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Attn: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-001

Subject: 10 CFR Part 21 Report
Notification of a Defect with Target Rock Modulating Valve Positioner; Model 810000-X

Dear Sir or Madam:

This letter provides notification of a defect with Target Rock Model 810000-X Modulating Valve Positioner manufactured and supplied by Target Rock.

(i) Name and address of the individual or individuals informing the Commission.

Alex DiMeo
Director of Quality Assurance

Michael Cinque
General Manager

Target Rock, Business Unit of Curtiss-Wright Flow Control Corporation
1966E Broadhollow Road
East Farmingdale, NY 11735

(ii) Identification of the basic component supplied for such facility or such activity within the United States which may fail to comply or contains a potential defect.

Target Rock Modulating Solenoid Operated valves which utilize model 810000-X positioner manufactured and supplied by Target Rock.

Target Rock Modulating Solenoid Operated valves are equipped with a separate, remote mounted, positioner unit, which is a closed loop valve position control system. The valve positioner is electronically connected to the valve assembly via a wiring harness. This defect only applies to the current production 810000-X positioner model. All previous versions of the Target Rock Modulating Solenoid Operated valve positioners do not exhibit this defect.

(iii) Identification of the firm supplying the basic component which fails to comply or contains a defect.

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(iv) Nature of the defect or failure to comply and the safety hazard which is created or could be created by such defect or failure to comply.

Background

Three (3) 810000-X model positioners were returned to Target Rock by Duke Energy Carolinas, LLC, Oconee Nuclear Station for defective operation. Target Rock evaluated these units and found two defective circuits in the positioner PC board at unrelated locations: the 80 V Regulator Circuit and the Close Indication Relay Driver Circuit

- 1.) 80 V Regulator Circuit Failure – In the event of a failure of the positioners 80 V Regulator Circuit, the positioner, and therefore its associated modulating solenoid operated valve, will no longer receive voltage from the positioner, resulting in the return spring moving the valve disc to its “fail” position (fully open or fully closed depending on the design specification requirement). Based on the positioners returned by Duke Oconee, and additional testing performed by Target Rock, this 80 V Regulator Circuit Failure will only occur during initial powering of the device. Positioner units currently in operation, and constantly energized, will not have this failure occur. In the instance where the positioner is powered down and then powered back up during maintenance activity or other event, this failure has the potential to occur upon re-energization of the device. Having said that, should the positioner continue to be operational through power-up, it would be expected to perform its intended function throughout operations.
- 2.) Close Indication Relay Driver Circuit Failure – In the event of a failure of the positioners Close Indication Relay Driver Circuit, the positioner will be unable to send a signal to indicate the valve has reached its fully closed position. Typically, this circuit is enabled for plant monitoring purposes. This failure has no effect on the ability of the Modulating Solenoid Operated valve or positioner to control fluid flow as intended.

Root Cause

A root cause has been determined for each of the circuit failures described above. The root causes identified are a result of extensive testing and analysis performed by Target Rock on the returned units from Duke-Oconee.

- 1.) 80 V Regulator Circuit Failure – The defect observed on the 80 V Regulator Circuit is a failure of a Zener reference diode. The Zener reference diode reduces the normal 90 – 140 V supply voltage to approximately 80 V for this portion of the circuit. In the event of a failure of the Zener reference diode, full input voltage (90 – 140 V) is passed to the downstream components in the circuit. The downstream components from the Zener reference diode are not rated for 90 – 140 V operation and fail, rendering the positioner inoperable.

During initial power up of the positioner, there is a relatively high differential voltage across the device which results in a current of approximately 30 mA, which lasts for approximately 30 ms which is equal to the manufacturers maximum current rating of the device. Once

steady state operation is achieved, the current drops to approximately 15 mA, which is a safe operating level.

Given this scenario, the point of failure of the 80 V Regulator Circuit occurs during initial powering of the device, when the current rating of the Zener reference diode is either at its limit, or slightly in excess of its limit. The Zener reference diode will fail open, exposing the downstream circuit components to an unregulated input voltage. This results in a failure of the components in the circuit, as they are not rated for 90 – 140 V.

During testing of the 80 V Regulator Circuit failure on a unit returned by Duke-Oconee, it was discovered the maximum current measured through the Zener reference diode is highly influenced by the rise time of the input voltage signal. A power supply which has a slow ramp up to full voltage of 125 V, taking approximately 2 seconds, will only result in a maximum current of 9 mA. A toggle switch was added to the power supply to simulate a fast, essentially instantaneous ramp up of input voltage. This test resulted in a maximum current of 30.4 mA. These results were validated by Target Rock Engineering utilizing circuit simulation software.

The Target Rock power supply utilized to factory test the 810000-X positioner units feature a slow rise time of the input voltage. Therefore, this issue was not evident during qualification or production testing of 810000-X positioners as the Zener reference diode current never exceeded its limits. As the units were supplied to power plants which may utilize power supplies with an instantaneous voltage ramp when powering the positioner units, the Zener reference diode current limit could have been exceeded, resulting in failures in the field. It is noted the Zener reference diode may not fail on the first exposure to an instantaneous voltage ramp. It may fail over time as the component is repetitively stressed at or near its maximum rating.

Therefore, Target Rock considers the root cause of the 80 V Regulator Circuit failure is due to an insufficient rating of the Zener reference diode.

- 2.) Close Indication Relay Driver Circuit Failure – The defect observed on the Close Indication Relay Driver Circuit was a trace wire in the PCB which had opened (broke) at multiple locations.

The PCB trace on the failed positioners is sized at 12 mil wide, 2 oz copper, and is capable of carrying > 1 A of current, which is well above the actual load of 12 mA during operation.

Creating traces is a subtractive rather than an additive process. When a PCB is etched, it starts filled entirely with copper. Traces for the various connection are created by masking off the areas where the traces reside on the PCB. Then, acid is introduced to dissolve away any copper that is not masked. Etching away copper may lead to traces that are not perfectly rectangular in their cross-section. It is possible the shape is trapezoidal or undercut rather than a perfect 2 oz ribbon of copper. This narrowing effect will be more pronounced in narrow trace widths such as the 12 mil traces on the 810000-X Positioner PCB as any deviations will account for a higher % reduction in the copper trace.

The trace failure appears to be a manufacturing phenomenon due to localized self-heating over time at trace locations where the copper thickness is less than 2 oz. If the copper thickness in section(s) along the length are reduced, then severe localized heating can begin to lift the narrow width traces off the FR4 material at the affected locations. Once the trace begins to lift off the FR4 substrate the thickness is further narrowed increasing the likelihood of eventual breakage in that location.

The failed trace on a returned unit from Duke Oconee was examined under a high power microscope and was found to have opened up (trace is broken) at multiple locations along its length. Had the failure mode been high current or over heating due to power losses the trace path would have opened up at one location thereby acting as a fuse and preserving the rest of the trace.

Applicability to Other Target Rock Positioners

Prior versions of Target Rock Modulating Solenoid Operated Valve Positioners (also referred to as "Controllers") do not have the potential for these failures to occur. The 810000-X was a complete redesign which addressed component obsolescence for the entire unit. This included a new circuit design for the 80 V Regulator Circuit. Therefore, Target Rock considers this defect and resultant failure bounded to only model 810000-X positioners.

(v) *The date on which the information of such defect or failure to comply was obtained.*

Discovery of the defect was January 28, 2019.

(vi) *In the case of a basic component which contains a defect or fails to comply, the number and location of these components in use at, supplied for, being supplied for, or may be supplied for, manufactured, or being manufactured for one or more facilities or activities subject to the regulations in this part.*

810000-X Positioners currently supplied by Target Rock

Owner/Site	Affected TR Valve Model(s)	Valve Application	Positioner Part Number*	Qty Shipped
Duke/Oconee	09L-001	Emergency Steam Generator Makeup	810000-036-P-T3-0-FC-0.55-E4-18-N	14
Georgia Power/Vogtle	79AB-003, 79AB-006	Reactor head vent, CVCS/SIS	810000-156-P-T3-0-FC-0.23-E2-1-NC, 810000-152-P-T3-0-FC-0.230-E2-1-NC	11
STP	79AB-003BB, 79AB-011	Reactor head vent, CVCS/SIS	810000-096-P-T3-0-FC-0.230-E2-4-NC, 810000-152-P-T3-0-FC-0.230-E2-2-NC	7
Dominion/Millstone	79AB-003, 79AB-006	Reactor head vent, CVCS/SIS	810000-152-P-T3-0-FC-0.230-E2-1-NC	1

*The base positioner part number is listed in this table. It is possible repair kits have been issued as well. For example, repair kit part numbers replace "810000-036-P-T2-180-FO-1.23-E4-17-D" with "EK".

810000-X Positioners to be supplied by Target Rock.

Owner Site	Applicable TR Valve Model(s)	Valve Application	Positioner or Repair Kit Part Number	Qty
Duke/Oconee	09L-001	Emergency Steam Generator Makeup	810000-036-P-T3-0-FC-0.55-E4-18-N	2
Dominion/Millstone	79AB-003, 79AB-006, 81AB-003, 81AB-004, 81AB-005, 81AB-005-1	Reactor head vent, CVCS/SIS	810000-152-P-T3-0-FC-0.230-E2-1-NC, 810000-036-P-T3-0-FO-0.920-EK-6-NC, 810000-036-P-T3-0-FO-0.680-E2-7-NC, 810000-036-P-T3-0-FO-0.750-E2-8-NC	4

Note: The units listed above to be supplied will be upgraded prior to shipment (see section vii below)

(vii) The corrective action which has been, is being, or will be taken; the name of the individual or organization responsible for the action; and the length of time that has been or will be taken to complete the action.

Target Rock has documented the problem description, evaluation of problem, extent of condition, and Part 21 reportability.

Two corrective actions have been put in place. All new 810000-X positioner units manufactured by Target Rock will have these revisions incorporated:

- 1.) The Zener reference diode for the 80 V Regulator Circuit has been replaced with a different component. The rating for the Zener reference diode has been increased from 30 mA to 73 mA. This upgrade will ensure current ratings are not exceeded during initial powering of the device.
- 2.) The PCB trace which failed has been upgraded. The trace width has been changed from 12 mil to 70 mil. The wider trace width will be less susceptible to variations in width during the manufacturing process, and in the event of any minor variations in width, will still be sufficient to pass the required current.

(viii) Any advice related to the defect or failure to comply about the facility, activity, or basic component that has been, is being, or will be given to purchasers or licensees.

Modulating Solenoid Operated Valves Currently Installed with Model 810000-X Positioner:

For currently installed and energized positioners, Target Rock recommends these positioner units remain energized. At the next available opportunity, Target Rock recommends these positioner units be upgraded with the revised PCB/heat sink assembly. Based upon the root cause analysis findings, the failure of the 80 V regulator circuit can potentially occur when power is removed and reinstated to the device. The failure of the close indication relay circuit would likely occur after being energized and reaching a steady state temperature for a short period of time based on the evaluation of the returned units from Duke-Oconee. The close indication relay circuit failure will have no effect on the functionality of the modulating solenoid operated valve, unlike the 80 V regulator circuit failure which renders the positioner unit inoperable.

Model 810000-X Positioners Not Installed:

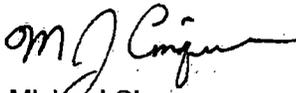
Target Rock recommends these units be upgraded with the revised PCB/heat sink assembly prior to being installed in a nuclear power plant.

(ix) In the case of an early site permit, the entities to whom an early site permit was transferred.

Not applicable.

Should you have any questions regarding this matter, please contact Michael Cinque, General Manager at (631) 293-3800

Very Truly Yours,



Michael Cinque
General Manager
Target Rock, Business Unit of Curtiss-Wright Flow Control Corporation

cc: James White
Steve Pauly
Alex DiMeo
Ed Bradshaw
Nick Campanelli
John DeBonis
William Velkoff
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