

# ITT ENGINEERED VALVES

33 CENTERVILLE ROAD  
LANCASTER, PA 17603

Written Notification to NRC of  
10 CFR 21 Event 48976, reported by ITT 04/26/13  
3" and 4" M1 diaphragms

REPORT BY:

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*5/24/13*

DATE

*IE20*

## **INTRODUCTION**

ITT Engineered Valves, LLC (ITT) has identified a defect with items considered Basic Components for Nuclear industry service. The items in question are 3" and 4" size M1 EPDM Diaphragms, which were sold as parts incorporated into valve assemblies or as individual spare parts since initial release in 2008. The "defect" only applies to certain 3" and 4" diaphragms that were intended for the specific design condition of 250° F, 220 psi, 40 year radiation dosage of  $1 \times 10^8$  Rad, or for conditions where the results of the tests conducted at this design condition were referenced in order to justify the use of these diaphragms.

Initial notification of the reported defect was made to the NRC via fax on 4/26/13. The defect report was designated Event 48976 shortly thereafter. Per 10 CFR part 21 requirements; this report is the written notification to support the initial fax notification.

## **DEFINITION OF DEFECT**

The nature of the defect in this case is best described by 10 CFR section 21.3 *Defect* definition as "an error, omission or other circumstance in a design certification or standard design approval that... could create a substantial safety hazard." ITT inadvertently qualified the 3" and 4" size M1 diaphragms for a design condition that includes the effect of radiation when in fact our recommendation was erroneously based on diaphragm testing that did not include radiated diaphragm test results for those sizes. The potential safety hazard stems from the fact that if these diaphragms see radiation in this particular service, there is no data to indicate that the diaphragm will perform its function in that service condition. The "defect" in this case is not with the diaphragm themselves, rather the fact that there is not sufficient radiation test data to justify the use of the 3" and 4" diaphragms at the design condition (that is, per 10 CFR part 21 this is not really a defect but a 'failure to comply').

## **EVALUATION**

On April 25, 2013 ITT's responsible officer convened a meeting of an Evaluation Group in order to review the incident that was discovered earlier that day. The Evaluation Group consisted of the Nuclear Product Engineer, Manager of Nuclear Quality Assurance and Product Engineering Manager. It was decided by the

Evaluation Group that there was indeed a potential for a substantial safety hazard due to the lack of supporting data for the functioning of the subject diaphragms in radiated service at a certain operating condition. The initial notification of a failure to comply was faxed to the NRC the next day, April 26, 2013.

## **EXPLANATION OF FAILURE TO COMPLY**

When the current EPDM M1 diaphragm compound was initially qualified during 2007 – 2008, samples of each size were manufactured and delivered to ITT's R&D lab. After conducting the standard qualification testing of unirradiated diaphragms, samples were prepared for radiated life cycle testing. This consisted of testing diaphragms at specific temperatures, pressures and radiation conditions based on past customer requirements, ASME N31 Code Cases, MSS SP-100 testing, etc.

At that time, there were two methods for testing simulated radiated diaphragm life testing, both of which had been established as equally acceptable for radiated diaphragm testing. Method 1 consisted of the following protocol:

- Assemble diaphragm into valve assembly, test diaphragm for 1,000 cycles unirradiated, in the target temperature and pressure (defined via N31 Code Case, MSS SP-100 or previous customer requirements).
- Disassemble; send out diaphragm for radiation, receiving 1/3 of the lifetime dose.
- Reassemble, test diaphragm for 1,000 cycles at target temperature and pressure
- Disassemble; send out for another 1/3 radiation dose
- Reassemble, test diaphragm for 1,000 cycles at target temperature and pressure
- Send out diaphragm for last 1/3 radiation dosage
- Test diaphragm for 4,500 cycles up to target of 7,500 cycles total.

Method 1 was developed many years ago and was envisioned to be a reflection of the life of a typical diaphragm for radiation service, with gradual aging occurring over a simulated lifetime.

Method 2 simply involved applying the full radiation dosage to the diaphragm from the very beginning before any cycles are applied, and then cycling the diaphragm to the target of 7,500 cycles. This is considered a very conservative

test, as the full effect of aging is felt from the very beginning of the simulated life. Method 2 does have the advantage of being a much easier test to conduct, as the radiation facility that ITT uses is three hours away.

Note: the 7,500 cycle target reflects a 5 year life of the diaphragm, 500 cycles per year maximum with a safety factor of three ( $500 \times 3 \times 5 = 7,500$ )

ITT initially set out to match all of the radiated diaphragm conditions that were met by the previous version of the M1 diaphragm that had been sold prior to 2008, which had gone obsolete due to the unavailability of the base polymer that was used in its compound formulation. In this effort ITT was mostly successful, as 90% of all the conditions tested for radiation service were able to be qualified for the new compound to the various operating conditions; that is, all radiated diaphragm samples were able to attain the qualification target of 7,500 cycles. Both Method 1 and Method 2 were used during this test program. For those conditions for which ITT was successful, ITT published a letter of understanding titled, "M1 EPDM Operating Conditions as of July 31, 2008" (see Appendix), that was distributed to all ITT Nuclear customers, who indicated acceptance of these conditions via signed letter back to ITT. Please note: these operating conditions are NOT affected by the 'failure to comply' event that is the subject of this report. Any ITT diaphragms that are used in valves with operating conditions covered by this letter are not subject to this 10 CFR part 21 action.

While the M1 test program was considered a success and the new compound was launched in 2008, there were still 10% of those conditions for which ITT was unable to meet the full qualification target of 7,500 cycles, and this was a source of some concern for certain ITT customers. Those customers had purchased the previous M1 diaphragm made from the polymer that had gone obsolete, and they would contact ITT for replacement valves or diaphragms subject to those conditions. ITT would note that while the data did not permit the diaphragm to be sold for that condition, the diaphragm could be used at a restricted service life base on the limited data that did exist. This was a common practice that had been used successfully with the previous M1 formulation, and customers with those certain operating conditions agreed to use the diaphragms with a specific reduced life.

Here is an example of how the restricted life of a diaphragm would be calculated: For a given condition, six diaphragms were radiated and then tested at the appropriate temperature and pressure, using Method 2 above. The test results showed that the diaphragms did not all attain the 7,500 cycle target life, so for the condition in this example the results would not be included in ITT's Operating

Conditions letter. However, while some diaphragms were able to attain 7,500 cycles, two failed at 6,000 and one failed at 4,200. Taking the most conservative approach, ITT would indicate to customers who required diaphragms for this condition that the limit of the diaphragm would be 1,400 cycles total over five years (4,200 divided by safety factor of three).

This brings us to the Failure to Comply condition: One of the conditions for which premature failure occurred was the N31 Code Case 250° F, 220 psi and 1x10E8 Rad. The test results were generated using Method 1 above. The least number of cycles attained by the 3" set of samples was 1,000 cycles. The least number of cycles attained by the 4" set of samples was 164 cycles. When inquiries were received on this condition for these sizes, the values given out for restricted cycle life for 333 cycles for the 3" and 54 cycles for the 4"

However, a review of Method 1 shows that any cycle test data that does not exceed the first 1,000 cycles does not come from radiated diaphragms (the first 1,000 cycles occurs on unirradiated diaphragms in Method 1). This was not accounted for when deriving the restricted life for this condition. Therefore, the recommended cycle life for this condition was erroneously based on non-radiated diaphragm testing.

As of 4/25/13, the use of 3" or 4" diaphragms in the radiated service of 250° F, 220 psi, 1x10E8 Rads, or any lesser pressures and temperatures qualified using this data, cannot be supported by ITT test data on radiated samples. This is the basis of the Failure to Comply.

## **AFFECTED CUSTOMERS**

ITT has conducted a thorough review of all customer orders since the release of the subject diaphragms in 2008. ITT has identified one customer who has purchased a valve using the noncompliant qualification data within the design requirements for the valve. This customer has already been notified of the Event and was given recommendations on how to proceed. Other customers were given noncompliant data as the basis for quotes and inquiries; while there have been no translation of this data into formal requirements cited in any valve or spare parts orders, ITT intends to contact these customers directly to ensure that any such diaphragms are identified.

# **APPENDIX**

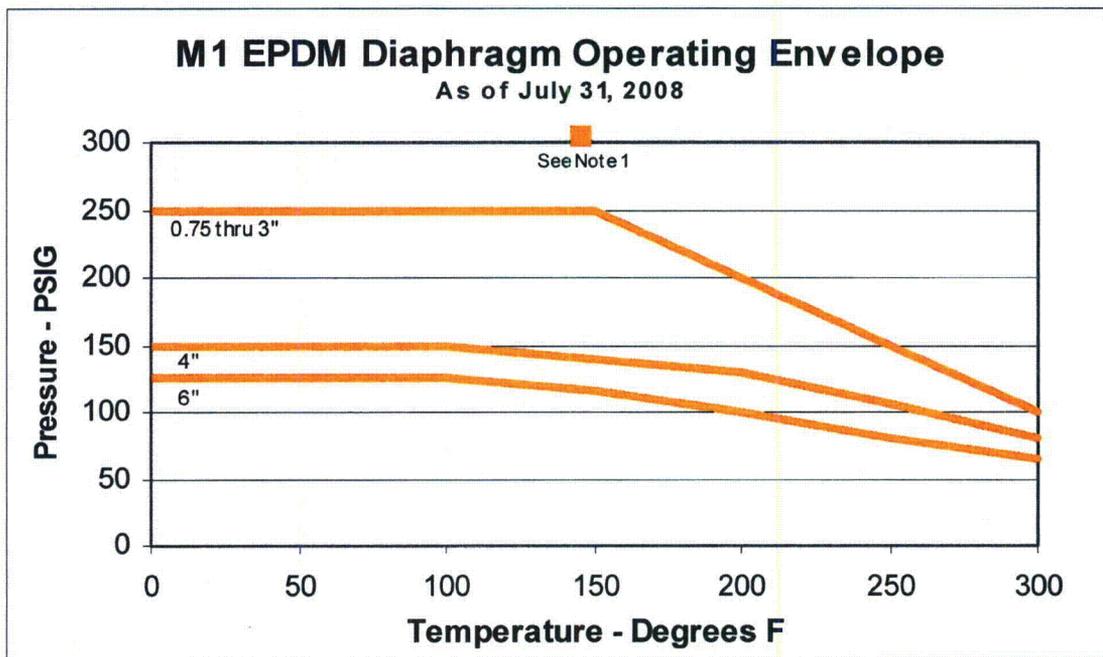
## M1 EPDM Operating Conditions as of July 31, 2008

We have completed testing the new M1 EPDM compound and have approved it for use in the operating envelope shown below. This document enhances and supersedes the conditions dated 03/14/08. If your application conditions are not listed, please contact ITT for discussion.

Our testing protocols are based on 7500 cycles:

- 5 Year cycle life
- 500 cycles per year
- Safety Factor of 3
- 5 yr accumulated radiation dose of 7.5E6 Rads.  
(Based on 40 yr dose of 1E8 Rads with 40% shielding)

Size	Old Part Number	New Part Number
0.5"	28603	44681
0.75"	18987	44680
1"	18988	44673
1.5"	18990	44674
2"	18991	45557
2.5"	18992	44676
3"	18993	44677
4"	18994	44678
6"	18995	45558



Additionally, we have tested (and approved) to the MSS-SP-100 protocols listed below:  
(Based on 40 yr dose with 40% shielding.)

• 0.5 & 0.75"	140°F @ 180PSIG, 1.2E7 Rads	<u>40 yr dose</u> 1.6 E8 Rads
• 1.0"	130°F @ 170PSIG, 1.2E7 Rads	1.6 E8 Rads
• 1.5"	120°F @ 150PSIG, 7.5E5 Rads	1 E7 Rads
• 2.0"	120°F @ 170PSIG, 2.4E6 Rads	3.2 E7 Rads
• 3.0"	155°F @ 170PSIG, 3.75E6 Rads	5 E7 Rads
• 4.0"	120°F @ 130PSIG, 3.75E6 Rads	5 E7 Rads

**NOTES:**

1. 0.75, 1, 2, 3, 4 & 6" are also approved for: 150°F @ 300PSIG, 1.2E6 Rads (Based on 40 yr dose of 1.6E7 Rads with 40% shielding)
2. Many 0.5" diaphragm valves use 0.75" diaphragms. Contact ITT for 0.5" diaphragm information.