

ITT ENGINEERED VALVES, LLC

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Report of 'Failure to Comply' Event 48976 (reported by ITT
4/26/13) and Identification of Resulting Potential Substantial
Safety Hazards – 3" and 4" M1 diaphragms

REPORT BY:

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1.0 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 of the latest M1 compound in 2008. The "defect" only applies to certain 3" and 4" diaphragms that were intended for the specific operating condition of 250° F, 220 psi, 40 year radiation dosage of 1×10^8 Rad, or for conditions where the results of the tests conducted at this operating 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. A written notification of the defect report was provided 5/27/13.

Per 10 CFR part 21 requirements, this report is the 30-day Written Report.

2.0 DEFINITION OF DEFECT (or 'Failure to Comply')

The nature of the defect in this case is best described by 10 CFR section 21.3, where a *Defect* is defined as "an error, omission or other circumstance in a design certification or standard design approval that... could create a substantial safety hazard." ITT qualified the 3" and 4" size M1 diaphragms for a limited cycle life for a particular operating condition that included radiation exposure, but 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 3" or 4" 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 specific operating condition (that is, per 10 CFR part 21 this is not really a defect but a 'failure to comply').

3.0 10 CFR PART 21 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.

4.0 ROOT CAUSE 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. Qualification testing of diaphragms for Nuclear service consisted of a combination of radiation exposure and cycle testing, with the radiation being applied at an outside facility. The radiated diaphragm tests were performed at select temperatures and pressures based on past customer requirements, such as ASME N31 Code Cases, MSS SP-100 testing, etc.

At that time, there were two methods for conducting tests that simulated diaphragm life for Nuclear plant conditions, both of which had been established as equally acceptable for radiated diaphragm testing.

Method 1 testing consisted of the following protocol:

- Assemble diaphragm into a test valve assembly, test diaphragm for 1,000 cycles unradiated, 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 at ITT many years ago and was envisioned to be a realistic depiction 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 due to radiation 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 operating 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 new 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 that were fully satisfied by the old compound but not by the new. ITT would respond to those customers by stating that while the data did not permit the diaphragm to be sold for that condition for a full service life, the diaphragm could be used at a restricted service life based on the data that did exist. This was a common practice that had been used successfully with previous diaphragm formulations. Customers with those applications that fell within the 10% were advised of the reduced service life, and were given the option to purchase diaphragms with full knowledge of the limitations.

Here is an example of how the restricted life of a diaphragm would be calculated: For a given condition, a number of 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, some 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 that is the subject of this report: One of the conditions for which premature failure (that is, all samples did not reach 7,500 cycles) occurred was the N31 Code Case which consisted of 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 regarding 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, could not be supported by ITT test data on radiated samples. This is the basis of the Failure to Comply, and the reason why a 10 CFR part 21 report was made on 4/26/13.

However, as of May 20, 2013, ITT can report that we do have radiated test data supporting these conditions. See Section 5.0 below.

5.0 MITIGATION OF 'FAILURE TO COMPLY'

ITT obtained a statistically significant number of 3" and 4" M1 diaphragms from inventory and sent them out to our approved Radiation facility in preparation for conducting testing per the N31 Code Case condition of 250° F, 220 psi, 1x10E8 Rad. Upon return, the radiated diaphragms were installed in valves on ITT's R&D lab hot water circulating loops (hot loops) at 250 psi, 220° F. The diaphragms were then tested in accordance with the same procedures that were used to determine the qualification of these diaphragms in 2008, except this time Method 2 was used (see Section 4.0).

As a result of this testing, the least number of cycles to failure of the samples from each set was found to be 989 cycles for the 3" M1, and 110 cycles for the 4" M1. This corresponds to an effective life of 329 cycles for the 3" (compared to 333 cycles before), and 36 cycles for the 4" (compared to 54 cycles before).

6.0 AFFECTED CUSTOMERS

ITT has conducted a thorough review of all customer orders fulfilled since the release of the subject diaphragms in 2008. The review consisted of reviewing all documentation to determine if the Code Case in question (250° F, 220 psi, 1x10E8 Rad) was referenced during the course of the order fulfillment process, or if the stated operating conditions of the 3" or 4" valves/diaphragms were within the realm of the 10 CFR part 21 Code Case in question.

ITT identified one customer, Westinghouse Pittsburgh with a 3" valve at Watts Bar, who purchased a valve using the noncompliant qualification data within the design requirements for the valve. This customer was formally notified on May 21, 2013 that their valve was affected by the Event. In response, this customer has already updated their information to incorporate the new data from section 5.0 above; their 3" valve was re-rated from a service life of 333 cycles to 329 cycles. In fact, ITT was instructed to formally update and re-issue the design drawings for this valve to reflect the new cycle life.

Another customer, Union Electric (Ameren) in Callaway, MO, is also subject to this Event, as ITT found documentation that they had inquired about this condition and was given the discrepant data to justify 3" diaphragms already in their possession. ITT has also formally notified this customer of the 10 CFR part 21 Event on June 6, 2013, and that customer has also already incorporated the reduction in cycle life from 333 to 329 cycles into their specification.

ITT has also identified three other customers who were given documentation referencing the noncompliant data as the basis for potential quotes and inquiries. While there have been no translation of the discrepant data into formal requirements cited in any valve or spare parts

orders, ITT has contacted all three of these customers directly and is in the process of ensuring that there are no diaphragms that are operating in applications that may have been justified by the discrepant data.

7.0 WRITTEN REPORT SUMMARY

On 4/26/13, ITT reported a 'failure to comply' defect to the NRC which involved the qualification of 3" or 4" M1 diaphragms for one of the N31 Code Case applications with operating conditions of 250° F, 220 psi and a 40 year radiation dosage of 1×10^8 Rad. The qualification of this particular condition had been justified using data that erroneously referred to test results of unirradiated diaphragms. This lack of appropriate supporting data was evaluated at ITT and deemed to be a potential cause of a substantial safety hazard per 10 CFR part 21.

While ITT reviewed customer orders for references to the subject operating condition, preparation for radiated diaphragm testing began immediately. On May 20, 2013 testing was completed for the 3" and 4" M1 diaphragm under the conditions above, with a resultant cycle life that was qualified using properly radiated diaphragm samples.

ITT was able to determine that two customer diaphragms, one at Watts Bar from Westinghouse - Pittsburgh and one at Union Electric (Ameren) in Callaway, MO, were found to have been using 3" M1 diaphragms in a service that was qualified using the discrepant data. The new data that became available May 20 was submitted to these two customer sites, and both have had the new data incorporated into their specifications for these valves.

Since 2008, three other customers had been given the discrepant data by ITT in response to inquiries concerning the Code Case in question or an application that could have been satisfied by the Code Case data. There is no evidence to show that providing this data resulted in orders or re-qualifications of any diaphragms or valves. Nevertheless, all three customers have been advised of the 10 CFR part 21 situation, and are working with ITT to identify any diaphragms that may have incorporated the discrepant data for any application.

APPENDIX

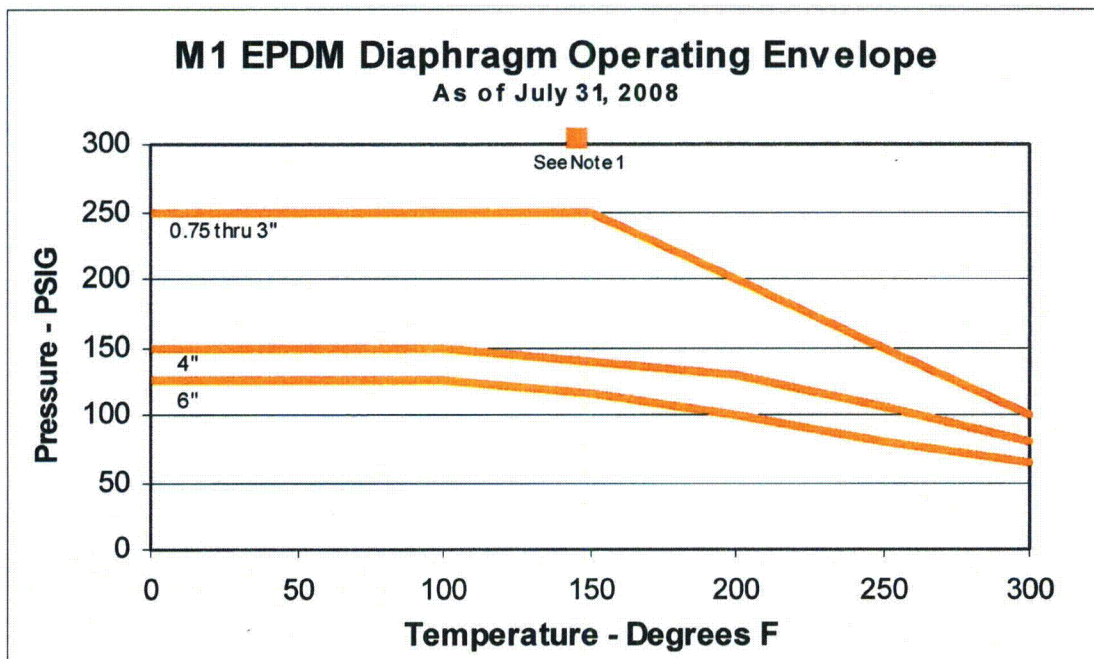
M1 EPDM Operating Conditions as of July 31, 2008

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.)

		<u>40 yr dose</u>
• 0.5 & 0.75"	140°F @ 180PSIG, 1.2E7 Rads	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.