How Resilient Hinge Check Valves could save the UK Water industry £millions.

Abstract

This business white paper illustrates the exponential monetary savings and operational benefits of employing Resilient Hinge Check Valves (RHCV), or a Recoil Resilient Hinge Check Valves (RRHCV), versus simple Weight & Lever Swing Check Valves.

The author demonstrates that the whole life cost benefits of a RHCV, such as the Val-Matic® Swing-Flex™, over the next 5 AMP periods could result in savings, for a moderately sized water company, approaching:

- Up to £40m on reduced maintenance costs.
- Up to £9m from not having to replace the valve.
- Energy savings amounting to more than £4m.

The paper explores the changing regulatory environment presented by the UK Water Industry move towards TOTEX. It then provides an overview of the basic construction and operation of Weight & Lever Swing Check Valves before demonstrating the superior attributes, and data proven monetary savings, of switching to RHCV or RRHCV alternatives.

Image 1: Val-Matic Swing-Flex™ Resilient Hinge Check Valve (RHCV) (showing optional mechanical indicator)

Image 2: Val-Matic Surgebuster™ Recoil Resilient Hinge Check Valves (RRHCV) (showing optional mechanical indicator)

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1.0 Introduction

As the UK Water Industry moves into AMP 6, taking a 'TOTEX' approach is now an extremely high priority. This theme can be seen to be dominating thinking and behaviours and is expected to dramatically influence supply chain selection for the next five years and beyond.

But just how far, and how quickly will any new practices extend into the supply chain?

This paper takes a brief look at how the appropriate selection of something as straightforward as a Non Return Valve (NRV) can save the Water Operating Companies millions of pounds over the operating lifecycle of the product.

2.0 TOTEX

"A total expenditure, or TOTEX approach considers expenditure in a more holistic way. This means looking at a total expenditure requirement rather than separate OPEX and CAPEX allowances." OFWAT

This effectively means that the UK Water Industry is being urged to take a longer-term decision making approach to its operational behaviour. This is a major change in the regulatory environment and it will prompt companies to think carefully about their organisational structure and their approach to the management of both their assets and risk.

Understanding the interrelationship between capital and operational costs will have a major part to play in achieving the TOTEX objectives. From now on, asset decision making will require an intimate understanding of component capital cost and dynamic performance; operational costs; return on investment; existing asset mortality; component energy usage and energy improvement potential.

3.0 Non-Return Valve (NRV)

The simple Weight & Lever Swing Check Valve is already deployed in significant numbers throughout the entire UK Water Industry.

3.1 Basic construction and operation of Weight & Lever Swing Check Valve

This valve contains a hinge and disc assembly of up to a dozen or so components that can snag fibres and rag up in wastewater applications. This can ultimately cause the valve to block or clog up, increasing the necessity for regular maintenance.

The Water Industry Mechanical and Electrical Specifications (WIMES) and Asset Standards for many Water Companies often specify the inclusion of an external arm or lever and weight (with a protective guard) to ensure the valve closes with an increased speed.

This weight can also often prevent the valve from fully opening, as it requires a fluid velocity of around 2.5m/s, and the arm can often be seen to lift only half way. This increases steady state head loss and reduces flow through the valve. The arm can often be seen to be oscillating

at the hinge, increasing wear of the hinge assembly, resulting in leaking hinges and ultimately in disc hinge assembly collapse.

Even with the additional weight, the valve can be slow to close. This can allow reverse velocities to increase to such a point that the disc is slammed into the seat, causing damage to both disc and seat and allowing high surge pressures to reach the pump. This can damage pump shaft seals and impellers and lead to considerable unnecessary expenditure.

Often the seat is not drop-tight and, as wear progresses, the NRVs can allow passing of the fluid; 'reverse turbining' of the pump; damage to pump seals; and the additional cost of re-pumping fluid that has drained from the rising main back into the wet-well. In clean water applications this can result in contamination of bore holes and reservoirs.

3.2 Summary

Due to the large installed user base of the Weight & Lever NRV throughout the industry, the cost consequences of failure and/or poor performance can be astronomically high. However, these costs are not always directly visible from a cause and effect perspective.

By specifying this type of product as a standard within projects, Water Companies can sometimes be susceptible to the supply of valves that merely meet the minimum valve specification requirement; the Cast Iron Check Valve Standard, BS EN 12334 for example.

This can sometimes result in manufacturers driving the cost of the product down and subsequently the quality, robustness and longevity of the valve can sometimes be compromised. Very often, these valves can have a moderately short life span. In some more severe applications, it has been observed that they may need to be replaced every two to three years, or perhaps even sooner.

4.0 Is there a viable alternative?

When asked to define the characteristics of the perfect NRV, Water Industry engineers asked for a valve that had been proven to minimise clogging in wastewater applications, would eliminate slamming, would require little or no maintenance; could be mounted in a vertical orientation without compromising performance and could bring significant whole life cost benefits!

4.1 Does such a product exist?

Such a product is already a rigorously tried and tested solution and this paper illustrates that over the guaranteed product life cycle of 25 years, and for a moderately sized Water Company, its deployment can bring about vast cost savings.

For example, the following savings can easily be realised:

a) Cost savings of up to £40m on reduced maintenance costs – see Table 1.
b) Energy savings amounting to over £4m – see Table 2.
c) Cost savings of up to £9m from not having to replace the valve – see Table 3.

The Val-Matic Swing-Flex™ Resilient Hinge Check Valves (RHCV) and the Surgebuster™ Recoil Resilient Hinge Check Valves (RRHCV) have been in circulation for nearly 30 years. However, it is only over the last four or five years that they have been introduced to the UK. They have now been successfully trialled and deployed in hundreds of installations throughout the UK Water Industry.

4.2 Basic construction and operation of RHCV

The **RHCV** was designed to be clog-free in the vertical and horizontal orientation. As supplied in the UK, the valve has a 45° seat; 35° stroke; a non-stick Fusion Bonded Epoxy Coating, internally and externally; and a Buna-N or Ethylene Propylene Diene Monomer (EPDM) fully encapsulated, drop-tight disc that is ideal for handling Hydro-Carbons, and Hydrogen Sulphide, as well as clean water.

The valve construction contains no snagging points and along with the non-stick finish, does not rag-up. It therefore requires little or no maintenance in typical raw sewage or sludge handling applications.

The speed of closure, due to the short stroke from fully open to fully closed, is such that the valve often closes silently before reverse velocities can build up. Protection of the pump is improved as it prevents the repetitive strain, caused by high surge pressures from reaching the pump on every shut-down.

The valve is fully open at fluid velocities of 1.5m/s through the fully open valve and the head loss is half that of a typical W&L SCV, resulting in year-on-year energy savings. Improved flow through the valve can also encourage cleansing velocities, helping to maintain a healthy wastewater pumping system.

The disc hinge is guaranteed to perform for 25 years in a typical SPS application and the drop-tight performance is achieved by having an O-ring moulded into the disc. This can significantly reduce re-pumping costs.

Since there is no arm and weight, it removes the problem of the frequent omission of the guard, which can be an important health and safety concern. With no hinge assembly, there is no leak path, a major cause for the flooding of SPS dry wells with a hazardous fluid, and a cause of clean water leakage.

With the RHCV now being described within WIMES 8.09, the valve type can now be specified as an alternative to the historical Swing Check Valve not only for projects and/or extreme applications but also for mainstream applications.

The RRHCV version is a faster closing variant of the valve and increases the speed of closure by more than 50 per cent in common sizes. It maintains all the benefits of the RHCV and is interchangeable with a typical Weight & Lever check valve. This allows Pumping Station upgrades with increased flow dynamics and will protect against surge, without pipework modification.

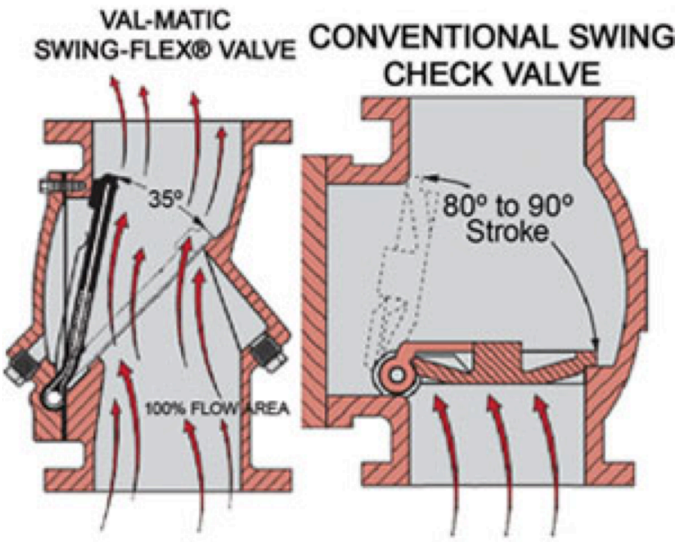

Image 3: Val-Matic Swing-Flex™ Resilient Hinge Check Valves (RRHCV) compared to a standard Weight & Lever Check Valve

4.3 Summary

To summarise, this alternative design of NRV will:

- Reduce maintenance costs, significantly in wastewater applications.
- Reduce pump energy consumption due to lower head loss by up to a half.
- Reduce pumping costs with improved flow and drop-tight seating.
- Provide greater pump protection with an increased speed of closure, minimising wear and tear of pump components and subsequent maintenance.
- Achieve silent closure helping to resolve customer complaints.
- Improve the working environment by protecting against contaminating leakage.
- Reduce clean water losses by having no leak path.

The design of the RHCV is not new. It has been successfully deployed and proven globally for nearly 30 years. What is new however, is the regeneration and testing of the design over the last four years to comply with the stringent dimensional and performance of British Standards for both clean and wastewater applications.

Within the UK, these valves have now been successfully deployed in Pumping Stations and Wastewater Treatment Works across many of the UK Water Companies, often in circumstances where slamming or frequent ragging has presented a longstanding challenge for the plant operators.

In such instances, the valves have not only fulfilled performance expectations but, due to the valve's **25 year warranty** and its **'fit and forget'** philosophy, it is now becoming apparent to UK operators that this valve delivers significant whole-life cost saving benefits.

Until the valve had achieved compliance with BS EN 12334 and was included within WIMES, it was being trialled across the UK and was not readily available for widespread adoption by the UK operators.

Now that this process has been completed and the valve type is now being included within the Water Industry Asset Standards, the valve is proving to be a cost-effective alternative to the standard Weight & Lever Swing Check Valve for almost all scenarios and applications.

5. Operational and maintenance cost savings

Whilst the RHCV's performance in severe operating applications is unquestionable, how does it actually compare on cost with the conventional Weight and Lever Swing Check Valve?

As well as mitigating against the unforeseen consequential cost of failures, the RHCV and RRHCV valves bring clear additional operational savings over the lifecycle of the immediate TOTEX directive of 20-25 years. These can come in the form of reduced maintenance costs and reduced energy consumption due to the lower head losses and also reduced valve replacement costs.

The table below helps us to better understand where the main savings occur for three different scenarios. For the purposes of this analysis we have assessed the costs for raw sewage with:

A. A high rag content.
B. A lower rag content.
C. A much reduced rag content.

As a valve de-ragging frequency will consume maintenance time and resources, it will therefore have a direct impact on cost. By analysing for different operating conditions, it allows us to compare best and worst case scenarios

Table 1.
Life cycle maintenance cost analysis of a typical weight & lever check valve

Scenario	Description	Frequency of manual de-ragging of typical W&L NRV	Average annual cost of de-ragging of typical W&L NRV	Typical 25 yr. maintenance costs
A	Raw sewage with a high rag content	every 3 months	£800	£20,000
B	Raw sewage with a lower rag content	every 6 months	£400	£10,000
C	Screened raw sewage with a much reduced rag content	every 12 months	£200	£5,000

For a Water Company with say 1,000 pumping stations, deploying more than 2,000 Weight & Lever check valves over a 25 year period, the maintenance costs can therefore range from £10m for screened raw sewage up to as much as £40m for extreme raw sewage conditions. The actual cost savings will be a composite of the savings across all 3 scenarios and will of course depend on the mix of valve sizes. (It is acknowledged that a Water Company must be able to redeploy its labour resources effectively to be able to realise such cost savings.)

However if these valves were to be replaced with a clog-free, maintenance free valve, such as the Val-Matic Swing-Flex™ NRV for example, the cost savings are undeniably impressive, particularly given the synergy with the TOTEX requirement to consider OPEX and CAPEX over four to five AMP periods. (20-25 years)

6. Energy cost savings

In addition to operational cost savings, the Val-Matic Swing-Flex™ NRV also provides operators with considerable energy cost savings, due to the considerably reduced head losses across the valve.

To facilitate a quantitative evaluation of the energy savings over a range of valve sizes, we have selected typical process media flow rates and have calculated the energy cost savings using an energy calculator. Calculations are based on the actual performance of Val-Matic Swing-Flex™ compared with Val-Matic Weight & Lever check valves in the field.

Table 2.
Life cycle energy savings for Val-Matic Swing-Flex™ versus a W&L check valve

Valve size	Flow rate l/s	Velocity m/s	Headloss m/h20 W & L	Headloss m/h20 Swing Check	Energy savings from using Swing Flex	Total 25 year cost saving
4"	20	2.47	0.497	0.247	£25/year	£625
6"	40	2.2	0.393	0.268	£40/year	£1,000
8"	80	2.47	0.497	0.247	£80/year	£2,000

Table 2. demonstrates that, depending on the valve size and flow rate, the energy savings alone can range from £625 over 25 years for a 4" valve up to £2,000 over 25 years for an 8" valve. This means for a moderately sized Water Company, with 2,000 sewage pumping stations, the energy savings alone could be as high as **£3-4m*** over a 25 year period. In addition, there will also be savings made due to a reduced duty cycle on the associated pumps. The energy savings that can be realised on the larger valve sizes can be expected to be even greater.
(* figure based on a valve size mix, 50% duty cycle, 80% efficiency and energy costs of 10p/Kwh)

7. Valve replacement cost savings

The standard W&L valve has been proven to have a relatively short life span, depending on its duty cycle. It is a known fact that de-ragging alone exacerbates the wear and tear on a valve's moving parts. If we therefore reasonably assume that a valve will need to be replaced after every ten or so de-ragging cycles, then we can see from the table below that over a 25-

year period, the cost of replacement can range from £1,125 to £4,500, depending on the severity of the duty cycle.

Table 3.
Costs savings achievable from having a 25-year valve guarantee

Scenario	Description	Typical W&L valve life expectancy (1)	Typical replacement costs of 8" hinged body W&L NRV over 25 year period
A	Raw sewage with a high rag content	2.5 years	£4,500
B	Raw sewage with a lower rag content	5 years	£2,250
C	Screened raw sewage with a much reduced rag content	10 years	£1,125

Note (1) - Assuming de-ragging takes place ten times before valve replacement becomes necessary and the cost of valve replacement and reinstatement is a conservative £450. It is acknowledged that there will be additional cost savings from failures of 4" & 6" valves also and these will contribute to the cost saving mix.

Once again, if we extrapolate these costs over a moderately sized Water Company with, for illustrative purposes, 2,000 such valves in operation, this tells us that the cost of valve replacement over a 25-year period can range from **£2.25m** to as much as **£9m**.

This is often a cost that is not readily visible. However, by replacing the standard W&L Check Valve with a product with a 25-year guarantee would undoubtedly bring about considerable cost savings in capital expenditure. It would also present a robust challenge to the economic justification for buying and installing cheaper and perhaps lesser quality products.

8. Proof and validation

The Val-Matic Swing-Flex™ NRV is neither a new product nor a new concept. This valve has been successfully deployed in the North American and Asia Pacific markets for nearly 30 years now.

What is relatively new, however, is that over the past four years or more, extensive work has been carried out to adapt and prepare this valve for the UK and European market place. Throughout this time the valve has been trialled and tested in extreme applications in hundreds of pumping stations across the UK.

The family of products has achieved the relevant British Standards compliance certification, is included within WIMES 8.09 and has so far been successfully deployed in multiple extreme applications with Yorkshire Water, Northumbrian Water, Thames Water and Wessex Water amongst others.

The valve is also currently being successfully deployed in clean water applications and is available with materials fully Water Regulations Advisory Scheme (WRAS) certified and compliant with Regulation 31(4)(b).

8.1 Product certificates, trials, expert endorsements

i. White Papers from the manufacturer ValMatic Valve & MFG Corp.
ii. Independent Laboratory Performance Test Results of a five year Case Study.
iii. Independent Laboratory Performance Test Results to 1,000,000 cycles.
iv. Certificate of Compliance to BS EN 12334.
v. Certificate of Compliance to BS EN 1074-3.
vi. Certificate of Compliance to Regulation 31(4)(b).
vii. Non-Metallic WRAS Certificates.
viii. Certificate of Compliance to CE PED 97-23-EC.
ix. DWI Acceptance for the SBCV Inconel X750 Disc Accelerator.
x. Inclusion within WIMES 8.09.
xi. Adoption Statement from Northumbrian Water.
xii. Approval for Use statement from Yorkshire Water.
xiii. Approval for Use statement from Severn Trent.
xiv. Framework Contract from Wessex Water.
xv. Pilot Scheme in operation with Thames Water.
xvi. Amendment of Thames Water Asset Standards to include the valve design.
xvii. Statement of approval from Simon Whatley, Lead Mechanical Engineer, Thames Water.

9. Conclusion

Within the changing regulatory environment prompted by TOTEX, the significant whole life cost benefits of a RHCV, such as the Val-Matic Swing-Flex™, cannot be underestimated. With 25-year cost savings approaching £40m on reduced maintenance costs; as much as £9m from not having to replace the valve; and energy savings amounting to over £4m, the positive monetary impact alone is significant.

However, the operational benefits are equally noteworthy. A Val-Matic Swing-Flex™ NRV minimises clogging in wastewater applications, eliminates slamming, protects the pumps, requires little or no maintenance and can be mounted in a vertical orientation. It is truly a **'fit and forget'** valve.

Coupled with its compliance with British Standards and WIMES regulations, an RHCV of this calibre can now be considered an extremely attractive proposition for the UK and European market place.