15510-2D

SIZING THE EXTROL® DIAPHRAGM-TYPE HYDRO-PNEUMATIC TANK

We suggest that you make an office copy of this page when ready to calculate.)

Critical Sizing Procedure

THINGS YOU MUST KNOW:

1. Total System Water Content ..... (1) _____ gallons
2. Minimum System Temperature ..... (2) _____ °F.
3. Maximum System Temperature ..... (3) _____ °F.
4. Minimum Operating Pressure at EXTROL Tank ..... (4) _____ PSIG
5. Maximum Operating Pressure at EXTROL Tank ..... (5) _____ PSIG

SELECTION OF EXTROL MODEL:

6. Find and enter "Net Expansion Factor" (use TABLE 1) ..... (6) _____
7. Amount of Expanded Water = line (1) × line (6) ..... (7) _____ gallons
8. Find and enter "Acceptance Factor" (TABLE 2) ..... (8) _____
9. Minimum Total EXTROL Volume = line (7) ÷ line (8) ..... (9) _____ gallons
10. Using TABLE 3 a, b, c, d, select an EXTROL that is at least equal to line (9) for "Total Volume" and line (7) for Max. Expanded Water Acceptance Gallons

TABLE 1. . . NET EXPANSION OF WATER

Maximum System °F	Minimum System Temperature °F						
	40°F	50°F	60°F	70°F	80°F	90°F	100°F
°F	.0005	.0049	—	—	—	—	—
0°F	.00149	.00143	.00094	—	—	—	—
80°F	.00260	.00254	.00204	.00111	—	—	—
90°F	.00405	.00399	.00350	.00256	.00145	—	—
100°F	.00575	.00569	.00520	.00426	.00315	.00170	—
110°F	.00771	.00765	.00716	.00622	.00511	.00366	.00196
120°F	.0100	.0099	.0095	.0086	.0074	.0060	.0043
130°F	.0124	.0123	.0118	.0109	.0098	.0083	.0066
140°F	.0150	.0149	.0145	.0135	.0124	.0110	.0093
150°F	.0179	.0178	.0173	.0164	.0153	.0133	.0121

Maximum System Temp. °F	Minimum System Temperature °F						
	40°F	50°F	60°F	70°F	80°F	90°F	100°F
160°F	.0209	.0208	.0204	.0194	.0181	.0165	.0148
170°F	.0242	.0241	.0236	.0227	.0216	.0201	.0184
180°F	.0276	.0275	.0271	.0261	.0250	.0236	.0219
190°F	.0313	.0312	.0307	.0298	.0287	.0272	.0255
200°F	.0351	.0350	.0346	.0336	.0325	.0311	.0294
210°F	.0391	.0390	.0386	.0376	.0365	.0351	.0334
220°F	.0434	.0433	.0428	.0419	.0408	.0393	.0376
230°F	.0476	.0475	.0471	.0461	.0450	.0436	.0419
240°F	.0522	.0521	.0517	.0507	.0496	.0482	.0465

TABLE 2. . . ACCEPTANCE FACTORS

Maximum Oper. Pressure at Tank (Psig)	Minimum Operating Pressure at Tank (Psig)										
	5	10	12	15	20	30	40	50	60	70	80
27	0.527	0.408	0.360	0.288	0.168	—	—	—	—	—	—
30	0.560	0.447	0.403	0.336	0.224	—	—	—	—	—	—
35	0.604	0.503	0.463	0.403	0.302	0.101	—	—	—	—	—
40	0.640	0.548	0.512	0.457	0.366	0.183	—	—	—	—	—
45	0.670	0.586	0.553	0.503	0.419	0.251	0.084	—	—	—	—
50	0.696	0.618	0.587	0.541	0.464	0.309	0.155	—	—	—	—
55	0.717	0.646	0.617	0.574	0.502	0.359	0.215	0.072	—	—	—
60	0.736	0.669	0.643	0.602	0.536	0.402	0.268	0.134	—	—	—
65	0.753	0.690	0.665	0.627	0.565	0.439	0.314	0.188	0.062	—	—
70	0.767	0.708	0.685	0.649	0.590	0.472	0.354	0.236	0.118	—	—
75	0.780	0.725	0.702	0.669	0.613	0.502	0.390	0.279	0.167	0.056	—
80	0.792	0.739	0.718	0.686	0.634	0.528	0.422	0.317	0.211	0.106	—
90	0.812	0.764	0.745	0.716	0.669	0.573	0.478	0.382	0.287	0.191	0.096
100	0.828	0.785	0.767	0.741	0.698	0.610	0.523	0.436	0.347	0.261	0.174
110	0.842	0.802	0.786	0.762	0.723	0.642	0.561	0.481	0.401	0.321	0.241

NOTE: For additional Net Expansion of Water factors and Acceptance factors see the AMTROL Engineering Handbook. Consult Form 900-84 (revised 3/85) and Form 901-85 for further EXTROL information.

AX Series EXTROLs are ASME certified and come in two styles, vertical and horizontal, that can be installed in a suspended or free-standing configuration. Eleven sizes are available in total tank volumes from 8 to 132 gallons.
MAX. WORKING PRESSURE: 125 psig
MAX. OPERATING TEMP: 240F

Model No.	Tank Volume (Gallons)	Max. Accept. (Gallons)	Vert. Series Height Inches	Series Length Inches	Dia. Inches
AX-15	7.8	2.4	—	19	12
AX-20	10.9	2.4	—	25-3/4	12
AX-40	21.7	4.8	—	49	12
AX-60	33.6	11.3	42-3/4	42-1/4	16
AX-80	44.4	22.6	56	55-1/4	16
AX-100	55.7	22.6	69	68-1/4	16
AX-120	68.0	34.0	44-1/4	40-1/4	24
AX-144	77.0	34.0	49-1/8	45-1/8	24
AX-180	90.0	34.0	56-1/2	52-1/2	24
AX-200	110.0	34.0	67	63	24
AX-240	131.7	45.2	76-3/4	74-1/4	24

TABLE 3a

L Series EXTROLS are ASME certified and eleven sizes are available in total tank volumes from 53 to 528 gallons. They are free standing on integral floor stands and are easily installed.
MAX. WORKING PRESSURE: 125 psig
MAX. OPERATING TEMP: 240F

Model No.	Tank Volume (Gallons)	Max. Accept. (Gallons)	Height Inches	Dia Inches
200-L	53	53	37-13/16	24
300-L	79	79	51-3/4	24
400-L	105	105	65-11/16	24
500-L	132	132	79-5/8	24
600-L	158	158	65	30
800-L	211	211	83	30
1000-L	264	264	73-1/2	36
1200-L	317	317	85-7/8	36
1400-L	370	370	98-1/4	36
1600-L	422	422	71-1/4	48
2000-L	528	528	85-1/8	48

TABLE 3b

WX-"L" Series EXTROLS are ASME certified and seven models are available in total tank volumes from 158 to 528 gallons. Free-standing on integral floor stands for easy installation, they are designed for use with potable water.
MAX. WORKING PRESSURE: 125 psig *(For higher working pressures, consult factory.)*
MAX. OPERATING TEMP: 240F

Model No.	Tank Volume (Gallons)	Max. Accept. (Gallons)	Height Inches	Dia. Inches
WX-600-L	158	158	72-5/16	30
WX-800-L	211	211	90-1/4	30
WX-1000-L	264	264	84-1/2	36
WX-1200-L	317	317	97	36
WX-1400-L	370	370	109-1/4	36
WX-1600-L	422	422	80-1/2	48
WX-2000-L	528	528	93-1/2	48

TABLE 3c

SX Series EXTROLs are designed for lower pressure commercial and industrial heating systems where ASME certification is not required.
MAX. WORKING PRESSURE: 100 psig
MAX. OPERATING TEMP: 240F

Model No.	Tank Volume (Gallons)	Max. Accept. (Gallons)	Height Inches	Dia. Inches
SX-30V	14	11.3	21 5/8	15-3/8
SX-40V	20	11.3	29 1/2	15-3/8
SX-60V	32	11.3	44 1/4	15-3/8
SX-90V	44	34.0	33	22
SX-110V	62	34.0	43-7/8	22
SX-160V	86	34.0	59-1/16	22

TABLE 3d

AMTROL INC.
WEST WARWICK, R.I. 02893
Printed in U.S.A.

Taco

LIST PRICE SHEET

NUMBER
400-3LCA-580

Effective: May 1, 1980
Supersedes: 400-3LCA-480
dated 4/1/80

CA SERIES
ASME EXPANSION TANKS

CA SERIES A.S.M.E. EXPANSION TANKS

PRODUCT NUMBER	LIST PRICE	VOLUME		DIMENSIONS INCHES *		APPROXIMATE
		LITERS	GALLONS	DIAMETER	HEIGHT	SHIP. WT/LBS
CA140	$1100.00	140	37	18	46¼	140
CA215	1250.00	215	57	18	64¾	180
CA300	1425.00	300	79	24	53¾	205
CA450	1600.00	450	119	24	75	270
CA600	2025.00	600	158	30	65	545
CA800	2700.00	800	211	30	83½	685
CA1000	3375.00	1000	264	36	74	765
CA1200	4050.00	1200	317	36	86	860
CA1400	4725.00	1400	370	36	98	970
CA1600	5400.00	1600	422	48	71	1535
CA2000	6750.00	2000	528	48	85	1820

*Dimensions are approximate

- Designed & constructed per ASME Section VIII
- Maximum working pressure = 125 PSI (862 k PA)
- Maximum operating temperature = 240° F (115° C) at tank

SALES POLICY - In case of an advance in prices, any unshipped order entered prior to the advance will be billed at prices in effect at time of shipment.

LIMITED (1 YEAR) WARRANTY - Taco, Inc. will repair or replace without charge (at the Company's option) any Taco product or part which is proven defective under normal use within one year of the date of purchase, if the defect was present at time of shipment from the factory.

In order to obtain service under this warranty, it is the responsibility of the purchaser to promptly notify the Company in writing and promptly deliver the item in question, delivery prepaid, to the factory. The address for notification and delivery is Taco, Inc., 1160 Cranston Street, Cranston, Rhode Island 02920. If the product or part in question contains no defect as covered in this warranty the purchaser will be billed for parts and labor charges in effect at time of factory examination and repair.

Any Taco product or part not installed or operated in conformity with Taco instructions or which has been subjected to misuse, mis-application, the addition of certain chemical additives, or other abuse will not be covered by this warranty.

TERMS

Taco, Inc. reserves the right to make such changes in details of design, construction, or arrangement of materials as shall in its judgement constitute an improvement over former practice without notification.

TACO INCORPORATED OFFERS THIS WARRANTY IN LIEU OF ALL OTHER EXPRESS WARRANTIES. ANY WARRANTY IMPLIED BY LAW, INCLUDING WARRANTIES OF MERCHANTABILITY OR FITNESS IS IN EFFECT ONLY FOR THE DURATION OF THE EXPRESS WARRANTY SET FORTH IN THE PARAGRAPH ENTITLED "LIMITED (1 Year) WARRANTY" AS SHOWN ABOVE.

TACO, INC. WILL NOT BE LIABLE FOR ANY CONSEQUENTIAL DAMAGES RESULTING FROM THE USE OF ITS PRODUCTS OR ANY INCIDENTAL COSTS OF REMOVING OR REPLACING DEFECTIVE PRODUCTS.

"This warranty gives you specific rights, and you may have other rights which vary from state to state. Some states do not allow limitations on how long an implied warranty lasts or on the exclusion of incidental or consequential damages, so these limitations or exclusions may not apply to you."

TAXES - To the prices and terms quoted add any manufacturers sales use or occupational taxes payable under any effective statute.

RETURNED GOODS - Material should be shipped to the factory, but only after obtaining written permission. When so returned, goods will be subject to a minimum deduction of 25% for restocking. All transportation charges must be prepaid by shipper. Material made on special order or cabinets parts not subject to return.

CANCELLATIONS - A charge will be applicable for the cancellation of any order for non-stock items except when specifically waived by Taco, Inc.

FREIGHT TERMS - F.O.B. shipping point. Our responsibility ceases upon delivery to the transportation company at that point. For your protection, please examine shipment at its arrival to ascertain if in good order. In any shortage or damage, have a full description made by transportation agent on expense bill before signing. All weights approximate.

REPLACEMENT PARTS - Generally require urgent attention. In order to avoid delays due to credit investigation, all such parts will be shipped COD except in such cases where we ship regularly on open account.

NUMBER **SD 400-9**	SUBMITTAL DATA Effective: January 1979 Supersedes: New

CA* SERIES

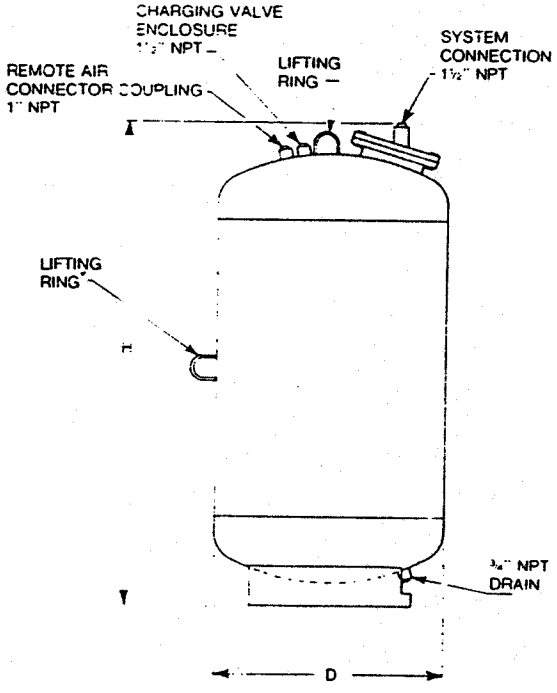
(*CAPTIVE AIR) ASME EXPANSION TANK

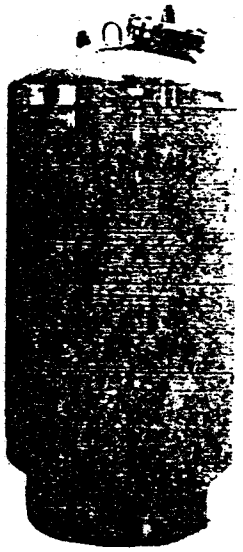
- **FEATURES:**
  - Water & air separation prevents corrosion
  - Tank size reduced up to 80% over conventional models
  - Replaceable bladder
  - Available sizes: 600 liters to 2000 liters
  - Steel shell; heavy duty Butyl Diaphram

HYDRONIC ENERGY, INC.
P. O. BOX 3779
DES MOINES, IOWA 50322
PH (515) 276-4935

- **SPECIFICATIONS:**
  - Designed & constructed per ASME Section VIII
  - Maximum working pressure = 125 PSI (862 k PA)
  - Maximum operating temperature = 240°F (115°C) at tank
- **NOTE** • Allow 460mm (18") minimum clearance for piping.
- **DIMENSIONS**

MODEL NUMBER	TANK VOLUME		H HEIGHT	D DIAMETER	SHIPPING WEIGHT-LBS.
	LITERS	GALLONS			
CA600	600	158	65	30	510
CA800	800	211	83½	30	600
CA1000	1000	264	74	36	750
CA1200	1200	317	86	36	850
CA1400	1400	370	98	36	960
CA1600	1600	422	71	48	1560
CA2000	2000	528	85	48	1780





Job: _____

_____

Date: _____

By: _____

Location Size

Taco Inc. 1160 Cranston Street, Cranston, Rhode Island 02920 Telephone: (401 942-8000 Telex: 92-7627

Taco (Canada) Ltd. 3090 Lenworth Drive, Mississauga, Ontario Telephone (416) 625-3160 Telex 06-961179

Effective May 1979

ACO INC.
P.O. BOX
FT. MORRIS, IOWA 50622
PH: (515) 276-4935

CA SERIES EXPANSION TANK
Sizing Procedure

The CA Series Expansion Tank sizing procedure is identical to that used for sizing conventional closed expansion tanks.

The ASME formula is as follows:

$$V_t = \frac{(0.00041t - 0.0466)\,V_s}{\frac{P_a}{P_f} - \frac{P_a}{P_o}}$$

where

V_t = minimum volume of tank in gallons

V_s = system volume in gallons

t = maximum design operating temperature

P_a = tank pressure before fill, PSIA

P_f = fill pressure, PSIA

P_o = maximum operating pressure *at the tank,* PSIA

NOTE: This formula is based on a system minimum temperature of 40°F.

A given size CA Tank will handle the expansion in a system which requires a much larger conventional expansion tank for two basic reasons:

1. The CA Tank is always precharged with air pressure which is equal to the fill pressure of the system thus $P_a = P_f$ above.
2. Because the air charge is separated from the system fluid by the bladder, increased pressure does not result in a larger volume of air going into solution.

As explained, the CA Tank only functions properly when $P_a = P_f$. We can then rewrite the ASME equation as follows:

$$V_t = \frac{(0.00041t - 0.0466)\,V_s}{1 - \frac{P_f}{P_o}}$$

This version of the formula is used in the sizing procedure which follows.

METHOD 1

To size a CA Tank for a given system, the following information must be known. The system designer will usually provide this necessary data:

V_s - the system volume in gallons

t - the maximum design operating temperature °F

P_f - the system fill pressure PSIA

P_o - the maximum operating pressure *at the tank* PSIA, usually the relief valve setting.

Example:

System volume	- 1500 gallons
Maximum average temperature	- 200°F
Fill pressure	- 12 psig + 14.7 = 26.7 PSIA
Maximum operating pressure	- 30 psig + 14.7 = 44.7 PSIA

Substituting in the revised formula:

$$V_t = \frac{[\,(0.00041 \times 200) - 0.0466\,] \times 1500}{1 - \frac{26.7}{44.7}}$$

$$V_t = \frac{(0.082 - 0.0466) \times 1500}{0.4026}$$

$$V_t = \frac{0.0354 \times 1500}{0.4026} = 132 \text{ gallons}$$

Select a CA 600, 158 gallon capacity, charged to 12 psig

A brief glance at the ASME formula will show that the numerator, $(0.00041t - 0.0466)V_S$, is a temperature related expression which calculates the actual increase in volume of the system water as it is heated from 40°F to the maximum system operating temperature. (0.0466 is a constant based on 40°F).

The denominator, $1 - \frac{P_f}{P_o}$, is a pressure related expression which calculates the ability of the air charge in the tank to accept the increased system liquid volume without exceeding the maximum system operating pressure. This we will call the "acceptance factor".

The ASME formula can thus be written: $V_t = \frac{\text{expansion volume}}{\text{acceptance factor}}$

The CA Tank sizing procedure which follows, Method 2, breaks the calculation into two simple steps. Because Method 2 considers the actual minimum temperature of the system, when known, rather than assuming 40°F, Method 2 is somewhat more accurate and in some cases permits the use of the next smaller sized tank. Method 2 is the recommended sizing procedure.

METHOD 2

The system designer will usually provide the data necessary:

- the system volume in gallons
- t - the initial temperature of the system, °F
- t - the maximum design operating temperature, °F
- P_f - the system fill pressure psig (also CA tank charge pressure)
- P_o - the maximum operating pressure *at the tank,* psig, usually the relief valve setting

NOTE: P_f & P_o are gauge pressure and need not be converted to PSIA as in Method 1. Table A which is used to determine acceptance factors has been designed to eliminate this calculation.

Method 2 uses two tables and two calculations to size the CA Tank.

$$V_t = \frac{\text{expansion volume}}{\text{acceptance factor}} = \frac{V_S \times \text{expansion factor from Table E}}{\text{acceptance factor from Table A}}$$

Example:

System volume	- 1500 gallons	500
Initial temperature	- 40°F	60
Maximum average temperature	- 200°F	180
Fill pressure	- 12 psig	12
Maximum operating pressure	- 30 psig	30

Entering the top of the Table E at 40°F (initial temperature) read down to 200°F to expansion factor - .0351.

Multiply system volume 1500 x .0351 = 52.65 gallons (expansion volume) 13.54

Entering Table A at the left at 30 psig (maximum operating pressure) read across to the 12 psig (initial pressure) column to select acceptance factor - 0.403

$$\frac{\text{expansion volume } 52.65 \text{ gal}}{\text{by acceptance factor } 0.403} = 131 \text{ gallons}$$

Select a CA 600, 158 gallon capacity, charged to 12 psig.

TABLE E — NET EXPANSION OF WATER

Net Expansion Factors

Gross expansion minus system piping expansion (Based on expansion of steel)

MAX TEMP °F	INITIAL TEMPERATURE F												
	40	45	50	55	60	65	70	75	80	85	90	95	100
50°	.00006	.00008											
55°	.00025	.00027	.00019										
60°	.00055	.00057	.00049	.00030									
65°	.00093	.00095	.00087	.00068	.00038								
70°	.00149	.00151	.00143	.00124	.00094	.00056							
75°	.00194	.00196	.00188	.00169	.00139	.00101	.00045						
80°	.00260	.00262	.00254	.00235	.00205	.00167	.00111	.00066					
85°	.00326	.00328	.00320	.00301	.00271	.00233	.00177	.00132	.00066				
90°	.00405	.00407	.00399	.00380	.00350	.00312	.00256	.00211	.00145	.00079			
95°	.00485	.00487	.00479	.00460	.00430	.00392	.00336	.00291	.00225	.00159	.00080		
100°	.00575	.00577	.00569	.00550	.00520	.00482	.00426	.00381	.00315	.00249	.00170	.00090	
105°	.00671	.00673	.00665	.00646	.00616	.00578	.00522	.00477	.00411	.00345	.00266	.00186	.00096
110°	.00771	.00773	.00765	.00746	.00716	.00678	.00622	.00577	.00511	.00445	.00366	.00286	.00196
115°	.00879	.00881	.00873	.00854	.00824	.00786	.00730	.00685	.00619	.00553	.00474	.00394	.00304
120°	.01004	.01006	.00998	.00979	.00949	.00911	.00855	.00810	.00744	.00678	.00599	.00519	.00429
125°	.01111	.01113	.01105	.01086	.01056	.01018	.00962	.00917	.00851	.00785	.00706	.00625	.00536
130°	.01236	.01238	.01230	.01211	.01181	.01143	.01087	.01042	.00976	.00910	.00831	.00751	.00661
135°	.01368	.01370	.01362	.01342	.01313	.01275	.01219	.01174	.01108	.01042	.00963	.00883	.00793
140°	.01501	.01503	.01495	.01476	.01446	.01408	.01352	.01307	.01241	.01175	.01096	.01016	.00926
145°	.01643	.01645	.01637	.01618	.01588	.01550	.01494	.01449	.01383	.01317	.01238	.01158	.01068
150°	.01787	.01787	.01779	.01760	.01730	.01692	.01636	.01591	.01525	.01459	.01330	.01300	.01210
155°	.01937	.01939	.01931	.01912	.01882	.01844	.01788	.01743	.01677	.01611	.01532	.01452	.01362
160°	.02092	.02094	.02086	.02067	.02037	.01999	.01943	.01877	.01811	.01732	.01652	.01572	.01482
165°	.02252	.02254	.02246	.02227	.02197	.02159	.02103	.02058	.01992	.01926	.01847	.01767	.01677
170°	.02418	.02420	.02412	.02393	.02363	.02325	.02269	.02224	.02158	.02092	.02013	.01933	.01843
175°	.02588	.02590	.02582	.02563	.02533	.02495	.02439	.02394	.02328	.02262	.02183	.02103	.02013
180°	.02763	.02765	.02757	.02738	.02708	.02670	.02614	.02569	.02503	.02437	.02358	.02278	.02188
185°	.02941	.02943	.02935	.02916	.02886	.02848	.02792	.02747	.02681	.02615	.02536	.02456	.02366
190°	.03127	.03129	.03121	.03102	.03072	.03034	.02978	.02933	.02867	.02801	.02722	.02642	.02552
195°	.03314	.03316	.03308	.03289	.03259	.03221	.03165	.03120	.03054	.02988	.02909	.02829	.02739
200°	.03510	.03512	.03504	.03485	.03455	.03417	.03361	.03316	.03250	.03184	.03105	.03025	.02935
205°	.03707	.03709	.03701	.03682	.03652	.03614	.03558	.03513	.03447	.03381	.03302	.03222	.03132
210°	.03911	.03913	.03905	.03885	.03856	.03818	.03762	.03717	.03651	.03585	.03506	.03426	.03336
215°	.04120	.04122	.04114	.04095	.04065	.04027	.03971	.03926	.03860	.03794	.03715	.03635	.03545
220°	.04335	.04337	.04329	.04310	.04280	.04242	.04186	.04141	.04075	.04009	.03930	.03850	.03760
225°	.04549	.04551	.04543	.04524	.04494	.04456	.04400	.04355	.04289	.04223	.04144	.04064	.03974
230°	.04762	.04764	.04756	.04737	.04707	.04669	.04613	.04568	.04502	.04436	.04357	.04277	.04187
235°	.04991	.04993	.04985	.04966	.04936	.04898	.04842	.04797	.04731	.04665	.04586	.04506	.04416
240°	.05220	.05222	.05214	.05195	.05165	.05127	.05071	.05026	.04960	.04894	.04815	.04735	.04645

TABLE A — ACCEPTANCE FACTORS $(1 - \frac{P_f}{P_o})$

(Use Gauge Pressure)

P_o MAXIMUM OPERATING PRESSURE PSIG	P_f — MINIMUM OPERATING PRESSURE AT TANK (PSIG)										
	5	10	12	15	20	25	30	35	40	45	50
30	0.560	0.477	0.403	0.336	0.224	0.112	–				
40	0.640	0.548	0.512	0.457	0.366	0.274	0.183	0.091			
50	0.696	0.618	0.587	0.541	0.464	0.386	0.309	0.232	0.155	0.078	–
60	0.736	0.669	0.643	0.602	0.536	0.469	0.402	0.335	0.268	0.201	0.134
70	0.767	0.708	0.685	0.649	0.590	0.531	0.472	0.413	0.354	0.295	0.236
80	0.792	0.739	0.718	0.686	0.634	0.581	0.528	0.475	0.422	0.370	0.317
90	0.812	0.764	0.745	0.716	0.669	0.621	0.573	0.525	0.478	0.430	0.382
100	0.828	0.785	0.767	0.741	0.698	0.654	0.610	0.567	0.523	0.479	0.436
110	0.842	0.802	0.786	0.762	0.723	0.682	0.642	0.601	0.561	0.521	0.481
120	0.854	0.817	0.802	0.780	0.742	0.705	0.668	0.631	0.594	0.557	0.520
125	0.859	0.823	0.809	0.787	0.752	0.716	0.680	0.644	0.608	0.573	0.537

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PROJECT	DATE	BY	PROJECT NO.

EXPANSION TANK GALLONS

PIPE SEE NEXT PG

	#		
UH, CH, FCU	____	x 2 GAL/EA	____
RAD			
1"	____	x .045 GAL/LF	____
1 1/4"	____	x .078 GAL/LF	____
COIL			
(.5 GAL/TON) (.75 GAL/FT² COIL) 7000 CFM	____	x 10 GAL/EA	____
7000 - 20000 CFM	____	x 30 GAL/EA	____
20000 - 40000 CFM	____	x 60 GAL/EA	____

BOILER

CAST IRON SECTIONAL	____	x .11 GAL/MBH	____
SCOTCH MARINE	____	x .26 GAL/MBH	____
FIREBOX	____	x .20 GAL/MBH	____

HEAT EXCHANGER DIA

4"	____	x .23 GAL/LF	____
6"	____	x .5	____
8"	____	x .9	____
10"	____	x 1.2	____
12"	____	x 2.2	____
14"	____	x 2.6	____
16"	____	x 3.5	____
18"	____	x 4.5	____
20"	____	x 5.5	____
22"	____	x 6.5	____
24	____	x 7.5	____
26	____	x 8.8	____
28	____	x 10.0	____
30	____	x 11.2	____

KJWW ENGINEERING CONSULTANTS

PROJECT	DATE	BY	PROJECT NO.

EXPANSION TANK GALLONS

CHILLER
CENTRIFUGAL
RECIP

____ X .25 GAL/TON ____
____ X .5 GAL/TON ____

[GALLON] = TOTAL = ____

$\frac{(\text{SUPPLY WATER TEMP} + \text{RETURN WATER TEMP})}{2} = [\text{TEMP}]$

$\frac{\quad + \quad}{2} = \quad = [\text{TEMP}]$

EXPANSION TANK TEMP BEFORE FILLING ____ [PSIG]

[FPSIG] X 2.307 + 34 = ____ = [PA]

HEIGHT OF SYSTEM ABOVE TANK ____ [TPFT]
(MINIMUM 27)

[TPFT] + 34 = ____ = [PF]

RELIEF VALVE PRESSURE SETTING ____ [PSIG]

[PSIG] X 2.307 + 34 = ____ = [PO]

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PROJECT	DATE	BY	PROJECT NO.

EXPANSION TANK GALLONS

HWS

[STEP 1] = ((0.00041 * TEMP) − 0.0466) * GALLONS

[STEP 2] = (PA/PF) − (PA/PO)

[VT]$_{\text{TANK SIZE}}$ = (STEP 1 / STEP 2) − 0.02 * GALLONS

CHILLED

[STEP 1] = 0.5 * ((0.00041 * ((200+70.0)/2.0) − 0.0466) × GALLONS)

[STEP 2] = (PA/PF) − (PA/PO)

[VT]$_{\text{TANK SIZE}}$ = (STEP 1/STEP 2)

Table 4 .... Dimensions and Properties of Steel Pipe

Nominal[a] Size	ASTM[b] Schedule	Diameter OD In.	Diameter ID In.	Wall Thickness In.	Surface Area Sq Ft/Lin Ft OD	Surface Area Sq Ft/Lin Ft ID	Section Area Sq In. OD	Section Area Sq In. ID	Area of Metal Sq In.	Volume Gal/Lin Ft	Weight[c] (plain end) Lb/Lin Ft	Working Pressure Psig
⅛	40 (s)	0.405	0.269	0.068	0.106	0.0704	0.129	0.0568	0.0720	0.00295	0.244	314[d]
	80 (x)	0.405	0.215	0.095	0.106	0.0563	0.129	0.0363	0.0925	0.00189	0.314	1084
¼	40 (s)	0.540	0.364	0.088	0.141	0.0953	0.229	0.104	0.125	0.00541	0.424	649
	80 (x)	0.540	0.302	0.119	0.141	0.0791	0.229	0.0716	0.157	0.00372	0.535	1353
⅜	40 (s)	0.675	0.493	0.091	0.177	0.129	0.358	0.191	0.167	0.00992	0.567	574
	80 (x)	0.675	0.423	0.126	0.177	0.111	0.358	0.140	0.217	0.00730	0.738	1191
½	40 (s)	0.840	0.622	0.109	0.220	0.163	0.554	0.304	0.250	0.0158	0.850	697
	80 (x)	0.840	0.546	0.147	0.220	0.143	0.554	0.234	0.320	0.0122	1.09	1206
	XX	0.840	0.252	0.294	0.220	0.0660	0.554	0.0499	0.504	0.00259	1.71	3824
¾	40 (s)	1.050	0.824	0.113	0.275	0.216	0.866	0.533	0.333	0.0277	1.13	604
	80 (x)	1.050	0.742	0.154	0.275	0.194	0.866	0.432	0.434	0.0225	1.47	1078
	XX	1.050	0.434	0.308	0.275	0.114	0.866	0.148	0.718	0.00768	2.44	3134
1	40 (s)	1.315	1.049	0.133	0.344	0.275	1.36	0.864	0.494	0.0449	1.68	651
	80 (x)	1.315	0.957	0.179	0.344	0.251	1.36	0.719	0.639	0.0374	2.17	1083
	XX	1.315	0.599	0.358	0.344	0.157	1.36	0.282	1.08	0.0146	3.66	2663
1¼	40 (s)	1.660	1.380	0.140	0.435	0.361	2.16	1.50	0.669	0.0777	2.27	449
	80 (x)	1.660	1.278	0.191	0.435	0.335	2.16	1.28	0.881	0.0666	3.00	805
	XX	1.660	0.896	0.382	0.435	0.235	2.16	0.630	1.53	0.0326	5.21	2315
1½	40 (s)	1.900	1.610	0.145	0.497	0.421	2.84	2.04	0.800	0.1058	2.72	417
	80 (x)	1.900	1.500	0.200	0.497	0.393	2.84	1.77	1.07	0.0918	3.65	756
	XX	1.900	1.100	0.400	0.497	0.288	2.84	0.950	1.89	0.0494	6.41	2122
2	40 (s)	2.375	2.067	0.154	0.622	0.541	4.43	3.36	1.07	0.174	3.65	376
	80 (x)	2.375	1.939	0.218	0.622	0.508	4.43	2.95	1.48	0.153	5.02	669
	XX	2.375	1.503	0.436	0.622	0.393	4.43	1.77	2.66	0.0922	9.03	1861
2½	40 (s)	2.875	2.469	0.203	0.753	0.646	6.49	4.79	1.70	0.249	5.79	505
	80 (x)	2.875	2.323	0.276	0.753	0.608	6.49	4.24	2.25	0.229	7.66	806
	XX	2.875	1.771	0.552	0.753	0.364	6.49	2.46	4.03	0.128	13.7	2048
3	40 (s)	3.500	3.068	0.216	0.916	0.803	9.62	7.39	2.23	0.384	7.57	454
	80 (x)	3.500	2.900	0.300	0.916	0.759	9.62	6.61	3.02	0.343	10.3	724
	XX	3.500	2.300	0.600	0.916	0.602	9.62	4.15	5.47	0.216	18.5	1529
3½	40 (s)	4.000	3.548	0.226	1.05	0.929	12.6	9.89	2.68	0.514	9.11	425
	80 (x)	4.000	3.364	0.318	1.05	0.881	12.6	8.89	3.68	0.462	12.5	692
	XX	4.000	2.728	0.636	1.05	0.714	12.6	5.85	6.72	0.304	22.9	1600
4	40 (s)	4.500	4.026	0.237	1.18	1.05	15.9	12.7	3.17	0.661	10.8	403
	80 (x)	4.500	3.826	0.337	1.18	1.00	15.9	11.5	4.41	0.597	14.9	663
	XX	4.500	3.152	0.674	1.18	0.825	15.9	7.80	8.10	0.405	27.5	1602
5	40 (s)	5.563	5.047	0.258	1.46	1.32	24.3	20.0	4.30	1.04	14.6	4[d]8[d]
	80 (x)	5.563	4.813	0.375	1.46	1.26	24.3	18.2	6.11	0.945	20.5	825
	XX	5.563	4.063	0.750	1.46	1.06	24.3	13.0	11.3	0.673	38.6	1951
6	40 (s)	6.625	6.065	0.280	1.73	1.59	34.5	28.9	5.58	1.50	18.0	467
	80 (x)	6.625	5.761	0.432	1.73	1.51	34.5	26.1	8.40	1.35	28.6	825
	XX	6.625	4.897	0.864	1.73	1.28	34.5	18.8	15.6	0.978	53.1	1912
8	30 (s)	8.625	8.071	0.277	2.26	2.11	58.4	51.2	7.26	2.66	24.7	351
	40 (s)	8.625	7.981	0.322	2.26	2.09	58.4	50.0	8.40	2.60	28.6	431
	80 (x)	8.625	7.625	0.500	2.26	2.00	58.4	45.7	12.8	2.37	43.4	753
	XX	8.625	6.875	0.875	2.26	1.80	58.4	37.1	21.3	1.93	72.4	1460
10	(s)	10.750	10.192	0.279	2.81	2.67	90.8	81.6	9.18	4.21	31.2	285
	30 (s)	10.750	10.136	0.307	2.81	2.65	90.8	80.7	10.1	4.19	34.2	324
	40 (s)	10.750	10.020	0.365	2.81	2.62	90.8	78.9	11.9	4.10	40.5	405
	60 (x)	10.750	9.750	0.500	2.81	2.55	90.8	74.7	16.1	3.88	54.7	600
12	30 (s)	12.750	12.090	0.330	3.34	3.17	128.	115.	12.9	5.96	43.8	290
	(s)	12.750	12.000	0.375	3.34	3.14	128.	113.	14.6	5.88	49.6	352
	(x)	12.750	11.750	0.500	3.34	3.08	128.	108.	19.2	5.63	65.4	503
14	30 (s)	14.000	13.250	0.375	3.67	3.46	154.	138.	16.0	7.17	54.6	4[d]8[d]
	(x)	14.000	13.000	0.500	3.67	3.15	154.	133.	21.2	6.70	72.1	653

Table 4 .... Dimensions and Properties of Steel Pipe (Concluded)

Nominal Size[a]	ASTM[b] Schedule	Diameter OD In.	Diameter ID In.	Wall Thickness In.	Surface Area Sq Ft/Lin Ft OD	Surface Area Sq Ft/Lin Ft ID	Section Area Sq In. OD	Section Area Sq In. ID	Area of Metal Sq In.	Volume Gal/Lin Ft	Weight[c] (plain end) Lb/Lin Ft	Working Pressure Psia
16	30 (s)	16.000	15.250	0.375	4.18	3.99	201.	183.	18.4	9.48	62.4	400[d(3)]
	40 (x)	16.000	15.000	0.500	4.18	3.93	201.	177.	24.3	9.18	82.8	570
18	(s)	18.000	17.250	0.375	4.71	4.52	254.	234.	20.7	12.1	70.6	355
	(x)	18.000	17.000	0.500	4.71	4.45	254.	227.	27.4	11.8	93.5	506
20	20 (s)	20.000	19.250	0.375	5.23	4.51	314.	291.	23.2	15.2	78.6	319
	30 (s)	20.000	19.000	0.500	5.23	4.97	314.	284.	30.6	14.7	104.2	454
24	20	24.000	23.250	0.375	6.29	6.08	452.	426.	26.8	22.1	94.6	265
	(s)	24.000	23.000	0.500	6.29	6.03	452.	415.	36.9	21.5	125.5	378

[a] 3½ double extra strong is no longer considered in ASTM specification but some pipe of this size is still manufactured.
[a] The sizes for wrought iron are approximately the same except wall thickness is slightly heavier. See *ASTM* A-72.
[b] *American Society for Testing and Materials* Schedule. The numbers 30, 40, etc., refer to the *ASTM* Schedule; the letter (s) refers to the former designation *Standard Weight*; the letter (x) refers to the former designation *Extra Strong*; the letters XX refer to the former designation *Double Extra Strong*.
[c] Weight per foot is based on plain end pipe. Threaded and coupled (T and C) pipe is slightly heavier.
[d] Working pressure for welded joints—see formula in Table 1. Refer to Table 1 for type of weld.
(1) Working pressure based on an allowable fiber stress of 6225 psi (for 250 F).
(2) Working pressure based on an allowable fiber stress of 8400 psi (for 250 F).
(3) Working pressure based on an allowable fiber stress of 12000 psi (for 250 F).
Note: Standard-weight pipe is generally furnished with threaded ends in random lengths of 16 to 22 ft, although when ordered with plain ends, 5 percent may be in lengths of 12 to 16 ft. Five percent of the total number of lengths ordered may be jointers which are two pieces coupled together. Extra-strong pipe is generally furnished with plain ends in random lengths of 12 to 22 ft, although 5 percent may be in lengths of 6 to 12 ft.

In general, Type K is used for underground services and for general plumbing service where corrosion conditions are severe. Type L is used for general plumbing and heating service where conditions may be considered normal. Type M is used for sanitary drainage and other non-pressure applications, for heating, and sometimes for other services less severe than those for which Types K or L are recommended. Type DWV is of lighter weight than Type M, and is used for sanitary drainage and other non-pressure applications. Type DWV tube should not be used underground. Type L is suitable for underground drainage applications. All three types are extensively used with soldered fittings. Unless adequately protected, no copper tube should be embedded in a cinder fill.

Soft-temper copper tubing in coils of 60 or 100 ft is commonly used for applications where the number of joints should be kept to a minimum, e.g., radiant heating panels in slabs, fuel lines, and lines below grade. In exposed locations hard temper copper generally should be used.

Standard dimensions, weights, and diameter and wall-thickness tolerances for these classes of copper tube are obtainable from Table 5. Copper pipe is also available with dimensions of steel pipe.

Materials commonly used in refrigerant piping are steel wrought-iron, malleable iron, copper, brass and bronze, as specified in ANSI B31.5-1966.[2] For low temperature service (−50 F to −320 F), ANSI B36.40 and ASTM A-333 are applicable, covering wrought steel or alloy, either electrical resistance welded or seamless pipe. Copper and brass must not be used with ammonia.

Other materials are not barred by the code, provided they are of suitable strength and are chemically suitable for use with the fluid conveyed. The code bars the use of magnesium base alloys with any halogenated hydrocarbon refrigerant, as well as the use of zinc, aluminum, die-castings, and magnesium alloys with methyl chloride.

For temperatures below −20 F, the code provides that materials shall be impact tested as required by Paragraph UG-84 of Section VIII of the ASME Code, with the exception of the following materials: certain types of aluminum, stainless steel, copper, red brass, copper-nickel and nickel copper alloys.

Furthermore, no impact tests are required for materials in a piping system for metal temperatures between −20 F and −150 F when the most severe pressure conditions are multiplied by 2½ in determining the thickness *t*.

A summary of available data on low temperature materials is contained in the publication *Properties of Metals at Subatmospheric Temperatures*, issued in 1941 by the American Society for Testing and Materials.

Specific minimum requirements for refrigerant pipe and tubing are set forth in the ANSI B9.1-1971 *Safety Code for Mechanical Refrigeration*,[3] as follows:

9.5 Specific Minimum Requirements for Refrigerant Pipe and Tubing

9.3.1 No less than Schedule 80 wall thickness carbon steel or wrought-iron pipe shall be used for Group II and Group III refrigerant liquid lines for sizes 1¼ in. and smaller.

No less than Schedule 40 wall thickness carbon steel or wrought-iron pipe shall be used for Group I refrigerant liquid lines sizes 6 in. and smaller. Group II and Group III refrigerant liquid lines sizes 2 in. through 6 in., and Group I, Group II, and Group III refrigerant vapor lines 6 in. and smaller.

Butt-welded carbon steel and butt-welded wrought-iron pipe shall not be used for refrigerant liquid lines.

Cast iron pipe shall not be used for Group I, Group II, or Group III refrigerant lines.

9.3.2 Standard iron pipe size copper and red brass (not less than 80 percent copper) pipe may be used and shall conform to ASTM Specification B-42 for copper pipe and ASTM Specification B-43 for red brass pipe.

9.3.3 Watertube size hard copper tubing used for refrigerant piping erected on the premises shall conform to ASTM Specifications B88-62 Types K or L, for dimensions and specifications, except that copper tubing with outside diameters of ⅜ in. and 1 in. shall have a minimum nominal wall thickness of not less than 0.030 in. and 0.032 in., respectively.

9.3.4 Soft annealed copper tubing used for refrigerant piping erected on the premises shall not be used in sizes larger than 1⅛ in. standard size (1.375 O.D.). Mechanical joints shall not be used on soft annealed copper tubing on sizes larger than ⅞ in. standard size (0.875 O.D.). It shall conform to ASTM Specifications