Installation Engineering Handbook 19
Western Electric Company, Incorporated
Kearny Works

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PARALLELING ENGINE-ALTERNATORS

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1. GENERAL

1.1 Scope

1.11 This section covers parallel tests of engine-alternators.

1.12 Paralleling covered in this section requires speed droops on all engine-alternators. If droop/isochronous paralleling is required, either the customer or this organization will furnish instructions for paralleling.

1.13 Existing equipment must be in good operating condition and suitable for parallel operation. It is the customer's responsibility to recondition and modify existing equipment. The customer may arrange for this work with the supplier, his authorized representative, or with the Western Electric Company for the necessary work.

1.14 If the Installer is asked to assume responsibility for work outside the scope of normal installing operations, such as engine overhaul, internal governor adjustments, etc., it is desirable to have the work done by the supplier or his authorized representative.

1.2 Sequence of Tests

1.21 A new engine-alternator shall meet all its individual test requirements, including the one-hour Preliminary Test at full load before doing any paralleling. Then a one-hour Preliminary Test in parallel should be run.

1.22 A suggested test sequence would be as follows:

(a) Individual Test
(b) Preliminary Individual Test
(c) "Phasing-Out" Tests
(d) Speed Droop Tests
(e) Voltage Droop Tests
(f) Reverse Power Test
(g) Preliminary Parallel Tests
(h) Final Acceptance Tests

NOTE: A total of 2-1/2 hours, uninterrupted, must be run in parallel for the Final Acceptance Test. Items (C) and (H) may be combined for a total of 2-1/2 hours, if no trouble is experienced during the first hour.

1.23 "Phasing-Out" Tests include "phasing-out" the individual engine-alternator output voltage for 1-2-3 order, "phasing-out" the output voltages of all units to operate in parallel for the same order, and "phasing-out" engine-alternator outputs with commercial power at all transfer switches.

1.24 Voltage droop tests are shown in Paragraph 6. Consider voltage droop on a new engine-alternator to be satisfactory. Check voltage droop on an existing set or new nonstandard set, whenever possible.

1.25 Preliminary Test Data will provide speed droop information on a new set. If the customer cannot provide this information on an existing set, it will be necessary to load the set to full KW output to determine the droop.

1.3 Precautions

NOTE: "Phasing-Out" procedures are covered in Section 135 in this handbook.

1.31 "Phase-Out" engine alternator voltage before applying any load to prevent damage to the connected equipment.

1.32 "Phase-Out" engine-alternator and commercial power voltages at each transfer switch to prevent damage to connected equipment.

1.33 Observe the precautions in individual engine-alternator test sections.

1.34 Do not attempt to parallel an engine-alternator with another before "phasing-out" the machine voltages.

1.35 Do not allow KW or full-load current ratings of an alternator to be exceeded.

1.36 When taking an engine-alternator out of parallel, make sure that the machines remaining on the bus have sufficient capacity to carry the load.

1.37 Do not open the field of an alternator while in parallel with other machines. The resulting high currents on the line will trip breakers, drop the load and probably result in damage.

1.4 Wiring Requirements

NOTE: The Installer must observe the following items in wiring the units to be paralleled. This will reduce circulating current problems to a minimum.

1.41 Output terminals of standard engine-alternators are marked 1, 2, 3. Carry lines 1 and 3 throughout the whole system so that voltage regulators of paralleled units monitor the same line voltage.

NOTE: Voltage regulators on standard KS- units monitor lines 1 and 3, except for KS-15929, where the regulator monitors Line 1 to neutral voltage.

1.42 If marking has been removed, or, if the new or existing machine is nonstandard, refer to the wiring diagram with the unit and trace out the voltage regulator connections. If the regulator is across lines other than 1-3, then the output leads for these two lines have to be connected to lines 1-3 on standard machines. This must be considered during the "phasing-out" procedures.

2. DESCRIPTION AND DEFINITIONS

2.1 Parallel Operation: Engine-alternators and other power sources are in parallel when like output terminals are connected.

2.2 Stable Parallel Operation: The operation is stable if system voltage is steady and KW load does not shift continuously between the machines.

2.3 Automatic or Manual Voltage Regulation: Output voltage of an engine-alternator is automatically regulated when controlled by the voltage regulator and manually regulated when the regulator is cut out and the field rheostat controls the voltage.

2.4 Power Factor: Real power (KW) divided by apparent power (KVA).

2 5 Isochronous: This term is sometimes applied to constant speed operation or a no droop operation of a governor. The speed does not change from no-load to full-load

2.6 Circulating Current: This current flows between paralleled machines and is not delivered to the load. It is also known as "cross current". An excessive amount of circulating current is undesirable as it overheats the windings and causes a loss of efficiency.

2.7 Cross-Current Compensation: The circuit that provides for distribution of reactive load current between alternators in parallel when each machine has a separate voltage regulator.

3. TOOLS AND TEST EQUIPMENT

Note	Quan.	Code	Description
	1	ITE-5250 or ITE-5356	Digital Multimeter or Universal Digital Multimeter
	1	ITE-4503	Volt-Ammeter, AC, Clamp-Type
1	-	ITE-4782	150 KW AC/DC Test Load
1	-	ITE-4785	250 KW 3-Phase AC Load
	1	R-3404	Indicator, Phase Sequence

NOTE 1: Order quantity required to load the paralleled units to half the total capacity.

4. METER ACCURACY AND CALIBRATION

4.1 General

4.11 Ammeters and voltmeters on new sets will be checked for accuracy, using the ITE-4503 Clamp-On AC Ammeter and an ITE-5250 or ITE-5356 Digital Multimeter. The wattmeter will be checked by calculating KW from observed readings of voltage and current. The meters should be replaced on a new set, through established routines, if they do not meet the accuracy requirements.

4.12 The customer is responsible for accuracy of these instruments on existing sets. He should arrange to have meters replaced or recalibrated, as necessary, if their accuracy is out of limits, or, he may decide to continue using them.

4.13 If a wattmeter is sent to be calibrated, external resistor boxes used with the instrument should also be sent. It is not necessary to send current transformers or potential transformers.

4.14 If a wattmeter is being repaired or recalibrated, and the customer desires to run the set without the wattmeter, it will, of course, be necessary to complete the current transformer circuits that were opened when the wattmeter was disconnected.

4.2 Voltmeter

4.21 Before checking accuracy adjust pointer of the panel meter to zero with the zero-adjuster.

4.22 Connect the portable voltmeter across a pair of engine-alternator line leads. Operate the voltmeter transfer switch on the set so that the panel voltmeter indicates the voltage on the same pair of lines.

4.23 The volmeter on the engine-alternator should indicate within 2% of its full scale the same as the portable. For example, a voltmeter with 300 volt scale should agree with the portable within .02 X 300, or 6 volts. If the voltmeter does not have this accuracy, it should be replaced or recalibrated.

4.24 If the voltmeter accuracy is all right but the reading differs several volts from the portable meter indication, the panel voltmeter may be adjusted to agree with the portable, with the customer's permission. This will help in paralleling to reduce circulating currents.

4.25 Stop the machine and disconnect the portable voltmeter. If the panel voltmeter was adjusted to agree with the portable, place a paper seal over the zero-adjuster and mark on the seal: "Correct at _____ volts."

4.3 Ammeter

4.31 Before checking accuracy adjust pointer of the panel meter to zero with the zero-adjuster. Do the same for the ITE-4503 or ITE-4503A.

4.32 Several times during the test run, clamp the Volt-Ammeter around an alternator line lead. Operate the ammeter transfer switch on the control to read the line current in the line being checked. The panel ammeter should agree within 4% of full scale. (.04 x full scale) with the ITE-4503 or ITE-4503A indication.

4.321 When leads are in conduit, the ITE-4503 can be clamped on the open leads in the control box or connection box.

4.322 When there is more than one lead per phase, current in all leads have to be measured. This meter can clamp on a maximum of two 500,000 circular mil leads. If unable to clamp on all leads for a phase, clamp the meter on each lead and add up the currents.

4.4 Wattmeter

4.41 Adjust pointer to zero by means of the zero-adjuster on the meter. On Westinghouse meter it will be necessary to remove the front cover plate of the meter to make this adjustment.

4.42 Check accuracy of the wattmeter several times during the run. The actual value is calculated and this will be compared to the wattmeter indication. The ID-946 Engine-Alternator Test Record gives the formula for the calculation.

NOTE: The calculation for KW is valid only where the power factor of the load is unity (1). The ITE-4782 and ITE-4785 Test Loads are unity power factor.

4.43 The wattmeter shall indicate within 6% of full scale of the value calculated from average values of line voltages and line currents.

5. SPEED DROOP AND ENGINE GOVERNORS

5.1 General

5.11 The present paralleling method requires all engine-alternators to have a speed droop from no-load to full-load. Table A lists the speed droops available on standard sets and shows which droops are set at the factory. Those sets with external droop adjustments will, of course, not have factory adjustments and the droop must be set by the installer before paralleling.

5.12 If any unit to be paralleled is listed in Table A with a 4% speed droop, use the 4% speed droop for each unit. Adjustments for the Woodward UG-8 governor are shown in Paragraph 5.2; adjustments for the Woodward PSG governor are shown in Paragraph 5.3.

NOTE: Units having droop adjustments from 4-1/2 to 5% (internal adjustments) should be changed to 4%. Details of this adjustment will be shown in the supplier's manual, or, a supplier's representative may be called in to make the adjustment.

TABLE A

SPEED DROOPS FOR STANDARD ENGINE-ALTERNATORS

KS NO.	GOVERNOR MFG.	GOVERNOR TYPE	RATED FL RPM	PER CENT RATED RPM	ACTUAL RPM	ADJUSTMENT
5574-01 and 5750	WOODWARD	-	1200	4-1/2 to 5	54-60	INTERNAL
5665	MARQUETTE	-	1200	4-1/2 to 5	54-60	INTERNAL
15622 120KW	WOODWARD	-	1800	4-1/2 to 5	81-90	INTERNAL
15622 170KW			1200	4-1/2 to 5	54-60	
15777	WOODWARD	UG-8	900	0 or 4	0 or 36	EXTERNAL
15884 and 15890	WOODWARD	-	1800	4-1/2 to 5	75-90	INTERNAL
15929	WOODWARD	PSG	1800	0 or 4-1/2	0 or 81	EXTERNAL
15954	WOODWARD	UG-8	1200	0 or 4	0 or 48	EXTERNAL
15992	WOODWARD	PSG	1200	0 or 4-1/2	0 or 54	EXTERNAL
19583 19584 19585	WOODWARD	PSG	1800	0 or 4-1/2	0 or 81	EXTERNAL
19586	WOODWARD	SG		3-4-1/2	81	INTERNAL
19587	ROOSA-MASTER		1800	0 or 4	0 or 72	EXTERNAL
19896	WOODWARD	PSG	3600	0 or 4-1/2	0 or 162	EXTERNAL
20520 20524 20525	WOODWARD	PSG	1800	0 or 4-1/2	0 or 81	EXTERNAL
20526	WOODWARD	SG		3-4-1/2	81	INTERNAL
20527	ROOSA-MASTER		1800	1-4%	18 or 72	EXTERNAL

NOTE: For KS-19587 and KS-20527 with a ROOSA-TRONIC Load Compensator the governor will be adjusted for isochronous operation; without the ROOSA-TRONIC the governor should have a 4% droop.

5.13 If all units to be paralleled are listed in Table A as having a 4-1/2 to 5% speed droop, they will parallel satisfactorily without any change in speed droop.

5.14 If a set is not listed in Table A, or, if the droop on a standard set has been changed from the factory setting, the customer may be able to provide information on speed droop. If not, the set will have to be loaded to full KW load to determine the speed droop. The droops of other sets may then be adjusted to match the droop of this set. However, the speed droop must not be less than 3% under any circumstances.

5.15 Parallel operation may be stable with speed droops less than those indicated above (including the 3% droop) but this will require experimentation and will be done only at the customer's request.

5.2 Woodward UG-8 Governor

5.21 Woodward UG-8 governors are furnished on KS-15777, KS-15899 and KS-15954 sets as well as on a number of nonstandard sets. The controls are as follows:

5.211 SPEED DROOP: This knob controls engine speed droop from no-load to full-load. Dial markings are 0-100, indicating % of available speed droop. Maximum droop available with the knob at 100 is about 36 rpm for KS-15777 sets and 48 rpm for KS-15899 and KS-15954 sets.

5.212 SYNCHRONIZER: This knob is a vernier speed adjusting control. It has no particular setting and the knob cannot be turned unless the engine is running.

5.213 SYN INDICATOR: This knob is directly below the SYNCHRONIZER knob and indicates the number of revolutions of that knob. It also has no particular setting.

5.214 LOAD LIMIT: This knob restricts the governor. Normal setting is 10 but the engine can be idled by setting the knob to 5, if instructions permit idling the engine.

CAUTION: Do not manually force governor linkage to increase fuel before turning LOAD LIMIT knob to 10.

5.215 COMPENSATION: A needle valve adjustment under the large screw on the front of the governor. The adjustment affects speed recovery of the engine after load changes. It has been set at the factory and should be changed only when hunting develops in parallel with other sets and if the hunting is traced to the governor. If readjustment is required, refer to a Woodward governor bulletin with the supplier's manual or call in an authorized supplier's representative. The pointer has no required setting and must not be moved except during an adjustment.

5.3 Woodward PSG Governor

5.31 This governor is furnished on KS-15929, KS-19583, KS-19584, KS-19585, KS-19586, KS-20523, KS-20524, KS-20525 and KS-20526 Diesel Engine-Alternators. It is also furnished on KS-15992, KS-19896 and KS-20542 Turbine-Alternators. Speed droop adjustment is external and can be varied from 0 to 4-1/2%.

5.32 Two positions should be marked on the governor adjustment, ISO and DROOP. The ISO position is that used for solo operation; DROOP position is used when the units are paralleled. The DROOP position gives the full 4-1/2% droop.

5.33 Set speed droop by loosening the knurled knob and pushing the arm against the stop at the position marked DROOP. After the arm has been set turn the knurled knob down on the slider to hold the position.

5.34 This governor has a compensation adjustment on the same side as the speed droop adjustment. The compensation adjustment will correct for hunting in parallel. Refer to the supplier's manual with the set for information on this adjustment.

6. VOLTAGE DROOP

6.1 General

6.11 Each set must have a cross-current-compensation circuit so that the voltage will droop when the machine carries an inductive load.

6.12 Standard engine-alternators have the voltage droops listed in Table B.

6.13 The voltage droop on a new set should be considered satisfactory unless trouble develops. In this case test for voltage droop as Paragraph 6.2 wherever possible.

6.14 Non-standard or existing sets must have approximately the same voltage droop as a new standard set. Test for voltage droops in accordance with Paragraph 6.2 and make the necessary adjustments.

6.2 Test For Voltage Droop

NOTE: This requires a lagging power factor load rating from 0.8 to 0.9. Use the office load at 0.9 lagging power factor.

6.21 Operate the Cross-Current Compensation Switch to place IN position.

6.22 Start the set under test.

6.23 Slowly place full load on the set.

6.24 Take a voltage reading after the set has run for twenty minutes at full load.

6.25 Take the load off the set and take a reading at no load voltage.

6.26 Calculate the percent voltage droop.

6.27 If the voltage droop doesn't meet the value given in Table B, refer to Paragraph 13.

TABLE B

VOLTAGE DROOPS FOR STANDARD ENGINE-ALTERNATORS

KS NO.	REGULATOR MFR.	REGULATOR TYPE	VOLTS	PER CENT	NOTE
5574-01 5750 15884 15890	Allis Chalmers	V-OO	5-10	2-1/2 to 5%	1
5665	G. E. Co.	GDA		2-1/2 to 5%	
15622	Allis Chalmers	V-221	2-10	1 to 5%	
15777	Allis Chalmers Brown Boveri	AA2 JC1/1		2-1/2 to 5%	1
15899 15904	Brown Boveri	JB1/1 JC1/1		2-1/2 to 5%	1
15992	Elec. Mach.	Static		4%	2
19583 19584 19585 19586	Delco	Static		4%	2
19587	Basler(Static)	97520		4%	2
19896	Elec. Mach.	Static		4%	2
20523 20524 20525 20526	Delco	Static		1 to 5%	2
20527	Basler(Static)	97520		1 to 4%	2
20542	Elec. Mach	Static			2

NOTE 1: Voltage droop is factory-adjusted but the cross-current-compensation circuit is shorted out on the terminal strip inside the cabinet. REMOVE THE STRAP FOR PARALLEL OPERATION.

NOTE 2: These units have a toggle switch on the voltage regulator or in the cabinet to cut the cross-current-compensation circuit in or out. This is usually marked CCC OUT/IN.

7. METHODS OF PARALLELING

7.1 General

7.11 Two methods of paralleling are described. Engine sets may be paralleled at no load on the emergency bus and then load added to the bus, or, one or more sets may be paralleled with a set already carrying a load.

7.12 Two general paralleling system

7.121 Droop-Droop paralleling is when both sets are adjusted for the same speed droop (approximately 4 1/2 to 5%).

7.122 Droop - Isochronous paralleling is when only one set has a zero speed droop and all other sets have a speed droop of approximately 4-1/2 to 5%. This method has the advantage of keeping the system frequency constant.

NOTE: The method used mostly is Droop -Droop paralleling unless Droop - Isochronous is requested by the customer. Droop - Droop paralleling methods will be used throughout this section.

7.13 Before paralleling any sets do the following:

7.131 If the governors have an ISO and DROOP position, set the governors to the DROOP position.

7.132 If the voltage regulators have a switch for the cross-current-compensation circuit, be sure that the switch is in the position to put the circuit in operation. Usually, the switch will be marked OUT/IN and IN position is required for paralleling.

7.14 Required sharing of KW and current of paralleled sets is in proportion to their KW rating. For example, if these are 150 KW and 300 KW sets, the total capacity is 450 KW. The 150 KW set should take 150/450 or 1/3 of the KW load on the bus and the 300 KW set should take 300/450 or 2/3.

7.2 Paralleling at No-Load

7.21 Start one set and adjust speed and voltage. Put this set on the emergency bus by closing the circuit breaker.

NOTE: The speed should be adjusted to normal no load speed. Later, after experience, the speed for the set at no load can be reduced to something less than normal no-load speed so that when load is added to the sets in parallel the frequency will be close to 60 hertz.

7.22 Start the other set. Operate the Synchronizing Lamp Switch on this unit to the ON position. Adjust speed and voltage of the oncoming set to match that of the set already on the bus. Speeds match very closely when the synchronizing lamps go on and off slowly.

7.23 If the sets have field current ammeters note the currents at no load.

7.24 When the synchronizing lamps are in the middle of their dark period, parallel the sets by closing the breaker of the oncoming set. Turn off the synchronizing lamps.

7.25 Make the following adjustments:

7.251 If current is indicated on both sets reduce to minimum by adjusting the regulator rheostat on one of the sets.

7.252 If one wattmeter indicates a few KW and the other a minus KW reading, adjust throttle or governor motor control in the lower direction on the set with a plus KW reading.

7.26 Add the load and then make speed and voltage adjustments so that the units share KW and current in proportion to their rating. Speed adjustments affect KW sharing and voltage adjustments affect current sharing.

7.261 Decrease the speed slowly on the set that takes more than its share of KW, unless system frequency is less than 60 hertz, in which case increase the speed on the other set. Continue the adjustment until both sets share KW properly.

7.262 Increase the voltage slowly on the set that is taking less than its share of current. Continue until the sets share the current properly.

7.27 If either set has a field current ammeter it should read higher than it should at no load (Paragraph 7.23) and there should be a lagging power factor on the Power Factor Meter, when the voltage adjustment is correctly made.

7.28 After the load is applied the system frequency or voltage may be too high or too low. Correct the frequency by operating the throttle or governor control a small amount in the required direction on one machine and then the other and alternating the adjustment until frequency is correct. To correct for voltage, adjust regulator rheostat on one machine a small amount in the required direction and then do the same on the other machine. Alternate the adjustment until system voltage is at the required point.

7.3 Paralleling With a Loaded Set

7.31 Start the oncoming set. Operate its Synchronizing Lamp Switch to ON. Adjust speed and voltage of this set to match that of the set already on the bus. Speed matches very closely when synchronizing lamps go on and off slowly. If this set has a field current ammeter note the current at no load.

7.32 When the synchronizing lamps are in the middle of their dark period, parallel the sets by closing the breaker of the oncoming set.

7.33 After the sets are in parallel, make the following adjustments on the oncoming machine.

7.331 Operate throttle or governor motor control in the raise direction until the set picks up its share of the KW load. (See Paragraph 7.14).

7.332 After the governor adjustment make voltage adjustments so that current is shared in the same ratio as the KW. Raise the voltage of the oncoming set slowly. Move the voltage regulator knob only a small amount each time and allow about 10 seconds before another adjustment. Continue the adjustment until the current is shared properly.

7.34 If there is a field current ammeter on the oncoming set, note the reading. It should now read higher than it did at no-load. If the field current is less than it was at no load, the voltage of the set was adjusted in the wrong direction.

7.35 After the above speed and voltage adjustments, additional load will probably be put on the emergency bus. Speed and voltage adjustments will probably have to be made so that the sets share the added KW and current in the desired ratio.

7.36 After the above adjustments system frequency or voltage may be too high or too low. Correct the system frequency by operating the throttle or governor control on one machine in the desired direction a small amount and then do the same on the other set. Alternate these adjustments until the desired frequency is reached and the KW is shared in the same way it was originally. Correct voltage by adjusting voltage first on one machine a small amount in the desired direction and then on the other set. Alternate these adjustments until the desired voltage is reached and load current is shared in the desired ratio.

8. REMOVING SETS FROM PARALLEL

8.1 General

8.11 How the sets are removed from parallel depends on the method of paralleling. The sets may be removed from the bus under no-load conditions, or some load may be taken off the bus and one set at a time removed from the bus and shut down.

8.2 Removing Sets At No-Load

8.21 Remove all load from the emergency bus by operating transfer switches for the loads to commercial power position.

8.22 Some current and KW may still show on the sets. Before removing any set from the bus make the following adjustments.

8.221 If the wattmeter on one set reads plus KW, adjust the throttle or governor motor control on this set in the lower direction for minimum KW.

8.222 If current is indicated on both sets reduce to minimum by adjusting the voltage on one of the sets.

8.23 After the adjustments in Paragraph 8.22, remove the sets from the bus by opening the associated circuit breakers.

8.24 The sets are usually allowed to run a few minutes to cool off, then they are shut down.

8.3 Removing One Set at a Time

8.31 Remove sufficient load from the bus so that the set(s) remaining on the bus will not be overloaded.

8.32 Operate the throttle or governor motor control on the set to be removed in the direction to reduce speed until the KW on this set is reduced to zero.

8.33 Lower the voltage on the set to be removed until the ammeter shows minimum current.

8.34 Disconnect the set from the bus by opening the circuit breaker. Allow the set to run a few minutes to cool off, then shut it down.

8.35 If more than one set remains on the bus and the load will be carried for some time, adjust speeds and voltages of the sets so that they share KW and current properly.

9. REVERSE POWER TEST

NOTE: Solid-state Reverse Power relays cannot be satisfactorily tested and adjusted without operating in parallel with another unit in accordance with this paragraph.

Table C

KS#	KW Rating	TYPE OF RPD	DESIRED SETTING
KS-15777	500 & 550	Westinghouse Electric Corp.	90KW
KS-15929	225	General Electric Company	50KW
KS-15954	350	General Electric Company	100KW
KS-15992	750	General Electric Company	100KW
KS-19583	30	J86634A Module	20KW
KS-19584	45	J86634A Module	20KW
KS-19585	75	J86634A Module	20KW
KS-19586	115	J86634A Module	20KW
KS-19587	115	J86634A Module	25KW
KS-19896	200	J86638A Module	75KW
KS-20523	30	Controllix	10KW
KS-20524	45	Controllix	20KW
KS-20525	75	Controllix	20KW
KS-20526	115	Controllix	25KW
KS-20527	115	Wilmar Electronic	25-30KW
KS-20542	200		75KW

NOTE: The Controllix is factory-set and should not require readjustment on the job.

9.1 Start the sets and parallel them at no load in accordance with the method shown in Paragraph 7.

9.2 Add a small amount of artificial load.

9.3 Adjust speed of the units for 60 hertz.

9.4 Reduce the speed of the unit to be checked for reverse power trip out by turning the governor control in the lower direction. If the unit does not have a governor drive motor then turn the fuel or throttle adjustment in a direction to reduce fuel.

9.5 Continue the fuel or governor adjustment and observe that the KW meter on this unit actually decreases below zero while the KW meter on the other set increases. Observe KW on the second unit at the time the unit going to reverse power shut down.

9.6 The shutdown should occur within 2% of the individual required setting. For example, KS19896 has a requirement of 75KW. For this actual load test the adjustment is satisfactory if shut down occurs within ±2% of 75KW or in the range: 73.5 - 76.5KW.

9.7 At shut down of the unit observe that the circuit breaker opens and that the correct alarms are provided

NOTE: Most breakers must be manually reset to OFF position before unit can be started again.

9.8 Start the unit that was shut down and again parallel with the other unit. Again adjust speed of the two units for 60 hertz.

9.9 Reduce the speed of the second unit to be checked by turning the governor control in the lower direction. If the unit does not have a governor drive motor then turn the feed or throttle adjustment in a direction to reduce fuel and repeat paragraphs 9.5 through 9.7.

10. PRELIMINARY PARALLEL TEST

TIME: Length of test is one hour, uninterrupted.

LOAD: Artificial load equal to at least one-half the total KW rating of the sets in parallel.

NOTE 1: Parallel a new engine-alternator with one existing set. If there are two new sets furnished these will be paralleled, but if there are existing sets it will also be necessary to parallel one of the new sets with one of the existing sets.

NOTE 2: The one hour Preliminary Test may be considered part of the FINAL PARALLEL TEST, if there are no interruptions and if this is agreeable to the customer.

10.1 Start the sets to be paralleled and run about 15-20 minutes to warm up.

10.2 Parallel the sets at no-load using the method in Paragraph 7.2. If hunting occurs refer to Paragraph 13 for possible causes of this condition. Correct as necessary before loading the sets.

10.3 Apply artificial load equal to about half the combined KW rating of the sets. Adjust speed and voltage so that the sets take their correct share of KW and current.

10.4 After the adjustments have been made record time, frequency, voltage, KW, amperes and engine temperatures and pressures on each set. Record on ID-946 test form.

10.5 After 30 minutes again record the data in Paragraph 10.4. Then adjust speed and voltage so that the units take their proportionate share of KW and current and again record voltage, current, KW and frequency

10.6 Thirty minutes later, again record the data in Paragraph 10.4. This set of readings shall meet the requirements in Paragraph 12. After the readings adjust speed and voltage so that the units take their proportionate share of KW and current. Record voltage, current, KW and frequency.

10.7 Reduct artificial load to about one-fourth of the combined KW rating of the sets. Then record frequency. voltage, current and KW on each set. Requirement in Paragraph 12.2 (shift of KW) shall be met by this set of readings.

10.8 After the readings in Paragraph 10.7 reduce the load to zero, unless it is desired to continue with the test as part of the FINAL PARALLEL TEST.

11. FINAL PARALLEL TEST

TIME: Length of this test is 2-1/2 hours. uninterrupted.

LOAD: Artificial load equal to one-half the combined KW rating of the two sets to be paralleled. Building and office load may be used in place of, or in addition to, the artificial load, if available and the telephone company gives its permission.

NOTE 1: This test must be witnessed by a customer's representative and made with his approval.

NOTE 2: The 1 hour PRELIMINARY TEST may be considered as part of the FINAL TEST, if the customer will allow this and no trouble was experienced in the first hour.

11.1 Start the sets to be paralleled and run them for about 15-20 minutes before connecting to the bus.

11.2 Parallel the two sets, using the paralleling method the customer will normally use. That is, either parallel at no-load (Paragraph 7.2) or with one set loaded (Paragraph 7.3).

11.3 Load the sets in parallel with the artificial load. Then add building and office load if the customer desires this.

11.4 After the sets are in parallel and all adjustments have been made so that the units share KW and current proportionate to their capacities, read and record speed. frequency, voltage. KW, amperes. engine temperatures and pressures and time. Record on the ID-946 Test Record

11.5 After thirty minutes again record the data listed in Paragraph 10.4. Speed and voltage adjustments may be made after the readings are taken so that the units share KW and current properly.

11.6 Take a set of readings every thirty minutes for the duration of the test run. Any necessary speed and voltage changes may be made after each reading. The requirements in Paragraph 12 shall be met by each set in parallel after the first thirty minute run.

11.7 After taking the last reading on the test run, take the units out of parallel. This will be done using the method the customer normally uses in taking the sets off the bus. (See Paragraph 8).

11.8 After the sets are taken out of parallel and the load removed, shut the sets down.

12. TEST REQUIREMENTS

12.1 The sets shall be stable in parallel and hunting should not be present at any load.

12.11 Hunting is the condition where system voltage or frequency is erratic and constantly changing, or the KW load is constantly shifting between sets.

12.2 The KW load that each set carries (after voltage regulators have heated and are stable) shall not change more than 5% of the KW rating for KS-5574-01 through KS-15890 sets nor more than 2% of the KW rating for KS-15899 through KS-19896 sets.

12.21 For example, a 500 KW set (KS-15777) shall not have a load shift greater than .02 X 500, or 10 KW. A 100 KW set (KS-15884) could have a load shift of .05 X 100. or 5 KW.

12.3 Circulating current between any two sets in parallel shall not exceed 10% of the combined full-load (.8 p.f.) current rating of the sets at the test voltage.

12.31 Refer to the nameplate of the alternator for rated current. Circulating current is the only current shown with the sets in parallel at no-load. or, with load on the sets this current circulates in the neutral connection and can be checked with the ITE-4503 Clamp-ON Ammeter.

13. TROUBLES AND CAUSES

13.1 Unstable Operation or Hunting: This may be due to constant change in load or incorrect governor compensation adjustment.

13.2 KW Load Shifts Between Units: Governor speed droops may be too small. Increase speed droops on both units but do not exceed a 5% droop.

13.3 KW Load Does Not Divide Properly: Increase speed droop on the unit taking too great a share of any KW load change.

13.4 Unit Takes More Reactive Current Than It Should: Reset tap on the cross-current-compensation resistor of this unit to put more resistance in the circuit.

13.5 Insufficient Voltage Droop or No Droop: The cross-current-compensation resistor may be shorted out. Check the wiring for this circuit against the control drawing. Current transformers other than the doughnut type have a shorting bar across the terminals. This has to be raised manually before the resistor will be in the circuit.

13.51 If the resistor is not shorted but voltage droop is too small, change the tap on the resistor to put more resistance in the circuit.

13.6 Voltage Rises Instead of Drooping: The current transformer for cross-current-compensation has the wrong polarity. This can be corrected by reversing the leads of the current transformer. Be sure to change the ground connection with the leads so that the compensating resistor is not shorted out.

→ Arrowed lines indicate new or changed information.

| Vertical lines at side of paragraph indicates requirements.

Manager, Product Engineering

Reason for Reissue:
(1) To add to Table A the KS-20523 thru KS-20527
(2) To add to Table B and Table C the KS-20523 thru KS-20527 and KS-20542
(3) To remove Note to the Reverse Power Test (Paragraph 9) and add a new Note.
(4) To change Test For Voltage Droop (Paragraph 6.2)