THE ENVIRONMENTAL TECHNOLOGY VERIFICATION PROGRAM

ETV

U.S. Environmental Protection Agency

Southern Research Institute

ETV Joint Verification Statement

TECHNOLOGY TYPE:	**Pressure Relief Valve**		
APPLICATION:	**Pressure Relief Valve for Low-Pressure Tank Protection**		
TECHNOLOGY NAME:	**Pin-Tech Bubble Tight < 500 ppm Relief Vent**		
COMPANY:	**The Protectoseal Company**		
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The U.S. Environmental Protection Agency (EPA) has created the Environmental Technology Verification (ETV) Program to facilitate the deployment of innovative or improved environmental technologies through performance verification and dissemination of information. The goal of the ETV Program is to further environmental protection by substantially accelerating the acceptance and use of improved and cost-effective technologies. ETV seeks to achieve this goal by providing high quality, peer reviewed data on technology performance to those involved in the design, distribution, financing, permitting, purchase, and use of environmental technologies.

ETV works in partnership with recognized standards and testing organizations, stakeholder groups which consist of buyers, vendor organizations, and permitters, and with the full participation of individual technology developers. The program evaluates the performance of innovative technologies by developing test plans that are responsive to the needs of stakeholders, conducting field or laboratory tests (as appropriate), collecting and analyzing data, and preparing peer reviewed reports. All evaluations are conducted in accordance with rigorous quality assurance protocols to ensure that data of known and adequate quality are generated and that the results are defensible.

The Greenhouse Gas (GHG) Technology Verification Center (the Center), one of 12 technology areas under ETV, is operated by Southern Research Institute, in cooperation with EPA's National Risk Management Research Laboratory. The Center has recently evaluated the performance of the Pin-Tech Bubble Tight < 500 ppm Relief Vent, which is a pressure relief valve for storage tanks, offered by The Protectoseal Company. This verification statement provides a summary of the test results for different models of this product.

TECHNOLOGY DESCRIPTION

Pressure relief valves (PRVs) are used in industry to protect storage tanks from damage caused by over-pressurization. Many are used in the oil industry for low-pressure (<15 psig) storage tanks, which contain volatile organic liquids like crude oil and chemical feed stocks. The Pin-Tech PRV incorporates a buckling pin that is designed to set the relief pressure. It is also designed to keep the valve tight from leaking substantial quantities of volatile organic compounds, including methane (a potent greenhouse gas), when the valve is in the non-venting mode. If the pressure inside the vessel rises to the set point, a pressure where the tank can be damaged, the relief pin is designed to buckle allowing a piston to rise and relieve the pressure. This test focuses on determining the valve's leak tightness in the non-venting mode. The Pin-Tech device is designed to reduce overall emissions of tank product vapors by maintaining "no detectable emissions" (<500 ppmv) in the non-venting mode.

The two versions of the Pin-Tech device that were tested are a direct-acting version and a diaphragm-assisted version. Both act basically the same except that the diaphragm-assisted version is used for very low-pressure applications and employs a diaphragm to focus the small pressure increase in the vessel on the buckling pin.

VERIFICATION DESCRIPTION

The three parameters that were verified are:

- **Leak Tightness**: Determine the PRV's leak tightness in the non-venting mode by performing direct concentration measurements.
- **Set Pressure Accuracy**: Compare the PRV's design set pressure versus the actual relief pressure.
- **Repeated Pin Stress Impact**: Assess the effect of repeated pin stressing on the PRV's leak tightness as the relief pressure is approached.

Four different Pin-Tech devices were tested; two direct-acting and two diaphragm-assisted. These valves represent the size range of the Protectoseal Pin-Tech product line. The Pin-Tech evaluation was conducted in a mobile laboratory designed and equipped for testing pressure relief valves. The laboratory setting allowed the tests to cover a wider range of test conditions in a more expedient manner than if the tests were conducted in the field on actual tanks. The test apparatus consisted of a gas cylinder, pressure regulator, pressure gauge, and receiving tank. The device to be tested was bolted to a fitting on top of the receiving tank, after which the tank was filled with the pressurized gas. The test gas was methane at 1.5 percent in nitrogen. This concentration was selected using the Gas Research Institute's Production Tank Emissions Model (E&P TANK version 1.0) to estimate the vapor composition in the headspace of a typical crude oil storage tank. A range of 3,300 to 22,900 ppmv total hydrocarbons was predicted. Based on this, a methane concentration of 15,000 ppmv (1.5 percent) in the tank was selected as the target value for testing.

Each PRV was tested by incrementally increasing the pressure on each valve until the valve relieved. Methane concentration measurements were obtained at the leak interface for each pressure increment. The initial pressure was approximately half of the relief set point. The pressure increments were approximately 0.5 psi for the higher-pressure valves, and approximately 1 in. water column (~0.5 oz/in.^{2}) for the low-pressure valves. Methane concentration measurements were obtained in accordance with EPA Method 21 procedures (40 CFR Part 60). An AutoFim II portable flame ionization detector (FID) was used to measure the methane concentration. This device exceeded all Method 21 performance specifications for leak screening including response time (9 seconds/30 seconds allowed) and calibration precision (3.2 percent/10 percent allowed).

Each Pin-Tech device was also tested to compare the design set pressure to the actual relief pressure of the valve. The pressure was incrementally increased while methane concentration measurements were made, and this was done until the valve relieved. Each test began at approximately half the design set point and increased to the point

where the valve released. This release pressure was recorded, and the entire cycle was repeated at least three times for each Pin-Tech device. Due to the very low set pressures for the diaphragm-assisted Pin-Tech devices, the actual relief pressure was difficult to accurately pinpoint, and thus is presented as a range.

As the set pressure is approached, the pin begins to bend or deflect. Therefore, the third objective of the verification test was to determine if the leak tightness of the Pin-Tech device was compromised after repeated deflections of the pin. A single set of tests was performed on the 2 in. direct-acting Pin-Tech device. Due to the size of the pin, deflection was most easily noticed for this valve. The test started at half the design relief pressure. The pressure was incrementally increased at approximately 0.5 psig steps, with methane concentration measurements made at each step. The incremental increases continued until the pin showed deflection. The pressure was then returned to half the design pressure, and the process was repeated to simulate different levels of stress on the pin. This was done a total of 12 times. Three distinct levels of deflection were noted: slight, moderate, and high. The test was continued as described until all three levels of deflection were encountered.

An attempt was made to determine a baseline emission rate for conventional weight-loaded PRVs. These devices are widely used in the industry, and thus would provide a basis from which potential emission reductions could be determined for the Pin-Tech devices tested. Two weight-loaded devices were tested to estimate this baseline, but it was concluded that testing only two devices and testing in a laboratory setting did not give the degree of representativeness required to make adequate conclusions about emission rates. This baseline establishment was abandoned, but data on the leak tightness of these valves were collected and are presented below.

VERIFICATION OF PERFORMANCE

- **Leak Tightness:** The Pin-Tech devices tested are 2 in. direct-acting, 24 in. direct-acting, 2 in. diaphragm-assisted, and 24 in. diaphragm-assisted. Emissions during the tests, from all the valves in the non-venting mode, were never greater than 25 ppmv. This is well below the 500 ppmv screening concentration specified by equipment leak requirements found in Parts 60, 61, and 63 of Title 40 of the Code of Federal Regulations**.** In a baseline test, two weight-loaded conventional PRVs (each tested twice, in the same manner) exceeded 1000 ppmv screening concentration before the set points were reached.

- **Set Pressure Accuracy:** The 2 in. and 24 in. direct-acting Pin-Tech devices relieved at 4.7 percent and 2.3 percent (respectively) above their design set pressures. For the diaphragm-assisted valves, the relief pressures are given as ranges since it was difficult to accurately pinpoint the exact relief pressure, possibly as a result of test equipment sensitivity. The 2 in. and 24 in. diaphragm-assisted valves relieved at between 138 and 195 percent and 0 and 40 percent (respectively) above their design set pressure.

- **Repeated Pin Stress Impact:** After the pin had been stressed to visible deflection multiple times, there was no significant increase in concentration. Measured concentrations remained below 20 ppmv throughout the test.

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