Westinghouse Electric Company
1000 Westinghouse Drive
Cranberry Township, Pennsylvania 16066
USA

U.S. Nuclear Regulatory Commission
Document Control Desk
11555 Rockville Pike
Rockville, MD 20852

Attn: Jeffrey Jacobson

Direct tel: (412) 374-2577
e-mail: zozulact@westinghouse.com

LTR-NRC-19-59

September 24, 2019

Subject: NSAL-19-2 Revision 0, "Contactors Failing to Release/Open When De-energized"

Westinghouse evaluated the A200 and Freedom Sizes 1-4 contactors in its Part 21 Program. Because the contactors are used in a variety of applications at each plant, Westinghouse was unable to make a judgement concerning a defect, as defined in 10 CFR 21. Therefore, NSAL-19-2 transfers the Part 21 scope to the affected plants.

As requested, the NSAL is included in this letter.

Camille T. Zozula, Secretary
Westinghouse Safety Review Committee

Attachment

Westinghouse

Nuclear Safety Advisory Letter

This is a notification of a recently identified potential safety issue pertaining to basic components supplied by Westinghouse.
This information is being provided so that you can conduct a review of this issue to determine if any action is required.

1000 Westinghouse Drive, Cranberry Township, PA 16066

Subject: **Contactors Failing to Release/Open When De-energized**	Number: **NSAL-19-2**
Basic Component: A200 Size 1-4 and Freedom Size 1-4 Contactors	Date: August 28, 2019
Substantial Safety Hazard or Failure to Comply Pursuant to 10 CFR 21.21(a) Transfer of Information Pursuant to 10 CFR 21.21(b) Advisory Information Pursuant to 10 CFR 21.21(d)(2)	Yes ☐ No ☐ N/A ☐ Yes ☒ Yes ☐

SUMMARY

This NSAL contains operating experience that should be evaluated for potential impact on installed contactors.

In May 2018 Westinghouse was notified of a Size 1 Freedom series contactor, used in a Full Voltage Non-Reversing (FVNR) application, which failed to open when de-energized. The initial failure analysis results were inconclusive; however, the plant performed an extent of condition by cycling all their potentially impacted FVNR contactors. In December 2018 the extent of condition cycling was completed and a total of 5 additional contactors failed to open when de-energized. All 6 Freedom series contactors that failed to open were energized continuously for 1 year or more before being de-energized.

The failed units were returned to Westinghouse for detailed analysis and testing to determine the cause of the failure. Westinghouse replicated the failure mode and simulated the installed operating conditions, which aided in identifying the source of the failure. More specifically, an organic material used in a subcomponent of the contactor was found to migrate between the internal mating surfaces, causing them to bond.

Additional information, if required, may be obtained from Dave Lucas, (724) 722-6008

Author:
*William J. Smoody
Licensing

Author:
*David C. Lucas
Electro-Mechanical Products

Verifier:
*Adam E. Tokar
Electro-Mechanical Products

Manager:
*Camille T. Zozula
Licensing

*Electronically approved records are authenticated in the electronic document management system.

Westinghouse has only been notified of this failure mode for Freedom Size 1 series contactors from one end user, however, this issue has been reported (References 1 & 2) on A200 contactors by other suppliers. Based on this and the similarity in designs (same organic materials used in Freedom and A200 products), components from both product families were included in the Westinghouse extent of condition testing. While Westinghouse included the A200 product family in the extent of condition testing, Westinghouse has not received any reports of Westinghouse provided A200 components failing to de-energize. The results of the testing concluded that both Freedom and A200 contactors were found to be susceptible to this failure mode.

Westinghouse has worked with the commercial equipment supplier (Eaton) on a design change to the affected products to reduce the content of the organic material in future production. Westinghouse performed testing to validate the changes and is in the process of revising procedures and inspections to prevent recurrence of this problem. Eaton is phasing out the use of the existing material with the organic coating in commercial applications, but a final cut-over date has not been established.

ISSUE DESCRIPTION

Freedom series and A200 series size 1 through 4 contactors may not open properly after being continuously energized for an extended period.

TECHNICAL EVALUATION

Failed contactors returned from service to Westinghouse were subjected to an extensive failure analysis and testing. Initial inspections of the contactors included the following as-found conditions:

- Visual inspection
  - No signs of overheating
  - Armature in the closed position
- Coil resistance verified
  - Found in “as new” condition
- Contacts inspected
  - No signs of electrical fault/contact welding
- The contactors were disassembled, and the magnet and armature were bonded together
- Date codes evaluated
  - Failures were observed across multiple different date codes and not an individual lot

Three methods of material testing were performed including Fourier Transform Infrared Spectroscopy (FTIR), Scanning Electron Microscope (SEM), and Gas Chromatography Mass Spectrometry (GCMS). The results of the material and chemical analysis showed a contaminant on the magnet and armature pole faces consistent with an organic material breakdown. The organic material was not considered to be a foreign material. This material is used in the manufacturing of some of the contactor subcomponents and is part of the original equipment design, indicating it was not related to a recent design change. These results narrowed the source down to only those sub-components manufactured from the suspect material.

Westinghouse tested over 100 Freedom and A200 contactors under specific temperatures, voltages, and durations to replicate the failure mode. In order for a contactor to fail in the field, the sticking force must become greater than the kickout spring force. For test purposes, all contactors tested were modified by removing the kickout springs such that any amount of sticking force was able to be measured. This allowed the test to determine whether the contactors were beginning to develop signs of sticking that were

less than the amount required to fail in service. Additionally, each configuration had different organic subcomponents removed from the contactor to help further narrow down the source.

Each test configuration resulted in test samples exhibiting the failure mode. These results narrowed the cause of the failure down to the breakdown of a single organic source within the contactor. Factors that contribute to and accelerate the failure mode include the following:

- Temperature
  - Type of coil installed – low voltage drop out coils produce higher temperatures
  - Voltage applied to coil – higher voltage drives much higher temperatures
  - Environment – higher ambient temperatures
- Time
  - Energized duration - lack of cycling for extended periods of time

Freedom Size 1 contactors were then mechanically opened, and the test was repeated on the samples under identical conditions.

Extent of Condition Testing:

Potentially susceptible parts other than Freedom size 1 contactors were identified based on the following criteria:

- OE identifying failures with A200 contactors
- OE identifying failures with Freedom contactors (other than size 1)
- Parts known to contain the same organic material
  - Material used on same subcomponents
  - Included relays and contactors
- Parts supplied by Westinghouse

These parts were subjected to similar testing as defined above for the Freedom Size 1 contactors.

The following contactors showed signs of sticking during extent of condition testing:

- A200 Size 1-4
- Freedom Size 2-4

None of the relays tested showed signs of sticking during the test. Note that relays operate at a lower service temperature than the contactors. Eaton is changing the material in the relays and contactors regardless whether they are susceptible to this failure mode.

Additional parts were tested mimicking the installed condition of Full Voltage Reversing (FVR) applications as follows:

- Duty cycle of 2.5 minutes (energized/de-energized)
- 400 back to back cycles

None of the FVR contactors tested showed signs of sticking during or after the completion of the test.

SAFETY SIGNIFICANCE

Freedom and A200 contactors, Sizes 1 through 4, are used in many different safety and non-safety related applications; however, this potential failure mode is limited to components used in FVNR applications. Operation at high ambient temperatures and/or high control voltages for an extended period increases the potential for a failure.

However, components used in momentary applications, such as FVR Starters, are not susceptible to this failure mode. The impact of this issue, if any, will need to be evaluated on a site specific and application specific basis. Some items to consider during the evaluations include:

- With a stuck contactor, loads are able to be de-energized locally via manual opening of the breaker at the motor control center cubicle.
- There could be a potential loss of automatic load shedding which may impact available diesel generator margin.
- If continuously energized/FVNR applications have been energized for a cumulative total of 1 year or more and have been cycled properly, Westinghouse data suggests they are no longer considered susceptible to this failure mode.

AFFECTED PLANTS

Westinghouse has sold the potentially affected parts to the following plants:

Angra	Arkansas Nuclear One	Ascó	Beaver Valley
Braidwood	Browns Ferry	Brunswick	Byron
Callaway	Calvert Cliffs	Catawba	Clinton
Columbia	Cooper	Comanche Peak	Davis Besse
Daya Bay	D.C. Cook	Diablo Canyon	Dresden
Doel	Duane Arnold	Farley	Fermi
FitzPatrick	Fort Calhoun	Ginna	Grand Gulf
Hatch	Hope Creek	Indian Point	Kori
Krško	LaSalle	Limerick	McGuire
Millstone	Monticello	Nine Mile Point	North Anna
Oconee	Oyster Creek	Palisades	Palo Verde
Peach Bottom	Prairie Island	Quad Cities	River Bend
Robinson	Salem	Seabrook	Sequoyah
Shearon Harris	Shin Kori	Sizewell B	South Texas Project
Takahama	Three Mile Island	Turkey Point	Hanul
Vandellòs	V.C. Summer	Vogtle	Waterford
Watts Bar	Wolf Creek	Hanbit	

Since this issue is the result of an organic material in the commercially manufactured part that is being operated at the design extremes, Westinghouse recommends that any plant that procured these parts from a different supplier, contact that supplier to verify if those parts could be affected by this issue.

NRC AWARENESS

The NRC is aware of this issue based on the 2 Part 21 reports and the NRC has been communicating with Westinghouse on this issue.

RECOMMENDED ACTIONS

- FVNR Freedom and A200 contactors that have not been cycled since the original installation should be cycled at the earliest available opportunity.
  - If the contactors have been energized for a cumulative total of 1 year or greater, and successfully cycled, the Westinghouse data suggests they are no longer susceptible to this failure mode.
- A200/Freedom Contactors that fail to open should be replaced with contactors manufactured with the new material. Future contactors supplied by Westinghouse will be of the new material design. Westinghouse is updating part numbers and the associated commercial dedication plans for these components to ensure existing commercial material still in circulation does not make it into nuclear applications.

Contact your Westinghouse parts specialist for additional information.

REFERENCES

1. Part 21 report 2019-05-00, “Initial Notification of potential 10CFR Part 21, EATON A200 Series Starters/Contactors” (ML19053A499)
2. Part 21 report 2015-81-00, “Notification of 10CFR Part 21 on Eaton/Cutler Hammer A200 series Starters (& Contactors)” (ML15357A042)