Installation Engineering Handbook 19
Western Electric
Kearny Works

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KS-15992 TURBINE-ALTERNATOR MANUALLY OR AUTOMATICALLY CONTROLLED 750 KW (J86838)

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1. GENERAL

1.1 Scope

1.11 This section covers installation and test of KS-15992 750 KW turbine-alternators made by Solar Division of International Harvester Company, San Diego, California.

1.12 Tests in this section are based on the following schematic drawings:

SD-81223-01 Alarm Circuit, Central Office
SD-81489-01 Typical Transfer Breaker Circuit
SD-81641-01 208-240 Volt Turbine Circuit
SD-81642-01 480 Volt Turbine Circuit
SD-81643-01 480 Volt Hardened Turbine Circuit
SD-81644-01 4160 Volt Turbine Circuit
SD-81645-01 Exciter and Voltage Regulator
SD-81687-01 208-240 or 480 Volt Plant
SD-81688-01 208-240 or 480 Volt Plant with Remote Control
SD-81689-01 4160 Volt Plant
SD-81690-01 480 Volt Hardened Plant
SD-81796-01 J87249B Rectifier
SD-81834-01 208-240 Volt Turbine for Remote Control
SD-81835-01 480 Volt Turbine for Remote Control
SD-81912-01 208-240 Volt Remote Control Bay
SD-81913-01 480 Volt Remote Control Bay
SD-81914-01 4160 Volt Remote Control Bay

1.13 The following equipment drawings cover the actual turbine installation:

ED-82118-30 Typical Air Intake and Exhaust
ED-82119-30 Typical Conduit Arrangements
ED-82120-30 Typical Air and Water Cooling

1.2 Description of Set

1.21 The turbine consists of an eight-stage axial compressor, fully annular combustor and three-stage axial turbine. The turbine power output shaft turns at 22,300 rpm and drives a two-stage reduction gear unit. The first stage of the reduction unit reduces speed to 6050 rpm and the second stage reduces output to 1200 rpm. The 1200 rpm shaft is coupled through a flexible coupling to a 750 KW alternator.

1.22 The flexible coupling between the 1200 rpm output shaft of the reduction gear unit and the alternator is disconnected for shipment. The services of a Solar representative is required to reconnect the coupling on the job; otherwise, the supplier's warrantee on the turbine is voided.

1.23 Figures 1 and 2 illustrate the turbine exterior and the interior of the enclosure. The enclosure is divided into three compartments or chambers. The front chamber is the air intake plenum, the second is the turbine compartment and the rear chamber contains the alternator, alternator coupling, voltage regulator, air circuit breaker (except for 4160 volt sets) and relays. Lube oil cooling is required. Standard sets use an oil cooler radiator with a hydraulically-operated fan. Hardened sets use a heat exchanger which requires connection to cooling water.

NOTICE: "NOT FOR USE OR DISCLOSURE OUTSIDE THE BELL SYSTEM EXCEPT UNDER WRITTEN AGREEMENT"

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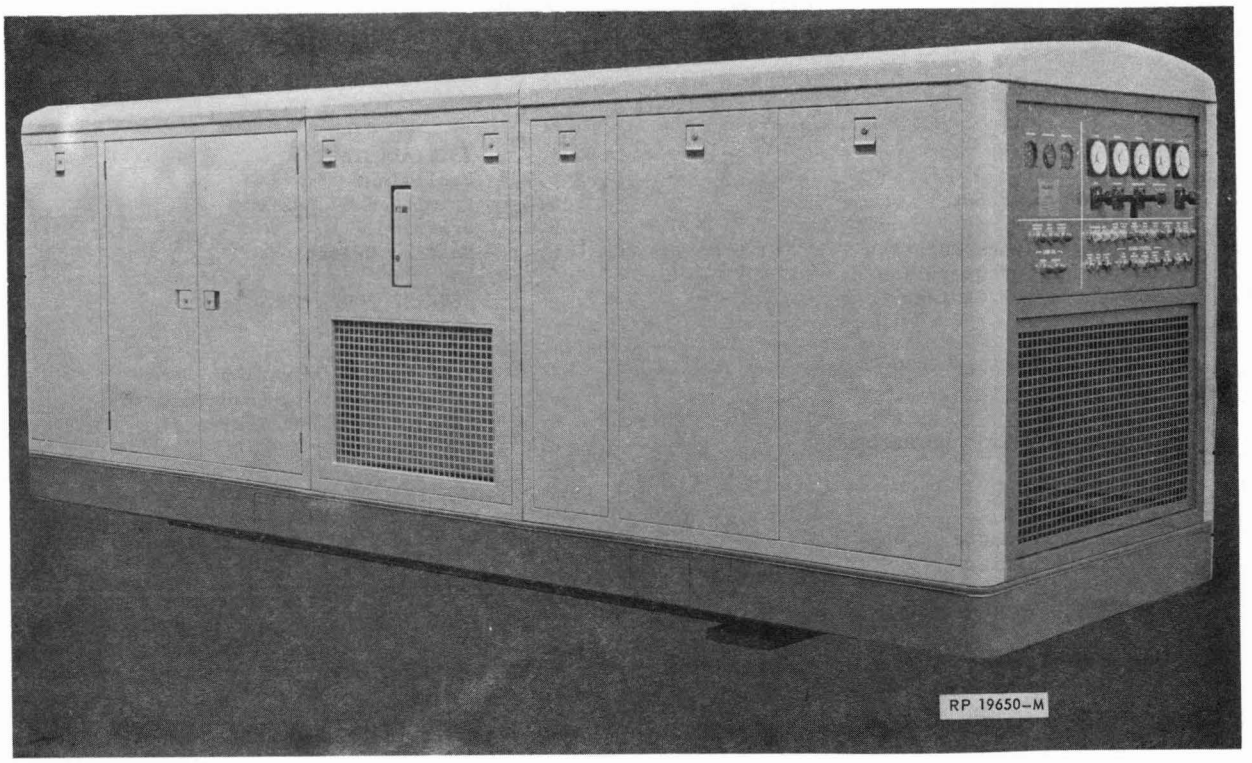

FIG. 1. VIEW OF MAIN CONTROL PANEL AND ENCLOSURE

1.24 The standard turbine control includes the following meters: AC Voltmeter, AC Ammeter, Wattmeter, Frequency Meter, Exciter Field Current, Engine Speed, Exhaust Temperature and Power Factor Meters. It also includes an OPERATION SELECTOR Switch, ENGINE SPEED Switch, alarm lamps, circuit breaker controls, starting switch, etc. The hardsite sets and other units with a remote control cabinet will not have the ac meters but do have speed and exhaust temperature meters, ENGINE SPEED and OPERATION SELECTOR Switches and some alarm lamps.

1.25 The front end of the turbine has an accessory drive system which drives the PSG governor, the high lift fuel pump, the lube oil pump, a combined No Lightoff, and Crane Cutoff switch and an oil pump for the Oil Cooler Fan. A Tachometer Generator, a combined Frequency Monitor and Overspeed Trip centrifugal switch and a fuel pump are mounted on the reduction gear unit at the rear of the turbine.

1.26 The Turbine is completely enclosed as shown in Figure 1. Side panels are lined with sound-deadening material. Side panels are arranged to be locked, if desired.

1.27 A special shock mount is available for hardened site (50 psi) application. The customer normally arranges to have hold-down bolts for the A-Frame embedded in the floor. Solar furnishes hold-down material for a standard or 10 psi unit consisting of 3 Lord mounts and 6 fasteners. Standard turbines are normally not fastened down except in earthquake areas.

1.28 All sets except the 4160 volt version have an air circuit breaker mounted in the enclosure. The 4160 volt version has OC relays monitoring each line. If overcurrent exists on any line the OC relay trips causing FS (Field Switch) to trip. This reduces output voltage to zero and opens the breaker on the low voltage side of the step-down transformer.

1.29 Shutdowns occur under the following conditions:

Turbine speed between 108-110% normal.
Lube oil pressure below 15 psi.
Lube oil temperature 240-260° F.
Exhaust gas temperature exceeds 940° F.
Set draws 100 KW or more in parallel.

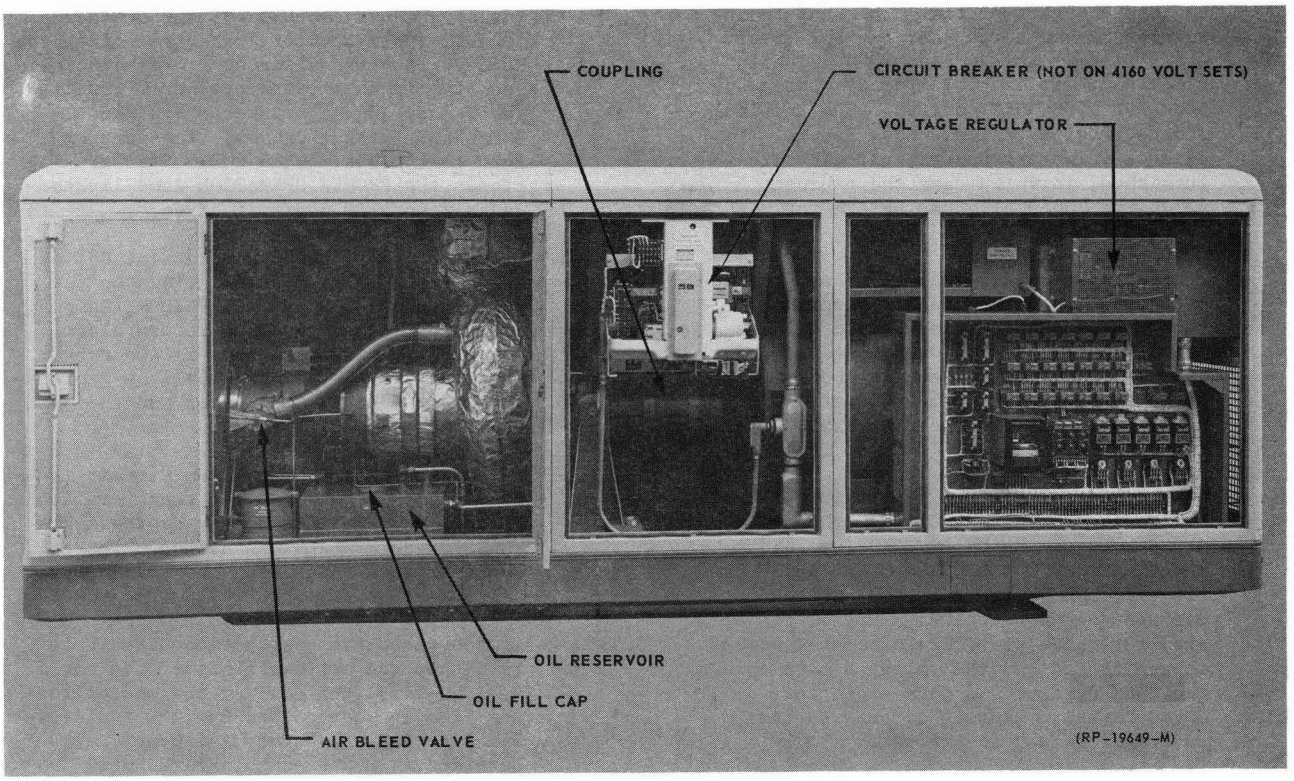

FIG. 2 VIEW OF LEFT SIDE WITH PANELS REMOVED

1.3 Inspection

1.31 As soon as possible after the unit is received on the job remove shipping materials and make a complete inspection of the unit and associated equipment. Examine carefully for visible defects and damage. Also examine the interior of the enclosure and the control cabinet for damage.

NOTE: Panels on the enclosure are locked for shipment. Six keys will be found in the control cabinet so that the panels may be unlocked.

1.32 Report any defects, damage or missing parts in accordance with established routines.

1.4 Supplier's Representative

1.41 A supplier's representative is required on the job to align gearbox and alternator and connect the flexible coupling between gearbox and alternator. If necessary he will be made available for consultation during installation testing. Charges for the representative's visit will be billed to the customer in accordance with the amount of services rendered.

1.42 The Installer's Notes in the Job Specification should inform the Installer to contact Chief of Field Service, Solar Incorporated, San Diego, California to schedule the representative's arrival at a mutually opportune time.

1.5 Description of Operation

NOTE: The OPERATION SELECTOR Switch has four positions, OFF, MANUAL OPERATION, AUTO and AUTO LOAD TEST. The set operation with the switch in each position is described below.

1.51 OPERATION SELECTOR Switch at OFF

1.511 The set is not available for use with the switch at OFF. It can be purge-cranked, however, with the switch in this position when purge-cranking is required.

1.52 OPERATION SELECTOR Switch at MANUAL OPERATION

1.521 With OPERATION SELECTOR Switch in this position the set will not start automatically on commercial power failure. However, if the turbine is running at no load when the failure occurs the load will transfer to the set if connections are made to a typical Transfer Breaker Circuit such as SD-81489-01.

1.522 An operator starts the set by depressing the MANUAL Start button. This has to be held depressed throughout the SDT (Start Delay Time). At the end of SDT a bell rings and this is cancelled by depressing the BELL DISCONNECT button. The turbine starts after SDT time unless remote exhaust valve and control circuits are furnished, in which case the exhaust valve must open slightly before the turbine starts.

1.523 The turbine cranks, lights off and accelerates. At about 65% rated speed the alternator field is flashed and voltage builds up to normal. When speed is about 92% of normal and voltage is about 91% of normal the WUT (Warm-Up Timer) starts. After WUT times out the READY TO LOAD lamp lights.

1.524 An operator closes the alternator circuit breaker by depressing CIRCUIT BREAKER CLOSE button. READY TO LOAD lamp stays on; the CIRCUIT BREAKER CLOSED lamp lights. The remote transfer breaker circuit does not receive a signal to transfer load (provided commercial power is available) and the operator must open the NORM Breaker and then close the EMERG Breaker, usually by push buttons, to transfer load to the set.

1.525 Assuming load was transferred to the set the operator restores load to commercial power by opening the EMERG Breaker and then closing the NORM Breaker, usually by push buttons. After the load transfer the operator opens the breaker on the set by depressing CIRCUIT BREAKER OPEN button. Then he shuts down the turbine by turning OPERATION SELECTOR Switch to OFF, although he should allow about 3 minutes at no-load to cool down the turbine.

1.526 If a Remote Exhaust Valve Control circuit is furnished it is energized when the set shuts down. The exhaust valve stays open for the VAT (Valve Timer) time period and then the valve begins to close. Once the valve starts to close it cannot be stopped and it must close fully before it can be reopened and the turbine started.

1.53 Operation Selector Switch at AUTO

1.531 The control monitors the 3-phase commercial power. If voltage drops below 93% in any or all phases and if this failure extends beyond the SDT (Start Delay Time) period the turbine will start. When it starts POWER FAILURE lamp lights and a remote power failure alarm is given if this is connected. However, if an exhaust valve and control (Lists 17 and 18) are furnished, cranking will not start until the valve is partially open.

1.532 The turbine cranks, lights off and accelerates. When speed and voltage are normal the WUT (Warm-Up Timer) starts. After the Warm-Up Time the alternator breaker closes and signals the Remote Breaker Circuit. The remote NORMAL Breaker opens and EMERGENCY Breaker closes, transferring load to the set. When EMERG Breaker closes the PROPER OPERATION lamp lights and a remote PO alarm is given.

1.533 When commercial power returns (at 88% of normal or higher) the bell rings on the turbine control and POWER FAILURE lamp goes out. A remote power return alarm may also be given, if this is connected. The operator silences the bell by depressing AUDIBLE ALARM OFF button and the BELL DISCONNECT lamp lights.

1.534 If the Automatic Restoration Circuit is not furnished, an operator transfers load back to commercial power by depressing TRANSFER SWITCH RESTORE button. The operator then shuts down the turbine by turning OPERATION SELECTOR Switch to OFF.

1.535 If the Automatic Restoration Circuit is furnished the set carries the load for a RT (Run-Time) period. At the end of the Run-Time the set enters the HOT (Hold-Over Time) period, if commercial power has returned. (HOT does not start until commercial power is available). After HOT times out it operates PRR relay (if TRANSFER SELECTOR Switch on the List 14 panel is in AUTO position), causing the remote EMERGENCY Breaker to open and the NORMAL BREAKER to close. When NORMAL BREAKER closes the CDT (Cool-Down Timer) is started, which trips the alternator breaker. After the CDT period, the fuel valve (FV) is released and the turbine shuts down. FVT (Fuel Valve Timer) must time out before the turbine can be restarted.

1.536 If TRANSFER SELECTOR Switch is in MANUAL with the Automatic Restoration Circuit, return to commercial power is not automatic. An operator must perform the transfer by opening the remote EMERG Breaker and closing the remote NORM Breaker. Then he shuts down the turbine by turning OPERATION SELECTOR Switch to OFF after about a three minute run at no-load.

1.537 If the Automatic Restoration Circuit is furnished the set can be started from a remote location by putting a ground on terminal T204. This operates RSR relay, which seals operated. Operated RSR removes the connection between T73 and T205, dropping TR relay, simulating a power failure.

1.538 A Remote Exhaust Valve Control is energized when the set shuts down. The exhaust valve stays open for the VAT (Valve Timer) time and then the valve begins to close. Once the valve starts to close it cannot be stopped and it must close fully before it can be reopened and the turbine started.

1.54 OPERATION SELECTOR Switch at AUTO LOAD TEST

1.541 When OPERATION SELECTOR Switch is operated to AUTO LOAD TEST a commercial power failure is simulated by releasing TR relay. Turbine start and load transfer will be as described for AUTO position in Paragraphs 1.531 and 1.532. However, load will not be automatically transferred back to commercial power.

1.542 If the Automatic Restoration Circuit is furnished load may be transferred to commercial power if the operator turns OPERATION SELECTOR Switch to AUTO. This operates TR relay, simulating return of commercial power, and the sequence of operation will then be as described in Paragraph 1.534. Restoration will be either on a manual or automatic basis, depending on the position of the TRANSFER SELECTOR Switch.

1.6 Remote Control Cabinet

1.61 A Remote Control Cabinet may be furnished to control a turbine from a remote location. The cabinet is applied only to sets which have the OFF-Set Transfer Breaker Circuit.

1.62 The Remote Control Cabinet includes the following ac meters: Voltmeter, Ammeter, Wattmeter, Power Factor Meter and Frequency Meter. It also includes Engine Temperature and Engine Speed Meters. An ENGINE SPEED Switch, an OPERATION SELECTOR Switch and a TRANSFER SELECTOR Switch are also provided on the remote cabinet as well as synchronizing lamps, alarm lamps, TEST ALARM button, MANUAL START and EMERGENCY STOP buttons and voltage adjusting control.

1.63 The OPERATION SELECTOR Switches on the turbine and remote cabinet are arranged so that the lowest position governs. They are normally set for the same operating mode, AUTO, for example. If they are not in the same position the resultant ... operation will be as follows:

Turbine OSS	Remote OSS	Operation
OFF	Any Position	OFF
Any Position	OFF	OFF
AUTO or AUTO LOAD TEST	MANUAL	MANUAL
MANUAL	AUTO or AUTO LOAD TEST	MANUAL
AUTO LOAD TEST	AUTO	AUTO LOAD TEST
AUTO	AUTO LOAD TEST	AUTO LOAD TEST

1.64 The Remote Control Cabinet can be ordered for control of 1 or 2 turbines or for control of three turbines.

2. PRECAUTIONS

2.1 Turbine-Alternator

2.11 When working on the turbine first turn OPERATION SELECTOR Switch to OFF. Then pull F3 fuse to make the control inoperative and disconnect the minus (-) battery lead at the starting battery.

CAUTION: Disconnect the J87249 Rectifier by removing an ac input fuse from the rectifier before disconnecting the starting battery lead.

2.12 When working inside the turbine control cabinet (either on the turbine or the remote cabinet) first turn OPERATION SELECTOR Switch to OFF. Then pull F3 fuse to make the control inoperative and disconnect the minus (-) starting battery lead. To disconnect commercial ac from the turbine remove the external fuses from the ac service cabinet that fuse CA, CB and CC leads into the turbine. On a remote control cabinet open CB1 Breaker.

2.13 Maintain a clean engine. Do not allow foreign objects to enter the air inlet duct. The greatest hazard to a gas turbine is entry of solid matter into the compressor.

2.14 DO NOT WALK ON or permit others to walk on the top of the engine enclosure or cabinet. It is advisable to have the customer build a wooden platform above the set for installers and outside workmen working overhead on conduit, ducts, etc.

2.15 The -4296 Ear Protectors should be worn by the Installer whenever the turbine is running.

2.16 The starting motor is not rated for continuous duty. Do not run the starter continuously for more than 30 seconds at a time. After a 30 second run wait five minutes before another start. After three successive starts wait 30 minutes for the motor to cool.

2.17 Do not mark stainless steel portions of the engine or exhaust system with lead pencils and do not use any zinc or zinc alloy material to score the surface of the stainless steel. Rapid corrosion will result if this is done. If necessary to mark stainless steel surfaces use a grease pencil and remove the marks before the surfaces are heated.

2.18 Do not attempt a start until the engine has coasted to a full stop.

2.19 Drain the fuel accumulator tank after every 10 engine starts or more often, if necessary. Also drain the accumulator tank before turning the set over to Telco.

2.2 J87249 Rectifier

2.21 The battery must be connected before connecting ac input. The open-circuit voltage from this rectifier is about 10 volts higher than with battery connected and damage to components will result. Also, if the battery is to be disconnected for any reason be sure to first remove an input fuse before disconnecting the battery.

2.22 Install only two input fuses: COM and 208V or COM and 240V according to the line voltage.

3. TOOLS, TEST SETS AND RECORDS

3.1 Tools and Test Sets

Note	Quan	Code	Description
	1	R-3404	Phase Sequence Indicator
	1	ITE-5250	Digital Multimeter
	1	ITE-4442	Volt-Ohmmeter
	3	R-4296	Ear Protector
1	3	ITE-4785	250 KW 3-Phase AC Test Load
2	X	R-3413	Wire & Lug Assembly
	1	ITE-4297	Auto Transformer
	1	ITE-9114	Test Cord
	1	ITE-9115	Test Cord

NOTE 1: Due to the heat produced by these leads they must be placed outside or in a well-ventilated area.

NOTE 2: In the 208-240 volt range one set of 3 leads will be required to feed one ITE-4785. At 480 volts one set of three leads can be used to feed 2 of the 3 ITE-4785. R-3413 leads are 50 feet long but can be bolted together for longer runs.

3.2 Records

ID-946	Engine-Alternator Test Record
ID-1275	Lubrication Record
ID-1285	Storage Battery Report
SD-4-1313	Test Trouble Record
SD-4-1315	Summary of Tests

4. INSTALLATION

4.1 Preliminary

4.11 Refer to Drawing ED-82118-30 for a layout of mounting feet for the standard turbines and for those used in 10 psi buildings. The floor slope between pedestal areas (87" total) shall not be more than 3/16 inch. Also, the mounting area for each foot shall be flat within 1/64 inch and these mounting areas shall not vary more than 1/32 inch in height from each other.

4.12 Refer to Solar drawings for location of anchor bolts for the hardsite sets. These sets are shipped on an "A" frame which is an integral part of the unit, and the "A" frame is bolted to the floor by eight 1 1/4 inch bolts. The bolts are arranged to be set in the floor by the customer. Before bringing the set into the building it would be advisable to check the location of these bolts against the dimension on the Solar drawings.

NOTE: Refer to Section 129 in this handbook for information on shimming the floor under the A frame.

4.13 Solar furnishes hold-down material with the standard turbines. This consists of of three Lord mounts and six fasteners per turbine. The unit may sit on tile or linoleum for standard applications or earthquake applications because the Lord mounts are used under the feet. The fasteners shall be used in earthquake areas and in 10 psi sites. Normal installations, however, do not require the use of fasteners.

4.14 Install associated systems such as air intake, exhaust, fuel, ventilation, etc. in accordance with the appropriate ED- drawings. Install line connections and conduits in accordance with ED- drawings.

4.15 Wire all external control circuits. Control leads terminate on terminal strips.

4.2 Turbine-Alternator

4.21 Open the OIL DRAIN and drain out any oil or residue left in the system. Then close the drain valve. Remove the filler cap on the lube oil reservoir (located on left at front of set) and add 27 gallons of KS-21273 List 1 Lubricating Oil.

4.22 Check relays in accordance with Circuit Requirement Tables. Check Power Failure Relays in accordance with Paragraph 10.

4.23 Timers should be set as follows:

Timer	Fig.	Function	Range	Setting	Note
NLT	2	No Lightoff	10-200 secs	30	-
SDT	2	Start Delay	.8-15 secs	-	1, 2
OLT	2	Overload	.8-15 secs	3	-
WUT	2	Warm-Up	.8-15 secs	15	-
OCT	2	Overcrank	10-200 secs	60	-
CDT		Cool Down	.5-10 min.	3 min.	-
FVT		Fuel Valve	10-200 secs	125	-
HOT		Hold-Over	1-20 min.	15 min.	-
RT		Run	1-20 min.	15 min.	-
VAT		Exhaust Valve	10-200 secs	105	-

NOTE 1: May be set for time desired customer (probably 5 seconds) except as shown in Note 2.

NOTE 2: Set SDT time 20 seconds less than VAT time if Fig. 6 (List 17) is furnished.

4.3 J87249B Rectifier

CAUTION: Do not connect the plug to the rectifier at this time.

4.31 Install the J87249B Rectifier in the space provided.

4.32 Remove the cover from the rectifier and check the marking on the card. List TA should be furnished with the 20 cell KS-15578 List 12W nickel-cadmium battery and List TB should be furnished with the 12 cell KS-15577 List 14 lead-acid battery.

4.4 Starting Batteries

CAUTION: Do not change factory adjustment of the controls on the J87249 Rectifier card.

4.41 Install batteries and connect to the turbine in accordance with appropriate job drawings. Refer to Handbook 18 for information on installing and mounting.

4.42 Connect the J87249B Rectifier as follows:

4.421 Remove all fuses from the rectifier. Remove the cover from the rectifier and ascertain that the following list number is marked on the card (according to the battery used):

List TA - 20 cell nickel-cadmium battery (setting is 28.5 volts)
List TB - 12 cell lead-acid battery (setting is 26.0 volts)

4.422 Put the plug into the rectifier. Install the output fuse. Install input fuses COM and 208V or COM and 240V, according to the line voltage.

4.423 Install ac fuses for the rectifier in the ac service cabinet.

4.43 Allow the rectifier to bring battery voltage up to the float values shown in Paragraph 4.421. Measure voltage across DC OUTPUT jacks with ITE-5250 Digital Voltmeter (Depress the VDC and 10 Range and turn on by depressing the POWER ON button). Measure output current across 4A/VOLT jacks with the 3 volt scale of ITE-4442 or with a good 3 volt dc voltmeter. Each volt measured is equivalent to 4 amperes charging current less 0.4 ampere for current consumed by R15 bleeder resistor.

4.5 Remote Control Cabinet

4.51 Install the Remote Cabinet in accordance with information provided on ED- Drawings.

5. 4160 VOLT SYSTEMS

5.1 The customer should normally arrange to have these high voltage systems installed complete from the turbine-alternator to the step-down transformer.

5.2 On occasion, portions of this work, by agreement with the Area, may be specified as an Installer's responsibility in job specifications.

6. INITIAL START

NOTE: When a Remote Control Cabinet is furnished turn REMOTE OPERATION SELECTOR Switch to MANUAL and leave it there until a change is indicated.

6.1 Preliminary

6.11 Separately test associated systems for required operation. These are such systems as Automatic Fuel Pumping System, Auxiliary Room Ventilating Circuit and other external circuits.

6.12 Connect the ITE-4785 Test Loads. Refer to TMO-4785 in Handbook 100 or to the Handbook 19 Section 24 for information on connecting the loads. The loads may be connected to the output side of the alternator breaker or to the emergency bus. Since the side covers will be put on for the full load test the leads for the artificial load should be run under the base.

NOTE: For the 4160 volt turbine the loads shall be connected on the low-voltage side of the stepdown transformer.

6.13 If the unit will be paralleled operate CROSS CURRENT OUT/IN Switch on the Voltage Regulator to IN position. Otherwise, operate this switch to OUT position.

6.14 Set the governor arm to the desired position, either ISO or DROOP. ISO position will always be used if the unit will not be paralleled. DROOP position has been used in the past on all units in a parallel system. However, one unit in a parallel system may be set at ISO, if droop-isochronous paralleling is to be used. (Refer to Section 130 in this Handbook).

NOTE: The ISO and DROOP settings are on the left side of the governor. The droop adjustment arm is held in position by a knurled knob. Loosen the knurled knob, set governor arm to desired setting and then tighten the knurled knob. ISO position is toward the front of the set, DROOP position toward the rear.

6.15 Turn OPERATION SELECTOR Switch to OFF position (on the turbine). Turn TRANSFER SELECTOR Switch (turbine or remote cabinet) to MANUAL position. Turn VOLTAGE SELECTOR Switch (Turbine or remote cabinet) to ALTERNATOR 1-2 position.

6.16 Since it is unlikely that the customer wants his remote transfer breakers to operate until the Automatic Control Tests (paragraph 11) temporarily disconnect the following leads: LB6, TR16, CB9 and TR15. Also, to prevent alarms from coming in during the testing period external alarm connections should be temporarily disconnected at the control terminals.

6.17 Vacuum the air intake plenum and any nearby area where there is dirt or dust which may be drawn into the compressor. Check for oil leaks, especially around the air inlet housing. Oil in this area will vaporize and be drawn into the compressor, leading to contamination of compressor blades and reduction of engine output.

6.18 Install F2, F3 and F4 fuses in the turbine cabinet. SWITCH OFF NORMAL lamp lights on the turbine and Remote Control Cabinet when F3 is inserted. Close CB1 Breaker on the Remote Control Cabinet.

6.19 For a 4160 volt set install the side covers on the alternator end of the set.

6.2 Priming Fuel System

6.21 Check that OPERATION SELECTOR Switch on turbine is at OFF.

6.22 Check that fuel drain valve is closed on the turbine. This valve is located on the left side of the engine.

6.23 Temporarily disconnect the turbine fuel inlet line at the turbine and allow fuel to drain into a bucket from the open line until it is free of air bubbles and foreign material. Then reconnect the line to the turbine. DO NOT ALLOW FUEL TO FLOW INTO THE TURBINE UNLESS FUEL IS ABSOLUTELY CLEAN.

6.24 Turn RUN/PRIME Valve above the hand pump to PRIME position. Fill the FUEL CUP by operating the hand pump briskly until considerable restriction is felt.

6.25 Connect the 3/8 inch flexible purge line to the "quick disconnect fitting" provided next to the hand pump. This purge line will be found on the shelf under the door sill near the fuel filters. Place the free end of the purge line in a bucket.

6.26 Pull down on the ball valve handle. At the same time push up the purge crank toggle switch. The engine cranks at about 20% speed as long as the switch is held operated. Purge in 30 second spurts until fuel flow into the bucket is steady without air bubbles or foreign matter.

CAUTION: Do not run the starter motor more than 30 seconds continuously. If further purging is necessary wait five minutes to allow starter motor to cool before making another purge cycle.

6.27 When purging is complete or at the end of each 30 second period release the switch and close the ball valve by pushing up the handle. Be sure the purge valve is closed while the engine is still rotating to prevent air from re-entering the system.

6.28 Disconnect the purge line. Turn RUN/PRIME Valve to RUN position.

6.3 Starting

NOTE: This first start should be made at the turbine. If a Remote Control Cabinet is furnished station one man at the turbine and one at the remote cabinet. Allow the operator at the turbine to make the start. At this start, or on any start made at the turbine, itself, the operator should be ready to shut down the turbine with the EMERGENCY STOP button if one of the following malfunctions occur:

MISFIRE: This is caused by the fuel igniter failing to ignite the fuel. Engine does not accelerate beyond about 20% speed and exhaust temperature does not rise. In this case the NLT Timer would normally shut down the turbine.

SURGE: Caused by momentary malfunction of fuel or air supply systems. At low speed the engine may fail to accelerate but exhaust temperature may rise, accompanied by a sudden, high-pitched pulsating sound. At higher speeds a surge may cause the engine to fail to reach rated speed accompanied by a loud roar and/or popping noises.

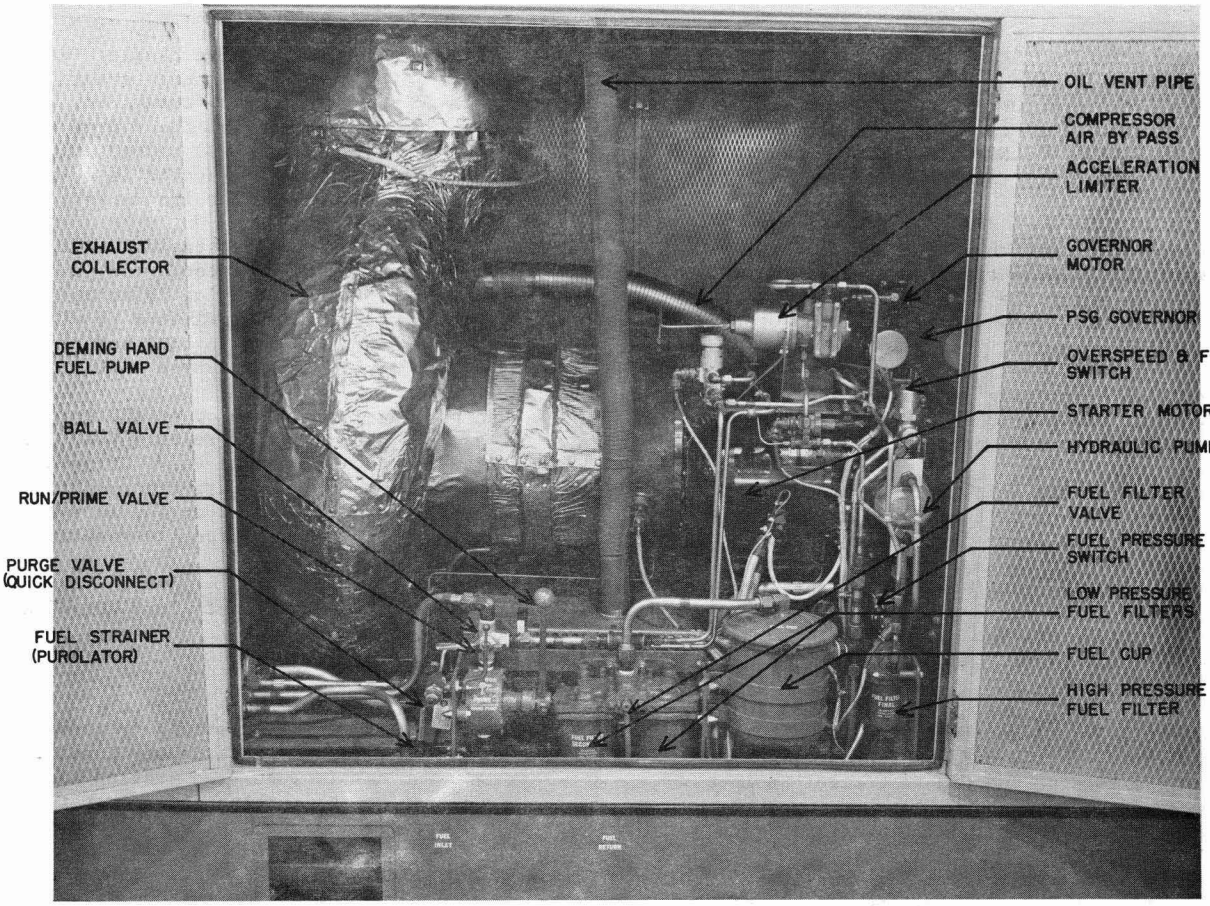

FIG. 3 RIGHT SIDE OF ENGINE SHOWING FUEL COMPONENTS

6.31 Turn OPERATION SELECTOR Switch on the turbine to MAN OPER. The SWITCH OFF NORM lamp goes out on the turbine and also on the Remote Control Cabinet.

6.32 Push MANUAL START button (at the turbine) and hold until the bell rings, indicating that SDT (Start Delay Timer) has timed out. Silence the bell by depressing BELL DISCONNECT Button. Cranking starts at this time unless a remote Exhaust Valve is furnished, which begins to open before the turbine can crank.

6.33 Observe that the turbine cranks, lights off and accelerates to rated speed in about 50 seconds. If surge or misfire occurs during this start immediately shut down the turbine by depressing EMERGENCY STOP button.

6.34 When the engine is running keep a careful watch on panel instruments and panel lamps.

6.35 Exhaust temperature should stabilize about 600-700°F. Adjust speed to 100% with ENGINE SPEED RAISE/LOWER Switch. Observe that Frequency Meter on the turbine or Remote Cabinet indicates 60 hertz at 100% speed. If DROOP position is used on the governor readjust no-load speed to 104.5%, or 62.7 hertz.

6.4 No-Load Operation

6.41 With alternator voltage available check phase sequence of the alternator voltage with R-3404 Phase Sequence Indicator. Refer to Section 135 in this handbook for method. 1-2-3 is required, using breaker terminal markings as reference.

CAUTION: For 4160 volt sets make this test on the low-voltage side of the step-down transformer.

6.42 Check the set over carefully for fuel and lube oil leaks.

6.43 Adjust voltage to normal value with the Voltage Adjusting Rheostat.

NOTE: This control is on the Remote Control Cabinet when remote control is furnished.

6.44 After a short run at no-load shut the set down by turning the OPERATION SELECTOR Switch to OFF.

NOTE: Drain the fuel accumulator tank after every 10 engine starts or more often, if necessary. Also drain the accumulator tank before turning the set over to Telco.

7. REVERSE POWER TEST

NOTE: This test is made if the set has a Reverse Power Relay (parallel sets only). The test requires an artificial load.

7.1 With the set shut down reverse the leads at terminals No. 5 and No. 6 on the Reverse Power Relay.

7.2 Start the set manually. After speed and voltage are normal, close the breaker.

7.3 Add approximately 75-85 KW artificial load. The Reverse Power Relay should not cause shutdown up to about 85 KW.

7.4 Increase artificial load to approximately 100-110 KW. The set should shut down, the breaker should trip, OVERSPEED & REV POWER lamp should light and the horn blows. The ENGINE FAILURE lamp lights on a Remote Control Cabinet and the horn blows. Depress ALARM OFF AUDIBLE button on the turbine to stop the horn.

7.5 Turn OPERATION SELECTOR Switch to OFF position to cancel the alarms.

7.6 Operate load switches on the artificial load to OFF.

7.7 With the set shut down change the leads at terminals No. 5 and No. 6 on the Reverse Power Relay to their original position. Reset the relay by pushing up the button in the lower left-hand corner of the relay, which removes the red flag indication.

7.8 Start the set manually and press the TRIP button on the front of the breaker housing to reset the breaker.

8. FULL-LOAD TEST

TIME: Make a Preliminary Full-Load Test of one hour duration before a Final Acceptance Test. The Final Acceptance Test is 2-1/2 hours in length, and a customer's representative must witness the test. Two hours of the Final Acceptance Test will be at full-load and the last half-hour should be at the usual office load, or at full-load.

LOAD: Artifical load equal to full capacity of the set.

PARALLEL: If the set will be paralleled an additional Acceptance Test, in parallel, will be required, in accordance with Section 130 in this handbook.

8.1 Preliminary Operations

8.11 Connect an ITE-5250 (with VAC and 1000 Range depressed) across the AC Voltmeter on the Control Cabinet for a 208-240 volt set, or across alternator output for a 440-480 volt set.

NOTE: These readings will be taken only on the 208-240 volt set and 440-480 volt set, not on the 4160 volt set.

8.12 Install all the side covers on the turbine enclosure.

8.13 Start any Auxiliary Fuel Pump or Auxiliary Room Ventilating Fan. Open doors to provide ventilation if this will be the normal method of ventilating the room.

8.14 Open the valve in the fuel suction line.

8.15 Close any condensate drain valves in the exhaust line.

8.2 Preliminary Full-Load Test

NOTE 1: ITE-5250 should be turned on only when taking readings. During all other times the ITE-5250 should be off by depressing the POWER OFF button.

NOTE 2: Where a Remote Control Cabinet is furnished start and control the set during this test from the Remote Cabinet. In this case turn REMOTE OPERATION SELECTOR Switch to OFF and then turn OPERATION SELECTOR Switch on the turbine to MANUAL OPER. Leave OPERATION SELECTOR Switch on the turbine in this position until instructed otherwise.

8.201 Turn REMOTE OPERATION SELECTOR Switch (when furnished) to MANUAL OPER. Start the set manually by depressing the MANUAL START button. Hold the button depressed until the bell rings, indicating SDT has timed out. Press ALARM OFF AUDIBLE Button.

8.202 Observe that the turbine cranks, lights off and accelerates to rated speed in about 50 seconds.

8.203 Adjust no-load frequency to the desired value, 60 or 62.7 hertz. Adjust voltage to the desired value.

8.204 Take a set of readings at no-load, which includes Time, Frequency, Volts, Exhaust Temperature, Time Meter, ambient temperature at the turbine and ITE-5250 indication.

8.205 After the READY TO LOAD lamp lights close the alternator circuit breaker. Add about 750 KW load to the turbine. Adjust voltage for normal line voltage and adjust speed for 60 hertz.

NOTE: READY TO LOAD lamp remains on after the breaker is closed.

8.206 Take a set of readings at full-load, which includes Time, Frequency, Volts, Amperes, KW, Power Factor, Exhaust Temperature, ambient temperature at the turbine, and ITE-5250 indication.

8.207 Take readings every 30 minutes until the set has run one hour at full-load. The requirements in Paragraph 8.4 shall be met.

8.208 With the alternator breaker closed check for correct phase sequence of alternator voltage at the EMERGENCY Breaker in the Remote Breaker Circuit.

NOTE: Refer to Section 135 in this handbook for information on "phasing-out" at transfer switch circuits. Whichever voltage (commercial voltage or alternator voltage) is connected first will be the reference for phase sequence, and the other source voltage must be "phased-out" to match this sequence.

8.209 Sometime during this run check for proper voltage between terminals 126 and 127 with the ITE-4442 (on the 600 VAC scale). These are leads LB6 (T 126) and TR16 (T 127) that run to the Remote Breaker Circuit.

8.2091 Turn OPERATION SELECTOR Switch to AUTO position temporarily.

8.2092 One or more PF relays should be deenergized. This can be accomplished by pulling out the F1 fuse head.

8.2093 Turn OPERATION SELECTOR Switch back to MANUAL OPER. after the test and restore F1 fuse head.

8.210 During this run also check voltage between terminals 124 and 125 with ITE-4442. These are leads CB9 (T124) and TR15 (T125) that run to the Remote Breaker Circuit.

8.2101 Make certain that PF relays are energized (commercial power available on CA, CB and CC leads).

8.2102 Depress TRANSFER SWITCH RESTORE Button to operate PRR relay.

8.2103 With PRR relay operated check for proper voltage between terminals T124 and T125.

8.2104 Check that voltage has been removed from terminals T126 and T127.

8.211 Reduce artificial load to zero and open the alternator circuit breaker.

8.212 Allow the set to run about three minutes to cool down. Then shut the set down by turning OPERATION SELECTOR (or REMOTE OSS) to OFF.

8.3 Final Acceptance Test

8.31 Turn OPERATION SELECTOR (or REMOTE OPERATION SELECTOR) Switch to MANUAL OPER. Start the set and adjust speed and voltage as necessary.

8.32 Close the alternator breaker and add artificial load until the set is loaded to full-load.

8.33 Take a set of test readings at full-load. Then take readings every 30 minutes until the set has run two hours at full-load. The requirements in Paragraph 8.4 shall be met during this run.

8.34 After two hours at full-load reduce load to the value of load normally carried by the set, or, continue at full-load. Take another set of readings if load is reduced from full-load.

8.35 After 30 minutes at the normal load value (or at full-load) take a set of readings. Then decrease artificial load to zero. Open the alternator breaker.

8.36 Allow the set to run about 3 minutes. Then shut down the set by pushing EMERGENCY STOP Button. The set shuts down, OVER-SPEED & REV. POWER lamp lights on the turbine and ENGINE FAILURE lamp lights on a Remote Cabinet. The horn blows. Silence the horn by depressing ALARM OFF AUDIBLE lamp.

8.37 After the set has coasted to a stop turn (REMOTE) OPERATION SELECTOR Switch to OFF. The alarm lamps go out.

8.38 Disconnect artificial load.

8.4 Requirements

8.41 The turbine shall carry 750 KW load under the following conditions:

(a) Exhaust gas temperature under 940° F.
(b) Altitude above sea level 1500 feet or less.
(c) Compressor inlet temperature 90° F or lower.

NOTE: Turbine is derated at altitudes greater than 1500 feet above sea level and at air inlet temperatures above 90° F in accordance with the schedule shown in Table A.

TABLE A: KW Versus ALTITUDE And AIR INLET TEMPERATURE

ALTITUDE (Feet)	COMBUSTION AIR INLET TEMPERATURE (° F)				
	70	80	90	100	110
0	750	750	750	745	705
1500	750	750	750	700	670
2000	750	750	730	690	660
3000	750	720	695	660	
4000	735	700	670	635	
5000	705	675	645	615	
6000	680	645	620	590	
7000	655	620	595	570	
8000	630	600	595	545	

8.42 With a hot engine (operated minimum of two hours at full load) speed at full-load, or at the derated schedule equivalent to full-load, shall not change more than 1/4 hertz. Also, speed change shall not be cyclic.

8.43 Voltage shall not vary throughout the full-load run more than ± 1% from the original full-load setting.

8.44 With governor set at DROOP, the speed change from no-load to full-load shall not exceed 4-1/2% of the rated or full-load speed.

8.45 With governor set at ISO, the variation from 60 hertz shall not exceed ± 1/4 hertz.

8.46 The Voltage indicated on the AC Voltmeter on the Control Cabinet should not vary from the ITE-5250 Digital Multimeter indication more than the following value:
208-240 set: 6 volt
416-480 set: 12 volt

9. OVERSPEED TRIP TEST

NOTE: The turbine is started manually for this test. Start at the turbine when a Remote Control Cabinet is furnished.

9.1 Turn OPERATOR SELECTOR Switch to MANUAL OPERATION. REMOTE OPERATION SELECTOR Switch may be in any position but OFF.

9.2 Start the turbine manually. When speed and voltage are normal increase engine speed by operating ENGINE SPEED Switch in RAISE direction. Watch ENGINE SPEED Meter which is marked in Per Cent Speed.

9.3 Turbine shutdown should occur in the range 108-110% speed. OVERSPEED & REV POWER lamp lights and the horn sounds. Depress ALARM OFF AUDIBLE Button to silence the horn.

CAUTION: Do not exceed 110% speed. If shutdown does not occur by 110% reduce speed to 109% and adjust the OS centrifugal switch for shutdown at 109%.

9.31 The shutdown point is controlled by OS (Overspeed Switch) centrifugal switch, which is contained in the same body with the FM (Frequency Monitor) switch. (Refer to Figure 3 for location).

9.32 If necessary to adjust OS the adjusting screw is under plug #2 on the centrifugal switch. Remove the plug and insert a 1/16 inch Allen wrench through the opening into the end of the adjusting screw. Turn the screw CW to raise operating point, or, CCW to lower the operating point.

9.4 Turn OPERATION SELECTOR Switch to OFF.

9.5 After shutdown turn the knurled ring on the governor about two turns in a CCW direction to prevent overspeed on the next start.

10. POWER FAILURE RELAY TESTS

NOTE 1: Voltage sensing relays should release when line-to-line voltage falls to 88% of normal or below. These relays should operate when line-to-line voltage is 93% of normal or higher.

NOTE 2: Assume phase #1 relay and associated connections and adjustments to be on the left, phase #2 in the middle and phase #3 on the right.

10.1 Preliminary

10.11 Measure commercial ac line-to-line voltage for the sets associated with the following SD- drawings as follows:

SD-81641-01 208-240 Volt Turbine Circuit
SD-81642-01 480 Volt Turbine Circuit
SD-81834-01 208-240 Volt Turbine for Remote Control.

10.111 Operate the AC Voltmeter Switch to OFF.

10.112 Connect the ITE-5250 Digital Multimeter across the AC Voltmeter on the Control Panel.

10.113 On ITE-5250 depress VAC and RANGE 1000 buttons. Turn on ITE-5250 by depressing POWER ON button.

10.114 Measures the three commercial line-to-line voltages with the ITE-5250 by operating the AC Voltmeter Switch to each commercial line voltage position and noting each reading.

10.115 Operate the AC Voltmeter Switch to OFF. Depress POWER OFF button on ITE-5250. Disconnect the ITE-5250.

10.116 Calculate the average line-to-line voltage from the readings of the ITE-5250 as follows:

$$\text{Average} = \frac{\text{Line 1-2 + line 2-3 + line 3-1.}}{3}$$

Then calculate 93% and 88% of this average value, which will be the pickup and dropout values, respectively.

10.12 Measure the commercial ac line-to-line for the sets associated with the following SD- drawings as follows:

SD-81643-01 480 Volt Hardened Turbine Circuit
SD-81835-01 480 Volt Set For Remote Control
SD-81644-01 4160 Volt Turbine Circuit

10.121 Depress the VAC and RANGE 1000 on the ITE-5250.

10.122 Measure the voltage across the following terminals in Table 3 for each line voltage with the ITE-5250. Turn on ITE-5250 by depressing POWER ON button.

TABLE 3

SD	CA	CB	CC
81643-01	T180 & T179	T179 & T178	T180 & T178
81835-01	T180 & T179	T179 & T178	T180 & T178
81644-01	T121 & T122	T122 & T123	T123 & T121

10.123 Calculate the average line-to-line voltage from the readings of the ITE-5250 as follows:

$$\text{Average} = \frac{\text{Line 1-2 + line 2-3 + Line 3-1}}{3}$$

Then calculate 93% and 88% of this average value, which will be the pickup and dropout values respectively.

10.13 Remove the three pole F1 fuse head. This fuses CA, CB and CC leads in the cabinet.

10.14 Disconnect leads from all terminals on the terminal strip at the bottom of the VF relay. Tape and mark each lead so that it can be reconnected later to the correct terminals.

10.15 Loosen the locknuts on each PICKUP and DROPOUT potentiometer shaft. Turn each PICKUP potentiometer full CW and each DROPOUT potentiometer full CCW.

10.16 Leave the relay for phase #1 in place, but remove the relays for phase #2 and phase #3.

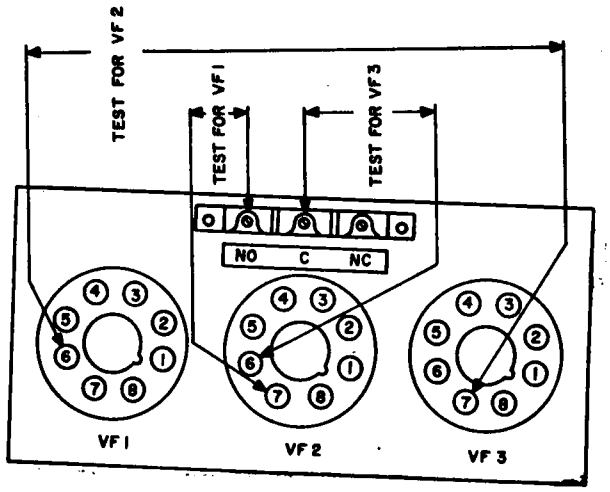

FIG. 4 RELAY PLUG ASSEMBLY OF VOLTAGE SENSING UNIT (FRONT VIEW)

10.2 Test

NOTE: Refer to Fig. 4 for ITE-4442 connections:

10.21 Connect the ITE-4297 with the ITE-5250 Digital Multimeter across it to monitor output voltage to phase #1 terminals as follows:

10.211 Connect spade tips at one end of the ITE-9364 to the terminals on the voltage relay terminal strip for phase #1 (Terminal 0 and 208 or 0 and 240).

10.212 Put the plug end of ITE-9114 and ITE-9115 cords into the OUTPUT Socket on ITE-4297. Connect the free spade tips of the ITE-9364 cord and the alligator clips from the ITE-9114 and ITE-9115 to the ITE-5250 Digital Multimeter.

10.213 Set dial on ITE-4297 to 0. With ITE-4297 turned off, plug the cord into a convenient 110 volt ac outlet.

10.22 Connect the ITE-4442 Volt-ohmmeter (R x 1 scale) between terminal 40 and pin #7 of the socket for phase #2 relay (Refer to Fig. 4). There should be no continuity.

10.23 Depress POWER ON button on ITE-5250. Turn on the ITE-4297. Increase output until voltage indicated on the ITE-5250 is 93% of the average line-to-line voltage (calculated in paragraph 10.116 or 10.123 depending on SD- drawing number. Turn PICKUP potentiometer for phase #1 slowly CCW until continuity is indicated on the ITE-4442.

10.24 Reduce the autotransformer output to 85% of the average line-to-line voltage (calculated in paragraph 10.116 to 10.123 depending on SD- drawing number). Turn DROPOUT potentiometer slowly CW until no continuity is indicated on the ITE-4442.

10.25 Increase voltage slowly until the ITE-4442 indicates continuity and note the voltage on the ITE-5250; this should be within 2 volts of the original dropout setting. Decrease voltage until no continuity is indicated on the ITE-4442 and note the voltage on the ITE-5250; this should be within 2 volts of the original dropout setting.

10.26 Decrease autotransformer voltage to zero and turn it off. Disconnect the autotransformer. Turn off ITE-5250 Digital Multimeter by depressing POWER OFF button.

10.27 Remove the phase #1 relay and insert phase #2 into its socket. Connect the ITE-4297 and ITE-5250 to 0 and 208, or, 0 and 240 terminals of phase #2. Connect the ITE-4442 Volt-Ohmmeter between pin #6 of the socket for phase #1 relay and pin #7 of the socket for phase #3 relay. There should be no continuity indication on the ITE-4442. Perform operations indicated in Paragraphs 10.23 through 10.26 for phase #2 relay.

TABLE C: ALARM LAMPS WITH TEST ALARM BUTTON

STANDARD TURBINE	Press	Rels.	TURBINE FOR REMOTE CONTROL	Press	Rels.	REMOTE CONTROL CABINET	Press	Rels.
POWER FAILURE	X		POWER FAILURE	X		POWER FAILURE	X	ALL LAMPS OUT
PROPER OPERATION	X		PROPER OPERATION	X		PROPER OPERATION	X	
BATTERY SUPPLY MONITOR	X		BATTERY SUPPLY MONITOR	X		TURB FUSE	X	
HIGH EXHAUST TEMPERATURE	X		HIGH EXHAUST TEMPERATURE	X		HIGH EXHAUST TEMPERATURE	X	
CRANK FAILURE	X	X	CRANK FAILURE	X	X	ENGINE FAILURE	X	
LUBE OIL PRESSURE	X	X	LUBE OIL PRESSURE	X	X	LUBE OIL PRESSURE	X	
LUBE OIL TEMPERATURE	X	X	LUBE OIL TEMPERATURE	X	X	LUBE OIL TEMPERATURE	X	
OVERSPEED & REV POWER	X	X	OVERSPEED & REV POWER	X	X	OVERSPEED & REV POWER	X	
			NOTE: ENGINE FAILURE and HIGH EXH TEMP lamps light on Remote cabinet.			PREL HIGH EXH TEMP	X	
						RECT FAILURE	X	
						CRANK FAILURE	X	
						ALTERNATOR OVERLOAD	X	
						POWER RETURN	X	
						ENGINE RUNNING	X	
						FUEL SYSTEM FAILURE	X	
						SWITCH OFF NORM	X	
						CAB FUSE	X	

NOTE: X indicates lamp is lighted.

10.28 Remove the phase #2 relay and insert phase #3 relay into its socket. Connect the ITE-4297 and ITE-5250 to 6 and 206, or, 9 and 240 terminals of phase #3. Connect the ITE-4442 between terminals C and pin #6 of the socket for phase #2 relay. There should be no continuity indication on the ITE-4442. Perform operations indicated in Paragraphs 10.23 through 10.26 for phase #3 relay.

10.29 Disconnect ITE-5250. Disconnect the ITE-9114, ITE-9115 and ITE-9364 cords.

10.3 Final Operations

10.31 Restore the phase #1 and phase #2 relays to their original positions.

10.32 Reconnect the leads to all terminals on the terminal strip at the bottom of the relay.

10.33 Replace the three pole F1 fuse head in the cabinet that was removed.

10.34 Operate the AC Voltmeter Switch to its original position.

11. AUTOMATIC CONTROL AND ALARM TESTS

NOTE: This test will be done with normal office load connected. Artificial load will not be used.

11.1 Preliminary

11.11 Check Power Failure Relays (Paragraph 10) if not done already.

11.12 After checking Power Failure Relays connect commercial power to CA, CB and CC leads for these relays. These leads are fused in the Remote Breaker Circuit. Also, install F1 fuse head in the turbine cabinet, if not already installed.

11.13 Connect CB-9, TR-15, LB-6 and TR-16 leads to the Remote Breaker Circuit, such as SK-81459-01.

NOTE: These leads come from the turbine except for the 4160 volt set where CB-9 and TR-15 come from the turbine and LB-6 and TR-16 from the Remote Control Cabinet.

11.14 Connect commercial ac to the Remote Transfer Breaker Circuit before proceeding further. Also, office load should be connected through the breaker circuit to commercial power.

CAUTION: Be sure that turbine-alternator voltage is "phased-out" with commercial voltage at the Transfer Breaker Circuit. Refer to information in Section 135 in this handbook for information on "phasing-out" operations, which depend on the first voltage connected, commercial or turbine-alternator, as the reference voltage.

11.15 Connect external leads to the alarm circuit.

11.16 Turn OPERATION SELECTOR Switch to AUTO. Also, turn REMOTE OPERATION SELECTOR Switch to AUTO, when a Remote Control Cabinet is furnished.

11.17 When an Automatic Restoration Circuit is furnished on the turbine turn TRANSFER SELECTOR SWITCH to AUTO.

11.2 TEST ALARM (Standard Turbine)

11.21 Press TEST ALARM Button on the turbine. Observe that lamps light as shown in Table C, that the bell rings and the horn sounds.

11.22 Both major and minor office alarms sound and major and minor office visual alarms light.

11.23 Release TEST ALARM Button and observe that certain lamps remain lighted as shown in Table C. The minor office alarms are cancelled.

11.24 Press ALARM OFF AUDIBLE Button to silence audible alarms on the turbine.

11.25 Turn OPERATION SELECTOR Switch to OFF to remove alarm indications on the turbine as well as the office alarms.

11.26 Restore OPERATION SELECTOR Switch to AUTO position.

11.3 TEST ALARM (Remote Control Turbine)

11.31 Press TEST ALARM Button on the turbine. Observe that lamps light on the turbine and on the Remote Control Cabinet as shown in Table C. The bell rings and the horn sounds.

11.32 Both major and minor office alarms sound and major and minor office visual alarms light.

11.33 Release TEST ALARM Button and observe that certain lamps remain lighted as shown in Table C. The minor office alarms are cancelled.

11.34 Press ALARM OFF AUDIBLE Button to silence audible alarms on the turbine.

11.35 Turn OPERATION SELECTOR Switch to OFF to remove alarm indications on the turbine as well as the office alarms. Then restore OPERATION SELECTOR Switch to AUTO.

11.36 Press TEST ALARM Button on the Remote Control Cabinet and observe that lamps light on the cabinet as shown in Table C that the bell rings and the horn sounds. Both major and minor office alarms sound and major and minor visual office alarms light.

11.37 Release TEST ALARM Button and observe that all alarms are cancelled on the turbine as well as in the office.

11.4 Automatic Start

CAUTION: Motor generators cannot be transferred from one power source to another until they come to a full stop. Shut these down until load transfer has occurred then restart them on emergency power or on commercial power.

11.41 Simulate failure of commercial power by turning OPERATION SELECTOR Switch to AUTO LOAD TEST.

NOTE: Controlling will be done at a Remote Control Cabinet when this is furnished. Turn REMOTE OPERATION SELECTOR Switch to AUTO LOAD TEST while OSS on the turbine remains at AUTO.

11.42 POWER FAILURE lamp lights and the bell rings after SDT Timer times out. Depress BELL DISCONNECT Button to silence the bell.

11.43 The turbine starts cranking after SDT times out unless an exhaust valve control is furnished, in which case the valve must start to open before cranking begins.

11.44 The turbine cranks, lights off and accelerates to normal no-load speed. MUT starts when speed and voltage are normal. READY TO LOAD lamp lights after MUT times out and transfer of load to the turbine should occur at this time. READY TO LOAD lamp stays on after the transfer. After transfer PROPER OPERATION lamp lights.

11.45 After transfer occurs turn OPERATION SELECTOR Switch (or REMOTE OPERATION SELECTOR Switch) to AUTO. This simulates return to commercial ac by operating TR relay which releases SDT and SR relays. POWER FAILURE lamp goes out and the bell rings (for power return). Silence the bell with BELL DISCONNECT Button. READY TO LOAD lamp goes out.

11.46 If Automatic Restoration Circuit is furnished, RT (Run Timer) starts as soon as (REMOTE) OPERATION SELECTOR Switch is turned to AUTO. After RT of about 15 minutes HOT (Hold-Over Timer) starts. After HOT of 15 minutes transfer back to commercial power occurs. The turbine runs through CDT (Cool-Down Timer) of about 3 minutes and then shuts down.

11.47 If load transfer to commercial power is done on a manual basis, the operator depresses TRANSFER SWITCH RESTORE Button. After transfer the operator should allow the turbine to run about 3 minutes at no-load before shutting down by turning OPERATION SELECTOR Switch to OFF.

11.5 Remote Start Test

11.51 If this circuit is furnished ground terminal T204 by whatever method is provided.

11.52 Observe that the set starts, with SDT, and runs through the sequence of events shown in Paragraph 11.4.

12. MAINTENANCE DURING INSTALLATION

12.1 Before Starting

12.11 Check the turbine over carefully for fuel oil and lube oil leaks and correct as necessary.

NOTE: If the fuel system is opened for removal of any component or line, or the tank runs dry, the system must be purged to eliminate trapped air in accordance with Paragraph 6.2.

12.12 Check oil level in the lube oil reservoir and add oil, as necessary, to bring level on the dipstick to the FULL mark.

12.2 Running

12.21 The turbine must be operated for a minimum of 30 minutes at least once-a-month. This run may be at no-load because the turbine may be run under no-load conditions without causing additional maintenance.

12.22 The turbine must be operated for one hour under load at least once very three months. The load should be 300 KW or greater.

12.3 During Running

12.31 Check for unusual vibration or noise.

12.32 Observe acceleration time to see that it is not excessive, which would mean that the compressor requires washing.

12.33 Check for signs of unusual operating conditions, both electrical and mechanical.

12.4 Weekly Checks

12.41 Check electrolyte level in the starting batteries and add water, as necessary, to keep level near the high level mark.

12.42 Measure starting battery voltage with a good dc voltmeter, such as the ITE-4474. Voltage should be within the following range:

Lead-Acid:	25.9-26.1 Volts
Nickel-Cadmium:	26.9-27-1 Volts

13. GENERAL TROUBLES

13.1 The Installer is not expected to correct other than minor troubles such as loose and broken wires, loose fuel connections and loose lube oil connections.

13.2 Troubles and corrective measures are listed in the manual with the turbine. The majority of these are the supplier's responsibility and, as such will be corrected by the representative when he visits the job to align the coupling and observe the initial start.

13.3 Troubles and corrective measures are also listed in BSP 155-201-301 for a manual set and in BSP 155-202-301 for an automatic set.

14. OVERVOLTAGE SHUTDOWN - ADD-ON OPTION

14.1 When the overvoltage feature is specified by the operating company for manual or automatic sets, mount and wire the CV-5 relay and the indicator lamp. The overvoltage feature is furnished as an "ZG" apparatus and wiring option and is shown as Figure 33 on SD-81687-01, SD-81688-01, SD-81689-01 and SD-81690-01. The time dial on the overvoltage relay should be set at 1.

14.2 The shutdown feature shall be tested at 105%, 115% and $\geq$130% of alternator output voltage.

14.3 Start the set manually and raise the voltage of the alternator output to 105% of the nominal voltage, e.g., 208V times 1.05 equals 218.4 volts, by turning the voltage adjust potentiometer on the front of control panel usually marked "alternator voltage". At this voltage, the set continues to function indefinitely and does not shut down.

14.4 With the voltage adjust potentiometer, elevate the voltage to 115% and note that the indicating lamp lights in 3 or more seconds after reaching the 115% value. The alternator circuit breaker will then shunt trip if previously closed to the EI bus and the set will shut down. Return the voltage adjust potentiometer to a lower setting.

14.5 Remove the lead or leads from one side of the "voltage adjust rheostat". Wire a single pole single throw switch in series with the potentiometer and the previously connected lead or leads. Use 14 gauge wire and extend this temporary switch and leads external to the control panel so the panel may be closed. Insulate the splice. Verify that the switch is closed.

14.6 Start the set and adjust the potentiometer to nominal voltage. Open the switch and observe that the voltage rises and the set shuts down. The indicating lamp will light in a maximum of 2 seconds. The unregulated alternator voltage will rise to or exceed 130% of nominal. This voltage is a function of the surge characteristic of the set and need not be measured.

14.7 Disconnect temporary switch and wiring and reconnect original wires to "Voltage Adjust Rheostat" VAR.

Reason for Reissue:
1. Add paragraph 2.19.
2. Replace paragraph 4.21.
3. Add paragraph 14.

Manager, Product Engineering