

167-620-306

**301C POWER PLANT
 ARRANGED FOR MANUAL START CONTROL
 OPERATING METHODS**

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1. GENERAL

1.01 This section describes how to operate 301C power plants (J86573) arranged for manual start control of motor-generator sets and rectifiers. The plant may have manual or automatic emergency cell switching. The usual operating routines are covered, and apparatus adjustments that apply particularly to this plant and are not covered in other sections are given. For day-to-day maintenance except battery equipment, it should not be necessary to refer to other sections unless defective apparatus or apparatus out of adjustment or needing other maintenance attention, such as lubrication or cleaning, is involved. Refer to the battery sections for specific information on batteries.

Caution: This plant includes automatically controlled equipment, and care must be exercised to prevent accidental starting of parts of the plant on which maintenance work is to be done. Before starting work, prevent automatic starting of equipment by removing fuses, blocking relays, opening switches, etc, as necessary. When maintenance work has been completed, make sure that the circuit has been restored to normal.

1.02 This section is reissued to add power alarm information and to revise the operating and adjusting methods. Since this reissue covers a general revision, arrows ordinarily used to indicate changes have been omitted.

1.03 Routine checks should be made during a period when they will cause the least service reaction.

1.04 The instructions are based on the drawings listed below. For detailed descriptions of the operation of individual circuits, see the corresponding circuit descriptions. The circuits associated with a particular installation are covered in the job wiring list.

Power Service Circuits

- SD-80592-01 — Power Service Circuit, Three Phase Service
- SD-80628-01 — Power Service Circuit, Three Phase, AC-DC Duplex Drive Motors
- SD-80749-01 — Power Service Circuit, Three Phase Service

Motor Starter Circuits

- SD-80572-01 — Motor-Starter Circuit for Manual and Automatic Starters
- SD-81036-01 — Motor-Starter Circuit for Manual and Automatic Starters

Charging Generator Circuits

- SD-80571-01 — Charging Generator Circuit for Manual and Automatic Operation
- SD-80601-01 — Charging Generator Circuit, Diverter Pole
- SD-81030-01 — Charging Generator Circuit, Manual and Automatic Control

Rectifier Circuits

- SD-80969-01 — Regulated Disc Rectifier Circuit, KS-5651
- SD-81087-01 — Rectifier Circuit, KS-5651-01
- SD-81115-01 — Rectifier Circuit, KS-5651-02
- SD-81129-01 — Rectifier Circuit, J86249
- SD-81242-01 — Rectifier Circuit, KS-15689
- SD-81317-01 — Rectifier Circuit, J86273

Rectifier Application Schematics

- SD-80979-01 — Application Schematic for KS-5651 and KS-5651-01 Rectifiers
- SD-80979-02 — Application Schematic for KS-5651-02 Rectifiers
- SD-81145-01 — Application Schematic for J86249 Rectifiers

Emergency Cell Charging Circuit

- SD-80465-01 — Charging Circuit, Emergency Cell Charge Using 6-amp, 10-volt Copper Oxide Rectifier

Generator Start Control Circuits

- SD-80582-01 — Generator Start Control Circuit, 45- to 50-volt Plant
- SD-80584-01 — Generator Start Control Circuit, 22 to 26 Volt
- SD-80602-01 — Generator and Countercell Control Circuit, Diverter Pole

Generator Regulation Circuit

- SD-80573-01 — Generator Regulation Circuit for Use With Manual Start Control

Discharge Circuit

- SD-80577-01 — Discharge Circuit, 22 to 26 and 45 to 50 Volt

Battery Control Circuit (Automatic Switching of Emergency Cells)

- SD-80838-01 — 22 to 26 Volt Plants
- SD-81121-01 — 45 to 50 Volt Plants
- SD-81234-01 — 6,000 to 10,000 Ampere 22 to 26 and 45 to 50 Volt Plants

Battery Distributing Circuits

- SD-80441-01 — Battery Distributing Circuit, Grouping of Frames and Racks, Panel
- SD-80658-01 — Battery Distributing Circuit, Panel Dial System, Without Common Power Filter

Alarm Circuits

- SD-80729-01 — DC Power Alarm Circuit
- SD-80730-01 — Power Audible Alarm Circuit

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

1.06 List of Tools and Test Apparatus
(Equivalents may be substituted)

| CODE OR SPEC NO. | DESCRIPTION |
|------------------|------------------------|
| TOOLS | |
| 411A | Test Pick |
| (Two reqd) | |
| 508A | Armature Blocking Tool |

| CODE OR SPEC NO. | DESCRIPTION |
|-----------------------|--|
| TOOLS | |
| — | 3-inch Cabinet Screwdriver |
| — | Fuse Puller, 7-1/2 inch, Ideal Industries, Inc |
| TEST APPARATUS | |
| KS-8039 | Voltmeter |
| KS-14510, List 1 | Volt-ohm-milliammeter |
| W1AF (Two reqd) | Cord |
| W2W | Cord, 6 feet long, equipped with one No. 310 Plug, one No. 360B Tool, and one No. 360C Tool (No. 2W17A) |
| — | 35-type Test Set |
| — | Headset, composed of one No. 716A Receiver, one No. 11A Headband, and one No. 2W21A Cord |

2. OPERATION

DESCRIPTION

2.01 The 301C power plant provides either 24- or 48-volt, or a combination of both 24- and 48-volt battery supply for equipments requiring a capacity within the range of 200 to 4000 amperes. With the addition of an SD-81234-01 battery control circuit, the capacity is increased to 6000 or 10,000 amperes for each potential.

2.02 The 24-volt battery consists of 11 or 12 cells together with two single-cell emergency cell groups and, in some plants a single-cell countercell group. The 48-volt battery consists of 23 cells, two groups of two emergency cells, and in some plants, one group of two countercells. The main battery, either 24 or 48 volts, consists of two or more strings of the above cells connected permanently in parallel. The main battery cells are continuously floated under control of the voltage regulation equipment. The emergency cells, and if provided, the countercells are cut into or out of the discharge circuit by manual or automatic means to maintain the discharge voltage within proper limits during emergency and overcharge periods. The emergency cells are continuously trickle charged by unregulated rectifiers.

2.03 The charging units consist of motor-generator sets and/or rectifiers for the main battery cells and rectifiers for the emergency cells. One motor-generator or rectifier for each voltage runs continuously, while others are started and stopped manually, as required, to maintain the battery voltage and carry the discharge circuit load. A 33-, 65-volt, or a combined 33- to 65-volt reserve set is generally furnished with these plants for use in case of abnormal load or when one of the other sets is disconnected from service for maintenance purposes. Two motor-generator sets or one motor-generator set and one rectifier for each voltage are generally arranged for automatic voltage regulation. In some cases when a 24-volt supply of less than 100 amperes is required, it is obtained from the 48-volt plant by using automatically controlled countercells, no manual switching being involved.

PREPARING TO START INITIALLY

2.04 Before putting the plant into service, check that:

All Plants

(a) All motor-generator sets are clear of any obstructions and are free to run. If possible, as a check it is desirable to turn by hand all parts that normally rotate.

Caution: Care must be exercised when doing this to prevent electric shock or physical injury.

(b) The procedures for preparing to start in the rectifier sections have been observed.

(c) The procedures for preparing to start in the voltage controller sections have been observed.

(d) STOP-NOR and ON-OFF keys are in the STOP and OFF positions, respectively.

(e) TEST-NOR keys are in the NOR position.

(f) Correct size fuses are in place.

(g) EM CELL SW MAN-AUTO keys are in the MAN position.

(h) GEN1-OFF-GEN2 key regulator switching key) is operated to the position to connect the voltage control to the generator or rectifier which is to be operated under automatic voltage control.

(i) GEN REG CHG-FLOAT key is in the FLOAT position.

- (j) In charging units, each generator control OLA potentiometer is turned completely cw (clockwise) and each OLR potentiometer is turned completely ccw (counterclockwise).
- (k) Generator knife switches are in the open (horizontal) position.
- (l) If necessary, provide test load sufficient to absorb 115 per cent of the rated load of the larger of the first two CUs (charging units) (CU1 or CU2).

INITIAL ADJUSTMENTS

2.05 Check each generator as follows.

(a) **Generator Start**

- (1) Rotate generator manual control handwheel maximum cw.
- (2) Operate TEST-NOR key to TEST.
- (3) Operate LOWER key until RL relay releases (all resistance in position).
- (4) Perform the appropriate operation below:

Generators Equipped With Key-type Starter

Operate the starter NOR-STOP key to NOR.

Generators Equipped With Push-button-type Starter

Operate the starter START-STOP button to start.

Generators Equipped With Manually Operated Starting Compensator

Operate the starter handle to the START position and when the generator comes up to speed (no further rise in tone or pitch), quickly operate the handle from the START to the RUN position.

- (5) The motor-generator set should start rotating cw as viewed from the generator end.

(b) **Generator Voltage**

- (1) Rotate VM key to GEN.
- (2) Rotate generator manual control handwheel cw until generator voltage is about 15 volts for 24-volt generator or about 30 volts for 48-volt generator.

(c) **Reverse Current Relay**

- (1) Block CC relay operated.
- (2) Slowly rotate the generator manual control handwheel ccw. Check that CB reverse current relay operates before 45 volts are reached on a 48-volt generator or 20 volts on a 24-volt generator. CA contactor should also operate.
- (3) Remove the block from CC relay.
- (4) Rotate the handwheel cw until CA contactor and CB relay release.
- (5) Close the generator knife switch to the 48- or 24-volt position.

Caution: *Never close the generator knife switch while CA contactor is operated, as personal injury and commutator damage may result.*

- (6) Connect an external voltmeter (KS-14510) across the main contacts of CA contactor. Use the 3-volt dc scale and connect the positive lead to the armature contact.
- (7) Rotate the handwheel slowly ccw until voltmeter reads 1 volt.
- (8) Reverse the external voltmeter leads (voltmeter reads -1 volt).
- (9) Rotate handwheel slowly ccw. CA contactor should operate before the external voltmeter reads 1 volt (that is, before the generator voltage is 1 volt higher than the battery voltage).
- (10) Remove the voltmeter.
- (11) Rotate handwheel slowly cw while observing the AR1 ammeter relay. CA contactor and CB relay should release when the reverse current (below the zero reading) is between 3 and 8 per cent of generator rated ampere output.

Caution: *Do not permit the reverse current to exceed the 8 per cent value as excessive reverse current may affect future operation of the CB reverse current relay.*

2.06 Overload Relay Associated With Commercial-type Generators: The OL relay should operate when the generator output rises to 115 per cent of rated current and should

release when generator output reduces to 85 per cent of rated current. In the following paragraphs, raise and lower the output of the generator, as required, by means of the generator manual control handwheel.

- (a) Rotate OLA potentiometer to its maximum ccw position.

Note: The cover must be on the OL relay when adjusting the OLA and OLR potentiometers. Observe the OLI relay to tell when OL relay is operated.

- (b) Move high contact of ammeter relay so that it does not make contact when generator is delivering full-load ampere rating.

(c) Connect a millivoltmeter or the voltmeter of the 35-type test set (see Section A702.002, Measurement of External Voltages) across the ammeter relay shunt at the same points as the connection for the winding of OL relay to read load currents in excess of 100 per cent. Connect the positive lead of the meter to the generator side of the shunt. Raise the generator output to its full-ampere rating.

(d) Read the drop across the ammeter relay shunt as indicated on the voltmeter, then increase output until the voltage drop is 110 per cent of that obtained when the generator is delivering full-load amperes. Slowly rotate OLA potentiometer in a ccw direction until OL relay operates.

(e) Decrease the output to 105 per cent of full-load rating and check that OL relay does not release.

(f) Continue to decrease the output of the generator until 85 per cent of generator rated output is reached or OL relay releases. If OL relay does not release at 85 per cent of generator rated output, check the OL relay circuit requirements. If the requirements are met and the relay does not release, cut the strap between OLA and OLR potentiometers. Then with the generator carrying 85 per cent of its full rated output, slowly rotate OLR potentiometer cw until OL relay releases.

Note: The OL relay normally releases within limits, in which case, removal of the strap is not necessary. Removal of the strap is required only in exceptional cases.

(g) Check the operation of the OL relay as follows.

(1) Raise the generator output to 105 per cent of rated output and check that OL relay does not operate.

(2) Raise generator output to 115 per cent of rated output and check that OL relay operates.

(3) Decrease generator output to 105 per cent of rated output and check that OL relay remains operated.

(4) Continue to decrease generator output to 85 per cent of rated output and check that OL relay is released.

- (h) Reset ammeter relay high contact.

2.07 Ammeter Relay Associated With Commercial-type Generators:

The high contacts of the ammeter relay shall be adjusted to close on a current equal to the full-ampere rating of the associated generator. No adjustment is required for the low contacts. Position the low contact pointer maximum ccw by removing the relay cover and moving the pointer by grasping it at its lower insulated end.

2.08 Ammeter Relay Associated With Rectifiers:

The high contacts of the ammeter relay shall be adjusted to close at rated full-load current for the rectifier. No adjustment is required for the low contacts. Position the low contact pointer maximum ccw by removing the relay cover and moving the pointer by grasping it at its lower insulated end.

2.09 Generator Rheostats: The rheostats associated with generators equipped with motor-driven rheostats shall be adjusted as follows.

(a) **BAT Position of Handwheel**

(1) Operate NOR-STOP key or START-STOP button to STOP. On generators equipped with a manually operated starting compensator operate the STOP button.

(2) Turn handwheel fully cw.

(3) Operate generator knife switch to the open (horizontal) position.

(4) Disconnect generator from battery and connect test load to generator.

- (5) Start the generator as covered in 2.05(4).
- (6) Operate RAISE key until RR relay releases (all resistance out position).
- (7) Turn handwheel ccw until generator is operating at rated ampere output at the voltages shown in the following table with the machine hot (run at full output for at least 1 hour).

| CELLS IN BATTERY | VOLTAGE |
|------------------|---------|
| 11 | 28 |
| 12 | 30 |
| 23 | 56 |

- (8) The setting of the handwheel at which the generator delivers full-ampere output at the required voltage shall be marked with a line and designated BAT on the front of the panel.
 - (9) Turn the handwheel cw and run generator at no load for 1 hour allowing it to cool.
 - (10) Stop the generator as covered in (1).
 - (11) Remove connection to test load and reconnect battery.
- (b) **Adjustment of Motor-Driven Rheostat**
- (1) Rotate handwheel to BAT position.
 - (2) Block FR relay operated (open the contacts).
 - (3) Start the generator as covered in 2.05(4).
 - (4) Operate LOWER key until RL relay releases (all resistance in position).
 - (5) Operate RAISE key and slowly increase voltage to 17 volts for 24-volt generators and 41 volts for 48-volt generators. Mark this point temporarily on the motor-driven rheostat.
 - (6) Operate the generator knife switch to the 48- or 24-volt position.
 - (7) Operate the RAISE key to increase the voltage to 1 volt above the battery voltage. The CA contactor should operate. Continue to operate the RAISE key until the generator is operating at rated ampere out-

put at the voltage shown in the following table. (Read voltage by operating VM key on generator control panel to GEN.)

| CELLS IN BATTERY | VOLTAGE | |
|------------------|-------------------|----------------------|
| | WITH COUNTERCELLS | WITHOUT COUNTERCELLS |
| 11 | 25.9 | 24.2 |
| 12 | 28.2 | 26.4 |
| 23 | 54.1 | 50.6 |

- (8) When generator reaches full output, slowly decrease the output by operating the LOWER key allowing time for the battery voltage to decrease until ammeter relay indicates no load (do not go to reverse current) with the battery voltage shown in the following table.

| BATTERY CELLS IN | VOLTAGE |
|------------------|---------|
| 11 | 23.1 |
| 12 | 25.2 |
| 23 | 48.3 |

- (9) Stop the generator as covered in [(a)(1)].
 - (10) Operate generator knife switch to the open (horizontal) position.
 - (11) The setting of the motor-driven rheostat in (8) or the setting previously marked in (5) depending on which results in the most resistance in the motor-driven rheostat shall be the **all resistance in** position. With the rheostat arm in this position, set the B limit switch operating lever against the limit switch so that the contacts just open and clamp the lever in place.
 - (12) Unblock FR relay.
- (c) **EM CELLS Position of Handwheel**
- (1) Rotate the handwheel fully cw.
 - (2) Operate the generator knife switch to EM CELLS position.
 - (3) Operate the EM CELL CHG knife switch to GR1 and GR2 position.
 - (4) Start the generator as covered in 2.05(4).
 - (5) Operate RAISE key until RR relay releases (all resistance out position).

(6) Rotate handwheel ccw until generator voltage is 1 volt above battery voltage. The CA contactor should operate. Continue to rotate the handwheel ccw until the generator delivers rated ampere output at the voltages in the following table.

| CELLS | VOLTS |
|-------------------------|-------|
| 11 cells and 2 EM cells | 30.3 |
| 12 cells and 2 EM cells | 32.5 |
| 23 cells and 4 EM cells | 62.8 |

(7) The position of the handwheel pointer in (6) shall be marked with a line and designated EM CELLS on the front of the panel.

Note: On some generators it will be found that the first setting of the generator manual control handwheel described in (a) will also meet the requirements for the second or EM CELL setting, in which case, the position should be marked and designated BAT and EM CELLS.

- (8) Operate LOWER key until generator output is zero.
- (9) Stop the generator as covered in [(a)(1)].
- (10) Operate generator knife switch to the open (horizontal) position.
- (11) Operate EM CELLS CHG knife switch to G1 position.
- (12) Close generator knife switch to EM CELLS position.
- (13) Start the generator as covered in 2.05(4).
- (14) Operate RAISE key until CA contactor operates. Raise voltage to voltage indicated in the following table allowing time for the battery to stabilize.

| CELLS | VOLTAGE |
|-------------------------|---------|
| 11 cells and 1 EM cell | 26.4 |
| 12 cells and 1 EM cell | 28.5 |
| 23 cells and 2 EM cells | 54.9 |

(15) Operate LOWER key to decrease output and verify that generator output can be decreased to no load by means of the motor-driven rheostat. If it is necessary to use the handwheel to do this, change the EM CELLS marking in (7) accordingly.

(16) Stop the generator as covered in [(a)(1)].

(17) Rotate handwheel to BAT position if two positions have been designated.

(18) Operate generator knife switch to the open (horizontal) position.

2.10 Ammeter Relays Associated With Diverter Pole Type Generators: The high contact of the ammeter relay shall be adjusted to close on a current equal to the full ampere rating of the associated generator. No adjustment is required for the low contact.

2.11 Rheostat Adjustment for Diverter Pole Type Generators: The generator field rheostat shall be adjusted as follows.

(a) Set the generator rheostat arm to the mark on the rheostat plate provided at the factory. It should be taken into consideration that the characteristics of the generator are such that for a given rheostat setting the voltage will be slightly lower if the load is increasing, and higher when the plant load is decreasing. After the battery has been brought up to float voltage with the generator hot, no further major adjustments of rheostat should be required. However, after observing the battery range over a period of a few days, and in subsequent regular routine observations of the average battery volts in accordance with Section A301.005, a slight correction in the rheostat setting may be necessary in order to average the battery voltage for correct float. The final setting of the rheostat should be marked with a line and designated BAT FLOAT on the front of the panel.

(b) With generator switch open and the TEST key in TEST position, start the generator and increase generator voltage until rheostat reaches *all resistance out* position and then slowly decrease generator voltage to 28 volts. Mark this position of rheostat temporarily. Stop the generator and with generator switch closed to battery and TEST key in TEST position, start the generator following the procedure outlined in (a). Adjust for average battery voltage at 27.5 volts. The rheostat position obtained shall be marked and designated BAT CHG.

(c) Following the same procedure as outlined in (a) and (b), the generator should be adjusted for a voltage of 33 volts when connected across the battery and both groups of emergency cells connected in series. When final setting of rheostat is obtained, it shall be marked with a line, and the space between the setting obtained in (b) and this latter mark shall be designated BAT & EM CELLS.

OPERATION OF PLANT

2.12 Automatic Operation of Voltage Regulation: For normal operation, with the keys in the positions specified in (a), (b), and (c) enough generators or rectifiers should be in operation to float the load. However, if an equalizing or boost charge is to be given using automatic regulation, the float charge key on the main control board should be operated to the CHG position.

(a) On main control board

- (1) FLOAT-CHG key should be in FLOAT position.
- (2) EM CELLS SW MAN-AUTO key should be in the NOR position.
- (3) GEN1-OFF-GEN2 key (regulator switching key) should be in the position to connect the regulation circuit to the generator or rectifier which is to be operated under automatic voltage control.

(b) Keys on generator bays should be in the NOR positions.

(c) On rectifier bays

- (1) ON-OFF or RECT key should be in ON position.
- (2) All other rectifier keys should be in NOR position.

2.13 Manual Operation of Voltage Regulation:

If the voltage regulation is to be done manually, the regulator switching key (GEN1-OFF-GEN2) in the regulation circuit should be operated to the OFF position. The voltage may then be raised or lowered by means of the generator RAISE and LOWER keys in the case of a generator. In the case of a rectifier, the MAN-TEST key of the rectifier should be operated to the MAN position and the voltage adjusted by the rectifier MAN potentiometer.

2.14 Rectifiers: In general, rectifiers can be used in conjunction with motor-generator sets in this plant. The rectifiers may be connected and disconnected in much the same manner as motor-generator sets.

Caution: *The rectifier MAN potentiometer should always be kept in the maximum ccw position except when the rectifier is both connected to the battery and being used under MAN control (MAN-TEST key in MAN position). If the rectifier should be operating under MAN control without battery or load and the MAN potentiometer is turned cw enough, the rectifying element may be damaged. Never turn the rectifier ON under automatic control before the battery or load is connected or the rectifying element may be damaged. Use the OFF or OPEN rotary switch to remove rectifier from service only after the rectifier has been shut down by operation of the ON-OFF or NOR-OFF key to the OFF position.*

2.15 In the following paragraphs, when keys on the J86249, KS-15689, or J86273 rectifier are referred to, uniform designations will be used for comparable keys as shown below.

(a) Keys designated MAN-TEST or MAN-NOR-TEST will be referred to as MAN-TEST; their positions, MAN, TEST, and NOR (center) and MAN, TST, and NOR, will be referred to as MAN, TEST, and NOR.

(b) Keys designated ON-OFF or RECT will both be referred to as ON-OFF and their positions, ON and OFF, and NOR and OFF, respectively, will be referred to as ON and OFF.

Removing CUs From Service and Restoring CUs to Service

2.16 Removing Generator Connected for Automatic Voltage Regulation

(a) If a generator connected for automatic voltage regulation is to be removed from service, the other CU which is arranged for automatic voltage regulation should be started and connected to load as covered in 2.17 or 2.25 before this generator is removed from service.

(b) Operate GEN1-OFF-GEN2 key (regulator switching key) to GEN position connecting CU started in (a).

- (c) Operate lower key on the generator panel until RL relay does not operate (all resistance in position).
- (d) On generators equipped with an automatic motor starter, operate NOR-STOP key to STOP. On generators equipped with a manually operated starting compensator, operate the STOP button on the front of the starter.
- (e) Operate generator knife switch to the open (horizontal) position.

2.17 *Restoring Generator Arranged for Automatic Voltage Regulation*

- (a) Operate LOWER key and check that RL relay does not operate (all resistance in position).
- (b) Rotate generator manual control handwheel to BAT or EM CELL position, as required.
- (c) Operate generator knife switch to 48V (24V) or EM CELL position, as required.
- (d) On generators equipped with an automatic motor starter, operate NOR-STOP key to NOR. On generators equipped with a manually operated starting compensator, operate the starter handle to the START position and when the generator comes up to speed (no further rise in tone or pitch) quickly operate the handle from the START to the RUN position.
- (e) Operate the RAISE key until CA contactor operates which indicates that the generator is connected to battery.
- (f) Adjust output, as required, using RAISE key.
- (g) If generator is to be under automatic voltage regulation, operate GEN1-OFF-GEN2 key (regulator switching key) to the position to connect the voltage control circuit to the generator.

2.18 *Removing Generator Arranged for Manual Regulation*

- (a) Rotate generator manual control handwheel cw until CA contactor releases.
- (b) Operate STOP button on the motor starter.

- (c) Operate generator knife switch to the open (horizontal) position.

2.19 *Restoring Generator Arranged for Manual Regulation*

- (a) Rotate generator manual control handwheel fully cw.
- (b) Operate generator knife switch to BAT or EM CELL position, as required.
- (c) On generators equipped with a push-button-type starter, operate START-STOP key to START. On generators equipped with a manually operated starting compensator, operate the starter handle to the START position and when the set comes up to speed (no further rise in tone or pitch) quickly operate the handle from the START to the RUN position.
- (d) Rotate the handwheel ccw until the CA contactor operates, which indicates that generator is connected to battery.
- (e) Adjust output, as required, using the handwheel.

2.20 *Removing Combination 24- and 48-volt Generator*

- (a) If the generator is being used as a 48-volt generator under automatic voltage regulation, the other CU which is arranged for automatic voltage regulation should be started and connected to load as covered in 2.17 or 2.25 before this generator is removed from service.

Note: A set operating as a 24-volt generator cannot be connected to the automatic voltage regulation circuit.

- (b) Operate GEN1-OFF-GEN2 key (regulator switching key) to GEN position connecting CU started in (a).
- (c) Operate LOWER key until RL relay does not operate (all resistance in position).
- (d) Rotate manual control handwheel fully cw.
- (e) On generators equipped with an automatic motor starter, operate NOR-STOP key or START-STOP button to stop. On generators equipped with a manually operated starting compensator, operate the STOP button on the front of the starter.

- (f) Operate the generator knife switch to the open (horizontal) position.

2.21 *Restoring Combination 24- and 48-volt Generator*

- (a) Rotate manual control handwheel fully cw.
- (b) Operate LOWER key and check that RL relay does not operate (all resistance in position).
- (c) Operate generator knife switches to BAT or EM CELL and 24V or 48V positions, as required.
- (d) Start set as covered in (1), (2), or (3) below.

(1) On generator sets with a key-type starter, operate NOR-STOP key to NOR.

(2) On generator sets equipped with a push-button-type starter, operate the START-STOP button to START.

(3) On generator sets equipped with a manually operated starting compensator, operate the starter handle to the START position and when set comes up to speed (no further rise in tone or pitch) quickly operate the handle from the START to the RUN position.

- (e) If generator is to be operated as a 48-volt generator:

(1) Raise generator voltage to 45 volts by rotating manual control handwheel ccw.

(2) Operate RAISE key until CA contactor operates, which indicates generator is connected to battery.

(3) Control generator output, as required, using RAISE and LOWER keys.

(4) If generator is to be operated under automatic voltage regulation, operate GEN1-OFF-GEN2 key (regulator switching key) to the position to connect the voltage control circuit to the generator.

(5) If generator is to be operated under manual control, all adjustment in generator output should be made by means of RAISE and LOWER keys.

- (f) If generator is to be operated as a 24-volt generator:

(1) Raise generator voltage to 23.5 volts by rotating manual control handwheel ccw.

(2) Control generator output, as required, using RAISE and LOWER keys.

Note: If generator is operated as a 24-volt generator, it cannot be connected to the automatic regulation circuit and all changes in generator output must be made by operating the RAISE and LOWER keys.

2.22 *Removing Generators From Service — Diverter Pole Type*

- (a) Operate NOR-STOP key to STOP.
- (b) Operate generator knife switch to the open (horizontal) position.

2.23 *Restoring Generator to Service — Diverter Pole Type*

- (a) Rotate manual control handwheel to line marked on panel.
- (b) Operate generator knife switch to BAT or EM CELL position.
- (c) Operate NOR-STOP key to NOR position.

2.24 *Removing Rectifier From Service (Automatic or Manual Regulation)*

(a) If the rectifier is being operated under automatic voltage regulation, the other CU which is arranged for automatic voltage regulation should be started and connected to the load as covered in 2.17 or 2.25 before this rectifier is removed from service.

(b) Operate GEN1-OFF-GEN2 key (regulator switching key) to GEN- position connecting CU started in (a).

(c) Operate MAN-TEST key to TEST.

(d) Operate LOWER key to reduce output sufficiently to cause incoming CU to assume load. Reduce output slowly, allowing time for the regulation circuit to function.

(e) As output of CU started in (a) builds up, operate LOWER key of rectifier until its output has decreased to the minimum reading for the ammeter associated with the rectifier.

(f) Operate ON-OFF key of rectifier to OFF.

(g) Operate rotary OFF or OPEN switch of rectifier to OFF or OPEN.

2.25 Restoring a Rectifier to Service (Automatic or Manual Regulation)

- (a) If rectifier is to be connected to battery only:
 - (1) Operate CHG-FLOAT switch to FLOAT.
 - (2) Operate rotary OFF or OPEN switch to 48V (24V) position.
- (b) If rectifier is to be connected to battery and emergency cells:
 - (1) Operate CHG-FLOAT switch to CHG.
 - (2) Operate rotary OFF or OPEN switch to EM CELL.
- (c) Operate MAN-TEST key to NOR.
- (d) Operate ON-OFF key to ON and wait about 1 minute for electron tubes to warm up.
- (e) Control rectifier output using RAISE and LOWER keys.
- (f) If rectifier is to be operated under automatic voltage regulation, operate GEN1-OFF-GEN2 key (regulator switching key) to position to connect the voltage control circuit to the rectifier.

Boost Charging Main Battery

2.26 General: If countercells are provided and are automatically controlled, the discharge voltage will be automatically maintained within proper limits. However, if the countercells are manually controlled, the voltage alarm will be given when the battery voltage rises and countercells must then be cut into the discharge circuit, as required. When the battery is being charged during the heavy-load period of the day, the temperature of the countercells should be observed frequently. If the temperature of the countercells rises to the maximum permissible value (see Section A401.004) the charge should be stopped, water added if necessary, and the main battery floated until the cells restore to 90 F or approximately room temperature.

2.27 Boost Charging Main Battery

- (a) *All Plants Except Diverter Pole Type*
 - (1) Operate FLOAT-CHG key on main control board to CHG.

(2) Circuit will make necessary adjustment in operation of automatically regulated CU.

(3) Adjust output of manually regulated CUs by operating the RAISE and LOWER keys on CUs equipped with a motor-driven rheostat or by the manual control handwheel in CUs without a motor-driven rheostat. (See 2.26 if countercells are provided.)

(b) Diverter Pole Type Plants

(1) Operate generator rheostats slowly to CHG. (See 2.26 if countercells are provided.)

(c) All Plants — When Boost Charging is Completed**Plants Without Countercells**

(1) Operate FLOAT-CHG key on main control board to FLOAT. On diverter pole types, operate generator rheostats to FLOAT.

Plants With Countercells

(2) Operate NOR-TEST key (or MAN-TEST key if rectifiers are provided) of each operating CU to TEST.

(3) Reduce output of each CU approximately 50 per cent by operating its LOWER key.

(4) Operate FLOAT-CHG key on main control board to FLOAT. On diverter pole types, operate generator rheostats to FLOAT.

(5) When battery voltage is at float value, operate NOR-TEST (MAN-TEST) key of each operating CU to NOR starting with lowest numbered CU. Allow time between restoration of each TEST key and succeeding key for battery voltage to stabilize.

(6) If countercells are manually controlled, the voltage alarm will ring when the battery voltage drops and countercells must be cut out of the circuit as required.

Boost Charging Emergency Cells

2.28 All Plants: Adjust trickle charger to increase output.

Recharging After Power Failure**General**

2.29 The 301C plant is arranged for recharging emergency cells by the method known as *charge by load*. The charging rate through the emergency cells will vary with the load. The maximum amount of charging current permissible through the emergency cells is determined by the finishing rate and temperature of the battery. The emergency cells shall be charged at a rate not exceeding the finishing rate (nominal charging rate). However, in the case of an emergency which has discharged a considerable part of the battery capacity, a high starting rate may be used but under no conditions should the cells be charged at more than 150 per cent of the 8-hour discharge rate at the start of the charge or at more than the finishing rate at the end of the charge (see Section A401.001.01). If the electrolyte temperature reaches 110 F (43 C) before the charge is completed, reduce the charge rate by 50 per cent. When charging emergency cells, any trickle charger in use may be left connected. If countercells are used, see Section A401.004 for precautions regarding temperature and charging rate.

2.30 If the power failure was short during a light-load period and the emergency cells were not cut in, the main battery will automatically recharge to float voltage.

2.31 The procedures given in 2.32 apply to plants with commercial-type generators. If the procedures are to be adapted for plants with diverter pole type generators, refer to 2.33.

2.32 The following procedures apply to 48-volt plants with automatically controlled emergency cell switches but may also be used for plants with manually controlled emergency cell switches by substituting manual operation of the emergency cell switches when required. In such cases, alarms associated with automatic operation of emergency cell switches will not be given. If the procedures are to be used for 24-volt plants, the specified emergency cell group voltage shall be halved. If ac power is being supplied from the emergency engine, do not start more CUs than the engine generator capacity will supply.

(a) If the power failure was of short duration during a light-load period and only the first group of emergency cells was cut in,

first permit the charging units to restore the main battery to float voltage and thus cause the motor-driven emergency cell switch to return automatically to normal. As the main battery is recharging, the output current of the voltage regulating CU will decrease. When the voltage regulating CU can absorb the load carried by the last CU, reduce the output of the last CU using the manual control handwheel until the last CU disconnects. Do not shut down the last CU until the voltage regulating CU can carry the last CUs load. When the last CU disconnects, if it is a generator, turn its manual control handwheel to the EM CELLS position if such a position is provided and operate its knife switch to the EM CELLS position. If the last CU is a rectifier, operate its rotary switch to the EM CELL GR1 position. Then, operate the EM CELL CHG knife switch on the emergency cell switch panel to the GR1 position. Restore the last CU to service under manual control as covered in 2.17, 2.19, 2.21, or 2.25. At the main control board read the voltmeter at the top of the panel. Then depress the 48V & EM CELLS voltmeter key while watching the voltmeter mounted at the top of this panel. The observed change in voltage is the voltage across the GR1 emergency calls. This voltage is hereafter referred to as GR1 voltage. When the GR1 voltage rises to 5 volts, reduce the last CUs output until the GR1 voltage is 4.4 volts. As the batteries approach full charge, the GR1 voltage will increase more rapidly and the CU output current will decrease. When the output of the CU is approximately zero, GR1 is fully charged. Operate the NOR-STOP key to STOP. Restore the CU handwheel to the BAT position if it is a generator and restore its knife switch to the 48V or 24V position. If the CU is a rectifier, restore its rotary switch to the 48V or 24V position. Restore the CU to normal operation as covered in 2.16 to 2.25, inclusive.

(b) If both GR1 and GR2 emergency cells were cut in during the power failure, and sufficient charging capacity is available, first permit the charging units to bring up the voltage of the main battery enough to cause the emergency cell switch to cut back to the normal position. When the voltage regulating CU can absorb the load carried by the last CU, reduce the output of the last CU using the

manual control handwheel until the last CU disconnects. Do not shut down the last CU until the voltage regulating CU can carry the last CUs load. When the last CU disconnects, turn its manual control handwheel to the EM CELL position, if it is a generator with such a position provided, and operate its knife switch to the EM CELLS position. If the CU is a rectifier, operate its rotary switch to the EM CELL GR1 & GR2 position. Then operate the EM CELL CHG knife switch on the emergency cell switch panel to the GR1 & GR2 position. Restore the last CU to service under manual control as covered in 2.17, 2.19, 2.21, or 2.25. Charge the GR1 and GR2 cells as in (a), except that the GR2 voltage should be measured directly with a portable voltmeter, rather than with the panel voltmeter. When the GR2 cells are fully charged, lower the last CUs output until it disconnects and the RL relay releases. Open the generator knife switch. Operate the EM CELL CHG switch to the GR1 position. Close the generator knife switch to the EM CELL position. Continue charging the GR1 cells as in (a).

(c) If the power is restored during a heavy-load period, and the motor-driven EM CELL switch is in the GR1 & GR2 position, the charging units must be connected to the GR1 & GR2 position if the charging capacity of the CUs is less than the load demand. However, if the charging capacity of the CUs is in excess of the demand, switching the CUs to the GR1 & GR2 position will cause the motor-driven EM CELL switch to quickly return to the GR1 position, thus requiring immediate switching of the CUs to the GR1 position. Therefore, if the charging capacity of the CUs is in excess of the load demand, the CUs should be connected initially to the GR1 position which would avoid repeating the switching operation of the CUs. The procedures for connecting the CUs to the GR1 position are covered below. Procedures for connecting the CUs to the GR1 & GR2 position which should rarely be required are similar, except that the EM CELL CHG switch is operated to the GR1 & GR2 instead of GR1 position.

(1) Starting with the highest numbered CU, remove the CU from service as covered in 2.16 to 2.25, inclusive, except that it is

not necessary to stop the set by means of the motor starter.

- (2) If the CU is a generator with an EM CELLS position provided for the manual control handwheel, turn the handwheel to this position.
- (3) Operate the EM CELL CHG knife switch on the emergency cell switch panel to the GR1 position.
- (4) Operate the CU knife or rotary switch to the EM CELLS or EM CELLS GR1 position.
- (5) Return the CU to normal operation as covered in 2.16 to 2.25, inclusive.
- (6) Repeat (1) to (5), inclusive, for each succeeding CU from the last CU downward.
- (7) Operate the GEN1-OFF-GEN2 key (regulator switching key) to OFF.
- (8) Operate FLOAT-CHG key on main control board to CHG.

When the battery voltage increases enough to cause the emergency cell switch to return to the normal position, check the GR1 voltage as in (a). Do not allow the charging current to exceed 150 per cent of the cell 8-hour rate. Remember that under these conditions the full CUs output is passing through the GR1 emergency cells. When the GR1 voltage rises to 5 volts, manually shut down CU1 by operating its NOR-STOP key to STOP or ON-OFF key to OFF. Then, operate its knife or rotary switch to the 48-volt position and the handwheel to the BAT position, if it is a generator. Restore it to normal operation, by operating the NOR-STOP key to NOR or ON-OFF key to ON. As charging continues, check the GR1 voltage. When it rises to 5 volts again, on each manually regulated CU, lower the output using the LOWER key until the CU disconnects. Then operate the knife or rotary switch to the 48-volt position and handwheel, if it is a generator with EM CELL position provided, to the BAT position. Restore to normal operation by operating the NOR-STOP key to NOR or ON-OFF key to ON, and the FLOAT-CHG key to FLOAT. Continue charging the GR1 and GR2 emergency cells, as required.

2.33 *Charging Emergency Cells With Diverter Pole Type Generators*

(a) *To Charge Both Battery and Emergency Cells at the Same Time*

- (1) Operate TEST key of lowest numbered generator to TEST.
- (2) Operate STOP key to STOP.
- (3) When set disconnects, operate generator knife switch to EM CELLS position.
- (4) Operate EM CELLS CHG switch to GR1 or GR1 & GR2 position.
- (5) Restore STOP key to NOR.
- (6) Slowly increase generator voltage using the handwheel, taking care not to overload generator or to exceed discharge circuit voltage.
- (7) Repeat (1) through (6) for other generators, as required, for charging emergency cells.
- (8) Restore all TEST keys to NOR.
- (9) If plant is equipped with manually operated emergency cell switches, operate counter cell switch to CHG position when voltage alarm occurs due to high voltage.
- (10) During charge period, use the handwheel to adjust generator voltage and output due to varying load and battery, so as not to exceed voltage limits of discharge circuit.
- (11) If charge rate of emergency cells must be reduced during charge due to high temperature of emergency cells and if more than one generator is connected to EM CELLS position, transfer one of the generators to the battery charge lead. If only one generator is connected to EM CELLS position, proceed as follows.

Operate TEST keys of all operating generators to TEST.

Using the handwheel, reduce the output of the generator connected to EM CELLS and increase the output of the generator connected across the battery, as required.

- (12) If temperature of counter cells rises to the maximum permissible value shown in Section A401.004, it will be necessary to float battery while completing emergency cell charge. [See (b) below.]

(b) *To Charge Emergency Cells While Floating Battery:* This routine requires at least two generators, one for connection across battery and the other for connection across emergency cells.

- (1) Operate TEST key of lowest numbered generator to TEST and then the STOP key to STOP.
- (2) When set disconnects, operate generator switch to emergency cell charge position.
- (3) Operate emergency cell switch to emergency cell group to be charged.
- (4) Restore STOP key to NOR position, and then by means of the rheostat, raise generator voltage until set connects to battery.
- (5) Operate TEST key of generator to be operated across battery to TEST position and place set in operation if it has not already been done.
- (6) Increase output of generator connected across emergency cells to the necessary value. During the charge period, the output of the generator charging the emergency cells will depend on load conditions; therefore it will be necessary to make frequent rheostat adjustments in order to maintain battery voltage within the floating limits and at the same time a suitable amount of current through emergency cells.

Emergency Cell Switches

2.34 *Manually Controlled Emergency Cell Switches*

(a) *Power Failure or Emergency Conditions:*

In the event of a power failure, or other conditions which prevent maintaining the battery voltage by means of CUs, the emergency cells shall be cut into the discharge circuit when low-voltage alarm operates.

- (1) Check that all manually controlled emergency cell switches are in their up positions (EM CELL control panel).
- (2) Operate the NOR-EM switch to the EM CELL position.
- (3) When low-voltage alarm operates again, operate the right-hand switch to the EM CELL GR1 & GR2 position.

(4) When generators have been restarted and connected to load, and the high-voltage alarm operates, operate the right-hand switch to the EM CELL GR1 position.

(5) When the high-voltage alarm again operates, operate the NOR-EM switch to the NOR position.

(b) **Main Battery Charge (With Countercells):** When the cells of the main battery are being charged and the voltage rises to cause a high-voltage alarm, check that the center switch is in the NOR position, and operate the left-hand switch to the CHG position to cut the countercells into the discharge circuit.

(c) **Emergency Cell Charge:** When it is desired to charge the emergency cells in series with the main battery, the NOR-EM switch should be in the NOR position and the right-hand switch should be in the down or EM CELL GR1 & GR2 position to charge both groups of emergency cells in series with the battery, or in the EM CELL GR1 position to charge the first group of emergency cells. In general, both groups should be charged until the charge of GR1 & GR2 is completed, at which time GR1 & GR2 should be removed from the circuit, and the charge of GR1 continued until completed.

2.35 Automatically Controlled Emergency Cell Switches: The emergency cell groups are automatically cut into or out of the discharge circuit under voltage control by the motor-driven emergency cell switch. If these cells are to be switched by manual control, the MAN-AUTO key, located with the emergency cell controls on the main control board, should be operated to the MAN position. The EM cells may then be cut in or out by operating the RAISE or LOWER keys, respectively, of the emergency cell circuit. These keys should be held operated momentarily, repeating the operation of the keys for each group of cells to be cut in or out. If the emergency cell switch fails to function, remove the EM CELL CONT A, B, and associated alarm fuses on the battery control board. Then if the switch is the slider motor-driven type, insert the hand crank into the aperture (front top of switch) and crank rapidly cw to remove emergency cells or ccw to add cells. Do not stop cranking until contacts

are fully engaged as stopping between positions will damage the current-limiting resistors. The contact position of the switch can be viewed through the window on the front cover. The knife-type motor-driven switch can be operated manually as follows. Remove the cotter pin holding the top of the insulated link. Disconnect the link and operate the switch manually.

2.36 Emergency Cell Float: A metallic-type unregulated rectifier is permanently connected to float the emergency cells. Adjustment is obtained by trial and should be made when the cells have been fully charged and the supply voltage is normal. Transformer taps in the rectifier provide means for changing the rectifier voltage and thereby its output current. The tap selected should be one which will hold the voltage nearest to the value covered in Section A301.005. This adjustment should be checked from time to time as the battery and rectifier age. It is not necessary to disconnect the rectifier after a power failure during which the cells have been discharged or during a recharging period. In some plants the power to the rectifier is supplied through an autotransformer which permits closer adjustment of the rectifier output.

Discharge Fuse Replacement

2.37 When replacing fuses on discharge panels equipped with KS-5047 fuse and switch units (single pole, double throw), always have the fuse shunted by the knife blade before removing or inserting fuse or fuses. When a discharge fuse blows, operate the switch to the other position which inserts the good fuse in the circuit. If this discharge fuse does not blow, replace the alarm fuse. If the second discharge fuse blows, check for trouble.

3. ROUTINE CHECKS

General

3.01 The purpose of making routine checks on this plant is to determine whether or not all the features, indications, and alarms are in proper operating condition. Basically, the objective of these checks is to cause all equipment to operate at periodic intervals without intentionally causing drastic or harmful situations such as complete power failure. The checking

time and testing intervals should be based on local conditions and past experience.

3.02 The operations described in Operation of Plant, should be periodically checked for each charging unit of the plant. In performing these operations, raise or lower the voltage just enough to start the necessary follow-up operation. Fully-automatic functions of the plant can be assumed to be in good operating condition if all the manual and test conditions shown in Operation of Plant are fulfilled during the periodic check.

Note: The automatic operation of the emergency cells can be checked by stopping enough charging equipment to cause one group of emergency cells to be cut into the discharge circuit. Observe voltages just before switching takes place. Readjust voltage relay if required.

Fuses and Alarms

3.03 Check all fuse-failure alarms and indicators periodically as covered in Table A. Test the alarms with a W1AF cord. Grasshopper fuse operation may be checked with either the No. 361B or 411A tool. The test can usually be made by connecting test battery or ground on the alarm bar or stud immediately under the fuse associated with the alarm being checked. Before making tests, the operator should analyze the test indication shown in Table A prior to applying the test voltage or test ground, to ascertain whether the test would shut down essential equipment. If such is the case, it may be desirable to postpone these tests to a lighter load period.

3.04 *Fuse Alarms — Alarm-type Fuse Shunting a Larger Fuse:* Remove the alarm-type fuse associated with a large fuse. With the W1AF cord, connect first one and then the other alarm fuse terminal to the fuse alarm stud or bar. Note each time that the alarm operates while the cord is connected. Remount the alarm-type fuse.

3.05 *Fuse Alarms — Circuit Supplied Through an Alarm-type Fuse:* Connect one pick of the W1AF cord to the terminal at the side of any fuse which is covered by the alarm under test. Momentarily connect the other test pick of the cord to the associated alarm stud or alarm

bar. Note that the alarm operates while the receiver is connected.

Charging Unit Failure Alarm

3.06 Each charging unit should be checked periodically for the associated failure alarms. If the charging unit is not idle, remove it from service as described in 2.16 to 2.25, inclusive. Carefully remove the fuses supplying ac power to the unit or operate associated switch or circuit breaker to its OFF position. Operate all keys to NOR. The GEN FAIL or RECT FAIL lamp on the unit under test should light. The GEN FA & CKT BKR lamp should light on the main control board. The PWR lamp in the emergency engine room should light and the minor alarm bell ring. The GEN FAIL and PWR lamps, and the audible alarm can be cut off by operating the ACO key on the main control board. When this key is operated, the FA & CKT BKR GD lamp lights on the main control board. Replace fuses or restore circuit breaker.

Voltage Control Alarms

3.07 Periodically the voltage alarm circuits should be tested. The paragraphs below are common to both the 24- and 48-volt plants and should be applied to both plants when the checks are made.

3.08 Using a W2W cord, connect the T & R test terminals of the 35-type test set across the test link of the voltage relay associated with the alarm under test. Connect the R terminal to the positive (G) side of the test link. Set the other test set keys as follows.

| | |
|-----------------|-----------------|
| KEYS | POSITION |
| BAT & GRD CO | Operated |
| REV | Normal |
| SWITCHES | POSITION |
| G | Open |

Connect dry cells in series to BAT and GRD terminals of the test set as required (estimate 1-1/2 volts per cell) to operate the voltmeter to its high contact, connecting the positive terminal of the dry cell to the GRD terminal of the test set. Connect an external voltmeter with an accuracy of at least 1/2 per cent across the terminals of the relay under test. Locking levers of No. 1 to 4 keys of the test set should be open and all the resistance sliders should be in their extreme right positions.

3.09 Close the locking lever of No. 3 key and move the No. 3 resistor sliders to their extreme left position. Close all resistance knife switches in the test set in such a way as to cut out all fixed resistance. Under this condition, the test set has its least resistance and the dry-cell battery is out of the circuit.

3.10 Cut the test set into the circuit by carefully removing the test link associated with the voltage relay under test. Care should be taken not to open the circuit through the voltage relay or to change the current flowing in such a way as to cause any violent operation of the relay as this may prevent a case of contact trouble from being detected in this test.

3.11 *High-Low-Voltage Alarm:* Test the low-voltage and high-voltage contacts of the HIGH VOLTAGE relay in the following manner.

(a) ***Low-voltage Test:*** Gradually move the No. 3 sliders of the test set to the right, thus introducing resistance and lowering the voltage across the voltage relay. Note that at the point where the low-voltage alarm should come in (see circuit requirement table), the major alarm sounds and the EM CELL SW lamp lights. If the voltage has not been lowered beyond the allowable range when both No. 3 sliders have reached their extreme right position, slide them fully back to the left. Then by means of the No. 3 knife switches cut in 25,000 ohms and again gradually move the sliders to the right.

(b) ***High-voltage Test:*** Move the No. 3 sliders to their extreme right positions. From the reading of the voltmeter, determine whether the voltage has been reduced sufficiently to permit the introduction of the test battery without causing the high contact to make. (See circuit requirement table.) Estimate the test battery voltage on the basis of 1-1/2 volts per cell. (If the voltage has not been reduced sufficiently, cut in additional resistance by opening one or more No. 3 knife switches as required to get the necessary reduction in voltage.) Then restore the BAT & GRD CO key and raise the voltage gradually by moving the No. 3 sliders toward the left to remove resistance from the circuit. Note that at the

point where the high-voltage alarm should come in, the major alarm sounds and the EM CELL SW lamp lights.

(c) Operate the BAT & GRD CO key of the test set and remount the test link before removing the test equipment.

Voltage Controller (Float Alarm)

3.12 Test the low- and high-float voltage contacts of the voltage controller in the following manner noting that at the approximate point where the alarms should come in, the audible and visual signals operate. (See circuit requirement table.) Check voltage by observing the battery control board panel meter.

(a) On main control board, operate FLOAT-CHG key to FLOAT and GEN1-OFF-GEN2 key (regulator switching key) to generator to be operated under voltage regulation.

(b) Check that all keys of voltage regulated CU are in NOR positions.

(c) To check low contacts, operate LOWER key on generator panel until R relay remains operated (low contacts make).

(d) After approximately 1 or 3 minutes, the -V FLOAT lamp should light and a minor alarm sound.

(e) To check high contacts, operate RAISE key on generator panel until L relay remains operated (high contacts make).

(f) After approximately 1 or 3 minutes, the -V FLOAT lamp should light and a minor alarm sound.

(g) Operate ACO key on MC board. The -V FLOAT lamp and minor alarm will be cut off and -V FLOAT GD lamp will light on MC board.

(h) Block PF relay nonoperated.

(i) Wait about 3 minutes until the indications covered in (f) are observed.

(j) Remove the block from PF relay which should cut off alarms.

Emergency Cell Lamp

3.13 Check that the -V EM CELL lamp operates when emergency cell GR1 or GR1 & GR2 are brought into circuit. See note in 3.02

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for instructions on bringing emergency cells into circuit.

CounterCell Voltage Control Alarms

3.14 CounterCells are cut in when the voltage is high and are cut out when the voltage is low.

3.15 Alarm Check

- (a) Insulate the top contacts 1 and 2 of H2 relay and the bottom contacts 1 and 2 of L2 relay in the counterCell switching circuit.
- (b) Block H1 relay operated.
- (c) Keep the relay blocked operated for about 3 minutes. After this time has elapsed, the CEMF CELL lamp should light and the major alarm bell ring.
- (d) Remove the block from H1 relay and block L1 relay operated.
- (e) Wait for about 3 minutes until the indications described in (c) are observed.
- (f) Remove the block from L1 relay and remove the insulation from the L2 and H2 relay contacts.

Alarm Multiple

3.16 The alarm multiple should be checked to be sure that major and minor power alarms in other parts of the building will operate in conjunction with corresponding audible alarms in the power room.

Emergency Cell Switch

3.17 Check the voltage drop requirement covered in Section A401.531, quarterly.

4. TROUBLES

4.01 Plant troubles listed are only those in connection with the charge control circuit which connects or disconnects units of charging equipment and the control which cuts counterCells or emergency cells in or out of the discharge circuit. Troubles in units of equipment, such as motor-generator sets, rectifiers, and regulators, are covered in the respective sections.

4.02 The generator field rheostats are adjusted at the time of installation and should not require adjustment unless disturbed for some reason, such as the replacement of a rheostat or parts of a rheostat. In the event that trouble is encountered, due to being unable to obtain the proper generator output and voltage, do not change the rheostat settings as the trouble is undoubtedly due to other conditions.

4.03 *Caution: Before replacing a battery charge or emergency cell charge fuse on the main control panel, operate all generator STOP keys to STOP; rectifier ON-OFF keys to OFF, and rectifier OFF keys to OFF. These precautions will prevent the generators or rectifiers from starting when the blown alarm fuse is replaced. After replacing the charge fuse and alarm fuse, restore the keys to their NOR or ON position, starting with the lowest numbered charging unit.*

4.04 The following table shows all alarm lamps in alphabetical order together with their functions. Action to be taken is also given in some cases.

| LAMP | INDICATES |
|-------------------|---|
| ABS | Alarm battery supply fuse blown. (See note.) |
| CBS | Control battery supply fuse alarm and voltage control fuse blown. (See note.) |
| CEMF CELL | CounterCell switching circuit may be in trouble. Check 24-volt discharge voltage. |
| CHG & MISC DISCHG | Charge or miscellaneous discharge fuse blown. (See note.) |
| DISCHG | Discharge fuse blown. (See note.) |
| FA & CKT BKR GD | GEN FAIL alarm has been cut off by operation of ACO key. |

| LAMP | INDICATES | TROUBLE | POSSIBLE CAUSE |
|--|--|--|---|
| 24) 48) - FLOAT VOLT | Float voltage alarm. Operate ACO key to cut off alarm. High or low battery voltage. | | Regulator key in OFF position or connected to wrong generator. Voltage regulator out of adjustment if voltage can be corrected by use of RAISE and LOWER keys. Failure of motor-driven rheostat. Rectifier out of adjustment. Battery trouble. Failure of rectifier. |
| 24) 48) - FLOAT GD | FLOAT VOLT alarm has been cut off by operation of ACO key. | Battery voltage high or low | |
| GEN FA & CKT BKR (at main control board) | Charging unit failure. Operate ACO key to cut off alarm. | | |
| GEN FAIL (at the generator) | Control fuse blown or charging unit failure. | | |
| GEN PAN | Generator panel fuse blown. Look for blown fuse on generator panels. (See note.) | Battery voltage high | FLOAT-CHG key in CHG position. |
| PABS | Power alarm battery supply fuse blown. (See note.) | Battery voltage low | Power failure or blown ac fuse. Load exceeds connected generator capacity. Generator stopped, C, CHG, or VM & VR fuse blown. |
| PWR | Trouble in power room. | | |
| RCT FAIL | Rectifier failure. | | |
| 24) 48) - V EM CELL | High or low battery voltage. Emergency cell switch may be in trouble. Check discharge voltage. | Discharge voltage high | CEMF cells not cut in while charging. Failure to switch emergency cells out of circuit. |
| | | Discharge voltage low | CEMF cells cut into circuit. Failure to switch emergency cells into circuit. |
| | | 24-volt discharge bus voltage high or low when obtained from a 48-volt plant through counter cells | Control circuit failed to cut counter cells in or out. |
| | | Rectifier line contactor operates but rectifier does not give output | Check rectifier per appropriate section. |

Note: Where alarm fuses are in parallel with supply fuses, replace blown supply fuse first and alarm fuse next.

4.05 Trouble Chart: The troubles and possible causes listed below are not necessarily all inclusive but are merely indicative of some of the difficulties that may be encountered when the 301C power plant is not operating normally. In the case of visual alarms, the operator can tell the trouble location by the designation of the lamp which is lit on the generator bay, rectifier bay, or main control board. In the case of fuse alarms, Table A will assist the operator in locating the difficulty. If the trouble is not found with the assistance of the indicators and trouble chart, reference must be made to the schematic diagrams and circuit descriptions.

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| TROUBLE | POSSIBLE CAUSE |
|---|--|
| Battery voltage low and emergency cell switch did not operate | Emergency cell MAN-AUTO switch is in MAN position. Trouble with EM CELL relay. Operate switch manually. (See 2.35.) |
| Alarm battery supply fuse alarm or control battery supply fuse alarm operates | Either alarm battery supply or control battery supply fuse on main control board blown. |
| Generator panel fuse alarm operates | Fuse blown on generator panel. Shut down generator before replacing fuse. |

| TROUBLE | POSSIBLE CAUSE |
|--|---|
| 24- or 48-volt high-low-voltage alarm with battery voltage within floating limits | Check that counter-cells are cut out of discharge circuit. |
| 24- or 48-volt high-low-voltage alarm with battery voltage outside floating limits | Voltage regulation control not operating properly. Operate the voltage regulation circuit by means of manual control keys and see if voltage can be corrected. If battery is on charge, CEMF cells should be cut in if necessary. |

| FUSE LOCATION | FUSE DESIGNATION | TEST PROCEDURE | INDICATION |
|---|---|---|--|
| Charging Unit Panel | Gen Cont CHG C VM or VM & VR Gen Cont 6.25A Gen Cont 1/2A | Connect 24 or 48 Volts on Alarm Stud Connect GND on Alarm Stud Connect 24 or 48 Volts on Alarm Stud Connect 24 or 48 Volts on Alarm Stud No Test Required Connect 24 or 48 Volts on Alarm Stud | Note 1 Note 1 Note 1 Note 1 None Note 1 |
| Main Control Board | CBS PABS | Connect 24 or 48 Volts on Alarm Bar Connect Battery to Alarm Bar Use 24 Volts on 24-volt Plant Use 48 Volts on 48-volt and Combined Plant | Note 2 Note 3 |
| Battery Control Board and Emergency Cell Control Panel (See Note 4.) | EMC G1 15A EMC G2 15A EMC G1 1/2A EMC G2 1/2A REG 15A REG 1/2A EM Cell Cont A and B EM Cell Cont A and B 1/2A EMC VM 3A VM 3A BAT CHG 1/2A DISCHG 1/2A CHG 1/2A | No Test Required for 15A, EM Cell Cont A and B and EMC VM 3A Fuses On 24-volt Plants Place 24 Volts on Alarm Stud On 48-volt Plants Place 48 Volts on Alarm Stud | None None Note 5 Note 5 Note 6 Note 6 Note 6 Note 5 A voltmeter reading indicates fuse is not blown. A voltmeter reading indicates fuse is not blown. None Note 6 Note 5 |
| 24-volt Fuses | CO Fire Drill Ring PWR BD 24V CBS PWR ALM ALM BAT SUP | Place 24 Volts on Alarm Stud | Note 6 Note 6 Note 6 Note 7 Note 7 |
| 48-volt Fuses | 24V CEMF Ring PWR BD 48V CBS PABS ABS | Place 48 Volts on Alarm Stud | Note 6 Note 6 Note 6 Note 7 Note 7 |

Notes

1. GEN PAN lamp lights on main control board; minor alarm bell rings; associated generator stops.
2. CBS lamp lights on main control board; PWR lamp in emergency engine room lights; major alarm bell rings.
3. PABS lamp lights on main control board; alarm battery supply bell rings.
4. All fuses shown do not appear on all plants. Check those which apply to the plant being checked.
5. CHG & MISC DISCHG lamp lights on main control board; minor alarm bell rings.
6. DISCH lamp lights on main control board; major alarm bell rings.
7. ABS lamp lights on main control board; rings alarm battery supply bell.