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Training Command
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LVSM 7305

STUDENT OUTLINE

MAINTAIN THE MK18 ELECTRICAL SYSTEM

LEARNING OBJECTIVES

1. Terminal Learning Objective: Given an MK48/18, tools, test equipment, and references, repair a faulty MK18 electrical system, per the references. (3521.13.26)

2. Enabling Learning Objectives:

a. Given an MK48/18, tools, test equipment, TM 2320-20/12A, and TM 2320-20/12A Supplement-1, TM 2320-34/13A, and TM 2320-20/13A Supplement-1 test the MK18 electrical system components for serviceability, per the references. (3521.13.26a)

b. Given TM 2320-20/12A, TM 2320-20/12A Supplement-1, TM 2320-34/13A, TM 2320-20/13A Supplement-1, and partial statements pertaining to the MK18 electrical system, complete the partial statements to describe the procedures used to diagnose a malfunctioning MK18 electrical system, per the references. (3521.13.26b)

c. Given TM 2320-20/12A, TM 2320-20/12A Supplement-1, TM 2320-34/13A, TM 2320-20/13A Supplement-1, and partial statements pertaining to the MK18 remote control system, complete the partial statements to describe the procedures used to diagnose a malfunctioning MK18 remote control system, per the references. (3521.13.26c)

OUTLINE

1. IDENTIFICATION, LOCATION AND FUNCTION OF THE MK18 ELECTRICAL COMPONENTS

a. Remote Control Unit (RCU). The RCU is located in a storage box at the front left side of the MK18 and acts as the man-machine interface. It receives analog signals from the operator through movement of the pushbuttons and joysticks and converts them to analog output signals, which are sent to the electronics box.

b. Electronics Box. The electronics box is mounted inside the RCU storage box. It receives these drive signals, which are voltages from the RCU and converts them to current signals for the control valve manifold. These signals are currents, not voltages: therefore, they cannot be measured with a voltmeter but can be measured with an ammeter. There are fourteen voltage signals in the electronics box and a corresponding current output for each one of them. They control the fourteen functions of the seven controls: one for up and one for down, one for slide load and one for slide unload, one for in and one for out, one for lock and one for unlock or whatever the function is.

c. Solenoid Drive Circuit Cards. The electronics box houses the motherboard with the circuit drive cards which supply the current drive signals to the control valve manifold. There are fourteen identical circuit cards, one for each of the output signals from the electronics box. These cards may be interchanged, which may be necessary for a temporary repair. For example, if you were in the container mode and the cylinder tilt card burned out, you could replace it with the winch card as the winch is used only for bridge/boat mode operations.

d. Fifteenth Card. There is a fifteenth card that is different from the other fourteen cards but as of now there is no information as to its purpose and function. This information will be a change to the TM.

e. Junction Box. The junction box is located inboard of the RCU storage box and contains four terminal strips, or blocks, for the distribution of all dc voltage used by the MK18. The dc voltage from the MK48 to the MK18 is sent to the junction box first and distributed from there.

f. Control Valve Manifold

(1) The control valve manifold is located on the left side of the MK18, just behind the RCU storage box. It contains seven hydraulic valve sections, SV1 through SV7. Each section can be operated manually or electrically. For electrical control, using the RCU, each valve contains two solenoid windings, one labeled A and one labeled B. The solenoid windings and their functions are indicated on this transparency.

(2) Each winding receives current from its respective solenoid drive circuit card. When the winding receives current, it opens a port in the valve section to allow hydraulic fluid to flow. The amount of drive current received determines how much fluid is allowed to flow.

g. Emergency Stop Solenoid. The emergency stop solenoid is affixed to emergency stop valve SV9, which is located inboard of the left tool compartment.

(1) The emergency stop solenoid is activated by pushing the RCU emergency stop pushbutton switch. This stops the current flow to the solenoid winding on valve SV9 and causes a port in the valve to close, thereby directing all fluid back to the MK48. This hydraulic shut off can be activated only by the RCU.

(2) When the RCU is not connected to the MK18, a relay in the electronics box keeps current flowing to the solenoid winding, which allows fluid to flow to the MK18.

h. Cable Tension Limit Switch

(1) The cable tension limit switch is mounted on the front cable roller guide. The purpose of this switch is to prevent the operator from unwinding the winch cable with no tension on the cable, thereby allowing the cable to become tangled on the winch spool. The switch has no effect on the cable as it is being wound in and it is activated in manual or RCU operation.

(2) If the operator attempts to unwind the winch with no tension on the cable, the open switch prevents voltage from being applied to the solenoid winding of hydraulic valve SV8. With no voltage applied, hydraulic fluid cannot flow to the winch and the winch will not operate. When tension is applied to the cable, the switch closes and the winch will unwind.

(3) You should remember from the operations class that one person pulled down on the switch arm while the other one operated the winch control button so the winch cable could be pulled out for maintenance checks.

i. Tilt Over Center Limit Switches S1 and S2

(1) The MK18 is equipped with two tilt over center limit switches, S1 and S2. The purpose of these switches is to prevent the mast from tilting more than 90 degrees from horizontal during ISO/ANSI container loading and unloading operations.

(2) A tilt over limit switch is attached to each ISO/ANSI container rear pivot on the MK18, switch S1 on the left side and S2 on the right side. The switches are wired in a parallel circuit and are normally closed.

(3) When the mast is tilted to approximately 90 degrees, the switches are mechanically opened. I say approximately 90 degrees because they are adjustable and they are to allow the mast to tilt to the vertical position but not beyond, or over center.

(4) Opening the switches disconnects voltage from the solenoid winding of hydraulic valve SV10. With the switch open, hydraulic fluid flows

through valve SV10 back to the MK48 reservoir, thus fluid flow to the tilt cylinders is ceased and the tilt process stops. Opening either switch will have the same effect.

2. ORGANIZATIONAL MAINTENANCE RESPONSIBILITIES RELATIVE TO THE MK18 ELECTRICAL SYSTEM

a. Organizational maintenance personnel are responsible for inspecting, testing, adjusting, and replacing all of the electrical components except the RCU and the chassis wiring harness.

b. However, the mechanic is responsible for repairing the chassis wiring harness to include repair and replacement of the 24-pin connector and replacement of the 4-pin connector attached to solenoid valve 9 (SV9).

3. INSPECTING THE MK18 ELECTRICAL SYSTEM FOR SERVICEABILITY

a. Check the components for any visible damage such as distortion, wear, cracks, breaks and loose or missing mounting hardware.

b. Check the wires and wiring harnesses for chafed or burned insulation, frayed or broken wires, and proper routing.

c. Check the terminal connectors for loose connections, broken parts, and corrosion.

d. Check the switch arms for freedom of movement: they should rotate back and forth freely.

e. Check switch covers for secureness. If moisture is suspected, remove the cover(s) and inspect the internal components for damage.

f. Inspect the inside of the electronics box for signs of moisture and to make sure that all the solenoid drive cards are properly seated and are not loose from the motherboard.

g. If discrepancies are found during the inspection process, make repairs to or replace the unserviceable components within the scope of your responsibility and notify your supervisor if the vehicle should be evacuated to a higher echelon maintenance facility for repair.

4. REPLACEMENT AND ADJUSTMENT OF SWITCHES

a. Cable Tension Limit Switch Replacement/Adjustment

(1) Removal and disassembly

(a) Make sure the MK18 is electrically disconnected from the MK48 at connector MC18.

(b) Tag all wires before removal to ensure proper installation.

(c) Remove the cover retaining screws, cover and gasket.

(d) Loosen the screws and remove the two wires from the switch.

(e) Loosen the compression nut while holding the compression tube and remove the cable from the switch.

(f) Remove the four locknuts and screws and remove the switch from the mounting plate.

(g) Remove the nut, washer, spacer, switch arm, and locking tab from the switch shaft.

(2) Cleaning/Inspection. Clean and inspect all parts and repair or replace all parts failing inspection.

(3) Assembly.

(a) Make sure the actuator is positioned correctly

(b) Install the locking tab, switch arm, spacer, washer, and nut on the switch shaft. Leave the nut finger tight for adjustment.

(c) Install the cable through the compression nut and compression tube and into the switch.

(d) Tighten the compression nut while holding the compression tube.

(e) Install the two wires on the switch screws and tighten the screws.

(f) Install the gasket, cover, and screws and tighten the screws.

(4) Adjustment

(a) Using a ruler or other measuring device to measure, slide the switch arm up until the distance from the top of the switch housing to the top of the switch arm roller is 2.25 inches.

(b) Hold the switch arm in this position and tighten the nut securely.

(5) Installation. Install the switch on the mounting plate and tighten the mounting screws.

b. Tilt Over Center Limit Switch Replacement and Adjustment

(1) Removal, cleaning/inspection and installation. The procedures for removing, cleaning, inspecting, and installing these switches are the same as for the cable tension limit switch with a couple of exceptions. The first is that the front tiedown hook assemblies and the rear tiedown hook assemblies are removed from their stowed position to gain easy access to the switches. The other difference is that the actuator must be positioned for right side or left side usage as required.

(2) Adjustment. The adjustment steps for the left and right side switches are the same.

(a) Make sure the left and right mode pins are installed properly for container lift operations.

(b) Loosen the nut securing the switch arm to enable free movement of the switch arm.

(c) With the RCU in the container mode, tilt the mast assembly up until the distance between the cylinder end and the clevis is 54.5 $\pm$.5 inches.

(d) Shut down the MK48 and make sure the ignition switch is OFF.

(e) Remove the cover screws, cover and gasket from the switch.

(f) Tag all the wires before removal, then loosen the screws and remove the wires from the switch.

(g) Connect an ohmmeter to the screws that secured the wires then rotate the switch arm counterclockwise for the left tilt switch or clockwise for the right tilt switch until the switch roller contacts the striker plate and secure the switch arm in place.

(h) As you observe the ohmmeter, rotate the switch shaft clockwise for the right tilt switch or counterclockwise for the left tilt switch until the ohmmeter indicates an open circuit. Hold the switch shaft in place and tighten the nut securely.

(i) Remove the ohmmeter and install and tighten the screws.

(j) Install the gasket, cover, and cover screws then tighten the screws securely.

5. DIAGNOSE A MALFUNCTIONING ELECTRICAL SYSTEM

a. General Information on Troubleshooting the MK18 Electrical System

(1) Chapter 2, Section III of TM 2320-20/12, Supplement-1 contains the troubleshooting instructions for the MK18; included are the malfunction, description, test or inspection procedures, and the corrective action to be taken.

(a) As you look under the heading of a malfunction, you'll notice there are usually several numbered tests. There may be any number of tests to conduct to isolate a particular defective component.

(b) As we successively complete the tests progressing toward the last test for a particular malfunction, we will have, in fact, tested several components, any one of which may be the cause of the malfunction. We're not simply testing one component at a time, we are testing a system.

(c) The final test in a series of tests to isolate a particular malfunction, or any test along the way, might direct you to replace a component that is the cause of the malfunction, depending of course on the results of the particular test you conducted. The results of the test may also direct you to skip one or more tests rather than proceed to the next numerically numbered test. Be sure to follow the TM or the diagnosis will not be correct.

b. There are also some do's and don'ts pertaining to conditions under which the specific tests are to be performed. They are listed as warnings, cautions and notes in the TM.

(1) The ignition switch must be in the ON position for all voltage tests.

(2) Always connect the negative lead of the multimeter to the chassis ground for voltage tests unless told to do otherwise in the tests.

(3) Make sure the auxiliary/steering valve is in the auxiliary steering position.

(4) Do not start the engine unless told to do so in the tests.

(5) Do not disconnect any plugs unless told to do so in the tests.

(6) Make sure the RCU is disconnected from the motherboard unless told to connect it in the test.

c. Hydraulics Inoperative (Remote and Manual)

(1) The first step is to make sure the hydraulic oil level is correct. If the oil level is not correct, then add or remove oil in accordance with the TM and the LO.

(2) Check all the hydraulic lines and fittings for leaks or damage and make the necessary repairs.

(3) Remove the 4-pin connector from solenoid valve SV9 which is mounted to the left mainframe rail, near the front of the vehicle.

(4) Connect the positive multimeter lead to pin 1 and the negative multimeter lead to pin 2 of the 4-pin connector and check for 24 volts. If 24 volts are present, go to test 4 which is a coil resistance test.

(5) To check the resistance of the solenoid coil in valve SV9, leave the 4-pin connector removed from SV9, connect the multimeter to pins 1 and 2 of the 4-pin connector and check for 15 $\pm$ 10% ohms resistance. If resistance is not 15 $\pm$ 10% ohms, replace the solenoid coil in solenoid valve SV9.

(6) If 24 volts were not present when testing the 4-pin connector at pin 1 and 2 or if resistance of the solenoid coil was within specifications, further testing of the system would be required.

Mast Will Not Tilt Up (Remote and Manual)

(1) Disconnect wires SV10/TB1-1 and SV10/TB3-4 from solenoid valve SV10.

(2) Condition the multimeter for voltage and connect the positive lead to the harness side of wire SV10/TB3-4 and negative lead to the harness side of wire SV10/TB1-1. With normally closed switches S1 and S2 not actuated, check for 24 volts.

(3) If 24 volts are present, we must now check the solenoid coil for resistance.

(4) With wires SV10/TB1-1 and SV10/TB3-4 still disconnected and the multimeter conditioned to measure resistance, connect the multimeter leads to the leads of solenoid valve SV10 and check for 50 $\pm$ 10% ohms of resistance.

(5) If resistance is not within specifications, you must replace the solenoid coil in solenoid valve SV10.

(6) If 24 volts were not present or resistance was within specifications, further testing of the system would be required.

(7) The cable tension solenoid valve is tested in this same measure.

e. Mast Will Not Tilt Up (Remote and Manual) Wherein Solenoid Valve SV10 is Serviceable

(1) In troubleshooting this malfunction this time, let's presume that we have tested solenoid valve SV10 and it is serviceable so now we will test the switches.

(2) The first step in testing the switch(s) is to remove the switch cover.

(3) Next, with the ignition switch ON and the voltmeter conditioned for voltage, check for 24 volts on terminal S1-11.

(4) If 24 volts are not present, you would repair or replace wire S1-11/TB3-8.

(5) If 24 volts were present, you would then check for 24 volts on terminal S1-12. Keep in mind that these switches are normally closed and that voltage should pass through the switches unless they are actuated, stopping the current flow.

(6) If 24 volts are not present at S1-12, you would adjust the switch. Before replacing any switch, you should first adjust it according to maintenance procedures in the TM and replace the switch if adjustment did not correct the problem.

(7) If 24 volts are present at S1-12, you would continue the testing of switch S2 in the same manner, referring to the TM for specifications and component repair or replacement procedures.

f. Roller Jack Will Not Raise (Remote Only)

(1) If you look at the troubleshooting section of the manual, you will see that in each instance where the malfunction occurs only during remote operation, the first test is to replace the RCU and RCU cable with a known good one. This will eliminate a lot of troubleshooting if the only defect is a faulty RCU or RCU cable. If this does not correct the problem, reinstall the original RCU and RCU cable.

(2) The next test you should do is check the solenoid drive card.

(3) Gain access to the motherboard by removing the screws that secure the cover. Then carefully remove solenoid drive card B1 from its slot, clean the card connectors and reinstall the card to its original slot.

(4) With the ignition switch on, condition the RCU for the container mode and press the ROLLER JACK UP button.

(5) If the roller jack still fails to raise, turn the ignition switch off and remove the junction box cover.

(6) Disconnect wires TB1-1/SV1B and TB4-1/SV1B at terminal boards TB1 and TB4 respectfully.

(7) Condition the multimeter to measure resistance, place one lead to wire TB1-1/SV1B and the other lead to wire TB4-1/SVB and check for 26 $\pm$ 10% ohms resistance.

(8) If the reading is not within specifications, further testing and or replacement of parts is required.

(9) For training purposes, let's assume that the resistance is greater than 26 $\pm$ 10% ohms.

(10) With the ignition switch OFF, disconnect wire TB1-1/SV1B at the terminal board (TB) 1-1.

(11) With the multimeter conditioned to measure resistance and using a sharp probe, check for continuity between the end of wire TB1-1/SV1B and the end of wire SV1B/TB1-1.

(12) If continuity was not found, you would repair or replace wire TB1-1/SV1B.

(13) If continuity is found, with the ignition switch OFF, check for continuity between TB1-1 and TB1-4.

(14) If continuity was not found, you would replace the ground bus terminal link from TB1-1 to TB1-4.

(15) If continuity is found, again with the ignition switch OFF and wire TB4-1/SV1B at TB4 disconnected, use a sharp probe and check for continuity between the end of wire TB4-1/SV1B and the end of wire SV1B/TB4-1.

(16) If continuity is not found, you should repair or replace wire TB4-1/SV1b.

(17) If continuity is found, replacement of the solenoid coil in the B side of solenoid valve SV1 is required.

g. Winch Will Not Wind Out (Remote and Manual)

(1) Keep in mind that the cable tension limit switch is a normally open switch and voltage will not pass through this switch unless the switch is actuated either by hand or tension from the winch cable.

(2) Disconnect wires SV8/TB1-7 and SV8/TB3-3 from solenoid valve SV8.

(3) Condition the multimeter for voltage, place the positive lead to wire SV8/TB3-3 ,the negative lead to wire SV8/TB1-8, actuate the cable tension limit switch and check for 24 volts.

(4) If 24 volts were present, testing of solenoid valve SV8 coil for resistance and a continuity test of the ground wires to SV8 would conclude your testing with repair or replacement of either of these components. So, for the sake of training, let's assume that 24 volts were not present and continue testing.

(5) Gain access to the cable tension limit switch by removing the two capscrews that secure the cover to the switch.

(6) Now check for 24 volts at terminal S3-13 of the switch. If 24 volts are not present at S3-13, further testing of the junction box terminal board and wires is required and you would refer to the TM for the specifications.

(7) If 24 volts are present at S3-13, you must actuate the cable tension limit switch and check for 24 volts at terminal S3-14.

(8) At this point, if 24 volts are present at terminal S3-14, further testing of solenoid valve SV8 and the ground wires would be required. Refer to the TM for these tests.

(9) If 24 volts were not present at terminal S3-14, the TM directs you to replace the cable tension limit switch. Again, as with the tilt over center switches, switch S3 is adjustable and you must adjust and retest/recheck the switch before discarding it.

REFERENCES:

TM 09470B-20/2
TM 2320-20/12 Sup-1
TM 2320-34/13 Sup-1
TM 2320-34/13A