NINE MILE POINT NUCLEAR STATION

UNIT II OPERATIONS

07-189-91

LESSON PLAN

02-REQ-0001-201-2-01-4

CONTROL ROD DRIVE HYDRAULICS

Prepared By: Unit #2 Training Department

APPROVALS	SIGNATURES	DATE AND INITIALS REVISION 4
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Summary of Pages

Revision: 4 (Effective Date: 6/4/88)

Number of Pages: 19

Date	Pages
May 1988	1 - 19

NINE MILE POINT NUCLEAR STATION

Attachment "A"

OBJECTIVE APPROVAL

Author: UNIT II OPS TRAINING

Training Dept: Unit II OPS.

Lesson Title: CONTROL ROD DRIVE HYDRAULICS

Lesson Plan #: NZ-OLP-7

Training Setting(s): Classroom

Purpose: INSTRUCTOR shall present information for the student to meet each Student Learning Objective. Additionally, he shall provide sufficient explanation to facilitate the student's understanding of the information presented.

Trainee Job Title: LICENSED OPERATOR CANDIDATE

Approvals/Review	Signatures	Date
Training Supervisor		4/15/88
Plant Supervisor		6/4/88
Training Analysts Supervisor		4/19/88

When complete, attach this form to the master lesson plan.

LESSON PLAN

I. TRAINING DESCRIPTION

A. TITLE: Control Rod Drive Hydraulics |4

B. PURPOSE: In a lecture presentation, the instructor shall present information for the student to meet each Student Learning Objective. Additionally, he shall provide sufficient explanation to facilitate the student's understanding of the information presented.

C. TOTAL TIME:

4.0 hours |4

D. TEACHING METHODS:

- Classroom Lecture
- Assign the Student Learning Objectives as review problems with the students obtaining answers from the text, writing them down and handing them in for grading.

E. REFERENCES:

1. Technical Specifications |4 |
   a. 3/4.1.3.1; Control Rod Operability |
   b. 3/4.1.3.2; Control Rod Maximum Scram Insertion Times |
   c. 3/4.1.3.3; Control Rod Average Scram Insertion Times |
   d. 3/4.1.3.4; Four Rod Group Scram Insertion Times |
   e. 3/4.1.3.5; Control Rod Scram Accumulators |
2. Procedures |
   a. N2-OP-30, CRD System, Rev. 2 |
3. NMP-2 FSAR |
   a. Design Basis Vol 12, Chapter 4, Pg. 4.6-1 |

II. REQUIREMENTS AND PREREQUISITES

A. REQUIREMENTS FOR CLASS:

1. AP-9, Rev. 2, Administration of Training |4
2. NTP-10, Rev. 3, Training of Licensed Operator Candidates |
3. NTP-11, Rev. 4, Licensed Operator Retraining and Continuing Training |
4. NTP-12, REv. 2, Unlicensed OperatorTraining |

B. PREREQUISITES |

1. Instructor |
   a. Demonstrated knowledge and skills in the subject, at or above the level to be achieved by the trainees as evidenced by previous training or education or |
   b. SRO license for Nine Mile Point Unit Two or a similar plant, or successful completion of SRO training including simulator certification at the SRO level for Nine Mile Point Unit Two. |
   c. Qualified in instructional skills as certified by the Training Analyst Supervisor. |
2. Students |
   a. Meet eligibility requirements per 10CFR55 or |
   b. Be recommended for this training by the Operations Superintendent or his designee or the Training Superintendent. |

III. TRAINING MATERIALS

A. TEACHING MATERIALS:

1. Transparency Package
2. Overhead Projector
3. Whiteboard and Felt Tip Markers
4. N2-OLP-7 |4
5. N2-OLT-7 |
6. See Section I.E.1 |
7. See Section I.E.2 |

B. STUDENT MATERIALS: |

1. N2-OLT-7 |
2. See Section I.E.1 |
3. See Section I.E.2 |

IV. QUIZZES, TESTS, EXAMS AND ANSWER KEYS

Will be generated and administered as necessary. They will be on permanent file in the Records Room.

V. LEARNING OBJECTIVES FOR THE CONTROL ROD DRIVE HYDRAULICS (CRDH) SYSTEM |4

Upon completion of this chapter, mastery of the required system knowledge will be demonstrated by performing the Enabling Objectives listed below.

7-1 State the purpose of the CRDH system.

7-2 On an HCU piping diagram, identify all components.

7-3 State the purpose and principle of operation of the following major system components:

a. Suction and discharge filters
b. CRDH pumps
c. Flow Control Station
d. Pressure Control Station
e. Charging, Drive, Cooling, and Exhaust Water headers
f. Stabilizing valves
g. Pressure Equalizing valves
h. Scram Discharge Volume
i. HCU's

7-4 Identify the seven risers on an HCU.

7-5 Describe the flow paths and sequence for an HCU performing: a) Insert, b) Withdraw, and c) Scram, include in your discussion any system automatic functions (ie. trips, bypasses, valve movements) to return system to normal operational status.

7-6 List the available Control Room indications and system controls along with normal values.

7-7 Given N2-OP-30, Control Rod Drive Hydraulics use the procedure to identify the appropriate actions and/or locate information related to: |4

a. Startup
b. Normal Operations
c. Shutdown
d. Off-Normal Operations
e. Procedures for Correcting Alarm Conditions

7-8 SRO Only Given Technical Specifications, identify the appropriate actions and/or locate information relating to limiting conditions for operation, bases, and surveillance requirements for the Control Rod Drive Hydraulic System.

7-9 State the power supplies to the CRDH pumps.

VI. LESSON CONTENT	Text Ref. Page	Text Ref. Fig.	S.L.O.
Activity			
INTRODUCTION			4
Student Learning Objectives	i		
A. Purpose	1		1
The Control Rod Drive Hydraulic System provides Reactor Grade water at different DP's (compared to Rx press.) for driving, scram, and cooling functions related to the operation of the control rod drives. The system also provides purging water for the reactor recirc pump seals.			
B. General Description	1,2	1,2,3	2,3
1. Project the diagrams with which the student should be familiar.			
2. Major components are 2 100% pumps, 185 HCU's, and assoc. valves, filters, and piping.			
3. Point out inlets, outlets, interconnections and instrumentation			
4. Describe basic flowpaths			5
II. DETAILED DESCRIPTION			
A. CRDM Pump Suction Filters	2	1	3
1. The CRDH pumps have two suction filters to protect the pump from foreign material.			
2. One filter is in service, one valved out.			
3. The filters are disposable elements.			
4. A Y-strainer is located upstream of each filter.			

Activity	Text Ref. Page	Text Ref. Fig.	S.L.O.	
5. A micron Y-strainer is located in the filter bypass line.	2	1	3	
B. Control Rod Drive Hydraulic Pumps				
1. The CRDH provides the driving force for normal control rod movement, control rod cooling, and charging the scram accumulators.				
2. The two 100% capacity pumps are 10 stage, centifugal, motor driven pumps.				
3. One pump normally is operating with the other in Standby.				
4. Each pump has an oil cooler to maintain pump temperature.				
5. Minimum flow bypass line has a restricting orifice to provide a continuous flow to the condensate storage tank from the running pump to prevent immediate pump overheating if the discharge path is blocked.	3			
6. The power supplies to the pumps are: a. P1A 2NNS-SWG014 b. P1B 2NNS-SWG015	2		9	4
C. CRDH Pump Discharge Filter	3	1	3	
1. Two redundant full flow pump discharge filters.				
2. One filter normally in service and the other is valved out of service.				
D. Reactor Recirculation Pump Seal Purge				
1. CRDH system supplies a continuous flow to each RR pump seal. Minimizing crud buildup; keeping the seal clean by supplying clean filtered water continuously to the RR pump seals.			5	
E. Reactor Sample Station				
1. A continuous sample flow is taken from the CRD system and continuously monitored.				

Activity		Text Ref. Page	Text Ref. Fig.	S.L.O.	
F.	Charging Water Header	3	1	3	
	1. CRDH pump discharge header supplies water to the charging water header for charging the water side of the scram accumulators.				
	2. The 185 scram accumulators "float" at the CRDH pump discharge header pressure, this pressure is independent of reactor pressure.				
	3. During a scram, the scram accumulators discharge to the CRDMs. This results in a pressure decrease in the charging water header allowing the CRDH pumps to "run out", increasing flow into the charging water header.	4		5	
	4. Restricting orifices prevent excessive pump flow during reactor scrams.				4
	5. The flow sensing system upstream of the charging water header senses the high flow in the system and closes the flow control valve, further increasing the flow into the charging water header.			3	
	6. The charging water header connects downstream of the flow element, so flow in the charging water header creates a high flow signal causing the FV to shut, diverting most of the flow to the charging water header.				

Activity		Text Ref. Page	Text Ref. Fig.	S.L.O.	
	The FCV has a mechanical stop preventing the valve from shutting completely thus maintaining a small flow to the reactor via the Cooling Water Header.	4	1	3 5	|4
G.	Flow Control Station			3	
	1. The flow control station automatically controls system flow during all modes of operation using one of the two flow control valves (FV).				
	2. Normally a constant flow of 63 gpm is maintained by the flow control valve.			6	
	3. The drive and cooling water pressure control valve is adjusted for the required differential pressure. Flow is automatically maintained constant if reactor pressure changes. Drive and cooling water differential pressures and flows are also maintained constant.				
	4. The FV remains closed when the accumulators are recharged.				
H.	Drive Water/Cooling Water Pressure Control Station	5	1	3	
	1. The pressure control station is located just downstream of the drive water header connecting the flow control station to the two cooling water headers.				
	2. The pressure control station consists of:				
	a. A constant position motor operated valve				
	b. Two sets of stabilizing valves				
	c. Manual bypass valve				
	d. Inlet and outlet isolation valves				

Activity		Text Ref. Page	Text Ref. Fig.	S.L.O.
3.	Drive water header pressure is maintained 260 psid above reactor pressure; cooling water header pressure is maintained 30 psid above reactor pressure by maintaining a constant flow through the pressure control valve (PV101)	5	1	3,6
4.	During control rod movement the stabilizing valves maintain the constant drive water header pressure.			
5.	Drive water header pressure is important since the speed of CRDM movement is dependent on drive water pressure.			
7. a.	Both solenoid valves in the on-line assembly are open (energized) when control rods are not being moved, bypassing water to the cooling water header.			
b.	During control rod movement, the stabilizing valve compensates for the water being diverted to the drive header. The stabilizing valves are adjusted to provide the flow required for CRDM insertion or withdrawal. Insertion flow 4 gpm; Withdrawal flow 2 gpm.			
c.	By compensating for intermittent drive header flows the stabilizing valves maintain constant drive water pressure and system flow.			

Activity	Text Ref. Page	Text Ref. Fig.	S.L.O.
I. Exhaust Water Header and Pressure Equalizing Valves	6	1	3
1. The interconnecting two exhaust water headers provide a buffer for CRDM return water. The headers receive water discharged from a moving CRDM and directs the water into the latched CRDM's through their hydraulic control unit (HCU) where 8 psid lifts the SOV121 valve disc. The small amount of water which enters each stationary (latched) CRDM leaks past the graphitar seals and into the reactor vessel.			
2. The cooling water headers are connected to the exhaust water headers by two pressure equalizing valves.			3
The two pressure equalizing valves serve to:			
a. Repressurize the exhaust water header following a scram, and thus			
b. Prevent excessively high differential pressure across the operating CRDMs, following a scram.			
c. Equalizing valves open at approximately 80 psid.			

Activity	Text Ref. Page	Text Ref. Fig.	S.L.O.
J. Hydraulic Control Units	7	2,3	3
1. The 185 HCUs are divided into Banks A, B, C, and D. Each HCU includes all the equipment and controls to actuate one CRDM during normal and scram operations.			
2. The HCUs perform three functions:			
a. The HCUs store energy and control valving necessary to scram within time limits.			
b. The HCUs have the valving necessary to insert or withdraw a CRDM in either continuous or discrete steps.			
c. The HCUs supply cooling water to its associated CRDM.			
3. a. The HCUs have four solenoid-operated valves that control normal directional movement of the CRDMs responding to timed signals from the RXMC.			
b. The scram accumulator and scram valves interconnect with the RPS system to cause a reactor scram.			
4. Each HCU has seven hydraulic risers		3	2,4
a. Insert			
b. Cooling water			
c. Charging water			
d. Exhaust water			
e. Scram discharge			
f. Drive water			
g. Withdraw			

Activity		Text Ref. Page	Text Ref. Fig.	S.L.O.	
5.	The inlet and outlet scram valves control the water flow during scram insertion. The valve bodies serve as junction points between the manifold and the risers.	7	3	3,4	
6.	Four normally deenergized DCVs are mounted on the manifold to direct drive and exhaust water to and from the CRDM for normal insertion and withdrawal.				
7.	The scram valves are spring to open, air to close.	8	2		
	They are held shut by instrument air supplied through the scram pilot air valve. The pilot valve supplies air to both the inlet and outlet scram valves. The spring preload in the outlet scram valve is greater than that of the inlet valve to allow the outlet valve to open first, preventing the pressure from the scram accumulators from creating a back pressure. The outlet scram valve connects the withdrawal riser to the scram discharge riser.				4
	Water from above the drive piston is discharged into the SDV. The inlet valve opens the insert riser to the charging water header and the scram accumulator, applying pressure to the CRDM.		1,2	5	

Activity		Text Ref. Page	Text Ref. Fig.	S.L.O.
8.	The scram pilot valve is a solenoid valve with two solenoids normally energized from separate channels of RPS. Air is normally supplied to the scram valves, keeping them shut. When both solenoids are de-energized, air is vented from the scram valve actuators and the scram valves open.	8	2	3,5
9.	The scram accumulator is a piston type water accumulator, pressurized by a cylinder of N_2 gas. The piston separates the gas from the water and is sealed by O-rings. The accumulator provides the energy to scram the reactor if the reactor pressure is low. When the accumulator is fully charged the piston is in the full down position with the piston side full of water and the gas side pressurized. There is adequate water capacity in the scram accumulator to fully scram the reactor at low pressure conditions. If reactor pressure should exceed the accumulator or charging pressure a ball check valve in the inlet port shifts, allowing reactor vessel pressure to complete the scram stroke.			
K.	Scram Discharge Volume			3
1.	The SDV receives and contains the water exhausted from all CRDMs during a scram, thereby limiting the loss of water from the reactor vessel prior to RPS reset.			

Activity		Text Ref. Page	Text Ref. Fig.	S.L.O.
2.	The SDV piping connects to each HCU and drains to an Instrument volume. The piping is sized to contain all the water discharged from the CRDMs during the scram, independent of the instrument volume. During the scram the backpressure does not exceed 65 psig.	8	1,2	3
3.	After the scram is completed, water leaking past the CRDM seals flows until SDV pressure is equalized with reactor pressure.			4
4.	The SDV vent and drain valves are normally open maintaining the SDV empty. The vent and drain valves are air-operated, spring to close globe valves held open by normally energized dual solenoid Instrument Air valves.	9		
5.	When a scram is initiated, the SDV instrument air valves are de-energized, bleeding the air off the operators to the SDV vent and drain valves causing them to shut, thus preventing excessive loss of reactor coolant.			5
6.	Two backup scram valves, normally de-energized solenoid valves actuated from RPS system, provide a redundant means of venting air from the 185 scram pilot valves and the SDV vent and drain valves. Both RPS channels must trip to energize either valve. Either valve will vent air off all 185 scram valves and the SDV vent and drain valves.			

Activity		Text Ref. Page	Text Ref. Fig.	S.L.O.
7.	Two Redundant Reactivity Control System Alternate Rod Insertion valves provide this same function as the backup scram valves except they are energized from the RRCS-ARI system.	9	2	3
8.	Level switches activate when water in the scram discharge volume (SDV) exceeds 3 gallons to provide an alarm, switches also activate if level exceeds 16.5 inches to provide a rod withdrawal block. Other level switches activate when water in the SDV exceeds 43.4 inches by level transmitter of 48.5 inches by float switch to cause a scram trip in the RPS. Four SDV High Water Level Trip Bypass switches are located on panel 603. The mode switch must be in the SHUTDOWN or REFUEL position to allow manual bypass of this trip. This bypass allows the operator to reset the RPS scram relays so that the SDV may be drained.			4

III. INSTRUMENTATION, CONTROLS AND INTERLOCKS 6

A. Control Room Indicators (Panel 603)

1. Pump Amps
2. Changing water pressure
3. Drive and Cooling water Diff. Press.
4. Drive water cooling water, and system flow
5. CRDH filter discharge conductivity

B. Control Room Controls (on P603)

1. The CRD flow control permits remote control of the flow control valve. The controller is a direct reading inst with an adjustable setpoint.
2. Both CRD pump switches are four position spring return to normal-start, stop and pull to lock.

Activity	Text Ref. Page	Text Ref. Fig.	S.L.O.
C. System Interlocks			
1. CRDH Pumps	10		5
a. Trip on low suction pressure 25" HG ABS			
IV. SYSTEM OPERATION			
A. Normal Operation			7
1. During normal operation the CRDH system requires no operator action. Monitor the following parameters for proper operation.			
a. Drive water header differential pressure			
b. Drive water header flow			
c. Charging water header pressure			
d. Cooling water header differential pressure			
e. Cooling water header flow			
2. Rod Insertion			
a. When a CRDM is selected for insertion, the reactor manual rod control system sends signals to the appropriate HCU. In receipt of an insert signal HCU directional control valve (DCV) SOV 123 and SOV 121 open. Simultaneously, the stabilizing valves close to maintain system flow control.		1,2	5 | 4 |

Activity		Text Ref. Page	Text Ref. Fig.	S.L.O.	
	b. If the operator has not selected the continuous insertion mode of operation, after the CRDM has moved slightly more than one notch DCV's SOV123 and SOV121 shut and DCV SOV120 opens for the settle function and the CRDM collet fingers engage a notch on the index tube locking the CRDM in position. When using the continuous insertion mode the CRDM is driven until the mode is discontinued. Then the settle function causes the rod to latch at the next notch position.	10 11	1,2	5,6	|4
3.	Rod withdrawal - in receipt of a rod withdrawal signal, the insert DCV's SOV123 and 121 open for a short time to take the weight of the CRDM off the collet fingers. The insert DCV's SOV123 and SOV121 shut and immediately the withdraw DCV's SOV122 and SOV120 open simultaneously. The stabilizing valve shuts, after the insert DCV's shut and the withdraw DCV's open, the stabilizing valve shuts to compensate for 2 gpm of drive flow. The settle function occurs automatically.	11			|4 |4
4.	Scram Function The scram signal results in de-energizing the scram pilot valves solenoids and energizing the backup scram valves. This causes the air pressure on the scram valves to bleed off, opening the scram valves. This vents the water above the CRDM drive piston into the SDV and applies water at high pressure (1400 psia) from the scram accumulator and the charging header to the underside of the CRDM drive piston.				

		Text Ref. Page	Text Ref. Fig.	S.L.O.	
	Activity				
	This force provides a high initial acceleration and provides a large margin of force to overcome friction. Following the scram, the system flow will be diverted to the accumulators to recharge them. Pump flow is limited to 200 gpm by restricting orifices.	12	1,2	5,6	
V.	SYSTEM INTERRELATIONS				
	A. Condensate-System - Provides preferred source of high quality water. Backup = CST's				
	B. RRCS - Controls 8 ARI valves in the scram air header	13			
	C. IAS - Provides are for component operations				
	D. RPS - Provides signal to hold scram valves shut				
	E. RXMC - Provide signal for CRD controls				
	F. RBCLCW - Provide cooling for CRD pump bearing and seal coolers				|4
VI.	DETAILED SYSTEM REFERENCE REVIEW				
	Review each of the following referenced documents with the class.				
	A. Technical Specifications	14		8	
	1. 3/4.1.3.1; Control Rod Operability				
	2. 3/4.1.3.2; Control Rod Maximum Scram Insertion Times				
	3. 3/4.1.3.3; Control Rod Average Scram Insertion Times				
	4. 3/4.1.3.4; Four Rod Group Scram Insertion Times				
	5. 3/4.1.3.5; Control Rod Scram Accumulators				
	B. Procedures			7	|4
	1. N2-OP-30; CRD System, Rev. 2				

Activity	Text Ref. Page	Text Ref. Fig.	S.L.O.
VII. RELATED PLANT EVENTS			4
A. Refer to Addendum "A" and review related events with class (if applicable).			
VIII. SYSTEM HISTORY			
A. Refer to Addendum "B" and review related modifications with class (if applicable).			
IX. WRAP-UP			
A. Review the system learning objectives.			