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To:		From:	**Kevin Armstrong**
Company:	**Nuclear Regulatory Commission**	Date & Time:	1-25-02
Fax Number:	301-816-5151	Pages:	10
Subject:	U02O3FBBR-**		

:

The attached analysis indicates a potential 10 CFR Part 21 reportable problem with Automatic Valve part number U02FFBBR-**

A total of 59 valves are impacted.

These valves are have been shipped to three separate plants, two of which have installed the product..

These plants have been informed of the problem.

Please contact me if you require additional information.

Kevin Armstrong
President
Automatic Valve

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TITLE: CORRECTIVE ACTION	LOCN: I:\WORD\DOCUMENT\D7174003.DOC	DATE: 10-21-1999
SUBJ: CORRECTIVE ACTION	TYPE: FORM DEPT RESP: DQA	REV: F-CN8020

REQUIREMENTS:

NUMBER: 15375

Type of Problem: ☒ Part U0203FBBR-AA ☐ Procedure Date: 11/30/01

Who found Problem: ☐ AV ☐ Supplier ☐ Distributor ☒ Customer

Company: Exelon – Limerick Contact Name: Will Astbury

Address: Phone: 610-718-1200-3768 Fax:

1 Team Working on Problem: Leader: D. S. Swinton Members:

T.J. Troy, K. W. Armstrong

2 Describe Problem (Initial Concern and Symptoms):

On 11-14-2001 Roger Stadnik of Exelon Power Labs (610-380-2643) called and reported that (2) U0203FBBR-AA valveshad been sent to their lab from Exelon – Limerick for evaluation with the complaint that the valves were leaking in the energized position. The valve is being used in the normally closed mode at an inlet pressure of 74 psig. Further, according to Mr. Stadnik, there are additional U0203FBBR-AA valves at Limerick that are exhibiting the same problem.

On 11-29-2001 one valve was returned to Automatic Valve for further evaluation. At inlet pressures of 74 & 125 PSIG it was determined that the valve did not reset after the solenoid was de-energized. It did no reset until the inlet pressure was reduced to approximately 40 psig respectively.

When tested in the normally open mode – pressure to port 1 as shown in Figure 1B, there was leakage at exhaust port 3 when the solenoid was energized but the valve immediately reset at its maximum rated inlet pressure of 125 psig when the solenoid was de-energized.

When the valve was disassembled a permanent set in the rubber in the top plunger seal was found that conformed to the shape of the top seat in the solenoid plunger guide. This deformation is normal and is not a concern.

The plunger was then dissected for additional analysis. It was determined that the that the top seat was .020" below the top surface of the plunger or .007" below the maximum design standard of .013".

With the top seat .020" below the top surface of the plunger, the top seal was touching the top orifice but was not compressing the internal spring and hence not creating a good seal. Consequently, there was severe leakage out of exhaust port 3 which is .125" in diameter. This severe leakage created a pressure differential across the top of the plunger, and thus a force tending to hold the plunger in place. This force could not be overcome by the external spring until the inlet pressure was reduced to approximately 40 psig.

It was observed that all parts of the dissected plunger were present and in their proper location. Further, it was noted that the tested leak rates and performance characteristics of the valve prior to the plunger being dissected did not match field reports from Exelon. Consequently, Exelon was contacted and additional samples were requested.

On January 3, 2002 a second U0203FBBR-AA valve was returned to Automatic direct from Exelon - Limerick by Mr. Will Astbury. This valve exhibited the same operational characteristics in the normally closed mode as did the valve returned on November 29, 2001. That is, it leaked excessively when energized. And, as with the previous valve examined by Automatic Valve, the inlet pressure at port 1 had to be reduced to approximately 54 psig after the solenoid was de-energized before the valve returned to its normally closed position.

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2. Describe Problem (Initial Concern and Symptoms) – Continued:

A second test was run on the valve returned on January 3, 2002. Previously both returned valves were tested "cold". That is, they had been at room temperature for a number of hours or days. When tested, pressurized air was plumbed to port 1, and the solenoid was energized only long enough to confirm that there was leakage out of port 3. Then the solenoid was de-energized and the inlet pressure reduced to a value that the plunger would return to its normally closed position. With the second valve, the solenoid was left energized with 125 psig of air to port 1. After a period of approximately 60 minutes, the leak at port 3 greatly diminished and, when the solenoid was de-energized, the valve immediately returned to its closed position. This test was repeated three (3) times with the same results.

In summary, evaluation of the (2) valves resulted in the following symptoms and concerns:

1. A faulty valve will leak out of port 3 when the valve is used in its normally closed mode as shown in Figure 1A or leak out of port 1 when the valve is used in its normally open mode as shown in Figure 1B.
2. There is no concern that U0203FBBR-** valves used in the normally open mode (pressure at port 3) will return to their de-actuated position (port 3 open to port 2 and port 1 blocked) when the solenoid is de-energized. In this mode both the internal spring, the external spring, and inlet pressure at port 1 act to return the plunger to its normal de-actuated position.
3. There does not seem to be a concern, based on field experience, that U0203FBBR-** valves used in the normally closed mode (pressure at port 1) will return to their de-actuated position.(port 2 open to port 3 and port 1 blocked) when the solenoid is de-energized provided the solenoid has been energized for an extended period of time. Test on the valve returned on January 3rd indicate that this period of time is approximately 15 minutes at 80 psig inlet pressure and approximately 60 minutes at 125 psig. However, the impact of further degradation of the shell relative to the seal, when the valve has been energized over an extended period of time is unknown.
4. There would no seem to be a concern in applications where the U0203FBBR-** valve is used in the normally closed mode (air at port 1) and the valve is normally de-energized provided that, when energized, it is not energized for a total period of time exceeding 6 months.
5. There is a concern that U0203FBBR-** valves used in the normally closed mode will not return to their de-actuated position if the valve has been in its de-energized position for a sufficient amount of time for the valve and the internal top seal to cool down. If the valve is energized then is de-energized, within a period of approximately 60 minutes with 125 psig at port 1, or 15 minutes with 80 psig at port 1 there is a high probability that the valve will not return to its de-energized condition.

3. Contain Symptom (Action):

All U0203FBBR-** valves were placed on hold as of November 30, 2001.

Approved by: [signature] Title: President Date: Nov. 30, 2001

4. Root Cause/s of Problem: **10 CFR Part 21 Report Required: YES – for U0203FBBR valves when inlet pressure is @ port 1**

When the valve is in its de-energized state, upward travel of the top seal and its containment shell is stopped when the shoulder of the shell contacts the top of the counter-bore in the plunger as shown in Figure 3A. In this de-energized position, the top seal is within a maximum distance of .013" from the top surface of the plunger. When the valve is energized, the top of the top seal first contacts the bottom of the top orifice as shown in Figure 3B. At this point further upward motion of the top seal and shell stops. The plunger continues its upward travel until the top of the plunger contacts the plunger stop as shown in Figure 3C. Because upward motion of the top seal and shell stops when the top seal contacts the top orifice, the additional upward motion of the plunger compresses the internal spring by the distance the plunger travels after the seal contacts the orifice – approximately .008. (Refer to Figure 4 for a detailed view showing the shell and plunger in the energized position.)

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4. **Root Cause/s of Problem – Continued:**

For valves with little or no leakage out of port 3, there is no pressure differential acting across the top of the plunger. The top of the plunger is at the same pressure as is the interior of the entire plunger guide. The only effective sealed area is the area of the top orifice which is .0123 in^2. When the solenoid is de-energized, both the internal and external spring act to force the plunger downward, away from the top stop, for a distance equal to the distance that the top seal was depressed during the energizing cycle – approximately .008". During this travel the top seal maintains contact with and seals off the top orifice. After the top orifice is opened, the top of the plunger has moved well away from the top stop, and exhaust port 3 is opened. The external spring then forces the plunger on down to its de-energized position.

However, when the valve stays in the energized position, the shell creeps upward relative to the top seal over extended periods of time. (Note: Extended periods of time are measured in months. Per Mr. Astbury, the earliest that any valve exhibited leakage from exhaust port 3 was 6 months and this one was one valve out of eight that are currently reported leaking. The remaining seven valves exhibited the leakage after a period of 8 months to a year.) As the creep continues, over a period of months, the shoulder on the shell comes closer and closer to the top of the plunger counter bore thus reducing the amount of compression of the internal spring. That is, the normal compression of .008 shown in Figure 4 becomes less and less. At some point in time, the shoulder on the shell contacts the plunger counter bore and additional creeping of the shell relative to the top seal stops.

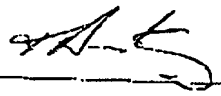
When this happens, the top seal is touching the top orifice but is not compressing the internal spring sufficiently to create a good seal and leakage occurs out of port 3. As the leak intensifies, it creates a pressure drop at the top of the plunger as shown in Figure 5. The greater the leak, the greater the pressure drop. At leak rates less than 60 SCFH, all plungers returned.

The reason that the valve resets when the solenoid is energized for an extended period of time – one hour or more - is that, with the solenoid energized, a substantial amount of heat is generated. In turn, the top seal expands upward relative to the shell and reduces the leak rate thus decreasing the pressure drop across the top of the plunger. With the reduced pressure drop, sufficient force is generated to return the plunger.

The root cause of the problem is the fact that the shell creeps upward with respect to the top seal due to two factors.

1. The bottom of the containment shell is not flush with the bottom of the top seal as shown in Figure 4. Consequently, the spring force generated by the internal spring, and transmitted through the disk, acts only on the bottom of the shell. Because the top of the seal is in contact with the top orifice it cannot move further upwards. The force acting to counter the internal spring force exerted on the bottom of the shell to keep the shell in place relative to the top seal is the friction force between the shell and the seal as shown in Figure 6.

2. The high force exerted by the internal spring against the bottom of the shell in U0203FBBR-** universal valves.. This spring must exert sufficient force to maintain a seal between the top seal and the orifice when the valve is used in the normally open mode and inlet air at port 3 is acting to push the top seal down and away from the orifice.

Approved by:  Title: President. Date: Jan. 22, 2002

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5. **Corrective Action:**

The shell retaining the top seal has been redesigned so that bottom of the shell is flush with the bottom of the top seal. By changing the design of the shell in this manner, the force exerted by the internal spring and transmitted by the disk, acts on both the bottom of the shell and the bottom of the seal. Because the force now acts equally on both components, there is no force acting on the bottom of the shell tending to move it upwards with respect to the top seal. (Refer to Figure 7.)

Test Conducted to Verify It:

Approved by: [signature] Title: President Date: Jan. 22, 2002

6. **Implementation (Describe: Include Applicable CN Numbers):**

1. The #7122-207 plunger assembly was changed to Rev "E" on January, 23, 2002 per change number 8584 requiring:
   - That the distance from the top of the plunger to the top of the top seal be inspected to verify that it is within its design specifications."
   - That one plunger from each lot that be disassembled and visual verification be made that the bottom of the shell is flush with the bottom of the seal.
2. All plungers used in the 7122-207 plunger assemblies were reworked to 7122-207 Rev "E" specifications – the bottom of the shell in the reworked plungers is flush with the bottom of the top seal.
3. The following companies, to whom U0203FBBR valves have been shipped under 10CFR21, are to be notified of the situation by Jan. 27, 2002

   Alabama Power Company — Exelon – Limerick
   Virginia Valve — Wyle Laboratories

4. The NRC is to be notified concurrently.

Approved by: [signature] Title: President Date: Jan. 24, 2002

7. **Corrective Action to System to Prevent Recurrence:**
None required.

Approved by: [signature] Title: President. Date: Jan 24, 2002

8. **Verification (Describe):**
The analysis performed in determining the root cause of the problem and the necessary corrective action needed to eliminate the problem serve as sufficient validation that the corrective action will effectively eliminate the problem.

Approved by: [signature] Title: President. Date: Jan 25, 2002

Figure 1. – U0203FBBR-** 3/2 UNIVERSAL VALVE – MODES OF OPERATION

Figure 1A – Normally Closed Mode

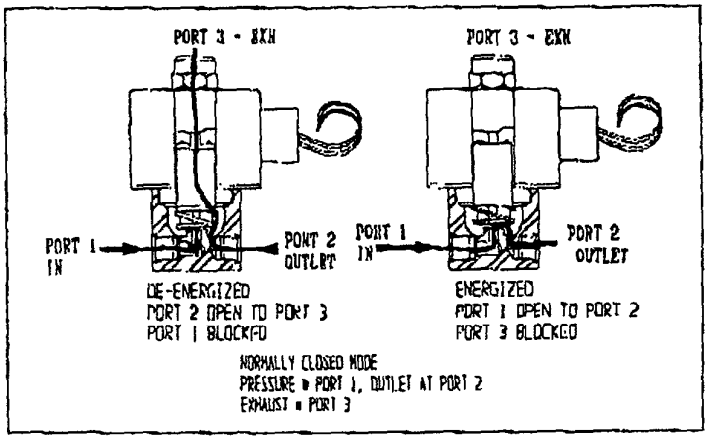

Figure 1B – Normally Open Mode

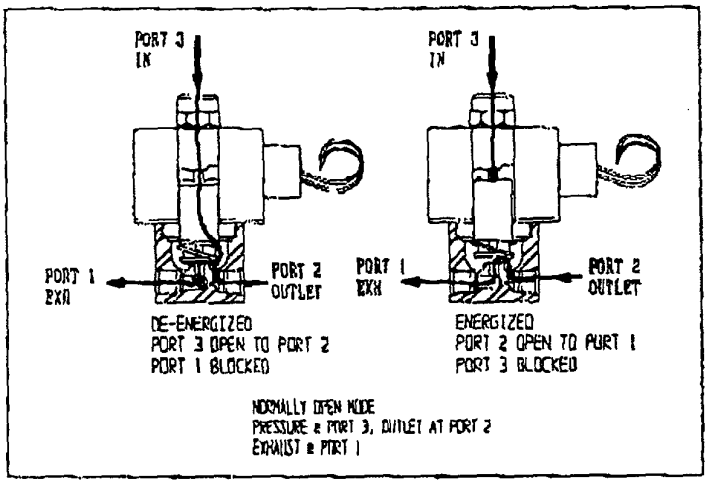

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Figure 2 - Nomenclature

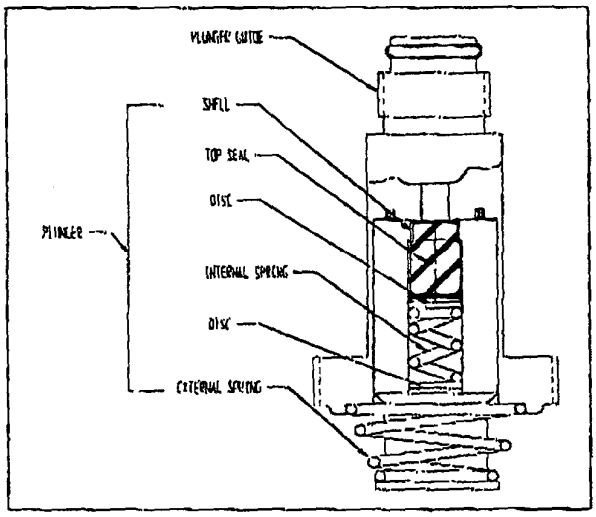

Figure 3 – Plunger & Guide – Energized to De-Energized - Normal Operation

Figure 3A – Plunger in De-Energized Position

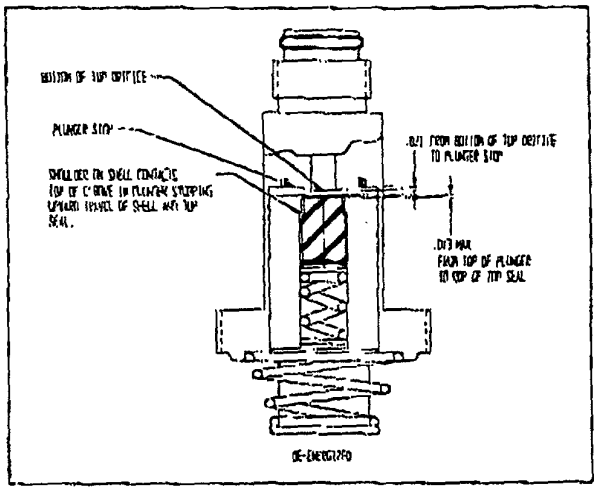

Figure 3 – Plunger & Guide – Energized to De-Energized - Normal Operation - Continued

Figure 3B – Partially Energized – Top Seal Contacting Top Orifice

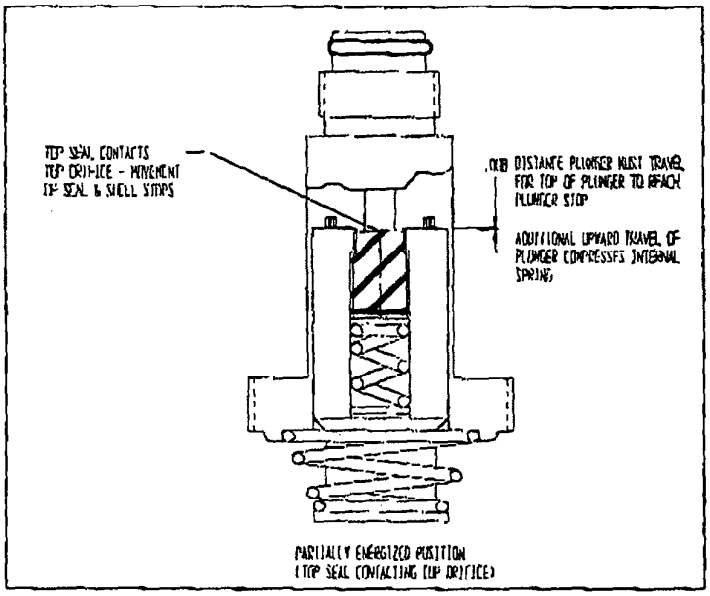

Figure 3C – Full Energized Position – Plunger Contacts Plunger Stop

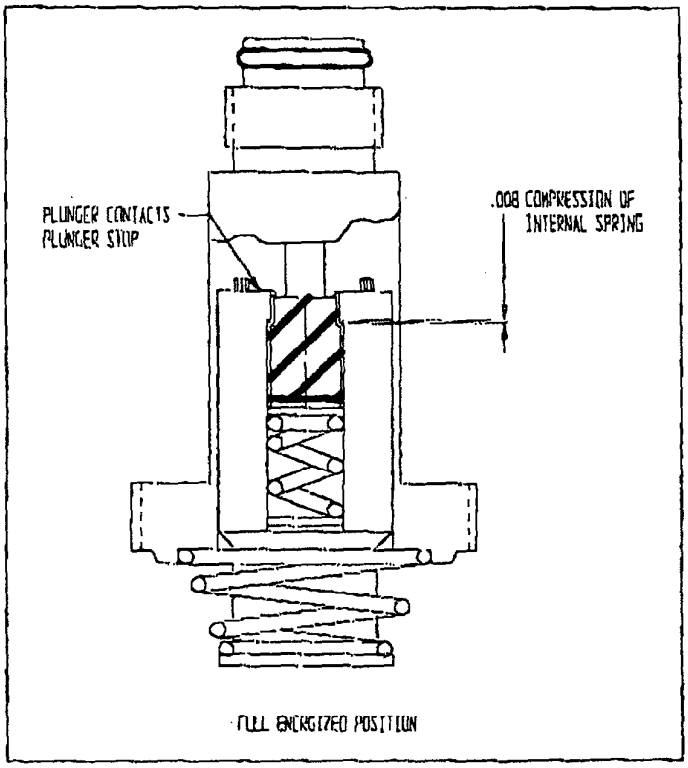

Figure 4 – Enlarged view of top seal and shell in the energized position.

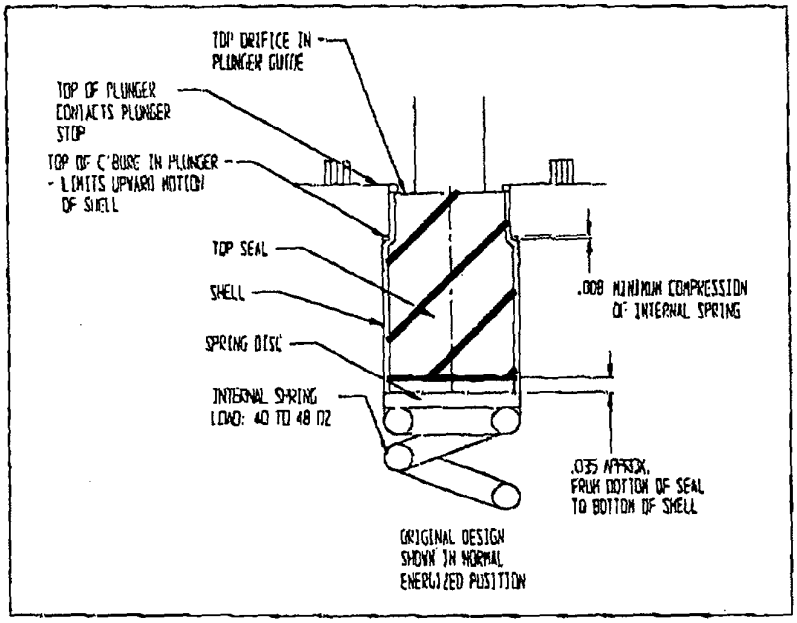

Figure 5 – Pressure Drop

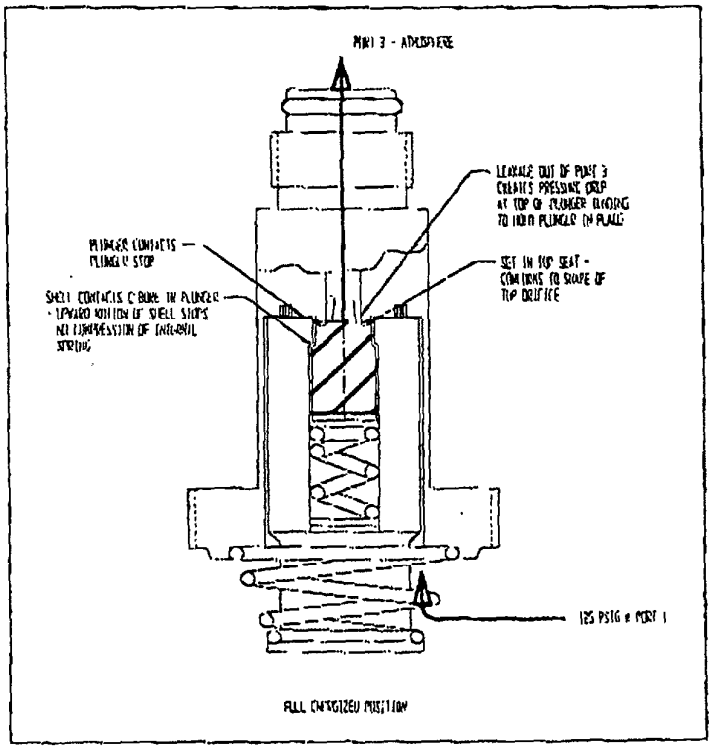

Figure 6 – Forces acting on shell

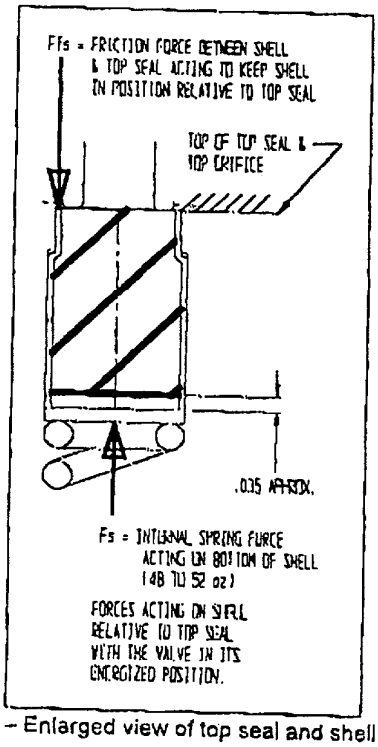

Figure 7 – Enlarged view of top seal and shell in the energized position with bottom of shell flush with seal: