PALO VERDE
NUCLEAR GENERATING STATION

Instrumentation & Controls Training

Classroom Lesson

I&C Program	**Date: 5/8/2007**
LP Number: NIA02L000502	**Rev Author: Christopher A. Mahar**
Title: Loop Troubleshooting	**Technical Review:** Reynolds, James J(Z78347) Digitally signed by Reynolds, James J(Z78347) DN: cn=Reynolds, James J(Z78347), email=James.Reynolds@aps.com Reason: I have reviewed this document Date: 2007.05.10 11:33:41 -07'00'
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INITIATING DOCUMENTS:

Site Maintenance Training Program Description

REQUIRED TOPICS

NONE

CONTENT REFERENCES

CRDR 2693211 (TCSAI 2693757): U-1 EW-A Surge Tank Makeup wiring at Foxboro racks found incorrect per plant drwgs

CRDR 2604430 (TCSAI 2681777): Cover ERO tasks RK02, SHO4, PRO51 in NIA02.

Lesson Plan Revision Data

May 03, 2007 Chris Mahar Record created

Tasks and Topics Covered

The following tasks are covered in Loop Troubleshooting:

Task or Topic Number*	Task Statement
Lesson:	**Loop Troubleshooting**
PRO39	Troubleshoot an instrument loop
RK02	Uses troubleshooting job aid to diagnose failure of main control board annunciator section.
SH04	Collects thermocouple data in the event of RVLMS failure.
PRO51	Installs temporary recorder for plant monitoring.

Total tasks or topics: 4

TERMINAL OBJECTIVE:

1.1 Given the necessary tools, equipment, and references,, the I&C Technician will troubleshoot instrumentation and control loops. Mastery will be demonstrated by successful completion of all in class exercises, Laboratory Practical Evaluations and scoring 80% or better on an end of course exam.

1.1.1 Define Systematic Troubleshooting

1.1.2 Describe the four steps of troubleshooting

1.1.3 Describe the bracketing and half-splitting methods of troubleshooting

1.1.4 Troubleshoot an instrument loop

1.1.5 Discuss troubleshooting job aid to diagnose failure of main control board annunciator section.

1.1.6 Discuss how to collect thermocouple data in the event of RVLMS failure.

1.1.7 Install a temporary recorder for plant monitoring.

Lesson Introduction: Loop Troubleshooting

The following items are things to consider in your Lesson Introduction. They are not mandatory. You should develop your own introduction and place that material in the Program Hierarchy in the Lesson Introduction Tab or appropriate Training Unit.

CLASSROOM GUIDELINES

- If applicable, remind students of class guidelines as posted in the classroom.
- Pass the attendance sheet around and have it signed in Dark ink.
- Ensure that student materials needed for the class are available for each student.
- Emphasize student participation and remind them of your philosophy on asking and answering questions, if applicable.

ATTENTION STEP

- Give a brief statement or story to get student concentration focused on the lesson subject matter.

LESSON INTRODUCTION

- Give a brief statement that introduces the specific lesson topic. Should be limited to a single statement.

MOTIVATION

- Focus student's attention on the benefits they derive from the training. At Instructor's discretion. The need for motivation in each succeeding lesson must be analyzed by the Instructor and presented as necessary.
- Instructor should include how the STAR process can be used to improve or enhance Operator Performance, if applicable.
- Read and discuss lesson terminal objective and review lesson enabling objectives, if desired.
- If applicable, briefly preview the lesson topic outline and introduce the major points to be covered. The objective review may have been sufficient.
- REINFORCE the following PVNGS management expectations as opportunities become available:

  Nuclear Safety
  Industrial Safety Practices
  STAR and Self-Checking
  Procedure Compliance
  Communication Standards
  ALARA
  Prevent Events

[Introduction]

T.Obj 1.1	**Given the necessary tools, equipment, and references,, the I&C Technician will troubleshoot instrumentation and control loops. Mastery will be demonstrated by successful completion of all in class exercises, Laboratory Practical Evaluations and scoring 80% or better on an end of course exam.**

EO 1.1.1	Define Systematic Troubleshooting

1.1.1.1 Main Idea

Troubleshooting is a thinking skill It's not intuitive	Methods & Activities: Optional Refer to PPT slides
It is focused and logical Proficient troubleshooters avoid unnecessary and expensive fixes by using a step-by-step process to detect, analyze, and prevent problems	
Troubleshooting & Prevent Events What's the worst thing that could result from my troubleshooting? What impact am I going to have on the plant? (moving valves, tripping pumps, …) Even if the process is out of service, are there ways I could be affecting this or other systems? Shared sensing lines? Permissives? What else can go wrong?	
Troubleshooting & Pre-job Briefs Everyone must know: What is the plan What are the expected results What they need to do What are the potential problems, hold points Who is in charge	
Troubleshooting Definition Locating and diagnosing malfunctions or breakdowns in equipment	
Non-systematic methods: The Easter-Egging Method The act of replacing unrelated components more or less at random in hopes that a malfunction will go away	

Non-systematic methods: The Intuitive Method When confronted with a problem, you intuitively come to a solution based on what you know Relies heavily on the knowledge, experience and memory of the troubleshooter (Tribal Knowledge) Works great on problems you're familiar with Not systematic	
Non-systematic methods: The 'Something Must Be Done' method Intermittent problem, ghost problem, imaginary problem Problem is no longer present It's not good enough to simply say the problem is gone. "SOMETHING MUST BE DONE!"	
The System Verification Approach Check every wire, every connection, every component and every measurement from beginning to end Very logical, thorough and systematic Will usually find most problems Usually used on new system startups Slow Expensive	
The Four Steps of Systematic Troubleshooting Determine the symptoms Localize to a functional unit Isolate to a circuit Locate specific trouble	

Determine Symptoms You must know what is happening before you can determine why it's happening Based on observations Requires some knowledge of how the equipment normally works Normal system manipulation may be required Comparisons between good and bad channels may be valuable Every attempt should be made to determine the nature of the fault through passive means Localize to a functional unit Use system drawings, functional block diagrams, big picture information sources Based on symptoms Test equipment not used at this point Requires reasoning; which functional blocks could be causing the problem? Eliminates functional units from consideration	
Isolate to a local circuit Use prints, schematics, tech manual and more detailed technical sources Use test equipment extensively to determine inputs and outputs Abnormal system manipulations may be needed	
Locate Specific Trouble Use prints, schematics, tech manual and the most detailed technical sources Use test equipment extensively to isolate down to the component level Requires detailed knowledge of system internal operation, circuit operation, signal tracing Frequently done in the rework facility	

Other Methods of finding problems Change analysis Bracketing Half-splitting Linear troubleshooting (Input-Output checks) Kepner-Tregoe (KT) analytical 7-step troubleshooting® Failure analysis and Root Cause analysis Change Analysis Based on the notion that if a process has been operating correctly, something must have changed to cause the problem Identify factors that could affect equipment performance Collect pre-failure and post-failure information Analyze for change and determine if this factor impacted or caused the failure Good in the early stages of troubleshooting	
Bracketing Place the first bracket at a known good input Place the second bracket at a known bad output Move brackets across functional units to reduce the set of suspected-bad functional blocks Good for linear systems	
Half-Splitting A variation of the Bracketing method Primarily good for linear systems Check for a good output 1/2 way through the system Continue splitting the remaining functional units, checking at the 1/2 way point Each check eliminates half the system Good for systems with many connections or long cable runs	
Linear Troubleshooting Check the input and output of each functional unit Primarily good for linear systems Easy and effective for systems with few components	
Test Selection Criteria -or- what do I do first? Check the most obvious thing Do the test that eliminates the most functions Do the easiest tests first Based on past history Based on what is most likely to fail What part of any system is most likely to fail?	

Operating Experience on Troubleshooting

Ask for examples

Date:09-30-1998 **Subject:**OE9292 - Manual Reactor Trip Following Main Feedwater Valve Closure

Unit Name: Davis-Besse Year Commercial: 1977 NSSS/AE: B&W/Bechtel Rating: 920 Mwe Turbine Manufacturer: General Electric Event Date: September 24, 1998

Abstract:

Davis-Besse was manually tripped on September 24, 1998 from 100% power after a main feedwater regulating valve closed unexpectedly during testing. While performing Steam and Feedwater Rupture Control System (SFRCS) testing, operators observed that SP6B, #1 Main Feedwater Control Valve had closed. The operators manually tripped the reactor due to the closure of the control valve.

Description:

On September 24, 1998, Davis-Besse was operating at 100% full power. At 1234, Instrument and Control (I&C) personnel began performing the Channel Functional Test of SFRCS actuation channel 2 logic. An actuation channel consists of two complimentary logic channels. Actuation channel 2 contains logic channels 2 and 4. During performance of the logic channel 2 portion of the test, an indicating light for one of the #1 Main Feedwater Control Valve trip solenoid valves remained extinguished and did not light as expected when the SFRCS trip logic was reset. This indicated that the trip solenoid was in its deenergized (tripped) state. With the solenoid in a tripped state, the #1 Main Feedwater Control Valve would be in a half trip condition where a trip of the complementary logic channel (channel 4) would result in the closure of the valve. A Potential Condition Adverse to Quality Report (PCAQR) was written to document the problem and provide resolution.

Troubleshooting by I&C and Plant Engineering personnel incorrectly concluded that the failure of the indicating light to illuminate was due to a failed limit switch internal to the solenoid , and that the solenoid was in its energized (not tripped) position. When in fact the solenoid coil was energized, but the valve spool had not been properly repositioned due to an undetermined internal failure of the valve. The solenoid is a 120VDC model SV43 manufactured by Circle Seal Controls with an optional spool

	position indication switch. A procedure deficiency form (PDF) was written to document the testing deficiency. The resolution of the PDF was to complete the procedure as written. The test was then completed for SFRCS logic channel 2. I&C personnel then proceeded into the logic channel 4 (complimentary channel) portion of the test. As the step which simulated a SFRCS logic channel 4 actuation on steam generator #2 low pressure was performed, control room operators observed that the #1 Main Feedwater Control Valve had closed. The control room operators manually tripped the reactor. Following the trip, one main steam safety valve (MSSV), which had previously been gagged, lifted after the gagging device became disconnected. This valve failed to reseat properly until main steam pressure was manually reduced below setpoint. Approximately 6 hours after the trip, one turbine bypass valve (TBV) failed, resulting in a slight cooldown. Causes: The manual Reactor Trip was required due to the closure of the #1 Main Feedwater Control Valve, SP6B. SP6B closure was initiated due to a failed trip solenoid valve in logic channel 2 (SVSP6B1), with concurrent logic testing in the complimentary SFRCS logic channel 4. The causes of the MSSV gag becoming disengaged and of the TBV

	failure are still under review and further information will be supplied via a follow-up OE when it becomes available. Safety Significance: There were no safety concerns identified during the review of the transient. Control room operators initiated a manual trip after observing main feedwater control valve SP6B closed. All four RPS channels actuated on RCS low pressure as expected after the reactor trip. Corrective Action: SVSP6B1 was replaced, the Main Steam Safety Valve gag was reinstalled, and the unit was returned to power operation. 100% power was attained at 2354 on 9/26/98.

EO 1.1.2	Describe the four steps of troubleshooting

1.1.2.1 Main Idea

A. Determine Symptoms 1. Requires use of senses 2. Requires knowledge of proper operation 3. Observation of equipment performance 4. Comparison between proper operation and actual operation. a. Manipulate operating controls b. Performance of functional or surveillance checks c. Comparison between good and bad channels	Methods & Activities: Optional Refer to PPT slides
B. Localize to functional unit 1. Requires the information gained from symptoms 2. Using functional block diagrams and reasoning of the symptoms, determine the functional unit 3. No test equipment is used at this point.	
C. Isolate to local circuit 1. Requires the use of more detailed drawings 2. Test equipment is used extensively at this point	

D. Locate specific trouble 1. Uses schematics and test equipment to locate the faulty device.	

EO 1.1.3	Describe the bracketing and half-splitting methods of troubleshooting

1.1.3.1 Main Idea

A. Bracketing The bracketing method of troubleshooting consists of placing brackets on the block diagram. One bracket is placed at a known good input, the other bracket is placed at the bad output. The fault then lies between the brackets. Tests are then performed to localize the fault. The results of each test will be a basis for moving on of the brackets. Testing will continue until only one unit/circuit is left.	Methods & Activities: Optional Refer to PPT slides ***Bracketing*** Place the first bracket at a known good input Place the second bracket at a known bad output Move brackets across functional units to reduce the set of suspected-bad functional blocks Good for linear systems
B. Half-Splitting Half-splitting is a variation on the bracketing method. In this case the points to be checked are determined by splitting the system/functional unit in half. Each test will eliminate half of the circuitry.	***Half-Splitting*** A variation of the Bracketing method Primarily good for linear systems Check for a good output 1/2 way through the system Continue splitting the remaining functional units, checking at the 1/2 way point Each check eliminates half the system Good for systems with many connections or long cable runs

IV. System Configurations A. Linear In linear systems a signal is passed from one component to the next in a straight line fashion. B. Convergent In a convergent system, there will be may inputs which will be combine to provide one output. C. Divergent In a divergent system, there will be one inputs which will be shared to provide many outputs. D. Feedback The components used to control a process use the output of the process as the input to the process	The type of system determines your method of troubleshooting. The simpler the system, the less sophisticated your troubleshooting need be. In feedback systems, a problem anywhere in the loop can be apparent elsewhere in the loop In divergent systems, a problem early in the loop will be apparent in many points later in the loop.

EO 1.1.4	Troubleshoot an instrument loop

1.1.4.1 Main Idea

Refer to Lab Practical Exercise "Troubleshoot and tune an instrument loop"

To promote Lab fidelity, PPE will be worn during the final phase of the lab performance evaluation, (once demonstration phase is complete) and during practice and performance of TPE. PPE is expected to be worn equivalent to that worn if the activity being trained on were being performed in the field.

EO 1.1.5	Discuss troubleshooting job aid to diagnose failure of main control board annunciator section.

1.1.5.1 Main Idea

Discuss use of Appendix C of 40AO-9ZZ15, "Loss of Annunciators" to diagnose failure of main control board annunciator section, to include:	Methods & Activities: Optional
Loss of power supply	
Burned out indicator	
Ground on field wiring	
Loss of single inverter	
Push Button Interface Card malfunction	
Control Card/Clock Card malfunction	
MI Logic Card malfunction	
Discuss the Emergency Plan requirement for an I&C tech to jumper out an RK input. Discuss various job aids such as the RK signal tracing database maintained by Glen Smith at h:\i&C\common\RK Discuss the instructions for planners in 30DP-9AP01 appendix on how to write instructions for jumpering out RK points.	

EO 1.1.6	Discuss how to collect thermocouple data in the event of RVLMS failure.

1.1.6.1 Main Idea

Discuss how to take thermocouple data using applicable sections of '40EP-9EO10 STANDARD APPENDICES' in the event of HJTC heater failure.	Methods & Activities: optional Refer to PPT slides Pull up the procedure and go over the appendix pages.
a) Cover Appendix 101 of '40EP-9EO10'.	
b) Point out that performing section '101-E' is a contingency for QSPDS failure.	
c) Collect thermocouple data in the event of RVLMS failure, to include:	
• Finding needed thermocouple terminal points.	
• Measuring thermocouple signal.	
• Expressing signal in needed temperature engineering units.	Discuss the various meters that could be used to take millivolt readings or thermocouple readings.

EO 1.1.7	**Install a temporary recorder for plant monitoring.**

1.1.7.1 Main Idea

Refer to Lab Practical Exercise "Install a temporary recorder"	Methods & Activities: Optional
Install a temporary recorder for plant monitoring, to include:	
• Determining the signal range to be measured	
• Selecting compatible recorder	
• Connecting recorder	
• Interpreting recorded signal in needed engineering units	
To be done in the Laboratory as part of Lab Exercise	
To promote Lab fidelity, PPE will be worn during the final phase of the lab performance evaluation, (once demonstration phase is complete) and during practice and performance of TPE. PPE is expected to be worn equivalent to that worn if the activity being trained on were being performed in the field.	

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.