ASME expansion tanks

WHY AN EXPANSION TANK?

An expansion tank is required in a closed loop heating or chilled water HVAC system for two very important reasons:

1. **To control the systems operating pressure range;**
2. **To give the expanded water in the system a place to go as the water is heated. In a heating system this occurs when the system is heated from its coldest fill temperature to operation temperature. In a chilled water system this expansion occurs when the system is shut down and the system temperature rises from operating to ambient.**

The goal in sizing any expansion tank is to make the system able to accommodate the expansion of the system water throughout the heating or cooling cycles without allowing the system to exceed the pressure limits of the lowest pressure rated component in that system. The lowest rated component in most systems is, by design, the pressure relief valve. The maximum system pressure is normally set at 90% of the pressure relief valve rating at its point of installation.

BLADDER OR DIAPHRAGM TANKS COMPARED TO PLAIN STEEL TANKS

The plain steel expansion tank has been used for many years, and, in some systems, has worked very well. Using a plain steel expansion tank makes the system an air control system. One must control the air volume or air cushion above the water level of the tank. The common interface between this air cushion and the water in the tank allows the air to be absorbed by the water. If the air is not removed properly from the water and placed back into the air cushion, the expansion tank will become waterlogged.

A waterlogged tank is an expansion tank that no longer has an air cushion large enough to allow all the expanded water from the system to enter the tank without exceeding the maximum system pressure. When this occurs, the safety relief valve will open and heated system water will be discharged to the drain.

CAUTION: An expansion tank does not need to be 100% full to be waterlogged. The same symptoms will also show if the expansion tank is sized too small.

The advantage of a plain steel tank is that the initial purchase cost is lower than a diaphragm/bladder tank, but in many cases the operation costs will offset this advantage.

The bladder / diaphragm expansion tank has been developed to allow the system's air cushion to be separated from the system's water. No waterlogging of the tank can occur as the air is held between the tank wall and the exterior of a bladder placed inside the tank, while the system water is contained inside the bladder. This changes the system to an air elimination system, as any air extracted from the system water is passed out of the system into the atmosphere.

The bladder tank is usually smaller than a plain steel tank for the same application as they are precharged with air to the system operating pressure before the system is filled with water. The only water that needs to be accommodated by a bladder/diaphragm tank is the expanded water. In a heating system, this occurs when the water is heated from the fill temperature to the operating temperature. In a chilled water system the water temperature rises from operating temperature to ambient temperature. The air elimination system allows the air vent and air separator to be placed at the most advantageous point in the system for air removal, usually at the system's high point where the pressure is the lowest or at the boiler outlet where the water temperature is the highest. The expansion tank can now be placed at floor level, since air no longer needs to be returned to the tank. The diaphragm/ bladder tank can also be placed at the most advantageous point in the system.

TYPICAL POSITIONING OF AN EXPANSION TANK

The system connection of an expansion is known as "The Point of No Pressure Change". This means that wherever the expansion tank is connected to the system, the pressure will always be the same as the pressure inside the tank. This is true if the tank is a plain steel or bladder/diaphragm type. This is also true whether the system pump is on or off. This pressure is only changed as water or air are added to or removed from the tank. To better understand this "Point of No Pressure Change", an in-depth study of Boyle's Law is necessary.

Because of this "Point of No Pressure Change", the system sees a pump additive pressure from the pump discharge to the expansion tank connection. From the expansion tank connection back to the pump suction, the system receives a negative pressure change from the tank pressure, due to the friction loss when there is flow.

With this loss of pressure added by the pump and the loss due to flow, it is usually better to place the "Point of No Pressure Change" or expansion tank system connection as close to the pump suction as possible.

SIZING GUIDE

CALEFACTIO

Plain steel expansion tanks / Plain steel – NA Series

Job Name: ____________	Date: ____________
Job Location: ____________	Model #: ____________
Contact Name: ____________	Date submitted: ____________
Engineer: ____________	Approved by: ____________
Contractor: ____________	Date of approval: ____________

INFORMATION REQUIRED

1. Total system water content	**(1)** ________	gal	________ L
2. Temperature of water when system is filled	**(2)** ________	°F	________ °C
3. Maximum operating temperature	**(3)** ________	°F	________ °C
4. Minimum operating pressure (typically fill pressure)	**(4)** ________	psi	________ kPa
5. Maximum operating pressure (10% below relief valve)	**(5)** ________	psi	________ kPa

SIZING FOR HYDRONIC HEATING/COOLING SYSTEMS

6. Enter total system water content from line **(1)**.	**(6)** ________	gal	________ L
7. Using the Expansion Factors table (see page 21), find and enter the expansion factor.	**(7)** ________		________
8. Multiply line **(6)** by line **(7)**. Enter expanded water volume.	**(8)** ________	gal	________ L
9. Determine the acceptance factor by $(P_a \div P_f)$ $(P_a \div P_o)$, where P_a = Pressure (atmospheric) P_f = Pressure at fill (atmospheric) P_o = Pressure at operation (atmospheric) and enter the result.	**(9)** ________		________
10. Divide line **(8)** by line **(9)** and enter tank size.	**(10)** ________	gal	________ L

MODEL SELECTION

Select plain steel tank from NA section (see page 15).

Model ________ NA ________

CAUTION: The expansion chart is for water only. Add 60% to the expansion factors for 50/50 glycol/water solutions or contact your local Calefactio representative for other concentrations.

SIZING GUIDE

CALEFACTIO

ASME expansion tanks / With fixed or replaceable bladder – AL, ALT, OT Series

Job Name: ______	Date: ______
Job Location: ______	Model #: ______
Contact Name: ______	Date submitted: ______
Engineer: ______	Approved by: ______
Contractor: ______	Date of approval: ______

INFORMATION REQUIRED

1. Total system water content	**(1)** ______ gal	______ L
2. Temperature of water when system is filled	**(2)** ______ °F	______ °C
3. Maximum operating temperature	**(3)** ______ °F	______ °C
4. Minimum operating pressure (typically fill pressure)	**(4)** ______ psi	______ kPa
5. Maximum operating pressure (10% below relief valve)	**(5)** ______ psi	______ kPa

SIZING FOR HYDRONIC HEATING/COOLING SYSTEMS

6. Enter total system water content from line **(1)**.	**(6)** ______ gal	______ L
7. Using the Expansion Factor table, (see page 21), find and enter the expansion factor.	**(7)** ______	______
8. Multiply line **(6)** by line **(7)**. Enter expanded water volume.	**(8)** ______ gal	______ L
9. Using the Acceptance Factors table (see pages 23 and 24), determine the acceptance factor.	**(9)** ______	______
10. Divide line **(8)** by line **(9)**; and enter tank size.	**(10)** ______ gal	______ L

Line **(8)** ______, expanded water (acceptance volume)

Line **(10)** ______, total tank volume

MODEL SELECTION

Select expansion tank model from chart on fixed/replaceable bladder section.
- HGT (non-code) or OT models must satisfy both lines **(8)** et **(10)**.
- AL models are selected by total volume only from line **(10)**.

For large systems, multiple tanks can be manifolded together.

CAUTION: The expansion chart is for water only. Add 60% to the expansion factors for 50/50 glycol/water solutions or contact your local Calefactio representative for other concentrations.

CONVERSION

CALEFACTIO

Converting plain steel tanks to diaphragm expansion tanks

Job Name:______________________________ Date: ______________

Job Location: ______________________________ Model #: ______________

Contact Name:______________________________ Date submitted: ______________

Engineer:______________________________ Approved by: ______________

Contractor:______________________________ Date of approval:______________

INFORMATION REQUIRED

1. Determine plain steel tanks volume (table 2, p. 22) **(1)**__________gal __________L

2. Temperature of water when system is filled **(2)**__________ °F __________°C

3. Maximum operating temperature **(3)**__________ °F __________°C

4. Minimum operating pressure (usually fill pressure) **(4)**__________psi __________ kPa

5. Maximum operating pressure (10% below relief valve) **(5)** __________psi __________ kPa

SIZING FOR HYDRONIC HEATING/COOLING SYSTEMS

6. Determine the acceptance by ($P_a \div P_f$) ($P_a \div P_o$),
where P_a = Pressure (atmospheric)
P_f = Pressure at fill (atmospheric)
P_o = Pressure at operation (atmospheric)
and enter the result. **(6)**__________ __________

7. Enter volume of plain steel tank
line **(1)**. **(7)**__________gal __________L

8. Calculate expanded water volume.
Multiply line **(6)** by line **(7)** and enter. **(8)**__________gal __________L

9. Using Acceptance Factors table (see pages 23 and 24),
and enter the acceptance factor. **(9)**__________ __________

10. Divide line **(8)** by line **(9)**,
enter tank volume required. **(10)**__________gal __________L

Line **(8)**__________, expanded water (acceptance volume)

Line **(10)** __________, total tank volume

MODEL SELECTION

Select expansion tank model from fixed/replaceable bladder section.
- HGT (non-code) or OT models must satisfy both lines **(8)** and **(10)**.
- AL models are selected by total volume only from line **(10)**.

For large systems, multiple tanks can be manifolded together.

CAUTION: The expansion chart is for water only. Add 60% to the expansion factors for 50/50 glycol/water solutions or contact your local Calefactio representative for other concentrations.

EXPANSION FACTORS TABLE

CALEFACTIO

Final temp.		Initial temperature												
°F	°C	40 °F 4.4 °C	45 °F 7.2 °C	50 °F 10 °C	55 °F 12.7 °C	60 °F 15.5 °C	65 °F 18.3 °C	70 °F 21.1 °C	75 °F 23.8 °C	80 °F 26.6 °C	85 °F 29.4 °C	90 °F 32.2 °C	95 °F 35 °C	100 °F 37.7 °C
50	**10**	0.00008	0.00006	–										
55	**12.7**	0.00027	0.00025	0.00019	–									
60	**15.5**	0.00057	0.00055	0.00049	0.00030	–								
65	**18.3**	0.00095	0.00093	0.00087	0.00068	0.00038	–							
70	**21.1**	0.00151	0.00149	0.00143	0.00124	0.00094	0.00056	–						
75	**23.8**	0.00194	0.00194	0.00188	0.00169	0.00139	0.00101	0.00045	–					
80	**26.6**	0.00260	0.00260	0.00254	0.00235	0.00205	0.00167	0.00111	0.00066	–				
85	**29.4**	0.00326	0.00326	0.00320	0.00301	0.00271	0.00233	0.00177	0.00132	0.00066	–			
90	**32.2**	0.00405	0.00405	0.00399	0.00380	0.00350	0.00312	0.00256	0.00211	0.00145	0.00079	–		
95	**35**	0.00485	0.00485	0.00479	0.00460	0.00430	0.00392	0.00336	0.00291	0.00225	0.00159	0.00080	–	
100	**37.7**	0.00577	0.00575	0.00569	0.00550	0.00520	0.00482	0.00426	0.00381	0.00315	0.00249	0.00170	0.00090	–
105	**40.5**	0.00673	0.00671	0.00655	0.00646	0.00616	0.00578	0.00522	0.00477	0.00411	0.00345	0.00266	0.00186	0.00096
110	**43.3**	0.00773	0.00771	0.00765	0.00746	0.00716	0.00678	0.00622	0.00577	0.00511	0.00445	0.00366	0.00286	0.00196
115	**46.1**	0.00881	0.00879	0.00873	0.00854	0.00824	0.00786	0.00730	0.00685	0.00619	0.00553	0.00474	0.00394	0.00304
120	**48.8**	0.01006	0.01004	0.00998	0.00979	0.00949	0.00911	0.00855	0.00810	0.00744	0.00678	0.00599	0.00519	0.00429
125	**51.6**	0.01113	0.01111	0.01105	0.01086	0.01056	0.01018	0.00962	0.00917	0.00851	0.00785	0.00706	0.00625	0.00536
130	**54.4**	0.01238	0.01236	0.01230	0.01211	0.01181	0.01143	0.01087	0.01042	0.00976	0.00910	0.00831	0.00751	0.00661
135	**57.2**	0.01370	0.01368	0.01362	0.01342	0.01313	0.01275	0.01219	0.01174	0.01108	0.01042	0.00963	0.00883	0.00793
140	**60**	0.01503	0.01501	0.01495	0.01476	0.01446	0.01408	0.01352	0.01307	0.01241	0.01175	0.01096	0.01016	0.00926
145	**62.7**	0.01645	0.01643	0.01637	0.01618	0.01588	0.01550	0.01494	0.01449	0.01383	0.01317	0.01238	0.00158	0.01068
150	**65.5**	0.01787	0.01787	0.01779	0.01760	0.01730	0.01692	0.01636	0.01591	0.01525	0.01459	0.01330	0.01300	0.01210
155	**68.3**	0.01939	0.01937	0.01931	0.01912	0.01882	0.01844	0.01788	0.01743	0.01677	0.01611	0.01532	0.01452	0.01362
160	**71.1**	0.02094	0.02092	0.02086	0.02067	0.02037	0.01999	0.01943	0.01877	0.01811	0.01732	0.01652	0.01572	0.01482
165	**73.8**	0.02254	0.02252	0.02246	0.02227	0.02197	0.02159	0.02103	0.02058	0.01992	0.01926	0.01847	0.01767	0.01677
170	**76.6**	0.02420	0.02418	0.02412	0.02393	0.02363	0.02325	0.02269	0.02224	0.02158	0.02092	0.02013	0.01933	0.01843
175	**79.4**	0.02590	0.02588	0.02582	0.02563	0.02533	0.02495	0.02439	0.02394	0.02328	0.02262	0.02183	0.02103	0.02013
180	**82.2**	0.02765	0.02763	0.02757	0.02738	0.02708	0.02670	0.02614	0.02569	0.02503	0.02437	0.02358	0.02278	0.02188
185	**85**	0.02943	0.02941	0.02935	0.02916	0.02886	0.02848	0.02792	0.02747	0.02681	0.02615	0.02536	0.02456	0.02366
190	**87.7**	0.03129	0.03127	0.03121	0.03102	0.03072	0.03034	0.02978	0.02933	0.02867	0.02801	0.02722	0.02642	0.02552
195	**90.5**	0.03316	0.03314	0.0330	0.03289	0.03259	0.03221	0.03165	0.03120	0.03054	0.02988	0.02909	0.02829	0.02739
200	**93.3**	0.03512	0.03510	0.03504	0.03485	0.03455	0.03417	0.03361	0.03316	0.03250	0.03184	0.03105	0.03025	0.02935
205	**96.1**	0.03709	0.03707	0.03701	0.03682	0.03652	0.03614	0.03558	0.03513	0.03447	0.03381	0.00302	0.03222	0.03132
210	**98.8**	0.03913	0.03911	0.03905	0.03885	0.03856	0.03818	0.03762	0.03717	0.03651	0.03585	0.03506	0.03426	0.03336
215	**101.6**	0.04122	0.04120	0.04114	0.04095	0.04065	0.04027	0.03971	0.03926	0.03860	0.03794	0.03715	0.03635	0.03545
220	**104.4**	0.04337	0.04335	0.04329	0.04310	0.04280	0.04242	0.04186	0.04141	0.04075	0.04009	0.03930	0.03850	0.03760
225	**107.2**	0.04551	0.04549	0.04543	0.04524	0.04494	0.04456	0.04400	0.04355	0.04289	0.04223	0.04144	0.04064	0.03974
230	**110**	0.04764	0.04762	0.04756	0.04737	0.04707	0.04669	0.04613	0.04568	0.04502	0.04436	0.04357	0.04277	0.04187
235	**111.7**	0.04993	0.04991	0.04985	0.04966	0.04936	0.04898	0.04842	0.04797	0.04731	0.04665	0.04586	0.04506	0.04416
240	**115**	0.05222	0.05220	0.05214	0.05195	0.05165	0.05127	0.05071	0.05026	0.04960	0.04894	0.04815	0.04735	0.04645
245	**118.3**	0.05451	0.05449	0.05443	0.05424	0.05394	0.05356	0.05300	0.05255	0.05189	0.05123	0.05044	0.04964	0.04874

SYSTEM VOLUME CALCULATION

CALEFACTIO

Add the total pipe fluid volume in gallons (from table 1) to the total fluid volume of all system components in gallons. Boilers,heat exchangers, etc.:

TABLE 1

Pipe volume in gallons per foot

PIPE DIAMETER	½"	¾"	1"	1 ¼"	1 ½"	2"	2 ½"
Steel pipe (Sch. 40)	0.0157	0.0277	0.0449	0.0779	0.106	0.174	0.249
Copper tube	0.0121	0.0251	0.0429	0.0653	0.0924	0.161	0.248

PIPE DIAMETER	3"	4"	5"	6"	8"	10"	12"
Steel pipe (Sch. 40)	0.384	0.66	1.04	1.51	2.61	4.11	5.82
Copper tube	0.354	0.622	0.971	1.39	2.43	3.78	5.46

TABLE 2

Plain steel tank volume in gallons from tank dimensions

Diameter (in)	Length (in)	Volume (gallons)	Gallons per each additional inch
12	33	15	0.49
14	48	30	0.67
16	72	60	0.87
20	78	100	1.36
24	72	135	1.96
30	84	240	3.06
36	93	400	4.41
42	96	525	6.00

TABLE 3

Water content in heat exchangers

Shell diameter (in)	Gallons per foot for shell length	
	In shell	In tubes
4	0.425	0.225
6	1.00	0.50
8	1.85	1.00
10	2.40	1.20
12	4.00	2.20
14	5.00	2.50
16	6.50	3.50
18	8.00	4.50
20	10.00	5.50
24	15.00	7.50

ACCEPTANCE FACTORS TABLE

Use gauge pressure

(P_0) Maximum operating pressure		P_f – Minimum operating pressure at tank (psig)/kPa											
psig	kPa	5 34.5	10 68.9	12 82.7	15 103.4	20 137.9	25 172.4	30 206.8	35 241.3	40 275.8	45 310.3	50 344.7	55 379.2
10	**68.9**	0.202	–										
12	**82.7**	0.262	0.075	–									
15	**103.4**	0.337	0.168	0.101	–								
20	**137.9**	0.432	0.288	0.231	0.144	–							
25	**172.4**	0.504	0.378	0.328	0.252	0.126							
27	**186.1**	0.527	0.408	0.360	0.288	0.168	–						
30	**206.8**	0.560	0.447	0.403	0.336	0.224	0.112	–					
35	**241.3**	0.604	0.503	0.463	0.403	0.302	0.202	0.101	–				
40	**275.8**	0.640	0.548	0.512	0.457	0.366	0.274	0.183	0.091	–			
45	**310.3**	0.670	0.586	0.553	0.503	0.419	0.335	0.251	0.168	0.084	–		
50	**344.7**	0.696	0.618	0.587	0.541	0.464	0.386	0.309	0.232	0.155	0.078	–	
55	**379.2**	0.717	0.646	0.617	0.574	0.502	0.430	0.359	0.287	0.215	0.144	0.072	–
60	**413.7**	0.736	0.669	0.643	0.602	0.536	0.469	0.402	0.335	0.268	0.201	0.134	0.067
65	**448.2**	0.753	0.690	0.665	0.627	0.565	0.502	0.439	0.376	0.314	0.251	0.188	0.125
70	**482.6**	0.767	0.708	0.685	0.649	0.590	0.531	0.472	0.413	0.354	0.295	0.236	0.177
75	**517.1**	0.780	0.725	0.702	0.669	0.613	0.558	0.502	0.446	0.390	0.333	0.279	0.223
80	**551.6**	0.792	0.739	0.718	0.686	0.634	0.581	0.528	0.475	0.422	0.370	0.317	0.264
85	**586.1**	0.802	0.752	0.732	0.702	0.652	0.602	0.552	0.502	0.451	0.401	0.351	0.301
90	**620.5**	0.812	0.764	0.745	0.716	0.669	0.621	0.573	0.525	0.478	0.430	0.382	0.335
95	**655.0**	0.820	0.775	0.757	0.729	0.684	0.638	0.593	0.547	0.501	0.456	0.410	0.365
100	**689.5**	0.828	0.785	0.767	0.741	0.698	0.654	0.610	0.567	0.523	0.479	0.436	0.392
105	**723.9**	0.835	0.794	0.777	0.752	0.710	0.668	0.626	0.585	0.543	0.501	0.459	0.418
110	**758.4**	0.842	0.802	0.786	0.762	0.723	0.682	0.642	0.601	0.561	0.521	0.481	0.441
115	**792.9**	0.848	0.810	0.794	0.771	0.734	0.694	0.655	0.617	0.578	0.540	0.501	0.463
120	**827.4**	0.854	0.817	0.802	0.780	0.742	0.705	0.668	0.631	0.594	0.557	0.520	0.483
125	**861.8**	0.859	0.823	0.809	0.787	0.752	0.716	0.680	0.644	0.608	0.573	0.537	0.501
130	**896.3**	0.864	0.829	0.815	0.795	0.760	0.726	0.691	0.657	0.622	0.586	0.553	0.519
135	**930.8**	0.868	0.835	0.822	0.802	0.768	0.735	0.701	0.6&8	0.635	0.601	0.563	0.534
140	**965.3**	0.873	0.840	0.827	0.808	0.776	0.743	0.711	0.679	0.647	0.614	0.582	0.550
145	**999.7**	0.877	0.845	0.833	0.814	0.783	0.751	0.720	0.689	0.658	0.626	0.595	0.564
150	**1034.2**	0.880	0.850	0.838	0.820	0.789	0.759	0.729	0.699	0.668	0.638	0.608	0.577
155	**1068.7**	0.884	0.854	0.843	0.825	0.795	0.766	0.736	0.707	0.677	0.648	0.618	0.589
160	**1103.2**	0.887	0.859	0.847	0.830	0.801	0.773	0.744	0.716	0.687	0.658	0.630	0.601
165	**1137.6**	0.890	0.863	0.851	0.835	0.807	0.779	0.751	0.724	0.696	0.668	0.640	0.612
170	**1172.1**	0.893	0.866	0.855	0.839	0.812	0.785	0.758	0.731	0.704	0.677	0.649	0.622
175	**1206.6**	0.896	0.870	0.859	0.843	0.817	0.791	0.764	0.738	0.711	0.685	0.659	0.632
180	**1241.1**	0.899	0.873	0.863	0.847	0.822	0.796	0.770	0.745	0.719	0.693	0.668	0.642
185	**1275.5**	0.901	0.876	0.866	0.851	0.826	0.801	0.776	0.751	0.726	0.701	0.676	0.651
190	**1310.0**	0.904	0.879	0.870	0.855	0.831	0.806	0.782	0.757	0.733	0.709	0.684	0.660
195	**1344.5**	0.906	0.882	0.873	0.858	0.835	0.811	0.787	0.7&3	0.739	0.716	0.692	0.668
200	**1379.0**	0.908	0.885	0.876	0.862	0.838	0.815	0.792	0.768	0.745	0.722	0.699	0.675
205	**1413.4**	0.910	0.888	0.878	0.865	0.842	0.819	0.796	0.774	0.751	0.728	0.705	0.682
210	**1447.9**	0.912	0.890	0.881	0.868	0.845	0.823	0.801	0.779	0.756	0.734	0.712	0.689
215	**1482.4**	0.914	0.892	0.884	0.871	0.849	0.827	0.805	0.783	0.762	0.740	0.718	0.696
220	**1516.8**	0.916	0.895	0.886	0.873	0.852	0.831	0.810	0.788	0.767	0.746	0.724	0.703
225	**1551.3**	0.918	0.897	0.889	0.876	0.855	0.834	0.813	0.792	0.772	0.751	0.730	0.709
230	**1585.8**	0.919	0.899	0.891	0.879	0.858	0.838	0.817	0.797	0.777	0.756	0.736	0.715
235	**1620.3**	0.921	0.901	0.893	0.881	0.861	0.841	0.821	0.801	0.780	0.760	0.740	0.720
240	**1654.7**	0.923	0.903	0.895	0.883	0.864	0.884	0.825	0.805	0.785	0.766	0.746	0.727
245	**1689.2**	0.924	0.905	0.897	0.886	0.866	0.847	0.828	0.808	0.789	0.770	0.751	0.731
250	**1723.7**	0.926	0.907	0.899	0.888	0.869	0.850	0.831	0.812	0.793	0.774	0.755	0.737

ACCEPTANCE FACTORS TABLE

CALEFACTIO

Use gauge pressure

(P_o) Maximum operating pressure		P_f – Minimum operating pressure at tank (psig)/kPa											
psig	**kPa**	**60 413.7**	**65 448.2**	**70 482.6**	**75 517.1**	**80 551.6**	**85 586.1**	**90 620.5**	**95 655.0**	**100 689.5**	**105 723.9**	**110 758.4**	**115 792.9**
60	**413.7**	–											
65	**448.2**	0.062	–										
70	**482.6**	0.118	0.059	–									
75	**517.1**	0.167	0.111	0.056	–								
80	**551.6**	0.211	0.158	0.106	0.053	–							
85	**586.1**	0.251	0.201	0.151	0.101	0.050	–						
90	**620.5**	0.287	0.239	0.191	0.143	0.096	0.048	–					
95	**655.0**	0.319	0.273	0.228	0.182	0.137	0.091	0.045	–				
100	**689.5**	0.347	0.305	0.261	0.218	0.174	0.131	0.087	0.043	–			
105	**723.9**	0.376	0.334	0.292	0.250	0.208	0.167	0.125	0.083	0.041	–		
110	**758.4**	0.401	0.361	0.321	0.281	0.241	0.200	0.160	0.120	0.080	0.040	–	
115	**792.9**	0.424	0.386	0.347	0.309	0.270	0.232	0.193	0.155	0.116	0.007	0.039	–
120	**827.4**	0.446	0.408	0.371	0.334	0.297	0.260	0.223	0.186	0.149	0.111	0.074	0.037
125	**861.8**	0.465	0.429	0.394	0.358	0.322	0.286	0.250	0.215	0.179	0.143	0.107	0.071
130	**896.3**	0.484	0.450	0.415	0.381	0.346	0.312	0.277	0.243	0.208	0.173	0.138	0.104
135	**930.8**	0.501	0.468	0.439	0.401	0.367	0.334	0.301	0.267	0.234	0.200	0.167	0.134
140	**965.3**	0.517	0.485	0.453	0.420	0.388	0.356	0.324	0.291	0.259	0.226	0194	0.162
145	**999.7**	0.532	0.501	0.470	0.438	0.407	0.376	0.344	0.313	0.282	0.250	0.219	0.188
150	**1034.2**	0.547	0.517	0.486	0.456	0.426	0.396	0.365	0.335	0.305	0.273	0.243	0.213
155	**1068.7**	0.559	0.530	0.500	0.471	0.441	0.412	0.382	0.353	0.323	0.295	0.265	0.236
160	**1103.2**	0.573	0.544	0.515	0.487	0.458	0.430	0.401	0.372	0.344	0.315	0.286	0.258
165	**1137.6**	0.585	0.557	0.529	0.501	0.473	0.446	0.418	0.390	0.362	0.334	0.306	0.278
170	**1172.1**	0.595	0.568	0.541	0.514	0.487	0.460	0.433	0.460	0.378	0.352	0.325	0.298
175	**1206.6**	0.606	0.579	0.553	0.527	0.500	0.474	0.447	0.421	0.395	0.369	0.343	0.316
180	**1241.1**	0.616	0.590	0.565	0.539	0.513	0.488	0.462	0.436	0.411	0.385	0.360	0.334
185	**1275.5**	0.626	0.601	0.576	0.551	0.526	0.501	0.476	0.451	0.426	0.401	0.376	0.351
190	**1310.0**	0.635	0.611	0.587	0.562	0.538	0.513	0.489	0.465	0.440	0.415	0.391	0.366
195	**1344.5**	0.644	0.620	0.597	0.573	0.549	0.525	0.501	0.478	0.454	0.429	0.405	0.381
200	**1379.0**	0.652	0.629	0.605	0.582	0.559	0.535	0.512	0.489	0.466	0.443	0.419	0.396
205	**1413.4**	0.660	0.637	0.614	0.591	0.568	0.546	0.523	0.450	0.477	0.455	0.432	0.410
210	**1447.9**	0.667	0.645	0.622	0.600	0.578	0.556	0.533	0.510	0.489	0.467	0.445	0.423
215	**1482.4**	0.674	0.653	0.631	0.609	0.587	0.565	0.544	0.522	0.500	0.479	0.457	0.435
220	**1516.8**	0.682	0.660	0.639	0.618	0.597	0.575	0.554	0.533	0.511	0.490	0.469	0.447
225	**1551.3**	0.688	0.667	0.646	0.625	0.604	0.583	0.563	0.542	0.521	0.501	0.478	0.459
230	**1585.8**	0.695	0.675	0.654	0.634	0.613	0.593	0.573	0.552	0.532	0.511	0.490	0.470
235	**1620.3**	0.700	0.680	0.660	0.640	0.620	0.600	0.579	0.559	0.539	0.521	0.501	0.481
240	**1654.7**	0.707	0.687	0.668	0.648	0.629	0.609	0.589	0.570	0.550	0.530	0.510	0.491
245	**1689.2**	0.712	0.693	0.673	0.654	0.635	0.615	0.596	0.577	0.558	0.539	0.520	0.501
250	**1723.7**	0.718	0.699	0.680	0.661	0.642	0.623	0.604	0.585	0.566	0.548	0.529	0.510

$$\textbf{Acceptance Factor} = 1 - \frac{P_f}{P_o}$$

P_f = minimum absolute pressure, P_o = maximum absolute pressure

SIZING GUIDE

CALEFACTIO

ASME expansion tanks for potable water – BFA, TXA and FTTE-C Series

Job Name:______________________________ Date: ______________

Job Location: ______________________________ Model #: ______________

Contact Name:______________________________ Date submitted: ______________

Engineer:______________________________ Approved by: ______________

Contractor: ______________________________ Date of approval:______________

INFORMATION REQUIRED

1.	Total volume of hot water tank	**(1)**__________gal	__________L
2.	Water temperature setting	**(2)**__________ °F	__________°C
3.	Minimum operating pressure at the tank	**(3)**__________psi	__________ kPa
4.	Maximum allowable pressure or relief valve setting	**(4)**__________psi	__________ kPa

SIZING ASME THERMAL EXPANSION TANKS FOR POTABLE WATER

5.	Enter the total volume of hot water tank from line **(1)**.	**(5)**__________gal	__________L
6.	Find and enter the “Expansion Factor”. (Refer to the table on page 43).	**(6)**__________ °F	__________°C
7.	Multiply line **(5)** by line **(6)** to determine the quantity of expanded water.	**(7)**__________gal	__________L
8.	Find and enter the “Acceptance Factor” according to the pressures on line **(3)** and **(4)**. (Refer to the tables on pages 44 and 45)	**(8)**__________psi	__________ kPa
9.	Divide line **(7)** by line **(8)** to obtain the minimum tank volume required	**(9)**__________gal	__________L

MODEL SELECTION

Refer to the appropriate submittal datasheet (BFA, FTTE-C or TXA models) and select the model which is equal to or greater than the minimum volume required **(9)** and the minimum acceptance volume required **(7)**.

EXPANSION FACTORS TABLE

TABLE 1

Expansion Factors based on 40 °F / 4.4 °C minimum water temperature

EXPANSION FACTORS Different level of maximum temperature				
120 °F / 48.8°C	**140 °F / 60 °C**	**160 °F / 71.1 °C**	**180 °F / 82.2 °C**	**200 °F / 93.3°C**
0.01006	0.01503	0.02094	0.02765	0.03512

For other temperatures, please refer to table on p. 21

ACCEPTANCE FACTORS TABLE

TABLE 2

Acceptance factors (use gauge pressures)

Maximum pressure (psig / kPa)	Minimum operating pressure at the tank (psig / kPa)							
	60 / 413.7	**65 / 448.2**	**70 / 482.6**	**75 / 517.1**	**80 / 551.6**	**85 / 586.1**	**90 / 620.5**	**95 / 655.0**
100 / 689.5	0.347	0.305	0.261	0.218	0.174	0.131	0.087	0.043
125 / 861.8	0.465	0.429	0.394	0.358	0.322	0.286	0.250	0.215

ACCEPTANCE FACTORS TABLE

CALEFACTIO

Use gauge pressure

(P_o) Maximum operating pressure		P_f – Minimum operating pressure at tank (psig)/kPa											
psig	kPa	5 34.5	10 68.9	12 82.7	15 103.4	20 137.9	25 172.4	30 206.8	35 241.3	40 275.8	45 310.3	50 344.7	55 379.2
10	**68.9**	0.202	–										
12	**82.7**	0.262	0.075	–									
15	**103.4**	0.337	0.168	0.101	–								
20	**137.9**	0.432	0.288	0.231	0.144	–							
25	**172.4**	0.504	0.378	0.328	0.252	0.126							
27	**186.1**	0.527	0.408	0.360	0.288	0.168	–						
30	**206.8**	0.560	0.447	0.403	0.336	0.224	0.112	–					
35	**241.3**	0.604	0.503	0.463	0.403	0.302	0.202	0.101	–				
40	**275.8**	0.640	0.548	0.512	0.457	0.366	0.274	0.183	0.091	–			
45	**310.3**	0.670	0.586	0.553	0.503	0.419	0.335	0.251	0.168	0.084	–		
50	**344.7**	0.696	0.618	0.587	0.541	0.464	0.386	0.309	0.232	0.155	0.078	–	
55	**379.2**	0.717	0.646	0.617	0.574	0.502	0.430	0.359	0.287	0.215	0.144	0.072	–
60	**413.7**	0.736	0.669	0.643	0.602	0.536	0.469	0.402	0.335	0.268	0.201	0.134	0.067
65	**448.2**	0.753	0.690	0.665	0.627	0.565	0.502	0.439	0.376	0.314	0.251	0.188	0.125
70	**482.6**	0.767	0.708	0.685	0.649	0.590	0.531	0.472	0.413	0.354	0.295	0.236	0.177
75	**517.1**	0.780	0.725	0.702	0.669	0.613	0.558	0.502	0.446	0.390	0.333	0.279	0.223
80	**551.6**	0.792	0.739	0.718	0.686	0.634	0.581	0.528	0.475	0.422	0.370	0.317	0.264
85	**586.1**	0.802	0.752	0.732	0.702	0.652	0.602	0.552	0.502	0.451	0.401	0.351	0.301
90	**620.5**	0.812	0.764	0.745	0.716	0.669	0.621	0.573	0.525	0.478	0.430	0.382	0.335
95	**655.0**	0.820	0.775	0.757	0.729	0.684	0.638	0.593	0.547	0.501	0.456	0.410	0.365
100	**689.5**	0.828	0.785	0.767	0.741	0.698	0.654	0.610	0.567	0.523	0.479	0.436	0.392
105	**723.9**	0.835	0.794	0.777	0.752	0.710	0.668	0.626	0.585	0.543	0.501	0.459	0.418
110	**758.4**	0.842	0.802	0.786	0.762	0.723	0.682	0.642	0.601	0.561	0.521	0.481	0.441
115	**792.9**	0.848	0.810	0.794	0.771	0.734	0.694	0.655	0.617	0.578	0.540	0.501	0.463
120	**827.4**	0.854	0.817	0.802	0.780	0.742	0.705	0.668	0.631	0.594	0.557	0.520	0.483
125	**861.8**	0.859	0.823	0.809	0.787	0.752	0.716	0.680	0.644	0.608	0.573	0.537	0.501
130	**896.3**	0.864	0.829	0.815	0.795	0.760	0.726	0.691	0.657	0.622	0.586	0.553	0.519
135	**930.8**	0.868	0.835	0.822	0.802	0.768	0.735	0.701	0.6&8	0.635	0.601	0.563	0.534
140	**965.3**	0.873	0.840	0.827	0.808	0.776	0.743	0.711	0.679	0.647	0.614	0.582	0.550
145	**999.7**	0.877	0.845	0.833	0.814	0.783	0.751	0.720	0.689	0.658	0.626	0.595	0.564
150	**1034.2**	0.880	0.850	0.838	0.820	0.789	0.759	0.729	0.699	0.668	0.638	0.608	0.577
155	**1068.7**	0.884	0.854	0.843	0.825	0.795	0.766	0.736	0.707	0.677	0.648	0.618	0.589
160	**1103.2**	0.887	0.859	0.847	0.830	0.801	0.773	0.744	0.716	0.687	0.658	0.630	0.601
165	**1137.6**	0.890	0.863	0.851	0.835	0.807	0.779	0.751	0.724	0.696	0.668	0.640	0.612
170	**1172.1**	0.893	0.866	0.855	0.839	0.812	0.785	0.758	0.731	0.704	0.677	0.649	0.622
175	**1206.6**	0.896	0.870	0.859	0.843	0.817	0.791	0.764	0.738	0.711	0.685	0.659	0.632
180	**1241.1**	0.899	0.873	0.863	0.847	0.822	0.796	0.770	0.745	0.719	0.693	0.668	0.642
185	**1275.5**	0.901	0.876	0.866	0.851	0.826	0.801	0.776	0.751	0.726	0.701	0.676	0.651
190	**1310.0**	0.904	0.879	0.870	0.855	0.831	0.806	0.782	0.757	0.733	0.709	0.684	0.660
195	**1344.5**	0.906	0.882	0.873	0.858	0.835	0.811	0.787	0.7&3	0.739	0.716	0.692	0.668
200	**1379.0**	0.908	0.885	0.876	0.862	0.838	0.815	0.792	0.768	0.745	0.722	0.699	0.675
205	**1413.4**	0.910	0.888	0.878	0.865	0.842	0.819	0.796	0.774	0.751	0.728	0.705	0.682
210	**1447.9**	0.912	0.890	0.881	0.868	0.845	0.823	0.801	0.779	0.756	0.734	0.712	0.689
215	**1482.4**	0.914	0.892	0.884	0.871	0.849	0.827	0.805	0.783	0.762	0.740	0.718	0.696
220	**1516.8**	0.916	0.895	0.886	0.873	0.852	0.831	0.810	0.788	0.767	0.746	0.724	0.703
225	**1551.3**	0.918	0.897	0.889	0.876	0.855	0.834	0.813	0.792	0.772	0.751	0.730	0.709
230	**1585.8**	0.919	0.899	0.891	0.879	0.858	0.838	0.817	0.797	0.777	0.756	0.736	0.715
235	**1620.3**	0.921	0.901	0.893	0.881	0.861	0.841	0.821	0.801	0.780	0.760	0.740	0.720
240	**1654.7**	0.923	0.903	0.895	0.883	0.864	0.884	0.825	0.805	0.785	0.766	0.746	0.727
245	**1689.2**	0.924	0.905	0.897	0.886	0.866	0.847	0.828	0.808	0.789	0.770	0.751	0.731
250	**1723.7**	0.926	0.907	0.899	0.888	0.869	0.850	0.831	0.812	0.793	0.774	0.755	0.737

ACCEPTANCE FACTORS TABLE

CALEFACTIO

Use gauge pressure

(P_o) Maximum operating pressure		P_f – Minimum operating pressure at tank (psig)/kPa											
psig	**kPa**	**60 413.7**	**65 448.2**	**70 482.6**	**75 517.1**	**80 551.6**	**85 586.1**	**90 620.5**	**95 655.0**	**100 689.5**	**105 723.9**	**110 758.4**	**115 792.9**
60	**413.7**	–											
65	**448.2**	0.062	–										
70	**482.6**	0.118	0.059	–									
75	**517.1**	0.167	0.111	0.056	–								
80	**551.6**	0.211	0.158	0.106	0.053	–							
85	**586.1**	0.251	0.201	0.151	0.101	0.050	–						
90	**620.5**	0.287	0.239	0.191	0.143	0.096	0.048	–					
95	**655.0**	0.319	0.273	0.228	0.182	0.137	0.091	0.045	–				
100	**689.5**	0.347	0.305	0.261	0.218	0.174	0.131	0.087	0.043	–			
105	**723.9**	0.376	0.334	0.292	0.250	0.208	0.167	0.125	0.083	0.041	–		
110	**758.4**	0.401	0.361	0.321	0.281	0.241	0.200	0.160	0.120	0.080	0.040	–	
115	**792.9**	0.424	0.386	0.347	0.309	0.270	0.232	0.193	0.155	0.116	0.007	0.039	–
120	**827.4**	0.446	0.408	0.371	0.334	0.297	0.260	0.223	0.186	0.149	0.111	0.074	0.037
125	**861.8**	0.465	0.429	0.394	0.358	0.322	0.286	0.250	0.215	0.179	0.143	0.107	0.071
130	**896.3**	0.484	0.450	0.415	0.381	0.346	0.312	0.277	0.243	0.208	0.173	0.138	0.104
135	**930.8**	0.501	0.468	0.439	0.401	0.367	0.334	0.301	0.267	0.234	0.200	0.167	0.134
140	**965.3**	0.517	0.485	0.453	0.420	0.388	0.356	0.324	0.291	0.259	0.226	0194	0.162
145	**999.7**	0.532	0.501	0.470	0.438	0.407	0.376	0.344	0.313	0.282	0.250	0.219	0.188
150	**1034.2**	0.547	0.517	0.486	0.456	0.426	0.396	0.365	0.335	0.305	0.273	0.243	0.213
155	**1068.7**	0.559	0.530	0.500	0.471	0.441	0.412	0.382	0.353	0.323	0.295	0.265	0.236
160	**1103.2**	0.573	0.544	0.515	0.487	0.458	0.430	0.401	0.372	0.344	0.315	0.286	0.258
165	**1137.6**	0.585	0.557	0.529	0.501	0.473	0.446	0.418	0.390	0.362	0.334	0.306	0.278
170	**1172.1**	0.595	0.568	0.541	0.514	0.487	0.460	0.433	0.460	0.378	0.352	0.325	0.298
175	**1206.6**	0.606	0.579	0.553	0.527	0.500	0.474	0.447	0.421	0.395	0.369	0.343	0.316
180	**1241.1**	0.616	0.590	0.565	0.539	0.513	0.488	0.462	0.436	0.411	0.385	0.360	0.334
185	**1275.5**	0.626	0.601	0.576	0.551	0.526	0.501	0.476	0.451	0.426	0.401	0.376	0.351
190	**1310.0**	0.635	0.611	0.587	0.562	0.538	0.513	0.489	0.465	0.440	0.415	0.391	0.366
195	**1344.5**	0.644	0.620	0.597	0.573	0.549	0.525	0.501	0.478	0.454	0.429	0.405	0.381
200	**1379.0**	0.652	0.629	0.605	0.582	0.559	0.535	0.512	0.489	0.466	0.443	0.419	0.396
205	**1413.4**	0.660	0.637	0.614	0.591	0.568	0.546	0.523	0.450	0.477	0.455	0.432	0.410
210	**1447.9**	0.667	0.645	0.622	0.600	0.578	0.556	0.533	0.510	0.489	0.467	0.445	0.423
215	**1482.4**	0.674	0.653	0.631	0.609	0.587	0.565	0.544	0.522	0.500	0.479	0.457	0.435
220	**1516.8**	0.682	0.660	0.639	0.618	0.597	0.575	0.554	0.533	0.511	0.490	0.469	0.447
225	**1551.3**	0.688	0.667	0.646	0.625	0.604	0.583	0.563	0.542	0.521	0.501	0.478	0.459
230	**1585.8**	0.695	0.675	0.654	0.634	0.613	0.593	0.573	0.552	0.532	0.511	0.490	0.470
235	**1620.3**	0.700	0.680	0.660	0.640	0.620	0.600	0.579	0.559	0.539	0.521	0.501	0.481
240	**1654.7**	0.707	0.687	0.668	0.648	0.629	0.609	0.589	0.570	0.550	0.530	0.510	0.491
245	**1689.2**	0.712	0.693	0.673	0.654	0.635	0.615	0.596	0.577	0.558	0.539	0.520	0.501
250	**1723.7**	0.718	0.699	0.680	0.661	0.642	0.623	0.604	0.585	0.566	0.548	0.529	0.510

$$\textbf{Acceptance Factor} = 1 - \frac{P_f}{P_o}$$

P_f = minimum absolute pressure, P_o = maximum absolute pressure

Hydro-pneumatic tanks – AFX Series

A) Hydro-pneumatic tanks functions

There are several different functions that an hydro-pneumatic tank can perform. In a booster pump application, it can provide water to the system during periods of no flow shutdown of the booster pump or it can provide water to replace leak loads. In a well water application, it can provide the desired volume of water required between the pump shut down pressure and the pump turn on pressure. In a sprinkler or irrigation pump application the tank may provide a cushion to maintain necessary pressure so the jockey pump will not short cycle. In any case, the amount of water that the tank will be required to supply to the system during any given cycle is called the drawdown. Drawdown must first be determined to properly size the hydro-pneumatic tank.

There are two types of hydro-pneumatic tanks, **plain steel** and **bladder/diaphragm** style. Both styles perform the same function in the system. The bladder style will be smaller in size and require less floor space, while the plain steel will have a lower initial cost. The bladder/diaphragm style also incorporates a rubber barrier which eliminates the common water/air interface that promotes water logging of the plain steel tanks. The sizing of these two styles of tanks is different and care must be taken to ensure that the proper sizing procedure is followed.

B) Determining drawdown

WELL WATER – In this application a pump is supplying water to a system and the hydropneumatic tank is to provide two functions.

First, it is to supply water to the system while the pump is off and second, it is to keep the pump from short cycling.

CYCLE TIME

Cycle time is the time elapsed between pumps starts. If the cycle time of the pump is to be controlled by the hydro-pneumatic tank, first determine how frequently the pump is to start. This is a judgment call by the designer. Some pump or motor manufacturers recommend the pump to be controlled so as not to start more than six (6) times per hour. There are two approaches to determine the hydro-pneumatic tank that will serve this system pump capacity and system demand. Lets examine each approach separately.

Hydro-pneumatic tanks – AFX Series

PUMP CAPACITY

The pump is usually sized to be somewhat larger than the system requirements and the hydro-pneumatic tank can be selected to work properly by using the pump capacity. If the cycle time is determined to be ten (10) minutes we can say that the shortest cycle time will be determined by a combination of when the pump is running and there is no system demand, followed by a period when the system demand is 100% and the pump is not running. Thus if the pump ran for five (5) minutes with no system demand, all the water would enter the hydro-pneumatic tank and if the system demand was then at 100% for the next five (5) minutes and the pump was off, all the water would exit the tank and the system would be ready for the next cycle to begin.

This would give us ten (10) minute cycle time, six (6) times per hour we are looking for; but as you can readily see, that it is not practical to imagine the pump running with no system demand or for the system to always operate only when the pump is off. Any combination of the pump and the system operating simultaneously will always increase the cycle time.

EXAMPLE

The pump capacity is 10 gallons per minute.

The drawdown would be 50 gallons.

If the pump starts at 30 psi and shuts off at 45 psi.

A bladder style hydro-pneumatic tank with a 200 gallons total capacity would be required.*

SYSTEM DEMAND

If the system demand is less than the pump capacity, the tank size can be reduced to reflect this difference.

EXAMPLE

The pump capacity is 10 gallons per minute.
The system demand is 5 gallons per minute.

A ten (10) minute cycle time would generate a system that would require a total of fifty (50) gallons per cycle. The pump at 10 gal/min. would run for five (5) minutes to produce this fifty (50) gallons, and this would be a fifteen (15) minute cycle time.

Since we are looking for a ten (10) minute cycle time, we divided ten (10) minutes by fifteen (15) minutes and determine a .66666 ratio factor. 50 x .66666 = 33.33 gallons required by the system per cycle, this would be the tank drawdown for the application:

33.33 gal = 10 gal per min. pump capacity
= 3.333 min. pump run time.

33.33 gal = 5 gal per min. system demand

= 6.666 min. system demand/cycle
10.0 minutes cycle time.

The tank drawdown is now 33.33 gallons if the pump starts at 30 psi and shuts off at 45 psi.

A bladder type hydro-pneumatic tank with a 133 gallons total capacity would be required.*

Refer to the appropriate submittal data sheet to get the tank's dimensions.

C) Booster pump systems

In a booster pump application, the tank may perform in many different ways.

(1) It may be used to provide the system with a constant supply of water, when the water usage is erratic and the pump is not to run constantly. An example of this would be an office complex where no specific water demand pattern can be established. Establishing drawdown for this application would be the same as for a well water application.

(2) The tank may provide water to a system when the pump is to be shut down for prolonged periods of time, such as during the night when the building is normally not occupied. Drawdown here would be determined by the anticipated demand on the booster system during the shutdown period, system leakage (dripping faucets), cleaning personnel in the building (buckets of water required) or flushing of water closets.

If the system in one above is large enough, say like a public school, controlling the run period with a time clock may reduce the size of the tank required. In this case, the pump runs continuously when the demand is fairly constant, but when the building is unoccupied during the night, the time clock would allow the booster system to operate as in two above. The drawdown could then be determined by the anticipated night time demand.

(3) In variable speed pumping systems the pressure and water flows are controlled by the booster pump and a hydro-pneumatic tank would only be required when the pump goes into a no-flow shut down mode. The tank would then provide water for system leaks to keep the booster pump from short cycling. For this tank to function, a pressure differential between the pump shut off point and the start point must be present. With this pressure differential and the required drawdown volume, the hydro-pneumatic tank can be properly sized.

D) Sprinkler systems

Many fire sprinkler systems incorporate a jockey pump to maintain the required pressure on the system. If there are leaks in the system, the jockey pump may start to short cycle since the water is not compressible. Placing a hydro-pneumatic tank after the jockey pump will provide a cushion that will eliminate the short cycling of the pump and still maintain the required system pressure. Drawdown would be determined by the allowable system leakage.

E) Irrigation systems

This application is the same as for a sprinkler system detailed above and the hydro-pneumatic tank would be sized in the same way. Here the jockey pump may also supply water for incidental use throughout the distribution piping.

ASME HYDRO-PNEUMATIC TANKS

CALEFACTIO

Sizing chart for hydro-pneumatic tanks

Job Name: ______________________ Date: ______________

Job Location: ______________________ Model #: ______________

Contact Name: ______________________ Date submitted: ______________

Engineer: ______________________ Approved by: ______________

Contractor: ______________________ Date of approval: ______________

INFORMATION REQUIRED

1. Drawdown (tank must supply)	**(1)** ________gal	________ L
2. Minimum pressure (pump turn-on pressure)	**(2)** ________psi	________ kPa
3. Maximum pressure (pump shut-off pressure)	**(3)** ________psi	________ kPa

MODEL SELECTION: BLADDER TYPE TANKS

4. Enter required drawdown from line **(1)**.	**(4)** ________gal	________ L
5. Using the Acceptance Factors table (see pages 63 and 64), enter acceptance factor.	**(5)** ________	________
6. Divide line **(4)** by line **(5)**, enter total tank volume.	**(6)** ________gal	________ L

EXAMPLE FROM PAGE 60

1. Drawdown..50 gal

2. Minimum pressure ....30 psi

3. Maximum pressure..45 psi

4. Drawdown from line **(1)** ....50 gal

5. Acceptance Factor frorm chart 0.251

6. Divide line **(4)** by line **(5)**,
Enter total tank volume..199.20 gallons

ACCEPTANCE FACTORS TABLE

CALEFACTIO

Use gauge pressure

(P_0) Maximum operating pressure		P_f – Minimum operating pressure at tank (psig)/kPa											
psig	kPa	5 34.5	10 68.9	12 82.7	15 103.4	20 137.9	25 172.4	30 206.8	35 241.3	40 275.8	45 310.3	50 344.7	55 379.2
10	**68.9**	0.202	–										
12	**82.7**	0.262	0.075	–									
15	**103.4**	0.337	0.168	0.101	–								
20	**137.9**	0.432	0.288	0.231	0.144	–							
25	**172.4**	0.504	0.378	0.328	0.252	0.126							
27	**186.1**	0.527	0.408	0.360	0.288	0.168	–						
30	**206.8**	0.560	0.447	0.403	0.336	0.224	0.112	–					
35	**241.3**	0.604	0.503	0.463	0.403	0.302	0.202	0.101	–				
40	**275.8**	0.640	0.548	0.512	0.457	0.366	0.274	0.183	0.091	–			
45	**310.3**	0.670	0.586	0.553	0.503	0.419	0.335	0.251	0.168	0.084	–		
50	**344.7**	0.696	0.618	0.587	0.541	0.464	0.386	0.309	0.232	0.155	0.078	–	
55	**379.2**	0.717	0.646	0.617	0.574	0.502	0.430	0.359	0.287	0.215	0.144	0.072	–
60	**413.7**	0.736	0.669	0.643	0.602	0.536	0.469	0.402	0.335	0.268	0.201	0.134	0.067
65	**448.2**	0.753	0.690	0.665	0.627	0.565	0.502	0.439	0.376	0.314	0.251	0.188	0.125
70	**482.6**	0.767	0.708	0.685	0.649	0.590	0.531	0.472	0.413	0.354	0.295	0.236	0.177
75	**517.1**	0.780	0.725	0.702	0.669	0.613	0.558	0.502	0.446	0.390	0.333	0.279	0.223
80	**551.6**	0.792	0.739	0.718	0.686	0.634	0.581	0.528	0.475	0.422	0.370	0.317	0.264
85	**586.1**	0.802	0.752	0.732	0.702	0.652	0.602	0.552	0.502	0.451	0.401	0.351	0.301
90	**620.5**	0.812	0.764	0.745	0.716	0.669	0.621	0.573	0.525	0.478	0.430	0.382	0.335
95	**655.0**	0.820	0.775	0.757	0.729	0.684	0.638	0.593	0.547	0.501	0.456	0.410	0.365
100	**689.5**	0.828	0.785	0.767	0.741	0.698	0.654	0.610	0.567	0.523	0.479	0.436	0.392
105	**723.9**	0.835	0.794	0.777	0.752	0.710	0.668	0.626	0.585	0.543	0.501	0.459	0.418
110	**758.4**	0.842	0.802	0.786	0.762	0.723	0.682	0.642	0.601	0.561	0.521	0.481	0.441
115	**792.9**	0.848	0.810	0.794	0.771	0.734	0.694	0.655	0.617	0.578	0.540	0.501	0.463
120	**827.4**	0.854	0.817	0.802	0.780	0.742	0.705	0.668	0.631	0.594	0.557	0.520	0.483
125	**861.8**	0.859	0.823	0.809	0.787	0.752	0.716	0.680	0.644	0.608	0.573	0.537	0.501
130	**896.3**	0.864	0.829	0.815	0.795	0.760	0.726	0.691	0.657	0.622	0.586	0.553	0.519
135	**930.8**	0.868	0.835	0.822	0.802	0.768	0.735	0.701	0.6&8	0.635	0.601	0.563	0.534
140	**965.3**	0.873	0.840	0.827	0.808	0.776	0.743	0.711	0.679	0.647	0.614	0.582	0.550
145	**999.7**	0.877	0.845	0.833	0.814	0.783	0.751	0.720	0.689	0.658	0.626	0.595	0.564
150	**1034.2**	0.880	0.850	0.838	0.820	0.789	0.759	0.729	0.699	0.668	0.638	0.608	0.577
155	**1068.7**	0.884	0.854	0.843	0.825	0.795	0.766	0.736	0.707	0.677	0.648	0.618	0.589
160	**1103.2**	0.887	0.859	0.847	0.830	0.801	0.773	0.744	0.716	0.687	0.658	0.630	0.601
165	**1137.6**	0.890	0.863	0.851	0.835	0.807	0.779	0.751	0.724	0.696	0.668	0.640	0.612
170	**1172.1**	0.893	0.866	0.855	0.839	0.812	0.785	0.758	0.731	0.704	0.677	0.649	0.622
175	**1206.6**	0.896	0.870	0.859	0.843	0.817	0.791	0.764	0.738	0.711	0.685	0.659	0.632
180	**1241.1**	0.899	0.873	0.863	0.847	0.822	0.796	0.770	0.745	0.719	0.693	0.668	0.642
185	**1275.5**	0.901	0.876	0.866	0.851	0.826	0.801	0.776	0.751	0.726	0.701	0.676	0.651
190	**1310.0**	0.904	0.879	0.870	0.855	0.831	0.806	0.782	0.757	0.733	0.709	0.684	0.660
195	**1344.5**	0.906	0.882	0.873	0.858	0.835	0.811	0.787	0.7&3	0.739	0.716	0.692	0.668
200	**1379.0**	0.908	0.885	0.876	0.862	0.838	0.815	0.792	0.768	0.745	0.722	0.699	0.675
205	**1413.4**	0.910	0.888	0.878	0.865	0.842	0.819	0.796	0.774	0.751	0.728	0.705	0.682
210	**1447.9**	0.912	0.890	0.881	0.868	0.845	0.823	0.801	0.779	0.756	0.734	0.712	0.689
215	**1482.4**	0.914	0.892	0.884	0.871	0.849	0.827	0.805	0.783	0.762	0.740	0.718	0.696
220	**1516.8**	0.916	0.895	0.886	0.873	0.852	0.831	0.810	0.788	0.767	0.746	0.724	0.703
225	**1551.3**	0.918	0.897	0.889	0.876	0.855	0.834	0.813	0.792	0.772	0.751	0.730	0.709
230	**1585.8**	0.919	0.899	0.891	0.879	0.858	0.838	0.817	0.797	0.777	0.756	0.736	0.715
235	**1620.3**	0.921	0.901	0.893	0.881	0.861	0.841	0.821	0.801	0.780	0.760	0.740	0.720
240	**1654.7**	0.923	0.903	0.895	0.883	0.864	0.884	0.825	0.805	0.785	0.766	0.746	0.727
245	**1689.2**	0.924	0.905	0.897	0.886	0.866	0.847	0.828	0.808	0.789	0.770	0.751	0.731
250	**1723.7**	0.926	0.907	0.899	0.888	0.869	0.850	0.831	0.812	0.793	0.774	0.755	0.737

ACCEPTANCE FACTORS TABLE

CALEFACTIO

Use gauge pressure

(P_o) Maximum operating pressure		P_f – Minimum operating pressure at tank (psig)/kPa											
psig	kPa	60 413.7	65 448.2	70 482.6	75 517.1	80 551.6	85 586.1	90 620.5	95 655.0	100 689.5	105 723.9	110 758.4	115 792.9
60	413.7	–											
65	448.2	0.062	–										
70	482.6	0.118	0.059	–									
75	517.1	0.167	0.111	0.056	–								
80	551.6	0.211	0.158	0.106	0.053	–							
85	586.1	0.251	0.201	0.151	0.101	0.050	–						
90	620.5	0.287	0.239	0.191	0.143	0.096	0.048	–					
95	655.0	0.319	0.273	0.228	0.182	0.137	0.091	0.045	–				
100	689.5	0.347	0.305	0.261	0.218	0.174	0.131	0.087	0.043	–			
105	723.9	0.376	0.334	0.292	0.250	0.208	0.167	0.125	0.083	0.041	–		
110	758.4	0.401	0.361	0.321	0.281	0.241	0.200	0.160	0.120	0.080	0.040	–	
115	792.9	0.424	0.386	0.347	0.309	0.270	0.232	0.193	0.155	0.116	0.007	0.039	–
120	827.4	0.446	0.408	0.371	0.334	0.297	0.260	0.223	0.186	0.149	0.111	0.074	0.037
125	861.8	0.465	0.429	0.394	0.358	0.322	0.286	0.250	0.215	0.179	0.143	0.107	0.071
130	896.3	0.484	0.450	0.415	0.381	0.346	0.312	0.277	0.243	0.208	0.173	0.138	0.104
135	930.8	0.501	0.468	0.439	0.401	0.367	0.334	0.301	0.267	0.234	0.200	0.167	0.134
140	965.3	0.517	0.485	0.453	0.420	0.388	0.356	0.324	0.291	0.259	0.226	0194	0.162
145	999.7	0.532	0.501	0.470	0.438	0.407	0.376	0.344	0.313	0.282	0.250	0.219	0.188
150	1034.2	0.547	0.517	0.486	0.456	0.426	0.396	0.365	0.335	0.305	0.273	0.243	0.213
155	1068.7	0.559	0.530	0.500	0.471	0.441	0.412	0.382	0.353	0.323	0.295	0.265	0.236
160	1103.2	0.573	0.544	0.515	0.487	0.458	0.430	0.401	0.372	0.344	0.315	0.286	0.258
165	1137.6	0.585	0.557	0.529	0.501	0.473	0.446	0.418	0.390	0.362	0.334	0.306	0.278
170	1172.1	0.595	0.568	0.541	0.514	0.487	0.460	0.433	0.460	0.378	0.352	0.325	0.298
175	1206.6	0.606	0.579	0.553	0.527	0.500	0.474	0.447	0.421	0.395	0.369	0.343	0.316
180	1241.1	0.616	0.590	0.565	0.539	0.513	0.488	0.462	0.436	0.411	0.385	0.360	0.334
185	1275.5	0.626	0.601	0.576	0.551	0.526	0.501	0.476	0.451	0.426	0.401	0.376	0.351
190	1310.0	0.635	0.611	0.587	0.562	0.538	0.513	0.489	0.465	0.440	0.415	0.391	0.366
195	1344.5	0.644	0.620	0.597	0.573	0.549	0.525	0.501	0.478	0.454	0.429	0.405	0.381
200	1379.0	0.652	0.629	0.605	0.582	0.559	0.535	0.512	0.489	0.466	0.443	0.419	0.396
205	1413.4	0.660	0.637	0.614	0.591	0.568	0.546	0.523	0.450	0.477	0.455	0.432	0.410
210	1447.9	0.667	0.645	0.622	0.600	0.578	0.556	0.533	0.510	0.489	0.467	0.445	0.423
215	1482.4	0.674	0.653	0.631	0.609	0.587	0.565	0.544	0.522	0.500	0.479	0.457	0.435
220	1516.8	0.682	0.660	0.639	0.618	0.597	0.575	0.554	0.533	0.511	0.490	0.469	0.447
225	1551.3	0.688	0.667	0.646	0.625	0.604	0.583	0.563	0.542	0.521	0.501	0.478	0.459
230	1585.8	0.695	0.675	0.654	0.634	0.613	0.593	0.573	0.552	0.532	0.511	0.490	0.470
235	1620.3	0.700	0.680	0.660	0.640	0.620	0.600	0.579	0.559	0.539	0.521	0.501	0.481
240	1654.7	0.707	0.687	0.668	0.648	0.629	0.609	0.589	0.570	0.550	0.530	0.510	0.491
245	1689.2	0.712	0.693	0.673	0.654	0.635	0.615	0.596	0.577	0.558	0.539	0.520	0.501
250	1723.7	0.718	0.699	0.680	0.661	0.642	0.623	0.604	0.585	0.566	0.548	0.529	0.510

$$\textbf{Acceptance Factor} = 1 - \frac{P_f}{P_o}$$

P_f = minimum absolute pressure, P_o = maximum absolute pressure