EMERGENCY DIESEL GENERATOR PRIME MOVER
CATERPILLAR D-3408TA

GENERAL INFORMATION

The T/V KINGS POINTER has an automatic starting (upon 20% loss of ship' service power) emergency generator that is directly coupled to a Caterpillar D3408TA diesel. The emergency diesel develops 450 horsepower at 1800 rpm. The engine and generator are mounted on a common base located in the Emergency Switchboard and Generator Room (01-9-0)

The D3408TA is complete with the following:

- AirCleaner
- Crankcase Vent Emission Filter
- Fuel Oil Primer
- Dip Stick Oil Level indicator
- Crankcase Relief Valves
- Manual Shutoff Control
- Radiator and Fan
- Fuel and Lube Oil Fitters
- Speed Governing System
- Marine Oil Pan
- Battery Starter
- Turbocharger
- Muffler
- Gauge board

The Woodward PSG (Pressure compensated Simple Governor) governor installed on the diesel engine is a hydraulic speed governor with buffer type compensation. Unless the engine is overloaded the governor maintains the same speed regardless of load, except momentarily at the time load change occurs. The governor is equipped with an electric motor to provide remote speed control from the Emergency Switchboard Control Panel. Positioning the speed control switch in the up position increases the speed (generator output frequency) and positioning the switch down decreases the speed. The speed adjustment operates independent of the generator output, therefore movement of the switch, while the emergency switchboard is being energized via the 450 volt ship's service switchboard, will cause the electric motor to reposition the speed adjustment screw on the governor. This will not be evident until the emergency generator is started. If the remote speed control is inadvertently adjusted to its maximum speed the diesel may overspeed upon start-up causing a shutdown. Attention to this will prevent the emergency diesel from overspeeding and shutting down during loss of ship's service power.
Some ships of the T-AGOS class are equipped with Woodward 2301 electronic governors.

EMERGENCY GENERATOR

GENERAL INFORMATION

KATO Engineering Reliance Electric manufactures the brushless revolving field synchronous alternating current emergency generator. It is a 250 KW, 450 VAC, 3-phase, 60 Hertz, 0.8 lagging power factor, 400 Amp, self-ventilated air cooled, 1800 RPM, 95°C rise above 50°C ambient, air-cooled. The generator is directly coupled to a Caterpillar D3408TA diesel engine. Generator and diesel engine are mounted on a common base.

A brushless exciter is used to provide the excitation current to the rotating field assembly. The brushless exciter is, in effect, a refinement of the conventional direct connected exciters which use brushes and commutators. The extensive brush rigging and sliding contacts are eliminated on the brushless assembly. Thus, parts subject to wear are eliminated and prolonged period of dependable, trouble free operation is assured. The exciter consists of two basic component assemblies: the rotating exciter armature and a rotating rectifier bridge assembly..

The exciter armature and rotating rectifier bridge assembly is sleeve mounted on the shaft of the synchronous generator. Three-phase exciter armature windings are wound on the exciter armature core. The rotating rectifier assembly consists of a full wave rectifier bridge made up of six semi-conductor devices mounted on aluminum heat sinks. Should a failure of a rectifier occur, the defective rectifier can be easily replaced in the heat sink. However, a failure of the "avalanche" type rectifier used in the rotating rectifier bridge should rarely occur, as this type will conduct without damage to the rectifier during transient voltage conditions. Heavy insulating rings separate the negative and positive components of the full wave rectifier bridge.

A high frequency exciter field assembly is used. Coil windings are wound in the insulated semi-closed slots. A heavy removable sheet metal cover protects the entire exciter assembly.

During operation of brushless revolving field generators, the three-phase power generated in the exciter armature is applied directly to the rotating rectifier assembly. The forward polarity rectifiers mounted on one heat sink and the reverse polarity rectifiers on the other heat sink are connected to form a three-phase, full wave rectifier bridge. The rotating rectifier bridge assembly rectifies the alternating current supplied by the exciter armature. The direct current output of the rotating rectifier bridge assembly is in turn applied to the rotating field of the generator via lead wires routed through a key-way shaped slot on the rotor shaft. Thus, the exciter armature, rotating rectifier bridge and the generator field form a single rotating assembly which eliminates the need of the sliding contacts associated with brush type rotating DC exciters.

Excitation current for the stationary field coils is normally supplied by the synchronous generator through an automatic voltage regulator.

The generator is designed with a self-contained cooling system which circulates coolant air through the machine. Ambient air is drawn into the machine through louvered openings at the exciter end of the machine by a large capacity fan attached to the generator shaft. The warm air is exhausted to atmosphere through the screened opening enclosing the blower assembly. Also, the bearing housing has a grease fill port and drain port.

A permanent magnet generator (PMG) is installed on generator. It delivers 120 volts, single phase AC to terminals (1) and (2) of the Auto-Manual module.

The PMG is basically a revolving field single-phase AC generator. Its distinctive feature is the use of permanent magnets Instead of electromagnets to provide the magnetic field. (As in a conventional AC generator, voltage is induced in the stationary armature when the magnetic field is rotated inside of it.)

The PMG stator is part of the exciter field assembly. The stator consists of armature windings in a laminated core which is welded to a steel frame.

The permanent magnets and soft pole tips of the revolving field are permanently attached to a steel hub by non-magnetic stainless steel bolts. The field is magnetized after the rotor is assembled and the permanent magnet material has been permanently secured in place in the magnetic circuit.

The PMG requires no other current source to initiate its own build-up. It will develop its rated output voltage, provided it is driven at its rated speed.

The PMG provides a voltage source that is independent of the terminal voltage of its associated generator. Full power will be available to the voltage regulator. Therefore the exciter, even during heavy transients caused by motor starting or during short circuit conditions.

The PMG delivers rated AC voltage to the voltage regulator via the Auto-Manual module. The power supplied by the voltage regulator energizes the exciter field. Therefore, the PMG acts as a pilot exciter.

The emergency generator utilizes a:

- BASLER ELECTRIC COMPANY Electronic Voltage Regulator
- KATO Volts-per-Hertz Sensing Module
- KATO Auto-Manual Module (Generator Excitation Control)
- KATO Pilot Exciter (Permanent Magnet Generators)
- SIMPLEX Automatic Engine Starting Control System
- Switchboard and Control Panel
- Woodward PSG Governor (Pressure Compensated Simple)

OPERATION

REQUISITE REQUIREMENT FOR AUTOMATIC EMERGENCY DIESEL GENERATOR OPERATION AT DIESEL ENGINE

At the Generator:

- Ensure the area around the emergency GENERATOR is CLEAN. Good housekeeping practices should become a daily habit.
- Ensure COOLANT LEVEL in the radiator is ADEQUATE.
- Ensure the emergency diesel FUEL OIL service tank is FULL.
- Ensure the FUEL OIL system is LINED-UP for operation.
- Ensure the AIR SUPPLY is ADEQUATE.
- Ensure that the AIR SHUTOFF SOLENOID VALVE is latched OPEN.
- Ensure JACKET WATER HEATERS are ON (EP-110-9).

At the Simplex Auto/Start Panel:

- Ensure the ENGINE CONTROL SWITCH is in AUTO.

At 120 VAC section of EDG switchboard:

- Ensure Circuit Breaker 3L (EP110•4) emergency generator start battery charger is CLOSED.
- Verify the blue SHIP'S SERVICE SWBD BUS TIE breaker lamp is ILLUMINATED.

At 450 VAC EDG Switchboard:

- Ensure MODE SELECTOR SWITCH "43" is positioned to AUTO.
- Ensure the VOLT REG MAN/AUTO SWITCH is positioned to' AUTO.
- Verify the white NORMAL POWER AVAILABLE lamp is ILLUMINATED.
- Verify the amber "52ECS" lamp is ILLUMINATED. (Gen Bkr Open).

- Verify the amber MODE SELECTOR SWITCH "43" lamp is ILLUMINATED. (SWBD in Auto)

NORMAL OPERATION

With the above requisites met, the emergency generator will automatically start and supply power to the emergency switchboard and emergency loads when the ship's service power drops below 85% rated voltage.

When ship's service normal power has been restored, emergency power and ship's service power must be manually transferred as follows:

- Verify NORMAL POWER AVAILABLE lamp is ILLUMINATED.
- Position "52ECS" BREAKER CONTROL to TRIP.
- Verify the amber "52ECS" lamp is ILLUMINATED.
- At the Emergency Switchboard position the SHIP SERVICE SWBD BUS TIE breaker (52N) to CLOSE.
- Verify the blue SHIP SERVICE SWBD BUS TIE breaker lamp, is ILLUMINATED.
- Position the selector switch "43" to OFF.
- SHUTDOWN diesel ENGINE.
- PERFORM REQUISITE REQUIREMENTS for automatic emergency diesel generator operation.

MAINTENANCE

450 VOLT EMERGENCY GENERATOR INSULATION RESTISTANCE MEASUREMENTS

OBJECTIVE : Establish a procedures for taking insulation resistance test measurements of the emergency 450 volt generator stator and field exciter windings.

TOOLS AND EQUIPMENT: 500 volt megger, AC/DC Volt Ohmeter, 40°C insulation resistance correction factor chart.

GENERAL INFORMATION AND INSTRUCTIONS:

Duration of application of an insulation resistance test potential should be one minute with readings taken at the end of the one minute test. A correction factor must be used to bring readings to a 40°C value (see Section III Appendix A). Insulation resistance readings should be permanently recorded for future trend analysis.

READ THIS BEFORE PROCEEDING

PRECAUTIONS:

Observe all normal safety precautions associated with electrical and mechanical equipment.

WARNING

Disconnect load lines and all controls from generator stator leads before testing generator windings.

Disconnect all power from the emergency switchboard to ensure safety of personnel performing this operation.

OPERATION STEPS	**KEY POINTS**
1. Verify emergency switchboard is de-energized at the 450 volt ship service switchboard and will remain de=energized during this operation.	Check that EDG is not set up for AUTO start up prior to securing power to the emergency switchboard.
2. At the emergency switchboard control section, disconnect leads E1 and E3 at the Volts to Hertz module and remove fuses FQ, FR and FS.	Disconnects control devices from the generator stator windings.
3. At the back of the emergency switchboard generator breaker compartment, verify zero volts on the breaker line bus bars.	Ensures no electrical shock hazard exists.
4. Connect megger leads to test generator stator windings to hull ground at 500 volts.	

5. Record readings after one minute of megger potential application.	Megger readings will usually start low and then increase during the one minute period.
6. Record generator winding temperature at the time the insulation resistance test is performed. -	This information is used in converting the megger readings to 40°C.
7. Reconnect leads removed from Volts to Hertz module and replace fuses FQ, FR and FS.	Ensure leads are connected to the same terminals they were removed from.
8. At the emergency switchboard control section, remove leads at EUTB terminals 9 and 10 cable marked FLD5.	Disconnects control devices from the generator field excitation windings.
9. Connect megger leads to test the generator field excitation windings to hull ground at 500 volts.	
10. Record readings after one minute of megger potential application.	Megger readings will usually start low and then increase during the one minute period.
11. Record generator winding temperature at the time of insulation resistance test is performed.	This information is used in converting the megger readings to 40°C.
12. Reconnect leads removed from EUTB terminals 9 and 10.	Ensure leads are connected to the same terminals they were removed from.
13. At the emergency switchboard control section, remove leads at EUTB terminals 11 and 12, cable marked REG 5.	Disconnects control devices from the generators perma nent magnet generator stator windings.
14. Record readings after one minute of megger potential application.	Megger readings will usually start low and then increase during the one minute period.
15. Record generator winding temperature at the time the insulation resistance test is performed.	This information is used in converting the megger readings to 40°C.

16. Reconnect leads removed from EUTB terminals 11 and 12. Ensure leads are connected to the same terminals they were removed from.

17. Utilizing megger readings and temperatures originally obtained and the 40°C insulation resistance correction factor chart, calculate and record readings for future trend analysis (see Section III Appendix A).

TESTING GENERATOR POWER RECTIFIER DIODES

1. To prevent misleading test results, the diode under test should be completely disconnected.

2. Determine if the diode under test is a "standard" or "reverse" diode by looking at the symbol printed on the diode.

   a. "Standard" diode - the threaded part is the CATHODE and the lead is the ANODE.

   b. "Reverse" diode - the threaded part is the ANODE and the lead is the CATHODE.

3. Connect the positive (+) lead of an ohmmeter to the ANODE of the diode.

4. Connect the negative (-) lead of an ohmmeter on the CATHODE of the diode.

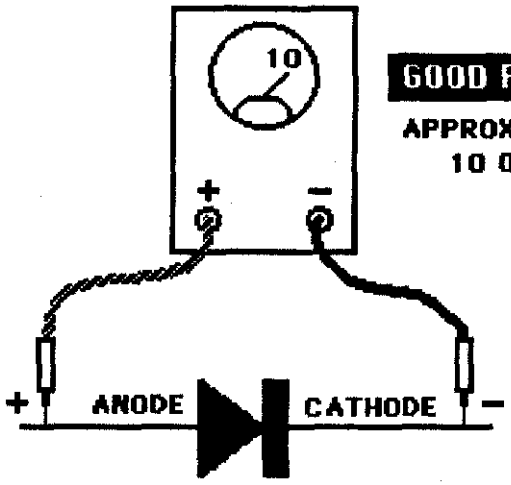
   The ohmmeter should indicate a LOW resistance (forward biased). Typical is about 10 ohms (good).

5. Reverse the ohmmeter lead on the diode.

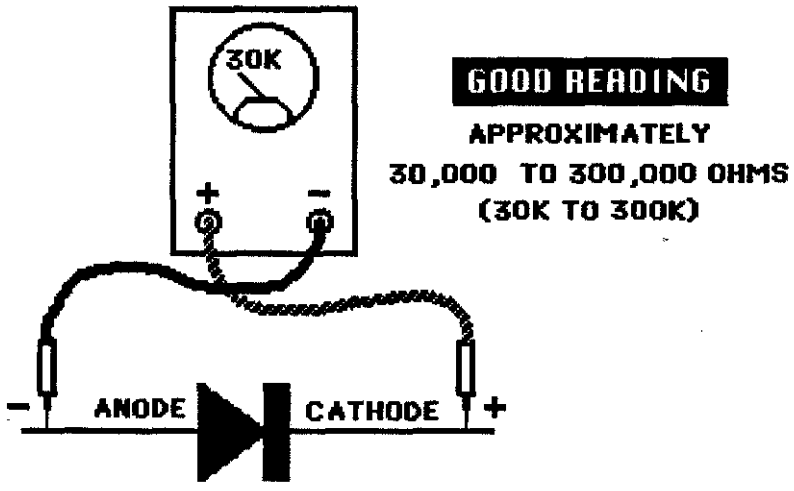
   The ohmmeter should indicate a HIGH resistance (reverse biased). Typical is about 30,000 to 300,000 ohms (good).

   An ohmmeter indication of "infinity" in both directions indicates an OPEN (bad).

   An ohmmeter indication of "zero" in both directions indicates an ANODE to CATHODE short (bad).



(FORWARD BIASED)



(REVERSE BIASED)

TESTING A DIODE RECTIFIER

SIMPLEX AUTOMATIC ENGINE STARTING CONTROL SYSTEM

GENERAL INFORMATION

The Simplex Automatic Engine Control is used to automatically start and stop a diesel engine upon closure and opening of control contacts. The automatic engine control also provides automatic engine protection (shutdown) and visual annunciation upon failure of the engine to function properly in the following areas:

- overcrank
- low oil pressure
- overspeed
- high water temperature
- Activation of the Halon Fire Fighting System

The engine control switch (ECS) is used to determine the mode of operation:

- "Off/Reset" - used to deactivate or reset the auto-start unit
- "Auto" - used for remote starting of the engine
- "Run/Test" position is used for local operation to start the engine or for test purposes.

Normal engine shutdown occurs by placing the engine control switch (ECS) in the "Off/Reset" position. The engine will automatically shut down under any one or more of the fault conditions as designated above, along with a light indication of which particular fault occurred. After the fault is corrected, the engine control switch (ECS) must be momentarily placed in the "Off/Reset" position.

DETAILED INFORMATION

Upon receipt of a start signal, by placing the engine control switch in the "Run/Test" position, or closure of the remote start contact (RSC) when the engine control switch is in the "Automatic" position, a positive signal is detected at Pin 'A' of the automatic start relay (ASR). ASR energizes and its contact 8-5 closes, arming the crank disconnect relay (CDR). ASR contact 7-1 opens, de-energizing the exhaust solenoid valve (VE) and ASR contact 7-4 closes, arming the shutdown relay (SDR).

In the same time interval the Crank Timer (CT) is activated by a positive signal on CR Pin #1. A positive signal can be detected at CT Pin #2, which energizes the start relay (SR). With SR energized, a positive signal is detected at SR contact 704, which activates the motor starter (MS). SR contact 8-2 opens to disconnect the battery charger during cranking attempts. The CT module will provide (6) cranking attempts for which the crank and rest time intervals are adjustable for a period from 10 to 25 seconds. If after (6) cranking attempts (there would be (5) rest periods in a (6) crank

attempt) the engine fails to start, a positive signal is detected at CT Pin #3, which energizes the Overcrank Relay (OCR) and halts any further cranking attempts until the engine control switch (ECS) is momentarily placed in the "Off/Reset" position.

In the other condition where the engine starts crank disconnect occurs with the closure of the crank terminator contacts on engine speed switch, thus energizing the crank disconnect relay (CDR). The CDR energized, its contact 7-1 opens disconnecting CT module and SR from the starting circuit. CDR contact 8-5 closes reconnecting the battery charger (BC) to the circuit. CDR contact 7-4 closes initiating the time delay on the oil delay relay (ODR) through the solid state oil relay timer (OTD). The purpose of ODT and ODR is to provide a signal sensing delay on low oil pressure (pre-alarm and shut) in order for the diesel engine to have time to build up oil pressure. The ODT time delay period lasts for approximately (20) seconds. With the time out of ODT, ODR energizes and its contact 7-1 and 8-2 open arming the low oil pressure relays to sense for loss of oil pressure. Note that LOPR, OSR, HFFR, LOPRPA and HWIRPA relays are energized under normal operation and normal shutdown. A failure occurs when one of the normally closed engine switches opens or there is a wire breakage between the engine switches and the autostart.

Shutdown due to engine failure occurs in the following manner: the overspeed to failure will be used as an example, but the sequence of operation is the same for other shutdown failures.

Upon an overspeed condition the engine Overspeed Switch (OSS) will open. The normally energized Overspeed Relay (OSR) will de-energize with the removal of the positive signal which was being supplied by the engine OSS. OSR contact 7-4 will open locking out the OSS input, at the same instant OSR contact 8-2 will close, activating the overspeed indicating light and energizing the engine failure relay (EFR). EFR contact 701 will open de-energizing the ASR relay. ASR contact 7-1 will close providing a positive shutdown signal through the SDR contact 7-4 to the rack solenoid (RS). Note that the Re-crank Delay Relay (RDR) is also energized by ASR contact 7-1 closing and RDR contact 7-1 opens the starting circuit assuring that there cannot be any starting attempt while the Shutdown Relay (SDR) is energized. The time period for which the SDR relay is energized is initiated by the closure of ASR contact 7-1 in series with the closed SDR contact 7-4 feeding the Time Delay (TD) component. Upon TD timing out; approximately 20 seconds after ASR contact 7-1 closes, the reset shutdown relay (RSDR) is energized. RSDR contact 7-1 will open re-energizing the SDR relay causing SDR contact 7-4 to open; thus removing the positive signal output to the rack solenoid. Power is also removed through opening SDR contact 7-4 to the RDR relay and RDR contact 7-1 will close partially arming the starting circuit again. Note that EFR contact 7-1 is locked open; thus the start circuit is locked out, though RDR contact 7-1 has closed. The engine is now shut down and the engine control switch (ECS) must be momentarily placed in the "Off/Reset" position, which resets the OSR relay to its energized state and de-energizes the EFR relay causing EFR contact 7-1 to close. Once the engine control switch has been placed in the "Off/Reset" position and the engine fault cleared, the engine ready to run by moving the engine

control switch back to the "Automatic" position. The engine will start by moving the engine control switch back to the "Test/Run" position.

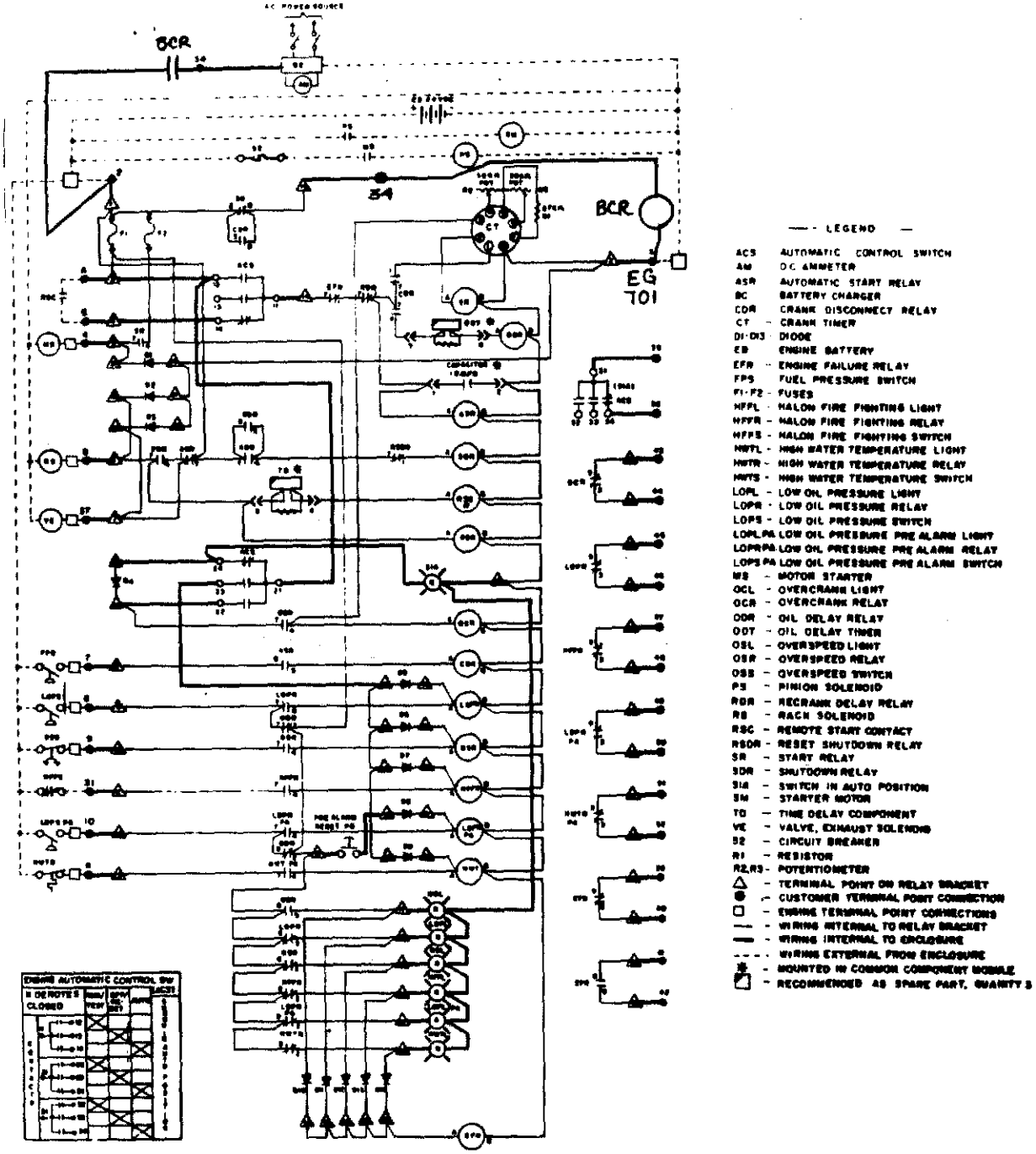
Under normal shutdown, the same sequence occurs for ASR, SDR, RSDR, and RDR, except the EFR relay remains in a de-energized state.

Diodes D1, D2 and D3 are "fly back" diodes provided to suppress the counter EMF of the Motor Starter (MS), Rack Ssolenoid (RS) and the Exhaust Valve (EV).

Diode D4 through D14 are provided for logic control.

OPERATION

The Engine Control Switch (ECS) is positioned to "AUTO". This is a requisite requirement for placing the Emergency Generator System to automatic (see chapter 20). When the ECS is in auto a yellow status lamp above switch "43" on the emergency generator control panel will be illuminated.


BCR
54
BCR
EG
701
— LEGEND —
ACS AUTOMATIC CONTROL SWITCH
AM DC AMMETER
ASR AUTOMATIC START RELAY
BC BATTERY CHARGER
CDR CRANK DISCONNECT RELAY
CT - CRANK TIMER
D1-D13 DIODE
EB ENGINE BATTERY
EFR - ENGINE FAILURE RELAY
FPS FUEL PRESSURE SWITCH
F1-F2 - FUSES
HFFL - HALON FIRE FIGHTING LIGHT
HFFR - HALON FIRE FIGHTING RELAY
HFFS - HALON FIRE FIGHTING SWITCH
HWTL - HIGH WATER TEMPERATURE LIGHT
HWTR - HIGH WATER TEMPERATURE RELAY
HWTS - HIGH WATER TEMPERATURE SWITCH
LOPL - LOW OIL PRESSURE LIGHT
LOPR - LOW OIL PRESSURE RELAY
LOPS - LOW OIL PRESSURE SWITCH
LOPL PA LOW OIL PRESSURE PRE ALARM LIGHT
LOPR PA LOW OIL PRESSURE PRE ALARM RELAY
LOPS PA LOW OIL PRESSURE PRE ALARM SWITCH
MS - MOTOR STARTER
OCL - OVERCRANK LIGHT
OCR - OVERCRANK RELAY
ODR - OIL DELAY RELAY
ODT - OIL DELAY TIMER
OSL - OVERSPEED LIGHT
OSR - OVERSPEED RELAY
OSS - OVERSPEED SWITCH
PS - PINION SOLENOID
RDR - RECRANK DELAY RELAY
RS - RACK SOLENOID
RSC - REMOTE START CONTACT
RSDR - RESET SHUTDOWN RELAY
SR - START RELAY
SDR - SHUTDOWN RELAY
SIA - SWITCH IN AUTO POSITION
SM - STARTER MOTOR
TD - TIME DELAY COMPONENT
VE - VALVE, EXHAUST SOLENOID
52 - CIRCUIT BREAKER
R1 - RESISTOR
R2,R3 - POTENTIOMETER
△ - TERMINAL POINT ON RELAY BRACKET
● - CUSTOMER TERMINAL POINT CONNECTION
□ - ENGINE TERMINAL POINT CONNECTIONS
— - WIRING INTERNAL TO RELAY BRACKET
— - WIRING INTERNAL TO ENCLOSURE
- - - - WIRING EXTERNAL FROM ENCLOSURE
- MOUNTED IN COMMON COMPONENT MODULE
- RECOMMENDED AS SPARE PART, QUANTITY 3