UNITED STATES MARINE CORPS
Utilities Instruction Company
Marine Corps Engineer School
PSC Box 20069
Camp Lejeune, North Carolina 28542-0069

U-08G01
NOV 99

STUDENT HANDOUT

TQG SCHEMATICS

1. **LEARNING OBJECTIVES**:

a. **Terminal Learning Objective:** Given a schematic, a faulty generator set electrical system, and applicable tools and test equipment, with the aid of references, repair the generator set electrical system so that it functions properly in accordance with the appropriate equipment technical manual. (1142.1.1)

b. **Enabling Learning Objectives:**

(1) Given a list of Tactical Quiet Generator components and a list of functions, identify the correct function in accordance with TM-09249A/09246A-10/1. (1142.01.03cw)

(2) Given a list of Tactical Quiet Generator Set components and an excerpt from the Technical Manual, identify the steps for testing the component in accordance with TM-09249A/09246A-10/1. (1142.01.03cx)

(3) Given a wiring diagram and a schematic diagram, identify the difference between a wiring diagram and a schematic diagram in accordance with TM-09249A/09246A-10/1. (1142.01.03cy)

(4) Given a schematic diagram of a Tactical Quiet Generator Set, identify the correct description of each primary DC circuit in accordance with TM-09249A/09246A-10/1. (1142.01.03cz)

(5) Given a list of Tactical Quiet Generator Set safety circuits, identify the correct description of each safety circuit in accordance with TM-09249A/09246A-10/1. (1142.01.03da)

(6) Given a list of Tactical Quiet Generator Set safety circuits, identify the correct description of each AC circuit that is controlled by DC, in accordance with TM-09249A/09246A-10/1. (1142.01.03db)

(7) Given a schematic diagram of a Tactical Quiet Generator Set, identify the correct description of each primary AC circuit in accordance with TM-09249A/09246A-10/1. (1142.01.03dc)

(8) Given a schematic diagram of a Tactical Quiet Generator Set, identify the correct description of each governor control circuit in accordance with TM-09249A/09246A-10/1. (1142.01.03dd)

(9) Given a description of a Tactical Quiet Generator Set components, identify the components that can be adjusted in accordance with TM-09249A/09246A-10/1. (1142.01.03de)

1. **THE ELECTRICAL/MECHANICAL COMPONENTS OF THE MEP-805A**

a. Control Cubicle: This is a compartment located directly behind the control panel. This assembly is located directly above the generator housing behind the panel door. Located within the cubicle are these items:

(1) A-1 (AC Voltage Regulator): A-1 is a solid state device, that receives an input signal from current transformers T1 and CT5 that is directly proportional to the actual load current. It then sends an output signal to the frequency switch, S12, and then thru the voltage adjust potentiometer, R1, and back to the voltage regulator where the DC voltage of the exciter is controlled.

(2) A-2 (Malfunction Indicator): A-2 is a solid state device, that receives DC potential from the various protective switches and relays and illuminates LED lamps to indicate which fault occurred first. If multiple faults occur simultaneously, only one lamp will illuminate to indicate only one fault occurred.

(3) A-3 (Kilowatt Transducer): A-3 is a solid state device, that receives AC input from CT1, CT2, and CT3. The Kilowatt Transducer converts the AC input into DC, and provides DC to M9, the Kilowatt Meter.

(4) A-4 (Load Measuring Unit): A-4 is a solid state device, that receives an AC signal from T7, T8, and T9, of the main generator. Additionally, the A4 receives an AC signal proportional to the load from current transformers CT1, CT2, and CT3. This reactive current signal is then felt at A3, and provides the S6, Ammeter/Voltmeter selector switch, with a potential for M8, the AC Ammeter.

(5) A-5 (Electronic Governor Control): A-5 is a non-repairable solid state device that works in conjunction with the MPU, Magnetic Pickup Unit, and A-6, the Electronic Governor Actuator. The A5 also houses the S13 Over-speed switch, and S14, the Starter Disconnect switch.

(6) A-7 (Frequency Transducer): A-7 is a solid state device that receives an AC signal from T7 (L1) and to (L0). It then converts this into DC and provides M2, the Frequency Meter, with DC that is directly proportional to the frequency of the generators output.

(7) A-8 (Resistor Assembly): A-8 is a circuit board containing various diodes and resistors that are used throughout the generators electrical system. R6-R9, the Synchronization Light Dropping Resistors; R10-R12, the Load Measuring Unit Burden Resistors; R14, the Field Flash Resistor; and R15, the LED Resistor. A8 also contains CR1- CR4 diodes.

(8) CB1 (DC Control Power Circuit Breaker): This circuit breaker protects the DC circuits from a short circuit condition, it is rated at 7.5 amperes. CB1 receives its 24 vdc potential from the S10, thru the CR1, and the S17.

(9) CB3 (Ground Fault Circuit Interrupter): CB3 provides 120 VAC to J1, the Convenience Receptacle. In the event a ground fault should occur at J1, CB3 will de-energize J1 on both the hot and neutral phases.

(10) CBGND (Control Box Ground): CBGND provides the control box housing with DC negative potential.

(11) CPGND (Control Panel Ground): CPGND provides the control panel with DC negative potential.

(12) CR1 (Reverse Battery Diode): CR1 is located inside the control panel and is mounted on the A8. CR1 protects the DC circuits from a reverse bias condition (someone connecting the batteries backwards).

(13) CR2 (Field Flash Diode): CR2 is connected in series with R14, and protects the field windings in the generator in the event a reverse bias condition occurs.

(14) CR3-CR7 (Blocking Diode): CR3-CR7 are connected throughout the DC circuits to provide protection from reverse bias.

(15) CR6 (Suppressing Diode): CR6 is utilized to protect L5, the Fuel Solenoid, in the event a short circuit or reverse bias condition occurs, the diode will prevent a possible fire or explosion.

(16) DS1, DS2, and DS3 (Panel Lights): These 24 vdc lights are used to illuminate the control panel at night so the operator can monitor the different indicators. They are controlled by S2.

(17) DS4 and DS5 (Synchronization Lamps): DS4 and DS5 are used during paralleling to ensure the generator set to be paralleled have the proper phase to phase relationship. DS4 and DS5 receive AC from S11 when this switch is in the Parallel position.

(18) DS6 (Battle Short Light): DS6 illuminates when S7, the Battle Short Switch, is activated. DS6 terminal 1 receives its positive DC potential from terminal 9 of TB6. The DS6 receives two negative potentials. The first is terminal 2 of the DS6, when the S7 is activated, and the second is terminal 3 of DS6, when DS6 is in the press to test position.

(19) DS7 (AC Circuit Interrupter Light): DS7 illuminates when S5, the AC Circuit Interrupter Switch, is activated, indicating that K1 is activated, supplying AC to the load terminals. DS7 terminal 1 receives its positive DC potential from terminal 9 of TB6. DS7 receives two negative potentials. The first is terminal 2 of DS7 when K1's normally open contacts 11 and 12 close, and the second is terminal 3 of DS7 when DS7 is in the press to test position.

(20) FU1 (Battery Charger Fuse): FU1 is rated at 30 amps, and protects the Battery Charging Alternator, MT4, and M4 in the Battery Charging Circuits.

(21) J1 (Convenience Receptacle): J1 provides a simple duplex outlet for use with low amperage equipment such as a drop light or a solder gun. It is just like a receptacle in your home rated at 120VAC, 15 amps.

(22) J2 (Parallel Receptacle): J2 provides the generator set with a Receptacle for the parallel cable allowing two generator sets to be run in parallel and double the KW output or provide for uninterrupted AC power while performing generator maintenance. The J2 provides each generator in parallel, the AC potential felt at the A1 of each set thru J2 terminals C and D. It also provides DC potential to be felt at pins A and B from the A5, so each generator’s speed can be monitored.

(23) J3 (Diagnostic Receptacle): J3 provides the generator technician with a multi-pin plug that is wired to specific points in the generator set electrical system to enable monitoring and troubleshooting of the generator set operation at a central location. During troubleshooting this plug can eliminate many of the circuits as possible causes for the malfunction. It will not take the place of actually troubleshooting each component as you will be required to do. The following is a chart which can be

used to check voltages at various points. Note, this chart is corrected from the one in your TM:

PIN	DESCRIPTION	EXPECTED OUTPUT*
B	AC to chassis ground (GND)	Continuity 0 volts
C	DC Parallel voltage for A5 synch.	0-20VDC
D	DC ground	Continuity 0 volts
E	AC Parallel voltage to A1	0-20VAC set frequency
F	DC exciter field voltage (+)	0-60VDC
G	DC Parallel voltage for A5 synch.	0-20VDC
H	AC Parallel voltage to A1	0-20VAC set frequency
J	DC exciter field voltage (-)	0-60VDC
M	DC voltage input to A5	24 vdc
N	DC starter L4 coil	24 vdc W/S1 in Start
O	DC volts to E1(fuel tank below 1/2)	24 vdc w/S1 Aux Prime
S	DC voltage to L5	24 vdc
T	DC voltage to K2 coil	24 vdc w/S1/S10Start
U	DC volt. w/CB1 energized, S10 Norm	24 vdc
V	DC volt. to TB5-14,15 & 20 (K1,K17)	24 vdc
X	DC voltage to B1	24 vdc w/S1/S10Start
Z	DC voltage to FL1(fuel tank empty)	24 vdc
a	DC volts from OP (oil press below 15psi)	24 vdc
b	DC voltage OP & HT	24 vdc
c	DC voltage to L6 w/ S9 on S1 Start	24 vdc
d	DC voltage from G2	24 vdc
x	AC voltage to A5 from MPU	2-3VAC
y	AC voltage to A5 from MPU	2-3VAC

(24) K5 (Over/Under Voltage Relay): The K5 receives an AC input from the main generator to monitor for an Over and Under voltage condition. An under voltage condition occurs at two different shutdown points. The first is at 99 VAC with a two second time delay. The second is at 48 VAC which will activate instantly. An Over voltage condition occurs at 153 VAC +/-3 volts.

(25) K8 (Overload/Short Circuit Relay): The K8 receives an AC input from the current transformers to monitor overload and short circuit conditions. An overload condition occurs when the load current exceeds 110% on any one phase. A short circuit condition occurs when the output current exceeds 425% on any one phase.

(26) K9 (Reverse Power Relay): The K9 receives an AC input from A4 via the load sharing rheostat, when in parallel operation. A reverse power condition occurs when power flow into the generator exceeds 20%.

(27) K10 (Permissive Paralleling Relay): K10 is the relay which allows 2 generator sets to be connected in parallel. The sensor of K10 receives AC from the S11 when it is in the Parallel

position. The K10 has one set of normally closed contacts (terminals 7 and 8) which when opened, will interrupt the ground potential at the coil of K1 and K17, (only when the S5 is held closed), which will prevent the load from being contacted. Terminals 3 and 4 of the K10 provide a DC operating potential. Anytime the two generators to be paralleled are not in sync with one another the NC contacts (terminals 7 and 8) will open. Basically, if the synchronization lights are on, the K10 NC contacts are open.

(28) K11 (Voltage Sensing Relay): K11 has two sets of normally open contacts connected in parallel with R6 and R8, (AC Schematic), the Synchronization Lights Dropping Resistors. Once the G1 is turning, and the magnetic field has been created, the G1 produces AC voltage. This voltage energizes the coil of K11 and closes the normally open contacts terminals 1 & 3, and 8 & 6 of K11. Once these contacts close and the load has been contacted, the S11 switch must be placed in the parallel position in order for the DS4 and DS5 to illuminate. Once this has been accomplished, the operator may then see the phase to phase relationship of the generator sets.

(29) K12 (Engine Fault Relay): K12 uses three sets of normally closed contacts, and one set of normally open contacts. The first set of normally closed contacts (terminals 3 and 9) are connected in series with the K13 and K14. All 3 of these relays provide the positive potential for all the fault indicators on the A2 via TB5, terminal 7. The next set of normally closed contacts of K12, terminals 2 and 8 provide L5, the Fuel Solenoid Valve, with 24 vdc potential during normal operation. The last set of normally closed contacts (terminals 1 and 7) provide ground potential for the coil of K15 thru the S7 switch. Finally, the normally open contacts (terminals 5 and 8) maintain 24 vdc positive potential to the coil of K12 after an engine fault has occurred and the generator has shut down. The coil of K12 receives its positive potential from either the normally open contacts terminals 5 and 8 as discussed before, or from the A2 when a Low Oil pressure, High Coolant temperature, Over speed, No Fuel, or Over voltage fault occurs.

(30) K13 (Electrical Fault Relay): K13 uses two sets of normally closed contacts. The first set of normally closed contacts, terminals 3 and 9, are connected in series with K12 and K14. These contacts provide positive potential to the A2 for all fault indicators on the A2 via TB5, terminal 7. The second set of normally closed contacts (terminals 1 and 7) provide negative potential to the holding contacts of the K1 and K17. The coil for K13 receives its positive potential from the A2 thru the S7 when a Short Circuit, Under Voltage, Reverse Power, or Overload fault occurs.

(31) K14 (Over-speed Relay): K14 uses two sets of normally open contacts and one set of normally closed contacts. The first set of normally open contacts, terminals 6 and 9, provide potential to A2 illuminating the Over-speed Indicator Lamp. The next set of normally open contacts, terminals 4 and 7, provide the coil of K14 with ground potential after over speed has occurred. The last set of normally closed contacts, terminals 2 and 8, are connected in series with K12 and K13. These contacts provide positive potential to the A2 for all fault indicators on the A2 via TB5, terminal 7.

(32) K15 (Start Relay): K15 uses three sets of normally open and one set of normally closed contacts. The first set of normally open contacts, (terminals 6 and 9), provide the exciter windings of G1 with negative potential during field flash. The next set of normally open contacts, (terminals 4 and 7), provide the exciter windings of G1 with positive potential during field flash. The last set of normally open contacts, (terminals 5 and 8), provide the coil of K2 with positive potential to energize. The only set of normally closed contacts, (terminals 7 and 1), of K15 provide the coil of K16, the Starter Disconnect Relay, with positive potential, when the S1 switch is in the Prime and Run or Aux Prime and Run position, (after field flash). The coil of K15 receives its positive potential from the S1 terminal 7 (Start position). K15 receives its negative potential through the normally closed contacts, (terminals 1 and 7), of K12 and through the S7, (terminals 7 and 8), when the S7 is in the off position.

(33) K16 (Crank Disconnect Relay): The main purpose of K16 is to keep the Oil Pressure and Under Voltage shut down devices from activating.

(34) K17 (K1 Auxiliary Relay): K17 enables the on-coming generator to establish the voltage and speed of the generator already on line.

(35) K19 (Fuel Level Relay): The coil of K19 energizes when the FL1 contacts close. This occurs when the fuel level in the tank will allow approximately 4 min. of operating time. Note, on the schematic the contacts of FL1 are shown with the fuel tank empty.

(36) K21 (Governor Control Power): K21 uses three sets of normally open contacts. When the S1 is in the Start position, the coil of K21 receives 24 vdc potential from terminal 7 of the S1 and energizes. Once the S1 is placed back in the Prime and Run or Aux Prime and Run position, the coil of K21 receives 24 vdc potential from the normally open contacts of K21, terminals 6 and 9. These contacts provide the L5 with 24 vdc potential during normal operating procedures. Contacts 6 and 9 of the K21 receive 24 vdc potential from the normally closed contacts, terminals 2 and 8 of K12 from TB4 terminal 12. The next set of normally open contacts, terminals 5 and 8 provide A5 terminal 3 with 24 vdc potential from the M4 terminal 4. The last set of normally open

contacts, (terminals 4 and 7), provide ground potential for the coil of K14 during an over speed condition.

(37) M1 (AC Voltmeter): The M1 indicates the AC voltage from phase to neutral **or** phase to phase.

(38) M2 (Frequency Meter): The M2 indicates the frequency output of the main generator.

(39) M3 (Time Meter): The M3 indicates the amount of time the generator set has operated. This meter reading is used for PM purposes.

(40) M4 (Battery Charging Ammeter): The M4 indicates the Charging or Discharging of the G2.

(41) M5 (Fuel Level Indicator): The M5 indicates the amount of fuel in the generator fuel tank.

(42) M6 (Coolant Temperature Indicator): The M6 indicates the temperature of the engine coolant.

(43) M7 (Oil Pressure Indicator): The M7 indicates the engine oil pressure.

(44) M8 (AC Ammeter): The M8 indicates the amount of AC output current of the load from phase to neutral only.

(45) M9 (Kilowatt Meter): The M9 indicates the percent of Power or Watt output to the generator load.

(46) MT4 (Battery Charging Ammeter Shunt): The MT4 is a resistor with low resistance that allows most of the battery charging current (has low resistance) to pass through it and allow only a small portion to pass through the M4. **Always remember when working on the MT4 or M4, DISCONNECT THE NEGATIVE LEAD OF THE BATTERY.**

(47) P4 (Plug Malfunction Indicator): P4 connects the A2 to the various components.

(48) R1 (Voltage Adjust Potentiometer): R1 is a variable resistor that enables the operator to increase or decrease the AC output voltage of the generator set.

(49) R2 (Frequency Adjust Potentiometer): R2 is a variable resistor that enables the operator to increase or decrease the frequency output of the generator set.

(50) R4 (Load Sharing Rheostat): R4 is a variable resistor that enables the operator to increase or decrease the load

sharing ability of the generator set while in paralleling operations.

(51) R5 (KVA Sharing Rheostat or Reactive Current Rheostat): R5 is a variable resistor that enables the operator to increase or decrease the generators ability to react to sudden changes in current caused by inductive loads such as motors or large transformers while the generator set is in parallel.

(52) R6-R9 (Synchronization Lights Dropping Resistors): These resistors limit current to the synchronization lights.

(53) R10-R12 (Burden Resistors): R10-R12 are resistors that are used to protect the M8, (AC ammeter).

(54) R14 (Field Flash Resistor): R14 is connected in series with the field flash circuits and F1 of the G1 exciter windings. It provides a voltage drop to the exciter during field flash, (S1 in Start, engine speed above 900 rpms), and this provides protection to the exciter.

(55) R15 (LED Resistor): R15 is connected in series with DS6 and DS7. The R15 creates a voltage drop which protects the LED's (Light Emitting Diodes) of DS6 and DS7.

(56) R16 (Voltage Adjust Resistor or Frequency Selector Switch Resistor): R16 is connected to S12, Frequency Selector Switch. It provides the S12 with a predetermined amount of resistance when the generator is running in the 60 Hz mode. The R16 is only used on 50/60 Hz models.

(57) S1 (Master Switch): The S1 is the start-run-stop switch. It is a four position switch. The first position is off, the second position is Prime and Run Aux Fuel, the third position is the Prime and Run position, and the fourth position is Start.

(58) S2 (Panel Light Switch): S2 is a two position switch that enables the operator to illuminate the control panel while working at night.

(59) S5 (AC Circuit Interrupter Switch): S5 is a three position switch that enables the operator to contact and disconnect the load.

(60) S6 (AM/VM Transfer Switch): S6 is a six position switch that allows the operator to measure current and voltage from different phases.

(61) S7 (Battle Short Switch): S7 is a two position switch. The S7 provides the operator with the means to override all protection devices except for the overload, short circuit, and over speed devices.

(62) S9 (Ether Start Assist Switch): S9 is a two position switch. The S9 enables the operator during cold weather starting, to inject ether into to the intake manifold of the engine as a starting aid.

(63) S11 (Unit-Parallel Switch): S11 is a two position switch. The S11 enables the operator to operate the generator in single unit or parallel operation with another generator of the same model and type.

(64) S12 (Frequency Selector Switch): S12 is a two position switch. The S12 enables the operator to select 50 or 60 Hz operation.

(65)S13 (Over speed Switch): S13 is a switch that is located inside the A5. The S13 will provide ground potential for the coil of K14, causing it to energize and shut down the generator set.

(66) S14 (Crank Disconnect Switch): S14 is a switch located inside the A5. The S14 has 2 sets of contacts, one normally open and one normally closed. It allows the A2 to monitor low oil pressure and under voltage conditions.

(67) S16 (Over-speed Reset Switch): S16 is a two position switch. The S16 enables the operator to reset the S13 after an over speed condition has occurred (2200 +/- 40 rpm).

(68) S17 (Emergency Stop Switch): S17 is a two position switch. The S17 enables the operator to open the DC circuits in emergency situations, this will cause the generator to shut down.

b. Engine Compartment: This compartment houses the engine. In addition, the engine compartment also houses the following components:

(1) A-6 (Electronic Governor Actuator): A-6 is a electromagnetic solenoid. The plunger of the actuator is connected to the fuel injection pump. This causes the fuel injection pump lever to allow more or less fuel into the engine.

(2) A-9 (Float Switch Module): A-9 is a solid state device which prevents inadvertent engine shutdown due to refueling by providing a one second time delay after the FL1 contacts have closed.

(3) B-1 (Cranking Motor): B-1 is the starter which is utilized to start the engine.

(4) BT1-BT2 (12 Volt Batteries): BT1-BT2 are two 12 VDC batteries that are connected in series to provide the generator

with 24 VDC. When the batteries are connected properly, the generator frame has negative potential.

(5) E1 (Auxiliary Fuel Pump): E1 is an electric fuel pump utilized to refill the generator fuel tank when the Auxiliary fuel line is connected to a fuel source such as a 55 gal. drum.

(6) FL1 (Low Fuel Level Float Switch): FL1 is a switch located in the fuel tank it has normally closed contacts (fuel tank empty). In the event that the generator is out of fuel, the contacts of FL1 will close and provide the K19 with the ground potential to energize.

(7) FL2 (Auxiliary Fuel Pump Float Switch): FL2 is located in the fuel tank, and has normally closed contacts, (fuel tank empty). These contacts close when the generator fuel tank level, is below one half empty.

(8) G2 (Battery Charging Alternator): G2 is an alternator (rated at 42 amps @ 24 VDC). It recharges the 24 VDC storage batteries with up to 30 amps during operation.

(9) HT (High Coolant Temperature Switch): HT is a switch with normally open contacts. During high engine coolant condition, above 225 °F +/- 5 ° F, the contacts in the HT close and illuminate the High Coolant Temperature Lamp on the A2.

(10) L4 (Starter Solenoid): The L4 has one set of normally open contacts. When the coil of L4 is energized, it engages the starter into the flywheel of the engine.

(11) L5 (Fuel Solenoid Valve): The L5, when energized, allows fuel to enter the fuel injection pump.

(12) L6 (Ether Start solenoid): The L6 receives its 24 vdc potential from the S9 in the on position. The S9 receives its 24 vdc potential when the S1 is in the Start position. The L6 should only be used if ambient temperatures are below -40 °.

(13) MPU (Magnetic Pickup): The MPU monitors the engine speed which in turns sends an AC signal to the A5.

(14) MT5 (Fuel Level Sender): The MT5 is a variable resistor that controls the ground potential for the M5.

(15) MT6 (Coolant Temperature Sender): The MT6 is a variable resistor that controls the ground potential for the M6.

(16) MT7 (Oil Pressure Sender): The MT7 is a variable resistor that controls the ground potential for the M7.

(17) OP (Low Oil Pressure Switch): OP is a switch that is normally closed, (engine not running). When the engine oil pressure is above 15psi +/- 3psi the contacts will open. If engine oil pressure falls below 15psi +/- 3psi the contacts of the OP will close.

(18) SR1 (Slave Receptacle): SR1 is a NATO type receptacle enabling the operator to slave-off another piece of equipment's 24 VDC batteries in the event that the equipment's batteries discharge.

(19) S10 (Dead Crank Switch): S10 is a three position switch. The first position is Normal, the second position is off, and the third position is spring loaded and is called the Dead Crank position. The S10 enables the technician to crank the engine without activating the generator run circuits.

c. Output Box Compartment: This compartment houses specific generator electrical components. This compartment contains the following:

(1) C1-C3 (EMI Capacitors): C1-C3 are used for noise suppression and are connected to the rear side of TB1.

(2) CT1-CT3 (Current Transformers): CT1-CT3 measure current output from G1, the Main Generator. CT1-CT3 provide this AC signal to the A3, A4, and the K8.

(3) CT5 (Droop Current Transformer): CT5 measures any changes in current from G1. This signal is used by the A1 and makes paralleling 2 generator sets possible.

(4) J16 (Switch Box Receptacle): J16 is a Receptacle that connects to J1 and is energized by CB3. The Marine Corps does not use this kit.

(5) K1 (AC Circuit Interrupter): K1 is a relay that energizes when S5 is activated. With the K1 contacts closed, this provides TB2, the Load Output Terminal Board, with AC voltage.

(6) K2 (Cranking Relay): K2 provides the L4, the Starter Solenoid with 24 VDC potential to engage the B1 and start the engine.

(7) TB1 (Voltage Reconnection Terminal Board): TB1 enables the operator to select high (240/416 VAC) or low (120/208 VAC) "Y" configuration. TB1 is connected to the terminals of G1, and provides the operator with a convenient means to reconnect the windings of G1.

(8) T1 (Potential Transformer): T1 supplies the A1 with an AC signal from the main generator. The AC signal to the A1 allows it to sense any changes in voltage of the G1.

d. Load Terminal Access Compartment: This compartment houses the following components:

(1) A10-A13 (EMI Filters): A10-A13 are capacitors which are mounted on the back side of TB2, Load Output Terminal Board. A10-A13 are used to filter interference (voltage spikes) which could damage radio equipment utilizing the generator as a power supply. They are connected in series from the load terminals to the ground plate and to GND.

(2) G1 (AC Generator): G1 is a revolving field type generator having a DC field revolving within a stationary AC winding called the stator. AC power is distributed from the generator through leads connected to the stator windings.

(3) GND (Ground): GND is noted throughout the schematic. Remember, you must always have a complete circuit, (both a positive and a negative potential), in order for a circuit to operate as it was intended.

(4) TB2 (Load Output Terminal Board): TB2 enables the operator to connect various loads to the generator. On TB2 are terminals LO, L1, L2, L3, and GND (Ground). A fusible link (ground plane bracket), connects LO to GND.

(5) V1-V4 (Varistor AC Load Lines): V1-V4 are connected in series with L1, L2, L3, and LO to ground. V1-V4 will discharge to ground when the K1 is de-energized. This discharging to ground will prevent the operator from being shocked while disconnecting or reconnecting a load to TB2.

2. TESTING COMPONENTS

a. If we were issued an ERO to replace the MT4 and found that it had already been removed, how would we find out which wires went where?

b. Using the wiring diagram on this page will identify each component by designator, wire, and terminal number.

c. If the wire numbers are not visible, we can look at the destination of the wire located next to the wire number and underlined. For example, terminal 1 of the MT4 is wire 163A. This wire is connected to TB4, terminal 1 and has a white grounding shield around it.

NOTE: These grounding shields have been omitted from your schematic for clarity; however, these are very important! Without these grounding shields interference will destroy the sensitive components in the governor control circuits.

d. In testing the frequency meter, (2-28-2), we see that we must first test the frequency transducer.

e. You will be required to use some common sense with these manuals, and by submitting NAVMC 10772's, we can get the changes entered into these TM's. When you get to the fleet and you find something wrong in the TM, see your pubs NCO or SNCOIC and they can submit the change.

3. **Electrical Schematics and Wiring Diagrams**

a. An electrical schematic shows the relationship and sequence of all the controls and components in the equipment.

b. A wiring diagram will show individual components with points of origin and destination points along with wire numbers.

c. On this page of the TM we can see the DC and AC electrical schematic for the 30kw TQG's. We will be discussing the DC schematic and wiring diagrams.

d. We must realize that there are several parallel and series circuits throughout the generators circuits. In addition, we must understand that these components are connected together to perform a certain task, and while we may be able to modify a circuit to work a certain way, we must take into consideration how it will effect other components.

e. Let's look at the S1 terminal 7 on our electrical schematic in the TM. First, we note there is no wire number on this wire. There are rarely wire numbers listed on electrical schematics. Now look at your wiring diagram S1 terminal 7. You can see that wire 190A is connected to this terminal. From the S1 this wire goes to TB6 terminal 8. On the Electrical schematic we do not see to what terminal board this wire connects. Again terminals of any kind are rarely listed on electrical schematics.

f. In our TM we see that the first dot we come to has one wire connected to pin P of J3. By looking at the wiring diagram we can see that at S1 terminal 7, wire 190A goes to TB6-8. We must also take into consideration the reference designators for components and where each terminal is connected. Additionally, we must concern ourselves with the state of these components, such as normally open or closed contacts. Finally, we must be able to identify the parallel, series, and compound circuits.

4. **OPERATION OF PRIMARY DC CIRCUITS**

a. (+) Battery Potential (RED)

(1) The first potential that will be covered is battery potential. This is the positive potential before the S10 switch (terminal 2). This potential starts from the positive terminal of BT1, and since BT2 is connected in series this will be 24 vdc potential. From this terminal it goes directly to SR1 positive terminal, this allows the generator to be slaved off even if there are no batteries in the generator set. Caution must be taken because this will mean the wire that used to be connected to BT1 could short to ground causing an electrical fire and severe damage to the generators wiring. From SR1 this potential goes to L4 terminal 1.

(2) From there it branches off to K2 terminal A1, and to MT4 terminal 4. From the K2 terminal A1 this potential stops, we will discuss later in this period of instruction where it goes. From the MT4 terminal 4 it branches off to terminal 8 of the K21 via wire 165G. At MT4 terminal 4, this potential is felt across terminal 3 to M4 (-) terminal. From MT4 (+) to terminal 2 of MT4 to terminal 1 of MT4 to TB4 terminal 1. At TB4 this potential branches off in two directions.

(3) The first wire, 163B goes to FU1 terminal 1, and as long as the 30 amp fuse is serviceable, through FU1 to terminal 2 of FU1. This potential then goes to TB4 terminal 2 and branches off. Wire 164B goes to J3 pin "d" and enables you to check for 24 vdc potential after the FU1 without opening the control panel. From TB4 terminal 2 the potential goes to G2 "Pos" and is jumped to G2 "S" where it ends.

(4) The other wire, 163C, goes to S10 terminal 2 and stops (S10 Off).

(5) This red circuit potential isn't protected by the CB1, so it is very important that you are careful around these circuits. When working on red/green circuits you must disconnect the batteries **remembering always to disconnect the negative lead first!** Failure to do so could result in serious electrical burns to you or to the equipment.

b. S10-Dead Crank position (YELLOW)

(1) When S10 is in the On position it enables the operator to crank the engine without the possibility of the engine starting. When S10 is On, terminal 2 (red circuit) makes contact with terminal 1 of the S10. This causes positive potential to be felt at the coil of K2 terminal X1, energizing the K2.

(2) Next, the normally open contacts of K2 (terminals A1 and A2) close. Since A1 has 24 vdc potential (red circuit) this potential flows across the NO contacts of K2 and provide the coil of L4 with 24 vdc (red circuit).

(3) Once the coil of L4 energizes, the plunger of L4 engages the B1 starter gear into the flywheel and closes the NO contacts of L4.

(4) When these contacts close, terminal 1 of the L4 provide 24 vdc potential (red circuit) to B1 causing the starter to turn the engine over.

c. <u>S10 in Normal position</u> (GREEN)

(1) When S10 is in the normal position, terminal 2 of the S10, (red circuit), makes contact with terminal 3 of the S10. From here the positive potential can be felt through wire 178A & J6 pin 8.

(2) From J6 pin 8 this potential can be felt through wire 178B to TB4, terminal 6. From there the potential can be felt through wire 178C to terminal 1 of CR1. The CR1 protects the DC circuitry in the event the batteries are connected incorrectly.

(3) From the CR1, terminal 2, the potential can be felt through wire 162A to terminal 1 of S17. Remember there should be continuity across terminals 1 and 2 when the S17 is out (normal position).

(4) At terminal 2 of the S17, the potential can be felt through wire 207A to terminal 2 of the CB1, and if CB1 is energized, the potential will be felt through CB1 to terminal 1, to wire 180A.

(5) After terminal 1 of CB1, wire 180A goes to TB5 terminals 1 and 2, (Grand Central Positive I). This potential can be felt via wire 180G and J3 pin U.

(6) At TB5 terminal 2, wire 180F provides 24 vdc potential for the S2 switch, terminal 2.

(7) At TB5 terminal 1, wire 180E provides 24 vdc potential for the A2 plug 4 pin 4 with Press to Test voltage.

(8) Also at TB5, terminal 1, wire 180B provides the coil of K14 with positive potential; however, this relay will not energize until it receives its negative potential from K21’s normally open contacts at terminals 4 and 7, through the S13 to CBGND.

(9) From TB5, terminal 1, wire 180C provides the normally open contacts, (terminals 6 and 9), of K14 with positive potential for the A2 when an over speed condition occurs.

(10) The last wire, 180D provides the S1 with positive potential at terminal 3 of S1.

d. <u>S1 in Start Position</u> (engine rpms less than 900)(BROWN)

(1) When S1 is in the Start position, the positive potential from terminal 3 will be felt at terminals 4,6,8, and 7. All of these terminals have positive potential. For now terminal 7 of S1 is the only terminal we will discuss.

(2) At terminal 7 of S1, positive potential (S1 in Start position) can be felt at TB6 terminal 8 via wire 190A. At TB6 terminal 8, this terminal provides positive potential for S9 terminal 1 via wire 190D. It should be noted that this is why the S9 will not operate without the S1 in the Start position. The next wire where this potential can be felt is wire 190B. The wire 190B provides the K15 coil with 24 vdc positive potential to energize the K2. This circuit will be discussed later. This potential can be checked through J3 pin P via wire 190E. The last wire connected to TB6, terminal 8 is wire 190C. Wire 190C is connected to terminal 1 of CR4,through CR4 to terminal 2, where wire 185B is connected.

(3) Wire 185B is connected to TB5, terminals 14 and 15 which are jumped to TB5 terminal 20 via wire 185E, (Grand Central Positive II). This potential can be checked at J3 pin V via wire 185H. This positive potential then energizes the coil of K21 via wire 185A, and closes the normally open contacts 6 and 9, and 5 and 8 of the K21. At the contacts 6 and 9, draw a line across these contacts. At this point, we will only color code wire 185F to terminal 19 of the A5 and wire 185H to J3 pin V; however, keep in mind that when S1 is in the Start position that all these wires have positive potential from terminal 7 of the S1, via wire 190C.

(4) Contacts 5 an 8 of K21 provide A5 with 24 vdc at terminal 3; this potential comes from the red/green circuit via wire 151A, and **<u>this potential is critical to the operation of A5.</u>**

(5) At terminal 19 of A5, this positive potential will be felt across the normally open contacts of S14 to terminal 18 of A5. This potential will exit A5 via wire 160A to the normally open contacts, terminals 5 and 8. Since K15 is energized, (engine speed below 900 rpms and S1 is in the Start position), this potential will be felt across these contacts via wire 167C to TB5 terminal 5. This potential can be checked at J3 pin T via wire 167E. The last wire at TB5 terminal 5 is wire 167D, which connects to plug 6 pin 21. From J6 pin 21, wire 167B connects to the coil of K2 terminal X1 energizing K2.

(6) With K2 energized, the normally open contacts, terminals A1 and A2, close and allow positive potential, (red circuit), to be felt across its contacts. This potential can be checked at J3 pin N via wire 166B through J6 pin 22 to wire 166C. From the K2 terminal A2, the positive potential (red circuit) goes to the coil of L4 via wire 166A and energizes the coil of L4 and engages the starter into the flywheel. With the coil of L4 energized, the positive potential (red circuit), from terminal 1 of L4 is felt across the normally open contacts of the L4 and provides 24 vdc, (red circuit), for B1 which will cause the engine to turn over.

(7) Once the engine has started and engine speed increases to 900rpms, the S14 contacts between terminals 19 and 18 of A5 open. At the same time this occurs, the contacts between 19 and 20 of A5 close, (field flash). This condition causes the positive potential felt on wire 160A to stop, making it impossible for the normally open contacts of K15, terminals 8 and 5, (which are still closed), to provide 24 vdc to energize the coil of K2 and engage the starter.

d. S1 Start Position (Engine speed above 900rmps) (ORANGE)

(1) This circuit will be explained from terminal 19 of the A5. Inside A5 from terminal 19, across the normally open contacts 19 and 20 of S14, (which are closed when engine speed is over 900rpms) to terminal 20 of A5. From A5 terminal 20, this potential can be felt at terminal 7 of K15 via wire 127A. At terminal 7 of K15 the potential will be felt across the normally open contacts, 7 and 4, (K15 is still energized), via wire 234A to terminal 1 of R14. The potential will then have a voltage drop across the R14, out terminal 2 of R14 to terminal 1 of CR2, to terminal 2 of CR2 to TB4 terminal 16 via wire 141E. This potential can be checked at J3, pin F via wire 141B. At TB4 terminal 16, this potential branches off to A1, terminal 1 via wire 141A. The last wire, 141C, goes to J5, pin 29 and changes to wire 141D and connects to TB8, terminal 2. From TB8, terminal 2, wire F1 connects positive field flash potential to G1. This will only occur after engine speed is over 900rpms, **and** S1 is in the Start position.

(2) Starting from TB6, terminal 4, (Grand Central Negative II), via wire 100W, to the normally open contacts of K15, terminals 6 and 9, (K15 energized, these contacts will be closed). Ground potential will be felt through these contacts to TB4, terminal 13 via wire 140F. From there it branches off to terminal 3 of A1 and to J5, pin 28 via wire 140C to 140D to TB8, terminal 1. There it goes to wire F2 of the G1. This potential can be checked at J3 pin J.

e. S1 Prime and Run position (BLUE)

(1) After the generator oil pressure has reached 15 psi, voltage has increased to the rated amount, and the engine has reached a stable operating speed; the operator should release S1 to the Prime and Run position, de-energizing the K15. Once this has occurred, the DC circuits are still energized from TB5 terminal 1, via wire 180D (red circuit), to S1 terminal 3, through terminal 3 to terminal 8, out wire 129B to Grand Central Positive I, then through the normally closed contacts, terminals 2 and 8 of K12, and to Grand Central Positive II via wire 225H.

(2) Terminal 19 of A5 still receives its potential from Grand Central Positive II via wire 185F.

(3) Potential is felt across the closed contacts of S14 and to terminal 20 of A5 via wire 127A. Wire 127A then allows this potential to be felt at the normally closed contacts of terminal 7 and 1 of K15, (K15 is de-energized), and through these contacts and out wire 128A. This potential is then felt through the normally closed contacts, terminals 2 and 8, of K16 then out to the coil of K16 via wire 249A. This causes K16 to energize and close the normally open contacts, terminals 5 and 8, of K16 to keep K16's coil energized.

(4) This allows K16 to be energized by Grand Central Positive III via wires 129H and 129U. At the same time, the potential from A5, terminal 20 is felt through the normally closed contacts of K15, terminals 7 and 1, to terminal 2 of K16 (since these contacts are open), to wire 128B, through CR5 to wire 249B and out wire 249A to ensure K16 remains energized.

(5) The two sets of normally open contacts of K16 that we have not discussed play a big part in the start-up, and they are contacts 6 & 9, and 7 & 4. The first set are normally open contacts, terminals 4 and 7 of K16. This relay keeps the generator from shutting down due to low oil pressure during start-up. After the generator speed exceeds 900 rpms, and S1 is in the Prime and Run position, these contacts will close and allow A2 to monitor the oil pressure. The last set of normally open contacts of K16, terminals 6 and 9, prevent the generator from dropping the load in an under voltage condition during start-up. Once the generator speed is above 900 rpms and S1 is in the Prime and Run position, these contacts will close and allow A2 to monitor the voltage. The generator will operate without a K16; however, if low oil pressure occurs, the generator will not shut-down,or drop the load if an under voltage condition occurs.

f. Negative Potential with S5 Energized (PURPLE)

(1) The ground potential controls most of the relays in the TQG's. K1 and K17 relays are prime examples. You should have

noticed that once Grand Central Positive II receives positive potential, that the coils of K1 and K17 also receive positive potential but do not energize. This is because the negative potential for the coils of K1 and K17 is interrupted by S5.

(2) Since we know that we control the negative coil potential with K1, we will start from K1, negative terminal Y. The wire connected to the negative side of K1's coil is 240A. This wire connects to J5 pin 7 via wire 240B. From there, it connects to TB5 terminal 18. At TB5 there are three other wires. Wire 240C connects to the B, (-), terminal of K17. Wire 240E goes to CR3, terminal 1. From terminal 1 of the CR3, potential is felt through the diode to terminal 2 and connects to wire 242A. From wire 242A, it connects to terminal 2 of S5 which in the normal position makes contact with terminal 3 of S5 (K1 holding circuit). We will discuss this circuit later on. The last wire is 240D, which connects to terminal 5 of S5. Since S5 is in the normal position, terminal 5 makes contact with terminal 4, which ends this circuit for now. Now let's discuss wire 242A and its potential as it goes through S5 at terminal 3. This potential continues on via wire 199A to the normally closed contacts of K8 terminal 11 and 12. At terminal 12, it is connected to the normally closed contacts of K13, terminals 7 and 1 via wire 301A. At terminal 1 of K13 it is connected to TB5 terminal 3 via wire 105D. At TB5 terminal 3 one wire goes to DS7 to provide it with negative potential when K1 is energized via wire 105E. The other wire at TB5 continues to J5, pin 5 via wire 105B. From J5 it continues to K1, normally open contacts 12 and 11 via wire 105A, and since the coil of K1 is still not provided with negative potential, these contacts remain open. When these contacts do close, the negative potential will be provided by wire 100K to TB7, terminals 6 and 7 (Grand Central Negative I). Remember, this positive potential will be felt along the entire circuit as long as K8 and K13 are not energized.

(3) When S5 is in the closed position, terminal 5 makes contact with terminal 6. This will provide potential to be felt via wire 306A to the normally closed contacts terminals 8 and 7 of K10 to wire 100T to Grand Central Negative I. This enables the coil of K1 and K17 to energize. Once this has occurred, the normally open contacts of K1, terminals 12 and 11 will close and until the operator returns S5 to the Normal position, there will be an additional path for negative potential for K17 and K1.

(4) With S5 in the closed position terminals 2 and 3 are making contact; therefore, the negative potential for the coil of K17 at TB5, terminal 18 will go through CR3. The normally open contacts, terminals 12 and 11 of K1 provide the coil of K17 with negative potential that holds K1's contacts closed.

(5) Once the operator releases S5 to the Normal position, terminals 2 and 3 of S5 are still closed, but unlike before, K1's

normally open contacts, terminals 12 and 11 are closed and the coil of K17 will remain energized because the negative potential will be provided via wire 199A at terminal 3 of S5. This potential is still felt through the normally closed contacts of K8, K13, TB5, terminal 3, and the normally open contacts of K1, (which are closed). At TB5, terminal 3 this negative potential provides DS7, terminal 2 ground and the DS7 illuminates.

(6) Because of the wire junction at TB5, terminal 18, K1 will also remain energized until the ground potential via wire 199A at terminal 3 of S5 is interrupted.

(7) When S5 is in the open position, that is what happens. Terminals 2 and 3 of the S5 open and remove ground potential from K1 and K17. Once this occurs, the generator will drop the load.

(8) If while contacting the load, (S5 in closed position), the coil of K10 is energized, the normally closed contacts, terminals 8 and 7 will open and this will prevent K1 & K17 from being energized.

(9) After the load has been contacted and S5 is in the normal position, should a Short Circuit condition occur and the coil of K8 were to energize, then the normally closed contacts of K8 terminals 11 and 12 will open and the K17 and K1 will de-energize, and the load will drop.

(10) If the load has been contacted and S5 is in the Normal position, should **any** electrical fault energize the coil of K13, then the normally closed contacts of K13, terminals 7 and 1 will open and the K17 and K1 will de-energize, and the load will drop.

5. OPERATION OF SHUTDOWN CIRCUITS

a. Low Oil Pressure shutdown circuit.

(1) The first device we will talk about is the low oil pressure shutdown switch. It's reference designator is OP on the schematic. This device has one set of normally closed contacts. These contacts will open when oil pressure is above 15psi $\pm$ 3psi.

(2) The OP receives its positive potential from A2, P4 pin 3 to wire 202A. From this wire it connects to terminal 9 of the normally closed contacts of K12. This potential can be felt at terminal 3 of K12 and on to wire 212A to terminal 3 of K13’s normally closed contacts. Through the contacts terminal 9 of K13, and across to wire 305A, which connects to terminal 2 of K14 normally closed contacts. Then back through the contacts to terminal 8 of K14 where it connects to wire 168F which in turn connects to TB5 terminal 7. This potential can be checked at J3

pin b via wire 168E. At TB5, terminal 7, wire 168G provides potential for the rest of the shutdown circuits which we will discuss later. The last wire connected to TB5, terminal 7, is wire 168D which connects to J6, pin 5. From J6 the wire number changes to 168C and connects to TB7 terminal 5. At TB7 terminal 5, two wires branch off. The first wire goes to the HT via wire 168B and provides the HT with its 24 vdc potential. The other wire 168A connects to the OP and provides the 24 vdc through the normally closed contacts and wires 169A to J6, pin 20. From J6 it changes to wire 169B and connects to TB5 terminal 8. This potential can be checked by J3 pin a via wire 169D. From TB5, terminal 8, the last wire 169C connects to terminal 7 of K16’s normally open contacts. The reason the low oil pressure lamp on A2 does not illuminate during initial start-up is because K16 is not energized until after the generator speed is over 900rpms and S1 is in the Prime & Run position. Then if a low oil pressure condition occurs, K16’s normally open contacts 7 & 4, will close and provide potential to A2.

(3) As potential enters A2 via pin 1 of P4, the SCR will gate and illuminate the LED on A2. Next A2 sends a 24 vdc potential to pin 13 of P4 to terminal 4 of S7’s normally closed contacts, and through the switch to terminal 5.

(4) From there, through wire 221A to TB5, terminal 16. Wire 221C carries this potential to the coil of K12.

(5) After the coil of K12 has been energized, the normally closed contacts, terminals 2 and 8 of K12 remove the positive potential from Grand Central Positive II. This causes L5 to de-energize and shutdown the generator.

(6) At this time, the normally open contacts terminals 5 and 8 of K12 close and provide 24 vdc potential to keep the coil of K12 energized via wire 221D to TB5, terminal 16. This will ensure the low oil pressure lamp on A2 will stay illuminated after shut down has occurred. This is also the reason you must place S1 in the off position to de-energize K12 to re-set A2.

(7) With K12 energized, the normally closed contacts of K12, terminals 3 and 9 open. This causes positive potential normally going to TB5-7 to stop. This removes the potential for any fault that should happen after a low oil pressure condition has occurred. With TQG's, only the first fault will be displayed on A2.

b. High Coolant Temperature Shutdown Circuit.

(1) The HT is a switch that senses the engine coolant temperature. It has one set of normally open contacts.

(2) But when the engine coolant temperature reaches 225 ± 5o F the normally open contacts will close. Since the HT receives

its positive potential from TB7, terminal 5, just as the OP did, once the normally open contacts close, this potential is felt across the contacts to wire 223B and to J6 pin 6. From P6 pin 6 wire 223A goes to P4 pin 8 of A2, and this potential goes to the SCR which gates, and illuminates the LED of A2.

(3) This potential is then sent to P4 pin 13 of A2 which energizes K12 the same way as the OP did. The only difference is that the HT lamp on A2 will illuminate.

(4) Because there are no normally open contacts like the K16 contacts for the OP, once a high coolant condition occurs, if the generator is restarted, it will shut down. **It cannot be bypassed by the S7 in this situation. You must let the engine cool down first.**

c. Low Fuel Level Shutdown Circuit.

(1) The reference designator for the Low Fuel Level Relay is K19. This relay uses one set of normally open contacts. K19 works in conjunction with,(which controls the ground potential for K19), A2, and K12.

(2) The positive potential for K19 comes from Grand Central Positive I via wire 129J. As discussed before, this relay receives positive potential, but the ground potential for K19 is controlled by FL1 via wire 171A. This potential can be checked at J3 pin Z via wire 171C or at TB5, terminal 6. From TB5, terminal 6, potential can be felt on wire 171B to J6 pin 19. From J6, potential continues via wire 171D to J15, pin 3 of A9. This continues to J12, pin 3, to FL1. On your schematic the FL1 is shown normally closed, (when the fuel tank is empty). If the fuel tank is empty, FL1’s contacts will close and allow potential to flow across the contacts via wire D.

(3) From wire D potential can be felt to J12, pin 4 through A9 to J15, pin 4 via wire 100P to Grand Central Ground I. This condition will cause the coil of K19 to energize and cause the normally open contacts of K19, terminals 6 and 9 to close.

(4) This allows the potential at TB5, terminal 7 to be felt through the contacts of K19 via wire 220A to P4, pin 2 of A2. This allows the 24 vdc potential to gate the SCR in A2 and illuminate the Low Fuel lamp on A2.

(5) Next, A2 allows the same 24 vdc to P4, pin 13 of A2.

(6) This 24 vdc potential can be felt at terminal 4 and 5 of S7, and then continue on just as the OP and HT did.

d. Over-speed Shutdown Circuit.

(1) The reference designator for the over-speed switchis S13. S13 is located inside A5, and to date, if S13 fails, then A5 must be replaced. S13 has one set of normally open contacts that are connected in series between terminals 4 and 5 of A5. S13, in conjunction with the normally open contacts, terminals 7 and 4 of K21, control the ground potential for the coil of K14. The contacts of S13 will close at 2200 $\pm$ 40 rpms and provide K14 with ground potential for K14 to energize.

(2) At Grand Central Positive, TB5, terminals 1 and 2, wire 180B provides 24 vdc positive potential to terminal A of K14’s coil. The ground potential for K14 is connected via wire 233A to TB5, terminal 19. When the generator is running, the normally open contacts terminals 4 and 7 of K21 close. This provides a path for ground potential via wire 233B from TB5, terminal 19, through the contacts of K21 to wire 155A and terminal 5 of A5.

(3) When an over-speed condition occurs, the normally open contacts of S13 close. This provides a ground path from terminal 4 of A5 to CBGND via wire 100J. Once this has occurred the coil of K14 will energize. This will provide ground potential for the coil of K14 via wire 233C, through S16, terminals 2 and 3, to wire 126A, and through the normally open contacts, terminals 4 and 7 of K14 to Grand Central Ground I via wire 100U.

(4) At the same time this has occurred, the normally open contacts of K14, terminals 6 and 9 will close allowing 24 vdc potential from Grand Central Positive via wire 215A. From wire 215A to P4, pin 7 of A2, A2 is provided with 24 vdc potential to gate the SCR, and illuminate the over speed lamp on A2.

(5) A2 sends 24 vdc potential to K12 via pin 13 of P4, and this 24 vdc potential energizes the coil of K12 which shuts down the generator as described before.

(6) In order for the generator operator to restart the generator, they must interrupt the ground potential path to the coil of K14 using S16. When S16 is in the On position, terminals 2 and 3 of S16 open and K14 de-energizes, and the generator can be restarted.

(7) Even though this is how the wiring system is designed, over-speed **cannot** be bypassed. The A5 board is specially designed so that it will shut itself off in an over-speed situation.

e. Over/Under Voltage Shutdown Circuit.

(1) The reference designator for the Under/Over Voltage Relay is K5. K5 uses two sets of normally open contacts.

(2) The first set of contacts, terminals 2 and 3 of K5 provide A2 and K12 with 24 vdc. Should an Over-voltage condition occur, 153 $\pm$ 3 VAC, these contacts will close and provide A2 with 24 vdc potential via wire 203A to P4, pin 9 of A2. This will gate the SCR and illuminate the over-voltage lamp.

(3) This same 24 vdc potential will go to pin 13 of P4, across the normally closed contacts 4 and 5 of S7 to energize the coil of K12. Once this has occurred, the normally closed contacts terminals 2 and 8 of K12 will open, (K12 energized), which will de-energize L5 shutting down the generator just as the OP, and HT did.

(4) The next set of normally open contacts terminals 7 and 8 of K5 provide A2 with 24 vdc potential through the normally open contacts of K16, terminals 6 and 9 via wire 204A to P4, pin 10 and illuminates the under voltage lamp. These contacts will close instantaneously when generator output is 48VAC. If generator output is 99VAC these contacts will close after time delay, (approximately 2 seconds).

(5) When this occurs, the 24 vdc from TB5, terminal 7 will be felt across the normally open contacts, (which are now closed), terminals 7 and 8. From there it will be felt across the normally open contacts, (which are now closed), terminals 6 and 9 of K16 and into A2 via pin 10. This 24 vdc will gate the SCR and illuminate the Under-voltage lamp on A2.

(6) This same potential will then go to pin 16 of A2 and across terminals 1 and 2 of S7, and energizes the coil of K13. When K13 energizes, the normally closed contacts, terminals 1 and 7 of K13 open, and the generator will drop the load.

(7) The coil of K5, terminal 1 receives its AC hot phase from TB1, terminal 7. K5, terminal 6 receives its neutral from TB1, terminals 10, 11, 12, and 13.

f. Overload\Shortcircuit Shutdown Circuit.

(1) The reference designator for the Overload/Short Circuit relay is K8. K8 has two sets of normally open and one set of normally closed contacts.

(2) First, we will discuss the normally open set of contacts of K8 terminals 5 and 6. These contacts will close during an Overload condition, (generator load current in any phase exceeds 110% of rated value). Once these contacts close,

the positive potential from TB5, terminal 7 will be felt through these contacts via wire 168G to wire 209A. This wire is connected to pin 18 of P4 of A2. Inside A2, the SCR gates and sends 24 vdc potential to the Overload LED on A2 which illuminates.

(3) At the same time, 24 vdc potential is sent to pin 16 of P4 which supplies the coil of K13 with positive potential causing K13 to energize.

(4) This will cause the load to drop by opening the normally closed contacts, terminals 1 and 7 of K13. This removes the ground potential from K1 and K17. **An overload condition cannot be bypassed.**

(5) The second set of normally open contacts, terminals 9 and 10 are responsible for a Short Circuit condition,(output current in any phase exceeds 425% rated value), and when these normally open contacts close, they send 24 vdc from TB5, terminal 7, to pin 11 of P4. From there, this 24 vdc potential gates the SCR in the A2, which then illuminates the LED, Short Circuit lamp.

(6) This 24 vdc potential exits A2 via pin 16 and through the normally closed contacts, terminals 1 and 2, of S7 to energize the coil of K13. Once K13 is energized, the normally closed contacts terminals 1 and 7 of the K13 open. This ensures the load will be dropped. **A Short circuit condition cannot be by-passed by S7.**

(7) The last set of contacts are normally closed, contacts 11 and 12 of K8. Once a Short Circuit or overload condition occurs, these contacts will immediately open and remove ground potential from K1 and K17 causing the load to drop. This is why a Short Circuit or overload condition cannot be by-passed. Even if K13 never energizes, these contacts will open and remove the ground potential from K1 and K17 causing the load to drop. **The generator will stay running.**

g. Reverse Power Shutdown Circuit.

(1) The reference designator for the Reverse Power relay is K9. K9 has one set of normally open contacts.

(2) Terminals 3 & 4 of K9 provide 24vdc potential for K9.

(3) When a reverse power condition occurs during paralleling (when power flow, into the generator set exceeds 20% of rated current), the normally open contacts, terminals 5 and 6 of K9 will close. When this has occurred, these contacts will allow 24 vdc potential from TB5, terminal 7 to be felt at P4, pin 17 of A2. Inside A2, the SCR gates and will provide 24 vdc potential to the Reverse Power LED and illuminate it.

(4) At the same time, A2 will send 24 vdc potential to the coil of K13 to energize it's coil, causing the normally closed contacts, terminals 1 and 7 to open and drop the load.

6. **OPERATION OF PRIMARY AC CIRCUITS CONTROLLED BY DC**

a. DC + POTENTIAL TO THE FIELD WINDINGS (YELLOW)

When S1 is in the Start position and engine speed is above 900rpms, positive potential will be felt on CR2, terminal 1. This is the positive potential from the normally open contacts of K15, terminals 4 and 7, (K15 energized). From terminal 2 of CR2 this potential can be felt at TB4, terminal 16. Here it branches off to terminal 1 of A1 and to wire 141C to J5, pin 29 to TB8, terminal 2 to F1. This potential can be checked at J3 pin F.

b. DC - POTENTIAL TO THE FIELD WINDINGS (RED)

(1) This circuit is energized with S1 in the start position and the engine speed is above 900rpms. Starting from TB6, terminal 4, (Grand Central Negative II), via wire 100W, to the normally open contacts of K15, terminals 6 and 9, (K15 energized, these contacts will be closed). Ground potential will be felt through these contacts to TB4, terminal 13 via wire 140F. From there it branches off to terminal 3 of A1 and to J5, pin 28 via wire 140C to 140D to TB8, terminal 1. There it goes to wire F2 of the G1. This potential can be checked at J3 pin J.

(2) Turning to our AC schematic, these circuits are the same as explained on the DC schematic. Keep in mind that this is where the DC and AC schematics come together.

7. **OPERATION OF PRIMARY AC CIRCUITS**

a. THE NEUTRAL PHASE (PURPLE)

(1) The neutral phase starts at wire T0 of G1 and connects to terminal 10, which is jumped to 11, 12, and 13 of TB1. At terminal 11, wire 110B connects to TB7, terminal 9 were it ends. All the neutral wires are numbered in the 110 series followed by a letter.

(2) At terminal 12 there are two wires, 110C and 110D connect to J5, pins 10 and 11 respectively. From J5 these wires change to 110E, pin 10 and 110F, pin 11 and connect to TB4, terminals 14 and 15. At TB4 wire 110M connects to A7 where it ends.

(3) Also from TB4, wire 110N connects to terminal 6 of K5's coil, where it ends.

(4) Follow the dotted lines from TB4 up to another terminal marked TB4, terminals 14 and 15. These are only located here on this drawing, but on the generator these terminals are the same. Wire 110G connects to terminal 12 of S6 where it ends. The other wire 110H, connects to terminal 8 of A4. At A4 terminals 8, 9, and 10 are jumped together. From terminal 8 of A4, wire 110J connects to N1 of A3.

(5) From terminal 9 of A4, wire 110K connects to terminal N2 of A3. At terminal 10 of A4, wire 110L connects to N3 of A3.

(6) The last wire at TB4, terminals 14 and 15 is a white wire. This wire provides neutral for J1 and neutral for J16. Remember, J16 is not used by the Marine Corps.

(7) The last wire connected to TB1, terminal 13 is wire 110A. This is the wire that is connected to TB2 terminal LO.

b. CURRENT TRANSFORMERS (ORANGE)

(1) There are a total of four current transformers. The designators are CT1, CT2, CT3, and CT5. As current flows through T1 to T7, T2 to T8, T3, T9, CT1, CT2, and CT3 current is induced and a signal is produced. This signal is directly proportional to the load.

(2) From CT1, terminal A1, this signal can be felt to K8, terminal 1. At K8 this signal also is felt over on A4, terminal 4 and the burden resistors. At terminal A2 of CT1 this signal can be felt at terminal L1 of A3.

(3) From CT2, terminal B1, this signal can be felt at K8, terminal 2. At K8 this signal also is felt on A4 terminal 5 and the burden resistors. At terminal B2 of CT2 this signal can be felt at terminal L2 of A3.

(4) From CT3, terminal C1, this signal can be felt at K8, terminal 3. At K8 this signal also is felt on A4 terminal 6 and the burden resistors. At terminal C2 of CT3 this signal can be felt at terminal L3 of A3.

(5) During single unit operation, CT5 provides A1 with this load signal. This enables A1 to react to changes in current, such as a reactive load like a motor.

c. A3 TO S6 SWITCH (BLUE)

(1) At terminal S1 of A3, the signal from A3 is felt on wire 117A and connects to terminal 16 of S6.

(2) At terminal S2 of A3, the signal from A3 is felt on wire 118A and connects to terminal 20 of S6.

(3) At terminal S3 of A3, the signal from A3 is felt on wire 119A and connects to terminal 24 of S6.

d. S6 SWITCH:

(1) S6 is used to measure voltage and amperage from phase to neutral and from phase to phase. S6 is a wafer type switch. It has 6 separate wafers and is a 6 position switch. The 6 positions are L1 - LO, L2 - LO, L3 - LO, L1 - L2, L2 - L3, and L1 - L3. Remember, while measuring current in **series** we will not be able to measure from phase to phase, as this will cause a short. S6 has been designed so if we do select phase to phase, there will not be an ammeter reading.

(2) First we w

externally jumped are 3, 7, and 11 which are connected to, negative, of M1 via wire 186A. These two sets of terminals are used for the M1's hot and neutral potential.

(3) The second two sets of terminals that are externally jumped are for M8's potential. Terminals 15, 19, and 23 provide M8 the hot phase via wire 183A. Terminals 13, 17, and 21 provide M8 with neutral via wire 184A. Notice on your schematic wire 184B from terminal 13 of S6 is connected to K8, then to terminal 7 of A4, and the burden resistors R10, R11, and R12.

(4) The contacts that are internally jumped are terminals 2 and 4, 6 and 8, 14 and 16, 18 and 20, and 22 and 24.

(5) The external connections to S6 are as follows: LO is connected to terminal 12; L1 is connected to terminal 10; L2 is connected to terminal 6; L3 is connected to terminal 2. All these terminals are used for voltage potential on M1.

(6) At terminal S1 of A3, wire 117A connects to terminal 16 of S6. At terminal S2 of A3, wire 118A connects to terminal 20. Lastly, terminal S3 of A3, wire 119A connects to terminal 24. All these terminals provide the hot phases for M8.

8. **OPERATION OF GOVERNOR CONTROL CIRCUITS**

a. MPU CIRCUITS, AC (GREEN/YELLOW)

(1) The MPU is the component that tells A5 what the generator speed is. The MPU creates an AC voltage, and when adjusted properly it should produce approximately 2.0 to 3.0 VAC. This can be checked at J3 pins y and x. **Remember this is AC voltage**.

(2) If we look at terminal 16 of A5, we find wire 147C connects to TB4 terminal 7. This is where pin y of J3 is connected by wire 147D. Wire 147A then connects to pin 10 of J6. From there wire 147B connects to terminal 1 of the MPU.

(3) Starting from A5, terminal 17, we find wire 148C connects to TB4 terminal 8. This is where pin x of J3 is connected by wire 148D. Wire 148A then connects to pin 11 of J6. From there wire 148B connects to terminal 2 of the MPU.

b. ACTUATOR CIRCUITS (RED/LIGHT BLUE)

(1) The A6 is the component that receives 24 vdc potential from A5. It is a solenoid that has a plunger that extends and retracts according to the signal A5 sends. This plunger is connected to the throttle control arm of the fuel injection pump. This allows A6 to control the amount of fuel entering the engine there by controlling the engine speed.

(2) If we look at terminal 10 of A5, we find wire 149A connects to pin 13 of J6. From there wire 149B connects to pin 1 of J10. From there, a wire (not marked) connects to terminal 1 of A6.

(3) If we look at terminal 9 of A5, we find wire 150A connects to pin 14 of J6. From there wire 150B connects to pin 2 of J10. From there, a wire (not marked) connects to terminal 2 of the A6.

(4) Because this potential is controlled by A5, it is possible that these potentials will reverse polarity from time to time depending on various load conditions.

c. R2 POTENTIAL TO A5 (RED/YELLOW)

(1) R2 is how the operator adjusts the generator speed to control frequency. By using this potentiometer, we can control the voltage drop across R2 which will increase or decrease the voltage to A5, terminals 6,7, and 8.

(2) Starting at A5 terminal 6, wire 153A connects to terminal R of R2.

(3) At terminal 7 of A5, wire 192B connects to terminal C of R2.

(4) The last terminal, terminal 8 of A5, wire 152A connects to terminal L of R2.

9. ADJUSTABLE COMPONENTS

a. Governor Acuator Assembly:

(1) A6 works much like a cruise control on an automobile. With the various road conditions changing, we require the speed of the car to be the same. Like when you are on a flat grade doing 55mph and you come to a steep grade or hill. The cruise control senses that in order to maintain 55 mph the engine will require more fuel. The same holds true when you are coming off a steep hill, but then the engine requires less fuel. In the generator's application, the steep hills are the changing loads. A6 is what controls the amount of fuel going into the engine like your foot does by manipulating the gas pedal in your car. The governor in a generator works like you do when you're driving your car. The speedometer tells you how fast you are going. This is what the MPU does for the generator. The speedometer let's you know whether to apply more or less pressure to the gas pedal to reach a desired speed. This is what A5 does in the generator; however, the governor cannot see at what speed the engine is running. The MPU uses AC voltage to tell A5 what is going on. From there the A5, tells A6, (using AC voltage), what to do.

(2) If any one component is not operating properly, the other two will not work properly. Therefore, it is very important that you check each component in accordance with the technical manual. The first component that must be adjusted is A6, Governor Acuator Assembly.

b. <u>The MPU (Magnetic Pickup Unit)</u>:

(1) As always when adjusting any components, we must refer to the technical manual. On page 2-158, paragraph 2-110-4 outlines the procedures and steps to adjust the MPU.

(2) Next, disconnect wire 147C from terminal 16 and wire 148C from terminal 17 of the governor control unit.

(3) Now with the MPU isolated from A5, using a multimeter, connect the multimeter leads to wire 147C and 148C. The resistance should be between 800 and 1100 ohms.

(4) Leaving the leads connected to the same wires, switch the multimeter to AC volts.

(5) Using the Dead Crank switch, crank the engine and observe the multimeter. The reading should be between 2.0 and 3.0 volts AC.

(6) If the reading is below 2.0 volts, the MPU is too far from the flywheel of the engine. This can be corrected by loosening the jam nut (see pg. 2-154, fig 2-30, item 7), and **turn the MPU in (clockwise) 1/8th of a turn**, tighten the jam nut, and repeat step 6 again. If the voltage is above 3.0 volts, the MPU is too close to the flywheel. This can be corrected by loosening

the jam nut, and turn the MPU out,(counterclockwise), 1/8 of a turn, tighten the jam nut, and repeat step 6 again.

(7) Once the proper voltage is obtained, disconnect the multimeter and reconnect the wires to their original location on the A5.

c. Governor Control Unit Adjustments:

(1) Once A6 and the MPU have been adjusted, it may be necessary to adjust the next adjustable component, A5, governor control unit.

(2) One reason you may need to adjust the A5 board is a symptom known as “hunting”. “Hunting” is when a precise generator is searching for the proper frequency. If a generator set does begin hunting the operator will be able to hear the fluctuation in the engine speed.

(3) One of the main purposes of A5,is to control the engine speed. However, if the A5 board is not adjusted properly and the engine is hunting, then you must adjust it in accordance with the TM.