PALO VERDE
NUCLEAR GENERATING STATION

Instrumentation & Controls Training

Classroom Lesson

I&C Program	**Date: 6/10/2008**
LP Number: NID60C0000201	**Rev Author: Christopher A. Mahar**
Title: Digital Feedwater Control System	**Technical Review: Dennis Sloan**
Duration : 20 Hours	
	Teaching Approval: Jeffrey Freitas Digitally signed by Jeffrey Freitas DN: cn=Jeffrey Freitas, c=US, o=Maintenance Training, ou=9611, email=Jeffrey.Freitas@aps.com Reason: I am approving this document Date: 2008.06.05 19:11:15 -07'00'

INITIATING DOCUMENTS:

Site Maintenance Training Program Description

REQUIRED TOPICS

NONE

CONTENT REFERENCES

Foxboro I/A Series Equipment Installation Manual

Foxboro I/A Series Hardware description Manual

TCSAI 2730892 DIGITAL FEEDWATER CONTROL SYSTEM (NID60) REVISION DUE TO THE COURSE FEEDBACK COMPILATION

Lesson Plan Revision Data

May 28, 2008	Chris Mahar	00 Robin Meredith New Course 5/26/2000 01 Added EO01, removed EO06, EO07 and EO09 per SME. Changed perfomrance objectives to comprehension objectives due to the DFWCSs being installed in the units and hands on no longer possible 02 Chris Mahar 5/28/2008 added objective on self checking to satisfy procedure requirement to have HU objective in continuing courses

Tasks and Topics Covered

The following tasks are covered in Digital Feedwater Control System:

Task or Topic Number*	Task Statement
Lesson:	Digital Feedwater Control System
SF18	Troubleshoot Digital Feedwater Control System
SF19	Perform Preventive Maintenance Associated with the Digital Feedwater Control System

Total tasks or topics: 2

TERMINAL OBJECTIVE:

1.1 Given the necessary references,, the I&C team member will troubleshoot and maintain the Digital Feedwater Control System. Mastery will be demonstrated by passing a written exam with at least 80%.

1.1.1 Describe the operation of the Main Feedwater System during normal operation

1.1.2 Contrast the operation of three element level control with single element level control.

1.1.3 Identify the input/output signals for the Digital Feedwater Control System, including their origin/destination.

1.1.4 Explain the operation of the Digital Feedwater Control System control system during the following operational conditions:
0%-16.5%
16.5%-50% Power
50%-100% Power
High Level Override
Reactor Tripped Override
Abnormal Conditions
Maintenance

1.1.5 Describe the various means of communication between Digital Feedwater Control System Components.

1.1.6 Describe the function of the following components:
Field Bus Modules (FBM)
Control Processor (CP40)
Application Workstation (AW)
Workstation Processor (WP)
Dual Node Bus Interface (DNBI)
Dual Bus Node Extension (DNBX)
Field Bus Isolators
Fiber Optic Modems
Flat Panel Displays
Display Stations
Power Supplies
Tri-Loop Converters

1.1.7 Describe how the FoxSelectFoxView can be utilized during maintenance.

1.1.8 Describe system and process alarms.

1.1.9 Describe the Re-booting of a computer station within the Digital Feedwater Control System.

1.1.10 Describe how a failed component can be identified.

1.1.11 Describe how failed components are replaced.

1.1.12 Describe why Self Checking is important when working on DFWCS

Lesson Introduction: Digital Feedwater Control System

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

Self Introduction

Introduce yourself and present your background and experience. Have the students introduce themselves if desired.

Classroom Guidelines

Identify the class guidelines as posted in the classroom. Discuss as necessary.

Materials

Ensure that materials needed for the class are available for each student.

Handouts

Drawings:

01-J-SFS-002 sheets 1 through 18

01-J-SFS-054 sheets 1 through 20

Questions and Participation

Discuss the importance of classroom participation

Attention Step

Get the attention of the class focused on the subject matter.

Course Introduction

Discuss the course and how it fits in with the qualification program.

Motivation

Focus the students attention on "what's in it for me".

Course Pre-summary

General Schedule

Discuss the schedule for the course, break times, examination types, etc.

Terminal Objective

Discuss the Terminal Objective with the class.

Enabling Objectives

Discuss the enabling objectives with the class.

Methods and Activities appear as italicized test and are optional

T.Obj 1.1	**Given the necessary references,, the I&C team member will troubleshoot and maintain the Digital Feedwater Control System. Mastery will be demonstrated by passing a written exam with at least 80%.**

EO 1.1.1	Describe the operation of the Main Feedwater System during normal operation

1.1.1.1 Main Idea

A. Main Feedwater Flowpath

1. Steam is condensed after performing work on the high and low pressure turbines
2. Condensate
    a. Pumps send water to demin system for chemistry control
    b. Low pressure heaters preheat the condensate
    c. Provides net positive suction head to turbine driven feedpumps
3. Feedwater
    a. Pumps send water to high pressure heaters for further heating
    b. Admitted to S/G through two control valves
        1.) Downcomer
        2.) Economizer

B. Digital Feedwater Control System (DFWCS)

1. Two DFWCS in each unit
2. Maintains water level automatically or manually in their respective Steam Generator
3. Downcomer is instrumented
4. Regulates the amount of feedwater three ways
    a. Modulating the downcomer valve position
    b. Modulating the economizer valve position
    c. Changing feedpump turbine speed

5. Feedwater enters the Steam Generator via three lines
    a. Downcomer feedline
        1.) Enters the feed ring section of the generator
        2.) Used when temperature is <200 degrees F
        3.) Prevents cold feedwater from thermal fatiguing the tube sheet
        4.) Mixed with water from the moisture separator support plate for pre-heating
        5.) Flow is directed to the area between the wrapper plate and the shell (downcomer area)
        6.) Receives further pre-heating from the tube sheath and then enters the evaporator section
    b. Economizer Feed line
        1.) Used when feed temperatures > 200 degrees F
        2.) 24" line splits near the S/G to two separate 14" nozzles
        3.) Enters a flow distribution box that wraps around the cold leg side
        4.) Flow distribution plate admits water to the evaporator region (economizer area)

EO 1.1.2	Contrast the operation of three element level control with single element level control.

1.1.2.1 Main Idea

A. Steam Generator Operation (Shrink and Swell)

1. Shrink

   a. Load decrease causes steam header pressure increase

   b. Increased steam pressure decreases boiling rate; area occupied by steam bubbles decreases

   c. Evaporator level rises due to decreased steam bubble

   d. . Downcomer level drops, giving misleading indication that mass leaving the steam generator is increasing

2. Swell

   a. Load increase causes steam pressure to drop

   b. Lowered steam pressure causes increased boiling rate; area occupied by steam bubbles increases

   c. Evaporator level drops due to force applied by the increased steam bubble

   d. Downcomer level rises, giving misleading indication that mass leaving the steam generator is decreasing

B. Single Element Control

1. Steam generator level signal compared with local setpoint to produce flow demand output signal.

2. Subject to shrink and swell errors.

3. Used during low power operation (<14%)

C. Three Element Control

1. Steam Generator level signal summed with a steam flow/feed flow mismatch signal to produce a combined error signal to the master controller.

2. Primary advantage that three element control system has over a single element is it recognizes steam and feed flow imbalances and compensates immediately to eliminate large level swings caused by shrink or swell.

    a. With an increased steam flow the mismatch signal is calling for an increase in feed flow at the same time the level signal is calling for a decrease. This helps smooth out the resultant undershoot.

    b. With a decreased steam flow the mismatch is calling for a decrease in feed flow at the same time the level signal is calling for an increase in feed flow.

EO 1.1.3	Identify the input/output signals for the Digital Feedwater Control System, including their origin/destination.

1.1.3.1 Main Idea

A. System Layout

Use drawing 01-J-SFE-054 Sheet 4 to show how major components are connected to each other.

1. 1J-SFN-C03
    a. Located on 140'Control Building outside control room.
    b. Contains the main control processors (CP40)
    c. Contains Field bus modules connect inputs and outputs
    d. Contains fiber optic modems to connect to cabinet 1J-SFN-C04.
    e. Contains Dual Node Bus Interfaces (DNBI) to communicate with external computer workstations.
    f. Field Bus Isolators
    g. Tri-loop converters
    h. Power transfer Switches
2. 1J-SFN-C04
    a. Located on 140' Turbine Building SW Corner
    b. Contains fiber optic modems to connect to cabinet 1J-SFN-C03
    c. Contains Field bus modules connect inputs and outputs
    d. Field Bus Isolators
    e. Has small air conditioner to cool cabinet

f. Power Transfer Switch

3. B06 Display Stations

a. Four display stations for each S/G

1) Master Control Station

2) Feedwater Pump Control Station

3) Economizer Valve Control Station

4) Downcomer Valve Control Station

4. Engineering Workstation

a. Located in the NE corner of the Computer room on the 140’ Control Building

b. Contains Application Workstation (AW51)

1) Connected to CP40 through DNBI

2) Receives ERFDADS inputs through data link

3) Receives clock signal from satellite clock

c. Monitor

d. Line Printer

e. Graphics printer

f. Tape Drive

5. Flat Panel Display Workstation

a. Workstation Processor (WP51)

b. Trackball allows operators to interface with system

c. Flat panel displays

B. Inputs/Outputs

Use Drawing 01-J-SFE-054 sheet 5 to show system inputs and outputs

1. Feedwater Temperature *(01-J-SFS-002 sheet 4)*
    a. TE 7X / 7Y and TE 8X / 8Y
    b. RTD (4 Lead Platinum)
    c. Input to C03
    d. Averaged or either can be selected
    e. Temperature compensation for total feedflow and controller gains
2. Total Feedwater Flow *(01-J-SFS-002 sheet 4)*
    a. FT 1112X / 1112Y and FT 1122X / 1122Y
    b. The X instruments feed into C03, Y into C04
    c. Inputs are averaged
    d. Can select either or average
    e. Temperature compensated
3. Downcomer Feed Flow *(01-J-SFS-002 sheet 7)*
    a. FT 1113X /1113Y and FT 1123X / 1123Y
    b. The X instruments feed into C03, Y into C04
    c. Inputs are averaged
    d. Can select either or average
    e. Used as total feedwater flow when <13% Power
4. Economizer Valve Position
5. Downcomer Valve Position
6. Steam Generator Level *(01-J-SFS-002 sheet 9)*
    a. LT 1111 / 1112 and LT 1121 / 1122

b. Selects highest of the two signals for each steam generator

c. Can select either channel

7. Steam Flow *01-J-SFS-002 sheet 3)*

a. FT 1011 / 1012 and FT 1021 / 1022

b. Inputs are totaled

c. Each individual measurement can be multiplied by 2 and used individually.

d. Opens the downcomer valve at 50% steam flow (reactor power)

8. Reactor Reg

a. Reactor Power *(01-J-SFS-002 sheet 11)*

1.) Control Channel

2.) Inputs are averaged

3.) Can select either or average

b. T_{avg}

9. CEDMCS UV Coils

a. Reactor Trip

b. Select two out of four logic

10. Steam Bypass

a. SBCS Master Controller output

b. Turbine Load Index

c. Used for biasing 1E controller as a feed forward input due to the controllers slow response

11. Power Supplies

a. 3 Nest power supplies associated with SO3

b. Single nest power supply assoicated with SO4

12. ERFDADS -

a. Additional inputs are monitored from ERFDADS that provide additional information that is displayed on the GUI screens (i.e. Tave Tc, S/G level WR, S/G pressure)

b. DPMS compound

C. Outputs

1. Feedwater Pump Speed Setpoint
2. Economizer Valve Position Demand
3. Downcomer Valve Position Demand
4. Reactor Tripped
   a. To SBCS
   b. Contact Action from CEDMCS - paralleled with DFWCS
5. Steam Flow
   a. To SBCS
   b. To Plant Computer (JSCALOR)
6. Total Feedwater Flow - to Plant Computer (JSCALOR)
7. S/G Level - to Plant Computer
8. ERFDADS
   a. Data points are shared with ERFDADS
      1) Downcomer Flow
      2) Downcomer Demand
      3) Economizer Demand

4) Pump Demand

EO 1.1.4	**Explain the operation of the Digital Feedwater Control System control system during the following operational conditions:** **0%-16.5%** **16.5%-50% Power** **50%-100% Power** **High Level Override** **Reactor Tripped Override** **Abnormal Conditions** **Maintenance**

1.1.4.1 Main Idea

A. 0-16.5 Power

1. Single Element Control (Level) *(01-J-SFS-002 sheet 13)*
2. Output Limited to 25%
3. Economizer Valve Closed *(01-J-SFS-002 sheet 14)*
4. Downcomer Valve in control
5. 13% Power
    a. Up until 13% power, the total feed flow is using only downcomer feed flow
    b. After 13% Power, total feed flow is from the total feed flow transmitters
6. 14% Power - switches to three element control at 14 % Power *(01-J-SFS-002 sheet 13)*
    a. Actually two element control
    b. Steam Flow input is used as a bias (inputs at the summing junction of controller 3E1
7. DFWCS is at a low gain at low power due to high gain of the process
    a. Low feedwater temperature
    b. high recirculation ratio

8. DFWCS is at a high gain at high power due to low gain of the process

B. 16.5%-50% Power *(01-J-SFS-002 sheet 14)*

1. Valve crossover takes place when:
    a. Power reaches 16.5%
    b. Power > 15% and either downcomer valve demand exceeds 80%.
2. Downcomer valve closes (lagged)
3. Economizer valve now in control

C. 50% Power *(01-J-SFS-002 sheet 14)*

1. Steam Flow is the monitored parameter
2. Downcomer Valve goes to 65% open (lagged)
3. Economizer still in control
4. 90% of the flow is though the economizer and 10% is through the downcomer

D. High Level Override *(01-J-SFS-002 sheet 14)*

1. 88 % Level
2. Closes Economizer
3. Closes Downcomer
4. FW Pump Speed controlled by other FWCS
    a. There is a logic > Signal select block that passes the larger of the two flow demand signals so that the pumps run at the same speed.
    b. This feedwater control system would be generating a zero flow demand, the other system would be generating a higher signal unless it also was in HLO.

E. Reactor Tripped Override

1. Initiated by CEDMCS UV Coils (2of 4) *(01-J-SFS-002 sheet 32)*
2. Single Element (T_{ave}) *(01-J-SFS-002 sheet 13)*
3. Resets
    a. >15 sec and
    b. Level > 51.9%
        1) Resets at 23.9%
        2) Should only come in one time, should not cycle in and out.
4. Downcomer valve in control *(01-J-SFS-002 sheet 14)*
    a. Initial refill demand will initially open the valve to 40% open. Then the RTO controller takes control.
    b. The max. limit of the RTO controller will limit the downcomer to a max. of 40% open.
5. Economizer closed
6. FWP at minimum
    a. Controlled from it's own system only, separated from the other FWCS through logic transfer switches.

F. Abnormal Conditions
1. Total Feedflow 8% Deviation (if >14% power)
    a. Switches to single element control
    b. Three element control can be restored if:
        1) Bad transmitter placed in maintenance mode

        And

        2) Popup display on transmitter screen cleared.
2. Steam Flow Deviation 50% (if > 14% power)

a. Switches to single element control

b. Three element control can be restored if:

1) Bad transmitter placed in maintenance mode

And

2) Popup display on transmitter screen cleared.

3. Economizer and downcomer valves placed in manual

a. Master control goes to manual and tracks the valve position of the valve in control, this allows bumpless transfer when restoring to auto.

b. When either of the valves is returned to auto, the master controller can be returned to auto.

4. TE Deviation 8%

a. Deviation alarm

b. TE signal defaults to 425°F

5. If neutron indication deviation 8%

a. If power is > 16.5%, defaults to 60% power

1) If reactor trips in this condition, defaults to 5% power

b. If power is < 16.5%, defaults to 5% power.

G. Maintenance

1. Use «STAR«proper transmitter is in the maintenance mode prior to performing work.

2. Steam flow and X-channel total feed flow and TE7X/8X will affect JSCALOR

3. Transmitter in maintenance and other transmitter fails:

a. Steam or total feed flow – single element

b. TE – defaults to 425°F

c. Reactor Power - defaults to 5% or 60% Power (Whether initially > or < 16.5%)

EO 1.1.5	Describe the various means of communication between Digital Feedwater Control System Components.

1.1.5.1 Main Idea

A. Field Bus

1. Allows the Foxboro I/A to communicate with the process
2. Field Bus Modules are input / output devices to and from the process.
3. The field bus is a twisted pair of wires that are connected at the ends of the field bus with terminators.
4. Connection to the field bus are made through different means
    a. In SFN-C03 *(01-J-SFE-054 sheet 17)*
        1) There are three nests in SFN-C03
        2) There is a back plane connector assembly at the back of each nest.
            a) Called a Cell Bus
                (i) Field Bus
                (ii) Node Bus
                (iii)Power bus
        3) Field Bus Modules are installed into the nest with Y-adapter to adapt the connections on FBMs to match the connector on the Cell bus.
        4) Inside each cell bus are four separate field busses.
            a) Upper Field Bus A
            b) Lower Field Bus A
            c) Upper Field Bus B
            d) Lower Field Bus B

5) The Y adapters will select either the upper field bus or the lower field bus.

Ours are all set to the upper field bus.

6) The field busses from each nest are connected together with extension cables such that the three nests make up one segment of the field bus

7) The field bus then is connected to a Filed Bus Isolator

a.) (FBI) which provides isolation and signal amplification.

b.) Must be used whenever a fieldbus is located in cabinets remote to the host CP

8) The FBI is connected to a Termination Connector Assembly (TCA)

b. SFN-C04 *(01-J-SFE-054 sheet 10)*

1) There is one nest in SFN-C04

2) Field bus modules are connected to the field bus through Y-adapters

3) There is a Field bus isolator that connects the field bus to the fiber optic modems through a TCA

4) There is another fiber optic modem in SFN-C03

5) The SFN-C03 FOM is connected to a TCA.

c. Board 6 (B06) *(01-J-SFE-054 sheet 17)*

1) Manual / Auto stations are installed on B06

2) These stations also connect to the field bus

3) The field bus daisy chains from M/A station to M/A station the connects to a TCA

d. CP40

1) The Field Bus then connects to the CP40 (control processor)

2) The CP40s run the programs for digital feedwater.

a) These programs are called compounds.

3) There are two ways to connect the CP40s to the Field Bus

a) Jumpers installed on top of the CP40

(i) This allows the CP40s to connect to the Local Field bus through the Cell Bus Connector

Not used for digital feedwater at PVNGS.

b) TCA (Termination Connection Assembly)

(i) This Connects a remote Field bus to the CP40s, not connecting them to the local field bus

This is the method we use for Digital Feedwater

B. Node Bus

Add the node bus to the field bus drawing, showing how each component is connected. (01-J-SFE-054 sheet 18)

1. The node bus is the control network with the I/A System.
2. The node bus is a coaxial cable
3. This connects the CP40s to the other stations.
   a. WP51
      1) Located in B06
      2) This is the operators interface terminal
   b. AW51
      1) Located in the Computer room on 140’ control building
      2) This is the engineering workstation
4. We have a local node bus.
   a. The node bus is only in the upper nest of SFN-C03. It is terminated also.

5. The CP40 is connected via the Cell Bus connector
6. The WP51 and AW51 are connected via an DNBI
    a. Dual Node Bus Interface.
        1) Two cables
            a) 25 Pin connector – control
            b) 15 Pin connector – information
        2) Good for up to 150 feet

EO 1.1.6	**Describe the function of the following components:** **Field Bus Modules (FBM)** **Control Processor (CP40)** **Application Workstation (AW)** **Workstation Processor (WP)** **Dual Node Bus Interface (DNBI)** **Dual Bus Node Extension (DNBX)** **Field Bus Isolators** **Fiber Optic Modems** **Flat Panel Displays** **Display Stations** **Power Supplies** **Tri-Loop Converters**

1.1.6.1 Main Idea

A. Field Bus Module

1. Input / Output modules
2. Installed with a Y-adapter
3. Connected to field wiring through termination cable assembly.
    a. Nose cone attaches to FBM
    b. Field wiring connects on wire blocks
    c. Each module will have a MID (Module Identifier) also known as a letterbug.
        1) This is the address for the module for communications to the CP40s.
    d. There are red and green lights on each nosecone.
        1) Green – Functioning Properly
        2) Red – Failed
        3) Both on – rebooting or of-line
        4) Both off – no power

4. Types used:
    a. FBM1
        1) 0-20mA Analog Inputs
        2) 8 inputs
        3) 2 wire analog sensors, either 4 - 20ma transmitter or self- powered 20 ma source
        4) Located in CO4 only *(01-J-SFE-054 sheet 10)*
        5) Inputs
            a) The "Y" downcomer and economizer feed flows
            b) Power status and temp switch
        6) Smart transmitters require a 249 ohm in-line resistor
    b. FBM3B
        1) 2 or 4 wire RTD input

We use four wire RTDs

        2) 8 inputs
        3) Located in CO4 only
    c. FBM4
        1) 0-20mA Analog Input Output
            a) 4 input
            b) 4 output
        2) Output functions aren't used (SPARE)
        3) Located in CO3
        4) Inputs

a) Steam flows

b) Downcomer and economizer valve positions

d. FBM5

1) Redundant 0-20mA Analog Input / Output

a) 4 input

b) 4 output

2) Redundancy-there are two separate FBMs connected to a single termination cable assembly

3) The redundancy is more important for outputs that provide a control function rather than inputs - outputs are as follows: *(01-J-SFE-012 sheet 12)*

i) Feedwater pump speed setpoint

ii) Downcomer valve position signal

iii) Economizer valve position signal

4) Inputs use dual transmitters for reliability, outputs use dual FBM modules (FBM05) for reliabilty ensuring a loss of a single components doesn't trip the system

e. FBM17C

1) (4) 0-10vdc analog inputs *(01-J-SFE-054 sheet 8)*

2) (2) 0-10vdc analog outputs

3) (4) 0.5 amp contact sensing (input)

4) (4) 0.5 amp contact output *(01-J-SFE-054 sheet 11)*

B. CP40

1. Control Processor

a. 486DX4 100MHz, 8 Mb RAM

1) Capable of running 2000 Blocks of software.

We use about 400 blocks (176 per S/G and 54 for 1DPMS)

b. Communicates with the Field Bus Modules and performs the control scheme loaded into the CP40

1) The control scheme is called the compound.

2) There are three compounds loaded into the CP40s. One for each S/G and one for communicating with ERFDADS.

c. There are two redundant fault tolerant CP40s.

1) One is the primary, one shadow

2) Both are running the program simultaneously

3) Only the primary sends out it's output.

4) The two are continuously compared.

5) If the lose synchronization the shadow will reboot, if repeated, may fail.

6) If the primary fails, the shadow becomes the primary and takes over the process.

C. Application Workstation (AW51)

1. This is our engineering workstation

a. Located in the 140' control building computer room.

b. SUN computer

1) 170Mhz microSPARC II RISC Processor

2) 96MB RAM

c. Has the following peripherals

1) Keyboard

2) Monitor

3) Tape Drive

a) 4 mm

b) 5 Gigabyte

c) SCSI address on back set to 5

4) Line Printer

a) Types system alarms etc.

5) Graphics Printer

a) Allows graphics printouts of displays

6) Internal CD ROM

7) Internal 3.5” Floppy Drive

8) Internal Hard Drive

a) 4.2 Gigabyte

9) Trackball

2. Combines the functions of two types of stations. AP – system processing / WP – Man-machine interface

a. System processing

1) System and network management functions

a) Collects system performance statistics

b) Performs station reloads

c) Providing message broadcasting

d) Handles station alarms and messages

e) Maintains consistent time and date in all stations.

2) Database management

   a) Storage, manipulation and retrieval of files containing data received or produced by the system.

3) File Requests

   a) Manages file requests associated with bulk memory attached to the application workstation

4) Historical Data

   a) Maintains a history of application messages, errors, alarm conditions, plus continuous and discrete values (i.e. measurements, setpoints, outputs, switch status)

5) Graphic display support

   a) Stores and retrieves display formats and real time update field definitions.

6) Production control software

   a) Requiring application resources are INFORMIX DMBS, historian, Spreadsheet, Physical properties library, and math library

7) Configuration

   a) Providing bulk storage for configuration parameters and executing some of the configuration processes.

      (i) These are the compounds that are loaded into the CP40s.

      (ii) When a CP40 reboots, it downloads its configuration from the AW51.

8) Application Development Facilities

   a) Providing development tools to document, enter, translate, link, test and maintain programs for all stations

b. Man-machine interface

1) Provides a link between the user and all system functions
2) Receive graphical and textual information for display
3) Generates video signals to display the information on video monitors

3. Software installed
   a. Operating System
      1) Fox IA – is a modified SUN operating system.
   b. Display Manager
   c. Alarm Manager
   d. Foxview/Foxdraw/Foxselect
   e. System Monitor
   f. Historian
   g. Report Writer
   h. Operator Action Journal
   i. Integrated Control Configurator

D. Workstation Processor (WP51)
   1. Control room operator's workstation - located in B06
   2. Performs only the man-machine interface functions
      1) Provides a link between the user and all system functions
      2) Receive graphical and textual information for display
         a) Has the display files located on its own hard drive
      3) Generates video signals to display the information on video monitors
   3. SUN computer
      a. 170Mhz microSPARC II RISC Processor

b. 64MB RAM

4. Peripherals include
   a. Internal CD ROM
   b. Internal 3.5” Floppy Drive
   c. Internal Hard Drive
      1) 2.1 Gigabyte
   d. 2 Flat Panel Displays
   e. Trackball
5. Software installed
   a. Operating System
      1) Fox IA – is a modified SUN operating system.
   b. Display Manager
   c. Alarm Manager
   d. Foxview/Foxdraw/Foxselect

E. Dual Node Bus Interface (DNBI)
   1. Provides the interface between the AW51 and WP51s to the node bus.
   2. Installed in Nest 1 in SFN-C03
   3. Connected to the node bus via the back plane cell bus connector.
   4. Communicates over two cables that are connected to the work stations
   5. Maximum cable length is 150’

F. Field Bus Isolators
   1. Half height Field bus module installed in nest with a Y-adapter.
   2. Normally installed in pairs

a. Upper isolator is Field Bus A

b. Lower Isolator is Field Bus B

c. Y-adapter determines whether Upper or Lower Field Bus A and B are used.

1) Needs to be the same as the Y-adapters for the FBMs.

Ours are selected to the upper.

3. Provides isolation and amplification of signals.

a. Needed when the field bus exceeds a length of 30'.

b. Field bus can be extended to 6000 feet with fieldbus isolators.

4. We have two

a. One for C04 components via FOM

b. One for C03 Components

G. Fiber Optic Modems

1. Can extend the field bus up 12.6 Miles

Even though our distance from C04 to C03 is only about 500 feet, fiber optic cable was used for future expansion. There are 24 fiber strands between the two cabinets and only four are used.

2. We have two in C03 and two in C04

a. One in each cabinet for each field bus.

H. Flat Panel Displays

1. Mounted on B06

2. Two of them

3. Connected to WP51 for the operator displays.

I. Display Stations

1. Mounted on B06
2. Four for each S/G
    a. Master
    b. Feedpump Speed
    c. Economizer Valve
    d. Downcomer Valve
3. Connected to the field bus via TCA in C03

J. Power Supplies

1. Each 1X8 Nest has four IPM2 modules
    a. Industrial Power Module
    b. AC in 36VDC out
    c. Upper IPMs are the primary
        1) Upper Left Slots 2,4,6,8
        2) Upper Right Slots 1,3,5,7
    d. Lower IPMs are secondary
        1) Lower Left Slots 3,4,5,6
        2) Lower Right Slots 1,2,7,8

Use Drawing SFE054 sheets 15-17 to show power distribution.

2. Power Transfer Switch
    a. Supports continuous power to 120VAC devices.
    b. Has two inputs (Primary and Secondary) and switches on loss of primary.
3. SFN-C04

a. Primary Power NNN-D11-09

120 Foot Control Building
SFE-054 Sh 15-17

b. Secondary Power – NNN-D12-04

120 Foot Control Building
SFE-054 Sh 17

c. Air Conditioner - NNN-D-15-08

100 Foot Turbine Building
SFE-054 Sh 17

4. SFN- C03

a. Two Sources of Power

b. NNN D11-01 (also supplies SBCS and RRS)

120 Foot Control Building
(SFE-053 Reactor Regulating System ILWD Sh 15 of 16)

1) Primary Power for Nests 1,2,3

SFE-054 sh 16

a) Through Fuses FU 1,2

2) Primary Power for STSW1

SFE-054 sh 16

a) Through CB52-01

3) Secondary Power for STSW2

SFE-054 sh 16

a) Through CB 52-03

c. NNN D12-01 (also supplies SBCS and RRS)

120 Foot Control Building
(SFE-058 Steam Bypass Control System ILWD Sh 62 of 70)

1) Secondary Power for Nests 1,2,3

SFE-054 sh 17

a) Through Fuses FU 3,4

2) Secondary Power for STSW1

SFE-054 sh 17

a) Through CB 52-02

3) Primary Power for STSW2

SFE-054 sh 17

a) Through CB 52-04

d. STSW1

SFE-054 Sh 16 and 17

1) M/A Displays on B06

2) WP51 and Flat Panel Displays in B06

e. STSW2

SFE-054 Sh 16

1) AW51 and peripherals in Computer Room

5. CRS Work Station (When installed) is powered from Computer Power Supply NQN-D01

140 Foot Control Building
SFE-054 Sh 17

K. Tri-loop converter

1. Provides indication of valve position

a. FBM output to control valve positioner is also connected to Tri-loop converter

b. The valve positioner is a smart positioner that can transmit the valve position superimposed onto the 4-20 mA signal.

c. The positioner is set-up in the burst mode, constantly sending out the valve position signal.

d. The tri-loop converter converts the signal and provides it as an input to an FBM and to ERFDADS for valve position indicator.

EO 1.1.7	Describe how the FoxSelectFoxView can be utilized during maintenance.

1.1.7.1 Main Idea

A. FoxSelect is part of FoxView / Foxdraw

B. Used during maintenance to display an indication for one of the end devices during loop cals.

C. Displaying a parameter

1. Selected with a button on the button bar
2. When the FoxSelect window opens, it shows the CP411 Control Processor
3. Double Click or expand
4. Shows the compounds running on the Control Processor
5. Select the compound, double click or expand.
6. **Caution:** Do not select the off button. This will turn off the compound and trip the unit.
7. Select the point.

D. 4 main types of blocks will be used during maintenance:

1. CIN
   a. Contact Input
   b. Window on right side will change color
      1) White = 1
      2) Gray = 0
   c. You have the ability to take the point to manual and toggle the point.
      1) This will have the same effect on the operating compound as if the input actually changed.

2. COUT
    a. Contact Out
    b. Window on the right side has two halves.
        1) 1 True
        2) 0 False
        3) The white portion is the current status.
    c. You have the ability to take the point to manual and toggle the point.
        1) This will actually change the output.
3. AIN / AINR
    a. Analog Input / Analog Input Redundant
    b. Window on upper right shows measurement
    c. Displays Raw Counts
        1) Raw Counts is the actual digital counts coming from the FBM.
        2) This is a 16 Bit resolution
        3) 0-65535 raw counts
        4) Max Scale = 64,000 raw counts
        5) Ex: 4-20 mA input
            a) 4mA = 12,800 raw counts
            b) 12mA = 38,400 raw counts
            c) 20mA = 64,000 raw counts
    d. Hi / low scale values
    e. OSV
        1) Overrange scale value

2) 2% for all FBMs (difference between 65635 - 64000 counts is 2%)

e. Can display Trend

f. Config

1) DEV_ID is the FBM

2) PNT_ID is the input number on the FBM

3) Period is how often the point is scanned by the CP40

4) Shows scaling and bias (if any)

g. Can be taken to manual and the value changed.

1) PNT can be changed which is the point input into the control compound

2) MEAS does not change, this is the actual measurement.

3) Typed in or toggled to the desired value

e. AINR shows both FBMs

1) Primary

2) Secondary

3) SELREQ shows the one selected

4. AOUT/AOUTR

a. Analog Output

b. Shows the value

1) M is the measurement

2) B is the Bias Value

3) O is the value output

c. Can display trend

d. CONFIG

1) IOM_ID is the FBM

2) PNT_NO is the output number on the FBM

3) Period is how often the output is updated from the CP40

e. AOUTR Configuration shows the two output FBMs

5. Maintenance Displays - they were generated so that it would not be necessary to access FoxSelect to perform maintenance

a. Steam Generator 1 Display Parameters

1) Total feed flow (redundant and non-redundant)

2) Downcomer feedflow (redundant and non-redundant)

3) Levels (redundant)

4) Feedwater temperature

5) Steam flow

6) Feedwater pump speed setpoint

b. Steam Generator 2 Display Parameters - same as SG1

c. Feedwater Display Parameters (common inputs to both DFWCS)

1) Reactor power

2) Turbine Load Index

3) Steam Bypass Control MCD

4) Reactor Trip Switch Gear status

5) Tavg

6. Resetting of the RTO and Downcomer Valve Logic

a. Ensures the RTO and Downcomer Valve logic is properly set following a reactor trip or an outage (refueling or SNOW).

b. It is necessary to ensure that logic bit B72B:B001 is set correctly to allow downcomer movement

1) Select the “File” pulldown menu and select the Maintenance Environment

2) Select “FoxSelect” from the display bar

3) Expand the CP411 block

4) Expand the FWCS1 block

5) Scroll down to B72B and double click

6) The Boolean logic block number “1” should be gray, if it is white it must be reset

7) Select the “AM” button at the bottom of the screen to transfer to manual

8) Select the number block 1

9) Select the “TOGGLE” button

10) Return the block to auto

PMs on DFWCS

- Calibrating the inputs: Inputs – done usually during outage
- Set clock, gather data, verify alarm manager and check printers: Set Clock – Can be done any time, usually transparent to ops
- Outage Calibration Checks: Outage Cal Checks – Mode 5 or 6 only, verifies the following inputs:
- Reactor Power 1 and 2,
- TLI,
- SBCS Master Controller output,
- TAVG,

- Feed Pump A, and B Speed,
- Feed Pump A and B Demand, and
- Reactor Trip signal.

- Check feedwater redundant FBMs for latent failures. Redundant FBM check – done every outage – uses a special cable found only in Dennis Sloan's desk – verifies the diodes in the TCSs are good. (somewhere in training we have the other cable – Sloan says we borrowed it in 2004 and never returned it.)
- There's also a generic troubleshooter at loc 390 ready to go

EO 1.1.8	Describe system and process alarms.

1.1.8.1 Main Idea

A. Upper left corner has two color buttons
    1. System
        a. Hardware of the IA System
            1) Module failures
            2) Bus failure
            3) Peripheral monitor
    2. Process
        a. Alarm conditions from the operating process (FWCS)
            1) Temperature alarms
            2) Flow alarms, etc.

B. Status
    1. Solid Green
        a. Normal – no active, uninhibited alarms
    2. Flashing Green
        a. Unacknowledged cleared alarm
    3. Flashing Red
        a. Unacknowledged active alarm
    4. Solid
        a. Acknowledged active alarm

C. System Manager

1. Click on the System button
    a. This brings up the Domain Page
        1) Shows the Stations
            a) Colors
                (i) White – normal, healthy station
                (ii) Yellow
                    (a) Failed device attached to the station
                    (b) Bad I/O Point associated with a device
                    (c) Fault tolerant state non-operational.
                    (d) FBM card Warning Bit
                (iii) Red
                    (a) Off line
                    (b) Failed
                (iv) Cyan
                    (a) Station selected
        2) Can select SAL – System alarm list
        3) Can select the inhibit display
        4) Network – takes you to the Node Bus Display
    b. Node bus Display – shows the stations connected on the Ethernet node bus
        1) When you select a station, it turns black
        2) Selecting next level takes you to the Field bus associated with that station
    c. PIO Bus display (PIO same as fieldbus)

1) Shows the Control Processor and all the field bus modules connected to the field bus

2) Shows the field bus that communications are on.

3) If one or both of the communications lines to the FBM are lost, the lost bus letter will display above the FBM in red.

4) If the FBM number is followed by a < , this module has inhibited alarming.

d. Station Equipment Information for CP40

1) Alarm state – inhibited / enabled

2) Run Mode – On Line / Off Line

3) FT (Fault Tolerant) State – Operational / Non-operational

4) Primary Mode – Single Primary / Married Primary

5) Shadow Mode – Married Shadow / Off Line

6) ROM addresses are unique to the module, if the stations swap roles, the ROM addresses will change.

e. Station Equipment Change (CP40)

1) Checkpoint Command

a) Sends the compounds that are currently running in the CP40 to the AW51. This compound will then be used to reboot the CP40s

2) Enable / Inhibit Station alarming

3) Reboot Station

4) EEPROM update

5) Enable / disable upload

6) Enable / disable download

7) Enable / disable reports

f. FBM Equipment Information

1) Name

2) Type

3) Run Mode

4) Device State

5) Download State

6) Alarming state

7) Compound name

8) Hardware / software information

g. FBM Equipment Change

1) On / Off Line

2) Download

3) Fieldbus switching

4) Enable / inhibit Device switching

D. Alarm Manager

1. Displays Process alarms

EO 1.1.9	Describe the Re-booting of a computer station within the Digital Feedwater Control System.

1.1.9.1 Main Idea

A. CP40 - there are two ways to reboot a station

1. From the AW51

   a. Select the "System" button on the upper left portion of the FoxView screen to get to the System Monitor Domain of the System Manager

   b. Select the "NETWORK" button on the lower left portion of the screen which accesses the Node Bus Display

   c. Select the CP40 FT block
   d. Select the "EQUIP CHANGE" button
   e. Select "REBOOT STATION" from the left menu

      1) On a fault tolerant (CP40) an option of PRIMARY, SHADOW or BOTH are provided

      2) Select the required reboot option

      3) **CAUTION:** If both fault tolerant CP40s are selected, it may trip the unit since there is no longer a program running

PREVENT EVENT: *Have the class participate in a discussion of what type of work practices and prevent event tools could be used to prevent a possible trip of the unit*

2. Manually – called a hard reboot

   a. Small hole on the CP40 module, inside is a reset button, depress with a small object.

B. AW51

1. Rebooting

   a. From the FoxView screen select the "Sftmnt" pulldown menu

b. Select “Reboot_Station”

2. Resetting the Master Timekeeper

a. After the reboot is complete it is necessary to set the Master Timekeeper for programs such as the Historian and Alarm Manager

b. Select the “System” button from the FoxView screen which will access the Domain screen

c. At the bottom of the screen tag the “TIME” button

d. Enter the Month, Day and Year

e. Set the Hour, Minute and Second slightly ahead of the satellite time and when the two concur tag the RETURN – SET button on the lower left portion of the screen

d. The printer will show that the Master Timkeeper is enabled

3. Device Monitor Verification (Performed at the AW51)

a. From the FoxView screen select the “File” pulldown menu

b. Select “Change Environment”
c. Select “Maintenance” then “OK”

d. From the FoxView screen select the “Sftmnt” pulldown menu

e. Select “Programs”

f. Select “Login” which opens the cmdtool_su screen (command tool)

g. Perform the following:

cd /usr/fox/cs (Enter) *a space is necessary following the cd input*
dm_recon d (Enter)
ls –l (Enter)

h. Locate the file date stamp of "cs_dm.current"

1) If the file indicates the current date the file is running on the AW51

2) No further action is required

i. If no file date exists or the date is incorrect

1) The file is running on the WP51 and must be transferred back to the AW51

2) Perform the following:

cd /usr/fox/cs (Enter)
dm_recon t (Enter) *Forces the transfer to the AW*
dm_recon d (Enter)
(wait at least 30 seconds)
ls –l (Enter)

j. Type "exit" (Enter) to close the command tool

EO 1.1.10	Describe how a failed component can be identified.

1.1.10.1 Main Idea

A. Module Indicating Lights

1. Green – Normal, healthy module
2. Red – Failed
3. Red solid and green solid
    a. Downloading
    b. Attempting to download - if the letterbug cannot be read by the CP40, it will not download.
4. Neither – No Power
5. Red solid and green flashing - attempting to communicate with a peripheral
    a. DNBI with the WP51 or AW51
    b. CP40 with the AW51 at the time of a reboot

B. Field Bus Isolator

1. Active field bus lights should be on
2. Standby Field bus lights will blink periodically, this is a check to ensure it is still functional.
3. Upper isolator in the nest is the "A" bus and the lower isolator is the "B" bus

C. Fiber Optic Modem

1. Similar to Fieldbus module above, plus indication of power

Methods & Activities: Give several sets of symptoms / troubleshooting scenarios and discuss symptoms and how the problem could be isolated:

Examples: The system is operating properly, but one CP40 has its red light on solid. After 30 minutes the red light is still lit. What could be happening? Answer: The CP40 could be trying to reboot but is not reading its litterbug, or the CP40 could be failed and the system is operating on the redundant CP40. Attempt to reseat the litterbug and reset the CP40 being very careful to not disturb the other CP40. If this fails, the CP40 will have to be replaced, which can be done online, and has been done here before.

Example: FWCS #1 has shifted to 1E control at 100% reactor power, and feedwater flow has an alarm box around it. What has happened? Answer: The indicated feed flow deviation has increased above 8%.

Example: The field bus is swapping between primary and secondary repeatedly. What components may be causing this problem? Answer: any fault on a field bus – so anything connected to the field bus including FBMs and CP40s.

EO 1.1.11	Describe how failed components are replaced.

1.1.11.1 Main Idea

A. Removal of a CP40 module

1. Lower elevator
2. Lower hinged cover plate from both modules
3. Pull the connector (jumper) from the front of both modules
4. Loosen upper and lower screws with Foxboro tool
5. Slide the module out
6. Remove the letterbugs

PREVENT EVENT: *Have the class participate in a discussion of what type of work practices and prevent event tools could be used to prevent a possible trip of the unit due to lowering the elevator of the good CP40*

B. Installation of CP40 module

1. Reverse above steps.
2. Observe lights to ensure proper boot-up

C. Removal of Dual Node Bus Interface

1. Lower elevator
2. Lower hinged cover plate from both modules
3. Loosen upper and lower screws with Foxboro tool
4. Slide the module out
5. Remove the letterbugs

D. Installation of Dual Node Bus Interface

1. Reverse above steps.

2. Observe lights to ensure proper boot-up

E. Removal of Field Bus Module

1. Remove nose cone from module
2. Loosen upper and lower screws with Foxboro tool
3. Slide Module out
4. Remove the letterbugs

PREVENT EVENT: *Have the class participate in a discussion of what type of work practices and prevent event tools could be used to prevent a possible trip of the unit in reference to the Redundant Analog Output FBM*

F. Installation of Filed Bus Module

1. Reverse above steps.
2. Observe lights to ensure proper boot-up

G. Removal of Field Bus Isolators

1. Loosen upper and lower screws with Foxboro tool
2. Slide Module out

H. Installation of Field Bus Isolators

1. Reverse above steps.
2. Observe lights to ensure proper boot-up

I. Removal of Y-Module adapters

1. Remove both FBMs installed in adapter
2. Loosen Adapter
3. Slide out adapter

J. Installation of Y-Module adapters

1. Ensure proper field bus is selected
2. Insert adapter
3. Tighten screws
4. Reinstall fieldbus modules

*If the Developmental Center is available have each course participant **individually** perform the Hands-On Worksheet to re-emphasize the information covered in class.*

K. Removing and Replacing a Termination Cable Assembly from the DIN rail

1. To remove a TCA from the DIN rail, you pull up from the bottom of the TCA and it should release. To reinsert the TCA, you insert the TCA from the top and push down on the bottom of the TCA.

EO 1.1.12	Describe why Self Checking is important when working on DFWCS

1.1.12.1 Main Idea

If working on DFWCS on line, an error has the potential exists to trip the unit.

If working on DFWCS offline, an error has the potential to negatively affect plant operation, up to and including a unit trip when the unit starts up.

In most DFWCS work packages second checking is not required on most or all steps. Therefore self checking is very important on this system.

Cover pages / steps from WSL 'Calibrate DFWCS Inputs' and point out steps that would require good self checking. Discuss how easy it is to 'click the wrong thing' and demonstrate on powerpoint screens what self checking would look like.

From Management Standards & Expectations Handbook on Self Checking:

Why

• Boosts attention and thinking just before a physical action is performed.
• Resolves any questions or concerns before proceeding.
• Provides a review of the results of the action to decide if the right result was obtained.

When

• Manipulating or altering plant equipment or controls.
• Entering plant data into a computer or recording it on a form.
• Performing a calculation.
• Revising drawings or procedures using cut-and-paste on a computer or by making handwritten annotations.
• Prior to and during an impending change in equipment status.
• Assembling components that contain similar parts that potentially could be interchanged.

How

1. Stop – Focus on the task's objective.
2. Think – Understand what will happen when the correct action is taken on the correct component.
3. Act – Perform the correct action on the correct component.
4. Review – Verify anticipated result obtained.

Coaching Tips

• STAR actions are expected to be observable.
• Self-checking must be performed against controlled sources of information.
• Self-checking is a continuous sequence. If interruptions occur during the sequence, then start over.

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.