NIAGARA MOHAWK POWER CORPORATION

NINE MILE POINT NUCLEAR STATION

02-LOT-001-212-2-00 Revision 6

TITLE: REACTOR PROTECTION SYSTEM

| | SIGNATURE | DATE |
|---|---|---|
| PREPARER | [signature] | 5/21/91 |
| TRAINING AREA SUPERVISOR | [signature] | 5/22/91 |
| TRAINING SUPPORT SUPERVISOR | [signature] for J. LeClair | 5-22-91 |
| PLANT SUPERVISOR/ USER GROUP SUPERVISOR | [signature] for JB Hecker | 5/24/91 |

Summary of Pages

(Effective Date: 5/29/91)

Number of Pages: 36

| Date | Pages |
|---|---|
| May 1991 | 1 - 36 |

THIS LESSON PLAN IS A GENERAL REWRITE

MASTER CONTROLLED DOCUMENT

TRAINING DEPARTMENT RECORDS ADMINISTRATION ONLY:

VERIFICATION: ________

DATA ENTRY: ________

RECORDS: ________

38 5/3/99

I. TRAINING DESCRIPTION

A. Title of Lesson: Reactor Protection System

B. Lesson Description: This lesson contains information that will provide the knowledge necessary for safe and efficient operation of the Reactor Protection (RPS) System.

C. Estimate of the Duration of the Lesson: 4 hours

D. Method of Evaluation, Grade Format, and Standard of Evaluation: A written exam will be given with a minimum grade of 80% required for satisfactory performance.

E. Method and Setting of Instruction: Lecture conducted in the classroom.

F. Prerequisites:

1. Instructor:

a. Certified in accordance with NTP-16.

2. Trainee:

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

G. References:

1. Technical Specifications

a. 2.2.1 Reactor Protection System Instrumentation Setpoints

b. 3.3.1 Reactor Protection System Instrumentation Setpoints

c. 3.3.4.2 Recirculation Pump Trip Actuation Instrumentation

d. 3.8.4.4 RPS Electric Power Monitoring (RPS Logic)

e. 3.8.4.5 RPS Electric Power Monitoring (SCRAM solenoids)

2. Procedures

N2-OP-97 Reactor Protection System

3. NMP-2 FSAR

a. General Plant Description, Volume 1, Chapter 1, Section 1.2.9.1, Page 1.2-27.

b. Instrumentation and Controls, Volume 15 Chapter 7, Section 7.2.1, Page 7.2.1.

c. Instrumentation and Controls, Volume 16 Chapter 7, Section 7.6.1.5, Page 7.6-7.

d. RPS Power Supplies, Volume 16, Chapter 8, Section 8.3.1.1.3, Page 8.3-27c.II. REQUIREMENTS

II. REQUIREMENTS

A. AP-9.0, 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 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

V. LEARNING OBJECTIVES

Upon satisfactory completion of this lesson the trainee will have gained the knowledge related to the Reactor Protection System to:

A. Terminal Objectives:

TO-1.0 Energize the RPS (Power Supplies 2VBB-UPS 3A/3B) service. (2120010101)

TO-2.0 Place an RPS channel in the Tripped Condition. (2120020101)

TO-3.0 Conduct a Manual SCRAM Functional Test. (N2-OSP-RPS-M004) (2120060201)

TO-4.0 Operate the Reactor Mode Switch during a Plant Startup or Shutdown. (2120070101)

TO-5.0 Shift the RPS Bus to the Alternate Supply. (2120090101)

TO-6.0 Perform the Monthly Functional Test of the RPS Turbine Control Valve Closure (N2-OSP-RSP-M001). (2120920201)

TO-7.0 Perform Functional Test of Turbine Stop Valve Closure (N2-OSP-RPS-M002). (2129030101)

TO-8.0 Perform the RPS Weekly Turbine Valve Cycling Test. (N2-OSP-RPS-W001). (2129050201)

Upon satisfactory completion of t:is lesson the Senior Reactor Operator trainee will have gained the knowledge related to the Reactor Protection System to:

TO-9.0 Authorize Placement of RPS Channel in the Test or Tripped Position. (3410430303)

TO-10.0 Authorize Bypass of an RPS Channel from a Trip Condition (Prevent actuation). (3410440303)

TO-11.0 Direct the actions required for a Loss of an RPS Channel. (3449230503)

TO-12.0 Respond to a Loss of RPS Bus. (3449950403)

TO-13.0 Authorize de-energizing the Reactor Protection System. (3450360103)

B. Enabling Objectives:

EO-1.0 Explain the function and the purpose of the Reactor Protection System and the Recirculation Pump Trip System.

EO-2.0 Explain the difference between the terms "SCRAM" and "half SCRAM".

EO-3.0 Explain the power supply network for the following RPS components:

a. Trip Systems
b. SCRAM Pilot Solenoids
c. Backup SCRAM Valve Solenoids

EO-4.0 Describe the purpose and function of the RPS major components listed below:

a. Electrical Protection Assemblies (EPAs)
b. RPS Trip System
c. RPS Trip Channel
d. Channel Sensor Relays
e. SCRAM Pilot Valves
f. Backup SCRAM Valves
g. SCRAM Discharge Volume (SDV) Isolation Pilot Valves
h. SDV High Water Level Bypass Switches
i. RPS Logic Reset Switches
j. Pilot SCRAM Valve Solenoid Indicating Lights
k. Power Source Selector Switch
l. Reactor Mode Switch
m. SDV Isolation Valve Test Switches
n. Hydraulic Control Unit Rod SCRAM Test (SRI) Switches

EO-5.0 List all automatic scram signals and the setpoint at which each is activated.

EO-6.0 Describe the two methods available to manually trip the RPS.

EO-7.0 Describe the method and any applicable setpoints utilized in bypassing the following RPS trip signals:

a. SDV High Level
b. MSIV Closure
c. TSV Closure
d. TCV Fast Closure
e. Neutron Monitoring System Inputs

EO-8.0 Utilize an RPS Trip System circuit drawing to describe the trip system response to a valid trip signal including:

a. Channel Sensor Relay response
b. Channel Reset logic response
c. SCRAM valve response (inlet, outlet, SDV isolation and backup SCRAM valve)
d. EOC-RPT actuation and bypass

EO-9.0 Regarding the Reactor Protection System, determine and use the correct procedure(s) to identify actions or locate information related to the following:

a. Startup
b. Shutdown
c. Normal Operations
d. Off normal operations
e. Annunciator responses

EO-10.0 SRO ONLY Given the NMP-2 Technical Specifications and a set of plant conditions, determine the appropriate bases, limiting conditions for operations, limiting safety system setting or action statement as applicable.

I. INTRODUCTION

Distribute TR for completion

Distribute Course Evaluation forms and describe how it should be utilized.

Review Student Learning Objectives

Describe Text Layout for Chapter

Explain the lesson will be evaluated by written exam at the end of the week.

Trainees must achieve an 80% to pass the course. EO-1.0

A. System Purpose

The Reactor Protection System (RPS) automatically initiates a rapid reactor shutdown called a SCRAM for one of the following reasons:

1. Preserve the integrity of the fuel cladding.
2. Preserve the integrity of the reactor coolant system.
3. Minimize the energy which must be absorbed during a loss of coolant accident.
4. Prevent inadvertant criticality.

The RPS is a dual-trip electrical alarm and actuating system designed to prevent the reactor from operating under unsafe, or potentially unsafe conditions. The RPS is designed to provide a signal to cause a SCRAM and shutdown the reactor when specific variables exceed predetermined limits.

End of Cycle Recirculation Pump Trip (EOC-RPT) — EO-1.0

The recirculation pumps are downshifted to slow speed to reduce the severity on the fuel of thermal transients caused by turbine trip or generator load rejection. By transferring the recirculation pumps to low speed early in the event, the rapid core flow reduction maintains void content for a longer period reducing reactivity in conjunction with a control rod insertion.

Although utilized throughout the core cycle the EOC-RPT system is specifically required at the end of cycle when thermal margins are smaller.

The EOC-RPT system is a part of the RPS.

B. General Description

*Delivery notes: Show TP of basic. System logic path.*

1. The RPS consists of two independent and identical trip systems (A and B).
2. Each trip system is divided into two independent trip channels (A1, A2, B1, B2).

3. Each RPS channel receives an input from at least one independent sensor for each critical reactor parameter. When a sufficient number of sensors for a parameter reaches its trip setpoint, a trip signal will be generated by the RPS logic.

   Minimum of four sensors for each parameter. Some parameters have more.

4. Electrical power to the scram pilot valves on each CRD-HCU is interrupted, and all control rods rapidly insert into the reactor core.

5. Two methods of manually causing a trip will also be discussed.

II. DETAILED DESCRIPTION

A. Power Supplies

1. Each trip system's sensor logic, trip logic, status lights, and AC/DC power supplies receive power from one of the two 10KVA, 120 VAC, 1-phase Uninterruptable Power Supply (UPS) systems.

   Show TP of RPS. Logic power supply.

   EO-3.0a

   a. RPS trip system A is fed from UPS 2VBB-UPS3A:

      Briefly review UPS operation.

      1) UPS is normally powered by 600 VAC, 2 LAT-PNL 100,

      2) UPS receives backup power from 125 VDC, 2 BYS-SWG001A.

a) The associated battery charger 1A1 is fed from 2NJS-US5.

3) The alternate source to the UPS is from 600 VAC, 2NJS-PNL500.

b. Trip system B is fed from UPS-2VBB-UPS3B:

1) UPS is normally powered by 2NJS-PNL402. EO-3.0a

2) UPS receives backup power from 2BYS-SWG001B.

a) The associated Battery Charger 1B1 is fed from 2NJS-US6.

3) The alternate source to the UPS is 2NJS-PNL600.

2. Two Electrical Protection Assemblies (EPA), in series, connects each UPS to its associated distribution panel.

a. EPA provides electrical separation between safety related RPS circuits and non-safety related normal power supplies. EO-4.0a

| LESSON CONTENT | DELIVERY NOTES | OBJECTIVES/ NOTES |
|---|---|---|
| b. These disconnect the RPS circuits whenever voltage deviates from 120V by more than ± 10% and whenever frequency drops below 60 HZ by 5%. | Exact numbers are in Tech. Specs. | |
| c. EPA's require local manual reset if tripped. | | |
| 3. The power supply to the scram pilot valve solenoids is from two high-inertia motor generator (MG) sets: | Show TP of RPS MG Set supply | EO-3.0b |
| a. MG set 2RPM-MG1A feeds all of the A solenoid valves. | | |
| b. MG set 2RPM-MG1B feeds all of the B solenoid valves. | | |
| c. Each MG set consists of a 3-phase induction motor, driving a 120 VAC, 60 HZ, 1-phase synchronous generator. | | |
| d. A flywheel mounted on the MG shaft helps control MG Set voltage and frequency (by utilizing inertia) during input power deviations. | | |
| e. The driving motor for 1A is powered by 600 VAC from 2NHS-MCC008 (stub bus 5), and motor 1B from 2NHS-MCC009 (stub bus 6). | | |

| LESSON CONTENT | DELIVERY NOTES | OBJECTIVES/ NOTES |
|---|---|---|
| f. Alternate power for the "A" solenoids comes from 2LAT-PNL100 via 2RPM-PNL1A. | | |
| g. Alternate power for the "B" solenoids comes from 2LAS-PNL400 via 2RPM-PNL1B. | | |
| h. Alternate power is used when the MG set is taken out of service for maintenance. | | |
| i. Only one alternate supply may be selected at any one time due to switch design. | | |
| j. EPA's work the same as previously discussed. | EPA's also have same purpose (i.e. provide separation). | |
| 4. Power for the Backup Scram Valve solenoids comes from 2BYS*SWG002A and 2B switchgear (Division 1 and 2 Battery buses): | Note these are RPM EPAs where others where VBS. | EO-3.0c |
| B. System Operating Fundamentals | | |
| 1. "One-out-of-two-taken-twice" logic: | RPS is a coincident, fail safe logic. | |
| a. Two trip systems control power to a group (A or B) of solenoids on scram pilot valves. Each trip stream contains two trip channels. | | EO-4.0b |
| b. At least one of two channels in <u>each</u> trip system must trip to cause a SCRAM. This will cause a rapid rod insertion. | | EO-4.0c |

| | | |
|---|---|---|
| c. "<u>Half-SCRAM</u>"--if only one trip system trips, the one group of solenoids on the scram pilot valves will de-energize, but no SCRAM will occur and no rod movement occurs. | Half SCRAM is simply a trip of one trip system. | EO-2.0 |
| 2. During normal reactor operation all sensor trip contacts are closed, the bypass contacts are open, and the channel sensor relays are energized. | Sensor trip contacts are the contacts operated in the trip channels by the various sensors of RPS monitored parameters. | |
| 3. Channel sensor relays operate contacts which interrupt power to solenoid valves in the CRDH system. | Channel sensor relays are normally energized and de-energized on a trip. | EO-4.0d |
| 4. Each HCU has:<br>a. One three-way, 120 VAC, dual-coil, solenoid-operated pilot scram valve.<br>b. One air operated exhaust valve.<br>c. Two air operated scram valves. | Note: All drawing are shown de-energized. | |
| Energizing of the A or B solenoid on the pilot SCRAM valves allows instrument air to hold the exhaust and scram valves closed. De-energizing <u>both</u> solenoids causes the SCRAM pilot valve to change position and the air bleeds off the SCRAM valves. The SCRAM valves will open by spring force and the rods insert into the core. | | EO-4.0e |

5. Channel sensor relays in Trip System "A" operate contacts to allow the "A" solenoid to be energized. Channel sensor relays in Trip System "B" operate contacts to allow the "B" solenoid to be energized.
6. Two backup SCRAM valves (normally de-energized, DC solenoid-operated valves) provide a backup means of bleeding air from the SCRAM valves. EO-4.0f
   a. When both trip systems trip, the backup SCRAM solenoids energize shifting the valves to block the instrument air supply to the CRD SCRAM valve pilot air header.
   b. The pilot air header bleeds down and the SCRAM valves open, causing insertion of all control rods.

   Backup SCRAM valve function only works if pilot SCRAM valve fails to reposition for blocking and venting air.
7. SCRAM Discharge Volume (SDV):

   SDV is part of CRDH System.
   a. Receives water from the over-piston area of the CRDM's when the scram outlet valves open.
   b. The Instrument volume (vertical section of the SDV) has two 120 VAC, dual solenoid-operated pilot valves (normally energized open).

c. The SDV Isolation Pilot Valves allow air to keep the volume vent and drain valves open during normal conditions and vent the air to allow isolation of the volume during a SCRAM. — EO-4.0g

d. De-energizing a channel sensor relay in one channel of both trip systems will cause the pilot valves to de-energize venting air from the SDV air operated vent and drain valves (2 each) which will cause them to close by spring pressure. This isolates the SDV from its vent path and drain path.

D. RPS Parameters, Inputs, Setpoints, Logic, and Bases

1. Turbine Stop Valve Closure — EO-5.0

a. When 3 out of 4 turbine stop valves close above 30% reactor power (sensed by first stage turbine pressure) a SCRAM is initiated.

*Delivery notes:* 2 valves may cause 1/2 SCRAM depending on which 2, 3 valves will always cause a SCRAM.

b. Inputs to the RPS come from valve stem position switches on the four turbine stop valves.

*Delivery notes:* Limit switches sense valve not full open at 95% open.

c. Turbine stop valve closure SCRAM initiates a SCRAM earlier than either the high neutron flux or vessel high pressure resulting from the valve closure.

d. Classified as anticipatory SCRAM.

2. Turbine Control Valve Fast Closure

a. When the turbine control valves trip closed, above 30% reactor power, a SCRAM is initiated. EO-5.0

b. Inputs to the RPS come from pressure switches N005A-D, located in the electro-hydraulic control system (EHC) emergency trip system (ETS) lines.

c. Each pressure switch (4) provides an input to one RPS channel and actuates at an EHC trip oil pressure of 530 psig decreasing.

d. Actuation of one pressure switch in <u>each</u> RPS trip system will cause a SCRAM. — Pressure switch per channel.

e. ETS fluid pressure was chosen as the input signal because the turbine control valve positions vary at different power levels, thus control valve position is not an appropriate parameter.

f. TCV fast closure initiates a SCRAM earlier than either high neutron flux or vessel high pressure resulting from the closure.

g. Classified as an anticipatory SCRAM.

3. Turbine Stop Valve and Control Valve Closure Bypass

a. Permits reactor operation with turbine valves closed at low power level (<30% power). EO-7.0c EO-7.0d

b. Inputs to RPS come from pressure transmitters mounted on each of the first stage pressure taps.

c. Actuation of at least one trip unit in each RPS trip system will cause bypass of the turbine stop valve and control valve closure SCRAM.

4. SCRAM Discharge Volume High Water Level
   a. A SCRAM is initiated by high level in SDV instrument volume to insure sufficient volume exist for the water exhausted from CRDM during SCRAM. EO-5.0
   b. Inputs to the RPS come from 4 non-indicating float switches and 4 level transmitters sensing instrument volume level. Float switch setpoint is $\leq$48.5 inches while transmitter setpoint is $\leq$43.4 inches.
   c. Each RPS channel gets input from one switch and one transmitter.

      *Delivery note:* Either switch or transmitter will trip the channel.
   d. Actuation of at least one switch or transmitter in each RPS trip system will cause a SCRAM.
5. SCRAM Discharge Volume High Level Bypass EO-7.0a
   a. The SDV high level SCRAM must always be bypassed prior to RPS reset. The level will exceed the setpoint following a SCRAM and the volume isolates from the drain path until RPS is reset.
   b. Four switches are provided, on panel 603 to bypass the trip, (one for each RPS channel). EO-4.0h

| LESSON CONTENT | DELIVERY NOTES | OBJECTIVES/NOTES |
|---|---|---|
| c. In order for the SDV High Level Bypass switches to bypass the scram signal, the reactor mode switch <u>must</u> be in either SHUTDOWN or REFUEL. | | |
| d. The bypass signal provides a rod block signal to the RMCS. | | |
| e. With the signal bypassed RPS reset can be accomplished (provided all other trip signals are reset or bypassed). With RPS reset the SDV vent and drain valves reopen and the volume drains. | | |
| 6. Main Steamline Isolation Valve Closure | | |
| a. A SCRAM is initiated if 3 of 4 Main Steam lines become isolated with the Reactor Mode Switch in the RUN position. | | |
| b. Inputs to RPS come from the MSIV position limit switches mounted on the MSIV's (HYV6A-D and HYV7A-D) when valve is 8% closed. | RPS input limit switches indicate valve closure at 92% open. | EO-5.0 |
| c. The logic is arranged such that any combination of MSIV closures resulting in three main steamlines being isolated (inboard <u>or</u> outboard valve closed) causes a reactor SCRAM. | Some 2 line isolations may result in a half SCRAM. | |

| LESSON CONTENT | DELIVERY NOTES | OBJECTIVES/ NOTES |
|---|---|---|
| d. One main steamline can be isolated completely without tripping either trip system. Two main steamlines isolated may result in a half SCRAM if it is the correct combination. | Note that at rated power a single steam line isolation will result in high steam flow through the other 3 lines causing a Group I isolation and resulting SCRAM. | |
| e. MSIV closure initiates a SCRAM faster than the high neutron flux or high vessel pressure resulting from the closure. | | |
| f. Classified as an anticipatory SCRAM. | | |
| 7. MSIV Closure Bypass | | EO-7.0b |
| a. This permits low power reactor operation with the main steamlines isolated. levels. | | |
| b. Bypass sensor relays are energized when the reactor mode switch is placed in <u>any</u> position other than RUN. | Checking MSIV position is required prior to placing mode switch to RUN. | |
| 8. High Drywell Pressure | | |
| a. A drywell pressure of 1.68 psig, will cause a trip. | | EO-5.0 |
| b. Input to RPS come from four pressure transmitters sensing drywell free air space pressure. | | |

c. The logic is arranged such that a high pressure signal from at least one transmitter in each RPS trip system will cause a SCRAM.

d. High pressure in the drywell may indicate a break in the nuclear system process barrier.

e. This function is never bypassed.

9. High Reactor Pressure

a. A reactor vessel pressure of 1037 psig will cause a SCRAM. — EO-5.0

b. Inputs to RPS comes from four pressure transmitters sensing vessel steam dome pressure. Each provides an input into one RPS channel trip unit.

c. This function is never bypassed.

10. Low Reactor Water Level

a. A reactor vessel water level below the low water level setpoint (159.3") causes a SCRAM. — Delivery notes: Level is also referred to as level 3 in GE Documentation. — EO-5.0

b. Inputs to RPS come from four differential pressure transmitters (one per channel).

c. This function is never bypassed

11. Main Steamline High Radiation EO-5.0
    a. Radiation levels in the vicinity of the main steamlines exceeding 3 times full power background level will cause a SCRAM.
    b. Inputs to RPS come from four gamma-sensitive ion chamber monitors, one monitor for each RPS channel.
    c. The monitors are geometrically arranged downstream of the outboard MSIV's so that each detector can sense radiation levels in each of the four steamlines.
    d. The RPS logic is arranged such that a high radiation signal from at least one monitor in each RPS trip system will cause a SCRAM.
    e. An inoperative signal from a monitor (i.e. module unplugged or low voltage) also causes a trip signal from that monitor.
    f. This function limits the release of fission products from the containment following a gross fuel failure.

12. Neutron Monitoring System (NMS) — EO-5.0

a. During startup and low power ops, eight IRM's provide inputs to RPS. During power range operation, six APRM's provide inputs to the RPS.

b. NMS SCRAMS are necessary to protect the fuel against excessively high power generation rates.

c. Two IRMs and two APRMs provide inputs to each RPS channel.

   Delivery note: APRM E and F are used by two RPS channels.

d. At least one monitor in each trip system must sense high flux or an INOP condition to cause a SCRAM.

   Delivery note: IRM and APRM trip setpoints are discussed in the associated system chapters.

e. When the reactor mode switch is placed in RUN, the IRM logic is bypassed. — EO-7.0e

f. Each NMS input is bypassed individually by joysticks on P603.

g. A non-coincident NMS protection logic may also be used (shorting links removed). The logic adds the SRM input to the RPS trip logic and makes all NMS trips non-coincident. (i.e. any one instrument sensing high flux will cause a SCRAM).

   Delivery note: This function is only used prior to proving Shutdown Margin following a refueling.

h. Shorting links are located in P609 and P611 in the Control Room.

13. Manual SCRAM — EO-6.0

a. Four manual SCRAM pushbuttons are located in the control room, on panel 603 (one pushbutton for each RPS channel) to provides the operator with a means to manually SCRAM the reactor.

b. Each pushbutton is armed by turning its collar clockwise.

c. At least one pushbutton in each RPS trip system must be armed and depressed to initiate a SCRAM.

Delivery notes: Pushbutton located on either side of 4 rod display. Arming and pushing the two buttons on either side will cause a SCRAM.

d. Placing the Reactor Mode Switch in the SHUTDOWN position will open a contact in all four RPS channels which causes a SCRAM.

1) The action also closes a contact in all four channels which energizes a time delay and seals in the signal for 10 sec.

14. SCRAM Reset — EO-4.01

a. Four RPS logic reset switches, (one for each channel), are located on panel 603.

Delivery notes: 2-position, spring return- to- normal, keylock switches.

b. When the reset switches are placed in the reset position the following occurs (in order): EO-8.0b

1) Reset contacts close.
2) Reset sensor relays K19A-D will energize.
3) Reset sensor relay contacts K19A-D close.
4) Channel sensor relays K14A-D energize (if all trip signals cleared or bypassed).
5) Channel sensor relay contacts K14A-D close to seal in the reset.

c. The reset is prevented for 10 seconds following a SCRAM to allow all rods to fully insert in the core.

A half SCRAM can be reset without the time delay.

III. INSTRUMENTATION AND CONTROL

A. Indications EO-4.0j

1. 2 groups of 4 white indicating lights on panel 603, one group on either side of the full core display.
2. The normally lit lights are each associated with one of the four rod groups in Trip System A or B.

3. The lights extinguish as a result of denergizing the associated group of solenoids.
4. This shows which RPS trip system (A or B) has tripped.

B. Controls

1. RPS Power Source Selector Switch
   a. Located on Control Rod Test Panel 610 in the control room. — EO-4.0k
   b. Three positions:
      1) NORMAL-RPS M-G sets A and B supplying power to solenoids
      2) ALT A-supply from 2 LAT-PNL100 for "A" solenoids, "B" solenoids from MG 1B
      3) ALT B-supply from 2 LAS-PNL 400 for "B" solenoids, "A" solenoids from MG 1A
   c. A loss of power will occur whenever this switch is operated, however, the trip system channel sensor relays will not de-energize (i.e. only a power loss to solenoids).

      Delivery notes: The loss of power will trip the RPM*EPA's. The EPAs must be locally reset.

2. MSIV and Turbine Stop Valve Closure Test Switches
   a. These switches are located in the control room on panel 609 and 611.
   b. Allow for testing of the MSIV or turbine stop valve sensor logic circuits.
3. Reactor Mode Switch
   a. 4-position keylock switch located on control room panel 603. EO-4.01
   b. The mode switch position establishes plant operating conditions and affects the RPS logic circuitry.
   c. When the mode switch is placed in SHUTDOWN both RPS trip systems are deenergized causing a SCRAM. A 10 second time delay ensures that all control rods are fully inserted into the core prior to automatically bypassing the SCRAM signal. This position also bypasses the trip functions for MSIV closure and allows bypassing the SDV High Water Level trip.

d. In REFUEL, the APRM setdown trip functions are in effect while the trip functions for MSIV closure are bypassed, and the SDV High Water Level trip can be bypassed.

e. In STARTUP, criticality and heatup are allowed with APRM setdown trip functions in operation and the trip functions for MSIV closure bypassed.

f. In RUN, higher power levels are allowed, but proper valve lineups, pressures, and flows must be adhered to strictly. IRM trip functions are bypassed.

4. Reactor Scram Manual Trip Switches
(Previously discussed)

5. Reactor Scram Reset Logic Switches
(Previously discussed)

6. Discharge Volume High Water Letter Bypass Switches
(Previously discussed)

7. Discharge Volume Isolation Test Switches — EO-4.0m
   a. Depressing both switches (S2A,B) will de-energize both solenoids on the SDV isolation valve pilot valves, closing the SDV vent and drain valves (pushing one only de-energizes A or B solenoid so no valves will reposition).
8. Rod Scram Test Switches
   a. Two, 2-position toggle switches located on each CRDH-HCU. — EO-4.0n
   b. These switches are used for:
      1) Testing of the individual coil of the scram pilot solenoid valve.
      2) Surveillance testing of the individual control rod scram lines.
   c. Placing both switches to TEST deenergizes both solenoids, causing that particular rod to scram.

C. Interlocks
1. SDV Bypass — EO-7.0a
   a. Allows resetting of RPS logic following a scram.
   b. Enables draining of the SDV, (i.e. once scram reset vent and drain valve reopen).

| LESSON CONTENT | DELIVERY NOTES | OBJECTIVES/ NOTES |
|---|---|---|
| c. Prevents rod withdrawal by inserting a rod block whenever SCRAM function is bypassed. | | |
| 2. MSIV Closure Bypass | | |
| a. Bypassed when reactor mode switch is not in RUN. | | EO-7.0b |
| 3. Turbine Stop and Control Valve Closure Bypass | | EO-7.0c |
| a. Automatically bypassed at less than 30% reactor power (129.6 psig first stage pressure). | Setpoint of less than or 119 psig equal to account for instrument drift. | EO-7.0d |
| 4. Neutron Monitoring Bypass | | EO-7.0c |
| a. IRM upscale and inoperative trip, and APRM setdown SCRAM are bypassed in the RUN mode. | | |
| b. Removal of shorting links: | | |
| 1) Inserts the SRM upscale SCRAM function, and | | |
| 2) Makes the SCRAM logic for the Neutron Monitoring System non-coincident (i.e. any NMS instrument trip causes a SCRAM). | | |

IV. SYSTEM OPERATION

A. Normal Operation

1. No SCRAM condition.

2. SCRAM logic system reset.
3. SCRAM Pilot Valve solenoids energized.
4. Backup SCRAM Valve solenoids de-energized.
5. SDV vent and drain valves open (Discharge Valve Isolation Valves solenoids energized).
6. Power from 2VBB-UPS3A, B for sensors and logic and 2RPM-PNL1A, 1B for pilot SCRAM valve solenoids.

B. Startup Operation
1. SCRAM logic is reset
2. SDV high water level bypass switches in NORMAL.
3. Reactor mode switch in STARTUP/HOT STANDBY
4. IRM SCRAM functions in effect
5. Setdown APRM SCRAM function in effect
6. MSIV Closure SCRAM bypassed
7. TSV and TCV closure trip bypassed

C. Non-coincident Logic
1. Used when required by Technical Specifications
2. SRM SCRAM signal is inserted ($\leq 2 \times 10^5$ cps)
3. Any single NMS trip signal causes SCRAM.

D. SCRAM occurs when any of the monitored parameters reaches its trip setpoint. This deenergizes the sensor relay for that parameter.

Then: EO-8.0a

1. The sensor relay contact opens
2. Channel sensor relays (K14) are de-energized.
3. SCRAM pilot valve solenoids de-energize. EO-8.0c
4. SCRAM pilot valve changes position.
5. Air flow to the exhaust pilot valve is blocked and valve is vented.
6. Exhaust pilot valve vents and opens.
7. SCRAM inlet and outlet valves open.
8. CRDH accumulator pressure or reactor pressure is applied to the below piston area of the CRDM.
9. Exhaust from the over-piston area is discharged into the SDV as the control rods are driven into the reactor core.
10. Backup SCRAM valves energize and bleed off the SCRAM pilot valve header to drive rods with failed SCRAM pilot valves into the core.
11. SDV isolation valve solenoids de-energize, causing the SDV vent and drain valves to close, isolating the SDV.
12. An additional SCRAM signal is caused by the SDV high level.

| | | |
|---|---|---|
| 13. EOC-RPT Logic | | EO-8.0d |
| a. RPS logic detects TCV fast closure and TSV closure using four channels of sensor logic. | Use TP of RPT logic. | |
| b. RPS logic combines the four channels of sensor logic into two divisions of RPT logic. | | |
| c. Trip of either division of the RPT logic will trip both recirculation pumps from fast speed to slow speed. | A logic trips the 3A and 3B Breakers. B logic trips the 4A and 4B Breakers. | |
| 1) Trip requires two channel sensor trip signals for the condition. | | |
| 2) The logic is automatically bypassed below 30% power sensed by turbine first stage pressure. | Turbine 1st stage pressure sensor also used to bypass RPS trips, same setpoint. | |
| 3) The RPT logics are powered from UPS 3A/3B. | | |
| d. Manual out of service pushbuttons for EOC-RPT on P602 physically disable the circuit. | Amber pushbuttons on vertical section of panel. Buttons generally just give warning annunciator in most systems. | |

E. Transfer to Auxiliary Power

1. If power is lost from an M-G set, power is lost to that set (A or B) of solenoids, resulting in a half- scram (Channel sensor relays do not de-energize).
2. The power source select switch at panel 610 is positioned to supply power from the alternate source.
3. Only one set of solenoids can be selected to an alternate source at one time.
4. Normal operation may be continued with one RPS-MG set out of service.

NOTE: If the power loss in one channel is coincident with a half SCRAM in the opposite channel, all rods will SCRAM. However, the SCRAM discharge volume vent and drain valves and the backup SCRAM valves do not reposition until the SCRAM discharge volume fills to the trip point.

V. SYSTEM INTERRELATIONS

A. Instrument Air System (IAS)

Supplies 70-75 psig air for scram inlet and outlet, exhaust pilot and SDV vent and drain valves.

B. Control Rod Drive Hydraulic (CRDH)

Provides motive force for initiation of control rod insertion during a reactor scram.

C. Neutron Monitoring System (NMS)

Provides trip input signals to RPS logic.

D. Reactor Manual Control System (RMCS)
Provides rod block when the SDV high level SCRAM signal is bypassed.

E. Reactor Recirculation System (RRS)
When >30% power, RPS supplies signals for EOC-RPT.

F. Radiation Monitoring System(RMS)
Supplies inputs to RPS for MSL high radiation scram.

G. Reactor Vessel Instrumentation (RVI)
Supplies inputs to RPS for vessel level and pressure functions.

H. Redundant Reactivity Control System (RRCS)
Controls 8 DC powered valves called ARI valves that provide alternate means to depressurize the scram air header.

VI. DETAILED SYSTEM REFERENCE REVIEW
Review each of the following referenced documents with the class.

A. Procedure N2-OP-97 — Delivery notes: Use latest revision. — Objectives: EO-9.0
1. Review applicable precautions.
2. Review startup, shutdown, normal, and off normal sections for applicable information.

B. Technical Specifications

1. 2.2.1 Reactor Protection System Instrumentation Setpoints — EO-10.0 (SRO Only)
2. 3.3.1 Reactor Protection System Instrumentation Setpoints
3. 3.3.4.2 Recirculation Pump Trip Actuation Instrumentation
4. 3.8.4.4 RPS Electric Power Monitoring (RPS Logic)
5. 3.8.4.5 RPS Electric Power Monitoring (SCRAM Solenoids)

VII. RELATED PLANT EVENTS

A. Refer to the following LER's:

1. 86-10 Quarter Core SCRAM
2. 86-14 Loss of Power to Group 2 SCRAM Solenoid Coils
3. 86-19 Recurrence of SDV High Reactor SCRAM due to Ineffective Corrective Action
4. 87-10 Spurious Reactor SCRAM Signal due to Technician Error
5. 87-54 MSIV Isolation Signal due to Turbine Stop Valve Surveillance Testing
6. 87-82 MSIV Isolation and subsequent SCRAM due to Mode Switch Design Deficiency

B. Industry Concerns

1. G.E Problem Report GE PRC 89-24
   Malfunction of CR2940 Switch
   a. Go over high lighted portions of the report with class - point out how to avoid this problem with "positive" key action
   b. Key lock switches (3 position) used in the following locations

The following is a list of applications of the GE CR 2940 switch (P/N 145C3040P022) at NMP2:

Control switches for safety relief valves;

| | | |
|---|---|---|
| 2MSS*PSV120 | 2MSS*PSV121 | 2MSS*PSV122 |
| 2MSS*PSV123 | 2MSS*PSV124 | 2MSS*PSV125 |
| 2MSS*PSV126 | 2MSS*PSV127 | 2MSS*PSV128 |
| 2MSS*PSV129 | 2MSS*PSV130 | 2MSS*PSV131 |
| 2MSS*PSV132 | 2MSS*PSV133 | 2MSS*PSV134 |
| 2MSS*PSV135 | 2MSS*PSV136 | 2MSS*PSV137 |

Turbine Stop Valve Closure Test Switches
Turbine Control Valve Fast Closure Test Switches
Main Steam Line Isolation Valve Closure Test Switches

7. 89-11 Miscalibration of Main Steamline Radiation Monitors causes Violation of Technical Specifications

B. See Attached

VIII. SYSTEM HISTORY

A. Refer to the following RPS System modifications:

1. PN2Y88MX085 Provide Lights to verify RPS TSV Closure Relays Energized.

IX. WRAP UP

A. Review the System Learning Objectives