PALO VERDE
NUCLEAR GENERATING STATION

I&C Program

Classroom Lesson

I&C Program	**Date: 1/20/2011 1:50:54 PM**
LP Number: NID20C000102	**Rev Author: ROBERT M. PIERCE**
Title: Reactor Regulating System	**Technical Review:** Jones, Warren H(Z54741) Digitally signed by Jones, Warren H(Z54741) DN: cn=Jones, Warren H(Z54741) Reason: I have reviewed this document Date: 2011.01.25 08:21:30 -07'00'
Duration : 10 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: 2011.01.31 21:16:40 -07'00'

INITIATING DOCUMENTS

Site Maintenance Training Program Description

REQUIRED TOPICS

None

CONTENT REFERENCES

N001-1.01-413 : CE Setpoint Document

TCS 93-0968 : Test Panel Pushbutton Concerns

N001-1.01-842: CE Setpoint Document

TCS-97-1929 : Reactivity Management Concerns

0X-J-SFE-053 : (Reactor Regulating System Instrument Loop Diagram)

Repetitive Tasks: 058119 (Unit 1), 060272 (Unit 2), 060273 (Unit 3). "Reactor Regulating System Calibration and Functional Test"

TCSAI 2694161: Revise settings for Tref and Tavg in RRS to accomodate operating U2 at a new Tavg.

TCSAI 2815203: Provide the revised setpoints and spans to recalibrate affected instrumentation due to the Power Uprate in Unit #1

TCSAI 2962539: Include coverage of heat transfer/fluid flow, reactor safety design, print reading, electrical safety, plant systems, and PV Standards & Expectations in NID20, RRS training.

TCSAI 2681259: Evaluate course feedback from 2003 winter teach for incorporation into next teach cycle.

VTD-C490-00072 Reactor Regulating System Tech Manual

OE11964: Millstone Unit 2 08/31/2001; Charging/Letdown Transient Occurred during RRS calibration

CRDR 2810646: PV U2 03-30-2001: “THOT” input failed, demonstrating erratic operation with frequent drops in temperature

LESSON PLAN REVISION DATA

Jan 20, 2011	Rob Pierce	Record created
		12/10/02 - SME input on Prevent Events
		01/25/06 - Added Human Performance objective & Revised EO 8

Tasks and Topics Covered

The following tasks are covered in Reactor Regulating System :

Task or Topic Number*	**Task Statement**
Lesson:	Reactor Regulating System
SF04	Troubleshoot reactor regulating system
	Understands the reactor control programming
	Knows the purpose of the Reactor Regulating System
	Knows the source and range of input signals
	Understands how CEA motion demand signals are generated
	Knows the destination and range of output signals
	Understands how this system interacts with other systems
	Knows how to select the signals with the meter select pushbuttons
	Compares the actual signal values to normal signal values
	Relates the pushbutton names to points on the block diagram

Total task or topics: 10

TERMINAL OBJECTIVE:

1 Given the appropriate references material, , the I&C Technician will describe the operation and maintenance of the Reactor Regulating System. Mastery will be demonstrated by passing a written examination with a score of 80% or better.

1.1 Describe the method of Reactor Control programming used at PVNGS

1.2 State the purpose of the Reactor Regulating System

1.3 List the input signals for RRS and describe the source instrumentation of these signals

1.4 Given a block diagram of the RRS for a reference describe how the RRS uses signal inputs to develop CEA motion demand output signals

1.5 Describe the RRS outputs and the effect of these on other systems when RRS is placed in the test mode

1.6 Given the appropriate procedures describe how the testing of RRS is accomplished

1.7 Describe the use of Prevent Event Tools and Electrical Safe Work Practices to minimize human performance errors.

1.8 Given examples of RRS maintenance problems, determine the fault using applicable RRS prints, Tech Manual, and Setpoint Document.

TO: 1 **Given the appropriate references material, , the I&C Technician will describe the operation and maintenance of the Reactor Regulating System. Mastery will be demonstrated by passing a written examination with a score of 80% or better.**

LESSON PLAN	**METHODS AND ACTIVITIES**
EO 1.1.1 Describe the method of Reactor Control programming used at PVNGS	
1) Constant T stm/ T cold/ T avg a) Constant T_{steam} i) With this method, T_{steam} is compared to a local setpoint, and CEAs are moved to maintain T_{steam} at its setpoint through varying turbine load. ii) P_{steam} will remain constant. iii) Best efficiency on secondary side. P_{steam} remains constant at all pwr levels. iv) As power increases, T_{avg} and T_{cold} must rise significantly. This causes high fuel center line temps at high pwr and lots of CEA motion. b) Constant T_{avg} i) With this method, T_{avg} is compared to a local setpoint, and CEAs are moved to maintain T_{avg} at its setpoint through varying turbine load. ii) With lower fuel temps, CEA motion is minimized. iii) Bad for secondary efficiency P_{steam} reduces significantly at high power. c) Constant T_{cold} (Programmed T_{avg}) i) RRS employs programmed T AVG for Rx control. ii) Using this method, TLI is conditioned to create T_{ref} which is used as a "setpoint." T_{avg} is the measured variable. (Setpoint measured variable = ERROR) iii) This Temperature error is used to generate a control action. iv) Control Action is a CEA withdrawal or insertion demand.	Display ppt and refer participants to Figure 1 in HO. Contrast the three reactor control philosophies. Explain that this method of control is not often used. (One example seen in nuclear industry is Fort St.Vrain, Helium Cooled unit in Colorado. Fort St. Vrain has since been decommissioned. In 1996, generation from FSV began again, this time with a combustion turbine burning natural gas and generating 130 megawatts of power.) Same as used on Nuclear Sub PWRs. Least efficient

v) CEAs then reduce or increase RX pwr to bring T_{avg} back to proper value for current turbine load. vi) Because T_{avg} is used as the process variable, T_{cold} will remain constant. vii) Generally a good compromise between constant T_{steam} and constant T_{avg}. d) PVNGS Program i) Similar to the Constant T_{cold} program ii) Use PVNGS Operator Information Manual to illustrate changes in Tcold, Thot, and Tavg due to SGR iii) Difference is that T_{cold} varies from 564°F at 0% power to 554°F at 100% power iv) Thot varies from 564 °F @ 0% power to 611 °F at 100% power v) Disadvantages (1) 42°F subcooled margin (2) Requires a larger Pzr to maintain pressure stability during full load to no load RCS volume contraction vi) T avg varies from 564°F at 0% power to 583°F at 100% power	Use PVNGS Operator Information Manual to illustrate changes in Tcold, Thot, and Tavg U1 T_{cold} varies from 564 °F @ 0% power to 559.8 °F @ 100% power. U2 Tcold varies from 564 °F @ 0% power to 558.3 °F @ 100% power. U1 T_{hot} varies from 564 °F @ 0% power to 615.9 °F @ 100% power. U2 Thot varies from 564 °F @ 0% power to 614.4 °F @ 100% power. Optional: Explain actual Subcooled Margin, use PI U1 Tavg varies from 564.1 °F @ 0% power to 587.1 °F @ 100% power. U2 Tavg varies from 564 °F @ 0% power to 585.6 °F @ 100% power.

LESSON PLAN	METHODS AND ACTIVITIES
EO 1.1.2 State the purpose of the Reactor Regulating System	
1) Overview A) RRS acts as feedback controller to match primary power (using CEAs) to secondary load demand	Display ppt "Simplified Plant Diagram", Figure 2 in Handout. Give a basic description of RRS.
B) Monitors TLI as a measure of turbine load a) EHC sets turbine load for auto or manual b) RRS scales the TLI signal to generate a program (Tref) compatible with Tavg units c) Tref is the setpoint program, value based on turbine load. C) Monitors T hot and T cold and generates T avg as a measure of primary energy D) Closed loop control system maintains RCS T_{AVG} to a "setpoint" (programmed from TLI) E) Error generated from the comparison of Tavg to Tref is sent to CEDMCS to control Tavg to Tref F) Monitor reactor power and is used to provide a derivative action to the control system G) CEAs used as final control element	First stg steam pressure Since there are specific heatup rates allowed for the RCS, power increase rates are controlled. Since PVNGS operates All Rods Out (ARO) at full power, RRS is utilized for down power changes.
H) The RRS sends control signals to other NSSS control systems. a) FWCS - Tavg only b) SBCS (1) Tavg (2) Reactor power (3) CEA Automatic Withdrawal (4) Turbine Load Index c) CEDMCS (1) CEA Withdrawal/Insertion	Display ppt "NSSS Control Interconnections", Figure 3 in Handout. Describe the RRS interfaces.

(2) CEA High/Low Rate (3) Hi Tavg-Tref AWP (4) Automatic Motion Inhibit	
I) PLCS - Tavg only	Programmed Setpoint
J) RCS Temperature a) T_{cold} varies from 564°F to 554°F from 0% to 100% power b) Flow constant, the delta T across the core increases as steam demand increases c) Implies a specific T hot and T cold for specific power demand d) Example: (Values given are for U3 old SG) (1) 0%: T hot = 564°F, Tcold = 564°F (2) 50%: T hot = 587.5°F (23.5°F increase) 50%: Tcold = 559°F (3) 100%: T hot = 611°F (23.5°F more increase) 100%: Tcold = 554°F e) Therefore; a specific Tavg for a specific power demand	Values given are for Old SG (U-3) *(Heat transfer/Fluid Flow)*
K) EMPHASIZE: The two purposes of RRS are: **a) Move CEAs to cause primary temperature program (Tavg) to follow secondary demand (Turbine Power)** b) **Maintain T_{avg} at the T ref program with a constant T_{cold}**	

LESSON PLAN	**METHODS AND ACTIVITIES**
EO 1.1.3 List the input signals for RRS and describe the source instrumentation of these signals	
1) HARDWARE	
a) Signal Inputs	Use drawing 02-J-SFE-053 (Sheet 2 of 16)
i) T avg	
(1) Two T_{cold} RTD's, located on the cold legs of Loop 1A and 2A, scaled for 0-10 VDC out for 500-650°F.	Mention recent discovery that RTD signals fluctuate, possibly due to "non-homogenous" mixture of RCS water.
(2) Two T_{hot} RTD's, located on the hot legs of Loop 1 and 2, scaled for 0-10 VDC out for 500-650°F.	
(3) Loop #1 T_{AVG}: T_{HOT} and T_{COLD} for Loop #1 averaged by summer card R301 to produce Loop #1 T_{AVG}.	
(4) Loop #2 T_{AVG}: T_{HOT} and T_{COLD} for Loop #2 averaged by summer card R302 to produce Loop #2 T_{AVG}.	
(5) Selector switch S11 selects either Loop #1 T_{AVG}, loop #2 T_{AVG} or the average via R303.	
(a) The average position is the normal operating position.	Explain that a Deviation Alarm in the TLI or the ϕ_N loops will also produce an AMI through R713 and R612 RK and Computer alarms from R611.
(b) If a difference $\geq$5°F or 3.3 % exists between the two inputs a T_{AVG} deviation alarm is generated by a 2AP+ALM-BS card (R 307). When the switch is in the "Average" position, an Automatic Motion Inhibit (AMI) signal will also be sent to CEDMCS.	
ii) TLI	
(1) Two Turbine Load Indexes (TLI), located on the Turbine First Stage, scaled 0-10 VDC out for 0-864 psig for	U1 TLI = 0-915 psig U2 TLI = 0-900psig

0-125% load. (U3 old SG)

(2) Deviation signal processing is similar to Tavg processing (deviation is at 5 %, 4% of the signal)

iii) ϕ_N

(1) Two Control Excore Channels, scaled 0-10 VDC out for 0-125% Reactor Power.

(2) Deviation signal processing is similar to Tavg processing (deviation is at 5 %, 4% of the signal)

b) Temperature Compensation Circuit

(1) Compares Reactor Coolant System T_{AVG} to a programmed setpoint (T_{REF}) generated from turbine power (TLI)

(2) TLI needs to be scaled down to be compared with T_{AVG} so that the error signal produced can be a power modulated temperature signal (Values for U3 are being used)

(a) A Dual Scaler is used to develop this scaling (R322)

(b) A Signal Limiter is used to prevent a signal of greater than 100% demand (R323)

(c) Output is designated Tref

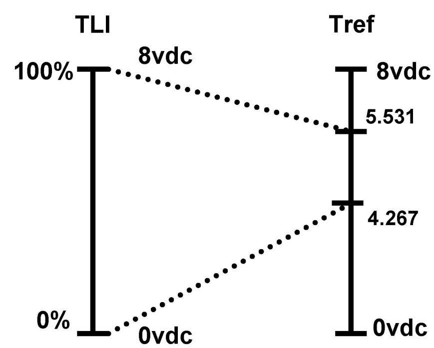
(3) T_{REF} and T_{AVG} are summed (R325) to produce a temperature error signal (ε_T) which:

(a) 5vdc output bias produces 5vdc when both Tavg and Tref are equal

(b) Tavg>Tref: additive to the bias; Tref>Tavg: subtractive to the bias

(c) Summer output > 5vdc: insertion demand;

Refer to drawing 02-J-SFE-053 (SH 3 of 16)



R322 U1: 0 – 8 vdc input
4.273 - 5.809vdc output

R322 U2: 0 - 8vdc input
4.267 – 5.771 vdc output

ε_T' is Compensated Temperature

Error signal used to generate the error summation signal for the control and alarm outputs to CEDMCS.

(d) summer output < 5vdc: withdrawal demand

(4) Outputs to an Alarm Card and a dynamic compensator

(5) Alarm card (R310)

(a) High and low alarms for a ε_T delta T of 6°F

(b) Provides a high or low alarm, (low alarm in conjunction with an AWP)

(6) The Dynamic Compensator (R327) is configured as a pure lag function

(a) Compensate for the spurious rod motion due to noise from the T hot RTD's

(b) Output is designated as Compensated Temperature Error

c) Power Compensation Circuit

(1) Compensated power error signal (ε_β') is generated by combining TLI and Reactor Power signal (ϕ_N) in a dynamic compensator.(output on changing signal only). (R324)

(2) Provides a derivative action to increase the response of the system

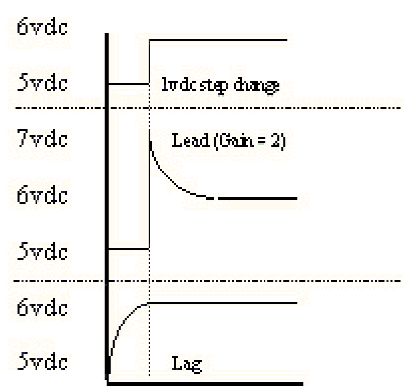
(3) Output proportional to the <u>rate</u> of change of the 2 input signals

(4) There is a 2 vdc output for no change. This feature ensures that errors in the measurement of RX power via flux will not cause the T_{avg} program to be erroneously biased and thus the need to periodically calibrate the excore channels is minimized

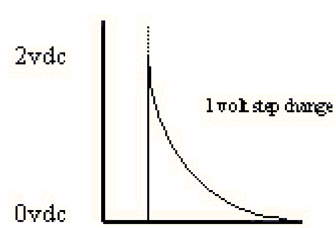
(5) TLI>Neutron flux: subtractive effect (withdrawal demand)

Mismatch of 3 degrees

Describe the three possible configuration for a DYC (Lead, Lag or
Impulse)



Lead/Lag function is determined by the gain



Impulse provides derivative action. (Gain = 2)

(6) Neutron flux>TLI: additive effect (insertion demand) d) CEA Motion Demand Signals (1) Summer R326 has ε_β' and ε_T' at the inputs and the output signal is called the Compensated Error Signal (ε_C). (2) Biasing (a) Such that at steady state conditions the output = 5vdc (b) Provides conversion to compare power and temp on a 1:1 (3) Additive/subtractive logic same as power/temperature circuits (4) ε_C is used to produce various signals to CEDMCS for CEA motion (5) Two alarm cards provide contact status to CEDMCS for rod motion demanded (a) R312 provides: (i) Slow withdrawal (3.5vdc) or insertion (6.5vdc) demand (ii) Appropriate status lights illuminated (b) R311 provides: (i) High rate regardless of the ε_C value due to OR gate (R721) (ii) Appropriate status lights illuminated (c) For R311 to provide an output, R312 should be providing an output (d) R311 determines rate, R312 determines insertion or withdrawal (e) Only fast withdrawal enabled at	RRS is always on. It only can provide a control action when CEDMCS is in Auto Sequential. This is done within CEDMCS ε_C used directly as a 0-10 vdc Motion Demand Signal.

CEDMCS due to heat up rates ***Prevent Events: Technicians should be aware:*** *Reactor Regulating System (RRS) provides Reactor Coolant Average Temperature (T_{AVG}) signal to Pressurizer level control system.* *Tavg signal sent to the Feedwater Control System (FWCS)* *Tavg signal sent to the Steam Bypass Control System (SBCS)* e) Outputs (1) Tavg (a) SBCS (b) FWCS (c) PLCS (d) Recorder (2) TLI - SBCS only (3) Neutron Flux - SBCS only	

<table>
<tr><th>LESSON PLAN</th><th>METHODS AND ACTIVITIES</th></tr>
<tr><td>EO 1.1.4 Given a block diagram of the RRS for a reference describe how the RRS uses signal inputs to develop CEA motion demand output signals</td><td></td></tr>
<tr><td>1) SIGNAL PROCESSING
A) Using the CE Setpoint Document
a) Find the Table of Contents. (pg 75 of 397)
b) Locate the NSSS Control System you are working on (in this case RRS).
c) The Setpoint Document Number is made up of the combination of the Nest and slot numbers in ascending order. To obtain the Setpoint Document number/location either:
(1) Look up the Tag Number on the RRS Module Index in the setpoint document on page 78.
(2) Find the Tag number in the CE Tag Number column and trace across to the left to find the Location/Setpoint document number/location in the location column.
d) The Setpoint Document has 4 columns across the page, and depending on the type of instrument the information in each column will vary. The columns are:
(1) Adjustment; which denotes what adjustments are available on that module.
(2) Setting; which indicates what value the adjustment should be set at.
(3) Remarks; provides pertinent data on the adjustment
(4) Parameter value; provides information such as Tau and time values.
e) At the bottom of the second page on some</td><td>Employ All Unit Edoc CE Setpoint Document 13-N001-0101-413-41 in support of circuit descriptions, for Ppt and Figure 4 in the HO
Prevent Events: Make sure Data is correct – Check for SDCN's/ “Change Mechs”
(Unit specific CE setpoint Documents N001-0101-842 available in hard copy in Unit Libraries)

Reference 2AP+DLS (R322) and determine the Document number/location to be R45 (Page 96)

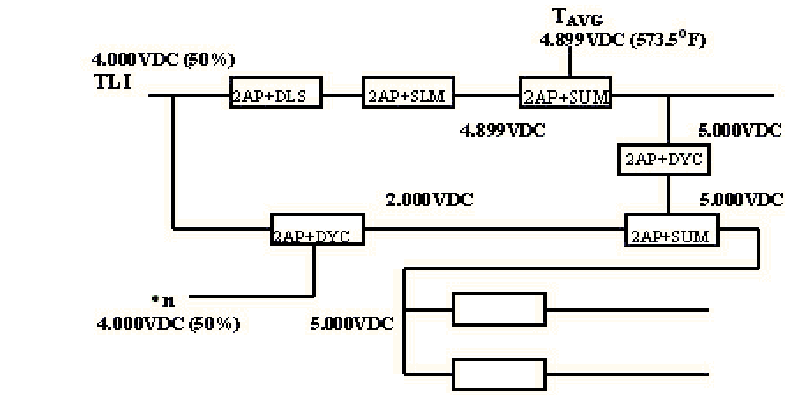
Reference R45

Reference R48 (Page 100 & 101)</td></tr>
</table>

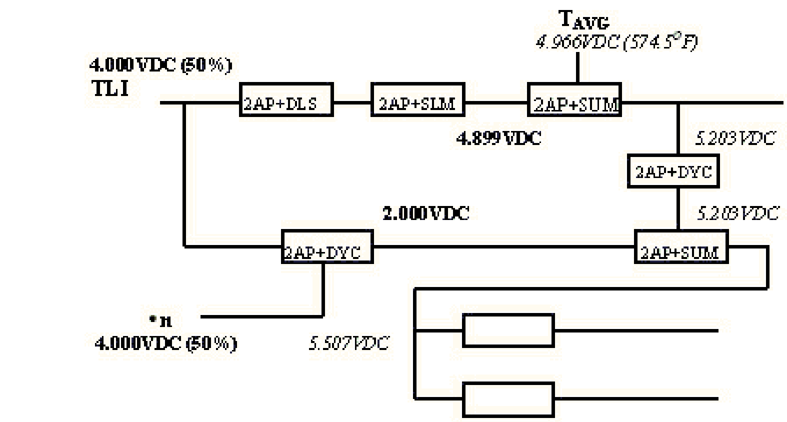
of the setpoint documents there is a section where the math formulas for that module are shown along with the input and output waveforms (do not depend fully on the waveforms being correct). In most cases there is also an appendix listed. Turn to the appendix listed and it will show the waveforms (input and output) that you will get on an X/Y plotter.	Reference R49 (102 & 103) Appendix A (283) Refer to 03-J-SFE-053 (sheet 3 of 16)
B) Temperature Compensation Circuit a) The math performed by this circuit determines the difference between load demand (TLI/T REF) and primary power (T AVE) b) TLI is conditioned by a 2AP+DLS (R322) (U3); (1) $V_{out} = V_{in}$ X Gain + Bias (2) With Gain = 0.158, Bias = 4.267 Vdc	Emphasize the necessity of checking the SDCN's in the front of the CE Setpoint Document
Prevent Events: Questioning Atitude:*13 –N001-0101-00413 CE setpoint book does not list all values for all cards in all units.* *01,02,03-N001-0101-00842 unit specific CE setpoint books are available in units.*	Go to the RRS task
C) Point out that the same information can be found in the RRS task, and is easier to find.	
Prevent Events: Procedure Use and Adherence; *Stress that certain cards have different calibration values depending on which Unit is referred to. Point out examples R322, R323, that are used to develop Tref. Note RRS task Prerequisites.*	
a) R323 2AP+SLM limits the reactor power being demanded to 5.53 vdc or 100% power b) T_{ref} and T_{avg} are compared @ R325 to obtain the Temperature Error Signal (ε_T) (1) Output bias = 5.0 vdc	

(2) Gain for both inputs = (3) Vout = 3 X (Input A) – 3 X (Input)B + 5 (4) When Primary energy equals secondary demand the output is 5vdc c) Compensated Temperature Error Signal (ε_T). (1) This output ε_T feeds a dynamic compensator (R327), to stabilize the response of ε_T and is called $\varepsilon_{T'}$. (2) Gain = 0 or minimum (3) Tau = 0.1 minutes	
D) Compensated Power Error Signal a) R324 is configured in the <u>+/-</u>Impulse configuration. The output, called ε_b', is in proportion to the rate of change of the inputs. b) Gain = 1.25 c) Tau = 0.5 minutes d) There is a Bias of +2 VDC applied to the output signal.	With no rate of change detected the output = 2 vdc Discuss math performed by summer: Input A ($E_{t'}$) = (5.0 vdc)(2.5) = 12.5 Input D ($E_{b'}$) = 2.0 vdc - 2.0 vdc = (0)(5) = 0
E) CEA Motion Demand Development. a) Compensate Error is developed by R326 (1) R326 has a gain of 2.5. (2) The e_B' signal input to the summer has a -2 vdc bias to negate the +2 vdc bias "live zero" applied to the output of R324. (3) A gain of 5 2.5 is applied to the ε_B' input. (4) A bias of -7.5 vdc is applied to the output of the summer. Input A ($E_{t'}$) = (5.0 vdc)(2.5) = 12.5	Output = 12.5 + 0 - 7.5 = 5 vdc Illustrate trip points as follows: 10.0 vdc +5.0° 7.3 +4.5° Fast Insertion 6.5 +3.0° Slow Insertion 5.0 0° 3.5 -3.0° Slow Withdrawal 2.7 -4.5° Fast Withdrawal 0.0 -5.0°

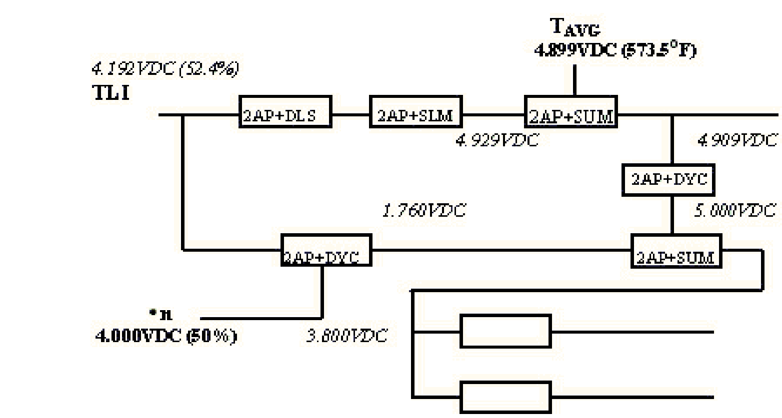
Input D ($E_{b'}$) = 2.0 vdc - 2.0 vdc = (0)(5) = 0 Output = 12.5 + 0 - 7.5 = 5 vdc b) **(Refer to Task for U3)** (1) Bistable R312 (2AP+ALM-AS) trips at: (a) 3.50 vdc (-3°F) for slow CEA withdrawal demand (CEAs move 4"/minute). (b) 6.50 vdc (+3°F) for slow CEA insertion demand. c) Bistable R311 (2AP+ALM-AS) trips at: (1) 2.735 vdc (-4.53°F) for fast CEA withdrawal (CEAs move 40"/min). (2) 7.265 vdc (+4.53°F) for fast CEA insertion. d) The ε_C signal is fed to a control room indicator on RMNBO4 F) Tavg-Tref/AWP Circuit a) ε_T of 6.2 vdc will cause a R310 Hi Alarm which will cause: (1) R614 contact isolator to output a T_{avg} - T_{ref} Alarm High. (2) R623 contact isolator to output a T_{avg} - T_{ref} High Automatic Withdrawal Prohibit. b) ε_T of 3.8 vdc will cause an R310 Low alarm which will cause R613 to output a T_{avg} - T_{ref} Low Alarm. G) Signal processing example (OPTIONAL)	**Fast Withdrawal not wired up at CEDMCS, for conservatism**



STEADY STATE CONDITION



1°F CHANGE IN T_{AVG}



2.40% CHANGE IN TLI

2) Testing

A) Test Features.

a) RRS Test Panel.

(1) Located in 01-03J-SFN-C03R (Behind the Control Room) (2) Input selector switches for: (a) T_{AVG}. (b) TLI. (c) ϕN. (3) Test/operate switches. (4) Test pots. (5) External test switches/selector switches. (6) Alarm lamps. (a) Light test switch. (7) DVM. (a) Meter input selection B) Monitoring a) RRS parameters can be monitored without interfering with system ops. b) DVM displays in VDC. c) DVM on/off switch. C) RRS Testing Precautions Test Mode. 1) ***Prevent Events: Pre-job Briefs, Procedure Adherence;*** *Prior to Placing RRS in test mode be aware:* *a) Reactor Regulating System (RRS) provides Reactor Coolant Average Temperature (T_{AVG}) signal to Pressurizer level control system. J-RCN-LIC-0110 must remain in Manual control with Local Setpoint to avoid tripping Charging Pumps when performing testing.* b) ***PLCS must be in local****. Verify/place the Pressurizer Level Controller J-RCN-LIC-110 (B04) in Manual Control and Local Setpoint.* c) ***CEDMCS must be in manual.*** *Verify/place Mode*	

Select Switch on CEDMCS Operators Module (J-SFN-UIC-0006) on B04 in any position except AS (Auto Sequential). d) *At RRS Test Panel in J-SFN-C03R, Verify*: i) '**PLCS IN LOCAL OR MANUAL**' *light is illuminated.* ii) '**CEDMCS IN MANUAL**' *light is illuminated* ***e)*** *Verify Reactor Power Cutback system in* **'AUTO-ACTUATE OUT OF SERVICE'** *(In modes other than 5 or 6 SBCS should be in* **'EMERGENCY OFF'** *and each SBCV in'* **OFF PERMISSIVE**) 2) Depress Test Switch (a) After test switch is depressed, inputs to system come from test pots (or external signal or test signal pot). ***Prevent Events, Two minute drill;*** *Between selecting test pushbuttons it is necessary to depress the TEST PROBE button to prevent shorting out of signal and verify the DVM reads no voltage* (TCS 93-0968) *(b) Between selecting test pushbuttons it is necessary to depress the TEST PROBE button to prevent shorting out of signal and verify the DVM reads no voltage* (c) Place RRS in test mode to perform circuit testing or troubleshooting	

LESSON PLAN	METHODS AND ACTIVITIES
EO 1.1.5 Describe the RRS outputs and the effect of these on other systems when RRS is placed in the test mode	
Prevent Events - Procedure Use & Adherence, Pre-Job Brief; *RRS outputs effect other systems when RRS is placed in test mode; Procedure has Precautions/Prereqs for mode 5 or 6, and online testing to minimize plant impact. Pre-Job Brief with Ops should ensure compensatory measures have been taken if testing online.* *1) T_{AVG} to FWCS:* *A) Provide measured variable for S.G. level control after a Rx trip. (Refill demand signal)* *B) 10 vdc from transfer switch R609 ensures the S.G. will fill following a Rx trip.* *a) Could overfill the S/G thus causing over cooling* *2) T_{AVG} to SBCS:* *A) Low T_{AVG} and Rx trip together will give SBCS a quick opening block.* *B) With T_{AVG} failed high, this function is disabled and this auto block will not occur following a Rx trip (T_{AVG} will never go low).* *C) This has the <u>potential</u> of possibly causing overcooling of the RCS following a Rx trip if the system remained in test. (Good potential for a SIAS from RCS Lo pressure).* 3) ΦN: Signal to SBCS may cause low power AMI during testing. Signal to FWCS not affected. 4) TLI : Signal to SBCS may cause an AMI or it may prevent a turbine runback on a reactor power cutback signal. 5) PLCS: The T_{AVG} signal to PLCS will vary during this test; however, the PLCS will be in local or manual	*TCS-97-1929 (Reactor Safety Design)* *Cover the following effects using the RRS task as needed* *QO would overcool RCS; instead of modulation* *(Reactor Safety Design)* Explain that this is unimportant as CEDMCS is in manual. Explain that this is also unimportant as CEDMCS is in manual. PLCS uses Tavg as a remote level setpoint input to the PLCS controller

control.	

LESSON PLAN	**METHODS AND ACTIVITIES**
EO 1.1.6 Given the appropriate procedures describe how the testing of RRS is accomplished	
1) Testing. A. *Prevent Events, Participate in Pre-Job Briefs: Control Room operator* <u>*should*</u> *be briefed that* T_{AVG} *to SBCS and FWCS fails high when RRS is in test.* B. *Control Room operator* <u>*should*</u> *be briefed that he can switch RRS from test to operate mode at any time by taking the PLCS control station to the Auto-Remote Position.* C. Procedures: a. "RRS CALIBRATION & FUNCTIONAL TEST" D. Testing of E_B' function difficult with mathematical certainty because steady state effect is zero.	Refer to Repetitive Tasks: 058119 (Unit 1), 060272 (Unit 2), 060273 (Unit 3). Example: Repetitive Task: 060273

LESSON PLAN	**METHODS AND ACTIVITIES**
EO 1.1.7 Describe the use of Prevent Event Tools and Electrical Safe Work Practices to minimize human performance errors.	
Prevent Events, Electrical Safe Work Practices; *Remind students that I&C personnel do not exclusively deal with low voltage signal processing (less than 50 volts). As a minimum safety glasses will be worn when working inside signal cabinets.* ***Two Minute Drill:*** *Troubleshooting boundaries may change. Power supplies, fuses, bus bars, etc, located in and around the Signal Processing cabinets often carry voltages greater than 50 volts. Appropriate measures should then be observed when checking these components (i.e. use of low voltage gloves, etc.)* *Maximum voltage encountered in RRS cabinets is 120vac. Per Electrical Safe Work Practices procedure, 01DP-0IS13, the restricted approach boundary and prohibited approach boundary for qualified employees is 'Avoid Contact'.* ***1) Prevent Events, Stop when Unsure - OE11964: Millstone Unit 2 08/31/2001; Charging/Letdown Transient Occurred during RRS calibration.*** *a) What happened?* *i) During calibration of RRS a Charging/Letdown transient occurred when a RTD lead was lifted in accordance with procedure.* *(1) Techs followed procedure, but were not alert to erroneous procedure change.* *b) Why did it happen?* *i) Cause of this event was inadequate preparation and review of procedure change which did not take into consideration the system design.* *(1) Procedure was not properly reviewed*	*Last line of defense*

(2) Initiator was independent reviewer *(3) Technicians did not catch error during pre-job brief or performance* *c) Could it happen here?* *i) PV RRS task is usually performed during refuel outages in Modes 5 & 6.* *(1) Precautions/Prereqs RRS task require placing PLCS in Manual control with Local Setpoint prior to testing.* *ii) RRS task could be used online for calibration, retest, or troubleshooting;* *(a) Failure to follow procedure could cause similar event* *(b) RRS task rewrite could cause similar event if procedure Precautions/Prereqs were made inadequate.* *d) How could we prevent this event?* *i) Procedure Compliance* *ii) Taking time to understand & question changes in recently revised procedures* *iii) Adequate Pre-job Briefs* *iv) Questioning attitude; I have done this test before but something's different!* *2) **Prevent Events, Operating Event:** Palo Verde U301-01-1991; TLI 2 input signal had drifted below the desired setpoint limit, causing an AMI. System Channel was degraded.* *a) What happened?* *i) TLI2 had drifted below desired setpoint limit causing an AMI when TLI avg was selected. System channel was degraded* *b) Why did it happen?* *i) Troubleshooting by I&C personnel determined cause of TLI2 1st stage pressure*	*Optional; review RRS task Precautions/ Prereqs with students* *Funny feeling moment*

xmitr decreasing signal to be caused by 'CRUD' buildup in sensing line. c) *Could it happen again?* i) *Site Unit chemistry has improved but evidence of 'Crud' can still be seen in secondary systems.* d) *How can PV prevent a reoccurrence?* i) *During PM performance open secondary systems should be checked as to overall system condition.*	

LESSON PLAN	**METHODS AND ACTIVITIES**
EO 1.1.8 Given examples of RRS maintenance problems, determine the fault using applicable RRS prints, Tech Manual, and Setpoint Document.	
1) Maintenance & Troubleshooting Practices a) **Paper Troubleshoot:** Operations receives an AMI (Automatic Motion Inhibit) and an alarm “RRS INPUT DEV ALARM” b) Ask students which inputs would cause AMI. c) Operations received TAVG DEV ALARM. They also noted that Tavg1 was significantly less than Tavg2. i) Tavg1 loop is problem ii) Ask students what loop components could be checked to help establish problem in Tavg input. (1) Discuss related cards. iii) Ask students what indications could be checked (1) Ask students what indications would be expected. iv) What passive checks could be made? v) How could problem be isolated to card? To RTD? (1) Cards expected resistance inputs checked against expected card outputs. (2) Thot inputs could be checked against each other. Same for Tcold inputs. (3) If Foxboro card needed replacement where would info be found on jumper configuration. a) CE Final Setpoint Document	Perform Paper troubleshooting on following problems with class. Discuss possible causes with students before adding more information. Tavg deviation, TLI deviation ØN deviation Two different Tavg signals, related cards Two different signals that create Tavg, i.e.; Thot1 & Tcold1, Thot2 & Tcold2 from RTDs. e.g. Visual Indications, Card voltage inputs/ outputs (As Temp goes up RTD resistance increases) Use unit specific CE Setpoint Document

2) ***Prevent Events, discuss CRDR 2810646:*** *PV U2 03-30-2001: "THOT" input failed, demonstrating erratic operation with frequent drops in temperature* *a) Have students read CRDR and discuss root cause* *i) Could problem occur in RRS?* *(1) Low insulation resistance occurred in a newly replaced RTD.* *(2) Problem attributed to manufacturing. Though at this time is considered to be isolated occurrence* *ii) Ask students what effect would this problem have on RRS if one of its Thot RTD inputs similarly failed?* *(1) Tavg deviation alarm, AMI* (2) *System would have to be switched to good input until problem was corrected*	*Tavg deviation alarm, AMI*
iii) Ask students what kind of indications would be observed if a similar problem occurred on a RRS Thot RTD. *(1) Low output from Foxboro RTD input card.* *(2) Lower than expected resistance when RTD is checked.* (a) *Checked at cabinet, leads would have to be lifted. Prior to performing this Pre-job brief with Ops would have to be performed.*	*Passive check* TLI deviation, ØN deviation
3) **Optional:** Discuss other inputs besides Tavg deviation which would cause an AMI. a) Operations receive a TLI deviation. i) Operations also noted TLI-2, PT11B indication is significantly lower than TLI-1, PT11A. ii) PT10 (used by EHC) 1st stage turbine pressure reads the same as PT11A (1) What does Ops need to do to continue	Ask students what other indications could be checked? (What is TLI anyway?) Students should conclude problem is in PT11B loop.

operating RRS appropriately? (a) Set RRS from TLI avg to TLI1 iii) Discuss with students possible checks that could be performed on PT11B loop (1) What checks would be used to identify a bad card? (2) Identify a bad xmitr? 4) Have students pair up and create trouble shooting scenarios. a) Emphasize that scenarios will have indications and proper system response b) Scenarios need to address proper use of Prevent Event tools and Electrical Safe Work Practices associated with replacement or repair. c) After 30 minutes have students present troubleshooting scenarios for class to solve. i) Ensure that the use of Prevent Event tools and Electrical Safe Work Practices is addressed. d) Have class vote on best scenario, best solution. 5) Optional if needed: **Paper Troubleshoot:** Ops receives an AWP. a) What causes an AWP? b) What indicator would be a very good place to start? i) Recorder (Half split) (1) Indications good: (a) Half split toward outputs (2) Indications bad: (a) Half split toward field inputs (b) What compensatory measures could Ops take if field inputs are bad? c) As students progress through loop ask what	Discuss passive checks versus checks that affect equipment

indications would be observed. i) Have students identify passive checks versus checks which would disturb the loop. 6) RRS Technical Manual a) I Introduction b) III Functional Description (Page 9) c) IV RRS Interface Functions (Page 16) d) V Equipment Description i) Note Fig 8A, 8B e) Section 3 Interface Design Requirements i) Provides ranges ii) Contact status iii) Sources and Destinations iv) Indications f) Section 4 Operating Procedure Guideline is for operators. g) Section 5 Troubleshooting i) Preferred Method: The steps listed are the very basic steps to be used when isolating a problem ii) Troubleshooting Example: Some of the data here is hard to follow, but the basic procedure is worth looking at. h) Section 6 Recommended Spare Parts: Lists 1) The spare parts that CE suggests be kept on hand for routine maintenance. The actual level has to be determined by each plant.	An overview of the information contained in the RRS tech Manual
Prevent Events: Tech Manual Drawings are not maintained *Tech Manual drawings may not be up to date and shall be used as "Information Only". Most Tech Manual drawings are available as an AS-BUILT controlled drawing.*	Convenient single location for information when doing paper troubleshooting/ brainstorming
i) Section 7 System Drawings.	Explain that the diagram is in two

No work shall be performed using Tech Manual Drawings. AS-BUILT controlled drawings should be used. i) NSSS Control Systems Block Diagram Legend (1 Sheet): Shows most of the symbols used on the block diagrams (1) Go over Allen Bradley logic versus Foxboro logic using Sheet 1 ii) NSSS Control Systems Cabinet Rack Loading Diagram(4 Sheets):Shows the rack location of the components of the following systems: (1) RRS (2) SBCS iii) FWCS iv) NSSS Control Systems Cabinet Termination Diagram (5 Sheets): Shows the wiring of the jacks and terminal boards in the racks. (1) NSSS Control Systems Cabinet Power wiring Diagrams (8 Sheets): Shows: (a) Power supply locations (b) AC Power connections (c) DC Power connections (2) RRS Hardware block diagram (2 Sheets) (3) RRS Wiring Diagrams (6 Sheets) (4) RRS Test panel layout (4 Sheets) **Optional: Perform Print exercise:** Have students Trace TLI1 signal using As-Built drawings XX-SFE-053 (Sheets 1 thru 16)	parts 1st section shows Foxboro symbols, and the 2nd section shows Allen Bradley symbols. FWCS has been upgraded to Digital DFWCS. Drawings may not be up to date. Explain the use of these diagrams in finding locations when tracing a signal, and when replacing units. The 1st sheet shows 1) Installation Notes 2) Wiring Notes 3) Color Coding 4) Wire Sizes 5) Rack Bill of material

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.