

J86742 CONTROLLER
AUTOMATIC PARALLELING AND
LOAD MANAGEMENT BAY

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PART I GENERAL

1. DESCRIPTION

- 1.1 The J-86742 is a floor supported cabinet 2' 6" wide, 2' deep (front to back) and 7' high. Full length doors on the front and back allow access to the apparatus and wiring. The fully equipped bay weighs approximately 400 pounds.

2. PURPOSE

- 2.1 The bay is designed to provide for fully automatic control of from two to six Emergency Engine Alternators. In addition to engine start-up, voltage and frequency adjustments, paralleling and load sharing, the circuitry will disconnect essential office loads from the commercial bus and connect them to the emergency bus in a predetermined manner and on a priority basis. Refer to Figure 1 for a typical ac power service distribution arrangement for telephone central offices.

3. MANNER OF USING TEST METHOD

- 3.1 If not familiar with the J-86742 Bay and this test method, it is suggested the entire section be read through at least once. Locating the apparatus, as it is referred to while reading through the test method, will prove beneficial by familiarizing yourself with the components and by saving actual test time.
- 3.2 While actually performing the tests, occasionally there is an advantage in reading ahead a couple of Paragraphs before starting that part of the test. For examples, are Paragraph's 9.12, 9.121 and 9.13 in PART IV.
- 3.3 Instructions in the section to operate S1 and S2 switches refer to the two switches on the right of the Common Control panel. S1 is on the right under the "48V" bracket and S2 is on the left under "48V RS".

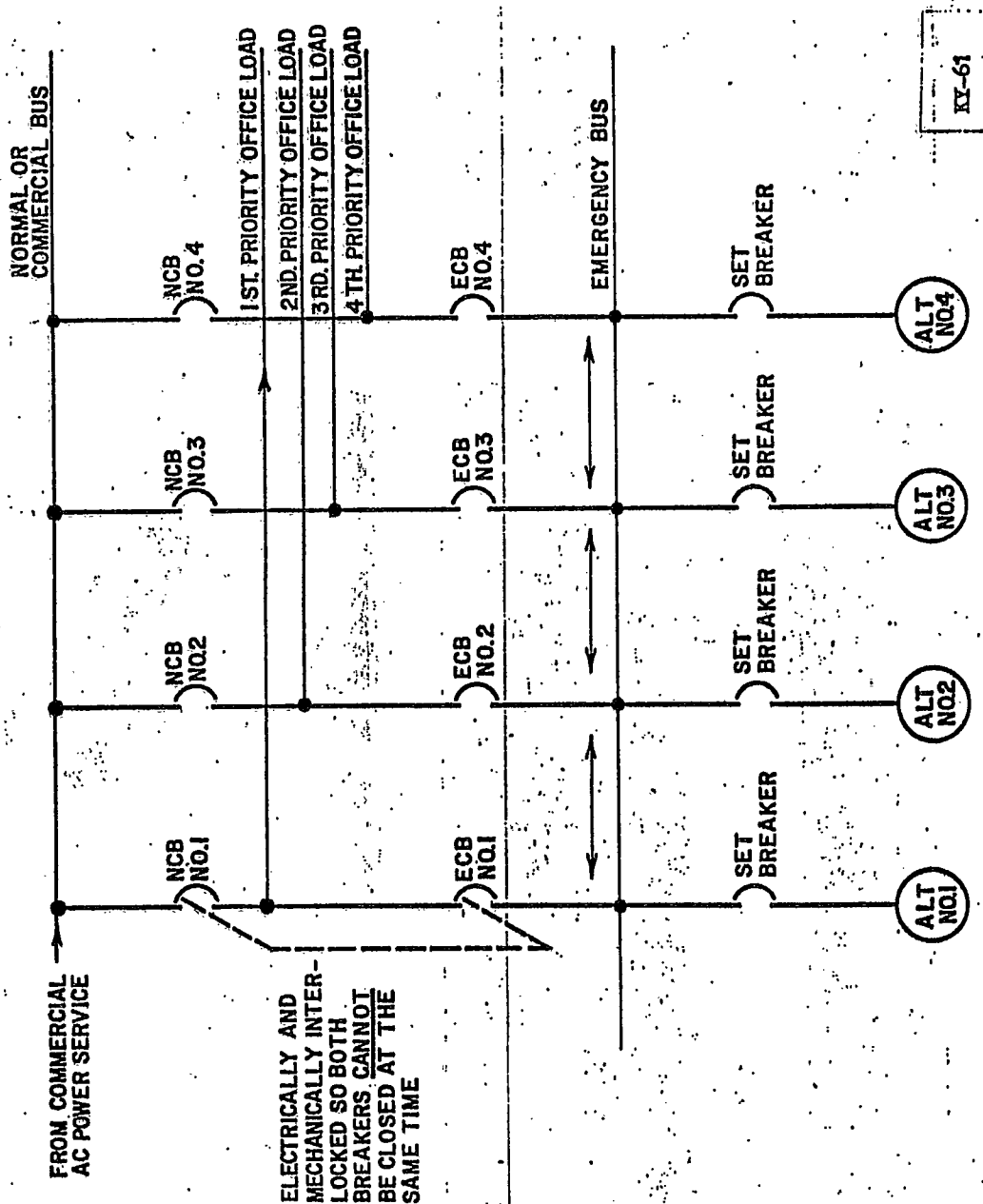


FIG. 1 TYPICAL SINGLE LINE DIAGRAM SHOWING FOUR ALTERNATOR SETS AND FOUR PRIORITY LOADS. EACH PRIORITY LOAD, FOR EXAMPLE NO. 1 PRIORITY LOAD, MAY, IN REALITY, CONSIST OF ONE OR MORE LOADS CONTROLLED BY ONE OR MORE NO. 1 NCB'S AND NO. 1 ECB'S OPERATED IN PARALLEL. THE ALTERNATORS ARE NOT ASSOCIATED BY NUMBER WITH THE LOADS. ONE ALTERNATOR (NOT NECESSARILY NO. 1) IS PLACED ON THE EMERGENCY BUS THEN THE FIRST PRIORITY LOAD CONNECTED BEFORE THE SECOND ALTERNATOR AND SECOND PRIORITY LOAD, ETC. THE SEQUENCE IN WHICH THE ALTERNATORS ARE CONNECTED DEPEND ON THE SPEED WITH WHICH THEY START UP, AND RETURN TO THE PARALLELING BAY, A "READY TO LOAD" SIGNAL.

PAR. 2.1

4. PREREQUISIT TO TESTING THE PARALLELING BAY

- 4.1 Before attempting to wire the Paralleling Bay into the existing engine circuitry and before making any tests concerning the Paralleling Bay, the engine alternators must meet all requirements of the appropriate Installation Engineering Handbook sections for the individual engines and their controllers.
- 4.2 All engines must be operated, paralleled and loaded manually in a satisfactory manner. Parallel No. 1 with No. 2 and then No. 2 with No. 1. With 3 machines or more, determine that each machine can be paralleled with the hot EM Bus. Determine that the voltage on all alternators is set at the nominal value for the office. The sync lights on each set must be properly phased to the EM bus, to all other sets, and, to the loads (correct phase rotation),
- 4.3 If engines are equipped with Electronic Governors that are set for isochronous operation (Load Sharing) the following four paragraphs do not apply.
- 4.4 It is recommended that all droop type governors be reset for a 1 1/2% speed droop from no-load to full-load unless the operating company specifically requests the setting be left at a higher value. Other speed droop settings are permitted as long as all engines operate with the same droop. Speed droop settings in Section 130 covering manual paralleling is superceded by this section when converting to automatic paralleling.
- 4.5 If it becomes necessary to readjust speed droops it should be noted that some droop adjustment changes are not apparent when the engine is kept running, viz., J-86653 750/900 kW engine. The engine must be stopped and restarted to reflect any change in adjustment.
- 4.6 Verify that the Voltage Droop potentiometer on each engine, when provided, is set for a 1% droop maximum from no-load to full-load using office inductive load, e.g., 1/2% droop at 1/2 load. All engines shall be set at the same voltage droop.

- 4.7 Verify that the Cross Current Compensator potentiometers on each engine is set to produce a 3% voltage droop from no-load to full-load at .8 Power Factor. If the reactive office load is better than .8, the CCC pots should be set proportionally, e.g., .9 PF = 1 1/2% voltage droop.

5. DRAWINGS

- | | |
|-------------|--|
| SD-82294-01 | J86742 System Controller and Paralleling Bay |
| SD-82295-01 | Circuit Pack Schematic for the J86742 Controller |
| SD-82325-01 | Application Schematic for Engines and Breakers |
| NOTE: | See CD-82325-01 for list of connecting circuits functional with this unit. |
| SD-81489-01 | Typical circuit breaker arrangement |
| SD-81061-01 | Figures 10 and 11 - Rectifier sequencing circuit |
| SD-81100-01 | Alarm circuits |
| SD-81223-01 | Alarm circuits |

6. PLACING THE UNIT AND WIRING

- 6.1 Locate the bay within the rectangular outline floor layout. In accordance with Installation Engineering Handbook 30, plumb, and secure with one 3/8" bolt or stud (5/8" hole for anchors) on each of the four corners.
- 6.2 Cover thoroughly all apparatus and wiring in the bay before drilling and cutting holes in the top.
- 6.3 When running and sewing the ac and dc forms in the rear of the bay, make sure the forms are brought all the way down to the hinged portion of the two hinged panels and then back up as the legs branch off. All wiring entering the panels must enter in the hinged area at the bottom of the panels. These panels must be lowered on occasion to gain access to wiring between panels. See the cabling path on the rear view of Figure 1 on J-86742 A-1.

7. WARNINGS

7.1 The instruments used for measurements throughout the section must not be grounded and must be so marked when plugged into 115V ac. When the ITE-5356 Universal Digital Multimeter is used it should be used with the internal batteries and not with the ac line cord. When the ITE-5517 Power Module and ITE-5519 Frequency Counter is used, the line cord must be plugged into an adapter so the instruments can be operated off ground. That is to say the green wire in the ac line cord and the "U" grounding pin in the plug must be isolated from the "U" grounding slot in the receptacle. Grounded instruments can damage the integrated circuits on the circuit packs. Use the R-3184 adapter and insulate the grounding wire. Be sure to tag the instrument to indicate it is not grounded. After plugging in the instrument, check with a voltmeter from the instrument framework to a known ground to determine no unsafe potential exists, which could cause a shock to operating personnel.

7.2 A GFI (Ground Fault Interrupter) such as a Harvey Hubbell Cat. GFP-115A (and GFP-P Pouch), may be used between the ac receptacle and the ungrounded instrument. GFI's have not yet been standardized as an installation tool, however, if purchased locally, they may be used to an advantage in reducing the hazard of what might be a serious electrical shock.

NOTE: The GFP-115A is a single receptacle outlet. If four outlets are desired the GFP-201 is recommended.

7.3 A portion of the circuitry and components have hazardous voltages on them. Ac output voltage is fed from each of the alternators and ac from the outside source of commercial power is brought in for sensing purposes. Power is also sent back to the bay from the EM bus. In some instances, hazardous voltages for operation of customer furnished circuit breakers may be present particularly on terminal strips and relay contacts.

7.4 With the exception of LL7 and LL5's, when provided, Switch S1 removes dc from the circuit packs and from the SBC (Set Breaker Closed) relay. The LL5's are powered with +12V and -12V from LL7 which in turn is powered by 120V ac from the EM Bus. Switch S2 only removes ground from the relay panels, therefore, exercise care when testing and shooting trouble.

7.5 Step down transformers are used to reduce the voltage coming in on the Twist Lock cord connectors from the EM bus and the engines when the voltage is higher than 115-120. Make sure when the engines are running that 115-120 volts appear on the J1, J2, J3, etc. A reminder to check this when the engine is running will follow.

8. CAUTIONS

8.1 DO NOT REMOVE OR INSERT CIRCUIT PACKS WITH POWER ON. ALWAYS TURN 48V S1 TO OFF FIRST.

8.1.1 Removing or inserting circuit packs with power on can easily destroy the integrated circuits. Static electricity picked up by the body can easily destroy the integrated circuits. Never touch these terminals unless all static has been discharged from the body, especially on a low humidity day or in a low humidity area.

8.2 When checking for presence or absence of voltage, use care in selecting the correct return reference, i.e., neutral, framework ground, circuit pack return paths (common - ungrounded), power supply negative jack and common Test Point jacks.

8.3 The circuit packs are powered by +12 volts from power supply LL6. The common or negative side of this supply is shown as a ground symbol on the schematics, viz., $\perp$ but is not at ground or ironwork potential level. When referencing circuit pack power, in relationship to true ground (ironwork), the common or negative side is at -48 volts and the "+12 volts" supply is at -36 volts.

8.4 The following should help to further clarify this relationship. Lead "GRD" on SD-82295-01 Circuit Pack Schematic, in relationship to ironwork, is at -48V while the ground symbol $\perp$ [i.e., lead 82(+)] on SD-82294-01 System Controller and Paralleling Bay, is at 0V in relationship to ironwork. On this same SD-82294-01 the "COM" lead is at -48V to ironwork and the "Vcc" lead (+12V) is at -36V to ironwork. Both sides of the 12 volt supply are floating off of true ground.

9. TOOLS AND TEST SETS

9.1 Tools:

R-1005 7/8" Jeweler's Screwdriver

Except for the additional tools listed herein, normally the tools furnished in the Installer's 168 Kit and the tools furnished in the General Power Kit 3 are adequate to make all connections and adjustments.

9.2 Test Sets

ITE-4782	150 kW Test Load (See Notes 1 and 2)
ITE-4785	250 kW Test Load (See Notes 1 and 2)
R-3413	Wire and Lug Assembly
ITE-5913	Phase Angle Meter
ITE-5356	Universal Digital Multimeter - or - ITE-5520 Digital Multimeter found in the ITE-5516 Emergency Engine Alternator Test Package. (See Note 4)
ITE-5351	Frequency Counter - or - ITE-5519 100 MHz Counter found in the ITE-5516 Emergency Engine Alternator Test Package. (See Note 4)
2Y Lamp	Test Lamp - or - Equivalent 48V lamp and leads, Harvey Hubbell Co. Ground Fault Interrupter, (Obtained Locally)
GFP-115	Single outlet - or -
GFP-201	Four outlets
R-3184	3 Wire "U" Pin Adapter (2 to 3 required) (See Part I Paragraphs 7.1 and 7.2)
R-3295	3 Conductor Extension Cord (30 Feet Long)
R-4296	Ear Protectors (1 for each person)
815A	Tool (Extender Card) (See Note 3)
R-3404	Phase Sequence Indicator

NOTE 1: Due to the heat produced by the test loads, they should be placed outside whenever possible or in a well ventilated area. This distance will determine the number of R-3413 Wire and Lug Assemblies required for connecting them.

NOTE 2: The total artificial load shall be a minimum of 25% of the total capacity of all alternators but not less than one test load-box per engine alternator set.

NOTE 3: Normally an extender card will be furnished with the Paralleling Bay. If not furnished, an attempt should be made to borrow one from the operating company. The card will be needed to make test connections and adjustments when setting the LL5's.

NOTE 4: The ITE-5516 Emergency Engine Alternator Test Package consists of the following:

ITE-5517	Power Module
ITE-5518	Oscillator
ITE-5519	Frequency Counter
ITE-5520	Digital Multimeter
ITE-5521	Temperature Simulator

10. RECORDS

SD-4-1313	Test Trouble Record
SD-4-1315	Summary of Tests

PART II WIRING CHECKS1. GENERAL

1.1 The test portion of this section assumes all leads are run and connected. Utilizing job drawings and applicable sheets from SD-82325-01, pertaining to the engines and switch gear involved, verify all wiring. Make continuity checks of all leads from the Paralleling Bay to the engines, Normal Circuit Breakers, Emergency Circuit Breakers, Alternator Circuit Breakers, Rectifier Sequence Control, alarms, ac service, etc.

1.2 There is a small time savings to be gained if the alternator circuit breaker control leads and building switch gear control leads are run, sewed and terminals attached but not connected. See Part IV Paragraphs 7.02 and 13.201.

PART III PRELIMINARY OPERATIONAL TESTS (WITHOUT CIRCUIT PACKS)

1. GENERAL

1.1 This section covers the following:

Verification of the engine functions at the Paralleling Bay

Operation of the Load Sharing control

Operation of the Frequency Reference control

Check and calibration of the Automatic Synchronizer

Operation of the switchgear from the Paralleling Bay

Operation of Rectifier Sequence Control, when provided

Overall automatic operation

1.2 Verify all wiring and connections (Wiring Check). Determine that all wiring has been run and connected correctly to the engines, office alarms, circuit breakers, control battery, ground supply, ac power service sensing fuses, etc. Attach P1 - EM BUS plug. After checking voltage on J cord bodies (Part I, Paragraph 7.5) attach to all P1 - ENG ALT plugs. The tests herein includes verification of the leads run between the controller and the engine. Also make a visual inspection of the leads run by the shop. Inspect for poor solder, loose connections and wires that may have broken in transit.

2. PRELIMINARY OPERATIONS

2.1 With S1 and S2 OFF, install the fuse at the Battery Distributing Fuse Board or Fuse Panel and install the F1 fuse on the Paralleling Bay. Verify that the fuse is properly identified at the BDFB.

2.2 Verify that 48 volt battery supply is present with the correct polarities. TS-19, +48V on Term 22 and -48V on Term 21. Verify the correct N or P wiring option is observed. The fuse and S1 switch is on the ungrounded side whether -48V or +48V office battery source is used.

2.3 Remove all circuit packs (except in the synchronizer) before starting any testing.

2.4 Verify that switches S1 and S2 on the Common Control panel are OFF.

2.5 The J86742 Paralleling Bay has had all circuit packs adjusted and functionally tested at the factory. When testing a particular circuit pack, disregard operation and lamp indications on packs associated with other sets, i.e., when working with LL5(2) circuit pack disregard LL5(3) through LL5(6).

2.6 In the beginning of the actual testing, detailed instruction cover silencing the alarms created and restoration of the system to normal. Since the same procedure for clearing the alarms and for restoring the Paralleling Bay to "normal" is required repeatedly after most of the test, repeating the instruction in each test has, in most instances, been eliminated.

3. DETAILED INFORMATION AND START OF TESTS

3.1 The remaining tests in this handbook section assumes the engine alternators are operational (See Part I, Paragraphs 4.1 and 4.2). All control-voltage circuit breakers on the engines are closed and the TSS's are in AUTO and the OSS's are in OFF.

3.2 Operate S2 (48V RS) to ON.

3.3 The following tests should be repeated for each engine, running only one at a time:

4. AUTO

4.1 On the Paralleling Bay, connect a voltmeter across Terms 11 (ground) and 12 (battery) on TS-15 for engine No. 1. See Paragraph 7 for TS's for other engines. Check for AUTO Signal by putting OSS in AUTO or AUTO TEST. If ground is present, battery will be furnished and if battery is present, ground will be furnished. Check to make sure AUTO or AUTO TEST signal is removed when placing OSS in MANUAL and in OFF.

4.2 To verify operation of engine set and Paralleling bay, for the next series of tests, operate one set at a time in AUTO mode (First set or next set OSS in AUTO). All other engine OSS switches in OFF.

- 4.3 Using the Application Schematic SD-82325-01 as a guide; check whether Battery (-) is present and a Ground is to be furnished, or, Ground is present and Battery (-) is to be furnished. Verify in the following tests presence of all 24V control signals from the engine alternator. Some engine alternators will furnish Battery and some will furnish Ground.

5. POWER FAILURE AND RESTORE

- 5.1 On the Paralleling Bay, connect a voltmeter across Terms 7 (plus ground) and 8 (negative battery) on TS-15 for engine No. 1. See Paragraph 7.11 for TS's for other engines.
- 5.2 Simulate an actual "Power Failure" condition by removing one of the sensing fuses CA, CB or CC (or opening one of the sensing circuit breakers).
- 5.3 Check for a "Power Failure" signal across the terminals after the Start Delay timer has timed out.
- 5.4 Before the engine completes its start sequence return the Sense fuse and cycle the OSS Switch to OFF and then back to AUTO. The "Power Failure" signal will be removed.
- 5.5 Check for a "Restore" signal across TS-15, for engine No. 1, Terms 9 and 10.
- 5.6 Without automatic restoration but when circuitry is provided, operate TRANSFER RESTORE pushbutton on the set and check for return ground signal on Term 9. As an example, on the 200 KW set, check for a return ground when the PRR (Power Restore Relay) is operated.

6. START

- 6.1 Start the first or next engine by finger operating the associated Start relay located on the Engine Load mounting plates. Run only one engine at a time. On the gas turbine engines it is necessary to hold the relay operated until the Start Delay Timer on each engine times out and the engine begins to build up speed (observe "% Speed" meter when provided).
- 6.2 Verify presence of 115-120V on the J cord connector associated with the engine being run. See Part I, Paragraph 7.5.

7. READY TO LOAD

- 7.1 After the engine alternator has attained full speed, verify READY TO LOAD signal back from each engine by checking for 24V across Terms 1+ and 2- on the Engine Alternator terminal strip on the Paralleling Bay.
- 7.11 ENGINE ALTERNATOR TS-15 for Engine No. 1

TS-27 for Engine No. 2

TS-28 for Engine No. 3

TS-24 for Engine No. 4

TS-26 for Engine No. 5

TS-25 for Engine No. 6

The above specific example, listing Engine Alternator terminal strips associated with each engine, is not repeated throughout the text for other terminal strips associated with engines No. 2 through No. 6. Refer to the drawings for the comparable terminal strip numbers associated with engines No. 2 through No. 6.

8. CLOSE SET BREAKER

- 8.1 Make sure only one set is running. Make sure all P1 plugs are attached to the J1 jacks on the rear (wiring side) of the bay. (Par. 1.2).
- 8.2 On the set, turn the Synchronizing Switch to OFF (On some sets, the switch may be marked Synchronization of Synchroscope Control).
- 8.3 On the Paralleling Bay, turn S1 to ON.
- 8.4 Except on the 225 kW sets, which has no OSS "MAN" position, turn OSS to MAN and momentarily finger operate the CSB (close set breaker) relay on the Paralleling Bay for the first or next set. In most cases, the CKT BKR CLS lamp on the engine or the remote bay will not light. On other engines such as the 125kW, etc., it will light.
- 8.5 Turn OSS to AUTO and momentarily finger operate the CSB relay. In all cases, the CKT BKR CLS lamp on the engine or remote bay should light.

8.6 The SBC (set breaker closed) relay on the Common Control panel of the Paralleling Bay should operate. This relay operates anytime a set breaker is closed.

8.7 Verify that the BD relay operates on the Common Control panel. (When any set breaker closes the BD relay operates).

8.8 Turn S1 to OFF.

9. SET BREAKER AUXILIARY CONTACTS

9.1 When the set breaker closes, the auxiliary contacts closes 24V through to TS-15 (for set No. 1). Terms 5 (-) battery and 6 (+). Check with a voltmeter.

9.2 Recheck for nominal 120V ac alternator output feeding the Paralleling Bay through ENG ALT P1 and J1, at the respective TS-1's on the rear of the Analog mounting plate at the top of the bay on Terms 21 and 22. See Paragraph 6.2 for plug and jack check.

10. OPEN SET BREAKER

10.1 Finger operate OSB (open set breaker) on the Paralleling Bay associated with the first or next set and the CKT BKR OPN (circuit breaker open) or ALT-CB IS OPEN lamp on the engine or remote bay should light. The set circuit breaker should be open. The SBC relay should release. The BD relay should release. Sync switch SSW on engine must be OFF.

11. FREQUENCY (SPEED) CONTROL - MANUAL TEST

11.1 Finger operate the RF (raise frequency) relay on the Analog mounting plate that mounts the kW transducer, for the particular engine running. Observe that the frequency increases. Finger operate the LF relay and observe that the frequency is lowered. Adjust the frequency to 60 Hertz.

12. LOAD CONTROL OPERATION

12.1 The following paragraphs under the above heading apply only when testing engine No. 1.

12.11 Remove P1 - ENG ALT plug and the P1 - EM BUS plug both at the rear of the Paralleling Bay.

12.12 Remove CT (current transformer) shorting strap(s) on ENG ALT GOV TS-2 () Terms 1 and 2 and store on spare Terms 3 and 4. Remove one strap for each engine alternator set.

12.13 Return P1 - ENG ALT plug and P1 - EM BUS plug.

13. SET SHUTDOWN

13.1 Manually open set breaker ACB if closed.

13.2 When automatic restoration is provided (SD-81644-01 Fig. 6) toothpick operated STOP relay in the Paralleling Bay. The engine shuts down, and after it stops, remove the toothpick.

13.3 Place OSS in OFF.

13.4 Repeat Paragraphs starting with 3.2 for each engine alternator set with only one running at a time.

13.5 Turn all engines OFF.

PART IV OPERATIONAL TESTS - DYNAMIC (WITH CIRCUIT PACKS)

1. PRELIMINARY

1.01 Some engines are equipped with electronic load sharing governors (See Paragraph 4.3 in PART I). When so furnished, and these sets are arranged for isochronous operation, CP5, CP7 and CP12 circuit packs will not be provided. See Table "A". In addition, tests in this section which verify correct operation of these circuit packs obviously cannot be made and the tests should be omitted. Mark the following paragraphs for omission:

Part III; Paragraph 12 and

Part IV; Paragraphs 6 through 11.

NOTE: Paragraph reference from here to the end of the section refer to Part IV, unless otherwise indicated.

1.02 With S1 and S2 OFF, install the LL6 circuit pack.

1.03 Operate 48V switch S1 to ON.

TABLE A
(PART 4, PAR. 1,01)

APPARATUS CODE	CIRCUIT PACK NUMBER	STAMPING	FUNCTION
LL1	CP1	ENG CONT	Engine control. One circuit pack per engine.
LL2	CP2	ALM CONT	Alarm Control.
LL3	CP3	COM CONT	Common Control.
LL4	CP4	BRKR CONT	EM Breaker Control. One per priority or engine. Used in place of LL10 for only disconnecting office loads.
LL5	CP5	LOAD BAL CONT	Load balance control. One per load priority but usually one per engine.
LL6	CP6	PWR SUP	Power supply for circuit packs, except CP5. 48V in and 12 volts out.
LL7	CP7	PWR SUP $\pm$ 12V	Power supply for kW calculators. 120V ac from alternator in and $\pm$ 12V out to CP5
LL8	CP8	CTR CONT	Counter control. From 2Hz clock to breaker control.
LL9	CP9	DECODER I	Matrix and decoder. Status indicator. Alternators 1, 2 and 3 and loads 1, 2 and 3
LL10	CP10	BRKR CONT	Normal breaker control and emergency breaker control. Actually one per load priority but usually one per engine. Used for DC operated office switch gear.
LL11	CP11	DECODER II	Matrix and decoder. Status indicator alternators 4, 5 and 6 and loads 4, 5 and 6.
LL12	CP12	FREQ STD CONTROL	Frequency standard control or frequency reference. Establishes first engine emergency bus frequency.
LL13	CP13	RECT SEQ CONTROL	Rectifier sequence control. Sequences central office rectifier loads back on the emergency bus.
LL14	CP14	BRKR CONT	Normal breaker control and emergency breaker control when office switch gear is ac operated. Used instead of LL10. Actually, one per load priority but usually one per engine.

- 1.04 Check input and output Test Point voltages on LL6.
INPUT to NEG - 42 to 53V dc.
12V to NEG - 12.35 to 13.65V dc.
- 1.05 CAUTION: DO NOT REMOVE OR INSERT CIRCUIT PACKS WITH POWER ON
- 1.06 Turn 48V S1 switch to OFF.
- 1.07 Verify that Screw switches S1-1 and S1-2 are open on all LLI's. The following tests are based on these switches being open.
- 1.071 S1-1 closed on one of the LLI's will fix the associated engine as the first engine on the line at all times and will always be the "reference" set.
- 1.072 If any LLI switches are instructed to be closed, alternate test arrangements should be discussed with your Regional Installation Engineer and your Line Engineer.
- 1.08 Install all LLI's, LL2 and LL3.
- 1.09 Turn S1 to ON.
- 1.10 Initialize per following Paragraph.
- 1.101 Operate RESET button on all LLI's (Engine Control) and LL2 (Alarm Control) to clear fault lamp indications. Operate MAN - RESET on LL3 to light SYS RESTORE lamp. When LLI3's (Rectifier Sequence Control) circuit packs are furnished operate RESET buttons.
- 1.11 On LL3, operate TEST-NOR switch to TEST. Observe that the associated lamp is lit.
- 1.12 On LL3, operate AUTO-MAN to AUTO and observe the associated lamp is lit. Operate to MAN and observe that the associated lamp is lit. Leave the switch in the MAN position.
- 1.13 On LL3, operate MAN - RESET (system restore) pushbutton momentarily and observe SYS RESTORE lamp lights.

2. ENGINE FAIL CHECK - ENGINES NOT RUNNING

- 2.1 Momentarily ground Engine Fail lead in the engine and check for SET FAULT light on the respective LLI's. When the ground is removed the SET FAULT lamp will go out. Examples of Engine Fail leads:

For 125 kW set TS 12 Term 470

For 200 kW set
W.E. Solid State Cont. Term T18
Relay Cont. Term T247
Continental Solid State Cont. TB 24-16

For 225 kW set Term 31A

For 750 kW set Term T78

For 750/900 kW set TB 24-16

Refer to drawings for terminals on other engines.

3. INITIALIZE - MANUAL SYSTEM-RESET

- 3.1 Operate RESET button on all LLI's (Engine Control) and LL2 (Alarm Control) to clear fault lamp indications. Operate MAN - RESET on LL3 to light SYS RESTORE lamp. When LLI3's (Rectifier Sequence Control) circuit packs are furnished operate RESET buttons.

4. GENERAL

- 4.1 To verify the operation of each engine set and Paralleling Bay, for the next series of tests, operate one set at a time in AUTO mode (First set or next set in AUTO). All other engine OSS switches in OFF.
- 4.2 Verify that the associated breakers in the House Service Cabinet are in the manual mode.
- 4.3 The following tests, up through Paragraph 8.5, should be repeated for each engine, running only one at a time;
- 4.4 Start the first or next engine by finger operating the associated START relay in the Paralleling Bay. Wait until engine is up to full speed and then RTL (Ready To Load) lamp on engine will light.

5. SET RTL STEP ON CHECK

- 5.1 Turn S2 to ON.
- 5.2 Operate MAN STEP button momentarily on LL3 and determine that the Step Switch on the Common Control panel steps to the next position.
- 5.3 If SYS RESTORE lamp is not lit, depress MAN RESET, pushbutton on LL3 and check for SYS RESTORE lamp indication.
- 5.31 The control for engines 1 through 6 on the Step Switch are on switch levels 2, 4, 6, 8, 10 and 11 respectively. As the switch advances through each engine level, when that engine is running, the SET RTL STEP ON lamp will light on the respective LL1 Engine Control circuit pack.
- 5.4 Repeat to check that the switch will advance through all 12 positions and leave on level 1.

6. LOAD CONTROL POWER SUPPLY

- 6.01 Only when testing engine No. 1, turn S1 to OFF.
- 6.02 Only when testing engine No. 1, verify that No. 1 set breaker is open.
- 6.03 Only when testing engine No. 1 insert LL7.
- 6.04 Only when testing engine No. 1 turn S1 to ON.
- 6.05 Initialize. (see Paragraph 3.1).
- 6.06 On the engine running, place OSS in MAN. Place the TSS (Transfer Selected Switch) in HAND or MAN.
- 6.07 Close the set breaker by operating Circuit Breaker Closed button on the engine or the remote cabinet. This furnishes ac power to LL7 via the EM bus.
- 6.08 Check for approximately 38V ac at AC jacks on LL7.
- 6.09 With a voltmeter, check from COMM to +12 and read approximately 13V. Check from COMM to -12 and read approximately -13V.

- 6.10 Open Set Breaker.
- 6.11 Insert the LL5 associated with the engine running.
- 6.12 Close Set Breaker.
- 6.13 Place OSS in AUTO.
- 6.14 Initialize. (see Paragraph 3.1).
- 6.15 Observe that the REF lamp on LL5 associated with the engine running is lit.

7. LOAD CONTROL CALIBRATION CHECK - NULL ADJUSTMENT

- 7.01 Turn switches S1 and S2 to OFF. The set breaker is still closed.
- 7.02 To prevent operation of building switch gear, temporarily disconnect the appropriate control leads at the Paralleling Bay. Before removal, identify the leads by tagging them with the corresponding terminal numbers. Remove the leads and tape individually to prevent any electrical contact. At ENG ALT LOAD TS-10 () disconnect leads going to the switch gear from Terms 3 and 4, and, 21 and 22 (close NCB); Terms 5 and 6, and, 19 and 20 (close ECB); Terms 7 and 8 (open NCB or ECB).
- 7.03 Turn switches S1 and S2 to ON.
- 7.04 Verify that the first or next engine OSS is in MAN.
- 7.05 The remaining paragraphs under Paragraph 7, is followed only once and not repeated for each engine.
- 7.06 Open set breaker.
- 7.07 Turn switches S1 and S2 to OFF.
- 7.08 Remove first LL5 circuit pack associated with the 1st, engine running. Insert extender card into the first position and reinsert an LL5 into the extender.
- 7.09 With LL3, AUTO-MAN switch in MAN, operate TEST-NOR to NOR.

- 7.10 Close set breaker.
- 7.11 Turn S1 and S2 to ON.
- 7.12 Initialize. (see Paragraph 3.1)
- 7.13 R5 on LL5 is factory adjusted, however, its adjustment should be rechecked during installation.
- 7.131 Remove P1 - ENG ALT plug. To check null adjustment on LL5 circuit pack, place the voltmeter across the COMM on LL7 and TP1. Using the low voltage dc scale, the voltage should read 0. If not 0 adjust R5 OFFSET NULL potentiometer with a jewelers screwdriver for 0 volts or as near to 0 as possible. It should always be possible to reduce the voltage to .5 or lower. R5 is found on the LL5 with a screwdriver adjustment facing upwards and located 2/5 of the way back on the board. It is the only potentiometer not accessible for adjustment from the front of the board.
- 7.14 Disconnect 120V power from EM Bus to Paralleling Bay by removing P1 - EM BUS plug.
- 7.15 Remove tested LL5 and insert into the extender the next LL5, replace P1 - EM BUS plug and repeat test starting at Paragraph 7.11 until all LL5's have been checked.
- 7.16 Upon completion, while P1 - EM BUS plug is still removed, remove extender and reinsert all LL5's.
- 7.17 Reinsert P1 - EM BUS plug and P1 - ENG ALT plug.
- 7.18 Initialize. (see Paragraph 3.1)
- 7.19 Check to make sure REF lamp is lit on LL5(1). REF lit indicates No. 1 engine is running and it's the "reference" engine.

8. POLARITY OF LOAD SENSING CIRCUIT

- 8.1 The output of the kW Transducer associated with each engine shall be checked for output and correct polarity. The transducers are mounted on the Analog mounting plate marked ENG ALT GOV () at the top of the bay.
- 8.2 With the engine running (OSS in MAN and the set circuit breaker closed) load the alternator (EM BUS) with 50 to 75 kW of artificial load.

DO NOT EXCEED THE kW RATING OF THE ALTERNATOR.
- 8.3 The range of the dc voltage output on LL5 TP1 is approximately 0 to 10 and varies directly with the load on the engine. Check each LL5 TP1 associated with the set under test, to determine that a small negative voltage exists when measured to COMM jack on Pwr SUP LL7.
- 8.4 If the polarity is incorrect open set breaker, reverse CT leads between the engine and the kW Transducer to agree with drawings and then close set breaker to complete above test. NEVER OPEN THE SECONDARY WINDINGS ON THE CURRENT TRANSFORMERS WITH THE SET RUNNING AS HIGH VOLTAGES ARE PRESENT.
- 8.5 Go back to Paragraph 4, and repeat tests up to this point for each engine set.
- 8.6 After testing last engine, shut last engine down.

9. LOAD BALANCE SET-UP PROCEDURE

- 9.01 Restart and readjust the first engine to 60 Hz (100% speed) and set the voltage the same as the commercial power.
- 9.02 Place the next engine OSS in MAN.
- 9.03 Start the next engine by operating the START button on the engine. The engine starts.

- 9.04 Adjust the alternator to 60 Hz and the same voltage as No. 1.
- 9.05 Manually parallel this set to the first set at the engine control or remote control bay with paralleling facilities provided.
- 9.06 Apply 50 to 75kW load to the EM BUS.
- 9.07 Repeat paralleling and loading for all remaining sets.
- 9.08 Readjust total artificial load on EM bus to approximately 25% of available alternator capacity.

ALL SETS SHOULD BE CARRYING THE SAME PERCENT kW LOAD.
- 9.09 Recheck that REF lamp is lit on LL5(1).
- 9.091 Make sure total load is never greater than capacity of "on-line" alternators. Opening all set breakers at the set (ACB's) except No. 1 will insure that No. 1 LL5 circuit pack is the "reference".
- 9.10 Turn S2 to OFF.
- 9.11 Readjust frequency and make sure voltage is the same on all sets as read on the engine or remote control bay since all are connected to the same bus.
- 9.12 Upset kW balance on second or next engine using FREQUENCY ADJUST or ENGINE SPEED control switch by first turning it up and then turning it down. See Paragraph 9.13. Keep reading.
- 9.121 The kW balance circuit will automatically restore the load balance between sets by pulsing the governor on each engine except the "reference" engine. The percent kW load difference between sets should, after restoration, not exceed $\pm 10\%$ of each other. Keep reading.
- 9.13 Turn S2 to ON to accomplish the above.

- 9.14 Repeat upsetting the kW balance as described above on sets 3 through 6. See Paragraphs 9.09 through 9.13.
 - 9.15 Check kW balance on set No. 1 by making LL5(2) "reference". See Paragraph 9.091.
 - 9.16 Upset kW balance as described above starting with Paragraph 9.09.
 - 9.17 Since the LL5 Load Balance Control circuit packs are factory adjusted they should perform satisfactorily, however, since all engines (same size and different sizes) have slightly different response characteristics, when pulsed to raise or lower the speed (frequency) and consequently the load, the LL5 circuit packs may require fine adjustments so the new load balance between engine alternators is accomplished in a minimum time without overshooting or hunting. Once an LL5 has been fine adjusted on the job it is then dedicated to a particular engine (position in the CP holder) but can be used in any of the other five positions if readjusted.
 - 9.18 If necessary, adjust the RAISE and LOWER DWELL potentiometers and/or the RAISE and LOWER pulse duration PULS T potentiometers so a new load balance is established in a minimum time. Adjust pulse duration PULS T CW to give the longest pulse without overshooting or hunting. Adjust dwell time DWELL CCW to give the shortest workable idle time between pulse that allows the engine to stabilize before the next pulse is initiated. Readjust both PULS T and DWELL as necessary. These adjustments and results are based on the assumption that the load balance gain is operational.
10. LOAD BALANCE GAIN ADJUSTMENT
- 10.1 The gain adjustment on each Load Balance Control circuit pack should produce satisfactory load balance, however, should the load balance remain outside of $\pm 10\%$, a load balance gain adjustment shall be made as follows:

- 10.11 On LL5(2), measure voltage from TP2 to COMM 11.1 cont'd

on LL7. (Voltage is positive for Lower and negative for Raise). Adjust GAIN CCW until TP2 is approximately plus or minus 10 volts at which time it will operate either the raise RF or lower LF relays located on one of the Analog panels. If the voltage at TP2 is between -7 and +7 it is in the dead band and no raise or lower signal will be given.

- 10.2 Repeat the load balance test and make necessary adjustments on the Load Balance Puls T, Dwell and Gain potentiometers as necessary on all remaining LL5's 3 through 6. Start at Paragraph 10.1.

- 10.3 To test LL5 in position No. 1 proceed as follows:

- 10.31 Remove all loads except 50 to 75 kW.

- 10.32 Open all ACB's except set No. 2.

- 10.33 Check that REF lamp is lit on LL5(2). No. 2 engine is now "reference".

- 10.34 Parallel remaining sets manually.

- 10.35 Repeat all Load Balance tests on LL5(1). (Paragraphs 10.1 through 10.2).

- 10.36 Upset kW balance on first engine as described in Paragraphs 9.10 through 9.13.

11. FREQUENCY STANDARD CONTROL DESCRIPTION

- 11.1 This describes briefly the operation of the Paralleling Bay as it involves the LL12 Frequency Standard Control. When all of the engines and the Paralleling Bay are in the AUTO mode and commercial power fails, all engines start. The first engine to return a RTL (ready to load) signal to the Paralleling Bay (not necessarily No. 1 engine) will be seized and its circuit breaker closed to the EM bus. The REF lamp on the first LL5 will be lit and after a five second delay, the FREQ CHK lamp will light steady.

This indicates LL12 is operating and is in the process of adjusting the frequency of the first machine to the No-Load Emergency Bus Frequency setting, adjusted to and set on LL12. On sets adjusted for isochronous operation, this will be 60Hz; RAISE FREQ and LOW FREQ (to lower frequency) lamps will flash on and off until the first machine on the EM bus is adjusted. When adjusted, the FREQ GOOD lamp will flash on briefly and then go out along with the FREQ CHK lamp. The first priority load will then be closed through to the EM bus by the EM breaker. The next set to return a RTL signal will by sync checked, adjusted and placed on the EM bus by the Synchronizer and the second priority load will be closed through to the EM bus via operation of the second EM breaker, etc.

12. FREQUENCY REFERENCE CALIBRATION CHECK

- 12.01 Engines equipped with electronic load sharing governors may not have LL12 furnished and therefore, portions of this Paragraph 12 dealing with LL12, do not apply.

- 12.02 The frequency setting for LL12 is determined by the following formula. This assumes all sets have had the governors adjusted to a 1 1/2% frequency droop or .9 Hz frequency droop. (60 Hz x .015 = .9Hz)

- 12.021 The following is the formula for determining the No-Load Emergency Bus Frequency setting:

$$\frac{A}{B} = C \quad \text{and then} \quad C \times .9 \text{ Hz} + 60 \text{ Hz} = y$$

A = Total kW load (maximum) that will normally be placed on the Emergency Bus as determined by the operating company.

B = Total kW of all engine alternators connected to the Paralleling Bay, (at 80% Power Factor).

C = Percent load on each machine.

y = The No-Load Emergency Bus Frequency desired.

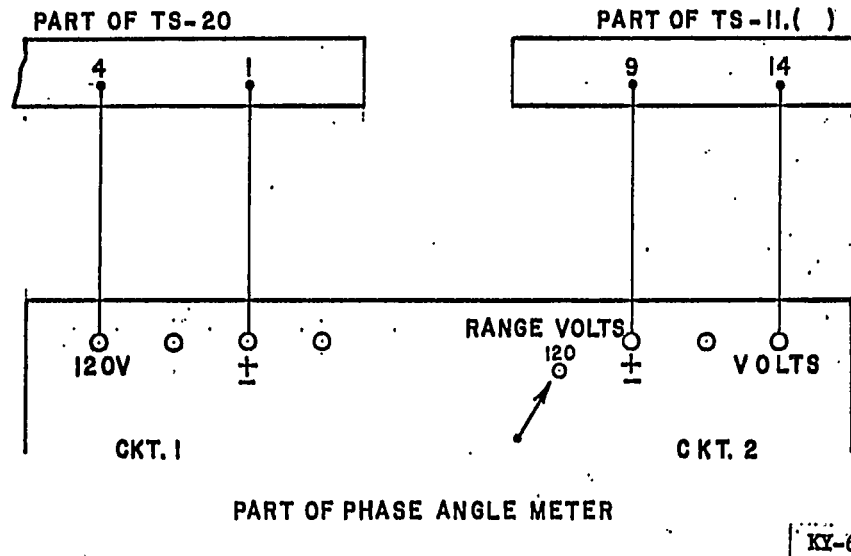


FIG. 2 CONNECTIONS TO ITE-5913 PORTABLE PHASE ANGLE METER FOR SYNCHRONIZING CIRCUIT NO. 2 WITH CIRCUIT NO. 1 (CKT. 1 EQUALS EM BUS, I.E., FIRST SET TO BE CONNECTED TO IT). PAR. 13.11

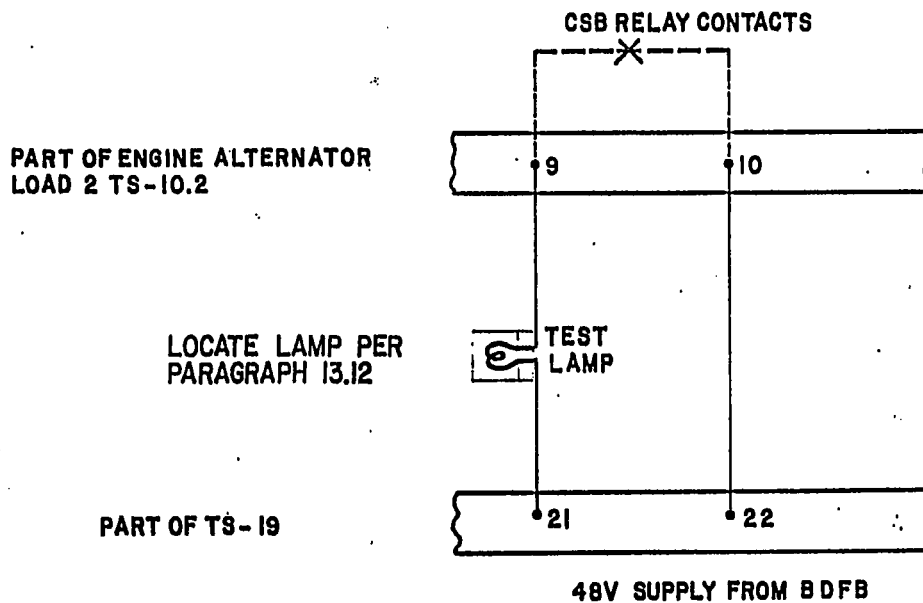


FIG. 3 TEST LAMP SET-UP TO INDICATE SET BREAKER CLOSURE. PAR. 13.12

- 12.03 Remove the load from all the sets.
- 12.04 Open all set breakers.
- 12.05 Shut down all sets but one.
- 12.06 Place OSS and ROSS associated with the running set in AUTO. The RTL lamp should be lit.
- 12.07 Turn S1 to OFF.
- 12.08 When furnished, install LL12 Freq Std Control and all LL10's or LL14's which ever were furnished (LL10's are used in connection with dc switch gear and LL14's are used with ac switch gear).
- 12.09 Install LL9 Decoder I (and LL11 Decoder II when engine No. 4 is furnished).
- 12.10 Turn S1 to ON.
- 12.11 Initialize.
- 12.12 On LL3, verify MAN-AUTO is in MAN or place MAN and operate TEST-NOR to TEST. Operate MAN STEP push button until SET RTL STEP ON lamp on LL1() is lit.
- 12.13 At the set, lower the frequency to 58Hz.
- 12.14 Close set breaker. Do not apply any artificial load.
- 12.15 In order for LL12 to regulate the frequency of the first alternator connected to the EM bus, to the No-load Emergency Bus Frequency value, it is necessary to adjust the clock.
- 12.151 The adjustment is made as follows:
Connect the ITE-5517 Power Module to ac using the R-3184 Three Wire "U" Pin Adapter Plug making sure the "U" pin is isolated from ground. Connect the ITE-5519 Frequency Counter to TP1 and TP2. Place the Counter in EXT and turn on the ITE-5517. Adjust R26 so the Counter reads 880 times the No-load Emergency Bus Frequency value. For example; if the No-load Emergency Bus Frequency is 60.3 Hz then R26 should be adjusted so the Counter reads 880 times 60.3 or 53.06 kHz.
- 12.16 Turn OFF the Counter and disconnect.
- 12.17 Turn S2 to OFF.
- 12.18 On LL3 place AUTO-MAN to AUTO and leave TEST-NOR to TEST.
- 12.19 Operate S1 to OFF and back to ON.
- 12.20 Initialize
- 12.21 Verify FREQ CHK lamp is lit.
- 12.22 Verify that RAISE FREQ lamp is flashing.
- 12.23 Check Pulse and Dwell factory settings as follows:
- 12.231 Observe RAISE FREQ lamp is lit approximately 1/2 to 1 second and off approximately 1 1/2 to 2 seconds. If outside of these limits, adjust R19 CW to increase RAISE FREQ Pulse Width (duration of time the lamp is lit) and/or adjust R18 CW to increase RAISE FREQ Dwell Time (duration of time lamp is off).
- 12.232 At the set, raise the frequency to approximately to 63 Hz.
- 12.233 Observe LOW FREQ lamp is lit approximately 1/2 to 1 second and off approximately 1 1/2 to 2 seconds. If outside of these limits, adjust R8 CW to increase LOW FREQ Pulse Width (duration of time lamp is lit) and/or adjust R7 CW to increase LOW FREQ Dwell Time (duration of time lamp is off).
- 12.234 At the set, slowly lower the frequency to the No-load Emergency Bus Frequency value.
- 12.24 Observe FREQ GOOD lamp lights. The FREQ CHK lamp will be lit since the first priority load is not being closed.
- 12.25 Open the set breaker and shut the set down.
- 12.26 When the screw switches on LL1's are arranged so that the LL12 adjusts whichever engine alternator is first on line, check each additional engine to see that the LL12 will regulate the frequency of that particular engine.
- 12.261 Start the next engine.
- 12.262 Repeat for each engine starting with Paragraph 12.12. Skip Paragraphs 12.15, 12.16 and 12.17.
- 13. ADJUSTMENT AND MANUAL CHECK OF SYNCHRONIZER**
- 13.1 Test Set-Up**
- CAUTION: UNDER THIS PARAGRAPH, AT NO TIME SHALL ANY TWO SET BREAKERS BE CLOSED AT THE SAME TIME.
- 13.11 Connect the ITE-5913 Portable Phase Angle Meter as shown in Figure 2.
- 13.12 Connect a 48V lamp (2Y or equivalent) as shown in Figure 3 so lamp can be placed adjacent to the Portable Phase Angle Meter.
- 13.13 Start the No. 1 set.

- 13.14 The Auto Synchronizer is located in the rear bottom of the bay. Set the synchronizer as follows:

AUTO SYNCHRONIZER SETTINGS SEE NOTE 1			
ITEM	750/900 GAS	200 GAS	GENERAL RANGE
BREAKER COMPENSATION	.1 second	.17 second	.1 to .12 second
SLIP FREQUENCY	.10 to .12 Hz	.2 Hz	.1 to .25 Hz
PULSE WIDTH	.1 second	.18 second	.3 second
NOTE 1: The settings shown for the above two engines were found to be satisfactory, however, each engine has different characteristics and may require a different setting than that shown. The settings under General Range are not intended to define limits since all alternators and breakers have different characteristics. Generally, the above settings may be varied $\pm 20\%$ to compensate for local conditions. Of the four items, the Breaker Compensation is the more critical of the settings. Although two typical engines are indicated above, a complete listing of all engine will not be shown.			

- 13.141 Incorrect settings on the Auto Synchronizer (Basler Electric Co.) may result in a FAULT lamp indication on LL2 and in turn will prevent paralleling. The AUTO Synchronizer must indicate closure within the 40% window on the Sync check. The older Asco (American Switch Co.) Sync Checks were set at $\pm 10\%$ but the present ones are factory set and marked on the name plate, " $\pm 20\%$." (Factory changes on the Synchronizer and Sync Check were covered on Change Notice 3624KY for those bays not yet turned over to the customer).
- 13.15 On the vertical four-terminal terminal strip inside of the Synchronizer (located in the lower left hand corner), check that there is not strap on Terms 1 and 2 and that there is no strap on Terms 3 and 4.
- 13.151 No strap on Terms 1 and 2 disables the anti-pump feature. No strap on Terms 3 and 4 allows synchronization of the oncoming set to be affected whether the oncoming set is at a higher frequency (speed) than the EM Bus frequency or is at a lower frequency (speed) than the EM Bus frequency. When the oncoming set frequency, CKT. 2 on ITE-5913, is higher than the EM Bus frequency CKT. 1, the needle on ITE-5913 will rotate in a clockwise direction. (A strap across Terms 3 and 4 allows synchronizing only when the oncoming set frequency is higher than the EM Bus frequency and the speed of the needle rotating in a clockwise direction, is being slowed down).
- 13.16 Turn S1 to OFF.
- 13.17 Normally LL10's are provided. (LL4's in place of LL10's provided only for load shedding or dumping of load). On LL10's verify that Screw switches S1-1, S2-1 and S2-2 are closed. (S1-2 is open). The following tests are based on this arrangement.
- 13.171 S1-1 closed allows the TEST-NOR switch on LL3 to function to simulate a power failure condition. S2-1 closed will allow automatic transfer (NCB to open and ECB to close) when commercial power fails. S2-2 closed will allow automatic restoration (ECB to open and NCB to close) when commercial power is restored.
- 13.18 If LL4's have been provided or if other switch arrangements on LL10 have been called for, alternate test arrangements should be discussed with your Regional Installation Engineer and your Line Engineer.
- 13.2 Test Procedure
- 13.201 On the engine alternator to be checked for timing of the signal to parallel, (the next engine alternator to be paralleled), to prevent an actual attempt to close the ACB, temporarily disconnect the control lead to the alternator from ENG ALT LOAD TS-10() Term 9 and 10.
- 13.202 Install all LL13's when provided.

- 13.203 Turn S1 and S2 to ON.
- 13.204 Initialize.
- 13.205 On LL3 place AUTO-MAN to MAN.
- 13.206 Start the second or next set.
- 13.207 At the set, close the "first" set breaker through to the EM bus. The frequency will be adjusted by LLL2 or automatically adjusted at the engine when electronic governors are provided. When LLL2 is provided the Frequency Good lamp will light.
- 13.208 When using LLL4's, if a priority load cannot be added to the EM bus, a temporary switch in its open position may be used to an advantage to simulate a closed breaker condition. Install it across TS18 Term 9 to Engine Alternator Load TS10() Term 18. Close switch when FREQ GOOD lamp lights.
- 13.209 Make sure LL9 shows 1 SET lamp lit and 1 LOAD lamp lit.
- 13.210 Make sure all engine OSS switches are in AUTO.
- 13.211 Turn on engine Sync Lights.
- 13.212 Operate MAN-STEP pushbutton until set RTL STEP ON lamp on LLL(2) or next LLL is lit.
- 13.213 On LLL(2) or next LLL operate and hold MAN PAR pushbutton. Observe the operation of the oncoming set Sync 1 and Sync 2 relays on the Eng Load 2 mounting plate. This action activates the synchronizes.
- 13.2131 Once it is determined the MAN PAR push button operates the Sync 1 relay, the relay may be temporarily toothpicked closed to relieve finger fatigue.
- NOTE: DETERMINE THE PHASE ANGLE METER IS AT 0° OR 12 0' CLOCK AT THE SAME TIME THE SYNCHRONIZING LIGHTS ON THE SET ARE OUT (DARK). THIS IS A VERY IMPORTANT CHECK THAT MUST BE SATISFIED.
- 13.214 Manual synchronization between sets was a prerequisite to the start of this handbook section. See Part I, Paragraphs 4.1 and 4.2.
- 13.215 The above check is to make sure each alternator is properly phased to the Paralleling Bay. See Paragraph 13.401.
- 13.216 If the above note is not true, the phasing of the 120V leads from the engine to the Paralleling Bay, possibly through a transformer and through P1 and J1, is incorrect and must be corrected before the Paralleling Bay, in the Auto mode, attempts to parallel the sets. The transformer that reduces the alternator voltage to 120 going to the Paralleling Bay (through transformer action) will alter the phasing by 180° but then reversing the output leads from the transformer to the Paralleling Bay, will reverse the phasing another 180° and, in effect, restore the phasing.
- 13.217 The alternator voltage will peak in a positive direction at the same instant the 120V set-sense-voltage at the Paralleling Bay peaks in a positive direction. As the needle approaches 0°, the 2Y test lamp should light 2 to 3° before the needle reaches 0°. If not, readjust the Breaker Compensation knob in the Synchronizer.
- 13.3 Pulse Width
- 13.31 The Pulse Width control may have to be readjusted if the signals sent out to speed up or slow down the engine, function too slow or too fast.
- 13.311 If the Pulse Width is not wide enough the oncoming set will approach the EM Bus frequency too slowly (needle will slow down at too slow a rate). Should this attempt occur over too long a period of time the timing circuit will time out and terminate the synchronizers attempt to parallel. (If AUTO-MAN on LL3 had been in AUTO - Par. 13.205 - the stepper switch would have looked for the next engine alternator with an RTL Ready-To-Load signal and attempt a parallel with it). If the Pulse Width is too wide the oncoming set will over-shoot the EM Bus frequency (needle will continue to reverse direction).
- 13.32 The final setting of all synchronizing controls will have to be acceptable to the characteristics of all engines. The Pulse Width may have to be reduced to satisfy the most responsive set to prevent it from hunting.
- 13.33 For additional information on the synchronizer, refer to the manual shipped with the bay.

13.4 Slip Frequency

- 13.401 The Slip Frequency (reflected in the speed that the needle rotates on the Portable Phase Angle Meter) must be relatively slow before a sync signal goes out from the Synchronizer and No. 2 alternator or next alternator is signaled to parallel with No. 1. When the Portable Phase Angle Meter slowly approaches 0° the CSB (Close Set Breaker) relay on Eng Load 2 mounting plate will close momentarily and in turn, will light the 2Y test lamp previously connected. Also check the synchronizing lights on the oncoming engine to make sure they are out when the Portable Phase Angle meter shows 0° and the 2Y test lamp flashes. The SYNC lamp on the synchronizer will also flash on. This indicates a successful sync has been achieved.
- 13.402 Repeat Paragraphs 13.1 through 13.217 until all set synchronizing circuits have been checked against the No. 1 set. Substitute No. 3 No. 4, etc., for No. 2 set.
- 13.403 CKT. 2 of the Portable Phase Angle Meter must be reconnected each time to the TS11.() associated with the set being synchronized.
- 13.404 The test lamp connection must be reconnected each time to the correct TS10. ().
- 13.405 The disconnected lead to the ACB (Paragraph 13.201) will also have to be reconnected on TS-10() after all tests are complete and the lead on Term. 9 associated with the next engine alternator to be paralleled with the Emergency Bus (Engine 1), will have to be disconnected.
- 13.406 After completion of all sets, open set breaker No. 1 at the set. At this point all circuit breakers are open.
- 13.407 Leave Ckt. 1 of the Portable Phase Angle Meter connected to the EM Bus. Reconnect Ckt. 2 on the Meter to set No. 1 TS11.1 and connect the test lamp to TS10.1.
- 13.408 Make sure all set breakers are open. Close set breaker No. 2 at the set. This feeds power via EM bus to Ckt. 1 of the Portable Phase Angle Meter.
- 13.409 Initialize.
- 13.410 No. 2 will become the "reference". Operate MAN STEP pushbutton until SET RTL STEP ON LAMP ON LL1(1) is lit.

13,411 Repeat Paragraphs 13.1 through 13.217 substituting set No. 1 as the set to be paralleled. Note Paragraphs 13.403, 13.404 and 13.405 about reconnecting the Meter, test lamp, and disconnecting and reconnecting the ACB control leads.

13,412 Open No. 2 set breaker at the set. Make sure all set breakers are open.

13,413 Make sure all ACB control leads are reconnected.

14. RECTIFIER SEQUENCE CONTROL - STATIC CHECK

14.1 When provided, the LL13 circuit packs are used for load management control of battery charging rectifiers. The LL13's will shut down rectifiers through a Charge Control Circuit or Rectifier Sequence Control Circuit such as SD-81061-01, by applying a ground signal to the applicable "RO" leads. When LL13's are called for, LL10's or LL14's will also be provided.

14.2 The first LL13 will control three rectifier control circuits (not necessarily limited to three rectifiers) and the second LL13 works in conjunction with load priorities 4, 5 and 6.

14.3 Install all LL13's and LL8 Counter Control.

14.4 All ECB and NCB control loads are disconnected. Par. 7.02.

14.5 With no engines running put Charge Sequence Control units in MAN STOP.

14.6 Turn S1 and S2 to ON simultaneously and immediately operate the MAN RESET on LL3 and LL13's.

14.7 The LL8 Counter Control will start a restore cycle. Observe the following:

PART I A. Pulse the LD OFF relay
B. SEQ() lamp ON on LL13
C. SE() relay operates

PART II A. Pulse LD TRANS relay
B. SEQ() lamp OFF LL13
C. SE() relay releases

14,8 Part I and II will start with the lowest priority available and continue toward the highest or 1st priority.

15. MANUAL CHECK - LOAD TRANSFER

- 15.1 Reconnect the ECB and NCB breaker control leads disconnected in Paragraph 7.02
- 15.2 This test requires that the various priority office loads be switched from the commercial bus to the EM Bus. Inform the operating company so arrangements can be made for this test, and similar service affecting tests (office involvement) while performing the tests under the following main paragraphs. They may wish to switch or block certain loads and they may wish to designate a preferred time for conducting such tests.
- 15.3 The following tests are assuming the use of LL10's (dc operated remote switch gear). When LL14's are furnished (ac switch gear) omit Paragraphs 15.5 and 15.7. Any load transfer arrangement other than SD-82325-01 Figure 10, SD-81489-01 Figures 1 to 3 must be analyzed for sequential operation by your equipment engineer or regional power installation engineer.
- 15.4 Test each priority load. The paralleling bay will be equipped with a separate Eng. Load mounting plate for each engine and each priority load.
- 15.5 Energize the EM Bus from one of the alternators by finger operating the associated CSB relay momentarily (1/2 to 1 second) on the Eng. Load mounting plate. Finger operate LD OFF relay. This will open the NCB. Finger operate the LD CLS relay. This will close the ECB and place one of the priority loads on the hot EM Bus. The alternator is now carrying this priority load.
- 15.6 Finger operate LD OFF relay again. This releases the ECB and disconnects the priority load from the EM Bus. Finger operate the LD TRANS relay. This closes the NCB and reconnects the priority load back to commercial power.
- 15.7 Repeat these tests for each engine and its set of priority loads.

16. FINAL FULLY AUTOMATIC OPERATIONAL TEST

- 16.01 Shut down all engines.
- 16.02 Turn S1 and S2 to OFF.
- 16.03 Disconnect the Phase Angle Meter.
- 16.04 Disconnect the Test lamp.

16.05

When provided, in the Charge Sequence Control Circuit, operate the control switch to the "Stop by Auto" position.

16.06

Inform the operating company representative of the intention to cause a power failure condition to test the Paralleling Bay in a fully automatic mode whereby the Emergency Engine Alternators will be carrying and sharing the office load. The operating company acceptance person should be present to witness the fully automatic operation of the emergency engine alternator plant (Semi-automatic operation if this is what the operating company requested). It should be recognized that the operating company may have designated particular options which reserves manual operation for certain switch gear, etc. When LL13's are provided, rectifiers will be sequenced off and back on.

16.07

On LL3 turn AUTO-MAN to AUTO. Turn TEST-NORM to NORM.

16.08

On LL4, when provided, turn AUTO-MAN to AUTO.

16.09

Turn all engine control OSS's to AUTO.

16.10

Turn all engine TSS (Trans Select Switches) to AUTO.

16.11

Operational System Initialization

16.111

Turn S1 to ON.

16.112

Leave S2 OFF

16.113

Reset Alarms (LL1 and LL2)

16.114

Reset LL13

16.115

MAN RESET LL3 - SYS RESTORE lamp

16.116

Wait approximately 10 seconds

16.117

Place S2 to ON

16.12

Inform the operating company that the above Operational System Initialization should be followed every time the bay is put in operation.

CAUTION: MAKE SURE ALL PERSONNEL HAVE BEEN APPRAISED OF THE AUTOMATIC STARTING AND RUNNING OF ALL SETS.

16.13

When all is clear, with a fuse puller, open one of the three phase sensing leads to the Paralleling Bay (usually located in the house service cabinet).

- 16.14 Check that a PWR FAIL lamp lights on LL3 and that the Normal Circuit Breakers are opened. The stepper switch is in operation. When provided, and in the same sequence, check to make sure SC1, SC2, etc., relays operate by observing that all of the corresponding SEQ OFF lamps light on LL13's.
- 16.15 Check that all sets have been started.
- 16.16 NORM CLS lamp on LL10 or LL14 will go out.
- 16.17 Check that the Step Switch is operating in the automatic hunting mode and stops on the first available set. SET RTL STEP ON lamp on the particular LL() will light.
- 16.18 Check for closure of the first set breaker (ACB).
- 16.19 When LL5's are provided, check that the REF lamp is lit. See Paragraph 1.01.
- 16.20 Except on engines with electronic load sharing governors, after a few seconds delay from LL5, check that the FREQ CHK lamp is ON and FREQ GOOD lamp is lit on LL12. This will occur after frequency corrections on the engine have been made.
- 16.21 1 SET lamp will light on LL9 (1 SET, not necessarily No. 1 engine). Check that the first priority load breaker (ECB) is closed as indicated by EMER CLS lamp lit on LL10() and 1 LOAD lamp is lit on LL9. Check that the FREQ CHK lamp and FREQ GOOD lamps on LL12 are OFF.
- 16.22 Check that SEQ 1 OFF lamp on LL13 is not illuminated and SC1 relay is released.
- 16.23 Check for Step Switch operation to the next available set.
- 16.24 Check for SET RTL STEP ON lamp for the next LLL.
- 16.25 With one engine connected to the EM bus and loaded, the Synchronizer will adjust the second engine until the frequencies are in phase and at that time will close the second set breaker (ACB), connecting the second engine to the Emergency Bus.
- 16.26 A load balance will be made between the two sets that are on the line.
- 16.27 After the load sharing delay, LL9 Decoder I will show 2 SET and 2 LOAD.
- 16.28 Check that the second priority load closes (ECB). EMER CLS lamp will be lit on LL10().
- 16.29 Check that SEQ 2 OFF lamp on LL13 is not illuminated and SC2 relay is released.
- 16.30 The remaining sets will follow the same pattern as the second set.
- 16.31 Observe status lamps on LL9, LL11 and LL10's.
- 16.32 With all sets on the line and all loads connected, check LL2 to determine SYS-FULL OPR lamp is lit indicating proper operation.
- 16.33 At this point in time, the system is operating in the full automatic emergency power standby mode.
17. PARALLELING - DELAY TIMER CHECK OUT
- 17.1 During the fully automatic paralleling operation, if one or more sets do not parallel, a timing circuit will time out which will terminate the paralleling attempt and will light the FAULT lamp on LL1().
- 17.11 Subsequent automatic attempts to parallel the "faulted" set can only be tried after the Paralleling Bay has been initialized. (FAULT lamp is RESET ON LL1). See Paragraph 3.1.
- 17.2 To check this feature proceed with the following tests:
- 17.3 After the Step Switch has selected the second engine, immediately block non-operated CSB for that particular set. This will prevent the set breaker from closing.
- 17.4 After a delay of approximately 2 1/2 minutes, check that the Step Switch advances to the next available set. Check for a FAULT lamp indications on LL1() associated with the blocked CSB relay.
- 17.5 If three or more sets are connected, leave CSB blocked until all remaining sets have been sync checked and paralleled. If only two sets are involved, the Step Switch will return to home (position 0).
- 17.6 Remove blocking tool from CSB relays.
- 17.7 Depress RESET BUTTON ON LL1() associated with the previously blocked relay and observe that the fault lamp goes out.
- 17.8 Check that the Step Switch advances to the previously blocked set and SET RTL STEP ON lamp illuminates.
- 17.9 After delay from the second LL5, not necessarily LL5(2), check that the second priority load is closed as indicated by EMER CLS lamp lit on LL10() and 2 LOAD lamp lit on LL9. Only the highest numbered lamps will remain lit on LL9.

18. LOAD SHEDDING CHECK

- 18.01 During an emergency condition when the engine alternators are carrying the office, should one or more engines fail, circuitry in the Paralleling Bay prevents an overload condition on the remaining engines by dropping the lowest priority load or loads from the EM bus.
- 18.02 The following test of this automatic feature requires that a portion of the office be without power for a short time. With a two set office, 1/2 of the office will be dead during the test, and, in a three or more set office, 1/3 to 2/3 of the office will be dead. This should be explained to the telephone company representative who may recommend the test be performed during the light load period, i.e., during the hours of from 1 to 6 AM.
- 18.03 On any set, operate OSS to MAN and operate "Open Set Breaker" at the set.
- 18.04 Check that the lowest priority load is disconnected (ECB opens).
- 18.05 Check that lowest priority SC () relay operates and SEQ () OFF lamp lights on LL13.
- 18.06 Assuming a three set office, on LL9 check that 2 SET and 2 LOAD lamps are lit.
- 18.07 On a two, four, five or six set office the lights will be one less than the number of sets and loads.
- 18.08 Select another set (three set or more office only) and turn OSS to MAN.
- 18.09 Operate "Open Set Breaker" at the set.
- 18.10 Check that the next lower priority load is disconnected.
- 18.11 Check that the next lowest priority SC () relay operates and the next lowest SEQ () OFF lamp lights on LL13.
- 18.12 On LL9 and/or LL11 check that () SET and () LOAD lamp each one number lower are lit.
- 18.13 To restore System to Proper Operation under commercial power failure conditions, operate OSS switch or switches to AUTO.

- 18.14 Check that the Paralleling Bay automatically parallels each set and restores the loads.

- 18.15 Check LL2 to determine SYS - FULL OPR lamp is lit indicating proper operation.

19. AUTOMATIC RESTORATION TO COMMERCIAL POWER

- 19.1 To return the system to commercial power, replace the fuse in the sensing lead previously removed in Paragraph 16.14

- 19.2 On LL3 check for a SYS RESTORE lamp indication after the longest of the engine Hold Over Timers has timed out.

- 19.3 All EM Load breakers and set breakers will be sequenced off and then all normal circuit breakers will be sequenced on.

- 19.4 When LL13 are provided, check to make sure SC relays operate and release in sequence by observing that all SEQ OFF lamps light and then go out.

- 19.5 All engines will be shut down.

- 19.6 On LL2, check for a SYS - NORM lamp indicating all loads have been restored to commercial power.

20. FINAL TEST FOR MANUAL OPERATION

- 20.1 After completing all tests, ascertain that the plant can still be operated manually without benefit of the Paralleling Bay.

- 20.2 On LL3 leave TEST-NORM in NORM and place AUTO-MAN in MAN.

- 20.3 Place engine OSS's in MAN and operate as a manual plant. (TSS in MANUAL or HAND) Parallel the engines and pickup office load by operating building switch gear from the building switchboard.

- 20.4 Once it is demonstrated the engines can be operated manually, the same way as before addition of the Paralleling Bay, restore the office loads to commercial power. Shut down the engines. After engines have completely stopped, place TSS and OSS in AUTO. On LL3, operate AUTO-MAN to AUTO.

Reasons For Reissue:

- (1) To recognize throughout the section that some engine-alternators may be equipped with electronic governors. These load-sharing governors may be set in an isochronous mode and not depend on the Paralleling Bay for handling this responsibility.
- (2) Under Warnings, to include the recommend a Ground Fault Interrupter to protect personnel when using ac operated test equipment.
- (3) To emphasize the installer should follow the drawing showing the manner of cabling the hinged rear panel.
- (4) To add Table A listing the various circuit packs and their functions.
- (5) To expand test of Frequency Reference as it applies to each engine alternator connected to the EM bus first.
- (6) To expand test for the correct operation of the Synchronizer.
- (7) To make numerous miscellaneous changes throughout the section.

Manager, Engineering
(KY-1)