NIAGARA MOHAWK POWER CORPORATION

NINE MILE POINT NUCLEAR STATION

UNIT II OPERATIONS

Q7-188-91

02-LOT-001-259-2-02 Revision 6

TITLE: FEEDWATER CONTROL SYSTEM

	SIGNATURE	DATE
PREPARER	[signature]	6/7/91
TRAINING AREA SUPERVISOR	[signature]	6/7/91
TRAINING SUPPORT SUPERVISOR	[signature] for J. LeClair	6-7-91
PLANT SUPERVISOR/ USER GROUP SUPERVISOR	[signature] FOR J BARKER	6/26/91

Summary of Pages

(Effective Date: 6/24/91)

Number of Pages: 17

Date	Pages
May 1991	1 - 17

TRAINING DEPARTMENT RECORDS ADMINISTRATION ONLY:

VERIFICATION:

DATA ENTRY:

RECORDS:

19 PP

5/3/355

ATTACHMENT 6
LESSON PLAN TEMPORARY/PUBLICATION/ADDENDUM CHANGE FORM

The attached change was made to:

Lesson plan title: Feedwater Control System

Lesson plan number: 02-LOT-001-259-2-02

Name of instructor initiating change: G Bridges

Reason for the change: add SOER 84-4 to the ref sect. (pg 1 - I.G) to protect

Type of change:

1. Temporary change ____
2. Publication change ____
3. Addendum change ✓

Disposition:

✓ 1. Incorporate this change during the next scheduled revision.

____ 2. Begin revising the lesson plan immediately. Supervisor initiate the process.

____ 3. To be used one time only.

Approvals:

Instructor: [signature] /Date 8/9/91

Training Area Supervisor (or designee): [signature] /Date 8/9/91

I. TRAINING DESCRIPTION

A. Title of Lesson: Feedwater Control System |6

B. Lesson Description: This lesson contains information pertaining to the Feedwater Control System. The scope of this training is defined by the learning objectives and in general covers the knowledge required of a Licensed Control Room Operator. |6

C. Estimate of the Duration of the Lesson: 1.5 hours

D. Method of Evaluation, Grade Format, and Standard of Evaluation: Written exam passing grade of 80% or greater.

E. Method and Setting of Instruction: This training should be conducted in the classroom.

F. Prerequisites:

1. Instructor:

a. The Instructor shall be familiar with the lesson materials and have achieved the necessary instructor certification in accordance with NTP-16.

2. Trainee:

a. In accordance with eligibility requirements of NTP-10.

G. References:

1. Tech Specs

a. None

2. Procedures

a. N2-OP-3 Condensate Feedwater System

3. NMP-2 USAR

a. Section 7.7.1.3 Feedwater Control

Addendum change 4/9/91 #1, SOER 89-4 (TRR 6008-01-14)

II. REQUIREMENTS

A. AP-9, Administration of Training

B. NTP-10, Training of Licensed Operator Candidates

III. TRAINING MATERIALS

A. Instructor Materials:

1. Training Record (TR)
2. Instructor's working copy of the Lesson Plan
3. Whiteboard and Markers
4. Overhead Projector
5. Transparencies as needed
6. Flipchart
7. Copy of Trainee Handouts
8. Trainee Course Evaluation Forms

B. Trainee Materials:

1. Handouts
2. Paper or notebook
3. Pen or pencil

IV. EXAM AND MASTER ANSWER KEYS

Will be generated and administered as necessary. They will be kept on file with the designated clerk. |6

V. LEARNING OBJECTIVES

Upon satisfactory completion of this lesson the trainee will have gained the knowledge to:

A. Terminal Objectives:

TO-1.0 Perform lineups on the Feedwater System. (2590010101)

TO-2.0 Place Feedwater control in automatic. (2590070101)

TO-3.0 Shutdown the Reactor Feedwater System. (2590110101)

TO-4.0 Perform single feedpump operation and second pump start. (259010101)

TO-5.0 Reset a level set point setdown. (2599030101)

TO-6.0 Respond to a feedwater LCV lockup/hydraulic failure. (2599110401)

TO-7.0 Direct actions for a loss of Individual Feedwater Systems. (3449210503)

TO-8.0 Direct the action for a loss of all Feedwater. (3449220503)

TO-9.0 Respond to a Feedwater controller malfunction. (3449030403) |6

B. Enabling Objectives:

EO-1.0 Explain the purpose of the Feedwater Control System.

EO-2.0 Describe the function and operation of each of the following major components of the Feedwater Control System. |6

a. Low Flow Master Controller
b. Low Pressure - Low Flow Controller
c. High Pressure - Low Flow Controllers
d. High Pressure - High Flow Controllers
e. High Flow Master Controller
f. Steam Flow/Feed Flow Summer Circuit |6
g. RPV Level/Flow Error Summer Circuit. |

EO-3.0 State the setpoint and purpose for the following interlocks:

a. Loss of Control Signal
b. RRCS Feedwater Runback
c. Setpoint Setdown
d. Flow Limiter Logic
e. Gain Change Network
f. RPV High Level Trip

EO-4.0 Describe the interrelationship between the Feedwater Control System and the following systems. |6

a. Feedwater System
b. Condensate System
c. Main Steam System
d. Reactor Recirculation System
e. Instrument Air System

EO-5.0 Explain the basis for each precaution and limitation listed in N2-OP-3.

EO-6.0 Regarding the Feedwater Control System, determine and use the correct procedure to identify the actions and/or locate information related to:

a. Startup
b. Shutdown
c. Normal
d. Off Normal
e. Annunciator Response procedures

EO-7.0 Given a specific set of plant conditions, determine how the Feedwater Control System responds.

EO-8.0 Given a specific set of plant conditions, describe the immediate operator actions required.

VI. LESSON CONTENT

LESSON CONTENT	DELIVERY NOTES	OBJECTIVES/ NOTES
I. INTRODUCTION		
	Preliminary Activities: Introduce self to class (if unfamiliar). Circulate Training Record for completion. Pass out copies of objectives. Describe daily quizzes/weekly exams. Pass out Course Evaluation sheets	
A. Trainee Learning Objectives	Review Trainee Learning Objectives	|6
B. System Purpose		
1. Controls the flow of feedwater into reactor vessel to maintain water level during all modes of operation.		EO-1.0 |6
C. General Description	Show TP-1 (Figure-1 of N2-OLT-54).	|6
1. The Feedwater Level Control System uses a combination of flow and level signals to automatically maintain water level inside the reactor vessel.	Point out flow and level inputs. Point out high and low flow controllers.	
2. The system also allows for manual control of RPV level.	Show TP-2 (Figure-2 of N2-OLT-54).	|6
3. RPV level is maintained by controlling the rate of feed flow into the reactor. This is achieved by controlling the position of three sets of flow control valves.	Point out sets of valves as discussed. Show TP-1 (Figure-1 of N2-OLT-54). Point out individual valve controllers.	|6

4. During the automatic mode of operation the system can either be operated in "Single Element" where RPV level instrumentation provides the only feedback signal or in "3 Element" where level, feed flow and steam flow instrumentation provide system feedback signals. The 3 element mode is also known as an "Anticipatory Level Control".

Show TP-1 (Figure-1 of N2-OLT-54). |6
Point out selector switch.
Switch is located on PNL-603 |6

5. These valves are modulated as necessary by the flow controllers in response to inputs from the feed flow, steam flow and RPV level sensing circuits when operating in automatic. The valve can also be positioned as desired by the operator utilizing the manual mode of operation.

Q: What is another function of the Main Steam System flow restrictors? |6
A: Limit the rate of vessel depressurization following a Main Steam Line break downstream of the flow restrictors. |

II. DETAILED DESCRIPTION

A. Low Flow Master Controller

1. Function - used for automatic control of either the Low Pressure-Low Flow Control valve or the High Pressure--Low Flow Control valves.

Show TP-1 (Figure-1 of N2-OLT-54) EO-2.a |6
Point out Low Flow Master Controller

2. Controller receives input signals from reactor level, feed flow and steam flow instrumentation. Normally operated in single element control (level signal only).

3. Single element or three element control selected by using selector switch on PNL-603.
4. Only one of the three low flow control valves may be controlled by the Low Flow Master Controller. |6
5. Used until a second feed pump is started.
   a. Single element control - uses level as only control signal when steam and feedwater flow rates are both low.
   b. Three element control - in addition to level, steam and feedwater flow inputs are used.
   c. Single element control used when <25% reactor power due to inaccuracy of flow meters at low power levels.

B. Low Pressure - Low Flow Valve Controller

Show TP-3 (Flow Control Valve Controllers). EO-2.b

1. The Low Pressure - Low Flow Control Valve (LV-137) can be controlled in either the automatic or manual mode. The mode of operation is determined by push buttons on the individual valve controller located on PNL-603.

Point out "Auto" and "Manual" select pushbuttons.

2. When in "Manual" the operator controls feed flow by manually changing the controller's output using pushbuttons on the controller.

Point out "open" and "close" push buttons. |6

3.	When "Automatic" is selected, the valve is repositioned by the output of the Low Flow Master Controller.	Point out Low Flow Master Controller Thumbwheel. Show TP-3 (Flow Control Valve Controllers).	
C.	High Pressure - Low Flow Valve Controllers		EO-2.c
1.	Each of the LV-55's has its own individual controller that can be operated in either "Manual" or "Automatic" control. The specific mode of operation for each valve is selected by pushbuttons on the individual controllers.	Point out the "Auto" and "Manual" select pushbutton on controllers.	|6 |
2.	In "Manual" the operator controls feed flow by manually changing the controller's output via push buttons on the controller to maintain desired RPV level.	Point out the "open" and "close" pushbuttons on controllers.	|6
3.	In "Automatic" the individual controllers output are determined by the Low Flow Master Controller output.		
D.	High Pressure - High Flow Valve Controllers		EO-2.d
1.	Each LV-10 valve has its own individual controller located on PNL-603 and can be controlled in either automatic or manual.	Point out the "auto" and "manual" select pushbuttons on controllers.	|6 |
2.	In "Manual" the individual valve controllers output is manually set by the operator via pushbuttons as necessary to control RPV level.	Point out the "open" and "close" pushbuttons on the controllers.	|6 |

3. In "Automatic" the individual controller output is determined by the output of the High Flow Master Controllers.

E. High Flow Master Controller — EO-2.e

1. Function - controls the position of the High Pressure-High Flow control valves (LV-10A, B, C).

Show TP-1 (Feedwater Control Circuit). Point out High Flow Master Controller.

2. The High Flow Master Controller sends a signal to the high pressure-high flow valve controller which in turn controls the position of the high pressure-high flow control valve.
3. Two methods of manual control of the High Pressure-High Flow control valves.
   a. Individual valve controller in manual.
   b. Individual valve controller in automatic and high flow controller in manual.
4. In automatic operation, both the individual valve controller and the High Flow Master Controller are in "auto", which maintains vessel level at setpoint.

5. High Flow Master Controller receives a three element control signal which is compared to the High Flow Master Controller tape setpoint.
6. The High Flow Master Controller output is proportional to the differences of the two signals.

III. INSTRUMENTATION, CONTROLS AND INTERLOCKS

A. Inputs to the Feedwater Control System

1. Reactor water level

a. Three Narrow Range transmitters PDT14A,B,C.

b. Operator can select PDT14A or B as level input to control system with selector switch on PNL-603.

c. The selected channel provides a high level alarm at level 7 (187.3) and all three transmitters supply a high level trip signal to the turbine/feedwater pumps at level 8 (202.3).
L4 (178.3") RCS runback
L3 (159.3") RCS downshift input to recorder.

Trip signal requires a 2/3 logic input.

6

2. Total feed flow is calculated by summing the flows from the two feedwater supply lines.
   a. Signal is also supplied to the reactor recirculation system for:
      1) recirc pump low power starting interlock
      2) recirc pump high/low speed transfer (power interlock)

   Show TP-4. (Figure-1 of N2-OLT-53)
   Point out the feed flow elements.
   Explain principle of operation.

   |6

3. Total steam flow is produced by summing the steam flows in the four main steam lines.
   a. Signal is also supplied to
      1) Process computer-reactor power input
      2) Rod Worth Minimizer power input.

B. Steam flow-Feed flow summer

   EO-2.f

1. Steam mass flow rate (+) and feedwater mass flow rate (-) are fed into an amplifier.

   Point out summer on TP-1.

   |6

2. This amplifier output (inventory rate of change) is added to the level input signal in the level/flow error summer so that:

   EO-2.g

   a. With balanced flows level in=level out
   b. With higher steam flow, level in is greater than level out, smaller level signal then compared to level setpoint, calls for more flow.

   Point out level/flow error summer.

c. With higher feed flow, level in is less than level out, larger level signal then compared to level setpoint, calls for less flow.

C. Interlocks

1. Loss of Control Signal - The LV-10's will fail in the "as is" position on a loss of control signal. EO-3.a

   a. The valves will remain locked up until reset by switches on PNL-603. EO-3.b

   b. The lock up is overridden by an RRCS feedwater runback signal.

2. RRCS Feedwater Runback - Following an RRCS initiation at 1050 psig in the RPV, all feedwater control valves are automatically closed.

   a. This occurs after a 25 sec. time delay if reactor power is still >4% or indication is inop.

   b. ~~30~~ 25 seconds after the runback initiation, feed flow can be restored in the manual mode.

   c. "RRCS Feedwater Runback Disable" Switch located on panel 601 will disable the runback circuitry. Switch is only used during surveillance testing of the RRCS System.

3. Setpoint Setdown — EO-3.c
   a. Prevents overfeeding the Rx vessel after a scram.
   b. Void collapse occuring during a scram will cause a large level decrease in the annulus region for the same vessel inventory.
   c. The setpoint setdown circuit reduces the operator selected setpoint by approximately 18 inches when the low level trip point is reached. The setpoint setdown circuit must be reset by the operator on PNL-603.
4. The Flow Limiter Logic — EO-3.d
   a. Prevents feed pump cavitation during a turbine trip should a low feed pump suction pressure <210 psig occur.
   b. The high pressure - high flow control valve (LV-10A, B, C) receive an 80% open clamp limit.
   c. The clamp limits the flow thru the valve to 48% of its design flow.
   d. "Flow Limiter Logic Engaged" light on PNL-603 indicates clamp engaged.

5. Gain Change Network — EO-3.e

   a. If only one high flow control valve is in "auto" then the Gain Change Network automatically doubles the output of the High Flow Master Controller to provide the same response time for one pump operation as two pump operation.

6. RPV High Level Trip — EO-3.f

   a. Upon receiving 2/3 RPV High Level Trips the following will occur in the Feed Water Control System.

      1. Low Pressure - Low Flow Controller shifts to manual.
      2. High pressure - Low Flow Controller Shift to Manual.

IV. SYSTEM INTERRELATIONS

A. Feedwater System — EO-4.a

The Feedwater Level Control System receives flow signals from the Feedwater System and controls the High Pressure-High Flow and High Pressure-Low Flow control valves.

B. Condensate System — EO-4.b

The Feedwater Control System controls the Low Pressure-Low Flow control valve in the Condensate System.

C. Main Steam System — EO-4.c

The Feedwater Control System receives main steam flow signals from the Main Steam System.

D. Reactor Recirculation System — EO-4.d

The Reactor Recirculation System receives inputs from the selected reactor level instrument for Recirculation Loop A/B flow control valve runback and the Recirculation pump downshift to LFMG circuitry. The Recirculation Loop A/B LFMG downshift circuitry receives a signal from the total feed flow summer. |6 |6

E. Instrument Air System — EO-4.e

The Instrument Air System provides the motive force used by the feedwater control system to position the Low Pressure - Low Flow and the High Pressure - Low Flow control valves. |6

V. SYSTEM OPERATION

A. Normal Operation (100% Power)

1. Two main feed pumps in operation.
2. High flow Master Controller in operation and automatically controlling RPV level by adjusting the LV-10 flow control valves for pumps in use.

B. Abnormal Operations (3 Element Control)

1. Loss of a Feedwater Flow Signal:

a. The loss of a feedwater flow signal will generate a flow mismatch in the flow comparator.
b. Steam flow-feed flow mismatch biases the level signal to produce a signal to open the flow control valves.
c. The Flow Control valves open until an equilibrium is reached with the level signal off-setting the 50% loss of feedwater flow signal.
d. Results in a level increase of approximately 24".

2. Loss of Steam Flow Signals:
   a. The results of a loss of a steam flow signal is similar to feed flow except it will result in lower level.
   b. Results in a level decrease of approximately 12 inches.
3. Loss of Reactor Level Signal:
   a. The circuit sees a low level and responds by increasing feedflow.
   b. Feedflow increases to maximum or until the mismatch between the feedwater flow and steam flow signal balances the loss of level signal.
   c. Reactor level will continue to increase until the high level trip is reached.

NOTE: An increase of this magnitude at the normal operating level of 182 - 183 inches will result in a high level trip at 202.3 inches. |6

LESSON CONTENT	DELIVERY NOTES	OBJECTIVES/ NOTES
VI. DETAILED SYSTEM REFERENCE REVIEW Review each of the following referenced documents with the class. A. Procedures 1. N2-OP-3, "Condensate and Feedwater System"	Review with trainees precautions and limitations, system startup, normal, operations, system shutdown, off normal and annunciator response procedures.	EO-5.0 EO-6.0 EO-7.0 EO-8.0 |6
VII. RELATED PLANT EVENTS A. Review the following LER's and SOER with the class. 1. LER 88-25 2. LER 88-17 3. LER 88-01 4. LER 87-31 5. SOER 84-4		|6
VIII. SYSTEM HISTORY A. Review the following modification packages with the class: 1. MOD 87MX259 2. MOD 86MX110		|6
IX. WRAP-UP A. Review the Student Learning Objectives.		