

PALO VERDE NUCLEAR GENERATING STATION

Mechanical Maintenance Training

Classroom Lesson



Mechanical Maintenance Training	Date: 7/23/2010 6:10:58 AM
LP Number: NMC61C000402	Rev Author: LEE BAKER
Title: Air Start System	Technical Review:
Duration : 5 HOURS	Teaching Approval:

INITIATING DOCUMENTS

Task Analysis of Tasks

REQUIRED TOPICS

None

CONTENT REFERENCES

PM Task # 013460, 007265

VTM-C628-001: Diesel Generator Tech Manual

VTM-C628-002: Diesel Generator Auxiliaries

LESSON PLAN REVISION DATA

Jul 23, 2010 Lee Baker

Revised Lesson Plan to:

Incorporate Human Performance and Prevent Events strategies [TCSAI 3478459]

Add systems training tie-in of the Class Electrical systems [TCSAI 3260637]

Include OE from IN 07-27 [TCSAI 3319710]

Tasks and Topics Covered

The following tasks are covered in Air Start System :

Task or Topic Number*	Task Statement
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Lesson: Air Start System

EDG004	Perform routine maintenance on emergency diesel engine
EDG010	Troubleshoot emergency diesel engine

Total task or topics: 2

TERMINAL OBJECTIVE:

- 1 Given applicable maintenance instructions the Maintenance Mechanic will, state the function of and explain the preventive maintenance performed on the EDG Air Start System, demonstrated by passing a written exam with a score of 80% or better.
 - 1.1 Describe the function of the EDG Air Start System
 - 1.2 Describe the EDG Air Start System Components
 - 1.3 Explain the starting sequence of the EDG Air Start System
 - 1.4 Explain the routine preventive maintenance performed on the EDG Air Start System

CONTENT**METHODS AND ACTIVITIES**

<p>I. Motivation</p>	<p>Focus student attention on “What’s In It For Me”.</p>
<p>II. Pre-Job Brief</p> <p>A. Pre-job briefing on the day’s activities modeling the use of the Palo Verde Standards & Expectations, Preventing Events</p> <p>B. Focus On Five (Task Preview)</p> <p>Familiarize worker with the scope of work, task sequence, and critical steps.</p> <p>1. Critical Steps (Terminal Objectives)</p> <p>Given applicable maintenance instructions the Maintenance Mechanic will, state the function of and explain the preventive maintenance performed on the EDG Air Start System, demonstrated by passing a written exam with a score of 80% or better</p> <p>2. Identify error likely situations (error traps)</p> <p>a. Discuss at least one specific error likely situation.</p> <p>3. Identify the Worst thing that can happen.</p> <p>4. Identify specific error prevention defenses to be used.</p> <p>5. Identify actions to assure proper configuration control.</p> <p>C. Break policy</p> <p>1. Two Minute Drill – After lunch at a minimum</p>	<p>PVNGS Standards & Expectation book (Focus on five) Highlight the critical steps (Terminal Objectives) on the power point presentation.</p> <p>Look at Error Precursors in S&E book</p> <p>Apply to the setting you’re in. (Lab versus Classroom)</p> <p>What defenses can we employ to prevent the “Worst thing that could happen”</p> <p>This may not be applicable in every training setting.</p> <p>At Instructor’s discretion, not to interrupt class flow.</p>

CONTENT

METHODS AND ACTIVITIES

III. Lesson Enabling Objectives

Read and/or discuss the lesson objectives

- EO01 Describe the function of the EDG Air Start System
- EO02 Describe the EDG Air Start System Components
- EO03 Explain the starting sequence of the EDG Air Start System
- EO04 Explain the routine preventive maintenance performed on the EDG Air Start System

TO: 1 Given applicable maintenance instructions the Maintenance Mechanic will, state the function of and explain the preventive maintenance performed on the EDG Air Start System, demonstrated by passing a written exam with a score of 80% or better.

EO: 1.1 Describe the function of the EDG Air Start System**CONTENT****METHODS AND ACTIVITIES**

I. Function

A. Provides for the storage and control of compressed air for starting the diesel in order to generate rated power in less than 10 seconds

B. Provides air for Engine Turning Gear

Not normally used, service air is used

II. Description

A. Two separate motor driven air compressors mounted on the starting air skid pump air through a refrigerant type air dryer into an air tank.

1. This is a dual system with either half capable of starting the engine.

B. Compressed air from starting air tanks is applied to starting air control valves on the engine, which are controlled by starting air solenoid valves

C. When the starting air control valves open, starting air is supplied to both banks of air start valves and air distributors

1. One start valve is located in each cylinder head and all are controlled by the air distributors

EO: 1.2 Describe the EDG Air Start System Components**CONTENT****METHODS AND ACTIVITIES**

- I. Components
 - A. Air Compressors
 1. Location –
 - a. 131' el. of EDG building
 2. Function –
 - a. Provide compressed air for the system
 3. Construction-
 - a. Three Stage reciprocating type Air Compressors
 4. Operation
 - a. Pressure switch on air tank panel starts compressor at 240 psi falling and stops it at 250 psi
 - b. Pressure relief valves are set at 265 psi
 - B. Air Dryer
 1. Location
 - a. 131' el. of EDG building
 2. Function
 - a. Remove all moisture from compressed air before it enters the air tanks to prevent corrosion and fouling of equipment
 3. Construction
 - a. Refrigerated type and contains
 - 1) Heat exchanger with two blowers
 - 2) Separator
 - 3) Air dryer with two motors

CONTENT

METHODS AND ACTIVITIES

C. Starting Air Control Valve

1. Location

- a. Two valves: One on either side of EDG cylinder banks

2. Function

- a. Admits starting air to the distributor and air start valves
- b. Supply venting location for system

3. Construction

- a. Air operated with a single inlet and a double outlet.

4. Operation

- a. Air from air tanks is applied to valve at all times
- b. When starting sequence is required:
 - 1) Control air is applied to top of piston that overpowers the spring and unseats the valve to admit starting air to the distributor and air start valves
 - 2) When engine starting sequence has been completed and control air is removed from valve, spring force seats the valve and unseats passage to vent.

D. Starting Air Distributors

1. Location

- a. Two each: One on either side of cylinder banks on forward end of the EDG

CONTENT**METHODS AND ACTIVITIES**

2. Function
 - a. Act as timers to open and close the air start valves in each cylinder head in proper timed firing order
 3. Construction
 - a. Bronze distributor body has inlet port that is connected to end of starting air header on its particular bank
 - b. Ports on body are connected to air start valves according to firing order of the engine
 4. Operation
 - a. Steel rotor inside distributor body turns at half engine speed and rotation is in the opposite direction of crankshaft rotation
 - 1) Driven off forward end of camshafts by a splined shaft and a flexible coupling
 - 2) Due to gear drive rotation of camshaft and distributor is opposite that of engine
 - b. Annular grooves on rotor are designed to connect with ports on distributor body to admit air to proper port
- E. Air Start Valve
1. Location
 - a. 20 each: One located in the top of each cylinder
 2. Function
 - a. Opens in timed relation to the crankshaft by the air distributor allowing starting air to enter cylinder to force piston down and therefore turn over the engine
 3. Construction
 - a. Reverse seated, air operated

CONTENT

METHODS AND ACTIVITIES

4. Operation
 - a. Air pressure from air distributor forces piston to move valve stem against valve spring to open valve
 - b. Spring will close the valve when air pressure is cut off and vented by the air distributor

EO: 1.3 Explain the starting sequence of the EDG Air Start System**CONTENT****METHODS AND ACTIVITIES**

- I. When either test mode or emergency start signal occurs, the diesel engine starts by the following sequence:
 - A. Electric signal causes air to be sent to
 1. Air distributor
 2. Air start valve of each cylinder via header
 - B. An air start valve is positioned to allow air into a cylinder
 - C. That air (250 psi) pushes down on piston
 - D. Engine starts to rotate
 1. As engine rotates cam shafts also rotate
 2. Air distributors, at end of cams redistribute air to the next air valve, according to firing order
 - a. This control air opens next air start valve.
 3. That next cylinder receives air forcing piston down.
 4. Engine picks up speed rapidly
 - E. Injection of fuel is also occurring at the same time
 1. When engine rpm's are sufficient fuel combustion sustains motion of pistons
 - F. Due to governor control (later in course under "controls") engine levels off at 600 rpm
 - G. Starting air shuts off at 178 rpm, or 10 seconds, whichever is first

CONTENT

METHODS AND ACTIVITIES

- H. With engine running, line from turbocharger air discharge to starting air intake headers purges air start piping to prevent explosion of any fuel that may leak past air start valve
- I. Air from turbocharger discharge is ported to air start piping and is vented through small orifice at air start control valve outlet flange

EO: 1.4 Explain the routine preventive maintenance performed on the EDG Air Start System**CONTENT****METHODS AND ACTIVITIES**

- I. Preventive Maintenance
 - A. Clean and Inspect the Starting Air Receiver
 - B. Replace Filter Elements and Clean and Inspect Starting Air Filter
 - C. Clean and Inspect Starting Air Dryer Drain Traps
 - D. Inspect Starting Air Piping and Air Dryers
 - E. Check Air Start Timing- This is done to verify that the air start distributors port air to the air start valve at the proper point relative to the crankshaft
 1. Two revolutions on flywheel are one complete cycle on cylinders
 2. **FLYWHEEL MARKINGS** are numbered marks on flywheel are for left side only at TDC.
 3. There are 72 degrees between left side cylinders
 4. The right side cylinders are 45 degrees after the left side
 5. Degrees are marked in one-degree increments 35 degrees before and after each left side TDC with two unmarked degrees between marked 35 degrees
 6. In firing order 1L (#1 Left) TDC, 1OR (#10 Right) TDC is 45 degrees later (or 27 degrees before 6L TDC), 6L TDC, 5R TDC is 45 degrees later (or 27 degrees before 9L TDC), 9L TDC, etc..

CONTENT**METHODS AND ACTIVITIES**

7. To find TDC on power stroke, check inlet and exhaust valves; if valves are closed, cylinder is TDC power stroke. If valves are open, cylinder is TDC exhaust stroke. Checking valve position is done by turning the push rods by hand. If the push rods turn easily, the valve is closed and the cylinder is on the power stroke. If the push rods do not turn easily, the valves are open and the cylinder is on the exhaust stroke.
8. If 1L is TDC power stroke, 10L is TDC exhaust stroke
9. Firing Order: 1L, 10R, 6L, 5R, 9L, 2R, 8L, 3R, 7L, 4R, 10L, 1R, 5L, 6R, 2L, 9R, 3L, 8R, 4L, 7R.
 - a. Basic Procedure:
 - 1) Verify Turning Gear is engaged
 - 2) Verify cylinder cock indicator valves are open
 - 3) Disconnect starting supply tubing to air distributor inlet. Left bank
 - 4) Disconnect air supply tubing for a selected cylinder from air start distributor
 - 5) Connect a temporary, regulated to ≤ 25 psig air supply, to the air start distributor inlet
 - 6) Rotate flywheel clockwise until it reaches 5 ± 1 degree ATC for selected cylinder
 - 7) If air escapes too soon, loosen four bolts securing body flange and rotate slightly counter-clockwise

NOTE: Air should start escaping from port on distributor just as flywheel comes up to 5.0 ± 1.0 degrees ATC (After Top Center) on power stroke of selected cylinder

CONTENT

METHODS AND ACTIVITIES

- 8) If air escapes too late, loosen four bolts securing body flange and rotate slightly clockwise
- 9) Tighten four bolts securing body flange
- 10) Disconnect temporary air supply from distributor inlet
- 11) Connect air supply tubing to the cylinder and starting air supply tubing to distributor inlet
- 12) Perform steps for right bank

SUMMARY OF MAIN PRINCIPLES

The following items are things to consider in your lesson summary. They are not mandatory. You should develop your own summary.,

Objectives Review

Review the Lesson Objectives

Topic Review

Restate the main principles or ideas covered in the lesson. Relate key points to the objectives. Use a question and answer session with the objectives.

Questions and Answers

Oral questioning

Ask questions that implement the objectives. Discuss students answers as needed to ensure the objectives are being met.

Problem Areas

Review any problem areas discovered during the oral questioning, quiz, or previous tests, if applicable. Use this opportunity to solicit final questions from the students (last chance).

Concluding Statement

If not done in the previous step, review the motivational points that apply this lesson to students needs. If applicable, end with a statement leading to the next lesson.

You may also use this opportunity to address an impending exam or practical exercise.

Should be used as a transitional function to tie the relationship of this lesson to the next lesson. Should provide a note of finality.