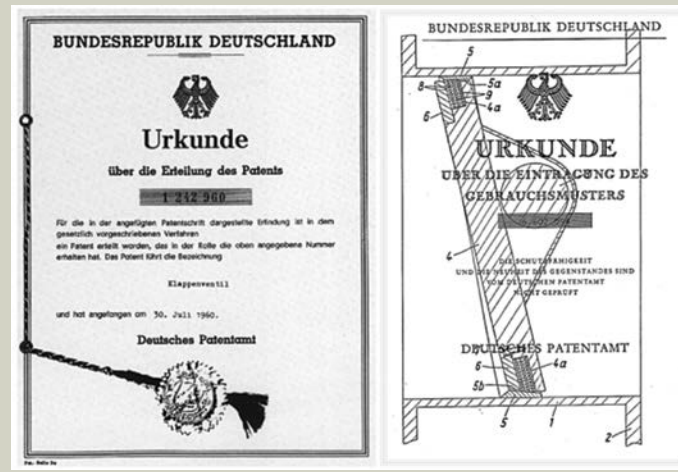
Severe Service Valves – Fro

In June of 2015, the first documented work towards defining Severe Service Valves, (SSVs) began with an article published in Valve Word Americas. Since then, a growing and widening interest has arisen to help push this initiative towards completion. One needs only search for the phrase "Severe Service Valves" to obtain a plethora of ideas, articles, opinions and guidance.

I've been fortunate enough to be assigned as the Task Force Leader of this initiative by the Manufacturers Standardization Society (MSS). It's our job to systematically quantify what severe service means, and what types of equipment should be used in Severe Service applications.

The impact the Standard Practice for SSVs will have on making industrial processes safer and more efficient are widespread. I'm honored to be involved in this process, and passionate about making sure it's done right. Because of which, I've taken a moment to quantify my own personal experience with SSVs, and how the idea has grown from a concept to a reality.



The first patents for a triple offset tight shut off valve, courtesy of Adams.

By Ross Waters – CGIS

High Performance – The Phrase that Started it all

The journey has been a very personal one for me starting when I was eleven, working as one does in a family start-up business as an unpaid or underpaid worker doing what was needed. The business was making gaskets, but as many young enterprises soon learn, making a go of it was challenging and my father accepted a partner who wanted to sell industrial products which included valves.

These valves, rather than the gaskets were what interested me.

The first inklings came from "high performance" valves, cited by Howard D. Freeman, inventor of the world's first PTFE seated ball valve through his company Jamesbury Corporation. An early mentor showed me the intricacies and abilities of these ball valves (floating design). Howard had succeeded in marrying the newly developed super material PTFE Teflon™ with the needs of a ball valve to provide "tight" and repeatable shut-off. This he did by designing the cantilever seat design and allowed the floating ball to seal tightly in either direction, the so-called "bi-directional bubble-tight" isolation.

The true metal seated ball valve - the highest performance SSV. Courtesy of ValvTechnologies.

Jamesbury was also involved in the re-development of the butterfly valve which until Howard's improvements were simple low pressure centric shaft resilient seat low performance valves. Using an offset shaft and his PTFE seating, Jamesbury pushed the boundary of the butterfly valve into ASME Classes 150 and 300 (PN20 and PN50) and later provided the spray of water that cushioned the shock waves of the space shuttle's engines as the spacecraft took off, injecting several hundreds of thousand gallons of water in under a minute.

Up until Jamesbury's advancement of the industry, nearly all valve designs were originally developed in the industrial revolution. These mainly consisted of wedge gates, globe and check valves with a few less important designs like slide gates and plug valves available to solve process control issues. The highest performance valve of that day was a steam isolation valve invented in England called Hopkinson.

Putting an End to Subjective Terminology

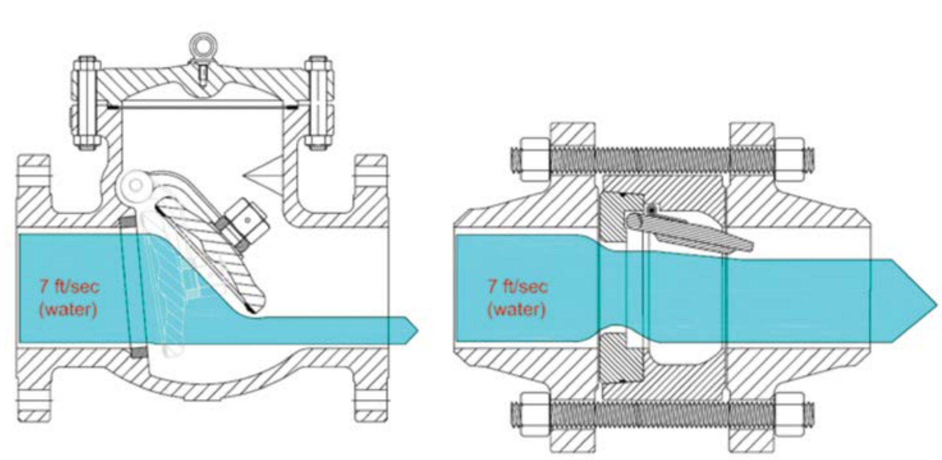
In those days our industry had no clear language about valve performance, we used subjective terminology like "high performance" and "tight shut-off" as if it was exact and measurable and objective. What I came to realize was that if I stated bubble-tight, I needed to add what that meant and how it was achieved. That required a test which included a test media, an energy source to push the test media, a duration to examine the test subject and a method to observe the test. If the test used air as the media and a known pressure, if a valve was tested from underneath and a liquid level existed on the top, then if there were no bubbles appearing in the liquid, the valve has achieved "bubble-tight status or zero leakage.

Arguments can be made that there really is no possibility of zero leakage as over time some forms of matter will get past any barrier, but from a practical perspective, zero leakage isolation is achievable, at least in the periods of time that applications need to operate.

Newer processes and refinements in others created a demand for better valves. Shortly after Jamesbury's innovation, several other advancements came into being. These included:

- the Push-Through knife gate patented by Clarkson
- the Guided Shear gate patented by Sistag-Stalder
- the Triple Offset Tight Shut-Off Valve by Adams
- the development of the world's first true metal seated ball valve by ValvTechnologies, today the most capable of all of the SSVs

Several years' later, refinement in check



Conventional vs a Sized Check Valve.

m a Concept to a Realization

Analysis Results

Required Opening Torque to unseat .... Mt open: 72875 inlb
the valve from closed position

Required Closure Torque to seat .... Mt closure: 72875 inlb
the valve in closed position

Reduction of torque values in % of calculated torque

100 % - Bidirectional tightness
90 % - Bidirectional tightness and Leakage Class V
80 % - Bidirectional tightness and Leakage Class IV
80 % - Unidirectional tightness
72 % - Unidirectional tightness and Leakage Class V
64 % - Unidirectional tightness and Leakage Class IV

Adams tightness chart for reference.

valves began to appear including the venturi inlet check valve that could be sized to the application; this fundamentally improved the longevity and performance of a type of valve that even to this day has less expectations than it deserves. Hy-Grade Valve understood that check valves open on flow and if the flow wasn't substantial enough, then the valve would not be stable and could wear itself to death.

With these higher performing valves, higher expectations by the clients kept pushing them along, advancing the capabilities and learning from trial and error. Failure analysis provided a road to a safer and better design and new materials and manufacturing techniques kept the momentum moving forward, at least for those in the industry.

Clearer language was necessary and much more process detail, especially for isolation valves. It proved inadequate to simply state the valve was "tight shut-off". What was tight? What were the parameters used to prove tightness? What is the recipe to use to re-create tightness? Industry had ANSI B16.104 later evolved into FCI 70.2 which provided guidance on seat tightness, but the mystery to me remains today why we use this for isolation valves as the title specifically refers to control valves. Why don't we have a Standard Practice for isolation valve seat tightness? (it is in the works, finally)

The above chart demonstrates the deep understanding of a valve's ability to isolate by the inventor of the Triple Offset Valve. The application of torque has a direct bearing on the valve's ability to seal tightly. When less than 100% of required torque is applied, less than perfect isolation is experienced. This knowledge is vital to enable a process designer to understand what the consequence would be if the selected valve did not seal tightly when closed. For example if the valve was used to isolate 300-psid (21bar) steam and did not seal tightly, the leaking stream would be erosive to the sealing mechanisms and remove mass allowing more leakage through the energy of the differential pressure and the acceleration of the leaking steam. If the valve was a tight shut-off valve, there would be no energy propelling the steam past the sealing surfaces and thus no wear. To me that means this application requires a valve capable of delivering zero leakage or tight isolation and that means an SSV.

Defining Severe Service Valves – The First Step

For five decades from within the valve industry, we gathered information and kept it in little and isolated silos. Valve manufacturers, suppliers and users often chose paths that concentrated and differentiated valves in various applications, some easy and some very challenging. Strategies for working in these differing applications led to some specialization as companies and individuals migrated to their comfort or interest zones.

My own journey as captured by my early trainer's and mentor's wish to simply supply the best. The best to them were the valves that did their job the longest with the highest performance; in the end providing the highest value to the user or owner.

Since there wasn't and never will be the perfect valve, the best valve always included a specific design and bill of materials that is suited to the application. Therefore, one had to know the application. As we have seen in past papers, most experts agree that SSVs are identified by those applications and that they are challenging to the valve's ability to provide a minimum acceptable level of performance over a minimum acceptable duration.

So, a germ of knowledge started to emerge. An application was severe (or not) so it follows there must be something in the application that made it so and that could be identified, a threshold. In drilling down into this concept, the threshold approach started to yield results. Work by Flowserve amongst others showed clear mathematical equations that would predict with 100% confidence a condition in a control valve installation where cavitation would occur (or not). Other sources like IEC and ISA provided these objective lines in the sand.

While looking over this field of work it became clear that the details surrounding the selection and understanding of control valves were far more complete than those that were provided for isolation valves; those two basic functions that all valves fall into.

It was this paucity of data that made finding objective thresholds for isolation valves a much bigger challenge than for control valves, and today we have a large amount or agreement on what those are for control applications.

In 2015, I decided to publish a paper with some suggested thresholds for both control and isolation. Valve World picked it up and published it in June of 2015. The purpose was twofold; to get some pushback and contrarian opinions as well as to get the industry talking about it.

My thoughts were that more minds thinking about this, whether positively or negatively, would spur the advancement which to me was a clear winner for all parties in the industry; users, manufacturers, suppliers, specifiers.

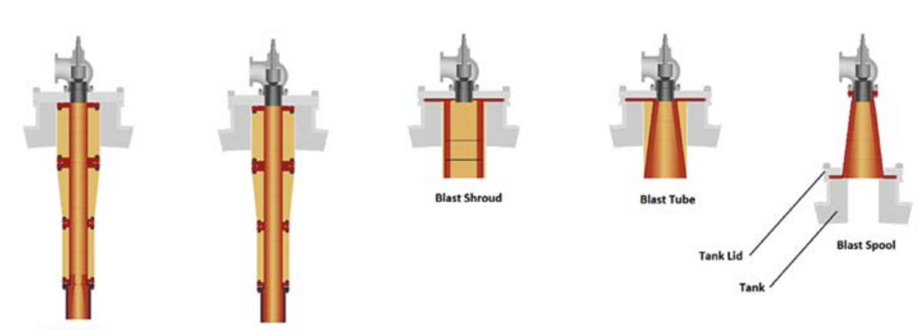
Official Recognition

I had joined Manufacturers Standardization Society (MSS) in 2010 when I recognized the need for a better Standard Practice for knife gate valves. MSS membership included many industry valve experts and offered vehicles to get new ideas published. It was during the several years there that the casual conversations amongst many of us pushed out the desire to add more knowledge and lift the industry to new levels.

During the open sessions at the annual meetings in May 2015 I requested consideration be given by MSS to creating a task force to study the subject of SSVs with the intention of publishing a Standard Practice once we had worked out all the details. It was generally well received, and several members raised their hands to be on the task force.

Determining Factor for Cavitation

Condition	Formula/Reference	Threshold	Notes
Cavitation	(P1-Pv)/(P1-P2)	σ > σi	Cavitation index per ISA–RP75.23



Some of the secondary options for control of the fluid exit of a SSCV – courtesy of Flowserve

Partial SSIV Rating System

Corrosivity				Estimated annual material loss (corrosion rate) for 300 SS					
1	2	3	4	5	6	7	8	9	10
0.001	0.002	0.003	0.004	0.005	0.01	0.02	0.03	0.04	0.05
Frequency of Operation				**1 to 1,000,000 per year**					
1	2	3	4	5	6	7	8	9	10
1	10	100	500	1k	10k	100k	500k	1000k	Unknown
Design Pressure				**0 to 5000 bar or 0 to 72,500 psig**					
1	2	3	4	5	6	7	8	9	10
0	10	50	100	500	1000	2000	3000	4000	5000
0	145	725	1450	7250	14500	29000	43500	58000	72500

The typical process is for the petitioner to write an abstract and scope and submit it to the Board at MSS. If they deem it to be worthy, a Project Number (PN) would be assigned and provided to the petitioner who generally wound up being the task force chair. That was exactly what happened and on October 7, 2016, PN-16-20 was issued with me as Task Chair and 8 individuals as task force members. These eight have since grown to 13.

The process has merit. Only worthy projects get PNs. Membership chooses which PNs they want to be on. Independent and group work happens during the year with a basic understanding that a final submission will be submitted to MSS by the next Annual Meeting which is generally May.

MSS has a long and storied history of producing both Standard Practices as well as Guidelines. Their work spans more than a century and contributes much to the fabric of the valve industry (as well as other products). To view the depth of the work MSS has produced visit www.msshq.org.

For reference, the MSS Scope of Standard Practice (tba) is below.

This Standard Practice specifies principles and parameters for defining Severe Service Valves (SSVs) and offers objective threshold values that distinguish them from General Purpose Valves (GPVs). SSV can be found in non-return, isolation, and control functions. These severe service applications are challenging to the valve's ability to provide a minimum acceptable level of performance over a minimum acceptable duration.

Creating a Framework for Severe Service Applications

From the work done in the control valve area by companies who specialize in severe service like Flowserve, a solid framework of knowledge has provided us with a good basis to determine whether a particular application is in fact severe. The easiest illustration for a "determining factor" or threshold is cavitation. Cavitation is without doubt a challenging situation and once predicted from proven and established formulas, drives the valve supplier to the cavitation is controlled, contained or eliminated by special trims and designs.

Drilling down into the applications that were deemed to be severe service for isolation valves offered less clarity or obvious answers. Some thresholds seemed reasonable like Category M fluids or slurries, but others like pressure and temperature were elusive to define as a single line in the sand.

It was during the work the MSS Task Force did outside of the annual meetings that the idea of a scoring or ranking system came about considering a number of conditions and ranking them numerically to arrive at a value that would be the threshold and separate SSVs from GPVs.

The original table (only partially shown above) was the first version and individual members were invited to try it out with applications each of us knew.

As we test this more and more and move towards consensus, we plan to go back to the traditional accepted Severe Service Valves and score them so that we can continue to refine and have confidence in the system.

Spreading the Standard Practice Internationally

Once balloted and decided upon, MSS will publish the work as a Standard Practice or a Guideline. We expect to see this before next annual meeting in May of 2018.

Overheard while at the ASTM G04 Gaseous Oxygen meetings last month – "if you want to go fast, go alone; if you want to go far, go together."

ABOUT THE AUTHOR

As the President of CGIS, Ross Waters has dedicated 35 years of his life to serving and improving the valve industry. Ross started CGIS, a valve distribution company, in 1980 in a small office in Vancouver, Canada. Thirty-five years later, the business has grown internationally and now serves clients and industries worldwide. Ross is the driving force behind increasing awareness of Severe Service Valves and is part of a MSS task force writing its definition. He has attended numerous conferences around the world presenting his paper, "Defining Severe Service Valves" and is well onto establishing himself as the leading expert in Severe Service. Ross is also an avid member of ASTM International G04 and has served as an expert witness.