NIAGARA MOHAWK POWER CORPORATION

07-191-91

NINE MILE POINT NUCLEAR STATION

UNIT II OPERATIONS

02-REQ-007-353-2-23 Revision 2

TITLE: PUMPS AND VALVES - INDUSTRY CONCERNS

	SIGNATURE	DATE
PREPARER	[signature]	7/31/91
TRAINING AREA SUPERVISOR	[signature]	8/14/91
TRAINING SUPPORT SUPERVISOR	[signature] for J. LeClair	8-2-91
PLANT SUPERVISOR/ USER GROUP SUPERVISOR	[signature] FOR TB [signature]	8/14/91

Summary of Pages

(Effective Date: ______________)

Number of Pages: 16

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July 1991	1 - 16

THIS LESSON PLAN IS A GENERAL REWRITE

MASTER

TRAINING DEPARTMENT RECORDS ADMINISTRATION ONLY:

VERIFICATION: ______________

DATA ENTRY: ______________

RECORDS: ______________

CONTROLLED DOCUMENT

I. TRAINING DESCRIPTION

A. Title of Lesson: Pumps and Valves - Industry Concerns

B. Lesson Description:

Lecture and discussion of Industry Events concerning various types of plant valves and the lessons learned.

C. Estimate of Duration of the Lesson: 2 hours

D. Method of Evaluation, Grade Format, and Standard of Evaluation: Class participation and response to Instructor questions during session will indicate trainee's grasp of information presented.

E. Method of Setting of Instruction:

1. Classroom setting, Lecture and discussion instruction.

F. Prerequisites:

1. Instructor:

a. Qualified for the material being delivered in accordance with NTP-16, Attachment A.

b. Qualified in instructional skills as certified by NTP-16.

2. Trainee:

a. Qualified for the course in accordance with NTP-11.

G. References:

1. SOER 83-9, "Valve Inoperability Caused by Motor Operator Failures"
2. SOER 84-7, "Pressure Locking and Thermal Binding of Gate Valves"
3. SOER 86-3, "Check Valve Failures or Degradation"
4. NRC IN 89-88, "Recent NRC-Sponsored Testing of Motor-Operated Valves"
5. NRC IN 89-08, "Pump Damage Caused by Low-Flow Operation"
6. ODI 5.08, Rev. 4, "Operator Good Practices"

II. REQUIREMENTS

1. NTP-11
2. Training Recommendations of SOER's

a. 83-9
b. 84-7
c. 86-3

III. TRAINING MATERIALS

A. Instructor Materials:

1. Copy of this Lesson Plan
2. Copy of SOER's
    a. 83-9
    b. 84-7
    c. 86-3
    d. NRC IN 89-88
    e. NRC IN 89-08
    f. ODI 5.08
3. Training Record

B. Trainee Materials:

1. Copy of references listed in I.G.
2. Course Evaluation

IV. EXAM AND MASTFR ANSWER KEYS

None

V. LEARNING OBJECTIVES

A. Terminal Objectives:

At the conclusion of this training the trainee will have gained the knowledge to:

TO-1.0 Position plant valves without resulting in valve damage or loss of valve operability.

TO-2.0 Recognize abnormal valve response.

TO-3.0 Operate plant centrifugal pumps in a manner to prevent damage due to low flow conditions.

B. Enabling Objectives:

Mastery of the above will be demonstrated by being able to satisfactorily:

EO-1.1 Describe the basic construction of a Motor Operated Valve.

EO-1.2 Describe the electric operation of an MOV

EO-1.3 Describe the manual operation of an MOV.

EO-1.4 State what torque switches are used for.

EO-1.5 Describe how a torque switch works.

EO-1.6 State what limit switches are used for.

EO-1.7 Describe how a limit switch works.

EO-1.8 Discuss industry events involving valve operator failures.

EO-1.9 Describe system parameter effects on valve operation.

EO-2.1 Discuss industry events involving stuck valves.

EO-2.2 Describe the Bonnet pressurization mechanism of valve binding.

EO-2.3 Describe the mechanism of Thermal binding.

EO-2.4 Describe how to differentiate between Bonnet pressurization and Thermal binding.

EO-2.5 Describe the corrective actions for Bonnet pressurization.

EO-2.6 Describe the corrective actions for Thermal binding.

EO-2.7 Discuss industry events involving check valve failures.

EO-2.8 Describe the operational symptoms of check valve failure or deterioration.

EO-2.9 Describe factors that lead to check valve deterioration.

EO-3.1 Discuss industry events involving pump failure due to low flow operation.

EO-3.2 Describe the hazards associated with operating pumps at low flow conditions.

EO-3.3 State in percent capacity what is meant by low flow.

LESSON CONTENT	DELIVERY NOTES	OBJECTIVES/ NOTES
I. Introduction		
A. Self		
B. Course Content	Review major topics to be covered, method of instruction to be used, and what is covered when.	
1. Review of industry events and training concerns resulting from weaknesses identified during event analysis.	Remind the trainee that proper operational knowledge can prevent or limit the effects of accidents. Pass out text, pencils, paper, objective sheet, course evaluations, training record, etc.	
C. Objectives		
II. MOTOR OPERATED VALVES (SOER 83-9)		
A. Construction/Operation		EO-1.1 EO-1.2
1. Electric Operation	Q: How does an MOV use rotational movement of an electrical motor to operate a valve?	
a. Rotational movement of an electric motor is applied through a gear train to a worm gear. The worm gear in turn rotates the stem nut which cannot move in axially. The valve steam which is threaded with the inside of the stem nut is forced to move axially as the stem nut rotates.	A: Show TP (MOV basic) Electric Operation	

LESSON CONTENT	DELIVERY NOTES	OBJECTIVES/ NOTES
2. Manual Operation a. Rotation of the declutch lever. separates the motor from the gear train and connects the handwheel. Rotation of the handwheel has the same effect as motor rotation.	Q: How is manual MOV operation accomplished? A: Show TP (MOV Cutaway) Manual Operation	EO-1.1 EO-1.3
b. Manual operation of MOV's controlled by N2-ODI-5.08.	Q: Where is guidance on MOV manual operation written? A: ODI 5.08 Refer trainees to ODI 5.08 and discuss manual OP Sections.	
3. Motor Start in Manual a. If the MOV motor energizes initial rotation of the motor disengages the declutching device and reconnects the motor while disconnecting the handwheel, resulting in electric operation with no handwheel motion.	Q: How would the valve respond to a motor start during manual operation? A: Motor Start	
4. Auxiliary Switches a. Limit Switch 1) Auxiliary contactor driven by gear train rotation.	Q: What are limit switches? A: Auxiliary contact switches.	EO-1.7
2) Does not measure actual valve position.	Q: What actuates a limit switch? A: Gear train rotation.	EO-1.6

LESSON CONTENT	DELIVERY NOTES	OBJECTIVES/ NOTES
3) Stops valve motion 4) Provides position indication 5) Provides interlock contacts in other control circuits.	Q: What are limit switches used for? A: a. Limit Switch 3), 4), 5)	
b. Torque Switches		
1) Torque switches are contactors driven by axial movement of worm gear. 2) When stem nut rotation is restricted (stem doesn't move) then the worm gear tends to move axially or walk.	Q: What are torque switches? A: 1), 2)	EO-1.5 EO-1.4
3) Excessive friction will cause torque switch to actuate before valve is opened or closed, otherwise will turn off motor when valve motion has stopped.	Refer trainees to SOER 83 Peach Bottom 3 event. Have them read to themselves as you overview.	
B. Industry Events 1. Peach Bottom 3		EO-1.8
a. HPCI MOV failed to fully close. b. RCIC surveillance begun. c. RCIC MOV motor overload tripped. d. RCIC MOV motor overload reset/valve lubricated. e. HPCI MOV discovered to have hardened grease in gear box.	Discuss effects of poor lubrication on ease of valve movement and resultant valve operation limitation.	

LESSON CONTENT	DELIVERY NOTES	OBJECTIVES/ NOTES
2. Oconee 2 a. RHR MOV would not open. b. Manual and electric operation failed to work. c. Valve operator removal and hoists were required to operate the valve. d. Valve was found to have bent stem. e. Possible courses of bent stem:	Refer trainees to event have them read along as you overview.	EO-1.8
1) Motor inertia applying torque even after motor power removed. 2) Materials used that could not withstand motor torque developed before torque switch operates. 3) Malfunctioning torque switch.	Discuss possible causes of bent stem.	
3. H.B. Robinson 2 a. Motor operated blocking valves fail to close electrically. b. Excessive friction determined to be cause. c. General maintenance, lubrication, repack performed. d. Valves opened until hydro performed on primary.	Refer trainees to event, have them read along as you overview.	EO-1.8

e. Valve would not close on initial motor OP.

f. When valve finally closed due to motor operation 3 of 4 yoke to bonnet bolts were broken.

Discuss similiar valve damage occurred at NMP2 involving operation of CSH*MOV107.

g. Incorrect lubrication, improper bolts and a improperly installed torque switch was the cause.

4. San Onofre 2

Refer trainees to event, have them read along as you overview. EO-1.8

a. MOV cycled to measure stroke time.
b. Valve indicated intermediate.
c. Valve was verified closed.
d. Limit switch was improperly set.

EO-1.9

C. System Parameter Effects

Q: How can system fluid parameters effect MOV operability?

A: Establish conditions of
1. High flow
2. High D/P
3. Subcooled liquid

1. In 89-88

a. NRC sponsored testing of MOV's
b. Test were conducted on different sizes and manufacturers valves.
c. Test results showed valves with nominally adjusted torque switches would not operated and operation required torques that often resulted in valve damage.

Refer trainees to IN 89-88

Q: How can these high flow, high D/P conditions be obtained?

A: Breaks in downstream piping.

LESSON CONTENT	DELIVERY NOTES	OBJECTIVES/ NOTES
III. GATE VALVE BINDING (SOER 84-7)		
A. Description		
1. Flexible wedge gate valves	Show TP (Gate Valve)	
a. Solid wedge hollowed out on edges between seating surfaces for flexibility.	Discuss valve disc construction pointing out components on TP.	
b. Disc is angled such that downward force of steam tends to apply seating torque.		
B. Binding		EO-2.3
1. Thermal binding	Q: If a valve is cooled which part will cool the fastest? Body or Internals?	
a. Differential contraction rates during cooldown results in body compression on disc adding seating torque. (Pinching)	A: Internals	
	Q: How can this cause valve to bind? A: B.1.a	
2. Bonnet Pressurization		EO-2.2
a. High pressure fluid either leaks into bonnet past disc or is trapped during closing and valve body internal pressure is subsequently lowered. OR	Show TP (Bonnet Press.)	
b. Cold liquid trapped in bonnet is heated up and applies pressure.		

EO-2.4

3. Determining Cause

   a. Situation's or scenario is the only hint to what has occurred.

      1) If happens during heatup more likely to be bonnet pressurization.

      2) If happens during cooldown could be either.

Q: How can we tell the difference between thermal binding and bonnet pressurization?

A: 3.a

Q: Why is it good to know which mechanism has caused valve to stick?

A: Corrective actions for each will make the other worse.

   b. Corrective actions

      1) Common thread is loosening packing, from there bonnet press. or thermal binding should be evident.

Discuss corrective actions for each.

EO-2.5

EO-2.6

4. Contributing Factors

   a. Other than the mechanisms already discussed excessive closing torque plays a major role in establishing binding situations.

   b. Excessive torque may be generated by:

      1) AOV's higher than nominal air pressures.

         Ex. Big Rock Point

         • Air Amplifiers installed on AOV's

Refer trainees to SOER 84-7, Big Rock Point event.

- AOV's Thermally bound during cooldown.

2) Improperly adjusted or malfunctioning torque switches on MOV's.

3) Excessive manual torque
   Ex. Lasalle 1 — Refer trainees to Lasalle 1 event. — EO-2.1
   - MOV seated manually to limit leakage.
   - Valve thermally bound during shutdown.

IV. CHECK VALVE FAILURES (SOER 86-3)

A. Operational Symptoms

Q: How can you tell if a check valve is malfunctioning? — EO-2.8

A: IV. A

1. Noise
   - To much noise
   - No noise at all
2. Back Flow
   - Reverse pump rotation
   - Pressure indications
   - Flow noise
   - Abnormal pipe/equip temp.'s

LESSON CONTENT	DELIVERY NOTES	OBJECTIVES/NOTES
B. Contributing Factors 1. Sizing • Too big, not enough flow to hold open so discs tend to bounce around and strike stops and seats. • Too small high flow velocities resulting in vibration and erosion.	Q: What types of things can result or lead to check valve failure? A: IV. B	EO-2.9
ex. Turkey Point 3 and 4 • During 2 month period seven valve failures occurred. • Cyclic Failure due to low fluid flow.	Refer trainees to SOER 86-3 Turkey Point 3 and 4 event. Note that event involved leakage past shut valves but shows the effect of low fluid flow. (ie As if check valve was to big).	EO-2.7
2. Valve Type • Valves are suited for specific system conditions. • Factors to consider are: a) Flow velocities b) Leakage rates c) Pressure drops d) Frequency of operation		EO-2.9
ex. Shoreham • HPCI exhaust line check valves failed. • Repeated operation at low flow	Refer trainees to Shoreham event.	EO-2.7

LESSON CONTENT	DELIVERY NOTES	OBJECTIVES/ NOTES
• Quick start procedure slammed valves open.		
• In some plants switching from swing checks to life checks alleviated problem.	Discuss that using a different type of check valve could eliminate problem.	
3. Location		EO-2.9
• Avoid flow reversals and turbulent flow.		
• Elbows, pumps, FCV's any of these can cause turbulence that will result in rapid check valve damage.		
ex. San Onofre 1	Refer trainees to San Onofre 1 event.	EO-2.7
• Feedwater check valves failed allowing backflow.		
• Backflow resulted in pipe voiding.		
• Pipe reflood produced damaging water hammer.		
• Check valves installed within two pipe diameters of flow restrictions.	Discuss check valves installed to close to flow restrictions. (ie within 10 pipe diameters)	
• Manufacturer recommends minimum space of 10 pipe diameters.		

LESSON CONTENT	DELIVERY NOTES	ECTIVES/ NOTES
V. PUMP LOW FLOW (IN 89-08)		
A. Circumstances	Refer trainees to IN 89-08.	EO-3.2
1. Extended operation at low-flow created hydraulic instability.	Discuss circumstances.	
2. Instabilities led to pump failure due to pressure pulsation/vibration or caritation.		
B. Events		
1. Haddam Neck	Refer trainees to Heddam Neck event, overview event as they read along.	EO-3.1
a. Increased operating current attributed to brass bushing damage.		
b. Bushing damage caused by extended operation at shutoff head.		
2. Susquehanna 1	Refer trainee to Susquehanna 1 event, overview event as they read along.	EO-3.1
a. Overcurrent trip of SW pump		
b. Pump suction bell had separated from pump.		
c. Impeller vanes eroded through.		
d. Similar conditions on other SW pumps.		
e. Attributed to operation of pumps at 60% or less capacity	Discuss Low Flow can be interpreted to be less than 75% capacity.	
f. Recirculation cavitation can be avoided by operating pumps at 75-100% capacity.		EO-3.3
C. Discussion		EO-3.2
1. Operation significantly less than design flow results in slow deterioration over long period.		

LESSON CONTENT	DELIVERY NOTES	ECTIVES/ NOTES
2. Normal surveillance procedures do not detect deterioration.		
3. Most likely that pump degredation will go undelected until total failure of pump occurs.		
VI. CLOSING		
A. Review Objectives	Ensure TR is completed.	
B. Ask for and answer questions		