PALO VERDE
NUCLEAR GENERATING STATION

Valve Services
P.M. Inspection Limitorque Actuators
Classroom Lesson

Valve Services	**Date: 1/25/2011 12:44:14 PM**
LP Number: NMV03C000103	**Rev Author: FRED ANGENEY**
Title: P.M. Inspection Limitorque Actuators	**Technical Review:** Feria, David J(Z35199) Digitally signed by Feria, David J(Z35199) DN: cn=Feria, David J(Z35199) Reason: I have reviewed this document Date: 2011.01.25 17:18:48 -07'00'
Duration : 40 HOURS	**Teaching Approval:** Baker Sr, Lee E(Z07641) Digitally signed by Baker Sr, Lee E(Z07641) DN: cn=Baker Sr, Lee E(Z07641) Date: 2011.01.26 10:12:50 -07'00'

INITIATING DOCUMENTS

Task Analysis for task to Inspect Motor Operated Valve (Limitorque)

REQUIRED TOPICS

None

CONTENT REFERENCES

13-J-ZZI-004 Control Motor Operator Data Base

Limitorque VTM L200

VTM 200-001: LIMITORQUE TECH MANUAL

39MT- 9ZZ02: PM/EQ INSPECTION OF THE LIMITORQUE SMB/SB/SMC MOTOR OPERATED VALVE ACTUATORS

73DP-9ZZ05 Lubricating Plant Equipment

39MT-9ZZ14 Troubleshoot Motor Operated Valve Actuators

01-E-GSF-002 Electrical Drawing

CRDR 2654606 U2 CW "C" Pump discharge valve was over torqued to the point of HBC thread failure

SOER 83-09 Valve Inoperability caused by motor operator failures (Oconee 2 Event)

O&MR 187 Excessive Grease affects Valve Motor Operator (Trojan)

OE 11953 Inadvertent Actuation of Carbon Dioxide Fire suppression during testing (Palo Verde U1)

OE 16460 HPCI Valve components damaged during a normally scheduled system outage (Hatch)

Generic Letter 89-10 MOV Testing and Survelilance

01DP-0IS13 Electrical Safety Work Practices

01-E-GSB-002

LESSON PLAN REVISION DATA

Jan 25, 2011	Fred Angeney	Updated Lesson Plan to meet the latest revision of 39MT-9ZZ02 PM or EQ Inspection of the Limitorque SMB/SB/SMC Motor Operated Valve Actuators.

Tasks and Topics Covered

The following tasks are covered in P.M. Inspection Limitorque Actuators :

Task or Topic Number*	**Task Statement**
Lesson:	P.M. Inspection Limitorque Actuators
VS 1070	Perform PM Inspection of Limitorque Actuator
VS 1018	Perform Optimize PM on MOV without Actuator Removal
VS 1071	Troubleshoot Limitorque MOV Actuator
VS 1017	Perform Retest Verification

Total task or topics: 4

TERMINAL OBJECTIVE:

1 Given various symptoms of actual Limitorque actuator failures in a laboratory setting, the maintenance technician will, demonstrate their knowledge of P.M. Inspections as well as the ability to troubleshoot by scoring 80% or more on written examination.

1.1 Discuss Pre-Test Activities

1.2 Discuss electrical safety

1.3 Demonstrate your understanding of an electrical elementary

1.4 Demonstrate how to install a (jumper) & Local control switch

1.5 Identify the external components of SMB and SMC Limitorque actuators.

1.6 Identify the components contained in the limit switch compartment of Limitorque actuators

1.7 Identify the components that make up the limit switch assembly.

1.8 Demonstrate your understanding of the inspection criteria for the Limit Switch Assembly

1.9 Identify the differences between the leaf and block type torque switches, and where they are used.

1.10 Demonstrate your understanding of the inspection criteria for torque switches

1.11 Identify grease sample points and describe how grease is inspected and evaluated

1.12 Demonstrate how to disassemble and reassemble SMB/SB Limit Switch Gear Frames and Cartridge Assembly for grease replacement.

1.13 Demonstrate to disassemble SMC-04 Limit Switches for Grease Change Out.

1.14 Describe how to perform a D.C. Motor Inspection

1.15 Motor T-Drain Inspection

1.16 Describe the difference between Rising non-rotating and Rising rotating valve stems

1.17 Describe how to properly clean and lubrication valve stem

1.18 Identify what document is used to find limit switch set points and how contact development chart is used to verify as found limit switch settings

1.19 Demonstrate how to adjust Limit Switches on SMB and SMC Limitorque actuators using ZZI-004 and contact development chart on electrical drawing.

1.20 Demonstrate how to adjust local/remote position indication.

1.21 State the Design characteristics and principles of operation of an SMC-04 Limitorque Actuator.

1.22 State the operation of SMB-000, 00 and SMB- 0 thru SMB-3 Limitorque actuator.

1.23 Discuss trouble-shooting techniques for stroke failure and indication problems.

1.24 Discuss Restoration and Retest of Limitorque Actuators

I.	Motivation There is a great need for technicians to perform inspections on Limitorque actuators during outages and on line. Limitorque actuator are a large part of the MOV population at Palo Verde	Focus student attention on ”What’s In It For Me”.
II.	Course Introduction The course is designed to enable you to perform P.M. work on Limitorque actuators at Palo Verde independently	
	A. Course Objective Given Limitorque actuators as training aids in laboratory conditions and classroom instruction, the maintenance Technician will demonstrate their knowledge of Limitorque P.M. Inspection as demonstrated by scoring 80% or more on a written examination and a score of PASS on a Laboratory Practical Evaluation.	Read and/or discuss the course terminal objective
	B. Schedule Breaks are 10 min on the hour, 14 hours classroom presentation, 16 hours in the lab. To minimize lecture fatigue a mix of Lecture and hands-on participation by the students will take place, this allows them to opportunity to demonstrate their understanding of the knowledge objectives and practice their performance skills.	Identify the schedule for the training
	C. Qualification Participant equipment qualification will be complete upon completion of Job Qualification Card (JPM)	Identify what they will be qualified to perform when completed with this course
II.	Lesson Introduction	Introduce the lesson material

TO: 1	**Given various symptoms of actual Limitorque actuator failures in a laboratory setting, the maintenance technician will, demonstrate their knowledge of P.M. Inspections as well as the ability to troubleshoot by scoring 80% or more on written examination.**

EO: 1.1 Discuss Pre-Test Activities

Main Idea

CONTENT	METHODS & ACTIVITIES
1) Conduct a Pre-Job-Brief using the graded approach in Standards & Expectations. At a minimum we always use focus on five. a) Identify critical steps and highlight them in the work document. b) Identify error likely situations. (See page 49 & 50 for Error Precursors) c) Identify the worst things that can happen. d) Identify specific error prevention defenses to be used. e) Identify actions to assure proper configuration control. 2) Pre-Job activities prior to leaving the shop. a) Verify the work document is ready to work. b) Verify you are qualified to perform the task. c) Verify the latest revisions for all documents used for the task. (Procedures, Prints, etc.) d) Verify a permit is adequate for the task and all parties are signed onto the permit. e) Verify proper lubrication point per the lube screen in SWMS for the component you are working on. (CPXCOMP Lube Points) Ensure grease sample labels are completed per current lube point data.	Explain how to use the Graded Approach. Have students follow with their Standards & Expectation Book.

CONTENT

METHODS & ACTIVITIES

f) Verify current Set Point Document and record Limit Switch Setting.

g) Determine if the valve has any stroking requirements of restrictions.

h) Determine is the valve is a Note 21 valve (Partial stroke).

i) Determine if the valve has any LLRT requirements.

EO: 1.2 Discuss electrical safety

Main Idea

CONTENT	METHODS & ACTIVITIES
1) Contact OPS to obtain permission to De-energize the breaker for this actuator and hang your SOD tag.	
2) Conduct a two minute drill using Standards & Expectations.	Have students follow the Two Minute Drill in their Standards & Expectations Book.
3) Reference: 01DP-OIS13 PVNGS Electrical Safe Work Practices.	
4) Open the breaker using a 4 foot extension breaker manipulation tool, or proper PPE, Hearing protection, Arc Flash Shield, VR Gloves, and FR Coveralls.	
5) All electrical equipment and circuits 50 volts or greater shall be considered energized at full voltage potential until tested (Live-Dead-Live) or otherwise determined to be de-energized.	
6) Live-Dead-Live voltage checks shall be performed prior to starting work, each instance (e.g. start of shift, after breaks, after lunch), or as needed to maintain positive control.	
7) Live-Dead-Live voltage checks shall be performed whenever changes to the isolation boundaries (permit) are made which reduces protection. (e.g. permit tag(s) removed, closing a breaker or disconnect, etc...) Always utilize the latest revision of design output documents to identify potential sources of electrical energy.	

CONTENT **METHODS & ACTIVITIES**

8) Special care shall be taken when performing Live-Dead-Live checks on ungrounded systems. On these systems you should not rely on one leg to ground measurements for this check. Check it at the source across the "positive to negative" for ungrounded DC systems or "hot and common" for ungrounded AC systems.

9) Live-Dead-Live verification testing **SHALL NOT** be performed using a multimeter in the "auto-range" mode on AC/DC voltages, but instead be set to the range of the voltage expected on the circuit on which work is to be performed and verified against a known energy source. Set meter on maximum voltage expected.

10) The Live-Dead-Live check shall be used to test each and every exposed electrical conductor or circuit part within the restricted approach boundary, AC and DC.

EO: 1.3 Demonstrate your understanding of an electrical elementary

Main Idea

CONTENT	METHODS & ACTIVITIES
1) There are two types of drawings that we use for MOV's at Palo Verde, B drawings and F drawings a) "B" drawings are the most commonly used, they are electrical elementary drawing like 01-E-GSB-002 that we use for this class. b) They give most of the information that we need to perform an inspection however, if it is required to know what wire is on what contact an "F" drawing is required. c) "F" drawings show exactly what wire comes from each termination point at the breaker to each contact point at the actuator.	
2) Review an electrical elementary drawing and identify all the components. a) Breaker, Transformer, Reversing contacts, Heaters, and Motor. b) Open and close contacts. c) Torque switch and bypass. d) Open and close light indication. e) Space heater and remote indication.	

f) Spare contacts.
g) Computer points.
h) Control switch.
i) Contact development chart.
j) Wiring Scheme.

Have students follow along using their drawing

EO: 1.4 Demonstrate how to install a (jumper) & Local control switch

Main Idea

CONTENT	METHODS & ACTIVITIES
1) Explain when a jumper is required and where to install it and how to install a local control switch.	ENSURE THE POWER IS OFF PRIOR TO INSTALLATION OF JUMPER OR TEMPORARY LOCAL CONTROL SWITCH.
2) One very important issue is to identify all circuits with potential on the elementary drawing. Remember that every electrical circuit can be different, with different interlocks and other potential sources of power. Always check every contact with a meter	
3) On the elementary for training 01-E-GSB-002, contacts 4&4C only see power when the jog open contacts 3&4 are made up in the control room.	
4) Contacts 5&5C open torque switch bypass and the torque switch contacts 18&18C receive power if contacts 4&4C are made up.	
5) Contacts 1&1C and close torque switch contacts 17&17C receive power when jog close contacts 1&2 are made up in the control room.	
6) Contacts 3&3C and 15&15C have potential when the breaker is on, they are for light indication	
7) Contacts 2&2C and 13&13C are computer points and have potential of low voltage fed from another source.	
8) If the heater is not energized at the actuator a jumper is required.	

9) At the breaker a jumper must be installed to bypass the open jog switch in the control room. A shop standard has been accepted to energize the open verses the close circuit. It is very important to tie the jumper to the wires so if the clip jumps off the contact, it can not come in contact with any other contacts.

10) Be sure the wire on the open limit contact 4 and the wire on the close limit contact 1 is lifted and taped off.

Explain the color code for wires.

Black	White/Black
White	Red/Black
Red	Green/Black
Green	Orange/Black
Orange	Blue/Black
Blue	Then white tracers.

11) Determ/Reterm sheets are used to document wires that are lifted and second party verification. Explain each block of the sheet while students follow.

12) Determ/Reteerm sheets required by procedure but not 2nd party, that is a Shop Management expectation.

Give students their own copy of a determ/reterm sheet to follow along with.

OE 11953 Inadvertent Actuation of Carbon Dioxide Fire Suppression During Testing (Palo Verde, U1)

On December 19,2000, during carbon dioxide CO2 fire suppression system functional testing in the “B” Train Battery Room, the CO2 system actuated in the “B” train Engineered Safety Features (ESF) Switchgear Room because fire department personnel incorrectly placed two jumpers across the wrong module terminals (Switchgear Room “B” vice Battery Boom “B”).

Discuss OE 11953 Inadvertent Actuation of Carbon Dioxide Fire Suppression During Testing

? Contributors:

- ? Self-checking and verification steps were performed incorrectly.
- ? Personnel incorrectly confirmed the alarm for “B” train Battery Room was displayed and that the “B” train Battery Room zone 1 LED was illuminated (vice “B” train ESF Switchgear Room).
- ? Both modules were virtually identical and housed in the same panel
- ? Failure to assign a dedicated person to monitor the display
- ? This was an infrequently performed test and may have contributed to unfamiliarity with the equipment.

1. **Ask student these questions to see if Pre-job brief is adequate prior to installing a jumper.**
2. What could go wrong when you install temporary jumpers?
3. What contingencies are prepared for these situations?
4. What kind of jumper is used to minimize inadvertently shorting electrical components?
5. Is Jumper installation training adequate?

OE 16460 HPCI Valve components damaged during a normally scheduled system outage (Hatch)

On May 2, 2003 during performance of a Motor-Operated Valve operator inspection, it was discovered that the motor for the HPCI Test motor-operated valve was not acceptable and required replacement. The motor was removed and power supply leads labeled. An exact replacement motor was used and the leads were connected back to the same location. The corrective maintenance procedure required that the valve be placed in the mid-position before confirming the motor had correct rotation. Maintenance personnel place the valve in what they perceived as mid-position using the manual operator and a closed signal was given to the valve. No movement and no indication on the amp meter was noted. An open signal was then given. Motor amps increased, relaxed, and then pegged quickly. Power was removed and the evolution was terminated. Subsequent inspection of the valve identified a bent valve stem and the valve's operator housing damaged due to the valve plug being driven into the seat.

? Important points:

- ? A dual indication was not confirmed by the control room prior to giving the valve a closed signal. As a result, mid-positioning of the valve was not confirmed.
- ? The use of a dead man switch (not used) would have allowed timely disconnection of power to the valve and possibly prevented equipment damage.
- ? An opportunity to prevent damage was missed by taking a time out to determine why the valve did not move when the closed signal was given.

? Contributor:

- ? The fact that an exact replacement motor was used and the power leads were landed back as they were removed led to over-confidence that the motor was wired correctly.

OE 16460 HPCI Valve components damaged during a normally scheduled system outage

EO: 1.5 Identify the external components of SMB and SMC Limitorque actuators.

Main Idea

CONTENT	METHODS & ACTIVITIES
1) SMB-000 a) Main housing and name plate b) Name plate data. c) Model and size. d) Serial number and order number. e) Overall gear ratio and spring pack number	This Course contains suggested instruction in the Methods & Activities column the instructor has the **option** to use all or a portion of that information. Performance activities such as; Electrical Safety, Safe Work Practices and Management expectations are NOT optional, but will be taught as specified.
f) Handwheel assembly. g) Motor and name plate. h) Name plate data. i) Serial number. j) Start and running torque. k) Horse power and phase number l) RPM and hertz. m) Volts, *nominal amps and lock rotor amps*. n) Insulation class /type and duty cycle.	Emphasize the importance of the motor name plate data. The need to compare the as found amp readings to the name plate.

o) Limit switch compartment cover.

p) Declutch lever.

q) Spring cartridge cap and spring cartridge cap cover.

r) Local position indication.

s) Pipe plugs and zerk fitting

2) SMB-00

a) These actuators are basically the same as SMB-000. They are slightly larger and have the option of *a side mounted or top mounted Handwheel.* SB actuators have a spring compensator mounted to the top of the actuator.

Use training aids to show the students the difference.

3) SMB-0 thru SMB-3

a) Main housing and name plate.

b) Name plate data.

c) Model and size.

d) Serial number and order number.

e) Overall gear ratio and spring pack number.

f) Housing cover.

g) Handwheel.

h) Some actuators are equipped with gear reduction units mounted on the Handwheel shaft.

i) Declutch lever.

j) Spring cartridge cap and spring cartridge cap plate.

k) Clutch housing.

Explain the importance of nameplate data. When an actuator is removed from a valve document the name plate data. This will ensure the proper actuator is installed on the proper valve during reinstallation.

l) Motor and name plate.

m) Name plate data.

n) Serial number.

o) Start and running torque.

p) Horse power and phase number

q) RPM and hertz.

r) Volts, *nominal amps and lock rotor amps*.

s) Insulation class /type and duty cycle.

t) Local position indication.

u) Pipe plugs.

Use the training actuators to show the location of nameplates and explain the differences.

4) SB Actuators replace the housing cover with a spring compensator.

5) SMC-04

a) Main housing.

b) Motor end bell.

c) Torque switch compartment cover.

d) Hand wheel assembly.

e) Declutch knob/lever

f) New models have levers.

g) *Older models have knobs.*

h) Declutch shaft cap.

i) Limit switch compartment cover.

j) If the actuator has local position indication it will be located in the end of the cover.

k) Pipe plugs.

Use the training actuators in the lab to show the difference between the two types of declutch levers.

EO: 1.6 Identify the components contained in the limit switch compartment of Limitorque actuators

Main Idea

CONTENT	**METHODS & ACTIVITIES**
1) Limit switch assembly.	
2) Torque switch. a) *SMC actuators have a separate compartment for the torque switch*.	Use the cut away actuator to show the location of SMC-04 torque switch compartment.
b) Termination board.	
c) Space heater.	

EO: 1.7 Identify the components that make up the limit switch assembly.

Main Idea

CONTENT	**METHODS & ACTIVITIES**
A. SMB Limit switch assembly. 1. Cartridge assembly. 2. Gear frame assembly. 3. Intermittent gear shafts. 4. Set rods. 5. Rotors and contacts. 6. Finger bases and L-brackets. F. SMC Limit switch assembly. 1. Gear frame assembly. 2. Intermittent gear shafts. 3. Set rod. 4. Rotor segments and spacer. 5. Contact and terminal block assembly (finger base and L-brackets.) 6. Rotor plate. 7. Terminal strip. 8. Space heater.	Show the type of space heater used on an SMC-04 and where it is located.

EO: 1.8 Demonstrate your understanding of the inspection criteria for the Limit Switch Assembly

Main Idea

CONTENT	METHODS & ACTIVITIES
SOER 83-09 Valve Inoperability Caused by Motor Operator Failures	Review SOER 83-09 San Onofre 2 loose Limit switch adjusting screws
SAN ONOFRE 2	
With the unit in mode 3 during in-service inspection testing, a hot leg sample isolation valve was cycled to measure the stroke time. During the test, the valve was declared inoperable due to simultaneous open and closed position indication. The valve was verified to be close.	
An ***investigation revealed that the erroneous position indication was caused by loosening of limit switch adjusting screws attributed to vibration***. After adjustment, correct position indication was restored and the valve was declared operable.	Emphasize that events such as these were precursors to initiate action by NRC to generate SOER's & GL-89-10 MOV Testing & Surveillance
Due to this and other Limitorque motor-operated valve failures, an in-depth investigation was performed by engineering personnel to determine if problems existed with maintenance and adjustment practices at the plant. Based on this investigation, it was concluded that station procedures did not adequately address the setting of limit switches, torque switches, and position indicators after equipment maintenance.	
In addition, procedures addressed characteristics such as stroke length; torque switch set points, ETC., only in a generic way. Specific information for each valve was not included in procedures.	

As a corrective action, procedures dealing with adjustment of limit switches, torque switches, and position indicators have been reviewed and revised. A certification program has also been established for personnel working on such switches.

Retest Procedures have been improved at Palo Verde to avoid an event such as this happening here.

1) SMB Limit switch inspection.

a) Ensure all mounting screws are tight.

b) ***Inspect finger bases for cracks and broken arc barriers. Also check the term board for broken arc barriers. Ensure that all Terminations are tight and L-brackets are tightly mounted.***

c) Cracks usually show up in the area where the finger base is screwed to the gear frame.

Explain the importance of arc barriers on finger bases and term boards

d) Inspect the L-brackets to ensure proper tension is applied to the contacts to maintain a proper electrical connection and ensure the contacts are clean.

e) Improper tension on the L-brackets have presented a problem in the past causing the valve not to stroke.

f) A small particle was found between the contacts and L-bracket also causing the valve not to stroke.

g) Clean contacts are a must on all electrical connections.

h) Verify low resistance across rotor contact (< 1 ohm).

a) Inspect the rotors for cracks and clean contacts.

b) Cracks usually show up where they are pinned to the gear frame.

c) Inspect the wiring for damage and proper connections.

d) Bad crimping is a common problem. Ensure the barrel is properly crimped to the insulation with no conductor showing. Lugs can not be bent more than a 60-degree angle. If the lug is bent more or there is any sign of cracking at the bend, the lug must be replaced by a person qualified in small Terminations.

e) Inspect wiring insulation for damage. Look for cut, nicks, burns or cracks. If any conductor is showing and the conductor is not damaged, heat shrink can be applied over the damage. If the conductor is damaged, the wire must be reluged or butt spliced and then heat shrink applied.

Use training aids to give students an example of a bad crimp terminal lug.

f) Be sure all wires are neatly trained. Use tie-wraps to hold wiring in place.

g) Inspect the space heater for proper mounting.

h) Ensure the heater is mounted so it can not come in contact with any wiring. Also check the wires connected to the heater for damage.

Show the students how important it is to train wires to prevent wires from coming in contact with space heaters on one of the actuators in the lab.

2) SMC limit switches.

a) Inspect terminal block assembly for cracks and broken arc barriers. Ensure that all Terminations are tight.

b) Inspect the L-brackets for proper tension applied to the contacts and contact cleanliness.

c) Check the springs and caps. These springs are very easily lost if the caps are misaligned.

d) Note that improper L-bracket tension is a cause for the valve to fail to stroke.

e) Verify low resistance across rotor contacts (< 1 ohm)

f) Inspect the rotor segments for cracks and missing spacers.

g) Cracks usually show up in the area where the segments join or meet the gear frame.

h) Inspect the rotor plate for cracks

i) Cracks usually show up in the area where the terminal strip is screwed to the rotor plate.

j) Inspect the terminal strip for cracks and broken arc barriers.

k) Inspect the wiring for insulation damage and proper connectors.

l) Bad crimping is a common problem. Ensure the barrel is properly crimped to the insulation with no conductor showing. Lugs can not be bent more than a 60-degree angle. If the lug is bent more or there is any sign of cracking at the bend, the lug must be replaced by a person qualified in small Terminations.

Pass around an SMC limit switch assembly for the students to see.

Show students the proper tension of the L-brackets on the training aid being passed around.

Use training aids to point out to students where cracks usually show up.

Pass training aids around the class to show examples of bad crimping.

EO: 1.9 **Identify the differences between the leaf and block type torque switches, and where they are used.**

Main Idea

CONTENT	METHODS & ACTIVITIES
1) Limitorque Technical Update 01-01 a) Limitorque Issued a letter 3/5/01 informing the industry that they were changing the color of fiberite from brown to black. The EQ and SEIZMIC qualifications have not changed only the color.	
2) Leaf type. *a) Leaf type torque switches are only used in SMB-000 actuators at Palo Verde.* b) The electrical connection is made when two leaf springs come in contact with two contact screws. *c) One major problem with this type of torque switch is the termination screws also hold the leaves in place. If the screws are found loose it could cause the torque switch to fail, thus VSE must be notified of these condition.* d) The adjustment screws are opposite of the contacts. e) The limiter plate is located under the striker hub. f) The only way to balance the leaf type is to bend the leaves to change the actuation point.	Use training aids to show different torque switches. Pass a leaf type torque switch around to let the students see the termination screw hold the leaf contacts in place.

3) Block type.
   a) Block type torque switches are used on SMB-00 through SMB-3 Limitorque actuators at Palo Verde.
   b) The electrical connection is made between the spring loaded contact fingers in the contact block and two contacts in the terminal block.
   c) The termination points of the wires do not affect the mounting of the contacts as on the leaf type.
   d) The block type is more easily balanced due to balancing screws mounted on the dial.
   e) The blocks and contacts can be replaced without replacing the entire torque switch.

Pass a block type torque switch around for students to inspect. Explain that the lightweight spring have been replaced on most block type torque switches with heavier ones. The light springs have been known to account for contact misalignment on some gate valves during unseating.

EO: 1.10 Demonstrate your understanding of the inspection criteria for torque switches

Main Idea

CONTENT	METHODS & ACTIVITIES
SOER 83-9 Oconee 2 Event	**Review SOER 83-9 Oconee 2 Event**
During a cool down to depressurize and stop a steam generator tube leak, a 12” motor-operated gate valve in the decay heat removal single suction line from the reactor coolant system RCS failed to open on demand. After repeated attempts to open the valve remotely, and three unsuccessful attempts at manual operation, the entire Limitorque motor-operator was removed and the valve was opened using hoists. This delay in achieving cold shutdown prevented final depressurization below minimum RCS pressure limits and prolonged the primary to secondary leakage an additional 17 hours. Later inspection of the valve revealed a bent valve stem. While the root cause for the bent stem could not be determined conclusively, several factors that might explain the failure include the following • Inertia forces generated by the Motor-operator before the motor stops • Use of valve components not capable of withstanding locked rotor forces (e.g. The motor-operator continues to apply torque while the valve disk in stuck causing the stem to be overstressed) • An improperly adjusted or otherwise non-functioning torque switch	

1) Leaf type torque switch
   a) Verify that all mounting bolts and setting adjustment screws are tight.
   b) Visually inspect the area around the torque switch to ensure no oil is leaking into the compartment. If oil is leaking from the torque switch, the o-ring needs to be replaced. This work is beyond the scope of an inspection; contact your team leader for proper paper work. When a torque switch is removed from an 89-10 actuator, Diagnostic testing is required to set up the torque switch after reassembly.

Pass around different types of torque switches for students to see the different torque switches use by Limitorque.

   c) Inspect contacts for cleanliness. If the contacts are corroded clean with a burnishing tool only.
   d) Verify that the leaves are not bent and springs and shunt are in tact.
   e) Verify the wire termination screws are tight. *This is a vital part of the inspection because the screws also are the mounting screws for the* ***leaf contacts.*** If the screws are loose contact your team leader and VSE.

Explain to the students the importance of the torque switch in the operation of the actuator.

2) Block type torque switch.
   a) Verify the mounting screws are tight and that there is no oil leaking around the o-ring. If oil is leaking from the o-ring contact your team leader for proper paper work to replace the o-ring. Remember that torque switches are not removed without paper work. 89-10 valve requires Diagnostic testing if the torque switch is adjusted or removed.

b) Inspect Terminations for tightness.

c) Balancing screws must be tight against the center lug and the lock nuts tight.

d) ***Check the face of torque switch by attempting to rotate it by hand for looseness, to verify roll / grove pins are not broken****. Normal conditions has a slight amount of play, exaggerated movement is an indication that the roll/grove pin is broken.*

Pass a torque switch around the class for students to see the location of the roll pins that may be damaged.

e) If the roll pins are damaged the torque switch will not stop the actuator and it will go locked rotor and possibly damage the actuator and valve.

f) Verify the set point adjusting screws are tight. .

g) Verify the contact block mounting screws are tight. Caution should be taken when checking these screws because this is only a plastic fiber block and the screws can very easily stripped out.

h) Verify the contacts and contact fingers are clean and free of excessive oxidation. If the contacts need cleaning use only a burnishing tool to clean them.

i) Check contact finger spring for proper line up.

j) Check terminal block for cracks and verify terminations are tight and jumpers are not damaged.

EO: 1.11 Identify grease sample points and describe how grease is inspected and evaluated

Main Idea

CONTENT	METHODS & ACTIVITIES
1) Any time grease or oil is added to any piece of equipment at Palo Verde, that equipment must be looked up and verified on lubrication screen in SWMS. CPXCOMP Lube Points will give you the proper grease for each Lube Point. a) **CAUTION!** You must know what type of grease you are adding to a component. I an outage past it was found that a grease gun was differently than the grease that was in the gun. Now grease guns are clear to identify the cup sticker on the tube inside the gun. This event caused a grease sample taken from every actuator that had been worked on during the outage. 2) Grease Relief Inspection; a) Actuators that require Grease Relief Valves will be listed in the PM procedure. If grease relief valves are found on actuators not listed it is acceptable. b) Remove the Grease Relief Valve and inspect for corrosion. Verify it is not capped and the end is clear of obstructions. Verify the internal ball is free to move. 3) Grease Inspection a) Remove one of the pipe plugs to perform the inspection and take a sample. Actuator should be 80% full. If the consistency of the grease is good and the quantity is low you can add new grease however, if the consistency of the grease is bad and the quantity low new grease can not be added to bad grease.	Reference document 73DP-9ZZ05 Lubricating Plant Equipment

4) Limit Switch Grease Inspection

   a) Remove the cover plate of one gear frame to perform the inspection and take a sample. If the sample is bad replace the grease in the entire limit switch assembly. This includes the cartridge assembly and the two gear frames. If the grease is good be sure the quantity is 80% full by adding new grease as required. Never add new grease to bad grease.

5) Motor Pinion Grease Inspection

   a) Remove the motor to perform the inspection.

   b) Take a grease sample

   c) Ensure the gear teeth have a coating of grease and the cavity is about 80% full. If the quantity is low add grease.

   d) Inspect the gasket

   e) Inspect the Motor Pinion per the following:

      i) No gear movement on the shaft.

      ii) Set screw is tight.

      iii) Lock wire is in place when grove is present.

      iv) Key is captured correctly.

6) SMC Actuators Grease Inspection.

   a) Remove a pipe plug to take a sample. Inspect the quantity of grease in the main gear case. Grease should cover the worm not to exceed 80% full.

   b) The motor pinion cavity is contained in the main cavity so no motor pinion grease sample is required.

   c) Complete removal of the limit switches is not necessary to take a sample. The removal of a pipe plug in the main housing may be necessary to break the seal.

   d) Evaluation- The grease should be of a consistency to coat the gear teeth with a film of lubrication, free of metal particles and moisture. If there is any question to the quality of the grease contact team leader and Valve Services Engineering to resolve problem.

O&MR 187, Excessive Grease Affects Valve Motor Operator (Trojan)

Discuss O&MR 187 and how Palo Verde handles grease in Spring Packs.

Description

During an operability test, the steam-driven auxiliary feedwater pump did not start because the motor-operated turbine trip and throttle valve failed to open.

Investigation revealed excessive grease buildup between the washers of the valve's spring pack. This prevented the closing torque switch from actuating and de-energizing the motor-operator when the valve was last closed.

Since the motor remained energized, the overload protective contacts tripped. No indication or alarm existed to reveal this condition. The problem went undetected for six weeks.

Grease intrusion into the spring pack can be considered a normal occurrence, and the packs should be inspected periodically.

EO: 1.12 Demonstrate how to disassemble and reassemble SMB/SB Limit Switch Gear Frames and Cartridge Assembly for grease replacement.

Main Idea

CONTENT

METHODS & ACTIVITIES

1) Limit Switch Grease Change Out.
   a) Remove the Gear Frames.
   b) Remove the Cover Plates.
   c) Remove all grease from the Gear Frame and Gears.
      i) If grease is being changed from one type to another be sure all old grease is removed.
   d) Inspect Gears and Set Rod for damage. If damage is found contact Team Leader and generate a PVAR.
   e) Fill the Limit Switch Gear Frame with approved lubricant. Do not exceed 80% full.
   f) Install new Cover Gaskets and install Cover Plates. NOTE: The inner cover plate has flat head screws and the outer plate has rounded head screws.
   g) Rotate the Intermittent Gear Shafts to verify the Rotors rotated 90%.
2) Four Train Cartridge Assembly Grease Change Out.
   a) Remove the Cover Plate.
   b) Remove the Idler Gears. The drive Gear is pinned to the Shaft and is not removed. It shall not be remove as part of this procedure.
   c) Clean out all Grease and replace with approved lubricant 80% full.
   d) Install the Gaskets and Cover Plate.
   e) Rotate the Pinion Gear to verify free movement. If there is any binding add Gasket Shims to free it up.

EO: 1.13 Demonstrate to disassemble SMC-04 Limit Switches for Grease Change Out.

Main Idea

CONTENT **METHODS & ACTIVITIES**

1) SMC Limit Switch Grease Change Out.

   a) Remove the Terminal Board and Adapter Plate.
   b) Remove the Rotor End Plate.
   c) Note the Rotor orientation.
   d) Remove the two Allen Head Screws holding the Finger Base in place.
   e) Remove the Finger Base and Rotors.
   f) Remove the Gear Case Cover.
   g) Clean all parts of Gear Components using solvent.
   h) Inspect all Component Parts for damage.
   i) Pack Intermittent Gears with approved lubricant.
   j) Install the Gear Case Cover. Rotate the Intermittent Gear Shaft to verify they rotate 90%.
   k) Install Rotor Bushings and Rotors.
   l) Install Finger Bases.
   m) Install the Rotor End Plate, Term Board Adapter and Term Board.

EO: 1.14 Describe how to perform a D.C. Motor Inspection

Main Idea

CONTENT	METHODS & ACTIVITIES
1) If the motor has D.C. brush inspection plates installed, remove the inspection plates, inspect the brushes and commutator per the following steps. 2) Inspect and verify the brushes extend greater than 1/16 out of the top of the brush rigging holder. 3) Remove the brushes and closely examine the face of the brush. 4) Ensure the brushes are the same type (Look the same). 5) Inspect for any evidence of chipping, or sparking along the edge of brushes. *6) Inspect the commutator for any accumulation of brush carbon dust, arcing across mica bars.* 7) Inspect the brushes for correct position, not sticking in holder, spring tension, and overheating of brushes. 8) If the brushes need replacing, initiate corrective action and replace brushes as follows: **Non-pre-shaped brushes**, install brushes with no special orientation or shaping required. Ensure spring tension is present on the brush and that brush floats in holder (no binding). **Pre-shaped brushes** ensure curved faces and offset brushes are properly installed into there holders. Ensure spring tension is present on top of brush and that brush floats in holder. 9) Reinstall the brushes and inspection plates.	

EO: 1.15 Motor T-Drain Inspection

Main Idea

CONTENT

METHODS & ACTIVITIES

1) Actuators that are required to have T-drains installed on the motors will be listed in the procedure. T-drains may be found on other actuators not listed in the procedure, this is acceptable.
2) What is a T-Drain?
3) Basically a T-drain consist of a pipe plug that has on horizontal hole drilled through the outer portion of the plug and a vertical hole drilled to connect the horizontal to the internal portion of the plug.
4) They are mounted on the bottom of the motors on each end to prevent condensate build up in the motors.
5) Safety Related Valves located in high temperature locations such as Containment require T-Drains.
6) The PM Procedure requires that T-Drains are inspected to ensure;
7) That they are installed.
8) That they are installed at the lowest possible point on the motor end bell.
9) That they are not clogged or capped.
10) Ensure the vertical hole is drilled through to connect with the horizontal hole.

EO: 1.16 Describe the difference between Rising non-rotating and Rising rotating valve stems

Main Idea

CONTENT	METHODS & ACTIVITIES
1) Rising non-rotating stems. The stem nut is splined to the drive sleeve and threaded to the stem. As the actuator rotates the drive sleeve and stem nut, the stem is threaded up and down the stem nut to open or close the valve. The stem nut is held in place inside the drive sleeve by a stem nut lock nut. The stem nut lock nut is locked in place by staking the threads with a center punch in two places 180 degrees apart.	
2) Rising rotating stems. The stem nut is not threaded to the stem it is bolted to the stem and splined to the ID of the drive sleeve. The stem is threaded to the yoke. The stem nut rotates with the drive sleeve; this rotates the stem, threading it up and down the threads in the yoke.	

EO: 1.17 Describe how to properly clean and lubrication valve stem

Main Idea

CONTENT	METHODS & ACTIVITIES
1) Record the As-found position of the valve 2) Inspect the stem lubrication for excessive dirt or metallic particles, dried out and caked lubricant. If these conditions are found contact your Team Leader and generate a PVAR. 3) In the closed position, clean and lubricate all exposed area of the stem with an approved lubricant. Clean and lubricate the Anti-Rotation device if applicable. 4) In the open position, clean and lubricate all exposed area of the stem. 5) It is very important that the stem nut lock nut is staked in place. If the stem nut lock nut were to become loose and work it self free of the threads, the valve would not stroke. 6) For rising rotation stem valves be sure to grease the inside of the drive sleeve where the stem nut splines ride up and down. 7) Cycle the valve to work lubricant through the stem nut/yoke bushing and wipe off any excess grease. 8) Butterfly valves have no threaded stem.	

EO: 1.18 Identify what document is used to find limit switch set points and how contact development chart is used to verify as found limit switch settings

Main Idea

CONTENT	METHODS & ACTIVITIES
1) *1,2,or 3-JZZI-004 Is the controlled document that we use to get our rotor set points. It gives what the as found and as left set points should be*. 2) The contact development chart at the lower left hand corner of the elementary drawing gives the configuration of the contacts from the close to open position. The dark black line represents the contracts being closed or made up and the absents of the line represents the contacts being open. For example contacts 4, with the valve in the closed position the presence of the line shows the contacts to be closed, until the valve reaches the open position then the contacts open. 3) For the most part limit switch settings are taken from the close to open position. There have been two MOD changes that have changed the way we set limit switches. a) The SG -1155 changes the closed control from torque seating to limit seated control on 13JSGUV134 and 13JSGUV138. The closed limit will be set from open to closed using the Diagnostic Test System to monitor closed seating thrust. b) The SI – 189 MOD changes 13JSIAUV0674 and 13JSIBUV0676 from limit seating butterfly valves to torque seated butterfly valves. CAUTION when reading torque switch as these valves after the MOD will have reverse acting torque switches. Adjustments to the torque switch will be made during Diagnostic Testing.	

EO: 1.19 Demonstrate how to adjust Limit Switches on SMB and SMC Limitorque actuators using ZZI-004 and contact development chart on electrical drawing.

Main Idea

CONTENT	**METHODS & ACTIVITIES**
1) Initial Set Up. New Actuator Installation/Refurbished Actuator. 2) Place the valve in a mid-stroke position. With a deadman installed, bump the actuator in the close direction to verify proper phase rotation. If the motor is not rotating in the proper direction, change the vendor motor leads (not the field leads) on A and C phase and change the labeling. a) Note: There is a potential after a Shop Refurb/EDC leads could be cross even though safeguards are in place. Placing valve in mid-stroke is an added check to minimize Human performance error. b) Limit switches at Palo Verde are set from electrically closed to open per Appendix E of 39MT-9ZZ02. *c) Prior to setting Limitorque limit switches several things should be known.* *(1) Was the valve electrically closed.* *(2) The desired contact configuration.* *(3) Direction of intermittent gear shafts are turning when valve is being open.* *(4) Existing contact configuration of limits switches* *d)* Read the Contact Development chart *i) Purpose- identify the configuration contacts should be in when setting limit switches, they are found on electrical elementary drawing.*	**Discuss why this check is critical when performing MOV Refurb's /EDC's,**

e) To set limit switches, open the valve, note the direction the intermittent gear shaft is turning when opening the valve

   i) Normally SMB limit switch intermittent gear shafts rotate counter clockwise going open and SMC gear shafts rotate clockwise.

Caution!!! When setting limit switches using hand wheel turns on SMB-0 and up, be sure hammer blow is taken up prior to counting turns.

f) Open the valve to the correct set point per 1,2, or 3-J-ZZI-04 and note the configuration of the contacts.

   (1) If the desired contact make up has not happened.

   (2) Engage the set rod, which disengages the intermittent gears. (clutch the gears)

   (3) Turn the intermittent gear shaft in the same direction it was turning while the valve was going open, until the desired contact configuration is met.

   (4) Disengage the set rod and check both the intermittent gear shafts to ensure the gears are made up.

   (5) If the desired contact make up has happened.

   (6) Engage the set rod.

   (7) Turn the intermittent gear shaft the opposite direction it was turning while the valve was going open, until the desired contact configuration changes. Then rotate the intermittent gear shaft the same direction it was turning while going open until the desired contact configuration is met.

   (8) Disengage the set rod and check the intermittent gear shaft to ensure the gears are made up.

3) Note 21 valves are partial stroke valves. Setting these valves requires allowing for inertia. This makes it very difficult to set the limit switches.
   a) You will find that when you get the limits close you will have to move the intermittent gear shaft one tooth at a time.
   b) Open the valve to the desired position for the open limit.
   c) If the desired contact make up has not happened.
   d) Engage the set rod, which disengages the intermittent gears.
   e) Turn the intermittent gear shaft in the same direction it was turning while the valve was going open. Rotate the shaft approximately one gear tooth.
   f) Disengage the set rod and check both the intermittent gear shafts to ensure the gears are made up.
   g) Stroke the valve closed and open electrically. Verify the stroke length. If the valve didn't coast far enough repeat the steps until the desired measurement is obtained.
   h) If the valve has stroked open too far you must rotate the intermittent shaft in the opposite direction.
4) This method is also used in setting the close limit for 13JSGUV134 & 138 while monitoring the QSS with the Diagnostic Testing System.
5) Butterfly Valves require adjusting the hard stops on the HBC when setting the open and close limits.
   a) Remove the hard stop cover plate and back off the stop nuts.
   b) Make required limit switch adjustment for the closed limit.
   c) Adjust the hard stop nut one flat off the housing and replace the cover.

d) Set the open limit switch and set the hard stop nut one flat off the housing and replace the cover.

e) Stroke the valve open and closed electrically and verify the hard stops are not hitting the housing which will cause the valve to torque out and not limit out.

f) If the hard stops are hitting make required adjustments.

EO: 1.20 Demonstrate how to adjust local/remote position indication.

Main Idea

CONTENT	METHODS & ACTIVITIES

1) Initial condition;
   a) Actuator is installed
   b) Limit Switched are set
   c) HBC Stops have been set

2) Local Position Indication.
   a) SMB-0 and above
   b) Close the valve electrically
   c) Remove the drive chain and adjust the pointer to indicate closed.
   d) Reinstall the drive chain.

3) SMB-000/00
   a) Remove local MDPI cover.
   b) Loosen dial plate and rotate dial to the closed position.

4) SMC-04
   a) Loosen the set screw on the indicator pointer and rotate the pointer to indicate 0.
   b) Tighten the set screw.

5) Remote Position Indication
   a) Electrically close the valve.
   b) Measure voltage between P2 & P3; adjust the potentiometer to bring the voltage reading as close as possible to zero.
   c) If no voltage is present you can adjust the potentiometer by measuring resistance between P2 & P3. Adjust the potentiometer to bring resistance reading to as close as possible to zero ohms.
   d) Electrically stroke the valve and verify the potentiometer is tracking properly.
   e) Close the valve and have the control room read their meter and verify it reads 0. Open the valve and verify the control room reads 100%. If the meter reads more than 100% more voltage needs to be dropped across the resister at the MCC. With the valve fully open the voltage reading between P2 & P3 should approximately 10 to 12 volts.
   f) Caution – This course does not qualify you to make. any adjustments to the resistors in the MCC.

Note: Our procedure dose not give instruction for work in the MCC.

EO: 1.21 State the Design characteristics and principles of operation of an SMC-04 Limitorque Actuator.

Main Idea

CONTENT	METHOD & ACTIVITIES
1) A. Design Characteristics a) The SMC actuators are a later design than the SMB. They were to take the place of the SMB 000 in many applications. b) SMC's can be used in Safety related applications, but can not be used as a EQ class actuator, c) This restriction as well as industry maintenance concerns has caused Limitorque to terminate its manufacture of the SMC actuators.	
2) At Palo Verde we have had problems getting parts along with mounting ***bolts stripping out of the aluminum housing***.	Discuss CRDR 2654606
3) CRDR 2654606 written was to address Over torquing of dissimilar metals	
4) U-2 "C" Pump discharge valve MOV was torque to the point a one inch bolt stripped when MG device was torque to 650 ft lbs.	
5) CBT course NDS16 was developed to reinforce awareness when torquing dissimilar metals.	
6) Procedure 30DP-9MP02 Fastener Tightening/Preload was revised to clarity when using torque charts and Engineering involvement when torquing dissimilar metals.	
7) Meeting thrust numbers during Diagnostic testing to get the valve to close under DP has caused us to replace the SMC 04 with SMB 00 actuators in many application.	

8) Motor Operation

a) The SMC just like the SMB actuator is always available for motor operation when the motor is energized.

Use the cut away SMC actuator to demonstrate the internal operations of the actuator.

b) When the motor is energized, the motor pinion keyed to the motor shaft turns the spur gear which is keyed to the worm shaft. The worm, keyed to the worm shaft drives the worm gear.

Explain to the students that electrical trouble shooting will be covered in another objective

c) If the motor is running and the actuator drive sleeve is not turning, the motor pinion key or worm shaft gear may be sheered off or missing.

Explain the importance of proper staking of the motor pinion key to keep it from slipping out.

d) The eccentric ring has lugs that fit into grooves on the worm gear. The ring is connected to the worm gear by two Allen cap screws

e) The eccentric ring has slots machined into the top that lugs on the bottom of the clutch sleeve fit into. The clutch sleeve is forced down to keep the lugs engaged with the sots by the clutch spring. ***These slots are larger than the lugs; this provides lost motion or hammer blow. Hammer blow gives the motor a chance to come up to speed and aids breaking the static friction between the stem and stem nut.***

Pass the drive sleeve from the cut away actuator around the class for students to get a better understanding of hammer blow.

f) If the clutch spring is broken or the clutch spring cup is missing this could stop the valve from stroking.

g) The clutch sleeve has two long lugs on the top portion, which engage the drive sleeve and bevel gear through two keyways in the ID of the bevel gear. The bevel gear is keyed to the drive sleeve. The limit switch gear meshes with the bevel gear counting revolutions of the drive sleeve.

h) Internal splines of the drive sleeve are made up with the external splines of the stem nut. The stem nut is threaded to mate the threads on the valve stem. ***The stem nut is held in place by a stem nut lock nut, which keep the stem nut lock nut from becoming loose and letting the stem nut back out of Drive sleeve***. Rotation of the stem nut will open or close the valve.

i) Thrust is absorbed by bearings on top and bottom of the drive sleeve.

j) As torque is developed the worm moves axially compressing the belleville springs. Compression of the springs causes movement of the bearing cartridge, which is geared to the torque switch in a rack and pinion fashion. As the torque switch shaft is rotated the contacts open and the motor stops.

k) Most thrusting valves are set up to limit open and torque close at Palo Verde.

C. Manual Operation

a) Older model actuators have declutch knobs and newer models have levers.

b) Turn the declutch lever counter clockwise until it latches. **DO NOT FORCE IT**. If it will not engage rotate the hand wheel slightly and try again.

c) When the declutch shaft is rotated it rotates the **<u>latch pinion</u>**, *keyed to the shaft and meshed with the clutch sleeve.* This raises the clutch sleeve disengaging the bottom lugs from the eccentric ring and engaging the upper lugs with the lugs on the hand wheel adapter.

Use cut away actuator to demonstrate the operation of the latch pinion.

d) If the lugs of the handwheel are lined up with the lugs of the clutch sleeve the actuator will not go into manual operation. Rotate the handwheel ¼ turn and try again.

e) If the declutch lever rotates without resistance one of the keys may be sheered or missing. Check the latch pinion key and the declutch lever key. If it will not stay in manual check the latch pinion spring for damage.

f) The latch gripping the bottom of the eccentric ring maintains manual operation.

g) When the motor is engaged the eccentric ring is rotated and the spiral surface forces the latch off the ring. The force of the clutch compression spring forces the clutch sleeve down into motor operation.

EO: 1.22 State the operation of SMB-000, 00 and SMB- 0 thru SMB-3 Limitorque actuator.

Main Idea

CONTENT	METHODS & ACTIVITIES
1) Motor Operation **SMB-000**	
a) Motors used on Limitorque actuators are high torque, totally enclosed weather-proof, submersible enclosures. Motors are lubricated at the factory for lifetime operation.	Use cut away actuator to demonstrate motor action of the actuator. Explain to the students the similarities of SMB-000 and SMB-00 actuators
b) Three phase AC motors or DC	
c) The motor has a helical pinion keyed and set screwed to the motor shaft.	
d) The motor pinion drives the worm shaft gear keyed to the worm shaft.	
e) If the motor is running and the actuator drive sleeve is not turning the motor pinion key or the worm shaft gear key could be sheered or missing.	
f) The worm has internal splines that mate with the external splines of the worm shaft. This allows the worm to move axially on the worm shaft yet rotate with the rotation of the worm shaft.	
g) The worm rotates the brass worm gear. The lugs on the worm gear contact the clutch keys. They ride in key ways in the drive sleeve 180 degrees apart held in place by the clutch ring. The clutch ring is held down by the clutch compression spring, keeping the keys against the worm gear lugs.	

(a) The keys being 180 degrees apart gives the motor a chance to get to full speed without a load. The initial contact occurs with considerable impact. This is referred to as hammer blow; it aids in breaking the static friction between the stem and stem nut.

(b) As the drive sleeve is rotated the internal splines of the drive sleeve mate with the external splines of the stem nut. The stem nut is threaded to mate with the threads on the valve stem to open or close the valve.

(c) The stem nut is held in place by a stem nut lock nut, staked in place.

(d) Keeps stem nut locknut from becoming loose and letting stem nut back out of drive sleeve

Explain the importance of staking and what could happen if the stem nut lock backs out of position.

(e) A hypoid gear is mounted to the drive sleeve where the geared limit switch rides. The limit switch count the revolutions and can be set to break electrical contact to the motor at any given setting.

(f) The torque switch has an arm with a roller on the end of it. The roller fits into a grove on the worm just in front of the bearing cartridge. As torque is developed the worm moves axially along the worm shaft, compressing the belleville springs. This axially movement rotates the arm of the torque switch to open the contacts and stop the motor.

2) Manual operation **SMB-00**

(a) A hand wheel is provided for local manual operation, and the actuator has a manually operated self-locking, motor -disengaging (declutching) mechanism

(b) To engage the actuator into manual operation, press down on the declutch lever. The lever is keyed to the declutch shaft.

(c) As the shaft is rotated it raises the clutch fork keyed to the de-clutch shaft. The fork has rollers that fit into the grove of the clutch ring.

(d) As the clutch ring is raised it raises the clutch keys. This disengages the bottom end of the keys from the worm gear and engages the top end of the keys with the hand wheel lugs.

(e) If the declutch lever will not depress rotate the hand wheel and try again. Occasionally the clutch keys are directly in line with the hand wheel lugs and will not allow full travel of the keys. If the declutch lever will still not depress the shaft may be twisted not allowing the clutch fork to get a full lift of the clutch ring or the tripper fingers need adjustment.

3) Tripper Assembly

(a) On the motor end of the declutch shaft, is the auto locking tripper assembly, it is keyed to the shaft. It is made up of a mounting block and two spring loaded tripper fingers, one slightly longer than the other.

(b) When the shaft is rotated the block is raised, allowing the spring loaded tripper fingers to move onto the adjustment arm. This holds the actuator in manual operation. If the adjustment arm is not adjusted properly the clutch ring will not get enough lift to bring the clutch keys in contact with the handwheel lugs.

Use cut away actuator to show proper tripper finger adjustment.

(c) There are two cams mounted to the worm shaft just behind the worm shaft gear. They are mounted 180 degrees apart and spaced apart so one lines up with each tripper fingers.

(d) When the motor starts the cams rotate and knock the tripper fingers off the adjustment arm. The clutch spring forces the clutch ring down, to engage the bottom end of the clutch keys with the lugs of the worm gear.

(e) One finger is 1/32” longer than the other is to be sure when the long finger is knocked off the adjustment arm it can not return, and then the second is knocked off.

4) Motor Operation SMB-0 thru SMB-3

(a) Procedure 39MT-9ZZ02 requires that an inspection in made of the motor pinion key to ensure that the shaft is staked on the end to keep the key from sliding out. If the key is flush with the end of the shaft, the key must be beveled to allow room for metal from the shaft to expand when tacked.

Use white board to give examples of the right and wrong way to stake a motor shaft.

(b) The motor pinion gear drives the worm shaft clutch gear, which has lugs on it meshing with lugs on the worm shaft clutch, causing the clutch to rotate. The worm shaft clutch is splined to the worm shaft causing the worm shaft to rotate

Use the cut away actuator to demonstrate motor operation.

Explain to the students that the components of these actuators are basically the same the size of the actuator changes.

(c) If the motor is running and the drive sleeve in not turning the motor pinion key may be sheered or missing.

(d) The worm shaft is splined to the worm; therefore the worm rotates turning the brass worm gear.

(e) The worm gear has lugs on top, which engage lugs located on the drive sleeve, causing the drive sleeve to rotate.

(f) The stem nut is splined to the drive sleeve and threaded internally to match the valve stem. The stem nut is held in place by a stem nut lock nut.

(g) Rotation of the drive sleeve and stem nut causes the valve to open or close.

(h) Thrust is absorbed by thrust bearings on top and bottom of the drive sleeve.

(i) As torque is develops the worm slides axially along the splines of the worm shaft and compresses the belleville springs.

(j) Compression of the springs causes movement of the bearing cartridge, which is geared to the torque switch in a rack and pinion fashion. As the torque switch shaft is rotated, the contacts open and the motor stops.

(k) The limit switch gear rides on the worm shaft, different from the SMB-00. The intermittent gears start turning as soon as the motor starts, not when the drive sleeve turns.

Pass a limit switch assembly around the class to see the assembly more closely.

(l) The 16 contact geared limit switch employs four rotary drum switches, each having four contacts. When set to trip two contacts open circuits and two contacts close. Each drum switch may be adjusted independently of the other.

5) Manual Operation SMB-0 thru SMB-3

(a) When the de-clutch lever is pulled down, the de-clutch shaft will rotate. The de-clutch link, being splined to the de-clutch shaft, will rotate and engage the de-clutch fork to push the worm shaft clutch out of engagement with the worm shaft clutch gear and into engagement with the hand wheel clutch gear.

Use the cut away actuator to demonstrate manual operation.

(b) The de-clutch fork has two rollers which fit into a machined grove in the center of the worm shaft clutch.

(c) The de-clutch fork is held in manual operation by tripper fingers, which rest on the fork extension, pulled together by the tripper spring. If the actuator will not stay in manual the tripper spring may be damaged or slipped out or place.

(d) The hand wheel is keyed to the end of the hand wheel shaft. On the opposite end of the shaft is the hand wheel gear keyed to the shaft. It meshes with the hand wheel clutch gear.

(e) When the hand wheel is rotated, the hand wheel gear rotates the hand wheel clutch gear, rotating the worm shaft, rotating the worm, rotating the worm gear and the drive sleeve.

(f) Unlike the SMB-000 & 00 the spring pack can be loaded up manually, because you drive the worm manually to operate the valve.

(g) Once the actuator is placed into manual operation it will stay in manual until the motor is started. You can not take it out of manual by raising the de-clutch lever. NEVER PULL UP ON THE DE-CLUTCH LEVER YOU WILL DAMAGE THE ACTUATOR.

(h) When the motor is energized, the tripper pin located on the worm shaft clutch gear, knocks the tripper fingers off the de-clutch fork extension. One finger notch is always longer than the other to keep it off the fork is while the tripper pin comes around to knock off the other.

(i) The clutch is forced to the worm shaft clutch gear by the clutch spring placing the actuator into motor operation.

EO: 1.23 Discuss trouble-shooting techniques for stroke failure and indication problems.

Main Idea

CONTENT	METHODS & ACTIVITIES
1. All work performed on energized or potentially energized electrical circuits shall comply with procedure 01DP-0IS13 Electrical Safer Work Practices	
2) Explain trouble-shooting techniques if an actuator fails to stroke electrically in the open direction.	**Students can follow along with their own copy of 01-E-GSB-002**
3) At the breaker; If no light indication is present check the control fuse. If the fuse is good the switch in the control room could be bad or the wiring from the switch to the breaker or from the breaker to the actuator could be damaged	
4) If power is present verify that the contacts are in proper alignment per the contact development chart at the bottom of the print. With the valve in the close position, contacts 4&4C, 5&5C, and the open torque switch contacts 18 should be made up. Verify the make up with a meter set on ohms.	
5) In some cases the meter will show that the contacts are made up however, if the resistance is high the contact will not allow the proper flow of current. If all the contacts are good the starter relay could be bad at the breaker or the motor itself.	**Remind students that a burnishing tool is the only type of abrasive used on electrical contacts. This is also a good time to emphasize the reason for a good L-bracket inspection during the PM.**

6) In some cases the motor will hum and the valve not stroke, this usually means that one of the leads to the motor is damaged or broken. This is commonly called single phasing.

7) If there is no voltage at the motor, at the breaker check the starting relay 42-0 and the over loads 49. The over loads or heater can be reset with a button on the breaker.

8) If the actuator fails to stroke in the close direction, the techniques are basically the same however, the contacts are different. We are now looking at contacts 1&1C and the close torque switch contacts 17. The close starting relay is 42-C however, the over loads are the same for open and close.

9) Explain trouble-shooting techniques for improper light indication.

10) Open light indication contacts 1515C. Per the contact development chart when the valve is starting open contacts 15&15C make up to light the red light.

11) Close light indication contacts are 3&3C. Per the contact development chart when the valve is starting close 3&3C make up to light the green light.

12) For the most part light indication problem occur when limit switches are out of adjustment, or a light bulb is bad.

13) Explain how voltage is dropped across the resistor changing the position indication in the control room.

14) The position indication in the control room is just a voltmeter that reads voltage from the potentiometer. As the valve strokes rotating the potentiometer voltage is dropped across the resistor.

15) Explain how to adjust indication. Show how to make the adjustment and what is acceptable to us.

Students can reference procedures 39MT-9ZZ02 for detailed instructions on setting indication.

16) With the valve electrically closed, with a meter set on voltage read between P2 and P3, adjust the potentiometer till the meter reads zero voltage or as close to zero as possible. Stroke the valve and verify the potentiometer tracks properly.

17) If indication power is off, with the valve electrically closed, with a meter set on ohms read between P2 and P3 adjust the potentiometer to zero or as close to zero as possible. Stroke the valve to verify the potentiometer track properly.

EO: 1.24 Discuss Restoration and Retest of Limitorque Actuators

Main Idea

METHODS & ACTIVITIES

CONTENT

1) Restoration:
   a) Ensure the last closure of the valve was electrical.
   b) Remove Jumper and Local Control Switch.
   c) Install the Stem Protector/Pipe Plug and ensure a gap exist between that and the Stem Nut Lock Nut or Drive Sleeve.
   d) Install the Limit Switch Cover & Gasket.
   e) Ensure all Mounting Fasteners are secure.

2) Retest:
   a) Perform Work Order designated retest, or if no designated retest, electrically operate the valve form the Control Room and ensure that all the indications/annunciators are indicating correctly.

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.