P.B.V.®
A GFT COMPANY

12735 Dairy Ashford Road
Stafford, Texas 77477 USA
Toll Free: 1.800.256.6193
www.pbvvalve.com

December 15, 2008

⚠WARNING PBV trunnion supported ball valves manufactured during the period 1990 through 1997 have the potential for a trunnion and gland cap screw failure if the valve is installed in a sour service as defined by NACE MR0175 or is installed in a buried service with applied cathodic protection.

Our records indicate that your company may have purchased PBV three-piece style, trunnion supported ball valves manufactured during the years 1990 though 1997 and that high strength steel cap screws may have been used to retain the gland and trunnion on these valves. These gland and trunnion cap screws may be susceptible to hydrogen embrittlement should they come in contact with atomic hydrogen. Appendix 1 of this notification provides background information and information on the hydrogen embrittlement failure mechanism.

Recommendation

We recommend that the standard high strength steel cap screws used in trunnion supported, three-piece style PBV ball valves manufactured during the period 1990 through 1997 be replaced with lower hardness cap screws if the valve is installed in a sour service as defined by NACE MR0175 or is installed in a buried service with applied cathodic protection. PBV will provide these cap screws at no cost

Valves that are affected by this notification

Affected valves:

- Trunnion supported, three-piece style PBV ball valves manufactured during the period 1990 through 1997 with standard high strength steel cap screws that are installed in a sour service as defined by NACE MR0175 or are installed in a buried service with applied cathodic protection

Valves not affected:

- PBV floating ball valves
- Trunnion supported, two-piece style PBV ball valves

CAUTION **Use extreme caution before uncovering or operating valves covered by this notification.**

What to do

If you believe you have trunnion supported, three-piece style PBV ball valves that may be affected by this notification you should:

1. Confirm the valves are installed in either:
   A. A sour service as defined by NACE MR0175.
   B. A buried service with applied cathodic protection.

2. Confirm the date of manufacture. The date of manufacture can be determined by the valve serial number. The serial number is on the valve nameplate and stamped into the valve body. To help you determine if the valve was made prior to 1998 the serial number format used for the period in question is MMYYXXX, where MM is the month, YY is the year, and XXX is the sequential number for the month.

If you have unidentified buried valves contact PBV for information concerning unique physical characteristics of PBV valves which may make identification possible by looking down a valve box or with minimal excavation.

If in steps 1 and 2 above you confirm you have trunnion supported, three-piece style PBV ball valves manufactured during the period 1990 through 1997 installed in a sour service as defined by NACE MR0175 or installed in a buried service with applied cathodic protection you should contact PBV with the list of serial numbers to determine if the cap screws in your valves should be replaced. If it is determined that the cap screws in your valves need replacing PBV will provide the cap screws and a procedure for replacing the cap screws without removing the valve from the line. The PBV factory contact information is:

PBV-USA
Attn: Randy Mayson
12735 Dairy Ashford
Stafford, TX 77477
Randy.Mayson@pbvvalve.com
281-340-5400

or

PBV-USA
Attn: Rhonda Pereyra
12735 Dairy Ashford
Stafford, TX 77477
Rhonda.Pereyra@pbvvalve.com
281-340-5400

PBV is committed to providing high quality products to our customers. If you have any questions concerning this notification please contact Randy or Rhonda at the PBV factory.

Appendix 1

H_2S service background

There were two reported instances of cap screw failures on trunnion mounted PBV ball valves in a sour service as defined by NACE MR0175 that resulted in a release of product. These product releases were the result of failed cap screws that fasten the trunnion to the valve body. When the cap screws failed, the trunnion was ejected from the valve body, which resulted in a release of product from the pipeline. These valves were manufactured prior to 1998. The valves were reportedly installed in a sour service and failed after a short period of time.

Buried service background

There have been two recent instances of cap screw failures on trunnion mounted PBV ball valves that resulted in a release of product. The two product releases were the result of failed cap screws that fasten the trunnion to the valve body. When the cap screws failed, the trunnion was ejected from the valve body, which resulted in a release of product from the pipeline. Both valves were manufactured in 1996 and reportedly installed in a buried cathodically protected service in early 1997. The cap screws in these valves failed after approximately ten years in service.

Investigation

From the information learned from investigations of these failures, we believe the cause of the failures was hydrogen embrittlement. In the case of the valves in sour service we believe the source of the atomic hydrogen was the H_2S in the pipeline product. In the case of the valves in buried service we believe the source of the atomic hydrogen was the chemical reaction generated by a cathodic protection circuit.

Hydrogen embrittlement failure mechanism

Hydrogen embrittlement is a form of environmentally assisted cracking whereby tensile stress associated with a part or component combines with a source of atomic hydrogen in a susceptible material resulting in a loss of ductility, brittle cracking and failure. Figure 1 shows the hydrogen embrittlement mechanism schematically as the intersection of three factors: stress, hydrogen and material. Typically, steels increase in susceptibility to hydrogen embrittlement with increasing strength, increasing levels of applied stress and increasing levels of atomic hydrogen. The resultant failure mechanism can be represented by enlarging the size of the appropriate circle in the diagram when a particular susceptibility parameter increases in severity. This results in an increased susceptibility to hydrogen embrittlement failure, which is reflected schematically as a larger intersection of the circular areas in Figure 2.

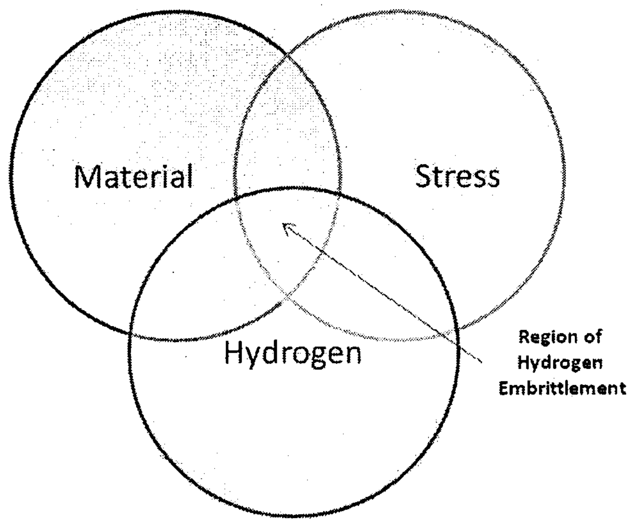

Figure 1 – Schematic of hydrogen embrittlement failure mechanism (only produced in the intersection of the three zones – material, hydrogen and stress).

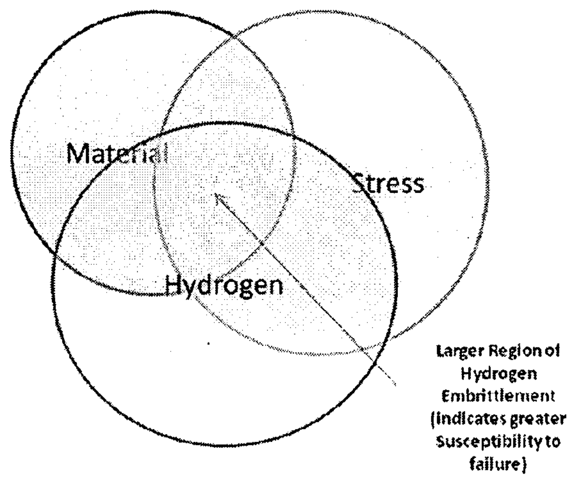

Figure 2 – Modified schematic of hydrogen embrittlement failure mechanism (Note – Shows increased susceptibility to hydrogen embrittlement due to increased amount of atomic hydrogen and increased level of stress).

There are two potential sources of atomic hydrogen in a pipeline system. The first is the presence of hydrogen sulfide in product in the pipeline. The second source of atomic hydrogen originates from the cathodic protection system on the buried steel pipe and adjoining metallic components.

In the cases where the cap screw failures were the result of hydrogen sulfide in the pipeline, the hydrogen sulfide produced atomic hydrogen on the metal surface as a result of the sulfide corrosion reaction shown below:

$$Fe + H_2S = FeS + 2H_{(atomic)}$$

The atomic hydrogen produced on metal surfaces progresses in two ways. Some of the hydrogen recombines to form molecular hydrogen that bubbles off the surface of the metal. However, a portion of the atomic hydrogen is absorbed by the steel and diffuses to locations of high stress in the steel, thus contributing to hydrogen embrittlement. The presence of the sulfur from the hydrogen sulfide promotes the absorption of the hydrogen into the steel, which increases the potential for hydrogen embrittlement.

In the cases where the cap screw failures were the result of cathodic protection on valves in buried service, a cathodic protection current is applied to the pipeline using a series of field-based rectifiers. This may also be supplemented locally by sacrificial anodes in some cases. The rectifiers are used to hold the exposed steel at a sufficient cathodic potential to effectively negate the steel oxidation corrosion reaction in the buried environment. In doing so, it replaces the corrosion reaction on the metal surface with the following cathodic reaction:

$$2H_2O + 2e^- = 2(OH)^- + 2H_{(atomic)}$$

The amount of atomic hydrogen increases with the potential used for cathodic protection. A portion of the atomic hydrogen produced by cathodic protection recombines to form molecular hydrogen and a portion stays as atomic hydrogen and diffuses into the steel. Once inside the steel, the atomic hydrogen diffuses to areas of locally high stress to produce the hydrogen embrittlement mechanism of failure. The steel used for the cap screws in pre-1998 PBV three piece style, trunnion mounted ball valves have relatively high hardness, which makes them less resistant to hydrogen embrittlement.

This atomic hydrogen does not cause failure in the other valve components because these components are made from steels of lower hardness and therefore they have a lower susceptibility to hydrogen embrittlement than the steel in the cap screws. Using the schematic presented previously to analyze the susceptibility of the other valve components to hydrogen embrittlement, the three regions in the diagram form no intersection (See Figure 3). This same diagram illustrates why the lower hardness replacement steel cap screws are not susceptible to hydrogen embrittlement.

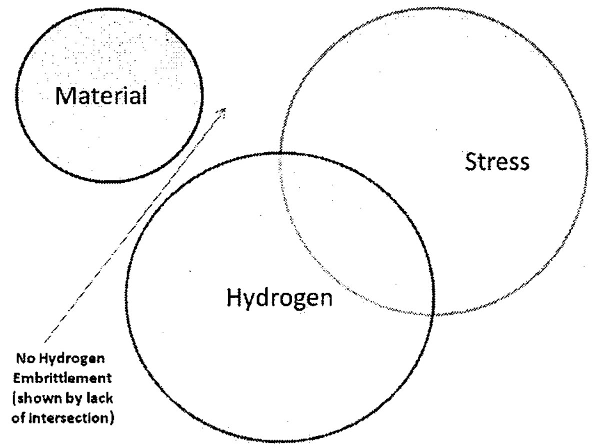

Figure 3 - Modified schematic of hydrogen embrittlement failure mechanism
(Note – Shows no susceptibility to hydrogen embrittlement due to
decreased material hardness).