ITT ENGINEERED VALVES, LLC

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Written Notification to the NRC of
10 CFR 21 Event 54118, reported by ITT 06/14/19
#25 AM diaphragms

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1.0 INTRODUCTION

ITT Engineered Valves, LLC (ITT) has identified a potential defect with an item considered to be a Basic Component for Nuclear industry service. The item in question is ITT p/n 42711, a #25 airmotor actuator diaphragm, which could be sold as a part or incorporated within a diaphragm valve assembly. The initial finding was that the airmotor diaphragm had broken down structurally after having been assembled within a valve, tested, and set aside in inventory for a little over one year. The valves containing the potential defective part never left the facility and did not make it to a customer site. However, the observed condition of the diaphragm was such that it was determined that the possibility of a 10 CFR part 21 failure could exist.

Initial notification of the potential defect was made to the NRC via fax on 6/14/19. The potential defect report was designated Event 54118 shortly thereafter. Per 10 CFR part 21 requirements, this report is the 30-day Written Notification to support the initial fax notification.

This potential defect is limited to the #25 airmotor diaphragm only. This issue is in no way related to any other size of airmotor diaphragm, and does not have any effect on the weir diaphragm within the diaphragm valve itself (the diaphragm identified as ITT's M1 diaphragm).

2.0 INITIAL EVALUATION

On June 14, 2019 ITT's responsible officer convened a meeting of an Evaluation Group in order to review a finding from the production floor in Lancaster.

During May of 2018, five valves had been assembled for a customer order. The valves were assembled and tested in preparation for shipment, pending customer approval of Code documents. However, customer approval was delayed over issues unrelated to the valve assembly; a disagreement in documentation validity occurred over several months such that the order for these five valves was eventually cancelled. The valves were held in production inventory on ITT's shop floor during this time period. ITT determined in May of 2019 that the valves should be dismantled and the parts dispositioned accordingly. When the valves were being dis-assembled in mid-June 2019, it was discovered that all five of the airmotor diaphragms were cracked around the edges and delaminating. No root cause of the damage was readily apparent; hence an Evaluation Group meeting was called to determine the potential impact of the damaged component.

The Evaluation Group consisted of the Nuclear Product Engineer, Plant Manager, Manager of Nuclear Quality Assurance and Product Engineering Manager. It was decided by the Evaluation Group that there was a possibility that a 10 CFR part 21 event could occur in customer applications due to the observed condition of the damaged airmotor diaphragm after assembly. The initial notification of a potential failure to comply was faxed to the NRC later that evening, June 14, 2019.

3.0 BACKGROUND INFORMATION

The #25 airmotor diaphragm is a 0.19" thick elastomer diaphragm, 9.88" in diameter, used exclusively in ITT's pneumatic actuator identified as the #25 series (3125 or 3225 airmotors). The airmotor diaphragm is a composite consisting of two layers of Buna-N elastomer with a thin layer of nylon fabric sheet sandwiched in between. The airmotor diaphragm is clamped between the upper and lower airmotor covers and forms upper and lower chambers that are pressurized depending on whether the valve is reverse acting (spring to close, series 3225) or direct acting (spring to open, 3125). The actuator diaphragm is attached to the valve stem such that any movement of the diaphragm transfers to the stem and travels with of the stroke of the valve diaphragm. Reverse acting actuators have a spring or set of springs that force the valve closed when air is removed/vented from the bottom chamber; the direct acting actuator has a spring that forces the valve open when air is unpressurized in the upper chamber. Each of these actuators makes use of the same #25 airmotor diaphragm.

The maximum operating pressure of the airmotor diaphragm is 85 psig. During assembly and production testing, ITT will conduct a special airmotor proof test of 110 psig for three minutes to verify that the diaphragm and cover will hold pressure. If there is no visible leakage the diaphragm and the valve is considered to be ready for shipment.

Past investigations of airmotor diaphragm failures indicate that there are two areas of primary concern:

1. Materials of construction. Are any of the component materials defective?
2. Were the proper assembly/test process steps followed during valve assembly?

Delamination is defined as the failure of the bond between a diaphragm's fabric layer and the elastomer which encases it.

4.0 POTENTIAL IMPACT OF NONCONFORMANCE

The #25 airmotor diaphragm is designated as a safety related part when the valve to which it is assembled is identified as an Active valve. The normal function of the airmotor diaphragm is to seal the airmotor chamber in order to permit conversion of air pressure to a thrust that can operate (open or close) the valve. The safety function is the same as the normal function. If the diaphragm should fail, the valve would not be capable of actuation, would not be capable of producing a force that would open or close the valve, so the safety function of an Active valve would be compromised if the actuator diaphragm were to fail.

The #25 airmotor diaphragm is not designated as a safety related part when the valve to which it is assembled is identified as a Passive valve. A Passive valve only needs to fulfill its basic valve function (to open or close at loss of air power) and is not required to operate. That is, a fail-to-close valve will still close (still maintain its primary function) if its airmotor diaphragm has failed, it will just not be able to actuate. Therefore, no safety function is compromised if the actuator diaphragm is part of a Passive valve.

5.0 AFFECTED CUSTOMERS

There were two sets of valves that were constructed at the same time (late May of 2018) from the same lot of #25 airmotor diaphragms, and using the same assembly procedures. One set of five valves was never shipped, was disassembled, and found to reveal the potential defect. The other set also consisted of five valves and was shipped to a customer in South Korea. At this time, ITT does not consider any other customers to be potentially affected.

6.0 ACTIONS TAKEN SINCE 6/14/19 NOTIFICATION

1. The supplier of the airmotor diaphragm has provided all relevant material property data for the elastomer material and for the fabric, as well as shop travelers showing the details of the diaphragm molding process. No anomalies or issues were noted, as all material properties are within specification.

2. In reviewing the conditions of assembly of the valves with damaged airmotor diaphragms with shop floor personnel, it was discovered that the assembly torque used to assemble the airmotor cover joint was exceeded significantly in order to attain a seal during the 110 psig pressure test.

3. All five of the damaged diaphragms were removed from the valve assemblies and examined. All exhibit delamination to various degrees, from a few inches along the circumference for one sample to nearly 65% of the entire circumference. The delamination was limited radially to the area of the diaphragm that was clamped by the covers.

4. Four of the five damaged diaphragms were placed back into the valve assembly and assembled to the specified preload torque. Upon pressurization to 110 psig, all four diaphragms showed some degree of leakage through the clamped joint. However, despite the leakage, all four diaphragms were able to operate and open/close the valve. In fact, these damaged diaphragms were cycled for 5,000 cycles, all the while retaining the ability to operate the valve (the last of the five has not yet been re-tested and cycled as of this writing).

5. One valve was built with a brand new #25 AM diaphragm, using the same hardware as the valve assembly that had produced a damaged actuator diaphragm. It was verified that the airmotor cover joint leaked at 110 psig when the specified assembly torque was applied, and that it was possible to attain a leak free joint by exceeding the specified torque.

6. In an attempt to replicate the original diaphragm failure, one valve was assembled using an excessive amount of bolt torque applied to the actuator cover joint. The airmotor chamber was verified to be leak free when pressurized to 110 psig. The valve was depressurized and allowed to set for an extended period of time. After four weeks, it was noted that the excessive torque had caused significant extrusion of the airmotor diaphragm that extended well beyond the outer diameter of the covers. There was also noted significant creep of the material and deformation of the edge surface of the diaphragm. It was observed over the four

weeks from assembly that some delamination can be observed to have occurred at the edge of the diaphragm.

7.0 PRELIMINARY ROOT CAUSE

At this point in time, it is believed that the cause of the delamination of the diaphragm is excessive assembly torque upon original construction. For the five dis-assembled valves, during the 110 psig production test the assembler noted that an excessive amount of bolt torque was required to attain a leak-free joint at 110 psig. It was observed that the preload force continued to act upon the already extruded diaphragm edge over time, causing eventual cracking and delamination. While we have not had been able to observe for an entire year, we have been able to simulate the same effect in a limited fashion on a brand new diaphragm using the same valve hardware over the last four weeks.

8.0 FUTURE PLAN OF ACTION

1. Complete testing on the fifth of five damaged diaphragms.

2. Continue to evaluate the effects of excessive torque on the #25 airmotor joint. A second valve assembly will be built with a diaphragm from stock with intentionally high assembly torque, while the first unit mentioned above will be dis-assembled and examined.

3. The customer noted in section 5.0 will be notified and given instructions on how to assess whether the damage observed in Lancaster is also possible on the other five valves that were built in the same time period.

4. Develop a means to identify problematic diaphragms after assembly, taking advantage of the fact that excessive torque on the joint in question will result in extrusion of the diaphragm beyond the outer diameter of the covers.

5. Prepare and submit a report or interim report within 60 days of date of discovery, which will be August 13, 2019.