



Nuclear Division
4800 East Tech Dr. • Cincinnati, OH 45245
Phone: 513.528.7800 • Fax: 513.528.9292
www.CWNuclear.com

October 8, 2018

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D.C. 20555-0001

Subject: Interim Notification Report for Potential Part 21.

Dear Sir or Madam:

Curtiss-Wright was notified on August 7th, 2018 by Exelon's Dresden Plant that a Curtiss-Wright Supplied Namco Limit Switch, P/N: EA700-90964 had failed during a planned maintenance test.

The switch contacts were found to be sluggish in returning to the normal shelf state after actuation, or would not return at all. The switch was identified as Curtiss-Wright Tag # 5T34603 and was provided as a safety related component to Exelon in September 2005. According to Exelon the item was stored for 8 years then failure occurred approximately 5 years into service. The part has a manufacturer date coded as August 2005.

The switch was subsequently sent to Exelon Powerlabs where a detailed failure evaluation was performed (See Attached). Exelon Powerlabs confirmed the failure mode and determined that there was insufficient lubrication in place to support normal switch function. The switch was then sent to Namco for further evaluation and Namco confirmed the lack of lubricant was the likely cause of the failure.

Curtiss-Wright is currently investigating this issue and will provide a follow up report by November 15th, 2018.

Sincerely:

Tim Franchuk
Director, Quality Assurance
Curtiss-Wright Nuclear Division, Cincinnati Operations
513-201-2176
TFranchuk@CurtissWright.com



To: Danny Srisawasdi, Quad Cities Station, 309-227-3847
From: Devan Wachter, 815-458-7599 devan.wachter@exeloncorp.com
Project: QDC-07067
Subject: Failure Analysis of a NAMCO Limit Switch from Quad Cities Station
Manufacturer: NAMCO Controls Corp
Component ID: 1-5699-MSV1 - ASSY -
U1 TURB MSV #1
AR/CR/WO: 04145668
PO.: FAILURE ANALYSIS
Model: Snap-Lock 700-90964
Quantity Received: 1

Date: 08/08/2018

DESCRIPTION

During performance of QOS 5600-02 (Turbine Stop Valve Closure Scram Instrumentation Functional Test) in June 2018, the Unit 1 main stop valve #1 testing did not produce the appropriate alarms or relay actuations for 10% RPS closure function. The failed limit switch was replaced and sent to PowerLabs west for failure analysis. The site reported the switch was installed during the Q2R22 refuel outage (roughly four and a half years prior to failure).

CONCLUSIONS

The failure analysis functionality testing verified the limit switch malfunction by replicating the issue identified on the Quad Cities work request. The limit switch did not operate smoothly and seized up when returning to shelf state. Based on the internal component inspections, the binding was due to insufficient (i.e., dried out) lubrication on the moving components. Manufacturer confirmed lubrication was not present in the Limit Switch and was the primary cause for component failure. In addition, the shaft O-ring was severely hardened from aging, which would have contributed to binding. Rye Lubrication 181 is applied during the manufacturing process.

COMMENTS AND RECOMMENDATIONS

The site should review/evaluate the limit switch replacement frequency for this application. The site may also want to look into limit switches with higher temperature ratings, or evaluating insulation to reduce the exposure temperature.

REQUIREMENTS

Determine the failure mechanism that prevented the limit switch from performing its intended function.

The Exelon PowerLabs Quality System meets 10CFR50 Appendix B, NQA-1 (1994), ANSI N45.2, ANSI/NCSL Z540.3-2006, ISO 9001:2008, ISO 17025:2005, and 10CFR21/10CFR50.55 (e).

TEST PLAN

1. Document nameplate, photograph sample, and inspect for defects.
2. Perform functionality testing on limit switch.
3. Examine internal components for causes of failure and take photographs if needed.
4. Manufacturer's Findings

STATEMENT OF QUALITY

Testing was performed with standard equipment that have accuracies traceable to nationally recognized standards, or to physical constants, by qualified personnel, and in accordance with the Exelon PowerLabs Quality Assurance Program.

Technician(s): Devan Wachter, 815-458-7599 devan.wachter@exeloncorp.com
Peter Graffy, (815)458-7603, peter.graffy@ExelonCorp.com

Prepared by:	<u>Devan Wachter</u>	<u>6/27/2018</u>
	ANSI Level III / Sr Engineer	Date
Reviewed by:	<u>Peter Graffy</u>	<u>6/27/2018</u>
	ANSI Level III / Sr. Engineer	Date
Approved by:	<u>Jim Chynoweth</u>	<u>7/3/2018</u>
	ANSI Level III / Sr. Engineer	Date

Project review and approval are electronically authenticated in the Exelon PowerLabs project record.

cc: PowerLabs F/A Fleet Distribution

OBSERVATIONS AND DATA

1. Document nameplate, photograph sample, and inspect for defects.

Manufacturer: Namco Controls Corp.

Model: EA 700-90964

Type: Limit Switch

Rating: 20A – 125VAC / 5A – 125VDC
 15A – 250VAC / 1.5A – 250VDC
 10A – 480VAC
 5A – 600VAC

Defects?: Limit switch appeared to have no visible defects.

2. Perform functionality testing on limit switch.

Table 1: Contact Resistance (Ω)

Contact	1 st Reading	2 nd Reading
A-B	0.01277	0.01095
C-D	0.06123	0.05865
E-F	0.00732	0.00459
G-H	0.06814	0.07258
J-K	0.04105	0.03680
L-M	0.01629	0.01685

Table 1: Contact resistance measurements show acceptable contact between pads. Acceptable resistance is below 0.1Ω .

Image 2

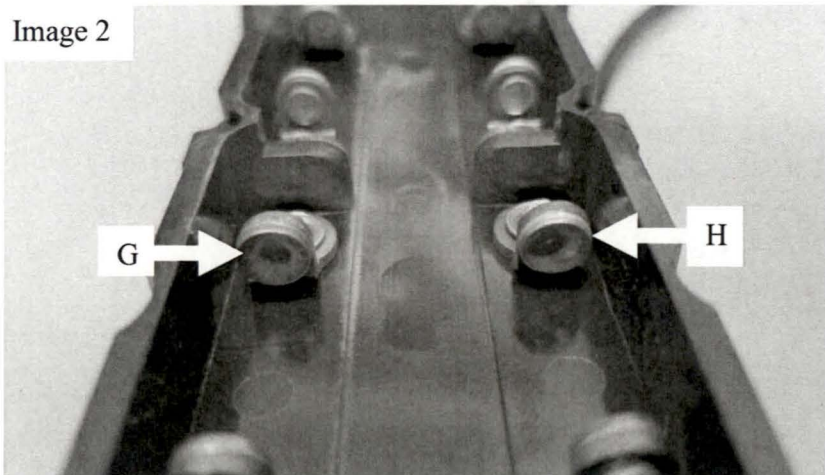


Image 2: Contacts G-H show signs of arcing between pads. From the data in table 1, contacts do not show signs of increased resistance.

Shaft / Torque Measurements

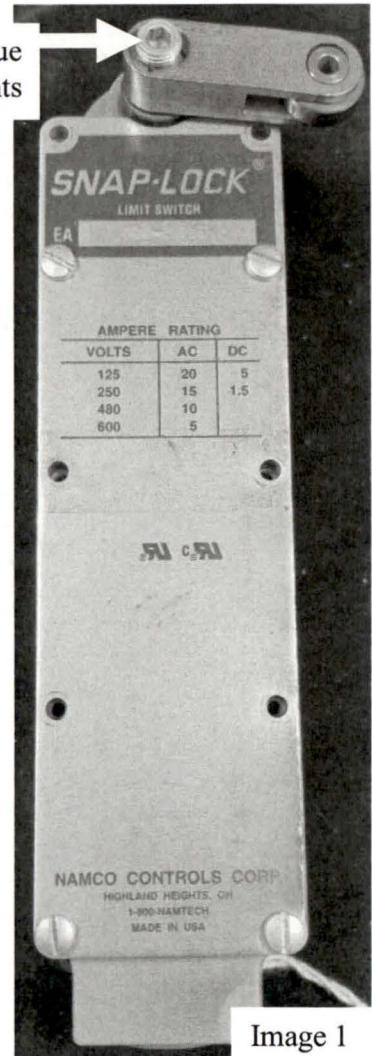


Image 1

Image 1: Namco Controls Limit Switch Nameplate.

Table 2: Torque Measurements	
Clockwise	17 inch-lbs
Counter Clockwise	26 inch-lbs

Table 2: The contacts inside the limit switch are actuated by rotating a shaft at the top (Image 1) clockwise or counter clockwise. By using a torque meter at the center of rotation, it was discovered that more torque is required to rotate the lever in the counter clockwise direction.

When releasing tension on the limit switch, the latch assembly would intermittently bind preventing the contacts from smoothly returning to shelf state.

3. Examine internal components for causes of failure and take photographs if needed.

The manufacturer uses Nye Lubricant 181 (Technical Data Sheet: Image 7). During examination, dry lubricant residue was found in all of the internal components (Images 3 and 4). The residue is suspected to be dried from the environmental temperatures or insufficient quantity of lubricant.

Image 3

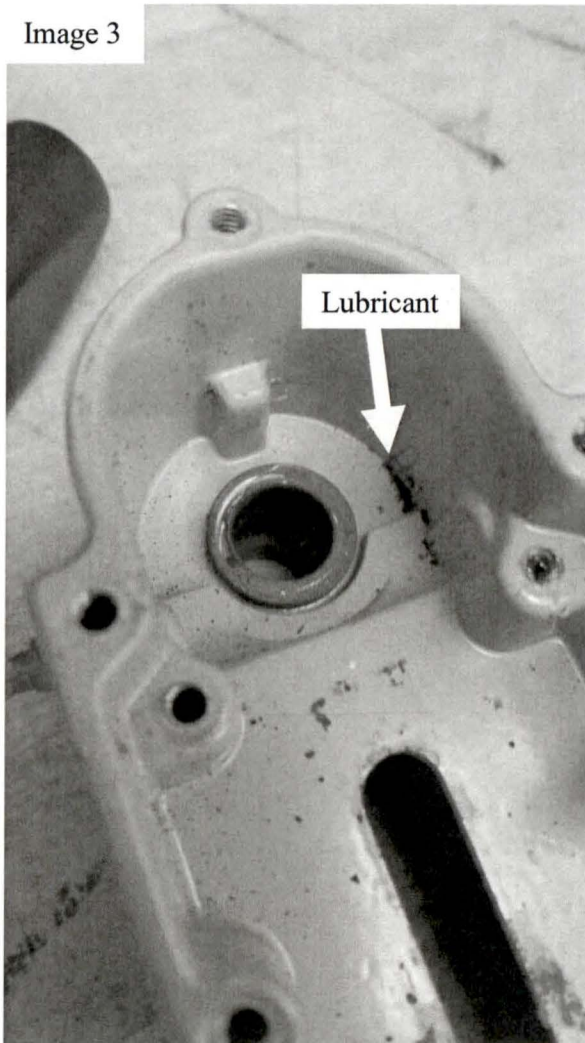


Image 3: With internals removed from limit switch casing, we can see signs of dried lubricant.

Image 4

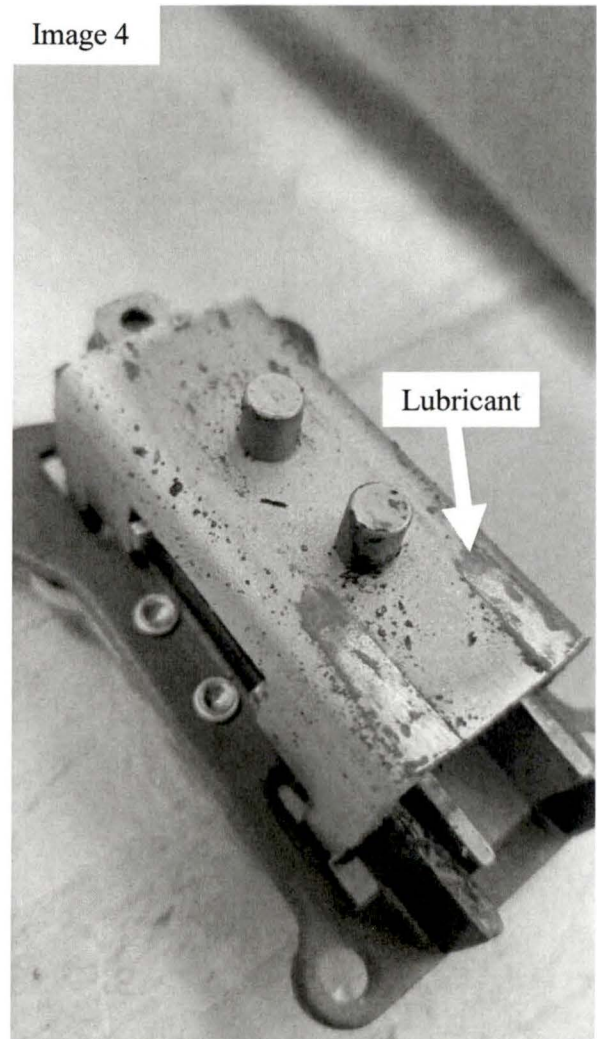


Image 4: Latch assembly shows signs of dried lubricant causing binding during operation.

When the shaft (Image 1 & 5) is rotated to actuate the limit switch, it pushes the roller (Image 6) located on the latch assembly (Image 4) inward. The latch assembly then moves the contacts (Image 2) together or apart, making or breaking connections.

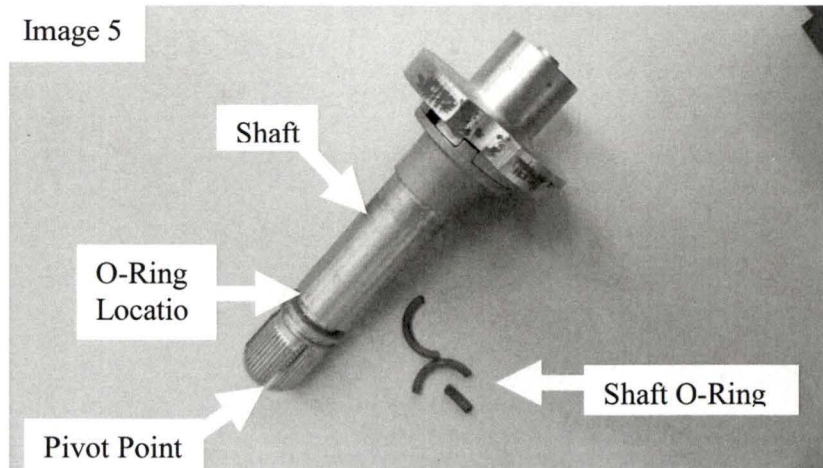


Image 5: The shaft O-Ring was found intact, but fractured into pieces during removal. The O-ring material was severely hardened and embrittled from environment aging. Using fourier-transform infrared spectroscopy (FRIT) techniques, the O-ring was found to be of Buna-N material (Image 8). The combination of dried lubrication and a hardened O-ring would have contributed to binding forces.

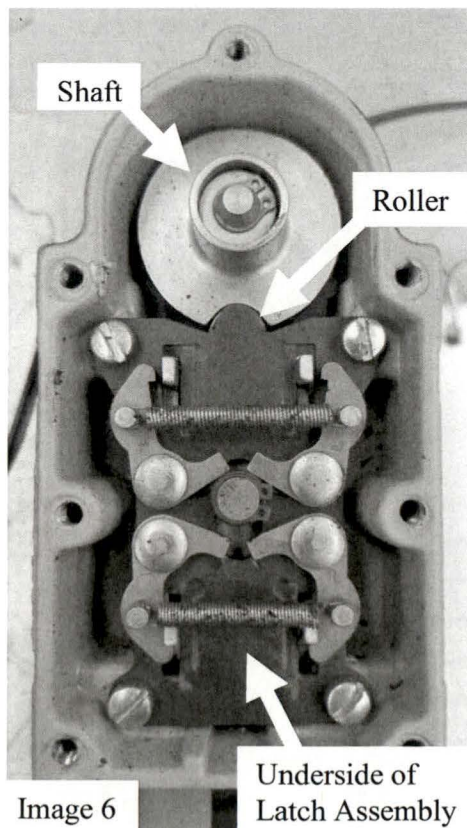


Image 6: Dried lubrication at multiple moving components contributed to the limit switch failure. The dried lubricant at the O-ring would increase the amount of torque required to rotate the shaft. If lubrication was present, the shaft would rotate and the roller on the latch assembly would properly operate to actuate the contacts. When torque on the shaft is released, a spring in the latch assembly pushes the contacts back to shelf state (opening the contacts).

EH310-00002		OIL, SYNTHETIC INSTRUMENT #181										
A MEDIUM VISCOSITY SYNTHETIC HYDROCARBON OIL FORMULATION ESPECIALLY INTENDED FOR SINTERED SLEEVE BEARING APPLICATIONS COMPATIBLE WITH PLASTICS, FILM STRENGTH OF NATURAL PARAFFIN LUBRICANT, EXCELLANT STABILITY AND HOMOGENEITY.												
TYPICAL PROPERTIES:		NOTES:										
③ COLOR	ASTM D445 CLEAR TO LIGHT AMBER	1. PROCESS PER NSP60-0010.										
③ VISCOSITY @ 100° F	ASTM D445 57.7 TO 63.7 CENTISTOKES	2. THIS OIL SHOULD BE STORED IN A CLOSED CONTAINER AT ALL TIMES. CHANCE OF ANY CONTAMINATION FROM DUST, LINT, ETC. SHOULD BE KEPT TO A MINIMUM.										
VISCOSITY @ 210° F	ASTM D445 9.5 CENTISTOKES											
POUR POINT	-70° F MAXIMUM											
EVAPORATION LOSS, 6-1/2 HRS. @ 400° F	3.7 %	③ VENDOR SHALL PROVIDE A CERTIFICATION OF ANALYSIS FOR THE NOTED PROPERTIES.										
NEUTRALIZATION NUMBER	0.01 mg. KOH/gr											
TEMPERATURE RANGE	-40° F TO 300° F											
MANUFACTURER: WILLIAM F. NYE NEW BEDFORD, MASS. 02742		<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="text-align: center;">▲</td> <td>NAVY/MARINE</td> <td>EH310-00012</td> </tr> <tr> <td style="text-align: center;">---</td> <td>STANDARD</td> <td>EH310-00002</td> </tr> <tr> <td>REMARKS</td> <td>DESCRIPTION</td> <td>PART NUMBER</td> </tr> </table>		▲	NAVY/MARINE	EH310-00012	---	STANDARD	EH310-00002	REMARKS	DESCRIPTION	PART NUMBER
▲	NAVY/MARINE	EH310-00012										
---	STANDARD	EH310-00002										
REMARKS	DESCRIPTION	PART NUMBER										
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 25%;">DUST. PART. NO.</td> <td style="width: 25%;">ASSY. NO.</td> <td style="width: 25%;">REF. NO.</td> <td style="width: 25%;"></td> </tr> </table>		DUST. PART. NO.	ASSY. NO.	REF. NO.		NAMCO NEWTON, MA 01460 USA						
DUST. PART. NO.	ASSY. NO.	REF. NO.										
CHANGE RECORD REVISION G E. C. No. A6467 DATE _____ CHECKED BY _____		TITLE OIL, WILLIAM F. NYE #181 MATERIAL: RM- DO NOT SCALE EH310-00002 SHEET 1 OF 1 ACAD										
UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS: XX # .51 XXX # .005 ANGULAR D'30° REMOVE ALL SHARP EDGES ALL MACHINED SURFACES		NOTICE: THE INFORMATION CONTAINED HEREON IS THE PROPERTY OF NAMCO SYSTEMS, A DIVISION OF THE AMEC-CLEVELAND CORP. AND IS SUPPLIED IN CONFIDENCE. THIS DOCUMENT MAY NOT BE COPIED OR REPRODUCED IN ANY MANNER THAT WOULD BE DETRIMENTAL TO OUR INTERESTS.										
		9 X 12. ENR GENERATED TAG										

Image 7: Technical Data Sheet for Rye Lubricant 181

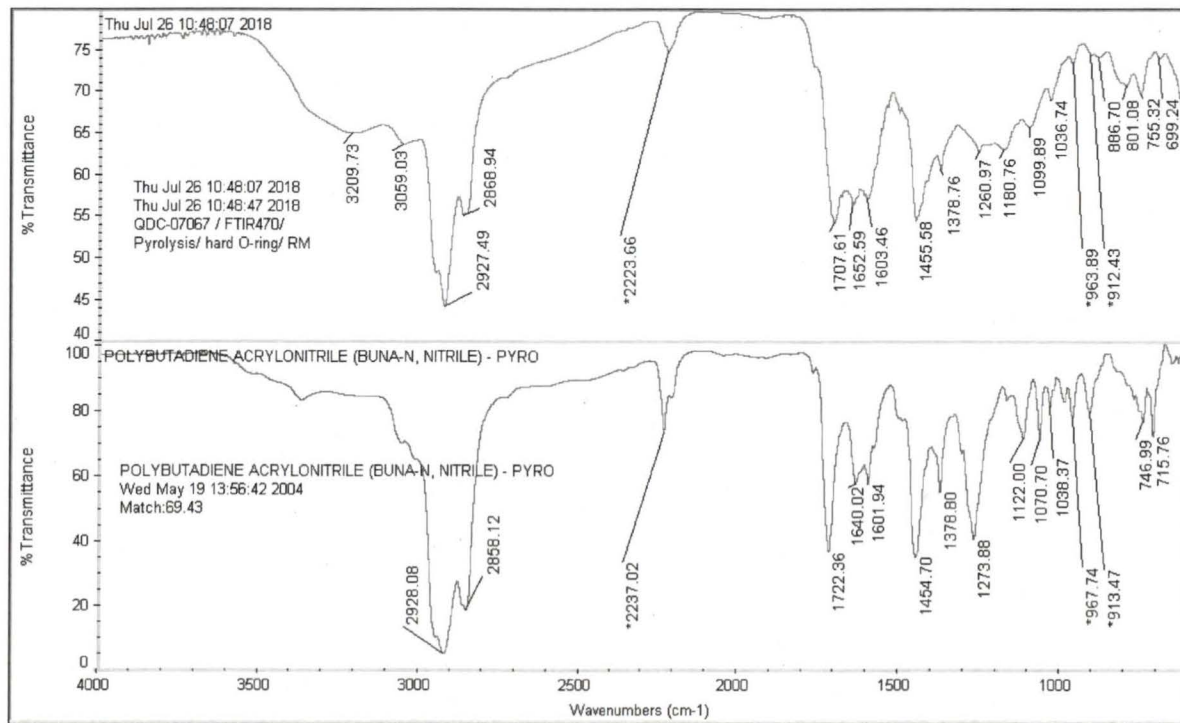


Image 8: FTIR showing the unknown hardened O-ring material to be consistent with Buna-N.

4. Manufacturer's Findings

Namco limit switch is 8 years or older due to the base plate being black paint (now manufactured as plated), gasket material is of earlier alternate, and the part number was stamped instead of engraved. Namco re-assembled the switch with a new O-ring and passed all tests. O-ring is confirmed to be made of Buna-N material. Lubrication is manually applied by manufacturer during assembly.

Manufacturer confirmed lubrication was not present in the Limit Switch and was the primary cause for component failure. Contacts were worn from use.

Note: There are double pole nuclear grade switches available. In our current application, two of these nuclear grade switches would be required for the one triple pole. Namco will discard the unit.