PALO VERDE
NUCLEAR GENERATING STATION

Electrical Maintenance Training Program

Classroom Lesson

Electrical Maintenance Training Program	**Date: 5/11/2011 2:45:07 PM**
LP Number: NEA40C000204	**Rev Author: MARK OWENS**
Title: Emergency Diesel Gen Lesson Plan #2	**Technical Review:** Frasquillo, Peter (Z35948) Digitally signed by Frasquillo, Peter (Z35948) DN: cn=Frasquillo, Peter (Z35948) Reason: I have reviewed this document Date: 2011.05.13 09:50:48 -07'00'
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INITIATING DOCUMENTS

None

REQUIRED TOPICS

None

CONTENT REFERENCES

VTM-C628-00001 EDG
13-MO18-141 to 156
13-MO18-157 to 162
13-M018-285 to 290
13-MO18-291
EDGB001-011, 15
EDGF001-011, 15
EPEB001-003
EDFB001-002
EHDB001-006

PROCEDURES

32MT-9PE01 18 DIESEL GEN. INSPECTION

REVISION COMMENTS

May 11, 2011	Mark Owens	Reworded enabling objectives for clarification

Tasks and Topics Covered

The following tasks are covered in Emergency Diesel Gen Lesson Plan #2 :

Task or Topic Number*	**Task Statement**
Lesson:	Emergency Diesel Gen Lesson Plan #2
EDG01	Maintain Emergency Diesel Generators (EDG)
EDG02	Maintain Non-Power Block Generators

Total task or topics: 2

TERMINAL OBJECTIVE:

2.0 Given references the student will, demonstrate the ability to read electrical prints, recognize how to fabricate Fiber Optic cables and describe testing/troubleshooting Fiber Optic circuits. Mastery will be demonstrated by obtaining a score of 80% or greater on a written evaluation.

2.1 Identify Engine and Generator Panel prints

2.2 Describe fiber optic/relay types and physical location in the Diesel Panels.

2.3 Describe contact types and their locations.

2.4 Describe how wiring and interconnection lists interface with diesel drawings.

2.5 Identify the fiber optic system purpose, function and components.

2.6 Identify the causes of fiber optic circuit losses.

2.7 Identify fiber optic fabricating precautions.

2.8 Identify tools and components required to fabricate a fiber optic cables.

2.9 Describe the sequence to fabricate a fiber optic cable.

2.10 Describe how to test a transmitter and receiver fiber optic board.

2.11 Analyze/describe a troubleshooting/rework progression for the fiber optic system.

TO: 2.0	**Given references the student will , demonstrate the ability to read electrical prints, recognize how to fabricate Fiber Optic cables and describe testing/troubleshooting Fiber Optic circuits. Mastery will be demonstrated by obtaining a score of 80% or greater on a written evaluation.**

EO: 2.1 Identify Engine and Generator Panel prints

LESSON PLAN	METHODS AND ACTIVITIES
• Print Groups: SDOC's Engine Prints: G5-**553-132** (Cooper) MO18-141 to 156 (APS) Generator Prints: G5-**253-200** (Cooper) MO18-157 to 162 (APS) Cabinet layout prints: G5-**262-1009** (Cooper) M018-285 to 290 (APS) Bill Of Materials: **BM**G5-**262-1009** (Cooper) MO18-291 (APS) Other prints needed for diesel troubleshooting: DIESEL ELEMENTARIES: EDGB001-011,15 EDGF001-011,15 EPEB001-003 EDFB001-002 EHDB001-006	Show students how to find latest revision on DMIMAIN in SWMS using M018-00141 and G5553132 Have students tab their prints to

- G5-553-132 & G5-253-200 Drawing Breakdown:

  "A" Drawings = CONTROL SCHEMATIC

  "D" DRAWINGS = SUB-VENDOR INTERFACING

  Interface from Cooper to their sub-vendor components (i.e. Woodward & Parson Peebles).

  "E" DRAWINGS = INSTRUMENTATION

  These drawings contain all the I & C devices (pressure switches, temp switches, etc).

  "F" DRAWINGS = EXTERNAL DEVICE INTERFACE

  These drawings show the interface between cooper drawing set (engine or generator) and other plant components not associated with that skid.

  "G" DRAWINGS = ANNUNCIATOR

  Windows alarm when they lose power to their windows.

  Windows 4-1 through 6-8 give low priority alarms in the control room.

  Any device that goes to the alarm windows 1-1 through 3-8 also cause 86S1/S2 to de-energize. This gives a high priority control room alarm.

  "J" DRAWINGS = LEGEND, SWITCH CONFIGURATIONS

  These drawings show all the locations to devices on those drawings, such as resistors, diodes, fuses, relays, etc.

speed up the print reading process

EO: 2.2 Describe fiber optic/relay types and physical location in the Diesel Panels.

LESSON PLAN **METHODS AND ACTIVITIES**

- Relay Coil Labeling:

  Coils are indicated by a circle. The Alphanumeric characters inside the circle indicate the component function (PG J1 for both the generator and the engine prints).

  The letters or numbers directly outside the circle (next to input and output wires) indicate pin or terminal connection number on relay.

  The numbers that are underlined directly above the coil indicates the physical location of the standard relay in the relay rack. Directly below the coil are shown the contacts and their locations in the print.

  If there is nothing stated below the relay. The relay operates some mechanical device (i.e. 20SD and 20F01).

  Example: R1-M1 A1E5
  M1-T1 A1G5

  The upper set R1-M1 are the pin numbers of the relay for the "B" contact. To the left of the R1-M1 is the location of that contact on the prints A1E5 where A1 is the page and
  E5 are the coordinates (E top coordinate, 5 is the side coordinate).

M1-T1 pins represent the "A" contact, which is located on print A1 at G5 coordinate.

The heavy bar to the side of the contacts indicates a heavy-duty contact.

- Timing Relays (E7000 Agastats):

  Agastat symbols are circles with the top or bottom filled in. Labeling is identical to the standard coil with the following exceptions:

  These relays are located inside the engine panel but not in the relay racks. They are located above the racks or on the front panel.

  Part of the circle is filled in to indicate if it is a TDE relay (time delay energized-top filled in) or a TDD relay (time delay de-energized-bottom in).

  Example: 3-5T A3C2
  5-1T

  Using the above Agastat contact designation example, the 3-5T represents the "B" contact (across pins 3 & 5) which is located on print A3 at coordinate C2.

  The 5-1T represents the "A" contact (across pins 5 & 1) which is not being used.

- Protective Relays:

  Protective Relays are shown as circles inside a

box. The Alphanumeric characters inside the circle indicate the component function.

Directly below the coil are shown the contacts and their locations in the print. If there is not anything below the relay, the relay operates some mechanical device (i.e. 20SD and 20F01).

Example: A protective relay contact designation shows 1-10 (D3B7). The contact across pins 1 & 10 is located on sheet D3 at coordinate B7.

- Fiber Optics:

  Fiber Optics are shown as emitters and receivers.

  An Emitter is a dotted box with an LED (light symbol with a diode symbol inside), and a resistor. Its label begins with a "DS". Its function and receiver location are labeled next to it.

  The receiver is also a dotted box that has transistors inside it and an LED symbol outside of the box. One transistor is a photoconductive transistor.

EO: 2.3 Describe contact types and their locations.

LESSON PLAN **METHODS AND ACTIVITIES**

- Relay Contact Designation**:**

  All relay contacts used externally contact rating 125 VAC/DC, 1 amp resistive, unless specified.

  Contacts are shown as parallel lines ("A" contact) or parallel lines with a third line that intersects at an angle ("B" contact).

- Terminal Labeling:

  All terminations except solder connections will be identified by a number at the side of the terminal symbol (circle with line through it).

  A black point connection indicates that the connection is an electrical/solder connection.

- Wire Labeling:

  A wire marking symbol is a half circle connected to the end of a line.

  The number to the side of the wire shows the wire identifier.

  These are useful to know when tracing wire problems. Although the prints show a single line, the actual wiring is connected to several points throughout the panel to develop a single run.

  Wires leading from terminal to devices with screw terminals will be marked on both ends with a terminal number.

  Where leading from terminals or devices to a device with solder connections will be marked on the end with screw terminals only.

- Standard Relay Contact Labeling:

  The alphanumeric characters next to the contacts indicate the pin or terminal connection.

  The number on top of the divider indicates the physical location of the relay in the panel relay rack.

  The number on the bottom of the divider indicates the component function.

- Timing Relay Contact Labeling:

  The alphanumeric figure on top of the divider shows the timing relay identifier for that particular contact.

  The bottom half indicates if the relay is a time delay to open (TDO) type or a time delay to close (TDC) type.

  6 & 4 show the pin or terminal to which that particular wire is landed on the timing relay.
- Switch Contact Labeling:

The alphanumeric figure on top of the divider gives the switch identification for that contact.

The bottom half indicates the position the switch must be in to operate the contact.

- Remote Contact Labeling:

  Remote contacts are indicated on the control wiring prints by dashed lines.

  The top line indicates where the remote contact is located.
  A. GP indicates the Generator Panel (B02).
  B. EP signifies the Engine Panel (B01).
  C. Skid means that the contact is coming from a device on the diesel or its auxiliary skid.
  D. CUST = plant component

  Characters below the line give the device function.

- Sensing Contact Labeling:

  These contacts are associated with pressure switches, temperature switches, vibration switches, level switches, etc

  The explanation is the same as that of the remote contact except the double ended arrow to the left of the contact tells what the contact does when the sensing device associated with it activates:
  A. Top letter is for energize (activate) and the bottom is for de-energize (de-activate)
  B. C = Close
  C. O = Open

If the contact in the figure was connected to a pressure switch, when it activated (goes up) the contact opens. When the device de-activates, the contact closes.

EO: 2.4 Describe how wiring and interconnection lists interface with diesel drawings.

LESSON PLAN

METHODS AND ACTIVITIES

- Engine Wiring List MO18-0431:

  Gives the actual wire routing in side of cabinet B01.

  The control prints may show a single wire connected to several components when in reality it is several wires connected in series.

  Pages 39-42 show the correlation between the Engine termination points and the Generator termination points.

  Page 43 shows fiber optic cable lengths.

- Generator Wiring List MO18-0432:

  Gives the actual wire routing inside of cabinet B02.

  The control prints may show a single wire connected to several components when in reality it is several wires connected in series.

- Interconnection List:

  This list gives the actual termination points for wiring that runs between B01 and B02 cabinets. Interconnection List.

Have students practice finding remote contacts in the Engine/Generator panels using pages 39-42

EO: 2.5 Identify the fiber optic system purpose, function and components.

LESSON PLAN **METHODS AND ACTIVITIES**

- Purpose:

  A plastic fiber designed to guide light along its length by confining as much light as possible in a propagating form.

  Prevents problems caused by electromagnetic interference (EMI).
  A. Since the fiber is a dielectric; it is not affected by electromagnetic fields.
  B. The fiber does not pick up or emit electromagnetic energy.

- Function: Fiber optics are used in the diesel is to separate class 1E equipment from non-class 1E equipment.

- Components:

  Transmitter:
  A. Boards A, C, and E.
  B. The transmitter receives an electrical signal and coverts it to a light signal and transmits it to the fiber optic cable.
  C. includes the electronic drive circuit and the led (light emitting diode) light source.

Put M018-00286 on desktop to view physical locations

Receiver:

A. Boards B, D, F, G, and H.
B. The receiver receives the light signal and converts it back to a useful electrical signal.

Cable & Connectors:
A. AMP OPTIMATE DNP Fiber Optic Plugs. Reference Dwg M018-01232. (AMP Instruction Sheet 408-2974).
B. The medium by which the light is transmitted to the receiver. #20 AWG Cable of 1000 mm plastic fiber.

EO: 2.6 Identify the causes of fiber optic circuit losses.

LESSON PLAN	METHODS AND ACTIVITIES
• Fiber Optic Losses: All of these losses can be mitigated by the technician End-Gap: Gap or space between the ends of the optic components. Finish and Dirt: Bad finish or dirt on connections. Do not handle the plastic fiber; oil from your skin can affect the connection.	**CRDR 2959958** Spurious alarms caused by aging/alignment issues on fiber optics SME: The new fiber optics can be too sensitive. Equipment has changed state just from turning on the light inside the cabinet.

EO: 2.7 Identify fiber optic fabricating precautions.

LESSON PLAN **METHODS AND ACTIVITIES**

- Precautions:

  The transmitter LED does not transmit a high powered signal. Therefore it will not cause eye damage when you look at it to see if it is turned on.

  Poor handling can cause fibers to break. Do not bend or pull fibers too tightly.

  The minimum allowable bending radius of the fiber optic cable is two inches. Reference Dwg M018-01232.

  Do not touch the ends of the connectors with your fingers. Dirt/oil is harmful to fiber optic connector performance.

EO: 2.8 Identify tools and components required to fabricate a fiber optic cables.

LESSON PLAN **METHODS AND ACTIVITIES**

- Fiber Optic Tools & Components: Ref AMP Drawing 408-2974

  Weller Exacto Hot Knife AMP 228085-1 or equivalent.

  Insulation Stripping Tool AMP #501198-1 or equivalent for #20 AWG Cable of 1000 □m plastic fiber.

  Insertion Tool (Pliers) 461 PL621 from Techni-Tool, Inc., or equivalent

  Tool Cutting Plastic Fiber Fixture, AMP 228837-1 DIGI-KEY 1-800-344-4539

  Fiber Optic Cable APN# 00066362 P/N 501232-3

  Fiber Optic Connector Assembly APN# 00066480 P/N 228087-1.

EO: 2.9 Describe the sequence to fabricate a fiber optic cable.

LESSON PLAN **METHODS AND ACTIVITIES**

- Fiber Optic Cable Assembly Instructions: See Figure 2 on AMP Dwg 408-2974. M018-01232.

  The minimum allowable bending radius of the fiber optic cable is 2 inches. Ref Dwg 13-M018-01232-0; AMP Dwg 408-2974.

  Adjust stripping tool for No. 20 AWG wire or 1000 µm plastic fiber. Strip approximately 6.25mm (.250 in.) of jacket from the fiber.

  Caution: Do not nick or cut the fiber.

  Using an insertion tool (Plastic Pliers) push the stripped cable into the plug until the cable bottoms and excess fiber extends out of the nose of the plug.

  Pull back slightly on the cable to ensure that the barbs on the retention clip engage the jacket and plug.

  See Figure 3(A & B) on AMP Dwg 408-2974:

  Slide the plug into the cutting tool fixture as shown. Dwg 408-2974 **Fig. 3(A)**

SME: When using hot knife for

Using the Beveled Edge of the hot knife blade, slice off excess fiber.

Place the flat side of the hot knife blade in the lower area (melting area) of the fixture. Press down on the blade to melt the remaining fiber flush with the end of the plug. AMP Dwg 408-2974 **Fig. 3(B)**

Allow the fixture to cool and then remove it.

Inspect the plug for proper termination. The end of the fiber should form a rivet flush with the end of the plug.

The plug is now ready to be mated with a single-position receptacle.

making up fiber optic cables, ensure proper use to avoid personnel injury or cable damage

EO: 2.10 Describe how to test a transmitter and receiver fiber optic board.

LESSON PLAN	METHODS AND ACTIVITIES
• Test a spare transmitter and receiver board per the following: A test rig may be used if one is available. A transmitter board is to be tested with a receiver board and a relay. A receiver board is to be tested with a transmitter board and a relay. Obtain a Power Supply (PS) capable of supplying 105VDC. Obtain a Power Supply (PS) capable of supplying 10VDC. Obtain a spare Agastat type relay. A relay base may be used if available. The transmitter and receiver boards may be connected with one or two fiber optic cables, depending on which channel is being tested.	**Don't Blow up boards** **SME:** If you use separate power supplies so that the negatives are not electrically connected, verify that there is no voltage differential between the two negatives.

Transmitter board: Make the following connections for testing (review prints and/or WSL for proper terminal point connections and polarity).
Pos./Neg. of the 105VDC PS to proper terminals of the transmitter board channel to be tested.
Connect a fiber optic cable from the channel to be tested to a working receiver board channel.

Testing: Energize the 10VDC power supply first, then the 105VDC power supply. Verify that the test relay is energized with the fiber optic cable connected and de-energized with the fiber optic cable removed (review circuit for special situations).

Acceptance Criteria: Enough light is produced by the LED of each channel to turn on a transistor on a receiver board and energize the test relay as expected.

Receiver board: Make the following connections for testing (review prints and/or WSL for proper terminal point connections and polarity).
Neg. of the 105VDC PS to point #9 of Receiver board.
Pos. of the 105VDC PS to point B1 of relay.
Point B4 of relay (Neg.) to the receiver board channel to be tested.
Pos. of the 10VDC PS to point #8 of receiver board.
Neg. of the 10VDC PS to point #10 of receiver board.
Connect a fiber optic cable from the channel to be tested to a working transmitter board channel.

Testing: Energize the 10VDC power supply first, then the 105VDC power supply. Verify that the test relay is energized with the fiber optic cable connected and de-energized with the fiber optic cable removed (review circuit for special situations).

Acceptance Criteria: For each channel verify that the test relay energizes and de-energizes as expected.

EO: 2.11 **Analyze/describe a troubleshooting/rework progression for the fiber optic system.**

LESSON PLAN **METHODS AND ACTIVITIES**

Fiber Optics: Provide a Neg. to a relay through the MOSFET (switch)

- Troubleshooting: Verify that the associated relay transmitter and receiver are functioning properly per the following:

  Measure DC voltage across the relay coil at points B1 and B4. If the reading is 135VDC, de-energize the power to the relay and measure coil resistance. Replace relay as required.

  If the relay coil does not have full voltage (135VDC) across the coil. Measure voltage at the associated fiber optic receiver board between terminal board points #9 (common) and the terminal board point for the affected relay.

  Expected reading is 1.6VDC. This means the MOSFET is closed and you are reading the voltage drop across diodes D31 and D32.

  If the voltage reading across the MOSFET is 135VDC, this means the MOSFET is open. Disconnect the fiber optic cable from the receiver board and verify that light is emitting from the cable.

  If light is emitting from the cable, replace the receiver board.

If light is not emitting from the cable, remove the fiber optic cable from the transmitter board. If light is being emitted from the transmitter LED, replace the cable.

If light is not emitting from the LED, measure voltage across the associated LED. Expected reading is 135VDC.

If voltage measures 135VDC across the LED replace the transmitter board.

If voltage is not present at the LED. Troubleshoot loss of power to the LED.