PALO VERDE
NUCLEAR GENERATING STATION

Electrical Maintenance Training Program

Classroom Lesson

Electrical Maintenance Training Program	**Date: 5/12/2011 9:32:44 AM**
LP Number: NEA40C000404	**Rev Author: MARK OWENS**
Title: Emergency Diesel Gen Lesson Plan #4	**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 10:05:40 -07'00'
Duration : 2 HOURS	
	Teaching Approval: Meredith, Robin T(Z00799) Digitally signed by Meredith, Robin T(Z00799) DN: cn=Meredith, Robin T(Z00799) Reason: I am approving this document Date: 2011.05.13 10:13:29 -07'00'

INITIATING DOCUMENTS

None

REQUIRED TOPICS

None

CONTENT REFERENCES

VTM-C628-00001 EDG

32MT-9PE01 18 DIESEL GEN. INSPECTION
CRDR 3681052
13-M018-000147
VTD-W290-00045 Woodward 2301A
VTD-W290-00046 Woodward DRU
VTD-W290-00048 Woodward EGB-50-P

PROCEDURES

None

REVISION COMMENTS

May 12, 2011	Mark Owens	Removed information about the old 65ENG system as the new 65ENG has been installed in all the EDGs. Added/clarified information about the new 65ENG

Tasks and Topics Covered

The following tasks are covered in Emergency Diesel Gen Lesson Plan #4 :

Task or Topic Number*	**Task Statement**
Lesson:	Emergency Diesel Gen Lesson Plan #4
EDG01	Maintain Emergency Diesel Generators (EDG)
EDG02	Maintain Non-Power Block Generators

Total task or topics: 2

TERMINAL OBJECTIVE:

4.0 Given reference materials the student will, identify the purpose and function of the EDG speed control system. Mastery will be demonstrated by achieving a score of 80% or greater on a written evaluation.

4.1 State the purpose, function and Identify components that interface with the UG8L Overspeed Governor.

4.2 State the purpose, function and Identify components that interface with the EG-B50-P Main Governor.

4.3 State the purpose, function and Identify components that interface with the 2301A controller.

4.4 State the purpose, function and Identify components that interface with the Digital Reference Unit (DRU).

TO: 4.0	**Given reference materials the student will, identify the purpose and function of the EDG speed control system. Mastery will be demonstrated by achieving a score of 80% or greater on a written evaluation.**

EO: 4.1 State the purpose, function and Identify components that interface with the UG8L Overspeed Governor.

LESSON PLAN **METHODS AND ACTIVITIES**

- Purpose:
  Provides mechanical overspeed protection of DG
  Trips at 656 ± 4 RPM's

- Function: Prevents the EDG from being damaged due to an overspeed condition in test and emergency modes.

  Driven off the diesel engine through reducing gears which turns the flywheel drive shaft.

  Inside the governor, centrifugal force operates flyweights that oppose a spring, with adjustable tension, that changes hydraulic oil to manipulate mechanical arms connected to the butterfly valve and operate valve UV237/8 (brass valve)

- Location: located on top of engine plant South East side.

- Components:

  Brass valve UV237/8: Operated by UG8L O/S Governor
  Pressurizes (opens) pressure switch 12EO and closes the fuel racks.

  Pressure switch12E0: Operated by UV237/238
  Opens at 656 ± 4 RPM's
  De-energizes relay 12EX, 86S1/2, and solenoid 20SD (UV13) in test mode only.

  Solenoid 20SD (UV13): affects the power cylinder to close fuel racks

  Power cylinder: Connected to and operates the fuel racks
  The left and right side of the power cylinder is pressurized/vented depending on the air system.

  Butterfly valve: Operated by UG8L O/S Governor by mechanical linkage
  Blocks air intake to diesel.
  Actuates limit switches 33E01/2 (SSH001/2).

  CRDR 3681052: During the performance of ISG testing, the EDG was manually tripped by actuating the Overspeed Governor. The procedure has you verify the "Butterfly" valve has tripped closed. Both electrical maintenance and operations verified the valve was closed and the step in the procedure was signed off. When a Simulated ESF/LOP start was initiated the diesel tried to start. Subsequent verification showed the "Butterfly" valve had not tripped closed.

  33E01/2 (SSH001/2): Operated by butterfly valve
  De-energizes Relays 4EX1/2/3/4 and 4EY2 which de-energizes the control circuit that causes 20SD to open (bleeds off control air).
  Operates power cylinder and fuel racks.
  33E01 is the Primary and 33E02 the Redundant.

EO: 4.2 State the purpose, function and Identify components that interface with the EG-B50-P Main Governor.

LESSON PLAN **METHODS AND ACTIVITIES**

- Purpose: EGB50–P
  Provides both mechanical and electric speed control to the EDG in startup/shutdown and steady state operation.

- Function: EGB50–P
  Maintains generator Speed/Frequency under varying conditions.

  The mechanical mode of operation is in effect upon diesel starts, shutdowns and failure of the electric mode
  (>608 RPM).

  The electric mode controls speed between 580 and 630 RPM during test mode and 600 ± .6 RPM in emergency mode.

  In the “Test Mode” Operations changes the DRU through either local or remote handswitches which raises or lowers speed to 580 – 630RPM.

  In the “Emergency Mode” speed is locked in at 600 ± .6 RPM by the DRU.

  During 32MT-9PE01, Main Governor is adjusted so the overspeed governor can be tested.

- Location: On top of engine plant South West side.
- Component Interface:

  Fuel racks: controlled directly through the power cylinder and associated fuel rack linkages.

  2301A Controller: Senses load and speed changes. The controller is a reverse acting controller; if current is lost to the Gov. coil the fuel racks open.

  A. Supplies a current to the solenoid winding attached to the pilot valve plunger during all operations. The coil is picked up all of the time when diesel is running.

  B. If load increases the diesel speed decreases and the current to the solenoid decreases.

- The new EGB-50–P has only one coil (input) and actually has a slower response time with load.

EO: 4.3 **State the purpose, function and Identify components that interface with the 2301A controller.**

LESSON PLAN	METHODS AND ACTIVITIES
Purpose/Function: • The 2301A is a low voltage (24VDC from the DC/DC-1/3 converters) reverse acting controller that monitors and controls a diesel engine in either the Isochronous or droop modes of operation. Isochronous: The speed control section keeps the prime mover (diesel engine) at the correct speed. Droop: During parallel operation with an infinite bus, the load-sensor section senses the load carried by the generator and causes it to carry the appropriate amount of load as set by the droop, load gain, and speed reference. The 2301A controller is the replacement for the 2301 controller. The control is housed in a sheet-metal chassis and consists of a single printed circuit board. All potentiometers are accessible from the front of the chassis.	This modification was performed due to reliability and replacement parts issues EDC 2006-01005

Characteristics:

- Reverse Acting:

  In reverse-acting systems, the actuator calls for more fuel when the actuator current decreases. A complete loss of signal to the actuator will drive the actuator to full fuel. This allows a backup mechanical ball head governor to take control rather than shut down the prime mover as would a direct-acting system. The reverse acting controls are designed so that zero voltage to the actuator corresponds to maximum fuel and 6 volts corresponds to minimum fuel to the EDG.

- Inputs: The 2301A receives voltage and current inputs from the Relaying Potential Transformer (RPT) and Current Transformers (CT2) in high voltage panel B03.

Options:

- Start Fuel Limit: Allows limiting the fuel setting during start up. The fuel limit is disabled in standby by start relay contact 4X2 which jumpers Pts. 31 to 32. When the EDG is started in the "Test" mode contact 4X2 opens and the jumper is removed allowing for a "slow/soft start". At 540 RPM the start fuel limit feature is again disabled by a contact from relay 13SX2. This ensures the mechanical ball head will not be prevented from controlling the engine if an electronic failure occurs. When the EDG is started in the "Emergency Mode" two redundant emergency mode relay contacts 4EX1 and 4EX2 close and jumper Pts. 31 to 32 disabling the "slow start" feature.

In use in U -2's EDG's (setting set on #2) (14 sec. for freq./11 sec. for voltage)

- Dual Dynamics: Dual Dynamics provide different RESET, GAIN, and ACTUATOR COMPENSATION settings for different responses which the engine or turbine may exhibit under different conditions.

  This option is currently not in use at PVNGS and we use only the #1 dynamic.

- RATED SPEED potentiometer: Sets the desired operating speed.

- LOW IDLE potentiometer: Adjusted so the reference voltage is correct for the desired idle speed.

- RESET, GAIN, and ACTUATOR COMPENSATION potentiometers: Adjusts the control amplifier to accommodate various types of prime-movers.
  Reset: Adjustment affects reaction time when recovering after a sudden load change.
  Gain: Controls the magnitude of the speed correction resulting from a sudden change in load.
  Actuator Compensation: Compensates for the time the actuator and prime-mover system take to react to signals from the control.

- ACCEL and DECEL RAMP TIME potentiometers: Sets the time required for the prime mover to accelerate from idle to rated speed or from rated to idle.

For U-3 “B” diesel the reset was set to 2 and the gain was set to 8.5

Operation:

- Frequency to voltage converter: The MPU generates an AC signal with a frequency proportional to EDG speed. The frequency-to-voltage converter receives the MPU frequency signal and changes it to a proportional DC voltage for use in the 2301A internal circuits.

- The speed reference circuit, which comes in at Pts. 23 and 24 from the DRU, generates a DC reference voltage to which the speed signal voltage is compared.

  The speed signal voltage is compared to the reference voltage at the summing point. If the speed signal voltage is lower or higher than the reference voltage, a signal is sent by the control amplifier calling for an increase or decrease in speed. The actuator is controlled by this signal, repositioning the fuel rack and thus changing the speed of the EDG until the speed signal voltage and the reference voltage are equal.

- Digital Reference Unit (DRU): The speed-reference circuit generates a DC reference voltage to which the diesel speed- signal voltage is compared. The speed reference being used is selected by the operator with an external switch or locked in at 600RPM in Emergency Mode.

Components:

- Magnetic Pickup Unit (MPU):
  Connected to terminals 28 and 29. No polarity is observed.
  The 2301A uses a separate MPU to determine speed of the EDG. The MPU generates an ac signal with a frequency proportional to speed

  $$HZ. = \frac{244 \text{ (teeth of flywheel)} \times RPM}{60}$$

  590 RPM = 2359 Hz.
  600 RPM = 2440 HZ.
  630 RPM = 2562 Hz.

  Minimum voltage required from the speed sensor to operate the electronic control is 1.0 volts RMS measured at cranking speed or the lowest controlling speed.

PVAR – 3169747 (W.O. 3169794)
MPU failed. Replaces MPU

Resistance of MPU as measured in B01 cabinet was 196.1 ohms

EO: 4.4 **State the purpose, function and Identify components that interface with the Digital Reference Unit (DRU).**

LESSON PLAN **METHODS AND ACTIVITIES**

- Purpose/Function:

  Digital Reference Units are used in place of MOPs (Motor Operated Potentiometers), but provide more precise and more dependable control functions. The Digital Reference Unit set points are easier to adjust than those on a MOP, and the adjustable ramp time is generally not available with a MOP.

  Digital Reference Units use a precise linear ramp to provide a 0 to 8 volt reference signal to the attached control (2301A).

  The DRU has a memory function and will stay at the setpoint (600RPM) until Operations manually raises or lowers the speed.

  The circuit automatically drives the DRU to 600 RPM when the EDG is shut down by supplying power to point #4 (contact 4X1 closes) of the DRU. This is maintained until a test mode start is attempted (contact 4X1 opens) and maintained with an emergency start through the emergency contacts 4EX3/4.

  The DRU is powered from 72DC1 (135VDC) at Pts. 1and 2 and has a 0-8VDC signal to the 2301A from Pts. 10 and 11.

Characteristics:

- Ramp Times:
  Ramp times are for manual adjustment only. The EDG will come up to speed as fast as the engine will respond to the fuel racks.

  The DRU has two separate ramps which are switch selectable to control the 0-8V reference signal.

  Ramp time is the time it takes the output to ramp from the low limit to the high limit and is independent of the values of the limits (ex. If the set point is halfway between the low and high limits, the ramp time will be one half of the overall ramp time).

  Ramp rates are independently adjustable by four mini rocker switches located inside the cover on the printed circuit board.

  Switch 1 and 2 adjusts ramp time #2 and switch 3 and 4 adjusts ramp time #1.

  The unit defaults to the first ramp if the second ramp is not selected.

- Limits:

  The “Low Limit” potentiometer sets the minimum output from the DRU.

  The “Range” potentiometer sets the maximum output at a position above the low limit setting.

  Since the “Low Limit” setting changes the setting of the high limit (Range), it is necessary to set the low limit first and to reset the High Limit after any change in the low limit.

  If two inputs are selected at the same time:
  The “Set Point” has priority over the “Raise”
  The “Lower” has priority over the “Set Point”
  If Raise is permanently closed, the unit will automatically go to the High Limit when neither Lower nor Set Point switches are closed.