CASE STUDY

Elvington To Brayton Barff Air valve replacement Program

Vent-O-Mat "Anti-Shock" Air valves have helped Yorkshire Water reduce maintenance costs, reduces surge and improve flows in their trunk mains.

Overview

Following frequent air valve failure and a marked deterioration in pipeline performance within in a key section of main within the Yorkshire water grid, the existing double orifice air valves were replaced with Vent-O-Mat "Anti-shock" air valves from Cla-Val. As a result, air valve failure has been eliminated, surge pressures considerably reduced and flow capacity increased.

A joint study was undertaken between Cla-Val UK and Yorkshire water to quantify the relative performance.

The Elvington pumping station to Brayton Barff reservoir system forms part of Yorkshire waters strategic grid built circa 1965. Up to 180 Ml/day is transferred 13.6 miles to Brayton Barff reservoir using up to eight vertically mounted three stage Centrifugal pumps each fitted with a swing type check valve. Additional capacity is available from Riccall pumping station approximately 8.8 miles downstream. Water is transferred from Elvington through a single 42" welded steel pipeline to Riccall pumping station. This 8.8 mile section incorporates seven air valve chambers containing nine 6" double orifice air valves at the high points. A 10 megalitre contact tank immediately downstream of Elvington feeds into the system in the event of pump trip.

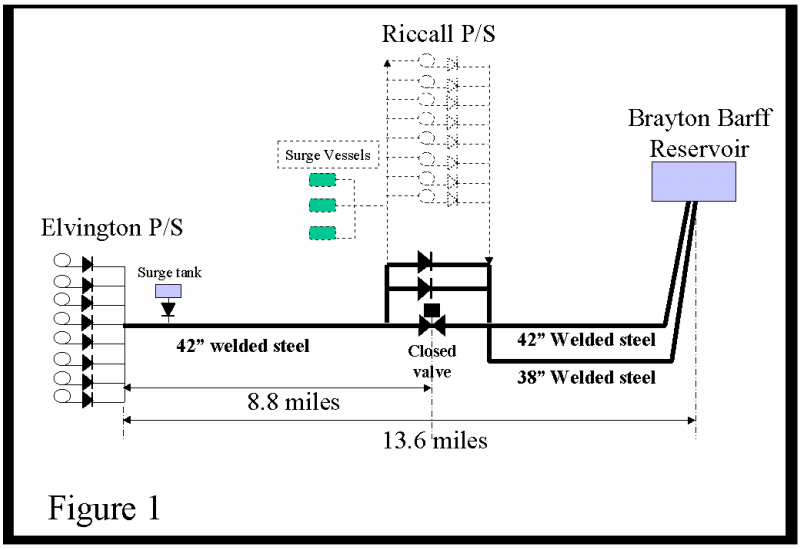

Figure 1

For the purposes of the test, Riccall pumping station was bypassed and water diverted through two 800mm diameter multi-door check valves, each feeding into welded steel pipes of 38" and 42" respectively providing a dedicated supply to Brayton Barff reservoir **(figure 1)**

The focus of the study is the single 42" pipeline between Elvington and Riccall Pumping stations where the velocity in the pipeline can exceed 2 m/s resulting in considerable air valve damage during pump trip conditions. The study involved installing 2 surge loggers (sampling at 0.05 second intervals) at the inlet flange of the following air valve sites to record pressures throughout a pump trip event **(figure 2)**.

1. Millfield Lane (AV3) chainage 3.25 miles, fitted with twin 6" Air valves.
2. Riccall (AV7),chainage 8.5 miles situated approximately 0.5 miles upstream of Riccall Pumping station.

Recorded data at Millfield Lane **(figure 3**) shows pressure falling to zero with a resulting negative pressure. (the surge loggers were not designed to measure negative pressure). This was rapidly followed by atmospheric pressure as the air valve opens to draw air into the pipeline. The low pressure wave reflects back from the now closed check valves at Riccall. As the pressure starts to build, air is being exhausted at very high velocity leading to premature lifting of the ball on to the seat of the air valve before all the air is released. The resultant surge

wave can be seen to dissipate slowly as it is totally dependant on the pipeline friction to bring the pipeline to a steady state condition. Air is remaining in the pipeline as the ball is kept closed by differential air pressure. This aggravates the oscillation in the system and reduces its performance because the retained air acts like an orifice plate, increasing power consumption whilst reducing output.

The close proximity of AV7 to the check valves at Riccall, shows a low pressure wave being followed appox. 1.5 seconds later by the reflected pressure, resulting in a –1.5 meter to 106.4 meter deflection **(figure 5)**

The high frequency of air valve failure was caused by the very rapid change from atmosphere where the ball dropped, followed immediately by the reflected pressure from the check valves resulting in the deformation of the hollow metal float **(figure 8)**

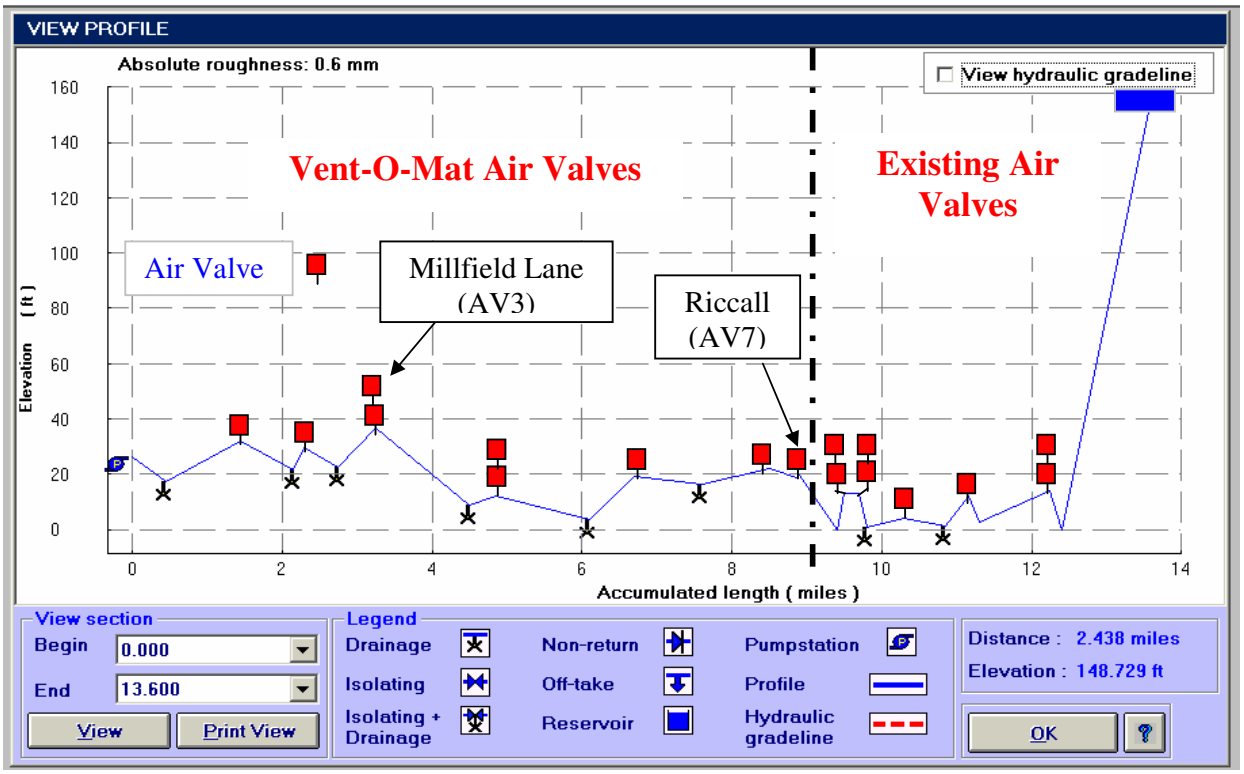

Figure 2

Yorkshire Water agreed to perform a six month trial of a 150mm Vent-O-Mat series RBX1601 “Anti-shock” air valve from Cla-Val UK at AV7 to assess its durability under pump trip conditions.

The Vent-O-Mat provides a high capacity air release and vacuum breaking capability together with a unique “Anti-Shock” orifice to provide controlled air release during the critical moments prior to the elimination of the remaining air pocket.
Furthermore, the floats are made from solid and shatterproof HPDE capable of withstanding high operating pressures. Following the success of the trial, the remaining eight air valves along the 8.8 miles section of pipeline between Elvington and Riccall were replaced with 150mm Vent-O-Mat series RBX1601 valves.

Subsequent logging of the pipeline has shown a reduction in the magnitude of the peaks at AV7- Riccall by over 20% **figure 6** and the elimination of the reflective surge wave around the Millfield Road Air valve (AV3) installation **Figure 4**. This happens as the “Anti-Shock” orifice

releases air in a controlled manner, thus absorbing the pressure transients in the retained air and dissipating it to atmosphere.

Early indications show a 3% increase in pipeline performance, where flow capacity has increased by approximately 5 Megalitres per day. This represents a considerable saving in energy costs where running costs at Elvington pumping station are approx. £1 million per annum. Following the success of the project, all remaining double orifice air valves between Riccall and Brayton Barff are to be replaced with Vent-O-Mats, which is predicted to increase performance by a further 3.5% whilst replacement of the swing type check valves will further reduce the magnitude of pressure rise.

MILLFIELD AIR VALVE (AV3)

Original Air Valve

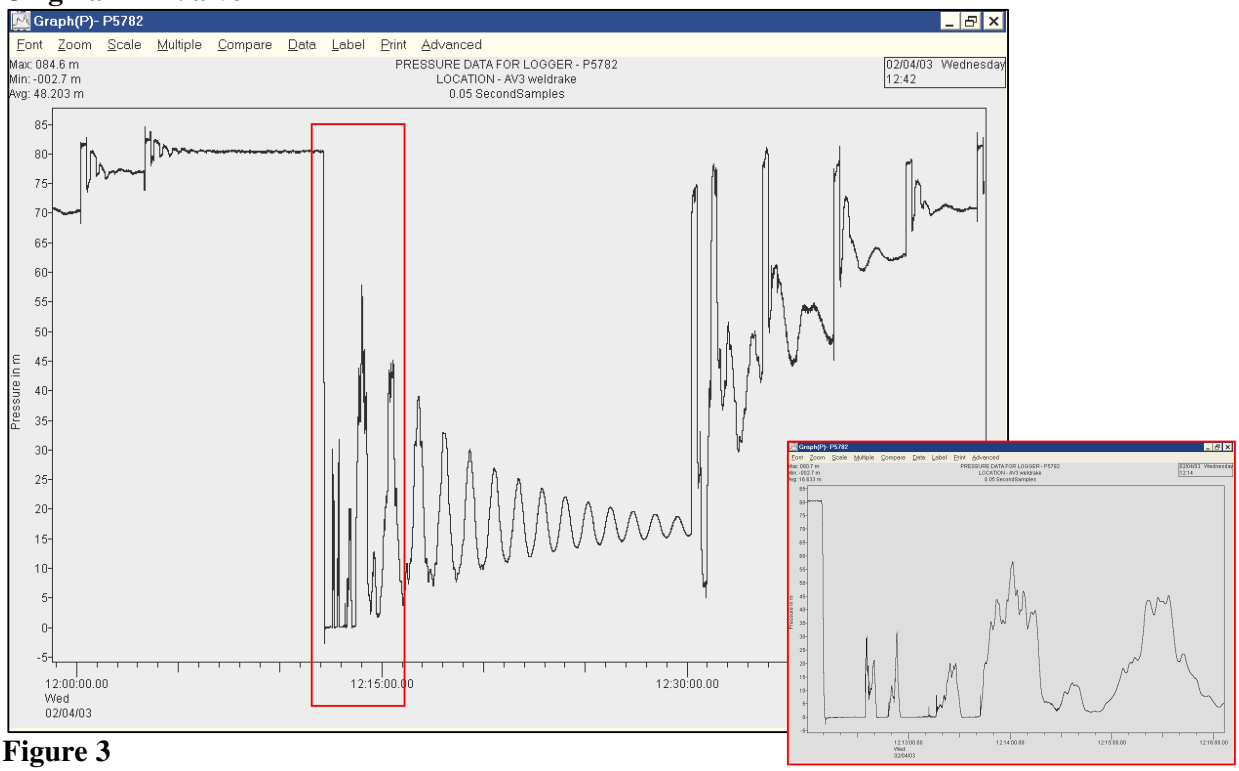

Figure 3

Vent-O-Mat

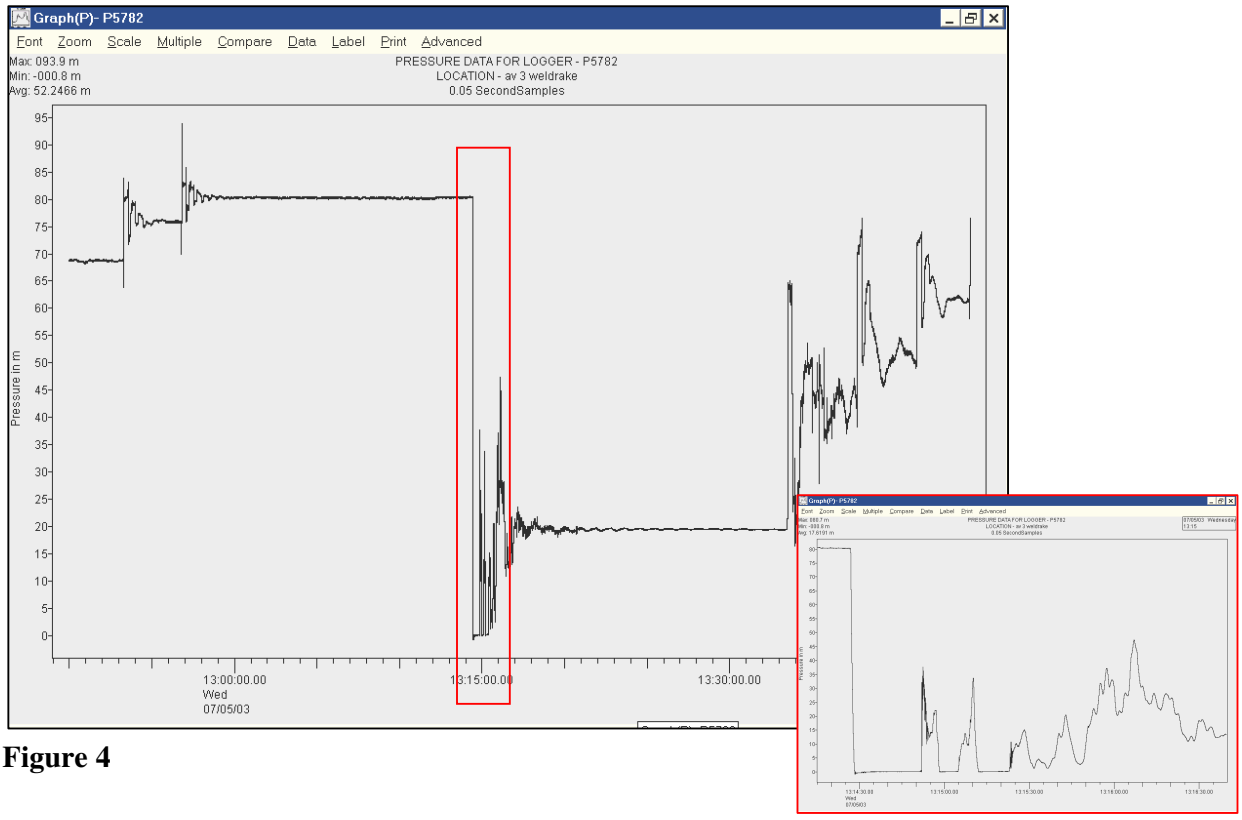

Figure 4

RICALL AIR VALVE (AV7)
Original Air Valve

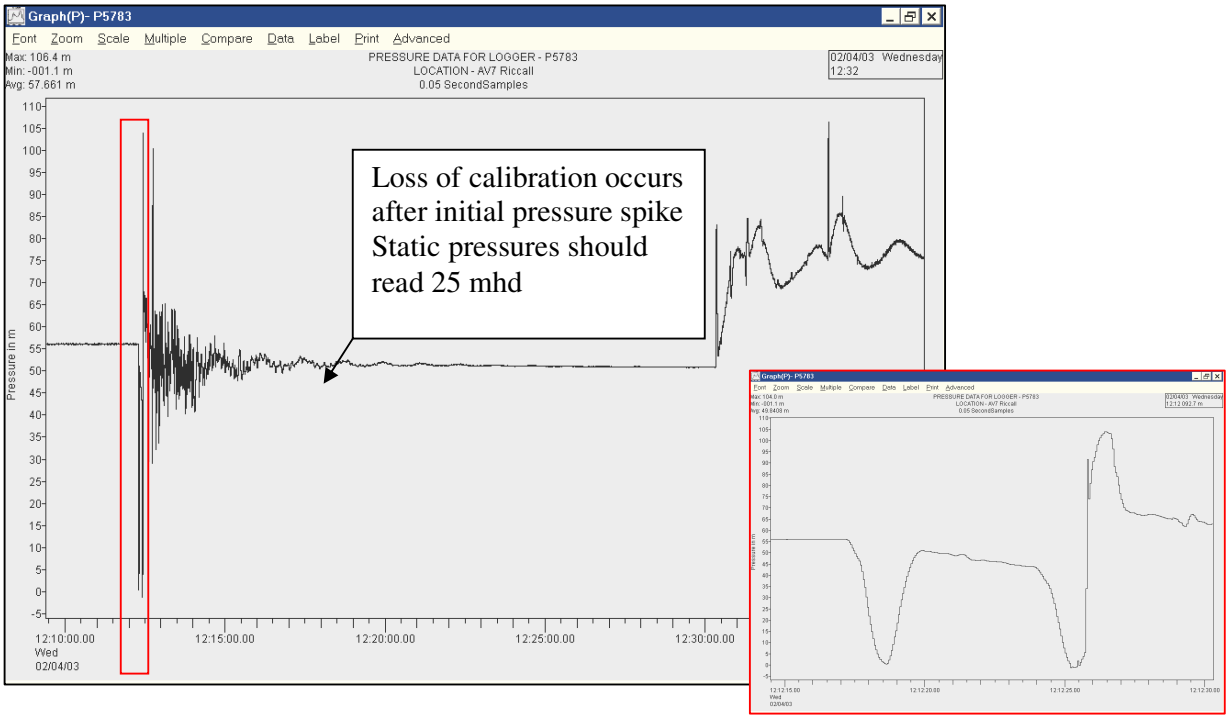

Figure 5

Vent-O-Mat Series RBX valve

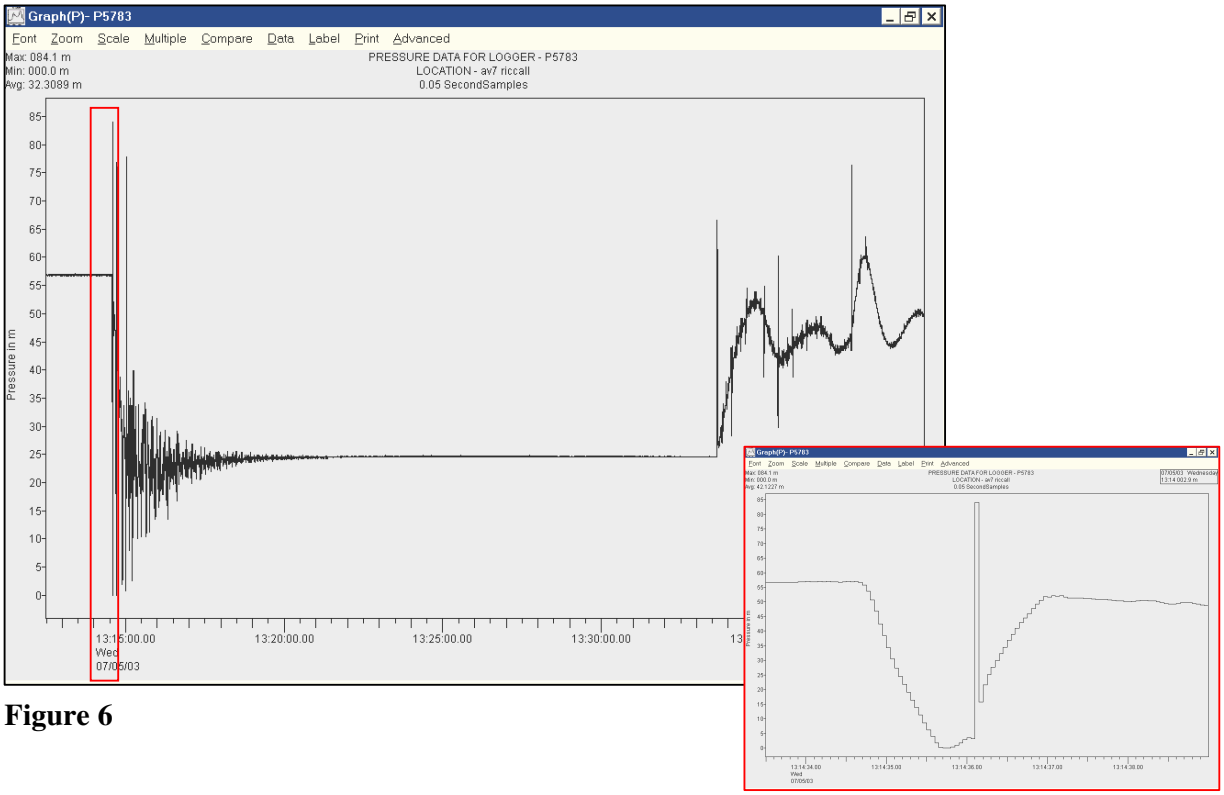

Figure 6

Ricall Air Valve Chamber – Taken Immediately after pump trip.

Figure 7

Millfield Lane Air Valve Chamber

2 x 150mm Vent-O-Mat RBX1601

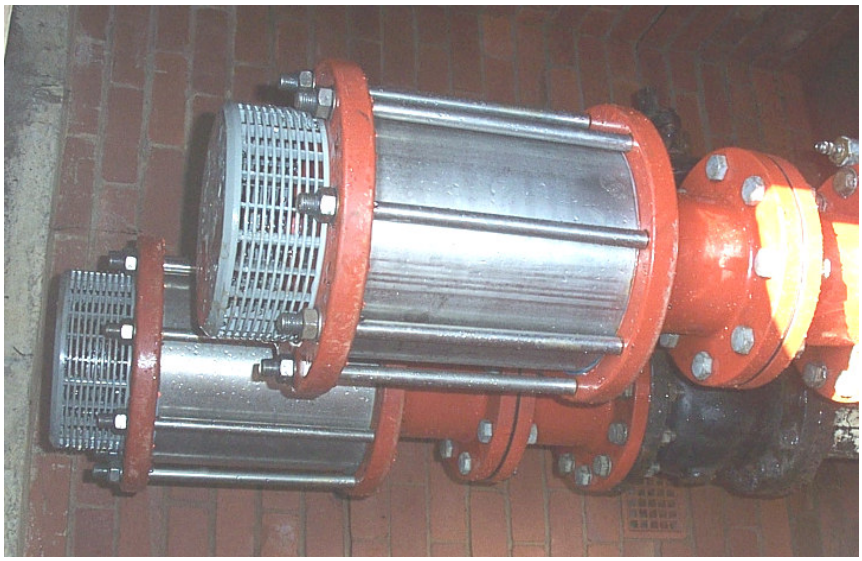

Figure 8

Date: May 2003