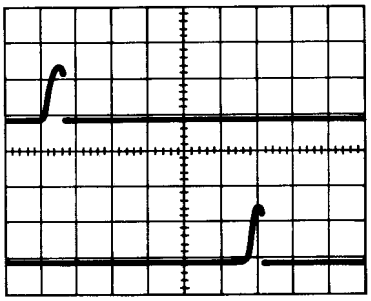

FIGURE 3
5 VOLTS/CM VERT.; 5 MILLISECONDS/CM HORIZ.
(SAME AS FIGURE 2 WITH RESISTANCE FROM TP8 TO TP24 OF EXTENDER CHANGED)

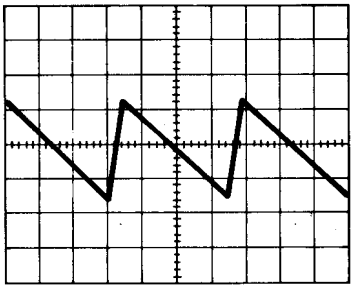

FIGURE 4
.1 VOLTS/CM VERT.; 5 MILLISECOND/CM HORIZ.
TP4 TO TP7
TP5 TO TP7
TP6 TO TP7

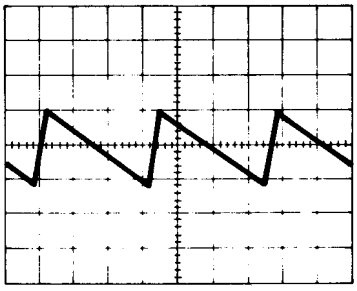

FIGURE 5
.1 VOLTS/CM VERT.; 5 MILLISECOND/CM HORIZ.
TP1 TO TP7
TP2 TO TP7
TP3 TO TP7