SNC·LAVALIN	Notes de calcul / Design Brief	# DU PROJET/PROJECT NUMBER 674195		SUBD
Vérifié par : Checked by : André Lévesque	TITRE DU PROJET/NAME OF THE PROJECT :	Date 30 juillet 2020	Page 1	de/of 11
Date :	Hydraulic and Transient Conditions Study Meliadine Project	Préparé par : Prepared by :	Christina Lachance	

MODIFICATION Date :	Vérifié par : Checked by :	Préparé par : Prepared by :

Hydraulic and Transient Conditions Study Meliadine Project

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1.0 PURPOSE

- To check the effects of transient phenomena in the new salt-water pumping pipelines of the Meliadine Mine;
- In the event that the transient conditions generate negative or excess pressure problems, solutions must be proposed to reduce or eliminate these problems;
- To position the air valve chambers for water hammer protection.

2.0 SOFTWARE

The software used for the simulations is HAMMER version 10.03.01.08 from the BENTLEY company.

3.0 DATA

The following data was considered in the study of hydraulic transient conditions.

3.1 Water to be Pumped

The water to be pumped is saline, with a specific gravity of about 1.05. The water comes from dewatering operations at the Meliadine Mine.

3.2 Pumping Station

The dewatering water is stored in a reservoir, to which three (3) pumps are connected.

Normal two (2) pump operation is expected, with the third pump providing redundancy.

Pumping rates are taken from design data provided by Stavibel, dated June 8, 2020 and are detailed as follows:

- Flow 2020: 1,600 m³/d
- Flow 2021: 6,000 -12,000 m³/d
- Maximum flow rate: 20,000 m³/d
- Summer pumping only (100 d/year)
- Continuous pumping 24 hours a day

For operation with 2 pipelines in parallel, the pumping head required is 73.5 m for a flow rate of 20,000 m³/d (data from Stavibel, 2020-06-08).

To reflect these pumping conditions, as the pumps were not selected at the time of the transient conditions study, the pump specifications are based on those of the Gould e-XC pump by Xylem. The pump curve entered in the Hammer software is available in Appendix A.

3.3 PIPES

Two parallel pipes will be installed between the pumping station at the Meliadine Mine and Rankin Inlet Bay. The characteristics of the pipes are as follows:

- Length of each pipeline: 34 km
- Pipe manufacturing material: PEHD PE4710 DR17
- Pipe diameter: DN400
- Hazen Williams coefficient of friction: 135
- Minimum thickness: 23.90 mm
- Average internal diameter: 355.6 mm
- Admissible nominal pressure: 862 kPa (125 PSI)
- Celerity: 315 m/s
- Pipelines placed on the ground
- Pipelines emptied in the fall

The characteristics of the pipes are summarized in the table in Appendix B.

3.4 Pipeline Profile

The profile of the pipelines was provided by Stavibel on June 16, 2020. It was first prepared from the elevations measured every 100 m. The profile was then refined so as to keep only the representative elevations.

Chaining 0 corresponds to the pumping station at the mine.

Profile elevation data is available in Appendix C.

4.0 RESULTS

The scenario studied is that of a power failure resulting in the sudden shutdown of two (2) pumps in operation.

Following the first simulations, it was observed that the installation of a control valve at the end of the course made it possible to keep the pipe under load. Under power failure conditions, however, the pressure in the pipe exceeded the resistance of the pipe.

In consultation with Stavibel, it was therefore ruled that gravity flow in the downward part of the pipe was to be preferred. Considering these conditions, the addition of the following equipment is recommended, on each of the two pipes:

Table 1 - Equipment Required on Each Pipeline

Chaining p/r to the pumping station (m)	Diameter (Air Inflow Orifice) (mm)	Diameter (Large Air Outflow Orifice) (mm)	Diameter (Small Air Outflow Orifice) (mm)	Proposed Model
11 040	75	75	6	APCO ASU or Ventomat 080 RGX or RBX*
12 207	75	75	6	
15 089	75	75	6	
26 040	75	75	6	
32 958	75	75	6	

* RBX model can be selected only if the percentage of solids in liquid is less than 5%

The proposed models are available in stainless steel. Despite the reluctance of supplier Provan (APCO) to specify stainless steel in saltwater, it was agreed with Stavibel that this product is acceptable given the life of the mine.

Figure 1 shows the pressures in each of the pipes under transient conditions. The green dashed line indicates the maximum allowable pressure in a HDPE DR17 pipe, i.e. 862 kPa. The red dashed line indicates the vapour pressure while the black dashed line indicates the maximum admissible vacuum pressure defined by Stavibel, i.e. -48.3 kPa (-7 PSI). The red dots indicate the proposed location of protective equipment.

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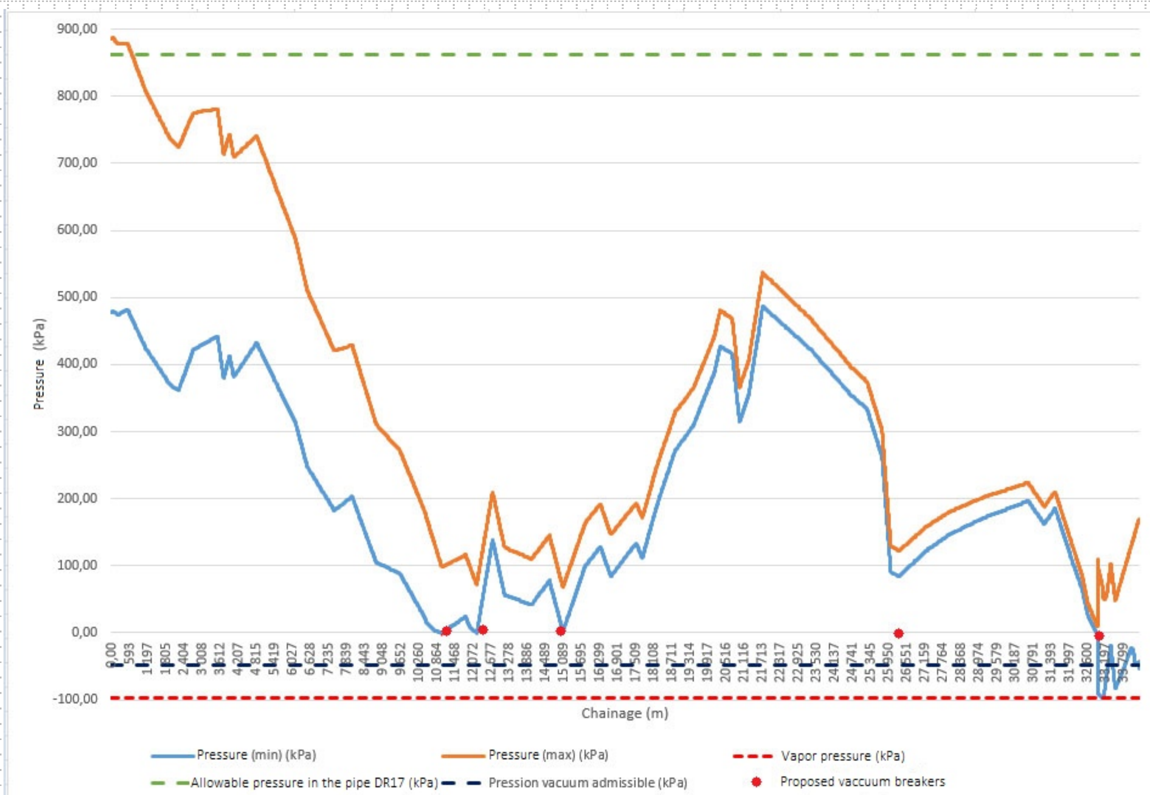
Figure 1 Pressures in each pipe under transient conditions



Negative end-of-course pressures are caused by the exit to the atmosphere simulated in the Hammer software. Exceeding the admissible pressure at the start of the course is due to the initial head and not to transient conditions. Under initial conditions, the pressure is 884 kPa at this point and it reaches 886 kPa under transient conditions.

5.0 CONCLUSIONS AND RECOMMANDATIONS

A hydraulic transient study was performed as part of the placement of two parallel pipelines, allowing dewatering water from the Meliadine mine to be transported to Rankin Inlet Bay.

Based on the simulation assumptions included in this design brief, the installation of five (5) combined air valves on each of the pipelines is recommended in order to adequately protect the pipelines against excessive or negative pressures. Since the use of the pipelines is limited to the summer period, the likelihood of a sudden stop of the pumps and the stress on the pipes that results from it are also reduced.

In the event of a sudden stop of the pumps, the maximum pressure in each pipe is expected to remain under the maximum allowable pressure in a HDPE DR-17 pipe (862 kPa), except at the pumping station where the pressure could reach 886 kPa due to the initial water head of 884 kPa. Conversely, the minimum pressure in the pipe should never be negative given the addition of protective equipment.

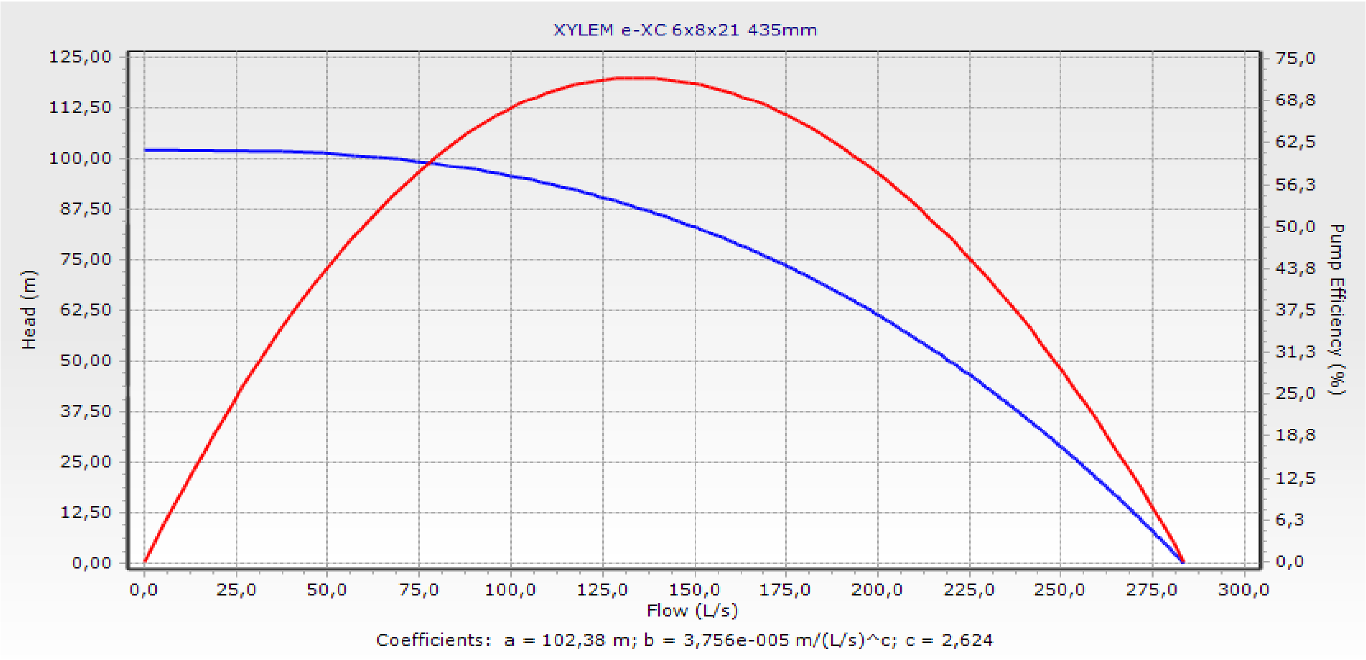
Considering that the route and the material of the pipelines cannot be modified, the configuration with the proposed equipment and without a pressure control valve at the end of the course seems the safest.

Appendix A

Pump Curve

Pump Curve - Meliadine

Flow (L/s)	Head (m)
40,5	101,3
46,3	101,04
52,1	100,77
57,9	100,48
63,7	100,15
69,5	99,76
75,3	99,29
81,1	98,74
87	98,08
92,8	97,32
98,6	96,45
104,4	95,45
110,2	94,32
116	93,05
121,8	91,65
127,6	90,12
133,4	88,45
139,2	86,64
145	84,71
150,8	82,65
156,6	80,48
162,4	78,19
168,2	75,81
174,1	73,34
179,9	70,8
185,7	68,19
191,5	65,55
197,3	62,87
203,1	60,2
208,9	57,53



Appendix B

Pipes Table

Pipes Table

Identification	Length (m)	Node Start	Node End	Diameter (mm)	Material	C Hazen-Williams	Celerity (m/s)
P-1	40	N-0	N-40	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-2	200	N-40	N-240	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-3	300	N-240	N-540	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-4	600	N-540	N-1140	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-5	800	N-1140	N-1940	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-6	300	N-1940	N-2240	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-7	500	N-2240	N-2740	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-8	800	N-2740	N-3540	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-9	200	N-3540	N-3740	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-10	200	N-3740	N-3940	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-11	135	N-3940	N-4075	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-12	765	N-4075	N-4840	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-13	1 300	N-4840	N-6140	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-14	400	N-6140	N-6540	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-15	900	N-6540	N-7440	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-16	600	N-7440	N-8040	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-17	800	N-8040	N-8840	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-18	800	N-8840	N-9640	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-19	800	N-9640	N-10440	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-20	600	N-10440	AVP-11040	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-21	800	AVP-11040	N-11840	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-22	367	N-11840	AVP-12207	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-23	533	AVP-12207	N-12740	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-24	400	N-12740	N-13140	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-25	900	N-13140	N-14040	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-26	600	N-14040	N-14640	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-27	449	N-14640	N-15089	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-28	751	N-15089	N-15840	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-29	500	N-15840	N-16340	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-30	347	N-16340	N-16687	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-31	853	N-16687	N-17540	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-32	200	N-17540	N-17740	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-33	500	N-17740	N-18240	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-34	600	N-18240	N-18840	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-35	600	N-18840	N-19440	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-36	700	N-19440	N-20140	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-37	200	N-20140	N-20340	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-38	401	N-20340	N-20740	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-39	244	N-20740	N-20984	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-40	300	N-20984	N-21284	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-41	316	N-21284	N-21601	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-42	139	N-21601	N-21740	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-43	1 600	N-21740	N-23340	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-44	1 400	N-23340	N-24740	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-45	500	N-24740	N-25240	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-46	501	N-25240	N-25741	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-47	299	N-25741	N-26040	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-48	271	N-26040	N-26311	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-49	929	N-26311	N-27240	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-50	800	N-27240	N-28040	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-51	1 100	N-28040	N-29140	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-52	1 500	N-29140	N-30640	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-53	537	N-30640	N-31177	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-54	363	N-31177	N-31540	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-55	900	N-31540	N-32440	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-56	200	N-32440	N-32640	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-57	318	N-32640	AV-N32958	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-58	182	AV-N32958	N-33140	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-59	252	N-33140	N-33392	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-60	148	N-33392	N-33540	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-61	800	N-33540	FCV-1	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-62	40	O-0	O-40	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-63	200	O-40	O-240	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-64	300	O-240	O-540	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-65	600	O-540	O-1140	355,6	PEHD 4710 16" DR17 100 psig	135	315

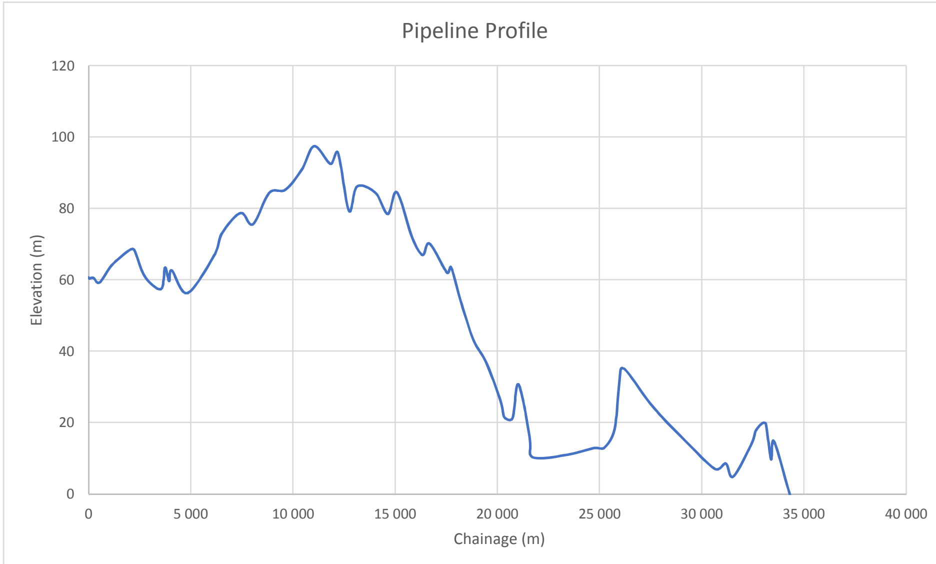
Identification	Length (m)	Node Start	Node End	Diameter (mm)	Material	C Hazen-Williams	Celerity (m/s)
P-66	800	O-1140	O-1940	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-67	300	O-1940	O-2240	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-68	500	O-2240	O-2740	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-69	800	O-2740	O-3540	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-70	200	O-3540	O-3740	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-71	200	O-3740	O-3940	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-72	135	O-3940	O-4075	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-73	765	O-4075	O-4840	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-74	1 300	O-4840	O-6140	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-75	400	O-6140	O-6540	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-76	900	O-6540	O-7440	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-77	600	O-7440	O-8040	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-78	800	O-8040	O-8840	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-79	800	O-8840	O-9640	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-80	800	O-9640	O-10440	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-81	600	O-10440	AVO-11040	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-82	800	AVO-11040	O-11840	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-83	367	O-11840	AVO-12207	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-84	533	AVO-12207	O-12740	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-85	400	O-12740	O-13140	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-86	900	O-13140	O-14040	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-87	600	O-14040	O-14640	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-88	449	O-14640	O-15089	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-89	751	O-15089	O-15840	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-90	500	O-15840	O-16340	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-91	347	O-16340	O-16687	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-92	853	O-16687	O-17540	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-93	200	O-17540	O-17740	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-94	500	O-17740	O-18240	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-95	600	O-18240	O-18840	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-96	600	O-18840	O-19440	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-97	700	O-19440	O-20140	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-98	200	O-20140	O-20340	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-99	401	O-20340	O-20740	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-100	244	O-20740	O-20984	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-101	300	O-20984	O-21284	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-102	316	O-21284	O-21601	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-103	139	O-21601	O-21740	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-104	1 600	O-21740	O-23340	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-105	1 400	O-23340	O-24740	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-106	500	O-24740	O-25240	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-107	501	O-25240	O-25741	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-108	299	O-25741	O-26040	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-109	271	O-26040	O-26311	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-110	929	O-26311	O-27240	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-111	800	O-27240	O-28040	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-112	1 100	O-28040	O-29140	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-113	1 500	O-29140	O-30640	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-114	537	O-30640	O-31177	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-115	363	O-31177	O-31540	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-116	900	O-31540	O-32440	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-117	200	O-32440	O-32640	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-118	318	O-32640	AV-O32958	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-119	182	AV-O32958	O-33140	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-120	252	O-33140	O-33392	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-121	148	O-33392	O-33540	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-122	800	O-33540	FCV-2	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-123	10	R-1	PMP-1	406,4	Ductile Iron	140	315
P-124	10	R-1	PMP-2	406,4	Ductile Iron	130	315
P-125	10	R-1	PMP-3	406,4	Ductile Iron	130	315
P-126	10	PMP-1	SP-1	304,8	Ductile Iron	140	315
P-127	10	PMP-2	SP-2	304,8	Ductile Iron	140	315
P-128	10	PMP-3	SP-3	304,8	Ductile Iron	140	315
P-129	10	SP-1	SP-2	457,2	Ductile Iron	140	315
P-130	10	SP-2	SP-3	457,2	Ductile Iron	140	315
P-131	10	SP-3	SP-4	457,2	Ductile Iron	140	315
P-132	10	SP-4	N-0	355,6	Ductile Iron	140	315
P-133	10	SP-4	O-0	355,6	Ductile Iron	140	315
P-134	10	FCV-1	TCV no.1	355,6	PEHD 4710 16" DR17 100 psig	140	315
P-135	10	FCV-2	TCV no.2	355,6	PEHD 4710 16" DR17 100 psig	140	315
P-136	10	TCV no.1	R-2	355,6	PEHD 4710 16" DR17 100 psig	135	315
P-137	10	TCV no.2	R-2	355,6	Ductile Iron	140	315

Appendix C

Nodes Table

Nodes Table

Chaining (m)	Elevation (m)
0,0	60,66
40,0	60,35
240,0	60,51
540,0	59,25
1140,0	64,10
1940,0	68,06
2240,0	68,30
2740,0	61,03
3540,0	57,39
3740,0	63,40
3940,0	59,64
4075,0	62,60
4840,0	56,28
6140,0	66,80
6540,0	73,14
7440,0	78,71
8040,0	75,55
8840,0	84,35
9640,0	85,28
10440,0	90,95
11040,0	97,46
11840,0	92,46
12207,4	95,52
12740,0	79,32
13140,0	86,16
14040,0	84,35
14640,0	78,43
15088,8	84,50
15840,0	71,73
16340,0	66,93
16686,9	70,13
17540,0	61,98
17739,5	63,47
18240,0	53,42
18840,0	43,00
19439,8	37,00
20140,0	26,41
20339,5	21,53
20740,0	21,22
20984,1	30,67
21284,2	25,47
21600,6	15,13
21740,0	10,26
23340,0	10,87
24740,0	12,87
25240,0	12,97
25740,6	18,29
26040,0	34,95
26311,0	34,54
27240,0	27,15
28040,0	21,67
29140,0	15,20
30640,0	7,04
31176,8	8,53
31540,0	4,86
32440,0	14,06
32640,0	17,68
32958,2	19,79
33140,0	19,61
33391,9	9,70
33540,0	14,70
34340,0	-0,79



CONCEPTION CRITERIA

Water flow :
Previous flow(2019) : 800 m³/day
2020 flow : 1 600 m³/day
2021 flow : 6 000-12 000 m³/d
Maximum flow : 20 000 m³/d
Pumping season : summer (100 days/year)
continuous pumping 24/24
Waterline :
2 parallel waterlines - 16" DR17 type PE4710 if a failure ever occurs, only one of the lines can be used.
Pumped fluid temp (startup) : 4°C maximum 25° C. fluid type : saline water
Life expectancy: 10 years

SYSTEM CURVE - 2 parallel pipeline

Reference : Chapter 6 - Handbook of PE pipe, page 175 and up

Flow	Velocity	Head	Pump head		Holding pressure	
(m³/day)	(m/s)	(m)	(m)	(psi)	(m)	(psi)
2000	0,12	1,5	31,8	45	93,2	133
5000	0,29	8,4	34,5	49	89,0	127
7000	0,41	15,7	37,2	53	84,6	120
9000	0,52	25,0	40,8	58	78,9	112
11000	0,64	36,2	45,2	64	72,0	102
15000	0,87	64,3	56,0	80	54,7	78
17000	0,99	81,1	62,5	89	44,5	63
19000	1,11	99,6	69,6	99	33,2	47
20000	1,16	109,5	73,5	105	26,9	38

(1) Pressure lost calculation with Hazen-Williams from the following value
(2) Conception flow 20 000 m³/day

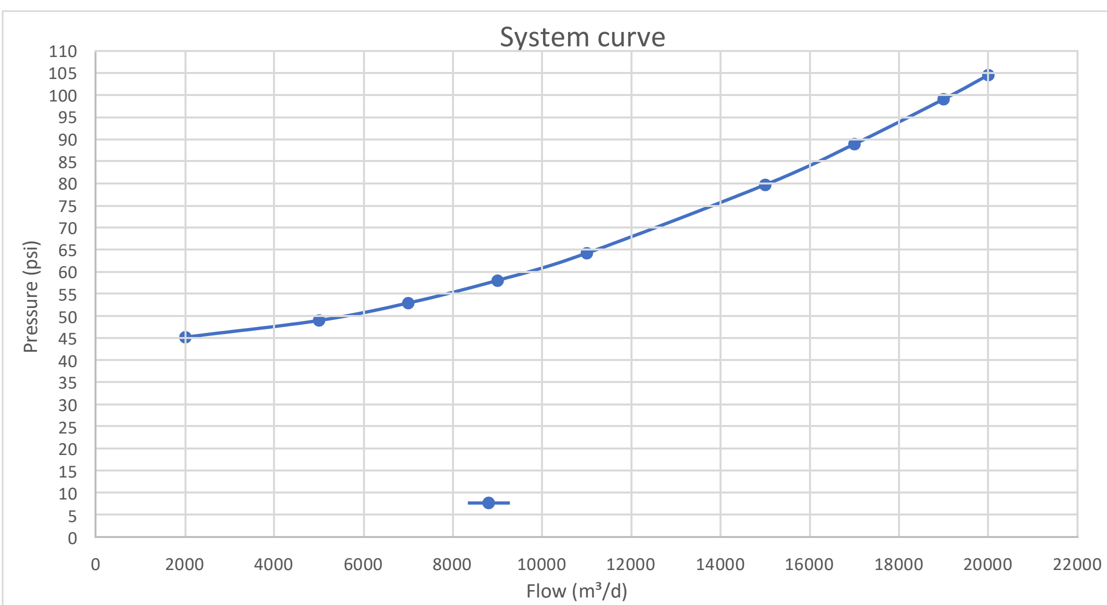
Data

Di :	14	in
C :	148,5	
L :	118041	feet
	35988	m

Note

Waterline 16" DR17 resin type PE4710 de MB (Uponor presumed)
Adjusted to obtain the same result as Darcy-Weis method.

(3) 5% singular pressure lost presumed
(4) Pumping head required based on pump at 68 m elevation and to keep a 3m minimal pressure at the highest waterline point (13 +900 elevation 98,5m)
(5) PEHD DR 17 nominal pressure is 125 psi



System curve – one pipeline operation

Reference : Chapter 6 - Handbook of PE pipe, page 175 and up

Flow	Velocity	Head	Pump head		Holding pressure	
(m³/day)	(m/s)	(m)	(m)	(psi)	(m)	(psi)
2500	0,29	8,4	34,5	49	89,0	127
3500	0,41	15,7	37,2	53	84,6	120
4500	0,52	25,0	40,8	58	78,9	112
5500	0,64	36,2	45,2	64	72,0	102
7500	0,87	64,3	56,0	80	54,7	78
8500	0,99	81,1	62,5	89	44,5	63
9500	1,11	99,6	69,6	99	33,2	47
10000	1,16	109,5	73,5	105	26,9	38
11000	1,28	130,6	81,6	116	14,0	20
11600	1,35	144,1	86,8	124	5,7	8

(1) Pressure lost calculation with Hazen-Williams from the following value
(2) Conception flow 20 000 m³/day

Data

Di :	14	in
C :	148,5	
L :	118041	feet
	35988	m

Note

Waterline 16" DR17 resin type PE4710 de MB (Uponor presumed)
Adjusted to obtain the same result as Darcy-Weis method.

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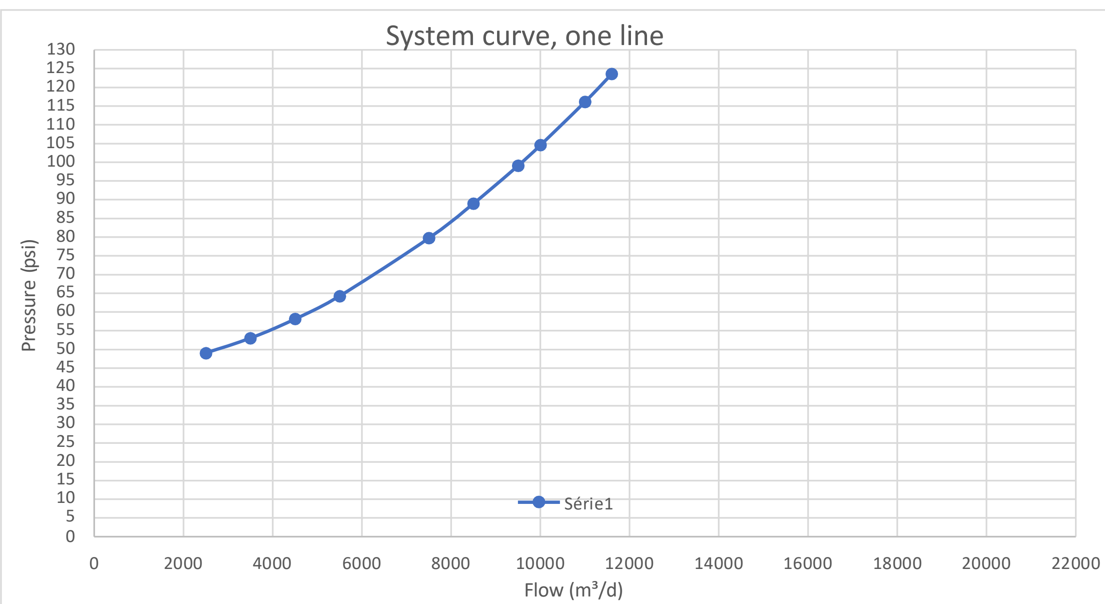


SNC·LAVALIN	Notes de calcul / Calculation Notes	# DU PROJET/PROJECT NUMBER 674195		SUBD
Vérifié par : Checked by : André Lévesque	TITRE DU PROJET/NAME OF THE PROJECT :	Date 30 juillet 2020	Page 1	de/of 11
Date :	Étude hydraulique et phénomènes transitoires Projet Méliadine	Préparé par : Prepared by :	Christina Lachance	

MODIFICATION Date :	Vérifié par : Checked by :	Préparé par : Prepared by :

Étude hydraulique et phénomènes transitoires
Projet Méliadine

DeZURIK
APCO | HILTON

BULLETIN 3000
JUNE 2020

APCO SURGE RELIEF ANGLE VALVES (SRA)

Design & Construction

APCO Surge Relief Angle Valves (SRA) are designed to limit surge pressure and the potential damage to the pump system. The surge relief valve is normally closed. The Surge Relief Valve protects the system by opening when the system pressure exceeds the relief pressure setting of the valve disc. As the disc opens, the surge pressure is spilled and dissipated through the valve. The valve is designed with a smooth flow area and minimal obstructions for efficient surge relief.

The Surge Relief Angle Valve (SRA) is an elbow body style surge relief valve that is held normally closed by a compression spring or system of nested springs. They are available in sizes 2-16" (50-400mm) and with pressure relief ratings up to 200 psi (1380 kPa). SRA Valves are available in ductile iron with seats of Acrylonitrile-Butadiene (NBR), Terpolymer of Ethylene, Propylene and A Diene (EPDM) or Fluoro Rubber (FKM).

Surge Relief Angle Valve (SRA)

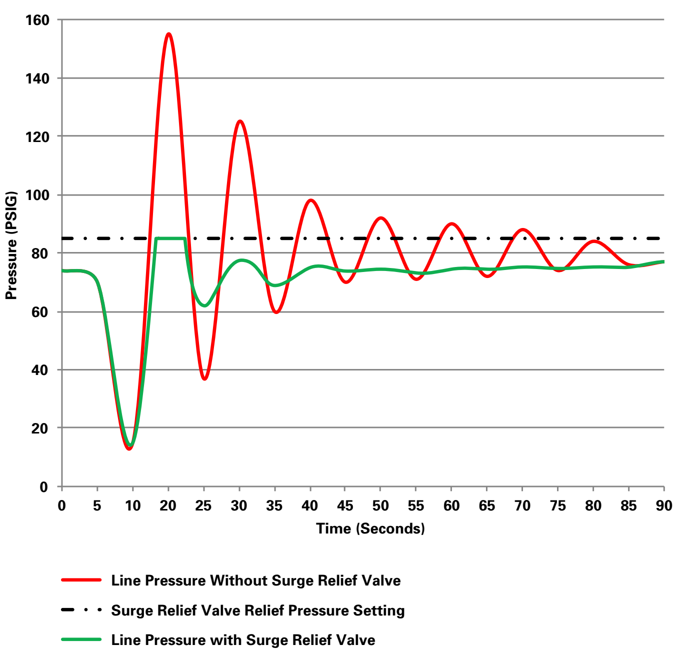
APCO Surge Relief Valves Provide Surge Protection

Pressure surges occur when fluid velocity changes. APCO Surge Relief Valves limit the surge pressure magnitude commonly associated with sudden pump shutdown in fluid piping systems.

The surge relief valve is typically installed downstream of the check or pump control valves on the pump discharge header with the valve inlet connected to the side outlet of a tee and the valve outlet piped to the sump.

The normally closed surge relief valve opens quickly when the system pressure rises (red line) above its adjustable relief pressure setting (dashed line) allowing fluid to be discharged from the system through the open surge relief valve to atmosphere. While the surge relief valve is open, the system is no longer contained, fluid compression is limited and surge pressure is controlled (green line). The valve will remain open as long as the system pressure exceeds the valve's relief pressure setting. The valve will slowly begin to close at an adjustable rate as the surge pressure subsides and the system pressure falls below the valve's relief pressure setting.

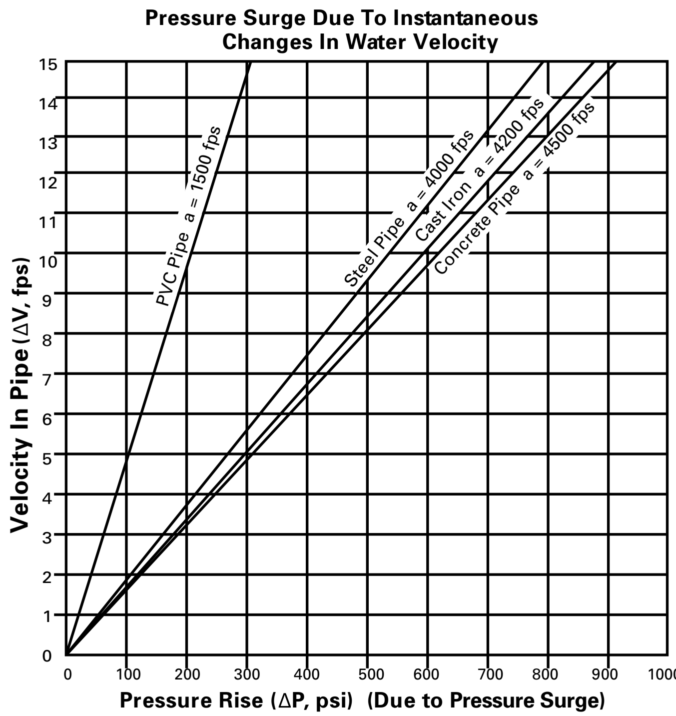
Typical Pressure Versus Time Graph With and Without a Surge Relief Valve



Incremental Pressure vs. Flow Velocity

The "Incremental Pressure vs. Flow Velocity" graph provides an estimate of incremental pressure rise due to surge for different pipe materials in typical sizes. The graph assumes that the flow velocity is changed in less than one surge period, or in less time than it takes for the surge wave to travel from the source to the end of the system and back.

Incremental Pressure vs. Flow Velocity



$$\Delta H = -a/g \, \Delta V$$

Surge Relief Valve Sizing

16 po
10 000 m3/jour (1 834 GPM)
3,34 fps (VL)
Max pressure : 120 psig (PL)
VL/PL = ,0278

Vanne de 4po

This sizing chart is based upon current engineering practice and offered as a general guideline for use on simple pipelines with standard operating conditions. Other factors, such as line length, pipe wall thickness, and pipe material have an effect on potential surge magnitude. Contact DeZURIK/APCO to discuss valve solutions for your particular pumping system.

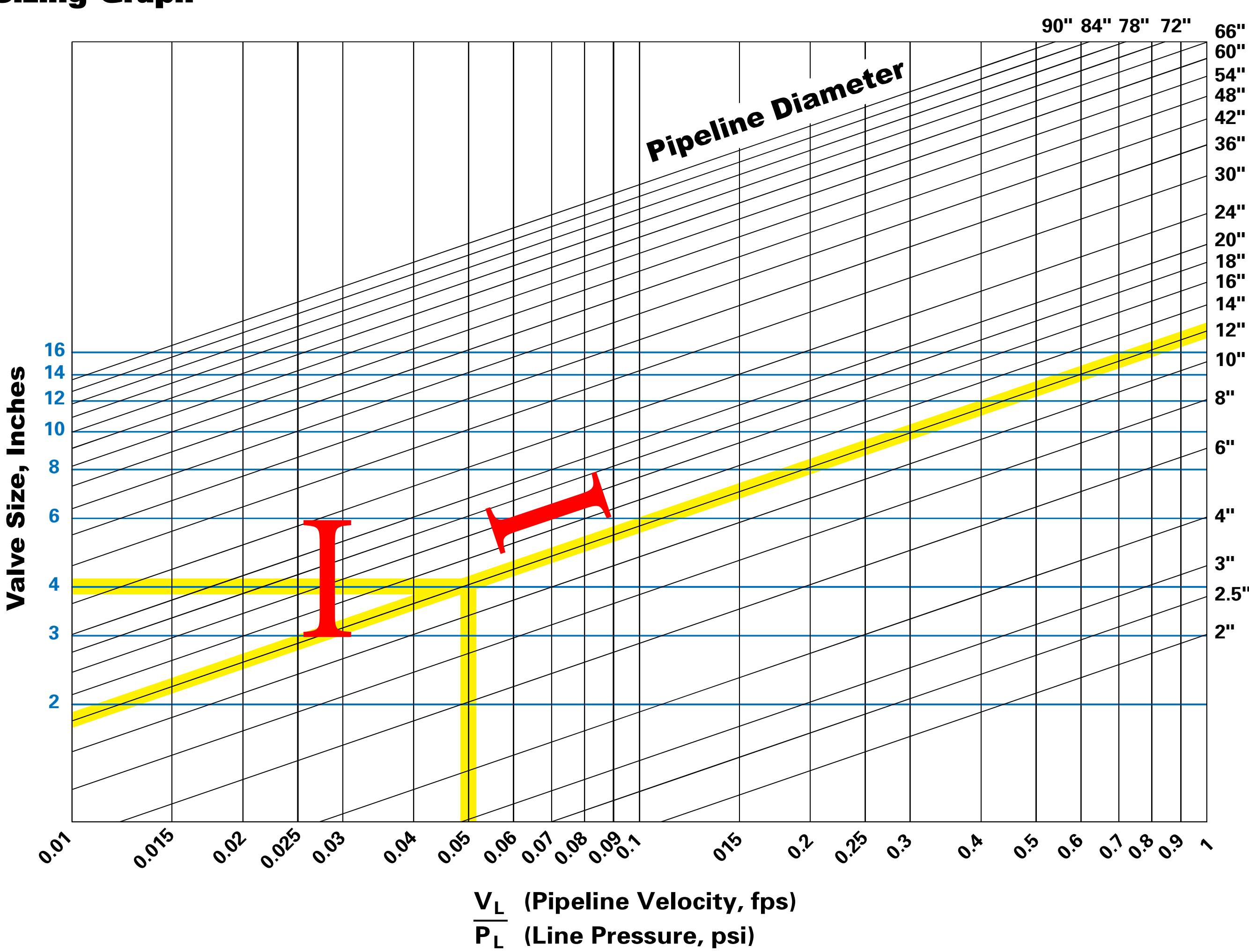
Sizing Steps

1. Determine Maximum Pipeline Velocity (V_L) in fps.
2. Determine Maximum Allowable Line Pressure (P_L) in psi. Suggested Maximum Allowable Line Pressure is 15% above normal pumping pressure, or rated pump pressure, to minimize pipe fatigue.
3. Calculate V_L/P_L.
4. Referring to the graph, read vertically up from V_L/P_L on the bottom scale to the intersection with the diagonal line representing the pipeline diameter then go horizontally over to the left for the Surge Relief Valve size. Round up to the next largest valve size.

Example

1. Data:
   - 12 inch diameter pipeline,
   - 3000 GPM maximum flow,
   - 170 psi maximum allowable system pressure
2. Divide velocity by pressure:
   V_L/P_L = 8.5 fps/170 psi = 0.05
3. From 0.05 on the bottom scale read vertically up to the intersection with the diagonal line representing a 12" diameter pipeline.
4. Read horizontally over to the point on the vertical scale that determines valve size and select a 4" size for this example.

Sizing Graph



Materials of Construction

Item	Description	Material
A1	Body	Ductile Iron, ASTM A536 Grade 65-45-12
A2	Cover	Ductile Iron, ASTM A536 Grade 65-45-12
A3	Cover O-Ring	Acrylonitrile-Butadiene (NBR)
		Terpolymer of Ethylene, Propylene and A Diene (EPDM)
		Fluoro Rubber (FKM)
A4	Lower Shaft Bushing	Bronze
A5	Body Seat	Aluminum Bronze C95200
		316 Stainless Steel, ASTM A240
A6	Disc Seat	Acrylonitrile-Butadiene (NBR)
		Terpolymer of Ethylene, Propylene and A Diene (EPDM)
		Fluoro Rubber (FKM)
A7	Piston	Carbon Steel, ASTM A108, Grade 1018 or ASTM A36
A8	Piston Seal	PTFE
A9	Piston Seal Engergizing O-Ring	Acrylonitrile-Butadiene (NBR)
A10	Disc	Carbon Steel, ASTM A108, Grade 1018
		316 Stainless Steel, ASTM A240/A276
A11	Lower Shaft	303 Stainless Steel, ASTM A582, Condition A
A12	Upper Shaft	303 Stainless Steel, ASTM A582, Condition A
A13	Cylinder Chamber Cap	Carbon Steel, ASTM A108, Grade 1018 or ASTM A36
A14	Cylinder Chamber Cap O-Ring	Acrylonitrile-Butadiene (NBR)
A15	Cylinder Chamber Cap Screws	Steel
A16	Spring Pressure Plate Guide	Carbon Steel, ASTM A108, Grade 1018 or ASTM A36
A17	Spring Compression Top Flange	Carbon Steel, ASTM A108, Grade 1018 or ASTM A36
A18	Spring Compression Guide	Carbon Steel, ASTM A108, Grade 1018 or ASTM A36; or Ductile Iron, ASTM A536 Grade 65-45-12
A19	Anti-Rotation Set Screw	316 Stainless Steel
A20	Pipe Assembly Lower Screws	Alloy Steel, Zinc Plated
A21	Pipe Assembly Upper Screws	Alloy Steel, Zinc Plated
A22	Spring Compressor	Alloy Steel, Zinc Plated
A23	Spring Compression Pipe Assembly	Steel
A24	Compression Shiping	Alloy Steel, ASTM A125
A25	Bushing O-Ring	Acrylonitrile-Butadiene (NBR)
		Fluoro Rubber (FKM)
A26	Lower Shaft O-Ring	Acrylonitrile-Butadiene (NBR)
		Fluoro Rubber (FKM)
A27	Upper Shaft O-Ring	Acrylonitrile-Butadiene (NBR)
A28	Rod Wiper	Polyethylene
A29	Inspection Hole Pipe Plug	316 Stainless Steel
A30	Body Seat Retaining Screw	316 Stainless Steel
A31	Disc Seat Retaining Ring	316 Stainless Steel, ASTM A240/A276
A32	Disc Seat Retaining Screw	316 Stainless Steel
A33	Body Seat O-Ring	Acrylonitrile-Butadiene (NBR)
		Terpolymer of Ethylene, Propylene and A Diene (EPDM)
		Fluoro Rubber (FKM)
A34	Cover Screws	Alloy Steel, Zinc Plated
A35	Flow Control Valve	Steel
A36	Shaft Collar	Alloy Steel
A37	Needle Thrust Bearing (6-16")	Steel
A38	Lock Nut	Alloy Steel, Zinc Plated
A39	Lower Shaft Retaining Ring	Steel
A40	Bushing Retaining Ring	Steel
A41	Piston Assembly Screw	Alloy Steel
A42	Mechanical Counter	Steel/Plastic
A43	Mechanical Counter Mounting Screws	18-8 Stainless Steel
A44	Mechanical Counter Hook (with Lock Nut)	Carbon Steel, Zinc Plated
A45	Mechanical Counter Wire	302 Stainless Steel
A46	Pipe Assembly Lower Screw Washer	Carbon Steel, Zinc Plated
A47	Pipe Assembly Upper Screw Washer	Carbon Steel, Zinc Plated
A48	Spring Compression Washer	Carbon Steel, Zinc Plated
A49	Oil Fill Pipe Plug	Steel
A97	Data Plate	316 Stainless Steel
A98	Drive Screw	18-8 Stainless Steel

Principle of Operation

The Surge Relief Angle Valve (SRA) is held normally closed by a compression spring(s) (A24). When the system pressure rises above the relief pressure setting of the spring(s), the disc (A10) moves quickly to the open position, raising the piston (A7) inside the integral oil cylinder of the cover (A02). This allows hydraulic oil from the top of the piston to flow freely through the flow control valve to the bottom of the piston.

As the system pressure subsides below the relief pressure setting, the surge relief valve closes at a slow adjustable rate. The spring(s) moves the disc toward the seated position as oil is metered from the bottom of the piston by the adjustable flow control valve (A35) to the top of the piston.

Closing Speed Adjustment

The flow control valve (A35) allows free oil flow in the direction of opening and controlled flow in the direction of closing to allow fast open and slow close of the surge relief valve. Closing speed can be adjusted to suit the system.

Pressure Setting

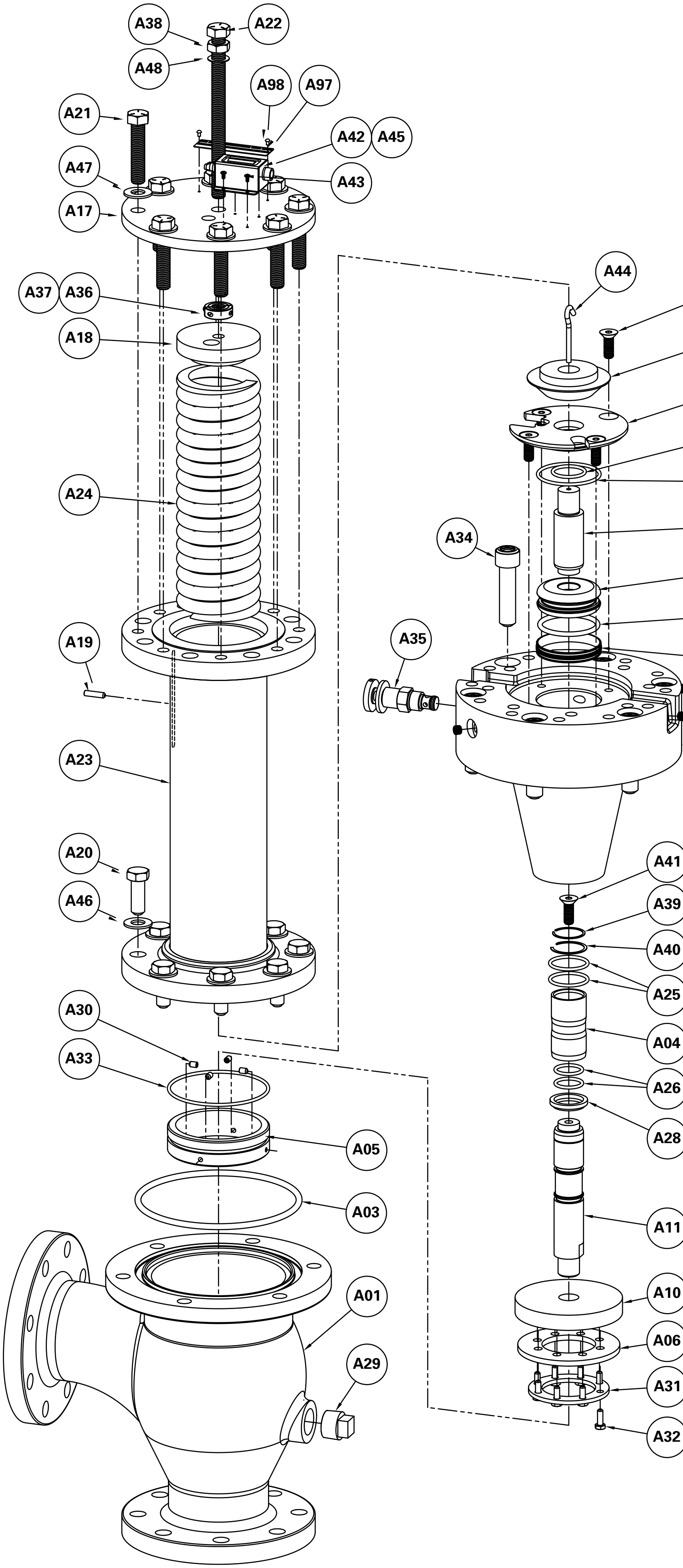
The relief pressure setting (valve opening pressure) is controlled by the amount of spring compression imposed by the spring compression guide (A18) as set by the spring compressor (A22). The relief pressure setting is factory set but can be adjusted, within limits, by rotating the spring compressor (A22). The lock nut (A38) is tightened to maintain the setting.

Field Installation

The Surge Relief Valve should be installed with the resilient seat of the disc facing the system pressure. The valve outlet must be piped to the sump or into a spillway for discharge to atmosphere. Surge Relief Angle Valves may be installed vertically or horizontally.

Mechanical Cycle Counter

The Mechanical Counter (A42) logs the number of surge events in the application.


A38
A22
A48
A98
A97
A21
A42
A45
A47
A43
A17
A37
A36
A44
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A18
A16
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A30
A04
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A26
A28
A05
A03
A11
A01
A10
A06
A29
A31
A32

Valve Selection

Shut-Off Capabilities

Resilient Seats	Drip tight shut-off

Temperature Ratings

Seat Material	Temperature Rating*
All Seats	-20 to 150°F (-20 to 65°C)

*Higher temperature ratings available on application.

Weights

Valve Size	Relief Pressure Set Point (psi)	Valve Weight (lbs/kg)
2" 50mm	30-135	154 70
	140-200	168 77
3" 80mm	30-60	204 93
	65-180	219 100
	185-200	352 160
4" 100mm	30 Only	219 100
	35-95	233 106
	100-200	291 133
6" 150mm	30-35	402 183
	40-110	459 209
	115-200	699 318
8" 200mm	30-60	591 269
	65-200	830 377
10" 250mm	30-35	749 340
	40-120	989 449
	125-200	1800 817
12" 300mm	30-55, 75-80	1290 586
	60-70, 85-200	2090 949
14" 350mm	30-50	2210 1003
	55-150	3010 1366
	155-200	4090 1856
16" 400mm	30-40	2030 922
	45-110	2840 1289
	115-200	3910 1775

Applicable Standards

DeZURIK SRA Valves are designed and/or tested to meet the following standards:	
ASME B16.1 (ASA B16.1)	Cast Iron Pipe Flanges and Flanged Fittings, 125 lbs. Conforms to related flange drilling dimensions.
ASME B16.5	Carbon Steel Flanges and Flanged Fittings, 150 lbs. Conforms to related flange drilling dimensions.
ASME B16.42	Ductile Iron Pipe Flanges and Flanged Fittings. Conforms to Class 150.

Pressure Ratings (Ambient Temperature)

Valve Style	Valve Size	Maximum Pressure*
Surge Relief Angle Valve (SRA)	2-16" 50-400mm	200 psi CWP 1380 kPa CWP

*Contact DeZURIK for higher pressures and larger sizes

Ordering

To order, simply complete the valve order code from information shown.
An ordering example is shown for your reference.

Valve Style
Give valve style code as follows:

SRA = Surge Relief Angle Valves

Valve Size
Give valve size code as follows:

2	=	2"	(50mm)	10	=	10"	(250mm)
3	=	3"	(80mm)	12	=	12"	(300mm)
4	=	4"	(100mm)	14	=	14"	(350mm)
6	=	6"	(150mm)	16	=	16"	(400mm)
8	=	8"	(200mm)				

Body Style
Give body style code as follows:

3000A = Angle Style Surge Relief Valve

End Connection
Give end connection code as follows:

F1 = Flanged ASME 125/150 Inlet & Outlet

Body Material
Give body material code as follows:

DI = Ductile Iron

Relief Pressure Setting
Give relief pressure setting point code as follows:

30P	=	30 psi	120P	=	120 psi
35P	=	35 psi	125P	=	125 psi
40P	=	40 psi	130P	=	130 psi
45P	=	45 psi	135P	=	135 psi
50P	=	50 psi	140P	=	140 psi
55P	=	55 psi	145P	=	145 psi
60P	=	60 psi	150P	=	150 psi
65P	=	65 psi	155P	=	155 psi
70P	=	70 psi	160P	=	160 psi
75P	=	75 psi	165P	=	165 psi
80P	=	80 psi	170P	=	170 psi
85P	=	85 psi	175P	=	175 psi
90P	=	90 psi	180P	=	180 psi
95P	=	95 psi	185P	=	185 psi
100P	=	100 psi	190P	=	190 psi
105P	=	105 psi	195P	=	195 psi
110P	=	110 psi	200P	=	200 psi
115P	=	115 psi			

Spring adjustment ranges are listed by valve size in the instruction manual.

Trim Combination
Disc Material
Give disc material code as follows:

CS = Carbon Steel
S2 = 316 Stainless Steel

Body Seat Material
Give body seat material code as follows:

S2 = 316 Stainless Steel
ALB = Aluminum Bronze

Disc Seat Material
Give disc seat material code as follows:

NBR = Acrylonitrile-butadiene
EPDM = Terpolymer of Ethylene Propylene & A Diene
FKM = Fluoro Rubber

Options
Give option code as follows:

SB16 = 316 Stainless Steel Bolting
Coatings = Special Coatings Available. Contact DeZURIK

Accessories
Give accessories code as follows:

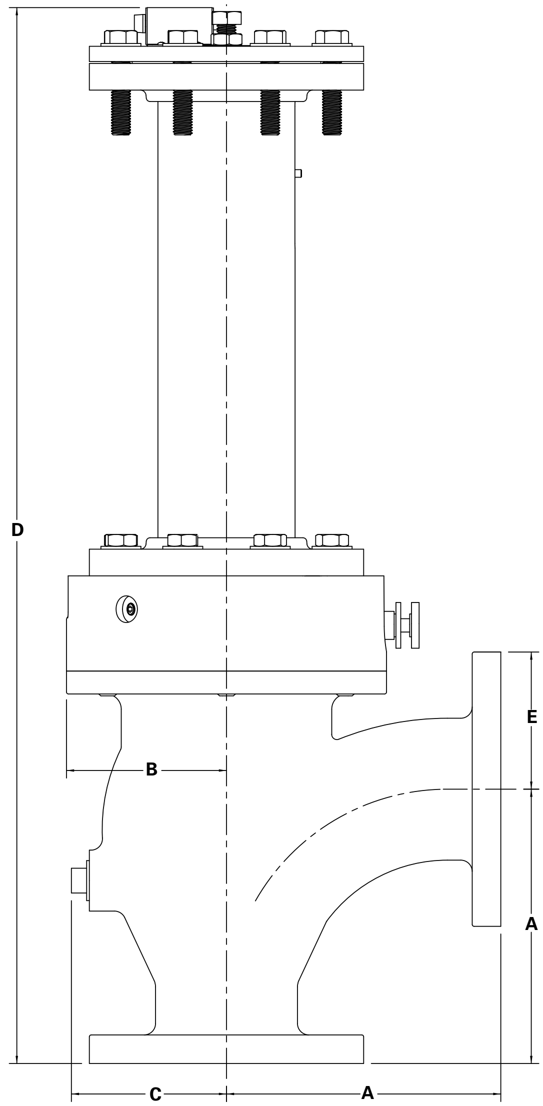
SEL45 = (1) Limit Switch DPDT (AB 802B-CSAD1XSXC3)
SEL30 = (1) Proximity Switch SPDT (GO 73-13526-B2)

Ordering Example:

SRA,8,3000A,F1,DI,55P,CS-S2-NBR*

Dimensions

Valve Size	Dimensions A	B	C	Relief Pressure Set Point (psi)	D
2" 50mm	6.50 165	4.50 114	3.50 89	30-135	26.94 684
				140-200	31.81 808
3" 80mm	7.75 197	5.25 133	4.25 108	30-60	29.44 748
				65-180	34.31 871
				185-200	41.13 1045
4" 100mm	9.00 229	5.25 133	5.13 130	30 Only	29.81 757
				35-95	34.69 881
				100-200	41.50 1054
6" 150mm	11.50 292	6.75 171	6.38 162	30-35	38.06 967
				40-110	44.88 1140
				115-200	54.00 1372
8" 200mm	14.00 356	8.63 219	7.63 194	30-60	49.13 1248
				65-200	58.25 1480
10" 250mm	16.50 419	9.50 241	9.94 252	30-35	53.38 1356
				40-120	62.50 1588
				125-200	75.06 1907
12" 300mm	19.00 483	10.50 267	10.94 278	30-55, 75-80	66.25 1683
				60-70, 85-200	78.81 2002
14" 350mm	21.50 546	11.75 298	13.94 354	30-50	70.00 1778
				55-150	82.56 2097
				155-200	83.31 2116
16" 400mm	24.00 610	11.75 298	14.44 367	30-40	75.25 1911
				45-110	87.81 2230
				115-200	88.56 2249



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For information about our worldwide locations, approvals, certifications and local representative:

Web Site: www.dezurik.com E-Mail: info@dezurik.com

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250 Riverside Ave. N. Sartell, Minnesota 56377 • Phone: 320-259-2000 • Fax: 320-259-2227

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