Part 21 (PAR) Event # 51053

Rep Org:	QUALTECH NP	**Notification Date / Time:**	05/07/2015 14:31 (EDT)
Supplier:	QUALTECH NP	**Event Date / Time:**	05/07/2015 (EDT)
		Last Modification:	05/07/2015
Region:	3	**Docket #:**	
City:	CINCINNATI	**Agreement State:**	Yes
County:		**License #:**	
State:	OH		

NRC Notified by:	TIM FRANCHUK	**Notifications:**	DAN SCHROEDER	R1DO
HQ Ops Officer:	STEVE SANDIN		SHANE SANDAL	R2DO
Emergency Class:	NON EMERGENCY		RICHARD SKOKOWSKI	R3DO
10 CFR Section:			GREG PICK	R4DO
21.21(d)(3)(i)	DEFECTS AND NONCOMPLIANCE		PART 21/50.55 REACTORS	EMAIL

POTENTIAL PART 21 INVOLVING STRUTHERS DUNN RELAYS WITH CONTACT RESISTANCE GREATER THAN ONE OHM

The following is excerpted from a report submitted by QualTech NP, Nuclear Division, Curtiss-Wright Corporation:

"Subject:

"PSEG reported failures for Struthers Dunn 219BBX200 relays related to greater than 1 ohm contact resistance. Two relays were evaluated by Exelon Power Labs. Of these, one had a failure consisting of a contact resistance greater than one ohm. Struthers Dunn has also provided an evaluation in this regard and does not agree with the failure mode as inferred in the Exelon Power Labs report.

"Lab and OEM report key difference:

"The Power Labs' Report(s) shows fiberglass fiber(s) embedded into gold plated contacts on one relay believed to result in a contact resistance greater than one Ohm (1.7 Ohm Max). The second relay, from stock, had evidence of fiberglass present but was not considered to have affected functionality.

"The Struthers Dunn evaluation suggests that the fiber embedded on the gold contact is not at the mating point of the contacts and should not impact operability. Struthers Dunn also indicates that the relay's application is operating below their minimum current.

"Discussion:

"The actuator board on the evaluated relays is manufactured from a printed circuit board (PCB) type fiber board.

IE19
NRR

The fibers from the edges of the board could become airborne. [. . .] this specific board material was utilized beginning in March 2010. Since there have been no prior reports of this issue, it is possible that the 2010 material change introduced a foreign materials exclusion (FME) concern. Since then, and solely for those relays manufactured in the USA, the material changed again in November 2014 and was incorporated into the products starting January 2015. The newest version of the actuator board is a molded material that does not contain fiberglass fibers.

"Struthers Dunn relays with base part numbers 219, 236, 237, and 255 have the common PCB type fiber board. This fiber board was used in relays with date code 1009 through 1452 with or without letter suffix (where the letter indicates made outside of the USA).

"Customer Input:

"1st 219 series relay failed due to contact issue, considered a random failure & discarded. 2nd 219 series relay failed due to contact resistance & sent to Exelon Power Labs. Five parts from inventory bench tested. One had high resistance and it was sent to Power Labs

"Note: All parts provided were 100% functionally tested for contact resistance during dedication process and passed testing at QTNP.

"Vendor Input:

"Struthers Dunn has, since 2010, experienced only one field complaint (PSE&G) on continuity issues related to fiberglass on these 219 relays. The material change to ULTEM 2300 was considered an ongoing quality/process improvement process to reduce potential defects proactively. Over the four years using this PCB type material, 13,000 relays were sold.

"Struthers Dunn has also questioned the application having current below the manufacturer's recommended value of 50mA, requiring bifurcated contacts. Please see their attached report and current product catalog for details.

"Recommendation:

"The root cause of the failure is inconclusive. Exelon Power Labs said 'The irregular contact surface patterns in conjunction with the presence of the embedded fiberglass fibers are the most likely cause of the excessive resistance. This finding is considered to be a manufacturing defect.' While the manufacturer sees the failure as a misapplication of its product and that the fiber 'was not located at the 'mating point' of the 2 contacts so therefore has no effect on the performance of the contacts or relay.'

"QualTech NP recommends an application review for the named relays. A review of the Exelon Power Labs reports and the vendor's report should also be completed by the utility to evaluate the impact on the safety function."

****

CURTISS-WRIGHT
QualTech NP, Nuclear Division
Curtiss-Wright Corporation
4600 East Tech Drive, Cincinnati, OH 45245
T: 513.528.7900 | F: 513.528.4537

DOCUMENT TRANSMITTAL QTNP560

CONTRACT
N/A

P.O. NUMBER
N/A

TO: **NRC'S DOCUMENT CONTROL DESK**
U.S. REGULATORY COMMISSION
WASHINGTON, DC 20555-0001
ATTN: HEADQUARTERS OPERATIONS OFFICER
hoo.hoc@nrc.gov
Phone: (301) 816-5100; **Fax: (301) 816-5151**
PROJECT:

ACTION	LEGEND	STATUS
1. For Approval 2. Final Documents for Record 3. For Information Only 4. For Preliminary Use 5. For Your Use 6. Revised as Requested		A. Approved-Released for Construction B. Approved as noted- Resubmit- Construction may proceed C. Not approved- Resubmit D. _____

DOCUMENT/ DRAWING NUMBER	REV.	NO. OF PRINTS/ COPIES	NO. OF SEPIAS	☐ DRAWINGS ☐ SPECIFICATION ☒ OTHER ☐ REPORTS ☐ PROCEDURE	LEGEND
N/A	N/A	1		INVESTIGATION FOR POTENTIAL PART 21 FOR STRUTHERS DUNN RELAYS	2

REMARKS _____

BY *Margie Hover* DATE: 5/7/2015
DOCUMENT CONTROL

PAGE: 1 of 1

PLEASE ACKNOWLEDGE RECEIPT BELOW AND RETURN A SIGNED COPY

RECEIVED BY _____

DATED _____

In order to avoid delays in the project these documents must be returned by: _____

QualTech NP
Nuclear Division
4600 East Tech Dr. • Cincinnati, OH 45245
Phone: 513.528.7900 • Fax: 513.528.9292
www.qualtechnp.cwfc.com

May 7, 2014

Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Subject: Potential 10CFR Part 21 Notification on Struthers Dunn Relays

Dear Sir or Madam:

This letter provides notification of a potential 10CFR Part 21 with Struthers –Dunn relays as described in the attached report. QualTech, NP offers recommendations to the industry within the body of the report. We have notified our customers that this 10CRF21 report will be issued.

If you have any questions or wish to discuss this further, please call me at 513-528-7900 x 2176

Respectfully,

Tim Franchuk
Director of Quality Assurance

4600 East Tech Drive, Cincinnati Ohio 45245
Phone: 513.528.7900 x 2176 Fax: 513.528.9292

Investigation for Potential Part 21
for
Struthers Dunn Relays

Subject:

PSEG reported failures for Struthers Dunn 219BBX200 relays related to greater than 1 ohm contact resistance. Two relays were evaluated by Exelon Power Labs. Of these, one had a failure consisting of a contact resistance greater than one ohm. Struthers Dunn has also provided an evaluation in this regard and does not agree with the failure mode as inferred in the Exelon Power Labs report.

Lab and OEM report key difference:

The Power Labs' Report(s) shows fiberglass fiber(s) embedded into gold plated contacts on one relay believed to result in a contact resistance greater than one Ohm (1.7 Ohm Max). The second relay, from stock, had evidence of fiberglass present but was not considered to have affected functionality.

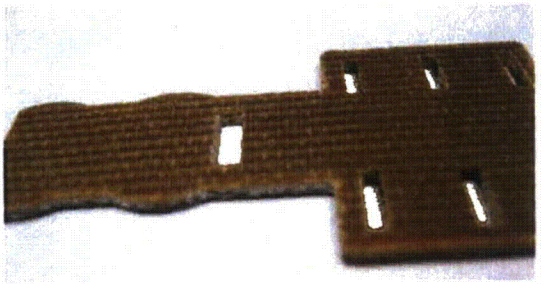
The Struthers Dunn evaluation suggests that the fiber embedded on the gold contact is not at the mating point of the contacts and should not impact operability. Struthers Dunn also indicates that the relay's application is operating below their minimum current.

Discussion:

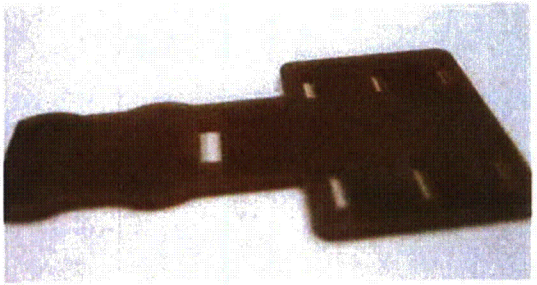
The actuator board on the evaluated relays is manufactured from a printed circuit board (PCB) type fiber board. The fibers from the edges of the board could become airborne. The attached design drawing and Struthers Dunn letter indicates that this specific board material was utilized beginning in March 2010. Since there have been no prior reports of this issue, it is possible that the 2010 material change introduced a foreign materials exclusion (FME) concern. Since then, and solely for those relays manufactured in the USA, the material changed again in November 2014 and was incorporated into the products starting January 2015. The newest version of the actuator board is a molded material that does not contain fiberglass fibers.

Struthers Dunn relays with base part numbers 219, 236, 237, and 255 have the common PCB type fiber board. This fiber board (per the attached Struthers Dunn drawing) was used in relays with date code 1009 through 1452 with or without letter suffix (where the letter indicates made outside of the USA).

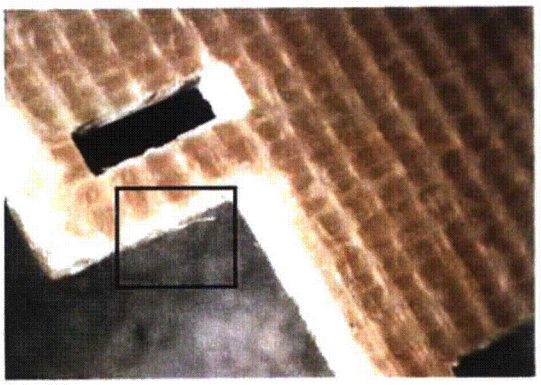
Investigation for Potential Part 21
for
Struthers Dunn Relays



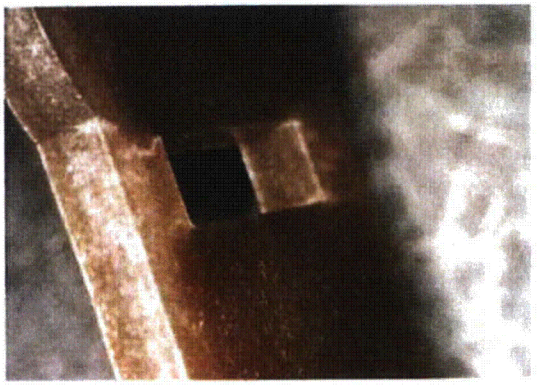
2010-2014 material



USA Manufactured Material starting 2015



Fiberglass Fiber shown in the box



ULTEM 2300 material

Investigation for Potential Part 21
for
Struthers Dunn Relays

Customer Input:

1st 219 series relay failed due to contact issue, considered a random failure & discarded.
2nd 219 series relay failed due to contact resistance & sent to Exelon Power Labs
Five parts from inventory bench tested. One had high resistance & it was sent to Power Labs

Note: All parts provided were 100% functionally tested for contact resistance during dedication process and passed testing at QTNP.

Exelon Power Labs reports on the tested parts are attached herein.

Vendor Input:

Struthers Dunn has, since 2010, experienced only one field complaint (PSE&G) on continuity issues related to fiberglass on these 219 relays. The material change to ULTEM 2300 was considered an ongoing quality/process improvement process to reduce potential defects proactively. Over the four years using this PCB type material, 13,000 relays were sold.

Struthers Dunn has also questioned the application having current below the manufacturer's recommended value of 50mA, requiring bifurcated contacts. Please see their attached report and current product catalog for details.

Recommendation:

The root cause of the failure is inconclusive. Exelon Power Labs said "The irregular contact surface patterns in conjunction with the presence of the embedded fiberglass fibers are the most likely cause of the excessive resistance. This finding is considered to be a manufacturing defect." While the manufacturer sees the failure as a misapplication of its product and that the fiber "was not located at the 'mating point' of the 2 contacts so therefore has no effect on the performance of the contacts or relay".

QualTech NP recommends an application review for the named relays. A review of the Exelon Power Labs reports and the vendor's report should also be completed by the utility to evaluate the impact on the safety function.

5/7/15

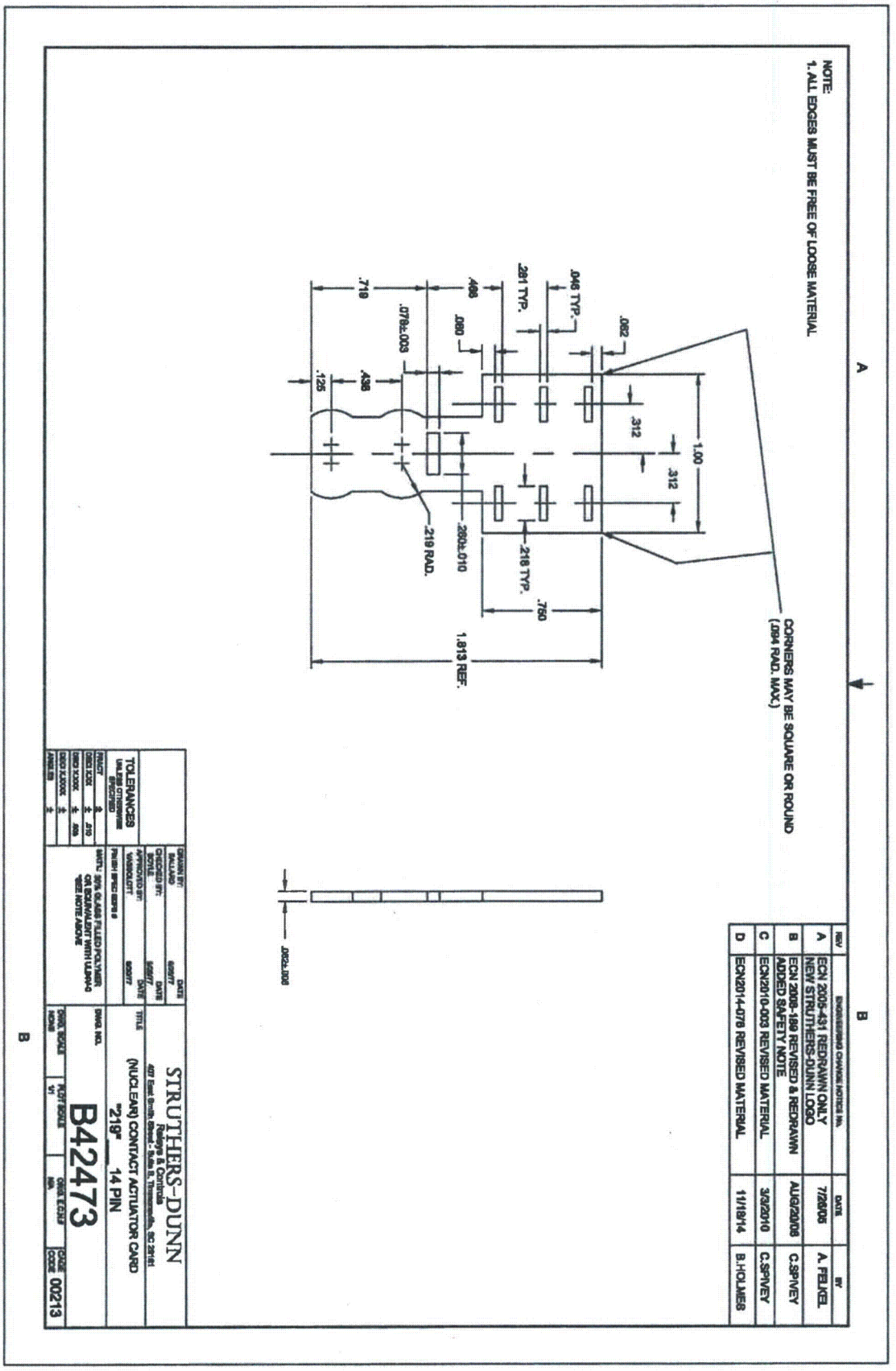
Jeff Troutner — Date
General Manager

5/7/15

Tim Franchuk — Date
Director of Quality Assurance / Safety

QualTech NP, Nuclear Division
Curtiss-Wright Corporation

Investigation for Potential Part 21
for
Struthers Dunn Relays



Relay Sub-component with material changes

Investigation for Potential Part 21
for
Struthers Dunn Relays

Material Change

Struthers-Dunn is committed to ensure quality products through its continuous improvement efforts. Therefore the following products have undergone changes to two parts currently used in the following relay series: 219, 236, 237 and 255. The material change will take affect for all the mentioned relay series that are made in the USA starting January 1st 2015.

A environmental analysis qualification has been done by an accredited company in compliance with 10CFR Part 21, 10 CFR Part 50 Appendix B, ASME NAQA-1, ANSI/ASME N45.2-1977 and IEEE Std. 323-1974.

Daniel Helder
Engineering Manager

Struthers-Dunn, LLC • 407 E. Smith Street, Suite B • Timmonsville, SC 29161 • Phone: (843)346-4427 Fax: (843)346-4460

Investigation for Potential Part 21
for
Struthers Dunn Relays

407B E Smith Street, Timmonsville, SC 29161
Phone: 843-346-4427
Fax: 843-346-4465

Date: April 30, 2015

To: Curtis Wright

Subject: Root Cause Analysis of a 219 Series Relay

Referenced Documents: Exelon PowerLabs PSE-83022, PSE-72352;

S-D Relay Type 219BBXP200
Date code: 1233

To Whom It May Concern,

After further review of the Exelon PowerLabs report, PSE-83022 and PSE-72352, Struthers-Dunn feels it is necessary to clarify any concerns with current and future customers.

Struthers-Dunn can make the following systematic conclusions of the failure analysis by Exelon PowerLabs' mentioned reports regarding the failure of a 219 series relay:

Although the situation addressed in this report was the fiber on the contact, Struthers-Dunn cannot agree with the failure mode due to the fact that Struthers-Dunn wasn't able to verify the relay had all the required adjustments (contact pressure, over-travel, etc.) after the incident happened. This is also the first time Struthers-Dunn was notified by any customer of a failed 219 relay with a claimed failure due to fiberglass on the contacts.

The exact root cause in this report points to the fiber being embedded in the contact. However, without knowing whether this fiber being embedded happened while being manufactured or was introduced while the relay was in operation, we cannot give an exact root cause. Although a fiberglass fiber was found on the contact it was not located at the "mating point" of the 2 contacts so therefore has had no effect on the performance of the contacts or relay.

Struthers-Dunn believes this fiber could be from the previous actuator card material. Due to our continuous process improvement done to the 219/236/237/255 production line from 2012 to 2014, we added a new ionized air gun to clean the relays and neutralize any static charge, which can attract dust and particles that could possibly adhere to the relay blades and contacts. The last step of our improvement efforts was the elimination of any potential source contamination inside the relay which resulted in producing the actuator card with a different material.

The actuator card had been previously constructed from a fiberglass composite material (between March 2010 and December 2014). But now we have switched to a new and better material, ULTEM 2300. On the previous material the actuator card was stamped out of a fiberglass sheet. Where the current actuator card is being injection molded and does not have any edges that could have potential fibers breaking off. In order to keep our nuclear grade rating of this relay family series we contracted Curtiss-Wright to do an environmental analysis qualification in compliance with 10 CFR Part 50 Appendix B, ASME NAQA-1, ANSI/ASME N45.2-1977 and IEEE Std. 323-1974. As of January 1st 2015 all U.S. manufactured 219 family relays are manufactured with the upgraded actuator card.

Furthermore, the PSEG application described in which the 219 relay was used had a load between 16 to 20mA @ 125VDC. This indicates the current being switched is below our specified minimum of 50mA for non-bifurcated contacts. Struthers-Dunn advises any customer to use bifurcated contacts to switch any current below the mentioned 50mA level. At this time Struthers-Dunn is testing to find out the exact minimum load level for bifurcated contacts, however it would certainly handle PSEG's stated load of 16 to 20mA @ 125VDC. Our current estimation is 10mA@48VDC but we will not publish that information until the testing confirms our findings.

In conclusion, Struthers-Dunn cannot pinpoint the exact mode of failure of this relay, due to the fact that there were various fundamental errors in the application by the customer and in the failure analysis by PowerLabs.

Daniel Helder
Engineering Manager

David Moore
President

David Mioduski
Product Marketing Manager

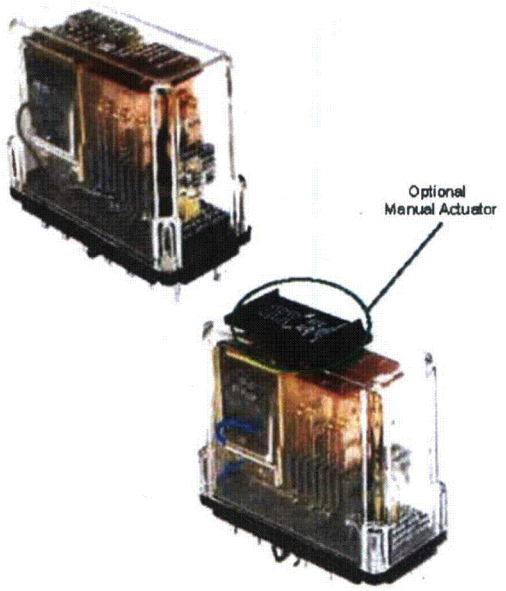
219 Series - Industrial Relays
DPDT, up to 6PST, 10 Amps

File No. E13224

Versatile. Rugged. Proven. These are but a few words used by customers to describe the 219 series. When long life and cost of down time / service are important the 219 solves the problem. It's a standard throughout industrial applications which many other relays are measured against. Capable of up to four poles double throw or six poles single throw. Contact arrangements are easily customized for special applications. NUCLEAR versions are available that utilize special platings and materials to minimize wear. All 219s are built with materials that meet the UL 94-V0 requirements.

GENERAL SPECIFICATIONS (@ 25° C)

Contacts:	
Contact Configuration	Up to 4PDT or 6PST
Contact Material	Silver Alloy-Gold Diffused
Contact Rating	
120 / 240VAC Resistive	10 Amp / 5 Amp
28VDC Resistive	10 Amp
Contact Resistance, Initial	50 milliohms max @ 6vdc
Coil:	
Coils Available	AC and DC
Nominal Coil Power	AC 5VA DC 1.8-2.5W
Input Voltage Tolerance - AC	85% to 110% of nominal
Input Voltage Tolerance - DC	80% to 110% of nominal
Drop-out voltge	10% of nominal
Duty	Continuous
Timing:	
Operate Time (max)	25 mS
Release Time (max)	20 mS
Dielectric Strength:	
Across Open Contacts	500Vrms
Between mutually insulated point	1500Vrms
Insulation resistance	1,000 Mohms min @ 500VDC
Temperature:	
Operating	AC = -20 to 60°C (-4 to 140°F) DC = -20 to 70°C (-4 to 158°F)
Storage	-40 to 105°C (-40 to 221°F)
Life Expectancy:	
Electrical (full load)	100,000
Mechanical (no load)	10,000,000
Miscellaneous:	
Mounting Position	Any
Enclosure	Clear Polycarbonate
Weight	8.5oz (241 grams)
Mating socket	12 PIN: 27390 (D)
(UL Listed when used)	14 PIN: 33377 (D)
	(D) is option for DIN Rail Mount



General Purpose Relays

Ordering Code 219 XBX PL -24VDC

Series
219

Contact Arrangement
XBX (DPDT)
ABA (1 Pole N.O. + DPDT + 1 Pole N.C.)
BBX (2 Pole NO & DPDT)
XDX (4PDT)
FXX (6 Pole-NO)
DXB (4 Pole - NO & 2 Pole-NC)

Optional Features
Permanent Magnet Blowout - CODE 69
Polycarbonate covers - CODE P
Indicator Lamp - CODE L
Manual Actuator - CODE M
Bifurcated Contacts - CODE 33

Coil Voltage
AC: 12, 24, 120, 240, (Add VAC)
DC: 6, 12, 24/28, 32, 48, 115/125, 250 (Add VDC)

Coil voltages and frequencies must be specified

UL Contact Load Ratings Table

Contact Configuration	Current	Load Voltage	Load Frequency Voltage	Type of Load
All Styles EXCEPT Code 33	10 Amp	120 VAC	50/60Hz	RESISTIVE
	5 Amp	240 VAC	50/60Hz	RESISTIVE
	10 Amp	28 VDC	DC	RESISTIVE
	0.5 Amp	125 VDC	DC	RESISTIVE
	3 Amp	120 VAC	50/60Hz	INDUCTIVE
	1 Amp	240 VAC	50/60Hz	INDUCTIVE
	3 Amp	28 VDC	DC	INDUCTIVE
	0.1 Amp	125 VDC	DC	INDUCTIVE

Use Code "69" for blowout magnet when switching voltages above 40VDC. (NOT UL OR CSA APPROVED)

Contact Configuration	Current	Load Voltage	Load Frequency Voltage	Type of Load
Single Make	1.5 Amp	125VDC	DC	RESISTIVE
Double Make	4 Amp	125VDC	DC	RESISTIVE
Single Make	0.5 Amp	250VDC	DC	RESISTIVE
Double Make	1.5 Amp	250VDC	DC	RESISTIVE
Single Make	0.5 Amp	125VDC	DC	INDUCTIVE
Double Make	1.5 Amp	125VDC	DC	INDUCTIVE
Single Make	150 mA	250VDC	DC	INDUCTIVE
Double Make	0.5 Amp	250VDC	DC	INDUCTIVE

Use Code "33" for bifurcated contacts when switching low level current below 50mA.

219 Coil Specifications

AC Coils, 50/60HZ

Nominal voltage	Resistance ohms ±10%	Milliamperes Cold	Milliamperes Hot	Impedance ohms
6	1.1	1500	840	7.2
12	4.2	750	410	27
24	15.5	375	200	120
120	540	75	40	2,700
240	2100	32	17	13,400

DC Coils

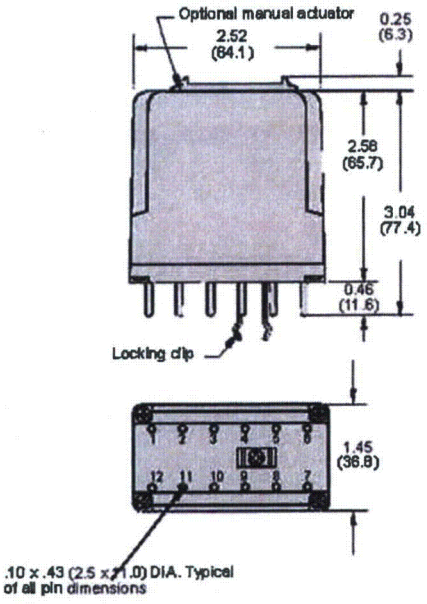
Nominal voltage	Resistance ohms ±10%	Milliamperes Cold	Milliamperes Hot
6	15.5	385	304
12	63.5	189	147
24 /28*	250	96	77
32	375	86	62
37.5	375	100	80
48	975	49	39
115/125*	6200	20	16
250	27777	9	7

Note: Stock 24VDC and 115VAC relays have nameplates stamped 24/28VDC and 115/125VAC respectively. These relays operate at 80% of the lower voltages and operate within allowable temperature rises at higher voltages.

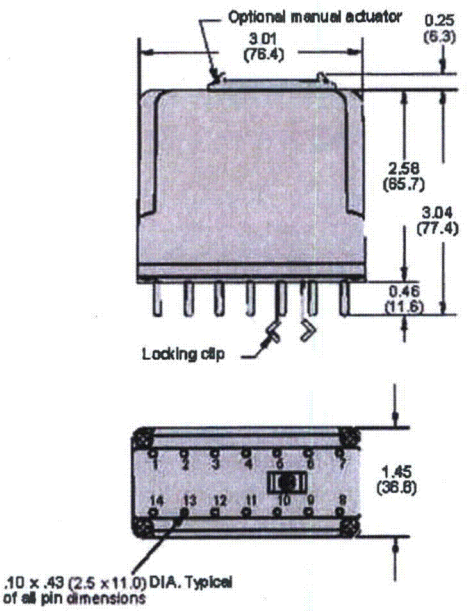
219 Series - Industrial Relays
DPDT, Up To 6PST, 10 Amps

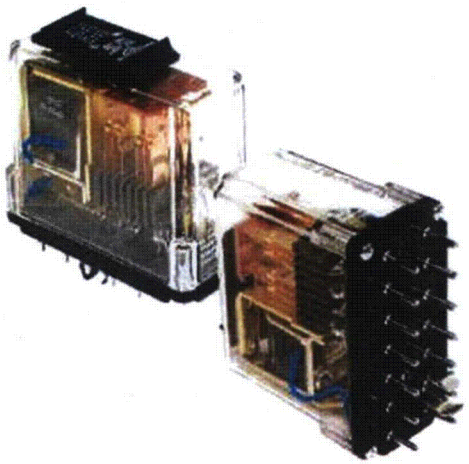
Outline Dimensions
Dimensions Shown in Inches & (millimeters)

12 Pin Plug-in



14 Pin Plug-in

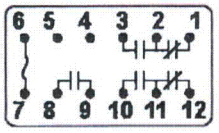




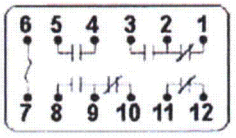
General Purpose Relays

219 Wire Diagram
(Top View) 12-Pin

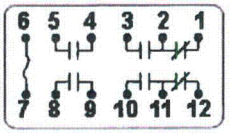
219ABX
(SPST-N.O. + DPDT)



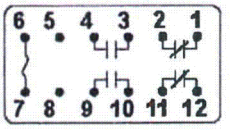
219ABA
(DPDT+SP-NO+1P-NC)



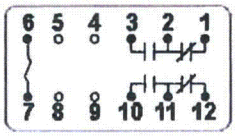
219BBX
(DPDT+2P- N.O.)



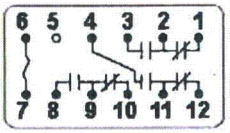
219BXB
(DPDT+2P- N.O.)



219XBX
(DPDT)



219XCX
(3PDT)



Many additional contact combinations and wiring schematics are available. Contact sales with requirements.

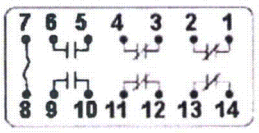
Standard Diode Suppression Wiring
(applies to relays with option "V", alternative polarity/wiring is also available as a special)

(12-Pin)

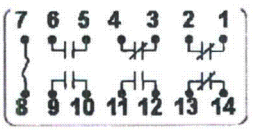
219 Wire Diagram
(Top View) 14-Pin

(14-Pin)

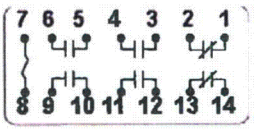
219BXD
(2P-NO+4P-NC)



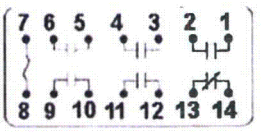
219CXC
(3P-NO+3P-NC)



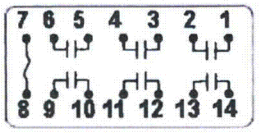
219DXB
(4P-NO+2P-NC)



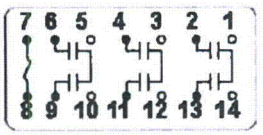
219EXA
(5P-NO+1P-NC)



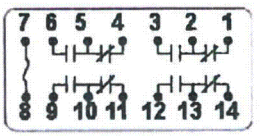
219FXX
(6P-NO)



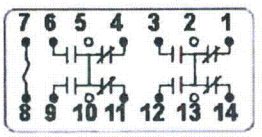
219KXX
(3PST-DM)



219XDX
(4PDT)



219XJX
(DPDT-DM/DB)



UL LISTED when used with mating sockets
27390 for 12 pin or 33377 for 14 pin

www.struthers-dunn.com (843) 346-4427

1/10

Investigation for Potential Part 21
for
Struthers Dunn Relays

Exelon Power Lab Report

PSE-72352 (20 pages)

Exelon Generation Exelon PowerLabs

To: **Bryan Ohmert, (856) 339-2949, PSEG-Nuclear**

From: **Lance Walls, 610-380-2309 lance.walls@exelonpowerlabs.com**

Project: **PSE-72352**

Subject: **Failure Analysis of a Relay**
Manufacturer: Struthers Dunn **Model: 219BBX200**
Stock Code/Cat ID: X400405 **Purchase Order No.: 4500850488-0**
Quantity Received: 1 **Qualtech Tag#: CJ358602-05**

Date: **19 March 2015**

STATION DESCRIPTION OF PROBLEM

The relay had been installed in service for 6 months at the time of the failure. The failure mode was a consistently excessive (> 1 ohm) and erratic resistance on contact set 8-9. The expected resistance was < 1 ohm.

CONCLUSIONS

The station observation of excessive resistance on the 8-9 contact was verified and duplicated via the testing performed at PowerLabs.

The relay was received free of any thermal, mechanical, or electrical damage, and the only deficiency identified during the functional testing was that of the excessive contact of the 8-9 contact. The 8 and 9 contacts were harvested from the relay for further examination. Both contact surfaces exhibited striation patterns that resembled scratch marks. The marks on the contact 9 surface being more widespread and conspicuous than that of the contact 8 surface.

SEM/EDS Analysis of both contacts revealed the presence of Gold, Copper, and Nickel, with the Nickel being of unknown origin. The 8 contact had the presence of the striation patterns, which are not thought to be due to normal wear through make/break operations and wiping action. The 9 contact surface was comprised of Gold and Copper and also had the striation patterns, but additionally had the presence of several fiberglass strands that were embedded into the contact surface, as opposed to being surface contamination. The fact that they were embedded suggests that they were present during the surface plating process during manufacturing. There were other cavities on the contact surface that were similar in appearance, which increases the likelihood that there were other fibers present at one time, but became disassociated via contact make/break operations. The irregular contact surface patterns in conjunction with the presence of the embedded fiberglass fibers are the most likely cause of the excessive resistance. This finding is considered to be a manufacturing defect.

COMMENTS AND RECOMMENDATIONS

No additional comments or recommendations.

REQUIREMENTS

If it is determined that a high resistance condition exists, determine the cause of the failure.

TEST PLAN

1. Document Nameplate Data
2. As Received Condition
3. Functional Testing
4. Disassembly / Analysis
5. Material Analysis (if necessary)
6. Discovery

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.

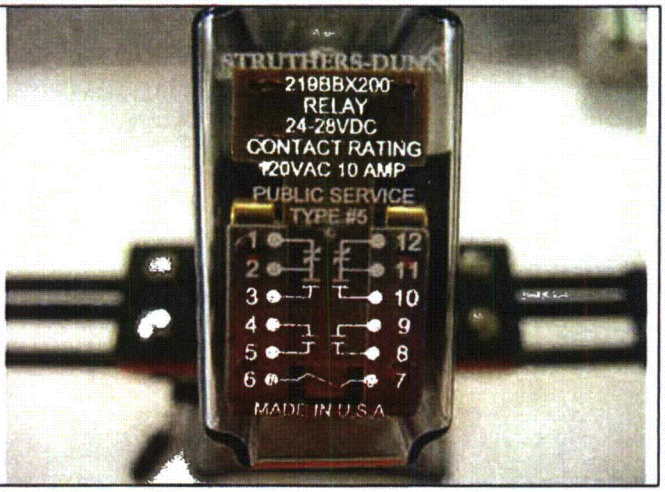
Technician(s): Lance Walls

Prepared by:	*Lance T. Walls*	*18 March 2015*
	Sr. Engineer	Date
Reviewed by:	*Joseph P. Mulcahy*	*18 March 2015*
	ANSI Level III	Date
Approved by:	*Lance T. Walls*	*19 March 2015*
	Sr. Engineer	Date

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

OBSERVATIONS AND DATA

1.) Document Nameplate Data

Photograph 1: Nameplate Data I **Manufacturer:** Struthers-Dunn **Model#:** 219BBX200 **Coil Voltage:** 24 – 28 VDC **Contact Rating:** 120 VAC, 10 A **N.C. Contacts:** 1-2 and 11-12 **N.O. Contacts:** 2-3, 4-5, 8-9, and 10-11 **Date Code:** 1233 (Not shown in photo)	

Photograph 2: Nameplate Data II **QualTech NP Tag#:** CJ358602 **QualTech NP S/N:** 05 **PSEG PO#:** 4500790578	

2.) As Received Condition

Photograph 3: As Received Condition

- There was no outward indication of any thermal, mechanical, or electrical damage.
- All soldered connections on the pins and contact block were microscopically examined and were verified as being acceptable.
- There was no indication of any arcing on any of the pins. There were only expected wear marks present that were associated with routine insertion / desertion operations.
- Manual manipulation of the assembly yielded no indication of the presence of free-moving or loose internal components or foreign material.
- There was no indication of coil outgassing on the internal surface of the case.
- There were no findings or observations that prohibit energized testing.

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3.) Functional Testing

Pre-Energization Tests (As-Received)

Measured Parameter	Measurement	Comment
Coil Resistance	254.4 Ω (Cold)	Reasonable per OEM spec. of 1.8 – 2.5 W
N.C. 1-2	16.3 mΩ	Acceptable
N.O. 2-3	> 500 MΩ	Expected in de-energized state
N.O. 4-5	> 500 MΩ	Expected in de-energized state
N.O. 8-9	> 500 MΩ	Expected in de-energized state
N.O. 10-11	> 500 MΩ	Expected in de-energized state
N.C. 11-12	9.6 mΩ	Acceptable

All of the static measurements in the de-energized state were acceptable or expected.

Energized Testing

Coil Characteristics

Measured Parameter	Measurement	Comment
Pickup Voltage	13.3 VDC (Cold)	Less than OEM-specified 80%
Current at Pickup	54 mA DC	Not specified by OEM. For information only
Sealed Current @ 24 VDC	94 mA DC	Not specified by OEM. For information only
Sealed Current @ 28 VDC	107 mA DC	Not specified by OEM. For information only
Coil Watts @ 24 VDC	2.26	Slightly greater than OEM-specified 1.8 W
Coil Watts @ 28VDC	3.00	Slightly greater than OEM-specified 3.0 W
Dropout Voltage	6.1 VDC	Greater than OEM-Specified 10% of nominal

The only reading that exceeded the OEM specification was that of dropout voltage.

Contact Resistance

Measured Parameter	Measurement	Comment
N.C. 1-2	> 500 MΩ	Expected in energized state
N.O. 2-3	9.4 mΩ	Acceptable
N.O. 4-5	9.5 mΩ	Acceptable
N.O. 8-9	**230 mΩ - 1.7 Ω**	**The station observation of excessive contact resistance was verified**
N.O. 10-11	12.3 mΩ	Acceptable
N.C. 11-12	> 500 MΩ	Expected in energized state

The station observation of excessive contact resistance with N.O. set 8-9 was duplicated, although the excessive resistance was not radically excessive.

Pickup Time

Pickup Times (3 iterations)	Comment
19.6 ms, 19.3 ms, and 20.0 ms	Less than OEM specified 25 ms

Release Time

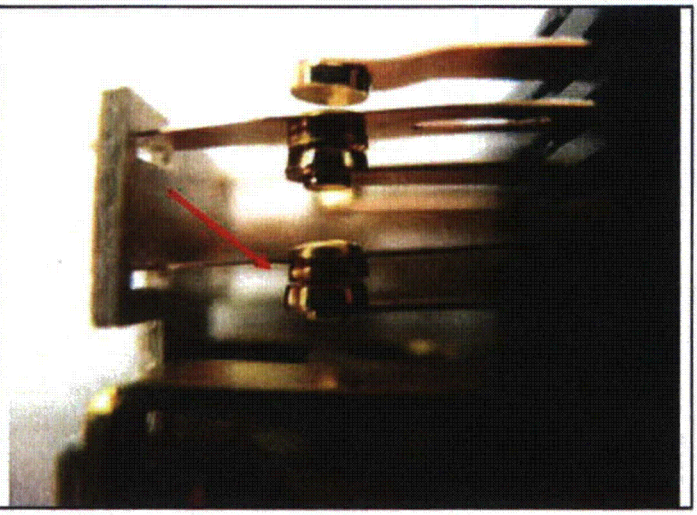
Release Times (3 iterations)	Comment
10.1 ms, 10.1 ms, and 9.9 ms	Less than OEM specified 20 ms

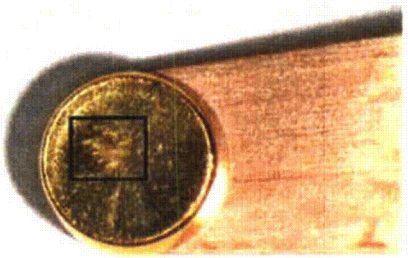
There was no indication of binding or sluggish armature movement with either the pickup or dropout movements.

The only anomalous observation / test result gleaned through both the de-energized and energized testing was that of the excessive and erratic closed contact resistance measurement associated with normally open contact 8-9.

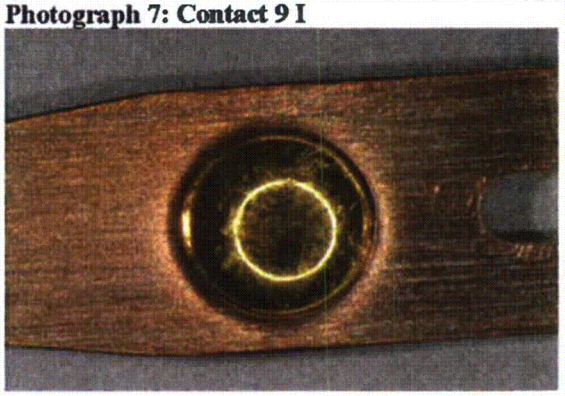
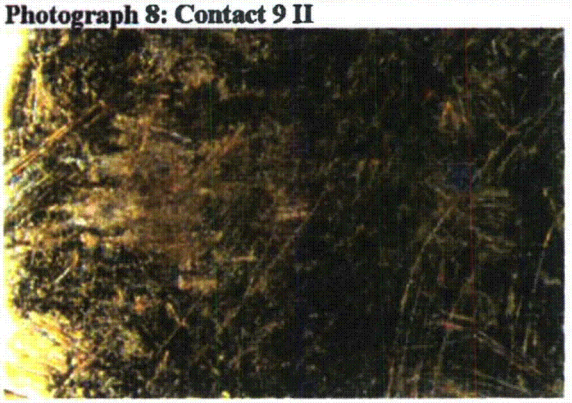
The focus of the balance of the analysis was placed upon N.O. contact 8-9.

4.) Disassembly / Analysis

Photograph 4: 8-9 Contact Connection The arrow in this photograph points to the closed 9-9 contact set. They were viewed via stereomicroscope ad there was clear surface – surface engagement in the approximate center areas, with no air gapping observed.	

Photograph 5: Contact 8 I	Photograph 6: Contact 8 II
	
The surface of the 8 contact exhibited pronounced striations in the approximate center of the area. They had the appearance of multiple scratch marks in close proximity and in parallel orientation to one another.	A closer view of the boxed area of photograph 5.

Contact 9

Photograph 7: Contact 9 I	Photograph 8: Contact 9 II
	
The surface of the 9 contact also had the striation marks that were observed with contact 8, although they were widespread and severe in nature. They appeared to be random and numerous scratch marks.	A closer view of the boxed area of photograph 7.

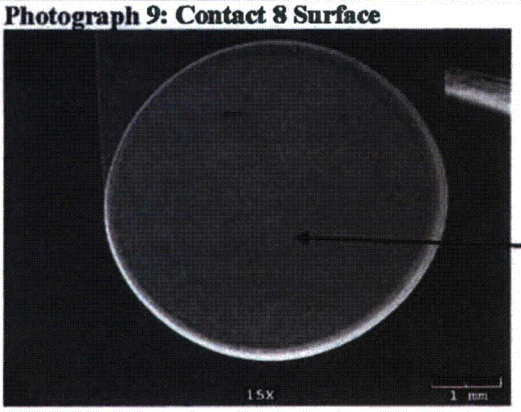
The striation / scratch marks observed with both the 8 and 9 contact surfaces are not a normal or expected observation with contacts that have not been mechanically burnished. Mechanically burnishing will produce scratched surface marks due to the inherent cleaning process, however it is not believed that either of these contacts were burnished.

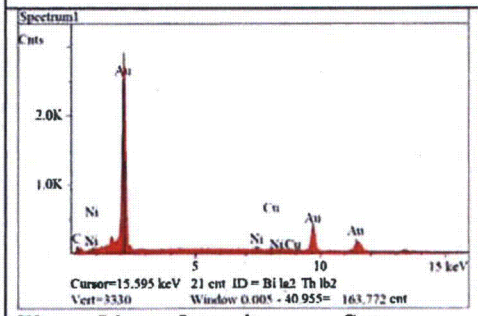
5.) Material Analysis

Both contacts were examined with high magnification and for elemental constitution via SEM / EDS analysis (Scanning Electron Microscope / Energy Dispersive x-ray Spectroscopy).

Contact 8

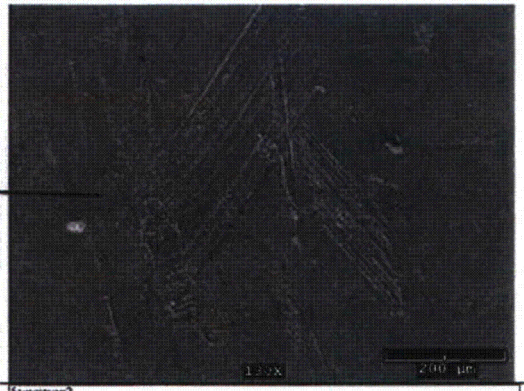
Photograph 9: Contact 8 Surface

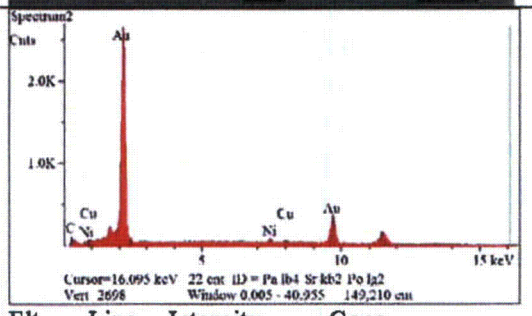




Elt.	Line	Intensity	Conc
Ni	Ka	5.21	0.877 wt.%
Cu	Ka	2.98	0.619 wt.%
Au	La	65.36	98.503 wt.%

Photograph 10: Contact 8 Surface – Center Area





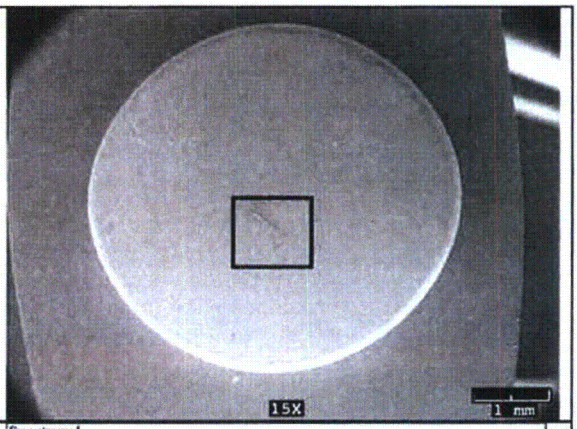
Elt.	Line	Intensity	Conc
Ni	Ka	6.37	1.055 wt.%
Cu	Ka	4.77	0.976 wt.%
Au	La	66.01	97.969 wt.%

Photograph 10 exhibits the striation patterns that were present on the contact 8 surface. Again, these patterns are not a typical wear pattern observed relay contact make/break or wipe operations. Gold was primary elemental constituent in both snapshots, with similar concentrations of Nickel and Copper in both.

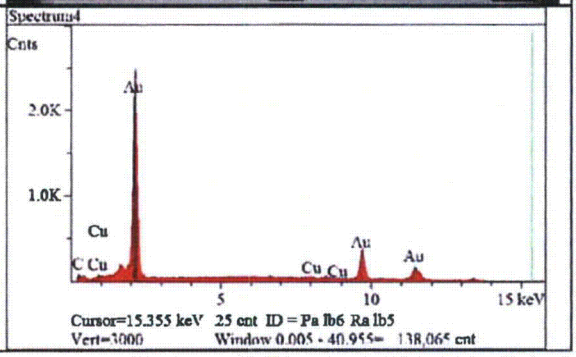
Contact 9

Photograph 11: Contact 9 Surface

The contact 9 surface had the striation patterns present both in the contact center area and away from the center area. Gold was the primary constituent, and the presence of Copper was also detected. No Nickel was detected. The boxed area will be better explained in photographs 12 and 13.



Elt.	Line	Intensity	Conc	Units
Cu	Ka	2.42	0.573	wt.%
Au	La	58.07	99.427	wt.%



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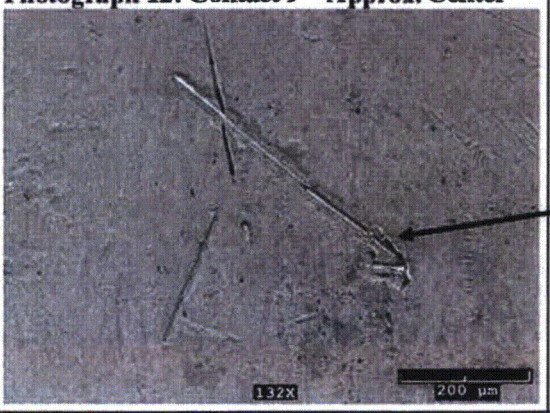
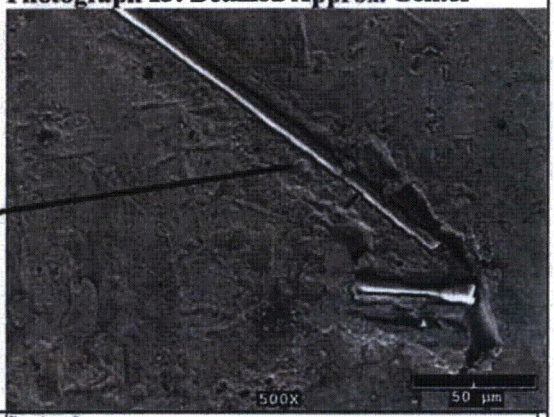
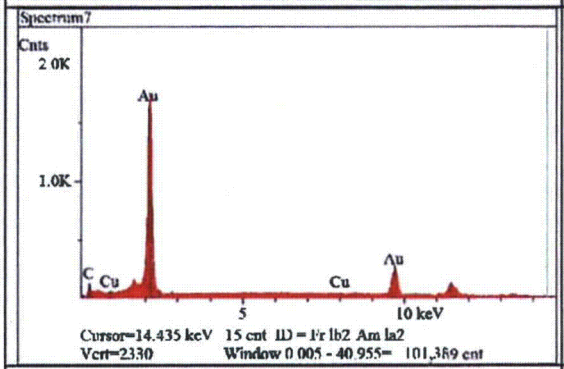
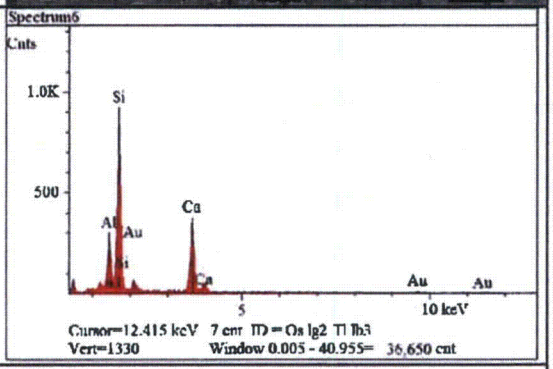
Photograph 12: Contact 9 – Approx. Center



Photograph 13: Detailed Approx. Center







Elt.	Line	Intensity	Conc	
Cu	Ka	2.17	0.508	wt.%
Au	La	58.66	99.492	wt.%

The embedded fibers shown in this photograph were primarily made up of Silicon, Aluminum, and Calcium. This is consistent with Fiberglass.

The embedded fibers in the contact surface, which are exhibited in photographs 12 and13 had an elemental composition consistent with Fiberglass. The fact that they are embedded into the surface of the contact suggests that they were present at the time of manufacture when the surface was coated. The presence of other similar cavities into the contact surface may suggest that there were other fiberglass fibers present at one time, but that they became disassociated due to contact make / break operations. The irregular patterns in the contact surfaces and the presence of the fiberglass fibers in the approximate center of contact 9 are the most likely cause of the excessive resistance.

6.) Discovery

There were no additional items of discovery.

Exelon Power Lab Report

PSE-830222 (7 pages)

Exelon Generation. Exelon PowerLabs

To: **Joseph Thompson, (856) 339-1177, PSEG Nuclear**

From: **Michael Minicozzi, 610-380-2427**
Michael.Minicozzi@exelonpowerlabs.com

Project: **PSE-83022**

Subject: **Scanning Electron Microscope Examination of Relay Contacts**
Manufacturer: Struthers-Dunn **Model:** 219BBX200
Purchase Order No.: 4500850488-1
Quantity Received: 2

Date: **4/15/15**

DESCRIPTION

Highly Magnified Examination of All Contacts in an Effort to Determine if Foreign Material and / or Manufacturing Defects Exist.

Site Information:
Due to the issues identified under notification 20682668, all of the existing stock associated with X400405 Struthers Dunn relay purchased from Qualtech as part number 219BBX200 has been placed in blocked stock.

To provide an adequate replacement relay for the failed relay in 21CFCU, 2 of the 5 relays purchased under PO 4500850435 have been sent to power labs to assure the sample and by extrapolation the entire batch is free from FM concerns.

CONCLUSIONS

All contacts from both relays were harvested and examined under the Scanning Electron Microscope.

Relay 1 displayed one contact (#2 N/O) with one piece of embedded foreign material (consistent with fiberglass). Similar to what was discovered under PowerLabs project PSE-72352. All the other contacts from Relay 1 did not contain any foreign material, but revealed scratches on the contact surface.
All contacts for Relay 2 revealed scratches on the contact surface, but no embedded foreign material was observed.

Investigation for Potential Part 21
for
Struthers Dunn Relays

TEST PLAN

1. Document Nameplate Data
2. Harvest contacts from Both Relays
3. Highly Magnified Examination (Scanning Electron Microscopy) of all contacts in an effort to determine if foreign material and / or manufacturing defects exist.

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): Lance Walls, Michael Minicozzi

Reviewed by:	*Lance Walls*	*4/15/15*
	ANSI Level III / Sr. Engineer	Date
Approved by:	*Michael Minicozzi*	*4/15/15*
	ANSI Level III / Sr. Engineer	Date

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

OBSERVATIONS AND DATA

1.) Document Nameplate Data

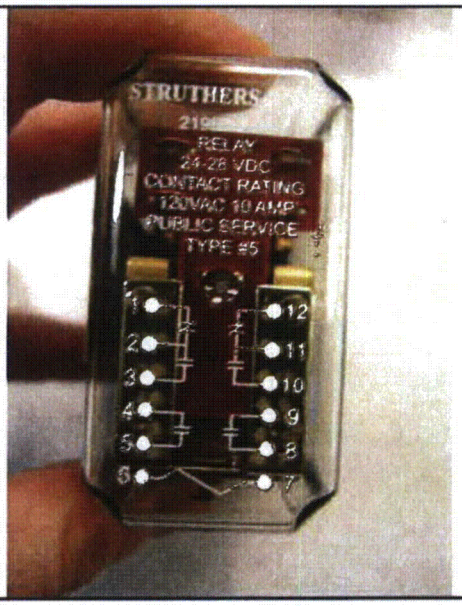
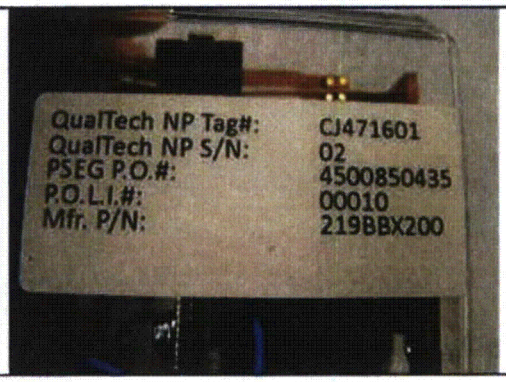
Photo 1: Nameplate Data I – Relay 1 **Manufacturer:** Struthers-Dunn **Model#:** 219BBX200 **Coil Voltage:** 24 – 28 VDC **Contact Rating:** 120 VAC, 10 A **N.C. Contacts:** 1-2 and 11-12 **N.O. Contacts:** 2-3, 4-5, 8-9, and 10-11	
Photo 2: Nameplate Data II – Relay 1 **QualTech NP Tag#:** CJ471601 **QualTech NP S/N:** 02 **PSEG PO#:** 4500850435	

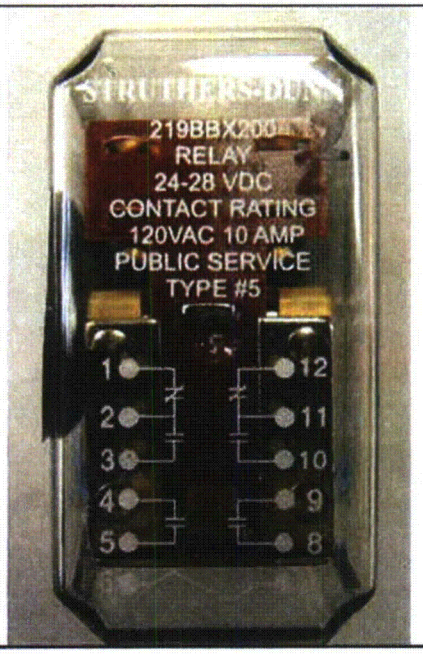
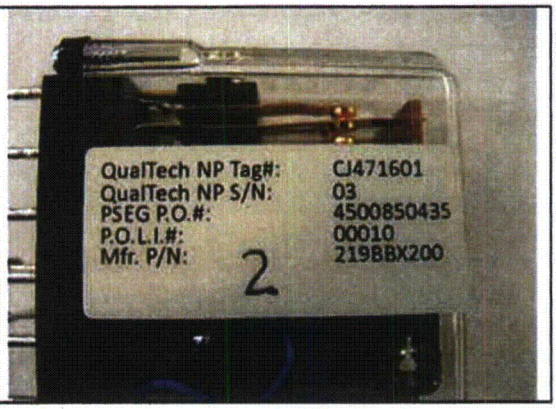
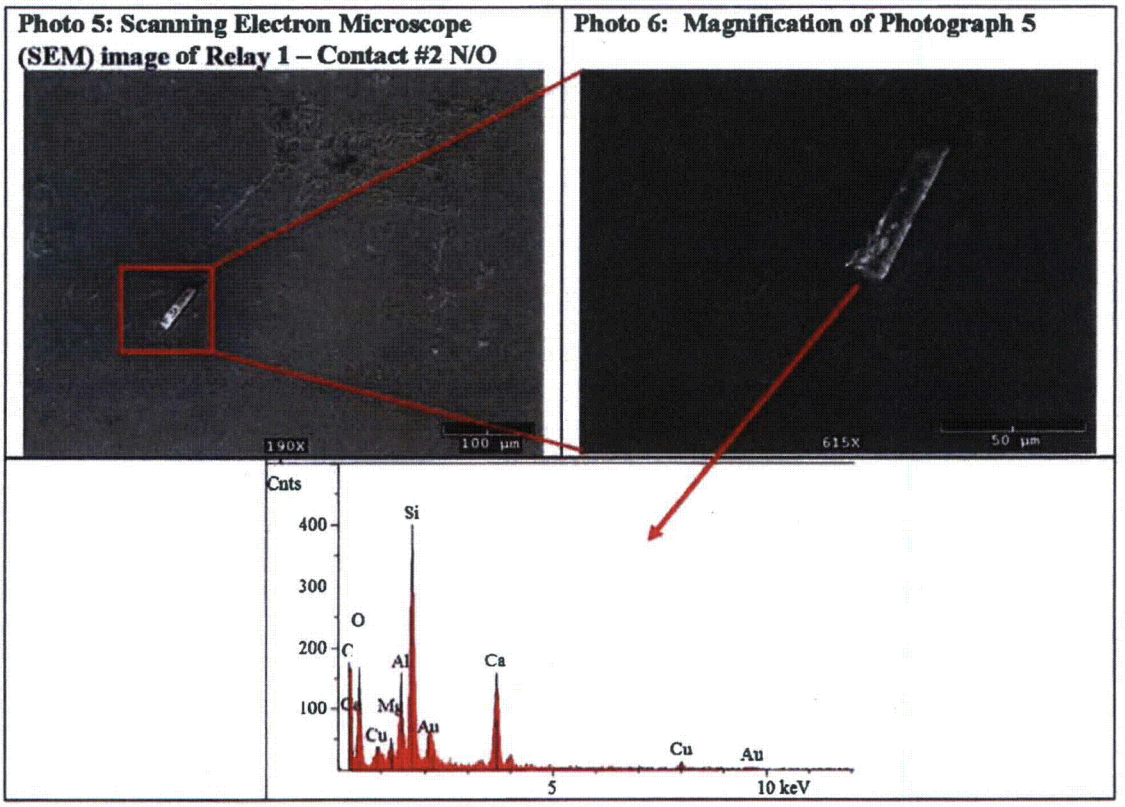
Photo 3: Nameplate Data I – Relay 2 **Manufacturer:** Struthers-Dunn **Model#:** 219BBX200 **Coil Voltage:** 24 – 28 VDC **Contact Rating:** 120 VAC, 10 A **N.C. Contacts:** 1-2 and 11-12 **N.O. Contacts:** 2-3, 4-5, 8-9, and 10-11	

Photo 4: Nameplate Data II – Relay 2 **QualTech NP Tag#:** CJ471601 **QualTech NP S/N:** 03 **PSEG PO#:** 4500850435	

2. and 3.) Harvest Relay Contacts and Perform Scanning Electron Microscopy of the contact surfaces

Photo 5: Scanning Electron Microscope (SEM) image of Relay 1 – Contact #2 N/O

Photo 6: Magnification of Photograph 5



Embedded foreign material was observed on the #2 N/O contact surface. The embedded foreign material in the contact surface had an elemental composition consistent with fiberglass shown in the Energy Dispersive Spectroscopy spectrum shown above (Primary constituents are Si, Ca, Al, O).

Photo 7: SEM image, Relay 1, Contact #10 N/O

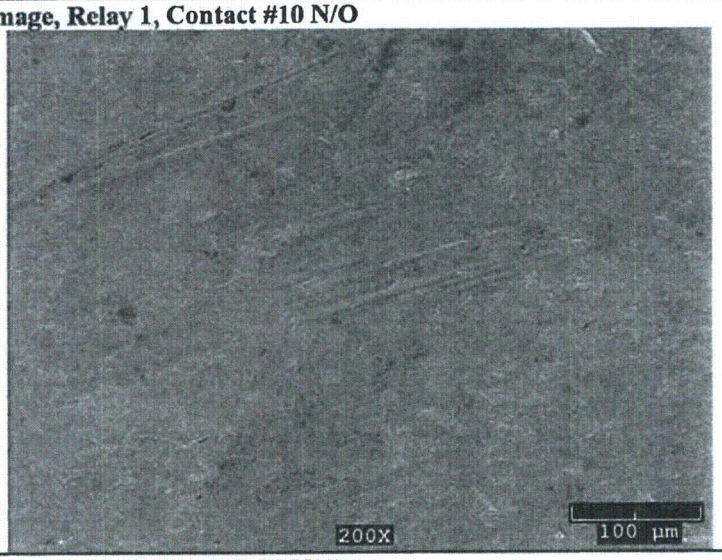
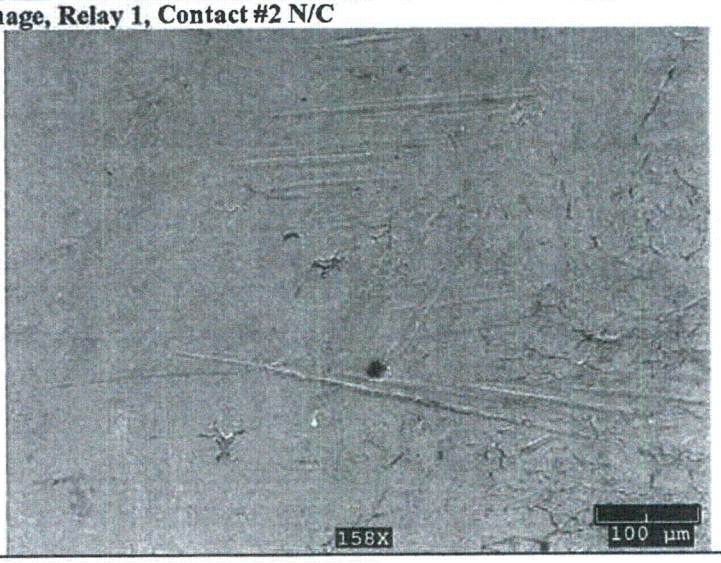


Photo 8: SEM image, Relay 1, Contact #2 N/C



The photographs above are representative of the remaining contact surfaces examined from Relay 1. All the other contact surfaces did not contain any foreign material, but revealed scratches on the contact surface.

Photo 9:SEM image, Relay 2, Contact #10 N/O

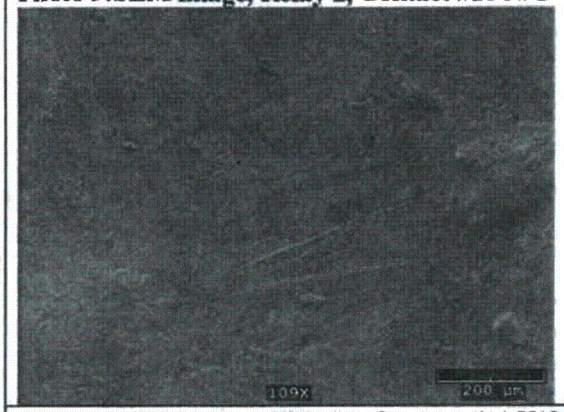


Photo 10:SEM image, Relay 2, Contact #9 N/O

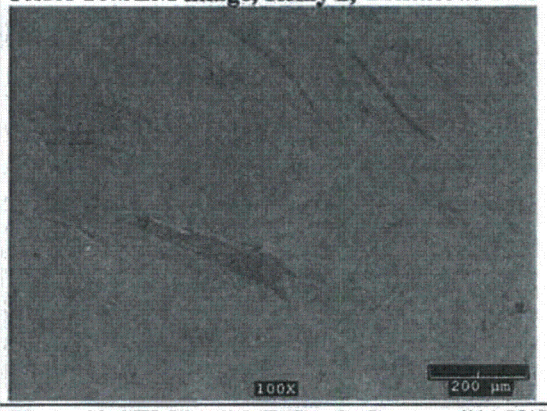


Photo 11:SEM image, Relay 2, Contact #11 N/O

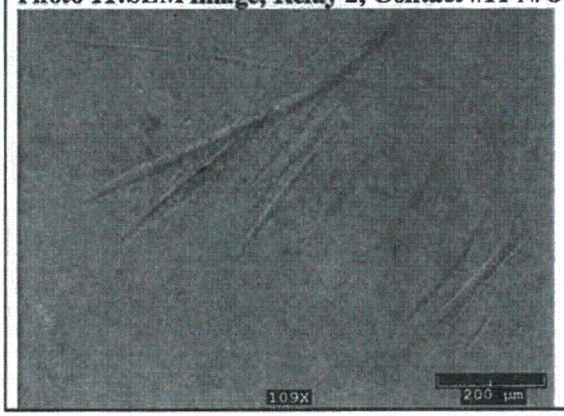
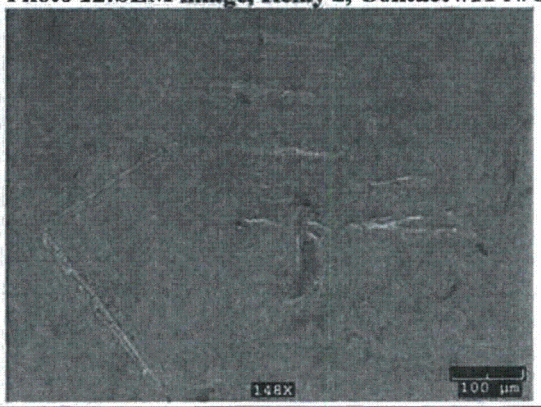


Photo 12:SEM image, Relay 2, Contact #11 N/C



The photographs above are representative of the contact surfaces examined from Relay 2. All of the contact surfaces did not contain foreign material, but revealed scratches on the contact surface.