International Valve Marketing

Vent-Tech

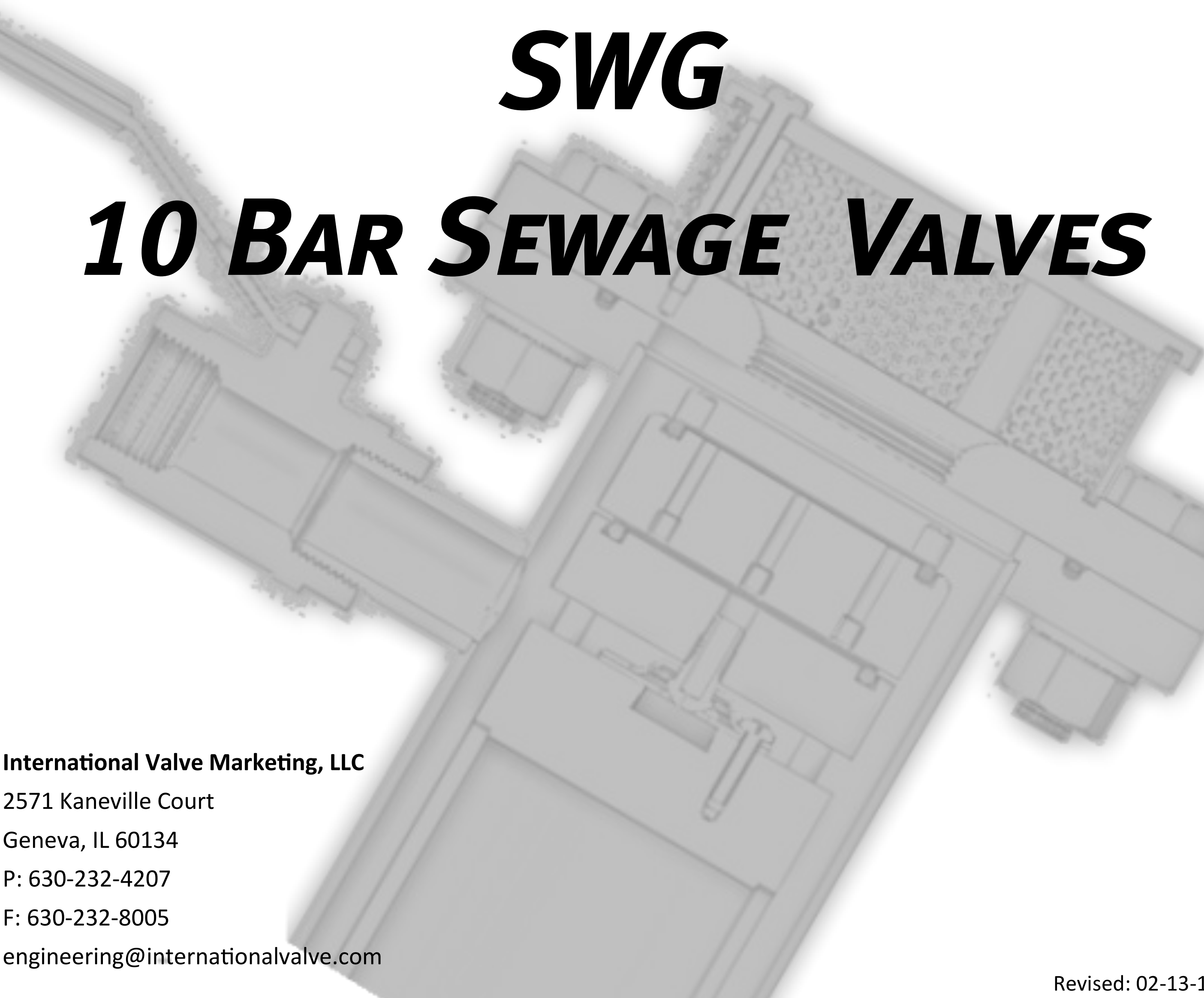
Combination Sewage Air Relief Valve

Model SWG

Flow Performance Data

SWG

10 Bar Sewage Valves



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Vent-Tech

SWG-C Valve - Standard Body

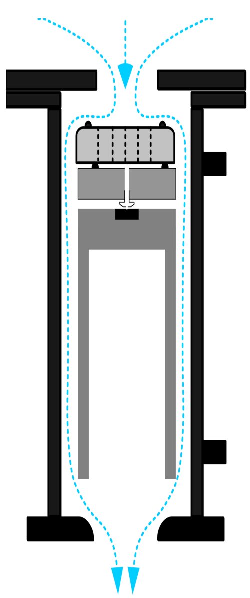
Flow Performance Characteristics

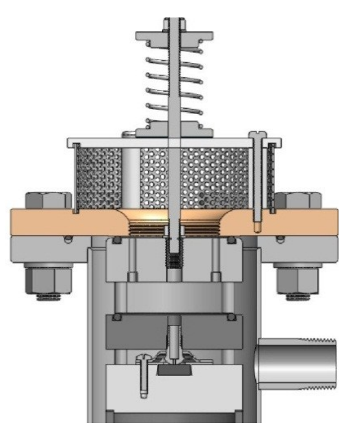
International Valve has prepared and provided the following data as a follow up to the meeting of January 24, 2013 in Modest California. While this report references data from physical testing, all the data presented for this model is a result of Computational Fluid Dynamics (CFD) analysis which we have found to give excellent precision when comparing different geometries and reasonable correlation (typically +/- 5%) to physical testing.

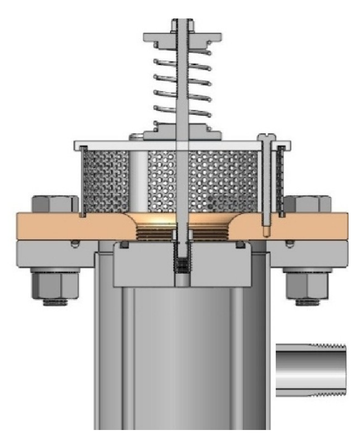
INTAKE CAPACITIES OF SERIES SWG 10 BAR SEWAGE VALVES

	02-SWG-10	03-SWG-10	04-SWG-10	44-SWG-10	54-SWG-10	05-SWG-10	56-SWG-10	06-SWG-10	08-SWG-10	10-SWG-10	12-SWG-10
psi	**Ft^3/min (feet cubed per minute @ 70 degrees Fahrenheit and 14.7 Psi)**										
0.73	257	618	791	790	1,139	1,449	1,670	1,981	3,566	5,132	7,725
1.45	358	859	1,089	1,093	1,571	1,995	2,296	2,734	4,891	6,999	10,577
2.18	430	1,028	1,301	1,306	1,883	2,381	2,733	3,265	5,827	8,430	12,751
2.9	486	1,161	1,457	1,469	2,118	2,675	3,055	3,658	6,521	9,471	14,359
3.63	532	1,265	1,581	1,605	2,302	2,906	3,305	3,956	7,067	10,239	15,567
4.35	574	1,338	1,675	1,712	2,446	3,086	3,487	4,187	7,490	10,797	16,555
5.08	604	1,411	1,745	1,799	2,560	3,226	3,622	4,380	7,826	11,248	17,308

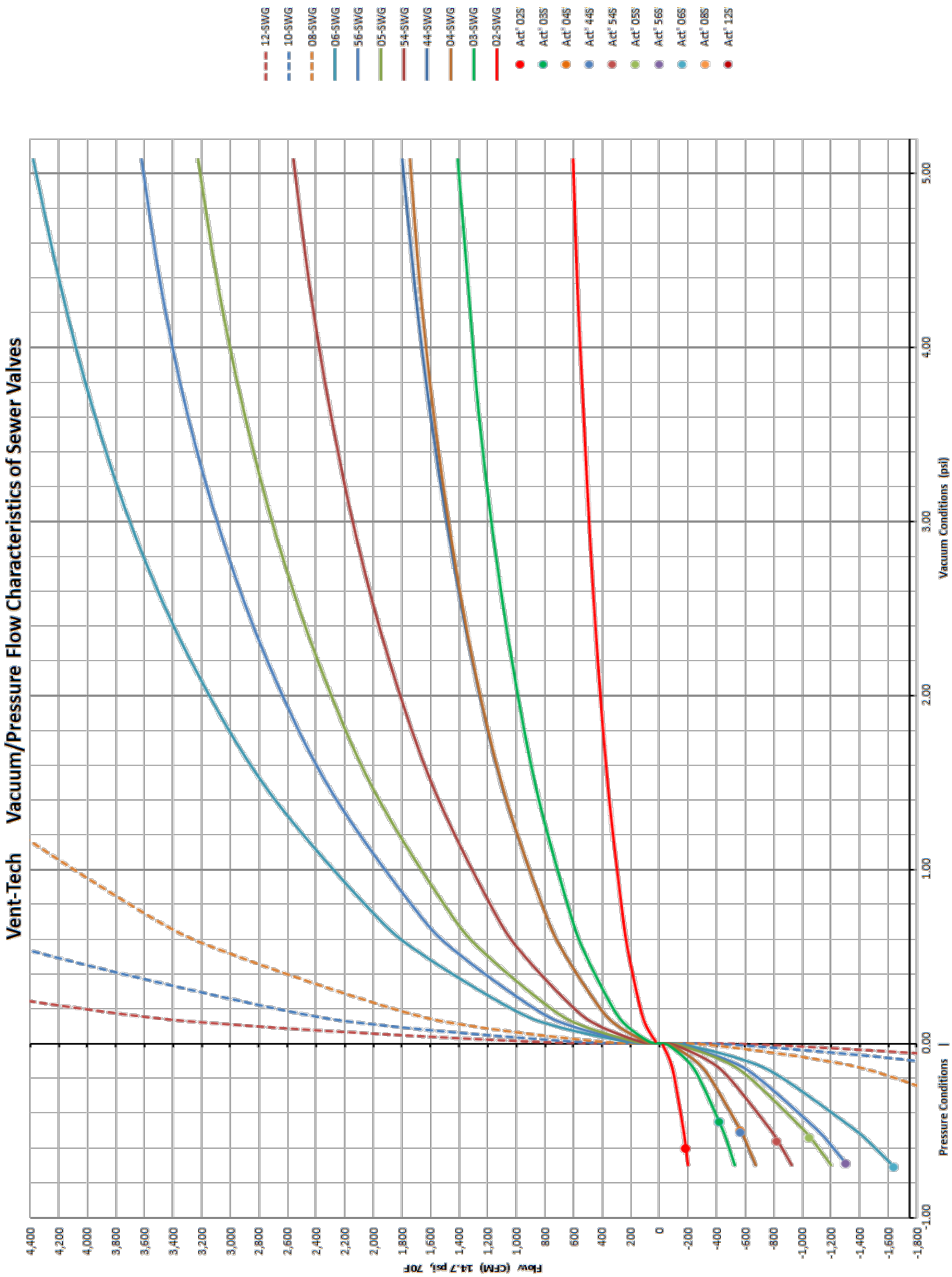
Large volume air intake - vacuum conditions: The large intake orifice of the air valve is equal to the nominal diameter of the valve. The bias mechanisms shown below (right) included on the model SWG series B and series N valves, when fully open in vacuum conditions, will achieve full intake capacities. With lower vacuum conditions, it is expected that these bias mechanisms will restrict air intake by approximately 7%. As vacuum levels increase, the intake capacity of biased valves become less restricted.







VENT-TECH
SWG-C VALVE - STANDARD BODY
FLOW PERFORMANCE CHARACTERISTICS

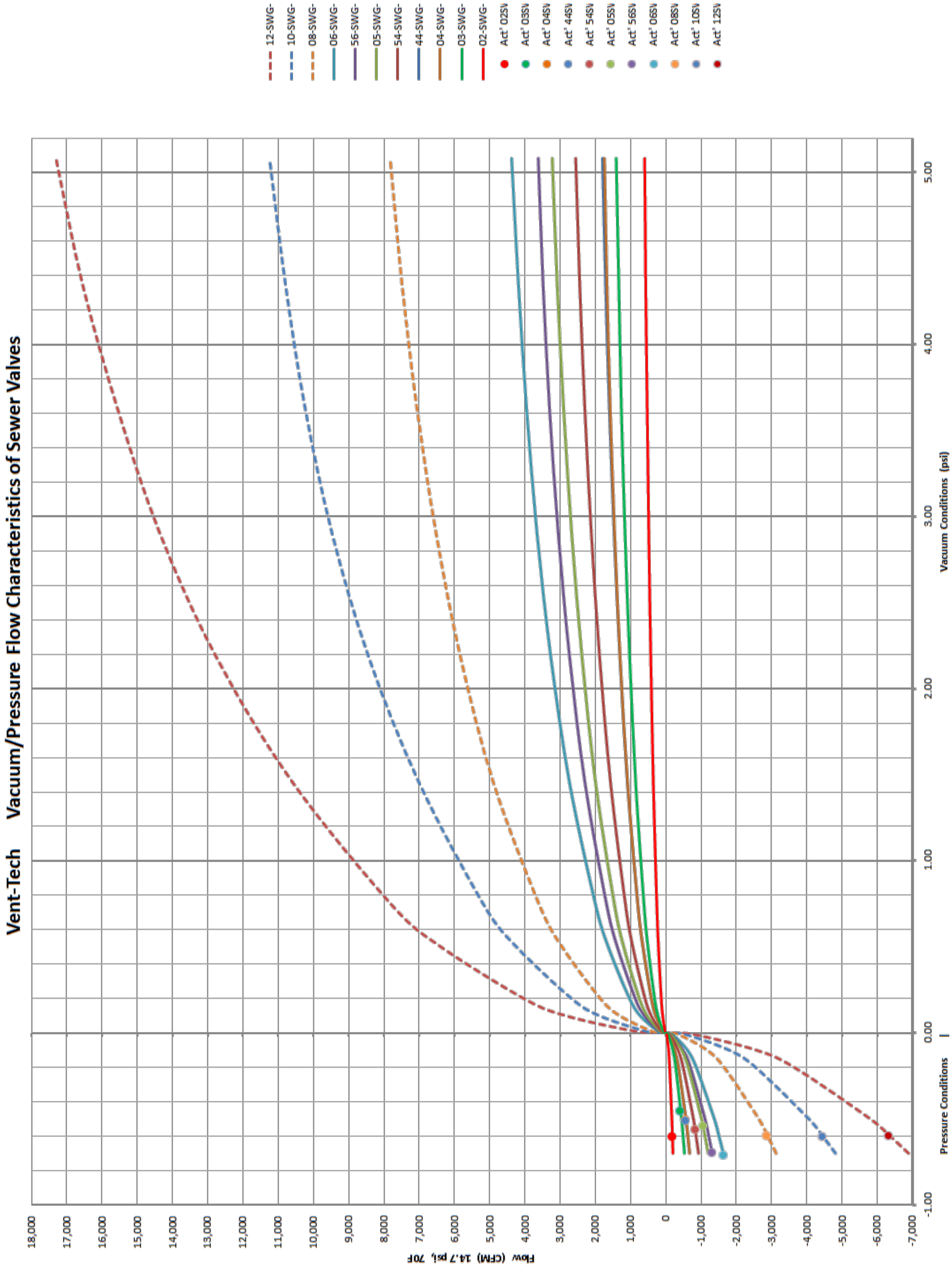


Negative Vacuum flow on these graphs, = pressure discharge characteristics of each valve. The 'dot' on this line indicates the Anti-Surge Activation flow

Vent-Tech

SWG-C Valve - Standard Body

Flow Performance Characteristics



Negative Vacuum flow on these graphs, = pressure discharge characteristics of each valve. The 'dot' on this line indicates the Anti-Surge Activation flow

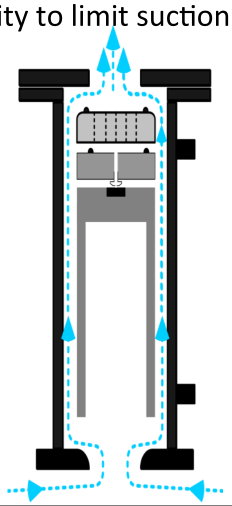
Sizing of Combination Air Venting Valves

Valve sizing and valve positioning can be a complex undertaking. For large, complex flow dynamics, engineers will often recommended the use of computer modeling to understand the surge and pressure wave dynamics that occur during pump start-up, shut-down, valve closure and system failure modes. Generally, however, venting valves are specified at the apex of an undulating pipeline and at approximately every third of a mile. Ideally, the placement of these valves would coincide where the pipeline changes in gradient or direction.

Besides venting entrained gases under normal operational modes, these valves perform two main duties which are governed by different events and physics: (1) controlling vacuum induced buckling or collapse of the pipeline by limiting suction to -5 psi; and (2) exhausting trapped gasses during pipeline filling. The suction event is governed by the maximum flow of the pipeline under either controlled operations, or as is more typical, by uncontrolled shut-down or rupture. Velocities induced during flow down a long steep hill can easily exceed the normal pumping rates.

The exhausting of gases during filling operations is more simply driven by the capacity of the pumps used during filling, and in these cases it is recommended that the valves exhaust velocity be limited to 60 meters per second. The valve at an apex needs to be sized to handle the max pump capacity, and once this is set, the valve sizes on the uphill gradient will likely be determined by its suction duty, since all the 'filling air' can adequately escape through the apex valve. And, because drainage rates may greatly exceed filling rates, even the apex valve size may be determined by its ability to limit suction.

Vent-Tech Valve Size (inches)	Vent-Tech Code	Max Line Filling Rate Prior to Anti-Surge Activation GPM (Per valve)	Based on -5psi Vacuum Rate Max GPM (Standard Valves)
2	02	1,376	6,510
3	03	3,142	15,200
4	04	4,241	18,800
4	44	4,264	19,400
4	54	6,171	27,600
5	05	7,862	34,770
6	56	9,747	39,000
6	06	12,268	47,210
8	08	21,514	84,300
10	10	33,257	121,200
12	12	47,374	186,500



DISCHARGE CAPACITIES OF SERIES SWG 10 BAR VALVES THROUGH THE LARGE ORIFICE

	02-SWG-10	03-SWG-10	04-SWG-10	44-SWG-10	54-SWG-10	05-SWG-10	56-SWG-10	06-SWG-10	08-SWG-10	10-SWG-10	12-SWG-10
Activation Flow (cfm)	184	420	567	570	825	1,051	1,303	1,640	2,876	4,446	6,333
Activation Pressure (psi)	0.60	0.45	0.50	0.51	0.56	0.54	0.69	0.71	0.60	0.60	0.60

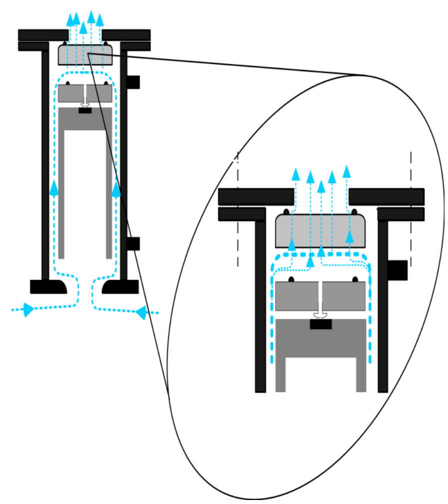
Vent-Tech

SWG-C Valve - Standard Body
Flow Performance Characteristics

DISCHARGE CAPACITIES OF SERIES SWG 10 BAR VALVES THROUGH THE ANTI SURGE ORIFICES

Pressure (Bar)	02-SWG-10	03-SWG-10	04-SWG-10	44-SWG-10	54-SWG-10	05-SWG-10	56-SWG-10	06-SWG-10	08-SWG-10	10-SWG-10	12-SWG-10
	Ft^3/min (feet cubed per minute @ 70 degrees Fahrenheit and 14.7 Psi)										
1	65	145	190	190	190	244	244	437	582	863	1,460
2	102	223	293	293	293	366	366	657	863	1,254	2,085
3	139	301	395	395	395	489	489	876	1,144	1,645	2,710
4	175	379	498	498	498	612	612	1,095	1,425	2,037	3,335
5	212	458	601	601	601	734	734	1,314	1,707	2,428	3,960
6	248	536	703	703	703	857	857	1,533	1,988	2,819	4,585
7	285	614	806	806	806	979	979	1,752	2,269	3,210	5,210
8	322	692	909	909	909	1,102	1,102	1,971	2,550	3,601	5,835
9	358	771	1,011	1,011	1,011	1,224	1,224	2,190	2,831	3,992	6,459
10	395	849	1,114	1,114	1,114	1,347	1,347	2,410	3,113	4,383	7,084

Perspectives on Errors of Comparative Physical Testing:



For the benefit of readers who are not familiar with physical testing of pressure and flow dynamics, it is an endeavor burdened with compounding sources of error. Why, because slight changes in the position and style of pressure and flow sensors can significantly affect the results as can the geometry and size of the enclosure used to mount or contain the air flow; and this is additive to the gauge and meter errors. Fortunately, many of these errors are either predictable or capable of being compensated for based on theory and assumptions on the set up being tested, however, errors in the assumptions and deviations between ideal behavior and reality are also issues. Even laboratory testing can inadvertently induce errors if the blower and its' associated ductwork induces unexpected turbulence or swirl to the air flow prior to entry into the valve, or even unanticipated energy recovery effects.

The use of CFD is an effort to approximate reality using the physical properties of a fluid (in this case, dry air) and using a common engineering technique called FEA to breakdown the mechanical problems into a matrix of small cells (in this case ~ 4 million) to determine the fluid movement and pressures. CFD is the technique commonly used to determine the flight characteristics of airplanes wings and turbines.

The accuracy of CFD is dependent on the size of the computational cell, and the development of suitable meshing techniques to characterize zones of rapid transitions and small gaps. In this regard, the smallest gap was measured at 0.08" and this was manually specified; the surrounding mesh quality was maximized such that it just fit within the computer WorkStation's 12GB of RAM, resulting in ~ 4.3 million full cells and 0.9 million partial cells. Our estimate is that these results should be within +/- 5% of actual, however, IVM, LLC and its staff accept no responsibility for the accuracy of their best efforts results.