TEMPERATURE CONVERSION

DEGREES FAHRENHEIT TO DEGREES CELSIUS AND VICE VERSA

When the central value in any row of these temperature conversion tables is taken to be in °F, its equivalent value in °C is shown on the left. When the central value is in °C, its equivalent in °F is shown on the right.

Basis: 9 x column 1 = 5 (column 2 – 32°)
5 (column 3 – 32°) = 9 x column 2

°C	← → °F °C	°F	°C	← → °F °C	°F	°C	← → °F °C	°F	°C	← → °F °C	°F	°C	← → °F °C	°F	°C	← → °F °C	°F
-268	-450	–	-56.7	-70	-94.0	-20.6	-5	23.0	15.6	60	140.0	51.7	125	257.0	87.8	190	374.0
-262	-440	–	-56.1	-69	-92.2	-20.0	-4	24.8	16.1	61	141.8	52.2	126	258.8	88.3	191	375.8
-257	-430	–	-55.6	-68	-90.4	-19.4	-3	26.6	16.7	62	143.6	52.8	127	260.6	88.9	192	377.6
-251	-420	–	-55.0	-67	-88.6	-18.9	-2	28.4	17.2	63	145.4	53.3	128	262.4	89.4	193	379.4
-246	-410	–	-54.4	-66	-86.8	-18.3	-1	30.2	17.8	64	147.2	53.9	129	264.2	90.0	194	381.2
-240	-400	–	-53.9	-65	-85.0	-17.8	0	32.0	18.3	65	149.0	54.4	130	266.0	90.6	195	383.0
-234	-390	–	-53.3	-64	-83.2	-17.2	1	33.8	18.9	66	150.8	55.0	131	267.8	91.1	196	384.8
-229	-380	–	-52.8	-63	-81.4	-16.7	2	35.6	19.4	67	152.6	55.6	132	269.6	91.7	197	386.6
-223	-370	–	-52.2	-62	-79.6	-16.1	3	37.4	20.0	68	154.4	56.1	133	271.4	92.2	198	388.4
-218	-360	–	-51.7	-61	-77.8	-15.6	4	39.2	20.6	69	156.2	56.7	134	273.2	92.8	199	390.2
-212	-350	–	-51.1	-60	-76.0	-15.0	5	41.0	21.1	70	158.0	57.2	135	275.0	93.3	200	392.0
-207	-340	–	-50.6	-59	-74.2	-14.4	6	42.8	21.7	71	159.8	57.8	136	276.8	93.9	201	393.8
-201	-330	–	-50.0	-58	-72.4	-13.9	7	44.6	22.2	72	161.6	58.3	137	278.6	94.4	202	395.6
-196	-320	–	-49.4	-57	-70.6	-13.3	8	46.4	22.8	73	163.4	58.9	138	280.4	95.0	203	397.4
-190	-310	–	-48.9	-56	-68.8	-12.8	9	48.2	23.3	74	165.2	59.4	139	282.2	95.6	204	399.2
-184	-300	–	-48.3	-55	-67.0	-12.2	10	50.0	23.9	75	167.0	60.0	140	284.0	96.1	205	401.0
-179	-290	–	-47.8	-54	-65.2	-11.7	11	51.8	24.4	76	168.8	60.6	141	285.8	96.7	206	402.8
-173	-280	–	-47.2	-53	-63.4	-11.1	12	53.6	25.0	77	170.6	61.1	142	287.6	97.2	207	404.6
-168	-270	-454	-46.7	-52	-61.6	-10.6	13	55.4	25.6	78	172.4	61.7	143	289.4	97.8	208	406.4
-162	-260	-436	-46.1	-51	-59.8	-10.0	14	57.2	26.1	79	174.2	62.2	144	291.2	98.3	209	408.2
-157	-250	-418	-45.6	-50	-58.0	-9.4	15	59.0	26.7	80	176.0	62.8	145	293.0	98.9	210	410.0
-151	-240	-400	-45.0	-49	-56.2	-8.9	16	60.8	27.2	81	177.8	63.3	146	294.8	99.4	211	411.8
-146	-230	-382	-44.4	-48	-54.4	-8.3	17	62.6	27.8	82	179.6	63.9	147	296.6	100.0	212	413.6
-140	-220	-364	-43.9	-47	-52.6	-7.8	18	64.4	28.3	83	181.4	64.4	148	298.4	100.6	213	415.4
-134	-210	-346	-43.3	-46	-50.8	-7.2	19	66.2	28.9	84	183.2	65.0	149	300.2	101.1	214	417.2
-129	-200	-328	-42.8	-45	-49.0	-6.7	20	68.0	29.4	85	185.0	65.6	150	302.0	101.7	215	419.0
-123	-190	-310	-42.2	-44	-47.2	-6.1	21	69.8	30.0	86	186.8	66.1	151	303.8	102.2	216	420.8
-118	-180	-292	-41.7	-43	-45.4	-5.6	22	71.6	30.6	87	188.6	66.7	152	305.6	102.8	217	422.6
-112	-170	-274	-41.1	-42	-43.6	-5.0	23	73.4	31.1	88	190.4	67.2	153	307.4	103.3	218	424.4
-107	-160	-256	-40.6	-41	-41.8	-4.4	24	75.2	31.7	89	192.2	67.8	154	309.2	103.9	219	426.2
-101	-150	-238	-40.0	-40	-40.0	-3.9	25	77.0	32.2	90	194.0	68.3	155	311.0	104.4	220	428.0
-96	-140	-220	-39.4	-39	-38.2	-3.3	26	78.8	32.8	91	195.8	68.9	156	312.8	105.0	221	429.8
-90	-130	-202	-38.9	-38	-36.4	-2.8	27	80.6	33.3	92	197.6	69.4	157	314.6	105.6	222	431.6
-84	-120	-184	-38.3	-37	-34.6	-2.2	28	82.4	33.9	93	199.4	70.0	158	316.4	106.1	223	433.4
-79	-110	-166	-37.8	-36	-32.8	-1.7	29	84.2	34.4	94	201.2	70.6	159	318.2	106.7	224	435.2
-73.3	-100	-148.0	-37.2	-35	-31.0	-1.1	30	86.0	35.0	95	203.0	71.1	160	320.0	107.2	225	437.0
-72.8	-99	-146.2	-36.7	-34	-29.2	-0.6	31	87.8	35.6	96	204.8	71.7	161	321.8	107.8	226	438.8
-72.2	-98	-144.4	-36.1	-33	-27.4	0.0	32	89.6	36.1	97	206.6	72.2	162	323.6	108.3	227	440.6
-71.7	-97	-142.6	-35.6	-32	-25.6	0.6	33	91.4	36.7	98	208.4	72.8	163	325.4	108.9	228	442.4
-71.1	-96	-140.8	-35.0	-31	-23.8	1.1	34	93.2	37.2	99	210.2	73.3	164	327.2	109.4	229	444.2
-70.6	-95	-139.0	-34.4	-30	-22.0	1.7	35	95.0	37.8	100	212.0	73.9	165	329.0	110.0	230	446.0
-70.0	-94	-137.2	-33.9	-29	-20.2	2.2	36	96.8	38.3	101	213.8	74.4	166	330.8	110.6	231	447.8
-69.4	-93	-135.4	-33.3	-28	-18.4	2.8	37	98.6	38.9	102	215.6	75.0	167	332.6	111.1	232	449.6
-68.9	-92	-133.6	-32.8	-27	-16.6	3.3	38	100.4	39.4	103	217.4	75.6	168	334.4	111.7	233	451.4
-68.3	-91	-131.8	-32.2	-26	-14.8	3.9	39	102.2	40.0	104	219.2	76.1	169	336.2	112.2	234	453.2
-67.8	-90	-130.0	-31.7	-25	-13.0	4.4	40	104.0	40.6	105	221.0	76.7	170	338.0	112.8	235	455.0
-67.2	-89	-128.2	-31.1	-24	-11.2	5.0	41	105.8	41.1	106	222.8	77.2	171	339.8	113.3	236	456.8
-66.7	-88	-126.4	-30.6	-23	-9.4	5.6	42	107.6	41.7	107	224.6	77.8	172	341.6	113.9	237	458.6
-66.1	-87	-124.6	-30.0	-22	-7.6	6.1	43	109.4	42.2	108	226.4	78.3	173	343.4	114.4	238	460.4
-65.6	-86	-122.8	-29.4	-21	-5.8	6.7	44	111.2	42.8	109	228.2	78.9	174	345.2	115.0	239	462.2
-65.0	-85	-121.0	-28.9	-20	-4.0	7.2	45	113.0	43.3	110	230.0	79.4	175	347.0	115.6	240	464.0
-64.4	-84	-119.2	-28.3	-19	-2.2	7.8	46	114.8	43.9	111	231.8	80.0	176	348.8	116.1	241	465.8
-63.9	-83	-117.4	-27.8	-18	-0.4	8.3	47	116.6	44.4	112	233.6	80.6	177	350.6	116.7	242	467.6
-63.3	-82	-115.6	-27.2	-17	1.4	8.9	48	118.4	45.0	113	235.4	81.1	178	352.4	117.2	243	469.4
-62.8	-81	-113.8	-26.7	-16	3.2	9.4	49	120.2	45.6	114	237.2	81.7	179	354.2	117.8	244	471.2
-62.2	-80	-112.0	-26.1	-15	5.0	10.0	50	122.0	46.1	115	239.0	82.2	180	356.0	118.3	245	473.0
-61.7	-79	-110.2	-25.6	-14	6.8	10.6	51	123.8	46.7	116	240.8	82.8	181	357.8	118.9	246	474.8
-61.1	-78	-108.4	-25.0	-13	8.6	11.1	52	125.6	47.2	117	242.6	83.3	182	359.6	119.4	247	476.6
-60.6	-77	-106.6	-24.4	-12	10.4	11.7	53	127.4	47.8	118	244.4	83.9	183	361.4	120.0	248	478.4
-60.0	-76	-104.8	-23.9	-11	12.2	12.2	54	129.2	48.3	119	246.2	84.4	184	363.2	120.6	249	480.2
-59.4	-75	-103.0	-23.3	-10	14.0	12.8	55	131.0	48.9	120	248.0	85.0	185	365.0	121.1	250	482.0
-58.9	-74	-101.2	-22.8	-9	15.8	13.3	56	132.8	49.4	121	249.8	85.6	186	366.8	121.7	251	483.8
-58.3	-73	-99.4	-22.2	-8	17.6	13.9	57	134.6	50.0	122	251.6	86.1	187	368.6	122.2	252	485.6
-57.8	-72	-97.6	-21.7	-7	19.4	14.4	58	136.4	50.6	123	253.4	86.7	188	370.4	122.8	253	487.4
-57.2	-71	-95.8	-21.1	-6	21.2	15.0	59	138.2	51.1	124	255.2	87.2	189	372.2	123.3	254	489.2

TEMPERATURE CONVERSION

°C	← → °F °C	°F	°C	← → °F °C	°F	°C	← → °F °C	°F	°C	← → °F °C	°F	°C	← → °F °C	°F	°C	← → °F °C	°F
123.9	255	491.0	165.6	330	626.0	207.2	405	761.0	248.9	480	896.0	290.6	555	1031.0	482	900	1652
124.4	256	492.8	166.1	331	627.8	207.8	406	762.8	249.4	481	897.8	291.1	556	1032.8	488	910	1670
125.0	257	494.6	166.7	332	629.6	208.3	407	764.6	250.0	482	899.6	291.7	557	1034.6	493	920	1688
125.6	258	496.4	167.2	333	631.4	208.9	408	766.4	250.6	483	901.4	292.2	558	1036.4	499	930	1706
126.1	259	498.2	167.8	334	633.2	209.4	409	768.2	251.1	484	903.2	292.8	559	1038.2	504	940	1724
126.7	260	500.0	168.3	335	635.0	210.0	410	770.0	251.7	485	905.0	293.3	560	1040.0	510	950	1742
127.2	261	501.8	168.9	336	636.8	210.6	411	771.8	252.2	486	906.8	293.9	561	1041.8	516	960	1760
127.8	262	503.6	169.4	337	638.6	211.1	412	773.6	252.8	487	908.6	294.4	562	1043.6	521	970	1778
128.3	263	505.4	170.0	338	640.4	211.7	413	775.4	253.3	488	910.4	295.0	563	1045.4	527	980	1796
128.9	264	507.2	170.6	339	642.2	212.2	414	777.2	253.9	489	912.2	295.6	564	1047.2	532	990	1814
129.4	265	509.0	171.1	340	644.0	212.8	415	779.0	254.4	490	914.0	296.1	565	1049.0	538	1000	1832
130.0	266	510.8	171.7	341	645.8	213.3	416	780.8	255.0	491	915.8	296.7	566	1050.8	543	1010	1850
130.6	267	512.6	172.2	342	647.6	213.9	417	782.6	255.6	492	917.6	297.2	567	1052.6	549	1020	1868
131.1	268	514.4	172.8	343	649.4	214.4	418	784.4	256.1	493	919.4	297.8	568	1054.4	554	1030	1886
131.7	269	516.2	173.3	344	651.2	215.0	419	786.2	256.7	494	921.2	298.3	569	1056.2	560	1040	1904
132.2	270	518.0	173.9	345	653.0	215.6	420	788.0	257.2	495	923.0	298.9	570	1058.0	566	1050	1922
132.8	271	519.8	174.4	346	654.8	216.1	421	789.8	257.8	496	924.8	299.4	571	1059.8	571	1060	1940
133.3	272	521.6	175.0	347	656.6	216.7	422	791.6	258.3	497	926.6	300.0	572	1061.6	577	1070	1958
133.9	273	523.4	175.6	348	658.4	217.2	423	793.4	258.9	498	928.4	300.6	573	1063.4	582	1080	1976
134.4	274	525.2	176.1	349	660.2	217.8	424	795.2	259.4	499	930.2	301.1	574	1065.2	588	1090	1994
135.0	275	527.0	176.7	350	662.0	218.3	425	797.0	260.0	500	932.0	301.7	575	1067.0	593	1100	2012
135.6	276	528.8	177.2	351	663.8	218.9	426	798.8	260.6	501	933.8	302.2	576	1068.8	599	1110	2030
136.1	277	530.6	177.8	352	665.6	219.4	427	800.6	261.1	502	935.6	302.8	577	1070.6	604	1120	2048
136.7	278	532.4	178.3	353	667.4	220.0	428	802.4	261.7	503	937.4	303.3	578	1072.4	610	1130	2066
137.2	279	534.2	178.9	354	669.2	220.6	429	804.2	262.2	504	939.2	303.9	579	1074.2	616	1140	2084
137.8	280	536.0	179.4	355	671.0	221.1	430	806.0	262.8	505	941.0	304.4	580	1076.0	621	1150	2102
138.3	281	537.8	180.0	356	672.8	221.7	431	807.8	263.3	506	942.8	305.0	581	1077.8	627	1160	2120
138.9	282	539.6	180.6	357	674.6	222.2	432	809.6	263.9	507	944.6	305.6	582	1079.6	632	1170	2138
139.4	283	541.4	181.1	358	676.4	222.8	433	811.4	264.4	508	946.4	306.1	583	1081.4	638	1180	2156
140.0	284	543.2	181.7	359	678.2	223.3	434	813.2	265.0	509	948.2	306.7	584	1083.2	643	1190	2174
140.6	285	545.0	182.2	360	680.0	223.9	435	815.0	265.6	510	950.0	307.2	585	1085.0	649	1200	2192
141.1	286	546.8	182.8	361	681.8	224.4	436	816.8	266.1	511	951.8	307.8	586	1086.8	654	1210	2210
141.7	287	548.6	183.3	362	683.6	225.0	437	818.6	266.7	512	953.6	308.3	587	1088.6	660	1220	2228
142.2	288	550.4	183.9	363	685.4	225.6	438	820.4	267.2	513	955.4	308.9	588	1090.4	666	1230	2246
142.8	289	552.2	184.4	364	687.2	226.1	439	822.2	267.8	514	957.2	309.4	589	1092.2	671	1240	2264
143.3	290	554.0	185.0	365	689.0	226.7	440	824.0	268.3	515	959.0	310.0	590	1094.0	677	1250	2282
143.9	291	555.8	185.6	366	690.8	227.2	441	825.8	268.9	516	960.8	310.6	591	1095.8	682	1260	2300
144.4	292	557.6	186.1	367	692.6	227.8	442	827.6	269.4	517	962.6	311.1	592	1097.6	688	1270	2318
145.0	293	559.4	186.7	368	694.4	228.3	443	829.4	270.0	518	964.4	311.7	593	1099.4	693	1280	2336
145.6	294	561.2	187.2	369	696.2	228.9	444	831.2	270.6	519	966.2	312.2	594	1101.2	699	1290	2354
146.1	295	563.0	187.8	370	698.0	229.4	445	833.0	271.1	520	968.0	312.8	595	1103.0	704	1300	2372
146.7	296	564.8	188.3	371	699.8	230.0	446	834.8	271.7	521	969.8	313.3	596	1104.8	710	1310	2390
147.2	297	566.6	188.9	372	701.6	230.6	447	836.6	272.2	522	971.6	313.9	597	1106.6	716	1320	2408
147.8	298	568.4	189.4	373	703.4	231.1	448	838.4	272.8	523	973.4	314.4	598	1108.4	721	1330	2426
148.3	299	570.2	190.0	374	705.2	231.7	449	840.2	273.3	524	975.2	315.0	599	1110.2	727	1340	2444
148.9	300	572.0	190.6	375	707.0	232.2	450	842.0	273.9	525	977.0	315.6	600	1112.0	732	1350	2462
149.4	301	573.8	191.1	376	708.8	232.8	451	843.8	274.4	526	978.8	321.1	610	1130.0	738	1360	2480
150.0	302	575.6	191.7	377	710.6	233.3	452	845.6	275.0	527	980.6	326.7	620	1148.0	743	1370	2498
150.6	303	577.4	192.2	378	712.4	233.9	453	847.4	275.6	528	982.4	332.2	630	1166.0	749	1380	2516
151.1	304	579.2	192.8	379	714.2	234.4	454	849.2	276.1	529	984.2	337.8	640	1184.0	754	1390	2534
151.7	305	581.0	193.3	380	716.0	235.0	455	851.0	276.7	530	986.0	343.3	650	1202.0	760	1400	2552
152.2	306	582.8	193.9	381	717.8	235.6	456	852.8	277.2	531	987.8	348.9	660	1220.0	766	1410	2570
152.8	307	584.6	194.4	382	719.6	236.1	457	854.6	277.8	532	989.6	354.4	670	1238.0	771	1420	2588
153.3	308	586.4	195.0	383	721.4	236.7	458	856.4	278.3	533	991.4	360.0	680	1256.0	777	1430	2606
153.9	309	588.2	195.6	384	723.2	237.2	459	858.2	278.9	534	993.2	365.6	690	1274.0	782	1440	2624
154.4	310	590.0	196.1	385	725.0	237.8	460	860.0	279.4	535	995.0	371	700	1292	788	1450	2642
155.0	311	591.8	196.7	386	726.8	238.3	461	861.8	280.0	536	996.8	377	710	1310	793	1460	2660
155.6	312	593.6	197.2	387	728.6	238.9	462	863.6	280.6	537	998.6	382	720	1328	799	1470	2678
156.1	313	595.4	197.8	388	730.4	239.4	463	865.4	281.1	538	1000.4	388	730	1346	804	1480	2696
156.7	314	597.2	198.3	389	732.2	240.0	464	867.2	281.7	539	1002.2	393	740	1364	810	1490	2714
157.2	315	599.0	198.9	390	734.0	240.6	465	869.0	282.2	540	1004.0	399	750	1382	816	1500	2732
157.8	316	600.8	199.4	391	735.8	241.1	466	870.8	282.8	541	1005.8	404	760	1400	843	1550	2822
158.3	317	602.6	200.0	392	737.6	241.7	467	872.6	283.3	542	1007.6	410	770	1418	871	1600	2912
158.9	318	604.4	200.6	393	739.4	242.2	468	874.4	283.9	543	1009.4	416	780	1436	899	1650	3002
159.4	319	606.2	201.1	394	741.2	242.8	469	876.2	284.4	544	1011.2	421	790	1454	927	1700	3092
160.0	320	608.0	201.7	395	743.0	243.3	470	878.0	285.0	545	1013.0	427	800	1472	954	1750	3182
160.6	321	609.8	202.2	396	744.8	243.9	471	879.8	285.6	546	1014.8	432	810	1490	982	1800	3272
161.1	322	611.6	202.8	397	746.6	244.4	472	881.6	286.1	547	1016.6	438	820	1508	1010	1850	3362
161.7	323	613.4	203.3	398	748.4	245.0	473	883.4	286.7	548	1018.4	443	830	1526	1038	1900	3452
162.2	324	615.2	203.9	399	750.2	245.6	474	885.2	287.2	549	1020.2	449	840	1544	1066	1950	3542
162.8	325	617.0	204.4	400	752.0	246.1	475	887.0	287.8	550	1022.0	454	850	1562	1093	2000	3632
163.3	326	618.8	205.0	401	753.8	246.7	476	888.8	288.3	551	1023.8	460	860	1580	1121	2050	3722
163.9	327	620.6	205.6	402	755.6	247.2	477	890.6	288.9	552	1025.6	466	870	1598	1149	2100	3812
164.4	328	622.4	206.1	403	757.4	247.8	478	892.4	289.4	553	1027.4	471	880	1616	1177	2150	3902
165.0	329	624.2	206.7	404	759.2	248.3	479	894.2	290.0	554	1029.2	477	890	1634	1204	2200	3992

TECH

TECHNICAL DATA

PRESSURE— VACUUM TREATISE

Pascal (Pa) — SI unit for pressure

Australia has adopted the pascal (symbol Pa) as the unit for pressure. Decimal multiples used in practice are kilo (k = 10^3) and mega (M = 10^6) which are known as kilopascal (kPa) and megapascal (MPa).

The pascal replaces . . .

pound-force per square foot	1 lbf/ft^2	=	47.880 259 Pa	kilogram-force per sq. mm.	1 kgf/mm^2	=	**9.806 65** MPa
pound-force per square inch	1 lbf/in^2	=	6.894 757 3 kPa	millimetre of water	1 mmH_2O	=	9.789 039 2 Pa
ton-force per square foot	1 $tonf/ft^2$	=	0.107 251 78 MPa	inch of water	1 inH_2O	=	0.248 641 60 kPa
kip per square inch	1 kip/in^2	=	6.894 757 3 MPa	foot of water	1 ftH_2O	=	2.983 699 2 kPa
ton-force per square inch	1 $tonf/in^2$	=	15.444 256 MPa	torr	1 torr	=	0.133 322 37 kPa
kilogram-force per sq.metre	1 kgf/m^2	=	**9.806 65** Pa	inch of mercury	1 inHg	=	3.386 383 7 kPa
kilogram-force per sq. cm.	1 kgf/cm^2	=	**98.0665** kPa	bar	1 bar	=	**100** kPa

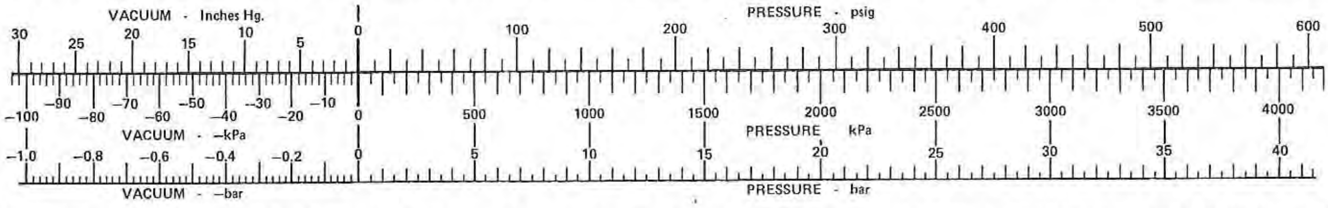
(Bold type indicates an exact conversion factor)

PRESSURE & COMPOUND (Pressure & Vacuum) GAUGES

While pressure and compound gauges reading in psi and inches Hg will be around for quite a while, the Australian Standard AS1349 - 1973 for Bourdon Tube Pressure and Vacuum Gauges specifies scales within the pressure range of —100 kPa to +100,000 kPa with the unit of pressure, the kilopascal (kPa).

The conversion from psi and inches Hg to kPa is best illustrated by the chart below. It should be noted that for vacuum ranges 30" to 0, the SI Metric kilopascals become a minus quantity — i.e. from —100 to 0 kPa.

SPECIAL NOTE: It should also be noted that some **Pressure Controls** imported from Europe are calibrated in bars — a non SI Metric Unit. A **"bar line"** conversion has been added to the chart below to assist in the setting of such controls.



While there is a wealth of information, Tables, Charts etc. available on conversion data from 0 psi upward, to kPa, very little information is currently available for the so called "Vacuum" range.

Note : Australian Standard AS1947-1976 — "Metric Units for Use in Mechanical Engineering and Related Fields" states — "In general expressions describing pressures below ambient pressures, the term "vacuum" may be used, but quantified expressions such as "at a vacuum of 30 kPa" are not to be used."
Using the concept of gauge pressure, a pressure below ambient pressure should be expressed as a negative value e.g. —30 kPa. Alternatively it may be expressed as e.g. 30 kPa below ambient pressure.
The following Table is therefore presented and upon which the above chart is based.

ENGLISH TO METRIC VACUUM CONVERSION TABLE

NOTE: The number in the center column refers to the vacuum either in "Hg or —kPa when it is desired to convert into either scale. If converting from "Hg to —kPa the equivalent vacuum will be found in the right column while if converting from —kPa to "Hg the answer will be found in the left column.

Inches Hg	⇩	—kPa	Inches Hg	⇩	—kPa	Inches Hg	⇩	—kPa	Inches Hg	⇩	—kPa	Inches Hg	⇩	—kPa
.2953	**1**	— 3.386	6.201	**21**	— 71.11	12.11	**41**	—	18.01	**61**	—	23.92	**81**	—
.5906	**2**	— 6.773	6.497	**22**	— 74.50	12.40	**42**	—	18.31	**62**	—	24.21	**82**	—
.8859	**3**	—10.159	6.792	**23**	— 77.89	12.70	**43**	—	18.60	**63**	—	24.51	**83**	—
1.181	**4**	—13.546	7.087	**24**	— 81.27	12.99	**44**	—	18.90	**64**	—	24.81	**84**	—
1.477	**5**	—16.932	7.382	**25**	— 84.66	13.29	**45**	—	19.19	**65**	—	25.10	**85**	—
1.772	**6**	—20.318	7.678	**26**	— 88.05	13.58	**46**	—	19.49	**66**	—	25.40	**86**	—
2.067	**7**	—23.705	7.973	**27**	— 91.43	13.88	**47**	—	19.79	**67**	—	25.69	**87**	—
2.362	**8**	—27.091	8.268	**28**	— 94.82	14.17	**48**	—	20.08	**68**	—	25.99	**88**	—
2.658	**9**	—30.477	8.564	**29**	— 98.21	14.47	**49**	—	20.38	**69**	—	26.28	**89**	—
2.953	**10**	—33.864	8.859	**30**	—101.60	14.77	**50**	—	20.67	**70**	—	26.58	**90**	—
3.248	**11**	—37.250	9.154	**31**	—	15.06	**51**	—	20.97	**71**	—	26.87	**91**	—
3.544	**12**	—40.637	9.450	**32**	—	15.36	**52**	—	21.26	**72**	—	27.17	**92**	—
3.839	**13**	—44.023	9.745	**33**	—	15.65	**53**	—	21.56	**73**	—	27.46	**93**	—
4.134	**14**	—47.409	10.04	**34**	—	15.95	**54**	—	21.85	**74**	—	27.76	**94**	—
4.430	**15**	—50.796	10.34	**35**	—	16.24	**55**	—	22.15	**75**	—	28.05	**95**	—
4.725	**16**	—54.182	10.63	**36**	—	16.54	**56**	—	22.44	**76**	—	28.35	**96**	—
5.020	**17**	—57.569	10.93	**37**	—	16.83	**57**	—	22.74	**77**	—	28.64	**97**	—
5.315	**18**	—60.955	11.22	**38**	—	17.13	**58**	—	23.03	**78**	—	28.94	**98**	—
5.611	**19**	—64.341	11.52	**39**	—	17.42	**59**	—	23.33	**79**	—	29.23	**99**	—
5.906	**20**	—67.728	11.81	**40**	—	17.72	**60**	—	23.62	**80**	—	29.53	**100**	—

METRIC CONVERSION

Pressure, stress: Pounds-force per square inch to kilopascals

Basis: 1 lb = 0·453 592 37 kg (exactly) 1 N = 1 kg.m/s²
g_n = 9·806 65 m/s² (exactly)

lbf/in²	0	1	2	3	4	5	6	7	8	9
	kilopascals (kPa)									
0	—	6·89476	13·7895	20·6843	27·5790	34·4738	41·3685	48·2633	55·1581	62·0528
10	68·9476	75·8423	82·7371	89·6318	96·5266	103·421	110·316	117·211	124·106	131·000
20	137·895	144·790	151·685	158·579	165·474	172·369	179·264	186·158	193·053	199·948
30	206·843	213·737	220·632	227·527	234·422	241·317	248·211	255·106	262·001	268·896
40	275·790	282·685	289·580	296·475	303·369	310·264	317·159	324·054	330·948	337·843
50	344·738	351·633	358·527	365·422	372·317	379·212	386·106	393·001	399·896	406·791
60	413·685	420·580	427·475	434·370	441·264	448·159	455·054	461·949	468·843	475·738
70	482·633	489·528	496·423	503·317	510·212	517·107	524·002	530·896	537·791	544·686
80	551·581	558·475	565·370	572·265	579·160	586·054	592·949	599·844	606·739	613·633
90	620·528	627·423	634·318	641·212	648·107	655·002	661·897	668·791	675·686	682·581
100	689·476	696·370	703·265	710·160	717·055	723·950	730·844	737·739	744·634	751·529
110	758·423	765·318	772·213	779·108	786·002	792·897	799·792	806·687	813·581	820·476
120	827·371	834·266	841·160	848·055	854·950	861·845	868·739	875·634	882·529	889·424
130	896·318	903·213	910·108	917·003	923·897	930·792	937·687	944·582	951·477	958·371
140	965·266	972·161	979·056	985·950	992·845	999·740	1006·63	1013·53	1020·42	1027·32
150	1034·21	1041·11	1048·00	1054·90	1061·79	1068·69	1075·58	1082·48	1089·37	1096·27
160	1103·16	1110·06	1116·95	1123·85	1130·74	1137·63	1144·53	1151·42	1158·32	1165·21
170	1172·11	1179·00	1185·90	1192·79	1199·69	1206·58	1213·48	1220·37	1227·27	1234·16
180	1241·06	1247·95	1254·85	1261·74	1268·64	1275·53	1282·42	1289·32	1296·21	1303·11
190	1310·00	1316·90	1323·79	1330·69	1337·58	1344·48	1351·37	1358·27	1365·16	1372·06
200	1378·95	1385·85	1392·74	1399·64	1406·53	1413·43	1420·32	1427·21	1434·11	1441·00
210	1447·90	1454·79	1461·69	1468·58	1475·48	1482·37	1489·27	1496·16	1503·06	1509·95
220	1516·85	1523·74	1530·64	1537·53	1544·43	1551·32	1558·22	1565·11	1572·00	1578·90
230	1585·79	1592·69	1599·58	1606·48	1613·37	1620·27	1627·16	1634·06	1640·95	1647·85
240	1654·74	1661·64	1668·53	1675·43	1682·32	1689·22	1696·11	1703·01	1709·90	1716·79
250	1723·69	1730·58	1737·48	1744·37	1751·27	1758·16	1765·06	1771·95	1778·85	1785·74
260	1792·64	1799·53	1806·43	1813·32	1820·22	1827·11	1834·01	1840·90	1847·79	1854·69
270	1861·58	1868·48	1875·37	1882·27	1889·16	1896·06	1902·95	1909·85	1916·74	1923·64
280	1930·53	1937·43	1944·32	1951·22	1958·11	1965·01	1971·90	1978·80	1985·69	1992·58
290	1999·48	2006·37	2013·27	2020·16	2027·06	2033·95	2040·85	2047·74	2054·64	2061·53
300	2068·43	2075·32	2082·22	2089·11	2096·01	2102·90	2109·80	2116·69	2123·59	2130·48
310	2137·37	2144·27	2151·16	2158·06	2164·95	2171·85	2178·74	2185·64	2192·53	2199·43
320	2206·32	2213·22	2220·11	2227·01	2233·90	2240·80	2247·69	2254·59	2261·48	2268·38
330	2275·27	2282·16	2289·06	2295·95	2302·85	2309·74	2316·64	2323·53	2330·43	2337·32
340	2344·22	2351·11	2358·01	2364·90	2371·80	2378·69	2385·59	2392·48	2399·38	2406·27
350	2413·17	2420·06	2426·95	2433·85	2440·74	2447·64	2454·53	2461·43	2468·32	2475·22
360	2482·11	2489·01	2495·90	2502·80	2509·69	2516·59	2523·48	2530·38	2537·27	2544·17
370	2551·06	2557·95	2564·85	2571·74	2578·64	2585·53	2592·43	2599·32	2606·22	2613·11
380	2620·01	2626·90	2633·80	2640·69	2647·59	2654·48	2661·38	2668·27	2675·17	2682·06
390	2688·96	2695·85	2702·74	2709·64	2716·53	2723·43	2730·32	2737·22	2744·11	2751·01
400	2757·90	2764·80	2771·69	2778·59	2785·48	2792·38	2799·27	2806·17	2813·06	2819·96
410	2826·85	2833·75	2840·64	2847·53	2854·43	2861·32	2868·22	2875·11	2882·01	2888·90
420	2895·80	2902·69	2909·59	2916·48	2923·38	2930·27	2937·17	2944·06	2950·96	2957·85
430	2964·75	2971·64	2978·54	2985·43	2992·32	2999·22	3006·11	3013·01	3019·90	3026·80
440	3033·69	3040·59	3047·48	3054·38	3061·27	3068·17	3075·06	3081·96	3088·85	3095·75
450	3102·64	3109·54	3116·43	3123·33	3130·22	3137·11	3144·01	3150·90	3157·80	3164·69
460	3171·59	3178·48	3185·38	3192·27	3199·17	3206·06	3212·96	3219·85	3226·75	3233·64
470	3240·54	3247·43	3254·33	3261·22	3268·11	3275·01	3281·90	3288·80	3295·69	3302·59
480	3309·48	3316·38	3323·27	3330·17	3337·06	3343·96	3350·85	3357·75	3364·64	3371·54
490	3378·43	3385·33	3392·22	3399·12	3406·01	3412·90	3419·80	3426·69	3433·59	3440·48

lbf/in²	kPa
0·1	0·689 48
0·2	1·378 95
0·3	2·068 43
0·4	2·757 90

lbf/in²	kPa
0·5	3·447 38
0·6	4·136 85
0·7	4·826 33
0·8	5·515 81
0·9	6·205 28

NOTE: This table may also be used to convert kip/in² to MPa without any change in the position of the decimal marker; e.g. 1 kip/in² = 6·894 76 MPa.

TECH

METRIC CONVERSION

HEAT TRANSFER

THERMAL CONDUCTIVITY

Conversion of k Factors from Btu.in/ft^{2}h^{o}F to W/m.C

Btu	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.10	0.0144	0.0159	0.0173	0.0187	0.0202	0.0216	0.0231	0.0245	0.0260	0.0274
0.20	0.0288	0.0303	0.0317	0.0332	0.0346	0.0361	0.0375	0.0389	0.0404	0.0418
0.30	0.0433	0.0447	0.0462	0.0476	0.0490	0.0505	0.0519	0.0534	0.0548	0.0562
0.40	0.0577	0.0591	0.0606	0.0620	0.0635	0.0649	0.0663	0.0678	0.0692	0.0707
0.50	0.0721	0.0736	0.0750	0.0764	0.0779	0.0793	0.0808	0.0822	0.0837	0.0851
0.60	0.0865	0.0880	0.0894	0.0909	0.0923	0.0937	0.0952	0.0966	0.0981	0.0995
0.70	0.1010	0.1024	0.1038	0.1053	0.1067	0.1082	0.1096	0.1111	0.1125	0.1139
0.80	0.1154	0.1168	0.1183	0.1197	0.1212	0.1226	0.1240	0.1255	0.1269	0.1284
0.90	0.1298	0.1312	0.1327	0.1341	0.1356	0.1370	0.1385	0.1399	0.1413	0.1428
1.00	0.1442	0.1457	0.1471	0.1486	0.1500	0.1514	0.1529	0.1543	0.1558	0.1572
1.10	0.1587	0.1601	0.1615	0.1630	0.1644	0.1659	0.1673	0.1687	0.1702	0.1716
1.20	0.1731	0.1745	0.1760	0.1774	0.1788	0.1803	0.1817	0.1832	0.1846	0.1861
1.30	0.1875	0.1889	0.1904	0.1918	0.1933	0.1947	0.1961	0.1976	0.1990	0.2005
1.40	0.2019	0.2034	0.2048	0.2062	0.2077	0.2091	0.2106	0.2120	0.2135	0.2149
1.50	0.2163	0.2178	0.2192	0.2207	0.2221	0.2236	0.2250	0.2264	0.2279	0.2293
1.60	0.2308	0.2322	0.2336	0.2351	0.2365	0.2380	0.2394	0.2409	0.2423	0.2437
1.70	0.2452	0.2466	0.2481	0.2495	0.2510	0.2524	0.2538	0.2553	0.2567	0.2582
1.80	0.2596	0.2611	0.2625	0.2639	0.2654	0.2668	0.2683	0.2697	0.2711	0.2726
1.90	0.2740	0.2755	0.2769	0.2784	0.2798	0.2812	0.2827	0.2841	0.2856	0.2870
2.00	0.2885	0.2899	0.2913	0.2928	0.2942	0.2957	0.2971	0.2986	0.3000	0.3014

Example :. To convert 0.29 Btu.in/ft^{2}h^{o}F read across from 0.20 in left hand column and down from 0.09 in top line i.e. — 0.0418 W/m.C.

THERMAL CONDUCTANCE

Conversion of U Values from Btu/ft^{2}h^{o}F to W/m^2.C

Btu	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.00	0.000	0.057	0.114	0.170	0.227	0.284	0.341	0.397	0.454	0.511
0.10	0.568	0.625	0.681	0.738	0.795	0.852	0.909	0.965	1.022	1.079
0.20	1.136	1.192	1.249	1.306	1.363	1.420	1.476	1.533	1.590	1.647
0.30	1.703	1.760	1.817	1.874	1.931	1.987	2.044	2.101	2.158	2.215
0.40	2.271	2.328	2.385	2.442	2.498	2.555	2.612	2.669	2.726	2.782
0.50	2.839	2.896	2.953	3.009	3.066	3.123	3.180	3.237	3.293	3.350
0.60	3.407	3.464	3.521	3.577	3.634	3.691	3.748	3.804	3.861	3.918
0.70	3.975	4.032	4.088	4.145	4.202	4.259	4.315	4.372	4.429	4.486
0.80	4.543	4.599	4.656	4.713	4.770	4.827	4.883	4.940	4.997	5.054
0.90	5.110	5.167	5.224	5.281	5.338	5.394	5.451	5.508	5.565	5.621
1.00	5.678	5.735	5.792	5.849	5.905	5.962	6.019	6.076	6.132	6.189
1.10	6.246	6.303	6.360	6.416	6.473	6.530	6.587	6.644	6.700	6.757
1.20	6.814	6.871	6.927	6.984	7.041	7.098	7.155	7.211	7.268	7.325
1.30	7.382	7.439	7.495	7.552	7.609	7.666	7.722	7.779	7.836	7.892
1.40	7.950	8.006	8.063	8.120	8.177	8.233	8.290	8.347	8.404	8.461
1.50	8.517	8.574	8.631	8.688	8.745	8.801	8.858	8.915	8.972	9.028
1.60	9.085	9.142	9.199	9.256	9.312	9.369	9.426	9.483	9.539	9.596
1.70	9.653	9.710	9.767	9.823	9.880	9.937	9.994	10.051	10.107	10.164
1.80	10.221	10.278	10.334	10.391	10.448	10.505	10.562	10.618	10.675	10.732
1.90	10.789	10.845	10.902	10.959	11.016	11.073	11.129	11.186	11.243	11.300
2.00	11.357	11.413	11.470	11.527	11.584	11.640	11.697	11.754	11.811	11.868

Example : To convert 0.32 Btu/ft^{2}h^{o}F read across from 0.30 in left hand column and down from 0.02 in top line i.e. = 1.817 W/m^2.C.

DESIGN VALUES FOR THERMAL RESISTANCE

Thermal Resistance Values for General Building Materials

Material	Nominal Thickness L (mm)	Resistance R (m^2.K/W)
Lining Boards, Sheets, Panels		
Asbestos Cement Products: Standard Sheet	4.5	0.017
"Wunderflex, Hardiflex" etc.	6	0.023
Fibrous Plaster: Standard Sheet	9.5	0.026
Gypsum Plasterboard: "Gyprock"	10	0.057
	13	0.074
Hardboard: "Timbrock, Masonite", etc.	3.2	0.022
	4.8	0.033
	5.5	0.038
Particle Board: Standard "Pyneboard"	10	0.087
	13	0.113
	16	0.139
Plywood:	4	0.025
	6	0.037
	9	0.055
	12	0.074
Softboard: Standard "Cane-ite"	9.5	0.19
	12.7	0.254
	19	0.388
Flooring Materials		
Carpet: With Standard Fibrous Underfelt		0.367
With Rubber Underlay		0.217
Ceramic Tile:	25	0.014
Cork Tile:	6	0.14
Floor Felt: Standard Jute Underfelt	13	0.27
Linoleum:	3	0.015
PVC Tiles: "Vinylflex"	3	0.004
	2	0.003
Timber Flooring: Softwood	19	0.173
Hardwood	19	0.10
Roofing Materials		
Asbestos Cement: Standard Sheet	5.5	0.021
Sheet Metal, all types:		Neg.
Tiles, burnt clay	16 min	0.018
Tiles, concrete	16 min	0.01
Cladding Materials		
Asbestos Cement Sheet:	4.5	0.017
	6	0.023
Glass: Window and plate	3	0.004
	6.5	0.008
Timber Weatherboards: Softwood	16 av.	0.145
Hardwood	16 av.	0.084
Masonry, Concrete		
Bricks: Common	76	0.106
	110	0.153
Concrete bricks, dense sand and gravel aggregate	76	0.042
	110	0.066
Concrete blocks — cored: Dense sand and gravel aggregate	100	0.126
	150	0.147
	200	0.176
	300	0.207
Plastering Materials		
Cement or Gypsum Plaster: Sand Aggregate	13	0.018
	19	0.026

CONDENSATION CONTROL

When considering condensation control, it may be necessary to calculate the temperature of the internal wall or ceiling surface when the outside temperature is at the lowest level anticipated. The appropriate formula is :

$$t_s = t_i - QR_i$$
$$= t_i - \frac{Q}{f_i}$$

Where
- t_s = internal surface temperature (^{o}C)
- t_i = inside air temperature (^{o}C)
- Q = calculated heat flow per square metre per second (W/m^2)
- R_i = resistance of inside air film (m^{2}C/W)
- f_i = inside surface heat transfer coefficient W/m^{2}C).

Room Temperature (Dry Bulb) ^{o}C	Dew Point Temperatures, 0^{o}C — Relative Humidity, Percent: 20	30	40	50	60	70	80	90
5	–0.6	0.0	0.7	1.4	2.0	2.9	3.7	4.3
10	2.5	3.6	4.5	5.5	6.5	7.5	8.3	9.2
15	5.9	7.3	8.6	9.8	10.9	12.0	13.0	14.1
20	9.3	10.9	12.3	13.9	15.2	16.5	17.7	18.9
25	12.4	14.4	16.2	18.0	19.5	21.1	22.4	23.7
30	15.7	18.0	20.1	22.1	23.8	25.5	27.2	28.6
35	18.9	21.7	24.0	26.3	28.2	30.1	32.0	33.6

If the internal surface temperature calculated in this manner is less than the anticipated dew point temperature, there will be the risk of condensation forming on the surface. This can promote mould growth and the accumulation of dust and stains, and lead to the eventual breakdown of paint and paper finishes.

It is therefore recommended that sufficient insulation material be added to raise the surface temperature of the wall or ceiling above the dew point. Under extremely cold conditions, the use of a vapour barrier should be considered This is located immediately behind the facing sheet with the objective of preventing the migration of moisture vapour from within the living space into the wall and ceiling cavities. If this happens, the thermal resistance of the insulation can be seriously reduced and structural damage can result.

The Table can be used as a guide in establishing the lowest anticipated dew point temperature. It lists the dew point temperatures for a range of inside air temps. and relative humidities.

Data on this Page reproduced from Bradford Air Conditioning Insulation Manual SfB(57)m1 UDC Nov. 1975.

METRIC UNITS AND CONVERSION FACTORS FOR SERVICE ENGINEERS

Reproduced from THE AIRAH DATA BOOK with the permission of The Australian Institute of Refrigeration Air Conditioning and Heating [Inc.]

Quantity in Imperial or Common Unit		x Factor	=	SI Unit	
Space and Time Length	thou'(mil)	x 2.54×10^{-5} *	=	m	metre
		2.54×10^{1}	=	µm	micrometre
	inch	2.54×10^{-2}	=	m	metre
		2.54×10^{1}	=	mm	millimetre
	foot	3.048×10^{-1}	=	m	metre
	yard (British Standard)	9.144×10^{-1}	=	m	metre
	mile	1.609×10^{3}	=	m	metre
		1.609	=	km	kilometre
Area	square inch	x 6.452×10^{-4}	=	m^2	square metre
		6.452×10^{2}	=	mm^2	square millimetre
	square foot	9.290×10^{-2}	=	m^2	square metre
	square yard	8.361×10^{-1}	=	m^2	square metre
	square mile	2.590×10^{6}	=	m^2	square metre
		2.590	=	km^2	square kilometre
	acre	4.047×10^{3}	=	m^2	square metre
		4.047×10^{-3}	=	km^2	square kilometre
Volume	cubic inch	x 1.639×10^{-5}	=	m^3	cubic metre
		1.639×10^{1}	=	mℓ	millilitre
	cubic foot	2.832×10^{-2}	=	m^3	cubic metre
		2.832×10^{1}	=	ℓ	litre
	cubic yard	7.646×10^{-1}	=	m^3	cubic metre
	pint†	5.683×10^{-4}	=	m^3	cubic metre
		5.683×10^{-1}	=	ℓ	litre
	gallon†	4.546×10^{-3}	=	m^3	cubic metre
		4.546	=	ℓ	litre
	gallon (US)	3.785×10^{-3}	=	m^2	cubic metre
		3.785	=	ℓ	litre
	litre	1×10^{-3}	=	m^3	cubic metre
Motion Velocity	foot/second	x 3.048×10^{-1}	=	m/s	metre/second
	foot/minute	5.080×10^{-3}	=	m/s	metre/second
	mile/hour	4.470×10^{-1}	=	m/s	metre/second
	knot	5.148×10^{-1}	=	m/s	metre/second
Acceleration	foot/second^2	x 3.048×10^{-1}	=	m/s^2	metre/second squared
Frequency	cycle/second	x 1	=	Hz	hertz

† All measures quoted are Imperial unless otherwise stated.
* All factors in bold print are exact values.

TECH

Continued next Page

METRIC UNITS AND CONVERSION FACTORS FOR SERVICE ENGINEERS (Cont'd)

Quantity in Imperial or Common Unit		x	Factor	=	SI Unit
Mass and Density					
Mass	ounce	x	2.835 x 10^{-2}	= kg	kilogram
			2.835 x 10^{1}	= g	gram
	pound		4.536 x 10^{-1}	= kg	kilogram
	ton		1.016 x 10^{3}	= kg	kilogram
	ton (short)		9.072 x 10^{2}	= kg	kilogram
	ton (metric)		**1 x 10^{3}***	= kg	kilogram
	grain		6.479 x 10^{-5}	= kg	kilogram
			6.479 x 10^{1}	= mg	milligram
Mass per unit length	pound/foot	x	1.488	= kg/m	kilogram/metre
Mass per unit area	pound/foot²	x	4.882	= kg/m²	kilogram/square metre
Density (specific mass)	pound/foot³	x	1.602 x 10^{1}	= kg/m³	kilogram/cubic metre
				= g/ℓ	= gram/litre
	pound/inch³		2.768 x 10^{4}	= kg/m³	kilogram/cubic metre
				= g/ℓ	= gram/litre
	pound/gallon		9.978 x 10^{1}	= kg/m³	kilogram/cubic metre
				= g/ℓ	= gram/litre
Specific volume	foot³/pound	x	6.243 x 10^{-2}	= m³/kg	cubic metre/kilogram
Flow rate					
Mass flow rate	pound/minute	x	7.560 x 10^{-3}	= kg/s	kilogram/second
	pound/hour		1.260 x 10^{-4}	= kg/s	kilogram/second
Mass flow per unit area	pound/foot²hour	x	1.356 x 10^{-3}	= kg/m²s	kilogram/square metre second
	pound/inch²hour		1.953 x 10^{-1}	= kg/m²s	kilogram/square metre second
Volume flow rate	cubic foot/second	x	2.832 x 10^{-2}	= m³/s	cubic metre/second
			2.832 x 10^{1}	= ℓ/s	litre/second
	cubic foot/minute		4.719 x 10^{-4}	= m³/s	cubic metre/second
			4.719 x 10^{-1}	= ℓ/s	litre/second
	gallon/minute		7.577 x 10^{-5}	= m³/s	cubic metre/second
			7.577 x 10^{-2}	= ℓ/s	litre/second
	gallon/hour		1.263 x 10^{-6}	= m³/s	cubic metre/second
			1.263 x 10^{-3}	= ℓ/s	litre/second
	gallon/minute (US)		6.309 x 10^{-5}	= m³/s	cubic metre/second
			6.309 x 10^{-2}	= ℓ/s	litre/second
	gallon/hour (US)		1.052 x 10^{-6}	= m³/s	cubic metre/second
			1.052 x 10^{-3}	= ℓ/s	litre/second
	cubic metre/minute		1.667 x 10^{-2}	= m³/s	cubic metre/second
			1.667 x 10^{1}	= ℓ/s	litre/second
	cubic metre/hour		2.778 x 10^{-4}	= m³/s	cubic metre/second
			2.778 x 10^{-1}	= ℓ/s	litre/second
	litre/minute		1.667 x 10^{-5}	= m³/s	cubic metre/second
			1.667 x 10^{-2}	= ℓ/s	litre/second
	litre/hour		2.778 x 10^{-7}	= m³/s	cubic metre/second
			2.778 x 10^{-4}	= ℓ/s	litre/second
Momentum					
Momentum	pound foot/second	x	1.383 x 10^{-1}	= kg.m/s	kilogram metre/second
Moment of inertia	pound foot²	x	4.214 x 10^{-2}	= kg.m²	kilogram metre squared
Moment of momentum (angular momentum)	pound foot²/second	x	4.214 x 10^{-2}	= kg.m²/s	kilogram metre squared/ second

* All factors in bold print are exact values.

Continued next page

METRIC UNITS AND CONVERSION FACTORS FOR SERVICE ENGINEERS (Cont'd)

Quantity in Imperial or Common Unit		x Factor	=	SI Unit
Force and Torque				
Force (weight)	pound force	x 4.448	= N	newton
	poundal	1.383×10^{-1}	= N	newton
	kilogram force	9.807	= N	newton
	dyne	**1×10^{-5}***	= N	newton
Torque (moment of force)	pound force foot	x 1.356	= N.m	newton metre
Pressure and Stress				
Pressure	pound force/inch^2	x 6.895×10^3	= Pa	pascal
	pound force/foot^2	4.788×10^1	= Pa	pascal
	kilogram force/centimetre^2	9.807×10^{-1}	= Pa	pascal
	inch H_2O (4°C)	2.491×10^2	= Pa	pascal
	foot H_2O (4°C)	2.989×10^3	= Pa	pascal
	millimetre H_2O (4°C)	9.807	= Pa	pascal
	inch Hg (0°C)	3.386×10^3	= Pa	pascal
	bar	**1×10^5**	= Pa	pascal
	millimetre Hg	1.333×10^2	= Pa	pascal
	torr	1.333×10^2	= Pa	pascal
	atmosphere (standard)	1.013×10^5	= Pa	pascal
Pressure drop per unit length	foot H_2O/100 feet	x 9.810×10^1	= Pa/m	pascal/metre
	inch H_2O/100 feet	8.176	= Pa/m	pascal/metre
Stress	pound force/inch^2	x 6.895×10^3	= Pa	pascal
	pound force/foot^2	4.788×10^1	= Pa	pascal
	ton force/inch^2	1.544×10^7	= Pa	pascal
	ton force/foot^2	1.073×10^5	= Pa	pascal
Viscosity Dynamic viscosity (absolute)	poise (dyne second/ centimetre^2)	x **1×10^{-1}**	= Pa.s	pascal second
	pound force second/foot^2	4.788×10^1	= Pa.s	pascal second
	pound force hour/foot^2	1.724×10^5	= Pa.s	pascal second
	pound/hour/foot	4.14×10^{-4}	= Pa.s	pascal second
Kinematic viscosity	stokes (centimetre^2/ second	x **1×10^{-4}**	= m^2/s	metre squared/second
	inch^2/second	6.452×10^{-4}	= m^2/s	metre squared/second
	foot^2/second	9.290×10^{-2}	= m^2/s	metre squared/second
	foot^2/minute	1.548×10^{-3}	= m^2/s	metre squared/second
	metre^2/hour	2.778×10^4	= m^2/s	metre squared/second
	Redwood No. 1 and No. 2 seconds	No direct conversion		
	SAE grades	No direct conversion		
Temperature —	See separate Tables			

* All factors in bold print are exact values.

Continued next page

TECH

METRIC UNITS AND CONVERSION FACTORS FOR SERVICE ENGINEERS (Cont'd)

Quantity in Imperial or Common Unit		x Factor	=	SI Unit
Heat Energy, work, quantity of heat	British Thermal Unit (Btu)	x 1.055×10^3 (see note below) 1.055	= J = kJ	joule (1 J = 1 N.m = 1 W.s) kilojoule
	horsepower hour	2.685×10^6 2.685	= J = MJ	joule megajoule
	kilowatt hour	**3.6×10^6*** **3.6**	= J = MJ	joule megajoule
	therm (100,000 Btu)	1.055×10^8 1.055×10^{-1}	= J = GJ	joule gigajoule
	foot pound force	1.356	= J	joule
	metre kilogram force	9.807	= J	joule
	kilocalorie (frigorie)	4.187×10^3 4.187	= J = kJ	joule kilojoule
	thermie	4.187×10^6	= J	joule

NOTE: The British thermal unit is temperature dependent; for instance, the energy required to raise the temperature of one pound of water from 39°F to 40°F (Btu_{39}) is equal to 1059.52 joule, whereas the mean value over the range 32°F to 212°F (Btu_{mean}) is equal to 1055.79 joule. The International Steam Tables use a value of 1055.06 joule (Btu_{IT}) and this value has been used for all the conversions involving the Btu. On this basis one Btu_{IT} per pound is equal to 2.326×10^3 joule per kilogram exactly. The calorie is temperature dependent in the same way as is the Btu. For example at 15°C it is equal to 4.1847 joule and at 20°C to 4.1808. The mean calorie is equal to 4.18605 absolute joules and the $calorie_{IT}$ to 4.18689 absolute joules. In addition, the Calorie has been taken in practice to be equivalent to 1000 calories.

Quantity in Imperial or Common Unit		x Factor	=	SI Unit
Heat flow Power, heat flow rate	Btu/hour	x 2.931×10^{-1} 2.931×10^{-4}	= W = kW	watt (W = J/s = N.m/s) kilowatt
	horsepower	7.457×10^2 7.457×10^{-1}	= W = kW	watt kilowatt
	horsepower (metric)	7.355×10^2	= W	watt
	foot pound force/second	1.356	= W	watt
	ton refrigeration (12,000 Btu/h)	3.516×10^3 3.516	= W = kW	watt kilowatt
	kilocalorie/hour	**1.163** **1.163×10^{-3}**	= W = kW	watt kilowatt
Intensity of heat flow rate	Btu/hour $foot^2$ watts/$foot^2$ kilocalorie/hour $metre^2$	x 3.155 1.076×10^1 **1.163**	= W/m^2 = W/m^2 = W/m^2	watt/square metre watt/square metre watt/square metre
Thermal conductivity	Btu inch/hour $foot^2$ °F	x 1.442×10^{-1}	= W/m.°C	watt/metre degree Celsius
	kilocalorie/hour metre °C	**1.163**	= W/m.°C	watt/metre degree Celsius
Thermal conductance	Btu/hour $foot^2$ °F	x 5.678	= W/m^2°C	watt/square metre degree Celsius
	kilocalorie/hour $metre^2$ °C	**1.163**	= W/m^2°C	watt/square metre degree Celsius
Thermal resistivity	$foot^2$ hour °F/Btu inch	x 6.934	= m.°C/W	metre degree Celsius/watt
	metre hour °C/kilocalorie	8.598×10^{-1}	= m.°C/W	metre degree Celsius/watt
Thermal resistance	$foot^2$ hour °F/Btu	x 1.761×10^{-1}	= m^2°C/W	square metre degree Celsius/watt
	$metre^2$ hour °C/kilocalorie	8.598×10^{-1}	= m^2°C/W	square metre degree Celsius/watt
Thermal diffusivity	$foot^2$ hour	x 2.581×10^{-5}	= m^2/s	square metre/second
	$metre^2$ hour	2.778×10^{-4}	= m^2/s	square metre/second

* All factors in bold print are exact values.

Continued next page

METRIC UNITS AND CONVERSION FACTORS FOR SERVICE ENGINEERS (Cont'd)

Quantity in Imperial or Common Unit		x Factor	=	SI Unit
Heat energy content Heat capacity	Btu/°F	x 1.899 x 10^3	= J/°C	joule/degree Celsius
	kilocalorie/°C	4.187 x 10^3	= J/°C	joule/degree Celsius
Specific enthalpy	Btu/pound kilocalorie/kilogram	x **2.326 x 10^3*** 2.326	= J/kg = kJ/kg	joule/kilogram kilojoule/kilogram
		4.187 x 10^3 4.187	= J/kg = kJ/kg	joule/kilogram kilojoule/kilogram
Specific heat capacity (Thermal capacity per unit mass)	Btu/pound °F	x 4.187 x 10^3	= J/kg.°C	joule/kilogram degree Celsius
		4.187	= kJ/kg.°C	kilojoule/kilogram degree Celsius
	kilocalorie/kilogram °C	4.187 x 10^3	= J/kg.°C	joule/kilogram degree Celsius
		4.187	= kJ/kg.°C	kilojoule/kilogram degree Celsius
Entropy	Btu/°R	x 1.899 x 10^3	= J/K	joule/kelvin
	kilocalorie/K	4.187 x 10^3	= J/K	joule/kelvin
Specific entropy	Btu/pound °R	x 4.187 x 10^3 4.187	= J/kg.K = kJ/kg.K	joule/kilogram kelvin kilojoule/kilogram kelvin
	kilocalorie/kilogram K	4.187 x 10^3 4.187	= J/kg.K = kJ/kg.K	joule/kilogram kelvin kilojoule/kilogram kelvin
Latent heat (specific energy)	Btu/pound	x **2.326 x 10^3**	= J/kg	joule/kilogram
		2.326	= kJ/kg	kilojoule/kilogram
	kilocalorie/kilogram	4.187 x 10^3	= J/kg	joule/kilogram
	foot pound force force/pound	2.989	= J/kg	joule/kilogram
Volumetric calorific value	Btu/foot^3	x 3.726 x 10^4	= J/m^3	joule/cubic metre
		3.726 x 10^{-2}	= MJ/m^3	megajoule/cubic metre
	kilocalorie/metre^3	4.187 x 10^3	= J/m^3	joule/cubic metre
		4.187 x 10^{-3}	= MJ/m^3	megajoule/cubic metre
Specific heat (volume basis)	Btu/foot^3 °F	x 6.707 x 10^4	= J/m^3°C	joule/cubic metre degree Celsius
		6.707 x 10^{-2}	= MJ/m^3°C	megajoule/cubic metre degree Celsius
	kilocalorie/metre °C	4.187 x 10^3	= J/m^3°C	joule/cubic metre degree Celsius
		4.187 x 10^{-3}	= MJ/m.°C	megajoule/cubic metre degree Celsius

* All factors in bold print are exact values.

Continued next page

METRIC UNITS AND CONVERSION FACTORS FOR SERVICE ENGINEERS (Cont'd)

Quantity in Imperial or Common Unit		x Factor	=	SI Unit
Moisture content Vapour permeability	pound foot/hour pound force	x 8.62 x 10^{-6}	= kg.m/N.s	kilogram metre/newton second
		8.62 x 10^{3}	= µg.m/N.s	microgram metre/newton second
	grain inch/square foot hour inch of mercury (perm-inch)	1.45 x 10^{-12}	= kg.m/N.s	kilogram metre/newton second
Vapour permeance	pound/hour pound force	x 2.834 x 10^{-5} 2.834 x 10^{4}	= kg/N.s = µg/N.s	kilogram/newton second microgram/newton second
	pound inch^2/foot^2/hour pound force	1.965 x 10^{-7}	= kg/N.s	kilogram/newton second
	grain/square foot hour inch mercury (perm.)	5.72 x 10^{-11}	= kg/N.s	kilogram/newton second
	grain/square foot hour millibar	1.94 x 10^{-9}	= kg/N.s	kilogram/newton second
Moisture content	pound/pound	x 1	= kg/kg	kilogram/kilogram
	grain/pound	1.428 x 10^{-1}	= g/kg	gram/kilogram
Moisture flow rate	grain/square foot hour	x 1.94 x 10^{-7}	= kg/m^2.s	kilogram/square metre second
	pound/square foot	1.357 x 10^{-3}	= kg/m^2.s	kilogram/square metre second
Mass transfer coefficient	foot/hour	x 8.47 x 10^{-5}	= m/s	metre/second
Light Luminous intensity	candle (International)	x 9.810 x 10^{-1}	= cd	candela
Illumination	foot candle lumen/foot^2	x 1.076 x 10^{1} 1.076 x 10^{1}	= lx = lx	lux lux
Luminance	foot lambert candela/inch^2	x 3.426 1.550 x 10^{3}	= cd/m^2 = cd/m^2	candela/square metre candela/square metre
Electricity Already largely SI				

* All factors in bold print are exact values.

OUTDOOR DESIGN CONDITIONS SUMMER & WINTER

Reproduced from THE AIRAH DATA BOOK with the permission of The Australian Institute of Refrigeration Air Conditioning and Heating [Inc.]

INTRODUCTION

This section presents data for outdoor design conditions. Table 1 contains data relating to 3 p.m. dry-bulb temperatures (summer) and 8 a.m. dry-bulb temperatures (winter). This table and some of the accompanying text are self-explanatory and are extracted from the Air Conditioning System Design Manual published by the Australian Government Department of Construction. They are reprinted here with the permission of the Government publishing office.

SUMMER OUTDOOR DESIGN CONDITIONS

For comfort and non-critical process installations it is customary to choose outdoor 3 p.m. dry-bulb temperatures which individually are exceeded on 10 days in the year. (The temperatures listed in Table 1 allow for the standard deviation, e.g. for Sydney [Mascot Airport] the design dry-bulb of 30.5°C occurs on 6 days with standard deviation of plus or minus 4°C). The locations for which complete, statistically valid information is available are marked with an asterisk . Figures listed for other locations are approximations or are based on incomplete information.

For critical process installations summer outdoor design conditions are based on dry-bulb and wet-bulb temperatures which individually are exceeded on 0.25% of the plant operating hours. Table 1 provides for two sets of temperature values, one for 24 hour operation and the other for operation between 8.00 a.m. and 6.00 p.m. every day of the year.

Outdoor summer design conditions for critical process installations should be discussed with and agreed to by the client.

WINTER OUTDOOR DESIGN CONDITIONS

For comfort and non-critical process installations it is customary to choose the 8 a.m. dry-bulb temperature which is not exceeded on 10 days in the year. (Temperatures listed in Table 1 allow for the standard deviation). The locations for which complete, statistically valid information is available, are marked with an asterisk. Figures listed for other locations are approximations or are based on incomplete information.

The design outdoor relative humidity should be taken as 80%.

For critical process installations, winter outdoor design conditions are based on the dry-bulb temperature which is not exceeded 0.25% of the plant operating hours. Table 1 provides for two temperature values, one for 24 hours operation and the other for operation between 8.00 a.m. and 6.00 p.m. every day of the year.

Outdoor winter design conditions for critical process installations should be discussed with and agreed to by the client.

TABLE 1 – OUTDOOR DESIGN CONDITIONS – SUMMER AND WINTER

Location City or Town and Meteorological Station Locality	Summer						Winter			Elev. Above Sea Level	Latitude	Average Daily Range	Yearly Range
	Comfort or Non-Critical Process Installations		Critical Process Installations				Comfort or Non-Critical Process Installations	Critical Process Installations					
			24 Hour Operation		8.00 a.m.-6.00 p.m. Operation			24 Hour Operat.	8.00am-6.00pm Operat.				
	(°CDB)	(°CWB)	(°CDB)	(°CWB)	(°CDB)	(°CWB)	(°CDB)	(°CDB)	(°CDB)	(m)	(°Sth.)	(°CDB)	(°CDB)
VICTORIA													
Bairnsdale	34.0	21.5	–	–	–	–	2.0	–	–	15	37° 49'	12.0	31.5
Ballarat	34.0	20.5	–	–	–	–	-1.0	–	–	437	37° 35'	14.0	35.0
Benalla	38.0	22.0	–	–	–	–	1.5	–	–	171	36° 34'	16.0	36.0
Bendigo	36.5	22.0	–	–	–	–	1.0	–	–	223	36° 46'	14.5	35.5
Melbourne * (Essendon Airport)	34.5	21.0	35.5	22.0	37.0	23.0	4.5	1.5	3.0	35	37° 49'	11.5	30.0
Mildura airport *	38.0	23.5	39.5	24.0	40.5	24.0	4.5	1.5	2.0	54	34° 11'	16.0	33.5
Sale airport	35.5	22.0	–	–	–	–	2.0	–	–	9	38° 6'	14.5	33.5
Seymour airport	36.5	21.0	–	–	–	–	1.0	–	–	142	37° 2'	16.5	35.5
TASMANIA													
Hobart airport *	26.0	19.0	30.0	20.5	31.5	21.0	3.0	0.5	1.5	54	42° 53'	9.5	23.5
Launceston airport	28.5	20.0	–	–	–	–	3.0	–	–	81	41° 27'	13.0	25.5
SOUTH AUSTRALIA													
Adelaide (Parafield airport) *	36.0	21.0	36.5	23.0	38.0	23.5	6.5	3.5	5.5	43	34° 56'	13.0	29.5
Mt. Gambier	35.0	20.5	–	–	–	–	4.0	–	–	42	37° 50'	11.5	31.0
Woomera airport *	39.5	22.0	40.5	24.0	41.5	24.5	5.0	3.5	5.0	165	31° 00'	–	34.5
NORTHERN TERRITORY													
Alice Springs airport*	39.5	23.5	40.5	24.5	41.0	24.5	3.5	1.5	3.5	580	23° 38'	14.0	36.0
Darwin airport*	34.5	28.5	34.5	28.5	35.0	29.0	18.5	–	–	10	12° 30'	7.0	16.0
Katherine	40.5	28.0	–	–	–	–	10.0	–	–	106	15° 30'	–	30.5
Tennant Creek	40.5	25.0	–	–	–	–	11.5	–	–	328	19° 34'	12.5	29.0
NEW SOUTH WALES													
Albury	39.5	22.0	–	–	–	–	1.5	–	–	165	36° 06'	16.5	37.5
Casino	39.0	24.0	–	–	–	–	6.0	–	–	24	28° 51'	13.0	33.0
Cessnock	35.0	23.5	–	–	–	–	7.0	–	–	12	32° 54'	13.5	28.0
Cooma	29.5	19.5	–	–	–	–	-4.0	–	–	690	36° 14'	15.0	33.5
Dubbo	39.0	23.0	–	–	–	–	1.5	–	–	265	32° 18'	15.5	37.0
Grafton	35.0	24.0	–	–	–	–	6.0	–	–	6	29° 43'	12.0	29.0
Griffith	35.0	23.0	–	–	–	–	4.5	–	–	128	34° 17'	15.0	30.5
Inverell	38.0	21.5	–	–	–	–	0.5	–	–	604	29° 47'	16.0	37.0

* Locations for which complete, statistically valid data are available.

Continued next page

TECH

OUTDOOR DESIGN CONDITIONS SUMMER & WINTER (Cont'd)

TABLE 1 – OUTDOOR DESIGN CONDITIONS – SUMMER AND WINTER (Continued)

Location	Summer						Winter						
City or Town and Meteorological Station Locality	Comfort or Non-Critical Process Installations		Critical Process Installations				Comfort or Non-Critical Process Installations	Critical Process Installations		Elev. Above Sea Level	Latitude	Average Daily Range	Yearly Range
			24 Hour Operation		8.00 a.m.-6.00 p.m. Operation			24 Hour Operat.	8.00am-6.00pm Operat.				
	(°CDB)	(°CWB)	(°CDB)	(°CWB)	(°CDB)	(°CWB)	(°CDB)	(°CDB)	(°CDB)	(m)	(°Sth.)	(°CDB)	(°CDB)
NEW SOUTH WALES (Continued)													
Lismore	35.0	24.0	–	–	–	–	9.0	–	–	11	28° 48′	11.5	26.0
Lithgow	32.0	23.0	–	–	–	–	1.5	–	–	920	33° 30′	14.5	30.5
Maitland	35.0	24.0	–	–	–	–	6.0	–	–	6	32° 44′	13.0	29.0
Moree	40.5	23.0	–	–	–	–	4.5	–	–	209	29° 28′	16.0	36.0
Newcastle	32.0	23.5	–	–	–	–	4.5	–	–	34	32° 35′	6.0	28.0
Orange	35.0	21.5	–	–	–	–	0.5	–	–	868	33° 17′	17.0	34.5
Parkes	38.0	21.5	–	–	–	–	4.5	–	–	316	33° 06′	14.5	33.5
Sydney (Mascot airport*)	30.5	23.0	33.5	24.0	35.5	24.0	7.0	4.5	7.0	42	33° 51′	7.5	23.5
Tamworth	38.0	21.5	–	–	–	–	-1.0	–	–	378	31° 06′	15.5	39.0
Taree	35.0	24.0	–	–	–	–	7.0	–	–	9	31° 55′	12.0	28.0
Wagga Wagga	39.0	22.0	–	–	–	–	1.5	–	–	187	35° 07′	15.5	37.0
Windsor	36.0	24.0	–	–	–	–	1.5	–	–	12	33° 51′	–	34.5
Wollongong	32.0	23.0	–	–	–	–	7.0	–	–	10	34° 25′	9.0	25.0
WESTERN AUST.													
Albany	32.0	21.0	–	–	–	–	7.0	–	–	12	35° 02′	8.5	25.0
Broome airport *	38.5	29.0	39.5	29.5	40.0	29.5	16.5	9.5	9.0	11	17° 57′	6.5	21.5
Bruce Rock	36.5	21.5	–	–	–	–	4.5	–	–	–	31° 51′	–	32.5
Bunbury	33.5	22.5	–	–	–	–	7.0	–	–	5	33° 18′	13.0	26.0
Carnarvon airport *	34.0	26.0	38.5	26.0	40.0	26.5	12.0	7.0	7.0	5	24° 54′	8.5	21.5
Collie	36.0	23.0	–	–	–	–	3.5	–	–	184	33° 21′	17.0	33.0
Corrigan	36.5	21.5	–	–	–	–	4.5	–	–	–	32° 18′	–	32.5
Derby	40.5	28.5	–	–	–	–	10.0	–	–	16	17° 18′	8.5	30.5
Geraldton	36.0	24.0	–	–	–	–	10.0	–	–	4	28° 45′	10.0	26.0
Kalgoorlie *	40.0	23.0	40.5	24.0	40.5	24.0	5.5	0.0	0.0	380	30° 45′	16.0	35.0
Kununurra	40.5	28.5	–	–	–	–	12.0	–	–	46	15° 46′	–	28.5
Northam	39.0	22.0	–	–	–	–	4.5	–	–	149	31° 40′	16.5	34.5
Perth (Guildford airport) *	36.0	24.0	39.0	25.0	39.0	25.5	9.0	3.5	3.5	60	31° 57′	12.0	27.0
Port Hedland airport	39.5	28.5	–	–	–	–	15.0	–	–	8	20° 19′	8.5	24.5
Wyndham	40.5	29.5	–	–	–	–	12.0	–	–	7	15° 27′	8.5	28.5
Anna Plains airport	41.0	29.0	–	–	–	–	–	–	–	3	19° 15′	9.5	–
A.C.T.													
Canberra airport *	34.0	21.0	34.0	21.0	35.0	21.5	0.5	-4.5	-1.5	560	35° 17′	15.0	33.5
QUEENSLAND													
Amberley airport	35.5	26.0	–	–	–	–	10.0	–	–	25	27° 25′	–	25.5
Brisbane (Eagle Farm airport)*	31.0	25.0	32.0	25.5	34.0	25.5	10.5	6.5	10.5	42	27° 28′	9.0	20.5
Cairns airport	33.0	26.5	–	–	–	–	17.0	–	–	5	16° 55′	8.5	15.5
Charleville airport *	39.0	24.0	39.5	24.0	40.0	24.5	5.0	0.0	4.5	294	26° 25′	15.0	34.0
Cloncurry airport *	41.0	25.5	41.5	26.0	41.5	26.5	10.0	6.0	11.0	193	20° 43′	12.5	31.0
Rockhampton airport *	36.0	26.5	36.0	26.5	36.5	27.0	11.0	4.0	11.0	11	23° 24′	10.0	25.0
Toowoomba airport	31.0	22.0	–	–	–	–	–	–	–	586	27° 33′	12.0	–
Townsville airport *	32.0	26.0	34.0	27.0	34.5	28.0	13.0	9.0	13.0	3	19° 14′	11.0	19.0
PAPUA NEW GUINEA													
Lae Airport	33.5	28.0	–	–	–	–	20.0	–	–	8	6° 48′	–	13.5
Madang airport	33.0	28.0	–	–	–	–	–	–	–	6	5° 00′	7.0	–
Port Moresby (Jackson's airport) *	33.5	28.5	34.0	37.0	34.0	27.0	22.0	–	–	38	9° 29′	7.5	11.0
Rabaul airport	33.5	28.5	–	–	–	–	21.5	–	–	13	4° 12′	9.0	11.5

* Locations for which complete, statistically valid data are available.

Reproduced from THE AIRAH DATA BOOK with the permission of The Australian Institute of Refrigeration Air Conditioning and Heating [Inc.]

PRESSURE-TEMPERATURE CHART

Refrigeration and Air Conditioning Metric Data

For an interim period, refrigeration mechanics will have either imperial or metric manifold gauges. This chart therefore provides pressure/ temperature relationships for refrigerant gases for both systems of units. The chart may be used for totally metric working, or to convert from imperial to metric working.

It should be noted that the values in the chart may vary marginally for gases of differing manufacture and that above 1000 kilopascals these values have been rounded to 3 significant figures. **(ACTROL NOTE: Manifold gauges are now available with dual scales. i.e. graduated in both kPa and PSI).**

Produced by the Metric Conversion Board

Pressure – Temperature Chart

Under the heading inHg/psi pressures in bold type are vacuum pressures in inches of mercury and in light type pounds force per square inch.

		R11		R12		R22		R500		R502		R717	
°C	°F	kPa	inHg psi	kPa	inHg psi	kPa	inHg psi	kPa	inHg psi	kPa	inHg psi	kPa	inHg psi
-70	-94.0			-89	26.3	-81	23.9	-87	25.7	-74	21.8	-90	26.7
-66	-86.8			-86	25.3	-75	22.1	-83	24.5	-66	19.6	-87	25.6
-62	-79.6			-81	24.0	-68	20.1	-78	23.0	-58	17.0	-82	24.3
-58	-72.4	-100	29.5	-76	22.4	-59	17.5	-71	21.0	-47	13.9	-76	22.6
-54	-65.2	-99	29.3	-70	20.6	-49	14.5	-64	18.9	-35	10.2	-69	20.5
-50	-58.0	-99	29.1	-62	18.4	-37	10.9	-55	16.2	-20	5.9	-61	17.9
-46	-50.8	-98	28.9	-53	15.7	-23	6.7	-44	13.0	-3	0.8	-50	14.7
-42	-43.6	-97	28.6	-43	12.7	-6	1.7	-33	9.7	17	2.5	-37	10.9
-38	-36.4	-96	28.2	-31	9.1	14	2.0	-18	5.5	40	5.8	-22	6.4
-34	-29.2	-94	27.8	-17	5.0	36	5.3	-3	0.9	67	9.7	-3	1.0
-30	-22.0	-92	27.2	-1	0.3	62	9.0	16	2.3	97	14	18	2.6
-28	-18.4	-91	26.9	8	1.2	76	11	27	3.9	113	16	30	4.4
-26	-14.8	-90	26.5	17	2.5	92	13	38	5.5	131	19	43	6.3
-24	-11.2	-89	26.2	27	4.0	108	16	49	7.1	149	22	57	8.3
-22	-7.6	-87	25.8	38	5.5	125	18	62	9.0	169	24	72	11
-20	-4.0	-86	25.3	50	7.2	144	21	75	11	190	28	89	13
-18	-0.4	-84	24.8	62	9.0	163	24	90	13	212	31	106	15
-16	3.2	-82	24.2	75	11	184	27	105	15	235	34	125	18
-14	6.8	-80	23.7	88	13	205	30	121	18	260	38	145	21
-12	10.4	-78	23.0	103	15	229	33	139	20	286	41	167	24
-10	14.0	-76	22.4	118	17	253	37	156	23	313	45	190	28
-8	17.6	-73	21.6	134	19	279	40	175	25	342	50	214	31
-6	21.2	-71	20.8	151	22	306	44	195	28	372	54	240	35
-4	24.8	-68	20.0	169	24	335	49	216	31	404	59	268	39
-2	28.4	-65	19.1	187	27	365	53	239	35	437	63	298	43
0	32.0	-61	18.1	207	30	396	57	262	38	472	68	329	48
1	33.8	-59	17.6	218	32	413	60	275	40	490	71	345	50
2	35.6	-58	17.0	228	33	430	62	287	42	508	74	362	53
3	37.4	-56	16.5	239	35	447	65	300	44	527	76	379	55
4	39.2	-54	15.9	250	36	464	67	313	45	547	79	397	58
5	41.0	-52	15.3	261	38	482	70	326	47	566	82	415	60
6	42.8	-50	14.7	273	40	501	73	340	49	586	85	434	63
7	44.6	-47	14.0	285	41	520	75	353	51	607	88	454	66
8	46.4	-45	13.4	297	43	539	78	368	53	628	91	474	69
9	48.2	-43	12.7	309	45	559	81	383	56	650	94	494	72
10	50.0	-41	12.0	322	47	579	84	399	58	672	97	515	75
11	51.8	-38	11.3	335	49	600	87	414	60	694	101	537	78
12	53.6	-36	10.5	348	51	621	90	430	62	717	104	559	81
13	55.4	-33	9.8	362	52	643	93	446	65	741	107	581	84
14	57.2	-30	9.0	376	55	665	96	462	67	764	111	605	88
15	59.0	-28	8.1	390	57	688	100	480	69	789	114	629	91
16	60.8	-25	7.3	404	59	711	103	498	72	814	118	653	95
17	62.6	-22	6.4	419	61	735	107	516	75	839	122	678	98
18	64.4	-19	5.5	435	63	759	110	534	77	865	125	704	102
19	66.2	-16	4.6	450	65	783	114	553	80	891	129	731	106
20	68.0	-12	3.7	466	68	809	117	570	83	918	133	758	110
21	69.8	-9	2.7	482	70	834	121	592	86	946	137	786	114
22	71.6	-6	1.7	499	72	861	125	611	89	974	141	814	118
23	73.4	-2	0.6	516	75	887	129	631	92	1000	145	843	122
24	75.2	1	0.2	533	77	915	133	651	94	1030	150	873	127
25	77.0	5	0.7	550	80	943	137	671	97	1060	154	904	131
26	78.8	9	1.3	568	82	971	141	693	101	1090	158	935	136
27	80.6	13	1.9	586	85	1000	145	715	104	1120	163	967	140
28	82.4	17	2.4	605	88	1030	149	737	107	1150	167	1000	145
29	84.2	21	3.0	624	91	1060	154	759	110	1190	172	1030	150
30	86.0	25	3.7	644	93	1090	158	782	113	1220	177	1070	155
32	89.6	34	4.9	684	99	1150	167	830	120	1280	186	1140	165
34	93.2	43	6.3	725	105	1220	177	880	128	1350	196	1210	176
36	96.8	53	7.7	768	111	1290	187	932	135	1420	207	1290	187
38	100.4	63	9.2	813	118	1360	197	985	143	1500	217	1370	199
40	104.0	74	11	859	125	1430	208	1040	151	1580	229	1460	211
42	107.6	86	12	907	132	1510	219	1100	159	1650	240	1540	224
44	111.2	97	14	957	139	1590	230	1160	168	1740	252	1630	237
46	114.8	110	16	1010	146	1670	242	1220	177	1820	264	1730	251
48	118.4	123	18	1060	154	1750	254	1280	185	1910	277	1830	265
50	122.0	137	20	1120	162	1840	267	1350	196	2000	290	1930	280
52	125.6	151	22	1180	170	1930	280	1420	206	2090	304	2040	296
54	129.2	166	24	1230	179	2030	294	1490	216	2190	318	2150	312
56	132.8	181	26	1300	188	2120	308	1560	226	2290	332	2270	329
58	136.4	198	29	1360	197	2220	322	1640	238	2390	347	2390	346
60	140.0	215	31	1420	207	2330	337	1720	249	2500	363	2510	364

Conversion Factors

Air Flow Rate
litre per second (L/s or litre/s)
1 ft³/min (1 cfm) = 0.472 L/s
= 0.000 472 m³/s

Air Flow Rate per Area
litre per square metre second (L/m².s)
1 ft³/ft².min (1 cfm/sq ft) = 5.08 L/m².s
= 0.005 08 m³/m².s

Fouling Factors
square metre kelvin per watt (m².K/W)
1 ft².h.°F/Btu = 0.176 m².K/W
0.0005 ft².h.°F/Btu = 0.000 0881 m².K/W
0.001 ft².h.°F/Btu = 0.000 176 m².K/W

Heat Flow
watt = joule per second (W = J/s)
1 Btu/h = 0.293 W
1 ton (refrigeration) = 3.517 kW

Liquid Flow
cubic metre per second (m³/s = 1000 L/s)
or litre per second (L/s)
1 imperial gal/min = 0.0758 L/s
1 US gal/min = 0.0631 L/s
1 imperial gal/h = 0.001 26 L/s

Loading Rate
watt per square metre (W/m²)
1 Btu/ft².h = 3.15 W/m²

Coefficient of Heat Transfer
watt per square metre kelvin (W/m².K)
1 Btu/ft².h.°F = 5.68 W/m².K

Pressure
pascal (Pa)
1 lbf/in² (1 psi) = 6.89 kPa
1 in Hg = 3.39 kPa
1 in H_2O = 0.249 kPa
1 ft H_2O = 2.98 kPa
1 kgf/cm² = 98.1 kPa
1 mmHg (= 1 torr) = 0.133 kPa

Velocity Range
metre per second (m/s)
3 ft/s (3 fps) = 0.914 m/s
10 ft/s = 3.05 m/s

TECH

TECHNICAL DATA
PROPERTIES OF REFRIGERANTS

Number or Name	Formula	Molecular Weight	Boiling Point at 1 atm		Freezing Point		Critical Temp.		Relative Latent Heat of saturated vapour at boiling point R11 = 1.0	Relative Vap. Specific Heat at 37.8°C & 138kPa abs. (20 psia) R11 = 1.0	Vapour Density		* Toxicity Class	Flammability	Oil Miscibility
			°C	°F	°C	°F	°C	°F			@ 21.1°C g/L	@ 70°F lb/cu.ft.			
R.11	CCl_3F	137.38	+23.8	+74.9	−111.1	−168	+198.0	+388.4	1.00	1.00	5.37	0.335	5a	None	Miscible
R.12	CCl_2F_2	120.93	−29.8	−21.6	−157.8	−252	+112.0	+233.6	0.99	0.91	33.5	2.091	6	None	Miscible
R.13	$CClF_3$	104.47	−81.4	−114.6	−181.1	−294	+28.8	+83.9	0.98	0.81	277.8	17.34	6	None	Partial
R.14	CF_4	88.01	−128.0	−198.3	−183.9	−299	−45.7	−50.2	0.99	0.74			6	None	Partial
R.21	$CHFCl_2$	102.9	+8.9	+48.1	−135.0	−211	+178.5	+353.3	1.05	0.73	6.95	0.434	4 or 5	Slight	Miscible
R.22	$CHClF_2$	86.48	−40.8	−41.4	−160.0	−256	+96.0	+204.8	1.04	0.69	39.68	2.477	5a	None	Partial
R.23	CHF_3	70.0	−82.0	−115.7	−155.0	−247	+25.6	+78.1	1.05	0.62			6	None	Partial
R.113	$CCl_2F\ CClF_2$	187.39	+47.6	+117.6	− 35.0	− 31	+214.1	+417.4	1.03		2.96	0.185	4 to 5	None	Miscible
R.114	$CClF_2\ CClF_2$	170.94	+3.8	+38.8	− 93.9	−137	+145.7	+294.3	1.01	1.52	14.02	0.875	6	None	Partial
R.115	$CClF_2\ CF_3$	154.5	−38.7	−37.7	−106.1	−159	+79.9	+175.9	1.00	1.38	65.79	4.107	6	None	Partial
R.13B1	$C\ Br\ F_3$	148.93	−57.8	−72.0	−167.8	−270	+67.0	+152.6	0.98	0.84	119.17	7.439	6	None	Miscible
R.142b	$CH_3\ CClF_2$	100.5	−9.8	+14.4	−131.1	−204	+137.1	+278.8	0.99	1.04	13.62	0.850	5a	Flammable	Miscible
R.152a	$CH_3\ CHF_2$	66.05	−25.0	−13.0	−117.0	−178.6	+113.5	+236.3	1.03	·0.86	16.24	1.014	6	Flammable	Miscible
R.C318	$C_4\ F_8$	200.04	−5.8	+21.5	− 41.4	− 42.5	+115.3	+239.6	1.06	1.98	25.1	1.567	6 est.	None	Partial
R.216	$CClF_2CF_2CClF_2$	220.93	+35.7	+96.24	−125.4	−193.7	+180.0	+355.98	1.02		5.56	0.347	6 est.	None	Partial
R.500	12 + 152a 73.8/26.2w/w	av. 99.31	−33.5	−28.3	−158.9	−254	+105.5	+221.9	1.00	0.87	32.99	2.059	5a	None	Miscible
R.502	22 + 115 48.8/51.2w/w	av. 111.6	−45.4	−49.8			+90.0	+194	1.02	0.92	57.91	3.615	5a	None	Partial
R.503	23 + 13 59.9/40.1w/w	av. 87.3	−88.7	−127.6			+19.5	+67.1	0.97	0.71			6	None	Partial
R.504	32 + 115 48.2/51.8w/w	av. 79.2	−57.2	−71.0			+66.4	+151.5	1.06	0.73	71.59	4.469	6	None	Partial
R.717 Ammonia	NH_3	17.03	−33.3	−28.0	− 77.8	−108	+133.0	+271.4	1.15	0.45	6.92	0.432	2	Flammable	
Ethane	$CH_3\ CH_3$	30.068	−88.8	−127.85	−182.8	−297	+32.2	+90.008	0.95	0.59	89.25	5.571	5b	Flammable	Miscible
Propane	$CH_3CH_2CH_3$	44.097	−42.1	−43.73	−132.1	−205.8	+96.8	+206.26	0.97	0.93	18.78	1.172	5b	Flammable	Miscible
n-Butane	$CH_3CH_2CH_2CH_3$	58.134	−0.5	+31.1	−138.5	−217.3	+152.0	+305.62	0.99		5.48	0.342	5b	Flammable	Miscible

* TOXICITY CLASS – REFER NEXT PAGE

TECHNICAL DATA

PROPERTIES OF REFRIGERANTS

TOXICITY CLASS – COMPARATIVE LIFE HAZARD *
(As applicable to Chart on Page 469)

CLASS	DEFINITION	EXAMPLES
1	Gases or vapors which in concentrations of the order of ½ to 1% for durations of exposure of the order of 5 minutes are lethal or produce serious injury.	Sulfur dioxide
2	Gases or vapors which in concentrations of the order of ½ to 1% for durations of exposure of the order of ½ hour are lethal or produce serious injury.	Ammonia, methyl bromide
3	Gases or vapors which in concentrations of the order of 2 to 2½% for durations of exposure of the order of 1 hour are lethal or produce serious injury.	Bromochloromethane, carbon tetrachloride, chloroform, methyl formate.
4	Gases or vapors which in concentrations of the order of 2 to 2½% for durations of exposure of the order of 2 hours are lethal or produce serious injury.	Dichloroethylene, methyl chloride, ethyl bromide.
Between 4 and 5	Appear to classify as somewhat less toxic than Group 4.	Methylene chloride, ethyl chloride.
	Much less toxic than Group 4 but somewhat more toxic than Group 5.	R-113, R-21.
5a	Gases or vapors much less toxic than Group 4 but more toxic than Group 6.	R-11, R-22, R114B2, carbon dioxide.
5b	Gases or vapors which available data indicate would classify as either Group 5a or Group 6.	Ethane, propane, butane.
6	Gases or vapors which in concentrations up to at least about 20% by volume for durations of exposure of the order of 2 hours do not appear to produce injury.	R-13B1, R-12, R-114.

* Underwriters' Laboratories, Chicago, Illinois.

NOTE : The Properties of Refrigerants listed on the previous page, including their Toxicity Class (defined above) is of American origin. Comparison with Australian ratings should not be made as they appear to be a reverse set of numbers i.e. High Toxicity USA — Class 1, — Victoria Aust. — Class 6.
e.g. Victoria Class 6 — Supertoxic, 5 — Extremely Toxic, 4 — Very Toxic, 3 — Moderately Toxic, 2 — Slightly Toxic, 1 — Practically Non-Toxic. Further details may be obtained from your State Health Departments.

GENERAL RULES FOR HANDLING FLUOROCARBON REFRIGERANTS

Keep Cylinders Upright

Keep cylinders in a cool, dry place, away from the direct rays of the sun. Rust developed from outside or damp storage locations may cause cap to stick. Cylinder Valve may be injured.

Do Not Force Connections

Cylinder connections should fit easily and snugly. Never force them. Use correct tools. Stripped threads can cause leaks and possible loss of refrigerant.

Protection – Handle Carefully

Cylinders should not be used for "rollers" or supports. Cuts and abrasions may result. Care in handling cylinders will prolong their life.

Read Labels

Because colour of cylinders cannot be relied upon for positive identification, labels should always be read carefully. Colour blindness might interfere with proper identification. If still in doubt other methods of identification are available from the manufacturer/supplier.

Visual Examination

Each time a cylinder is returned or delivered for re-charging, it should be carefully examined for evidence of corrosion, cuts, dents, bulges, condition of threads, valves etc. to ensure suitability for further service. State Codes also provide for examination and testing of cylinders to ensure their continued use.

Never Transfer

Refrigerant cylinders are labelled and identified for a particular refrigerant. Never put a different refrigerant into a cylinder labelled for another refrigerant.

Keep Away from Fire

No part of any cylinder should ever be subjected to direct flame, steam or temperatures exceeding 52°C (125°F). If necessary to warm cylinder to promote more rapid discharge, extreme caution should be taken — an easy and safe way is to place bottom part of cylinder in a container of warm or hot water not over 52°C(125°F).

Behaviour in Presence of Open Flame

All commercially available fluorinated hydrocarbon refrigerants are non-inflammable and non-explosive — an extremely important safety feature.
These refrigerants will decompose, however, if subjected to sufficiently high temperatures. Over 540°C (1000°F) is required for decomposition, and since the average flame temperature is higher, decomposition may occur. It should be noted that only the refrigerant vapour that actually passes through the flame will be affected.
When fluorinated hydrocarbon refrigerants are decomposed by high temperature, they form hydrogen chloride, hydrogen fluoride and small quantities of other gases which may cause ill effects if inhaled in sufficient quantities.
Generally the pungent odour of these products give ample warning of their presence.

Ventilation

Since many materials such as soldering flux, oil, dirt and all refrigerants decompose at the flame temperatures used in soldering, the area in which repair is carried out should be properly ventilated to remove the products of decomposition and combustion of all materials. An adequately ventilated work area is good practice at any time, but especially when an open flame of a leak detector or welding torch is to be used in the presence of "fluorocarbon" refrigerants.

Check Pressure

The pressure within the cylinder must be greater than in the system to cause the refrigerant to flow into the system. Pressure should be checked before charging.
CAUTION : Pressure should **never** exceed 1158 kPa (168PSI) gauge.

FIRST AID TREATMENT

When handled properly the "fluorocarbon" refrigerants are safe, non-poisonous, non-flammable and harmless to materials. However since they are capable of producing extreme "cold", certain precautions should be taken in case of accident. The following procedures should be taken:

Contact With Eyes

If liquified "fluorocarbon" refrigerant comes in contact with the eyes —
Firstly — put drops of sterile mineral oil in the eyes as an irrigant (dilutent/flushing agent).
Secondly — If the irritation continues, wash the eyes with either a weak boric-acid solution or a sterile salt solution, not exceeding 2% sodium chloride (common salt). After first aid treatment attendance at a hospital or to a doctor is recommended. Avoid rubbing or irritating the eye(s) further.

Contact With Skin

Should liquified "fluorocarbon" refrigerant come in contact with the skin, treat the injury the same as though the skin had become frostbitten or frozen. i.e. warm area affected as **rapidly** as possible. Fingers should be immersed in water as hot as the normal hand can bear 43°C (110°F). Many First Aid books still quite wrongly teach that return to warmth must be gradual.

Lack of Oxygen

Oxygen is needed to support life. A person working in a space where the oxygen has been displaced by any gas, including "fluorocarbon" refrigerants, may be overcome if there is not sufficient oxygen present. Should this occur, immediately remove the person to "open air" or a properly ventilated space and apply artificial respiration.

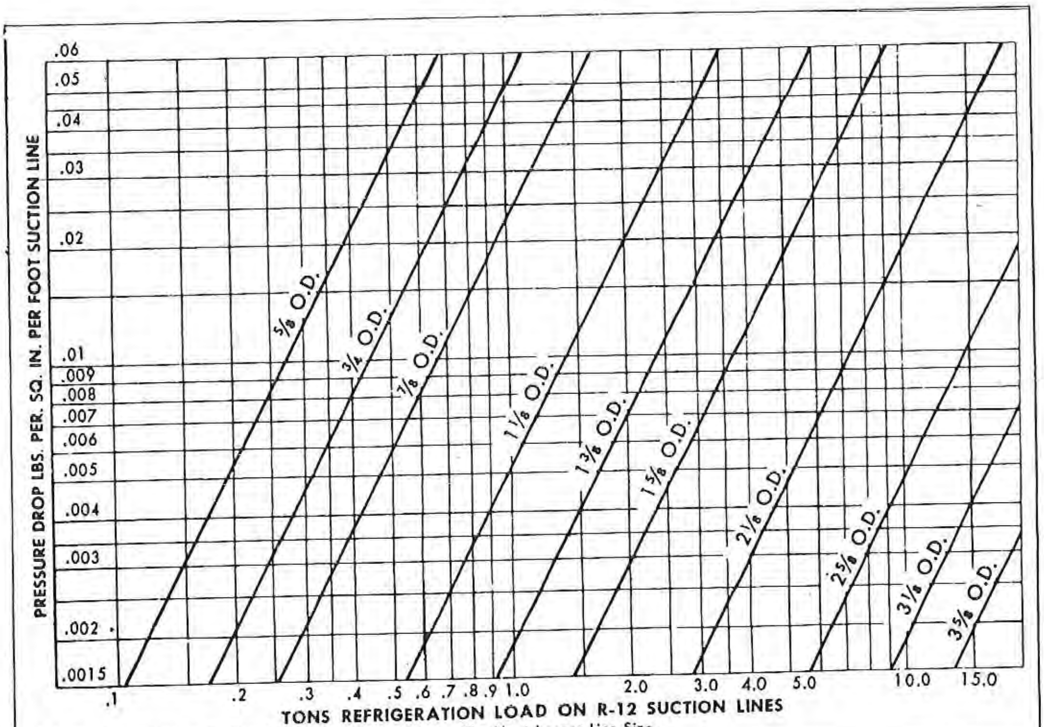
TECH

TECHNICAL DATA

R-12

Pressure Drop in Suction Lines

AT 20° SUCTION TEMPERATURE



Selection Points Falling To The Right Of Each Line Require The Next Larger Line Size.

suction line sizes for R-12

(O.D. IN INCHES)

Net Evaporator Capacity	Suction Temperature 40°				20°				0°				−20°				−40°			
Total Equivalent Length of Suction Line, Feet	25	50	100	150	25	50	100	150	25	50	100	150	25	50	100	150	25	50	100	150
3000	3/8	1/2	1/2	1/2	1/2	1/2	1/2	5/8	5/8	5/8	3/4	3/4	5/8	3/4	7/8	7/8	3/4	7/8	1 1/8	1 1/8
6000	1/2	1/2	5/8	5/8	1/2	5/8	3/4	3/4	3/4	7/8	7/8	1 1/8	7/8	1 1/8	1 1/8	1 1/8	1 1/8	1 1/8	1 3/8	1 3/8
9000	5/8	5/8	3/4	3/4	5/8	3/4	7/8	7/8	7/8	1 1/8	1 1/8	1 1/8	1 1/8	1 1/8	1 3/8	1 3/8	1 1/8	1 3/8	1 3/8	1 5/8
12,000	5/8	3/4	3/4	7/8	3/4	3/4	7/8	1 1/8	7/8	1 1/8	1 1/8	1 3/8	1 1/8	1 1/8	1 3/8	1 3/8	1 3/8	1 3/8	1 5/8	2 1/8
18,000	3/4	3/4	7/8	1 1/8	3/4	7/8	1 1/8	1 1/8	1 1/8	1 1/8	1 3/8	1 3/8	1 1/8	1 3/8	1 5/8	1 5/8	1 3/8	1 5/8	2 1/8	2 1/8
24,000	3/4	7/8	1 1/8	1 1/8	7/8	1 1/8	1 1/8	1 3/8	1 1/8	1 3/8	1 5/8	1 5/8	1 3/8	1 5/8	1 5/8	2 1/8	1 5/8	2 1/8	2 1/8	2 5/8
30,000	7/8	1 1/8	1 1/8	1 1/8	1 1/8	1 1/8	1 1/8	1 3/8	1 3/8	1 3/8	1 5/8	2 1/8	1 3/8	1 5/8	2 1/8	2 1/8	2 1/8	2 1/8	2 5/8	2 5/8
36,000	7/8	1 1/8	1 1/8	1 3/8	1 1/8	1 1/8	1 3/8	1 3/8	1 3/8	1 5/8	2 1/8	2 1/8	1 5/8	2 1/8	2 1/8	2 1/8	2 1/8	2 1/8	2 5/8	2 5/8
42,000	1 1/8	1 1/8	1 3/8	1 3/8	1 1/8	1 3/8	1 3/8	1 5/8	1 3/8	1 5/8	2 1/8	2 1/8	1 5/8	2 1/8	2 1/8	2 5/8	2 1/8	2 5/8	2 5/8	2 5/8
48,000	1 1/8	1 1/8	1 3/8	1 3/8	1 1/8	1 3/8	1 5/8	1 5/8	1 5/8	1 5/8	2 1/8	2 1/8	1 5/8	2 1/8	2 5/8	2 5/8	2 1/8	2 5/8	2 5/8	3 1/8
54,000	1 1/8	1 1/8	1 3/8	1 3/8	1 1/8	1 3/8	1 5/8	1 5/8	1 5/8	2 1/8	2 1/8	2 1/8	2 1/8	2 1/8	2 5/8	2 5/8	2 1/8	2 5/8	2 5/8	3 1/8
60,000	1 1/8	1 3/8	1 3/8	1 5/8	1 3/8	1 3/8	1 5/8	1 5/8	1 5/8	2 1/8	2 1/8	2 5/8	2 1/8	2 1/8	2 5/8	2 5/8	2 5/8	2 5/8	3 1/8	3 1/8
72,000	1 1/8	1 3/8	1 5/8	1 5/8	1 3/8	1 5/8	1 5/8	2 1/8	1 5/8	2 1/8	2 5/8	2 5/8	2 1/8	2 5/8	2 5/8	2 5/8	2 5/8	2 5/8	3 1/8	3 1/8
90,000	1 3/8	1 3/8	1 5/8	2 1/8	1 3/8	1 5/8	2 1/8	2 1/8	2 1/8	2 1/8	2 5/8	2 5/8	2 1/8	2 5/8	2 5/8	3 1/8	2 5/8	3 1/8	3 1/8	3 5/8
120,000	1 3/8	1 5/8	2 1/8	2 1/8	1 5/8	2 1/8	2 1/8	2 1/8	2 1/8	2 5/8	2 5/8	3 1/8	2 5/8	2 5/8	3 1/8	3 1/8	3 1/8	3 1/8	3 5/8	4 1/8
150,000	1 5/8	1 5/8	2 1/8	2 1/8	1 5/8	2 1/8	2 1/8	2 5/8	2 5/8	2 5/8	3 1/8	3 1/8	2 5/8	3 1/8	3 1/8	3 5/8	3 1/8	3 5/8	4 1/8	5 1/8
180,000	1 5/8	2 1/8	2 1/8	2 5/8	2 1/8	2 1/8	2 5/8	2 5/8	2 5/8	2 5/8	3 1/8	3 1/8	2 5/8	3 1/8	3 5/8	3 5/8	3 1/8	3 5/8	4 1/8	5 1/8
210,000	1 5/8	2 1/8	2 1/8	2 5/8	2 1/8	2 1/8	2 5/8	2 5/8	2 5/8	3 1/8	3 1/8	3 5/8	3 1/8	3 1/8	3 5/8	4 1/8	3 5/8	4 1/8	5 1/8	5 1/8
240,000	2 1/8	2 1/8	2 5/8	2 5/8	2 1/8	2 5/8	2 5/8	3 1/8	2 5/8	3 1/8	3 5/8	3 5/8	3 1/8	3 5/8	4 1/8	4 1/8	3 5/8	4 1/8	5 1/8	5 1/8
300,000	2 1/8	2 1/8	2 5/8	2 5/8	2 1/8	2 5/8	3 1/8	3 1/8	3 1/8	3 1/8	3 5/8	4 1/8	3 1/8	3 5/8	4 1/8	5 1/8	4 1/8	5 1/8	5 1/8	6 1/8

CONVERSION FORMULAE FOR ABOVE CHART AND TABLE

LBS/SQ.IN X 6.895 = kilopascals (kPa)
TONS REFRIG. LOAD X 3.517 = kilowatts (kW)
TONS REFRIG. LOAD X 12000 = BTU's
BTU X .0000833 = TONS REFRIG.
BTU X .0002931 = kW
FEET X .3048 = metres (m)

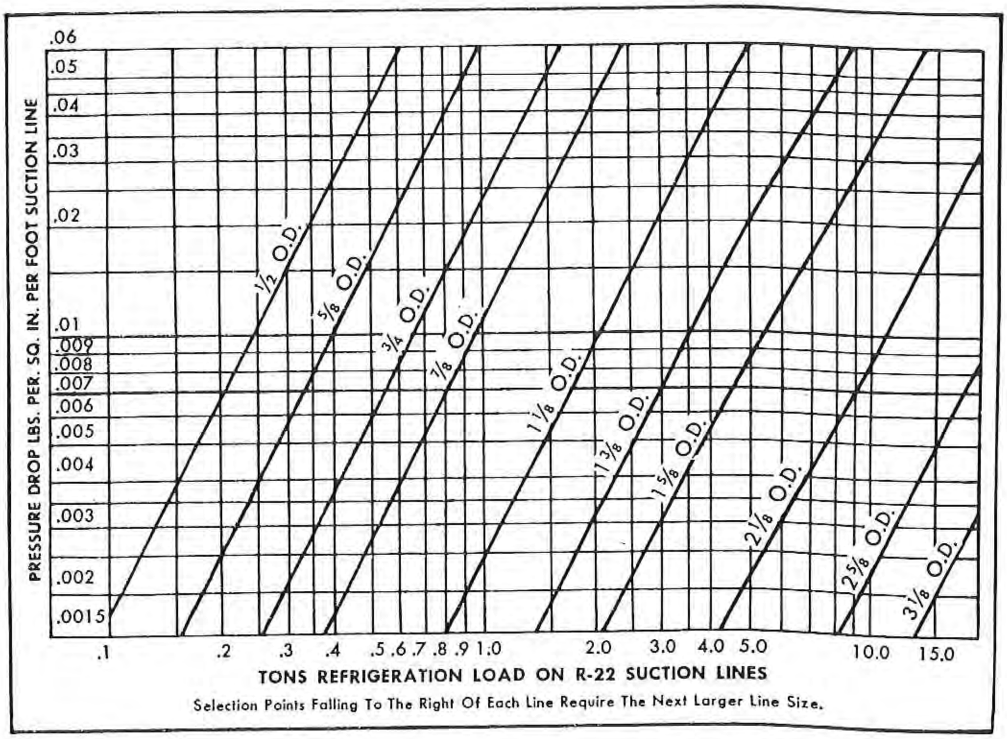
Suction Temperatures	
°F	°C
40	+ 4.4
20	− 6.7
0	−17.8
−20	−28.9
−40	−40.0

TECHNICAL DATA

R-22

Pressure Drop in Suction Lines

AT 20° SUCTION TEMPERATURE



suction line sizes for R-22

(O.D. IN INCHES)

Net Evaporator Capacity	Suction Temperature																			
	40°				20°				0°				−20°				−40°			
	Total Equivalent Length of Suction Line, Feet																			
	25	50	100	150	25	50	100	150	25	50	100	150	25	50	100	150	25	50	100	150
3,000	3/8	3/8	3/8	1/2	3/8	3/8	1/2	1/2	1/2	1/2	5/8	5/8	1/2	5/8	5/8	3/4	5/8	3/4	7/8	7/8
6,000	3/8	1/2	1/2	5/8	1/2	1/2	5/8	5/8	5/8	5/8	3/4	7/8	5/8	3/4	7/8	7/8	3/4	7/8	1 1/8	1 1/8
9,000	1/2	1/2	5/8	5/8	1/2	5/8	5/8	3/4	3/4	3/4	7/8	7/8	3/4	7/8	1 1/8	1 1/8	7/8	1 1/8	1 1/8	1 3/8
12,000	1/2	5/8	5/8	3/4	5/8	5/8	3/4	3/4	3/4	7/8	7/8	1 1/8	7/8	7/8	1 1/8	1 1/8	1 1/8	1 1/8	1 3/8	1 3/8
18,000	5/8	3/4	3/4	7/8	3/4	3/4	7/8	7/8	7/8	7/8	1 1/8	1 1/8	7/8	1 1/8	1 1/8	1 3/8	1 1/8	1 3/8	1 5/8	1 5/8
24,000	5/8	3/4	7/8	7/8	3/4	7/8	1 1/8	1 1/8	7/8	1 1/8	1 1/8	1 3/8	1 1/8	1 1/8	1 3/8	1 3/8	1 3/8	1 3/8	1 5/8	1 5/8
30,000	3/4	7/8	7/8	1 1/8	7/8	7/8	1 1/8	1 1/8	1 1/8	1 1/8	1 3/8	1 3/8	1 1/8	1 1/8	1 3/8	1 5/8	1 3/8	1 5/8	1 5/8	2 1/8
36,000	3/4	7/8	1 1/8	1 1/8	7/8	1 1/8	1 1/8	1 1/8	1 1/8	1 1/8	1 3/8	1 5/8	1 1/8	1 3/8	1 5/8	1 5/8	1 5/8	1 5/8	2 1/8	2 1/8
42,000	7/8	7/8	1 1/8	1 1/8	7/8	1 1/8	1 1/8	1 3/8	1 1/8	1 3/8	1 3/8	1 5/8	1 3/8	1 3/8	1 5/8	2 1/8	1 5/8	1 5/8	2 1/8	2 1/8
48,000	7/8	1 1/8	1 1/8	1 1/8	1 1/8	1 1/8	1 3/8	1 3/8	1 3/8	1 3/8	1 5/8	1 5/8	1 3/8	1 5/8	1 5/8	2 1/8	1 5/8	2 1/8	2 1/8	2 1/8
54,000	7/8	1 1/8	1 1/8	1 3/8	1 1/8	1 1/8	1 3/8	1 3/8	1 3/8	1 3/8	1 5/8	1 5/8	1 5/8	1 5/8	2 1/8	2 1/8	1 5/8	2 1/8	2 1/8	2 5/8
60,000	7/8	1 1/8	1 1/8	1 3/8	1 1/8	1 1/8	1 3/8	1 3/8	1 3/8	1 3/8	1 5/8	1 5/8	1 5/8	1 5/8	2 1/8	2 1/8	1 5/8	2 1/8	2 1/8	2 5/8
72,000	1 1/8	1 1/8	1 3/8	1 3/8	1 1/8	1 3/8	1 3/8	1 5/8	1 3/8	1 5/8	1 5/8	2 1/8	1 5/8	1 5/8	2 1/8	2 1/8	2 1/8	2 1/8	2 5/8	2 5/8
90,000	1 1/8	1 1/8	1 3/8	1 5/8	1 1/8	1 3/8	1 5/8	1 5/8	1 5/8	1 5/8	2 1/8	2 1/8	1 5/8	2 1/8	2 1/8	2 5/8	2 1/8	2 1/8	2 5/8	3 1/8
120,000	1 1/8	1 3/8	1 5/8	1 5/8	1 3/8	1 5/8	1 5/8	2 1/8	1 5/8	2 1/8	2 1/8	2 5/8	2 1/8	2 1/8	2 5/8	2 5/8	2 1/8	2 5/8	3 1/8	3 1/8
150,000	1 3/8	1 3/8	1 5/8	2 1/8	1 3/8	1 5/8	2 1/8	2 1/8	1 5/8	2 1/8	2 1/8	2 5/8	2 1/8	2 1/8	2 5/8	2 5/8	2 5/8	2 5/8	3 1/8	3 1/8
180,000	1 3/8	1 5/8	2 1/8	2 1/8	1 5/8	2 1/8	2 1/8	2 1/8	2 1/8	2 1/8	2 5/8	2 5/8	2 1/8	2 5/8	2 5/8	3 1/8	2 5/8	3 1/8	3 5/8	3 5/8
210,000	1 3/8	1 5/8	2 1/8	2 1/8	1 5/8	2 1/8	2 1/8	2 5/8	2 1/8	2 1/8	2 5/8	2 5/8	2 5/8	2 5/8	3 1/8	3 1/8	2 5/8	3 1/8	3 5/8	3 5/8
240,000	1 5/8	1 5/8	2 1/8	2 1/8	1 5/8	2 1/8	2 1/8	2 5/8	2 1/8	2 5/8	2 5/8	3 1/8	2 5/8	2 5/8	3 1/8	3 1/8	3 1/8	3 1/8	3 5/8	4 1/8
300,000	1 5/8	2 1/8	2 1/8	2 5/8	2 1/8	2 1/8	2 5/8	2 5/8	2 1/8	2 5/8	3 1/8	3 1/8	2 5/8	3 1/8	3 1/8	3 5/8	3 1/8	3 5/8	4 1/8	5 1/8

TECH

CONVERSION FORMULAE FOR ABOVE CHART AND TABLE

LBS/SQ.IN X 6.895 = kilopascals (kPa)
TONS REFRIG. LOAD X 3.517 = kilowatts (kW)
TONS REFRIG. LOAD X 12000 = BTU's
BTU X .0000833 = TONS REFRIG.
BTU X .0002931 = kW
FEET X .3048 = metres (m)

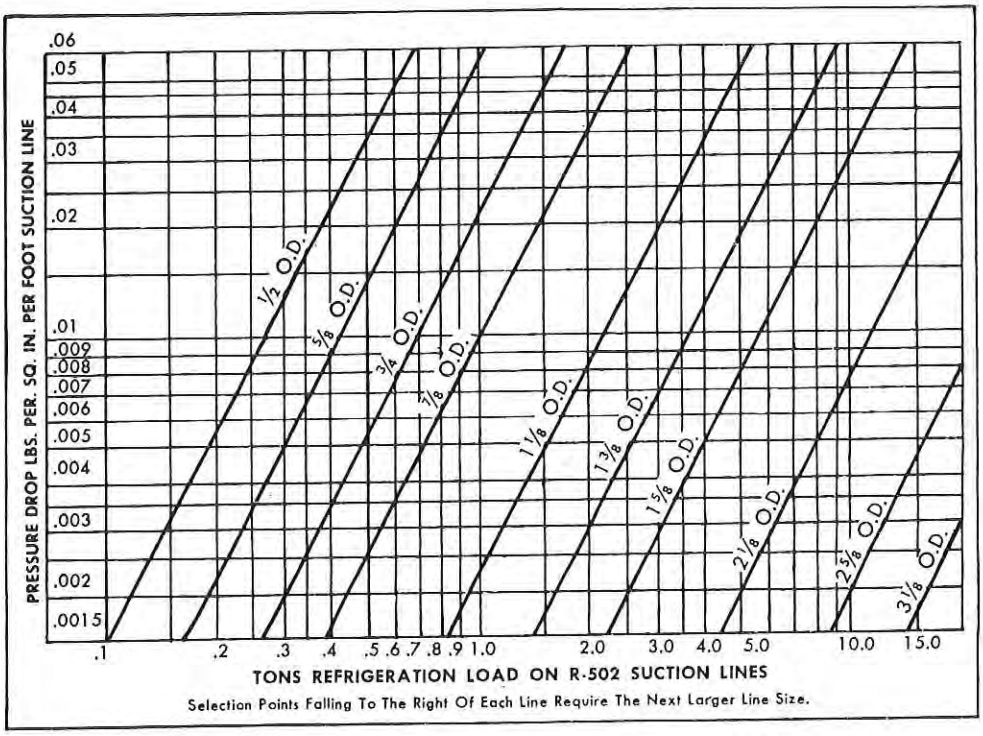
Suction Temperatures	
°F	°C
40	+ 4.4
20	− 6.7
0	−17.8
−20	−28.9
−40	−40.0

TECHNICAL DATA

R-502

Pressure Drop in Suction Lines

AT 20° SUCTION TEMPERATURE



suction line sizes for R-502

(O.D. IN INCHES)

Net Evaporator Capacity	Suction Temperature																			
	40°				20°				0°				−20°				−40°			
	Total Equivalent Length of Suction Line, Feet																			
	25	50	100	150	25	50	100	150	25	50	100	150	25	50	100	150	25	50	100	150
3,000	3/8	3/8	3/8	1/2	3/8	3/8	1/2	1/2	1/2	1/2	5/8	5/8	1/2	5/8	5/8	3/4	5/8	3/4	7/8	7/8
6,000	3/8	1/2	1/2	5/8	1/2	1/2	5/8	5/8	5/8	5/8	3/4	7/8	5/8	3/4	7/8	7/8	3/4	7/8	1 1/8	1 1/8
9,000	1/2	1/2	5/8	5/8	1/2	5/8	5/8	3/4	3/4	3/4	7/8	7/8	3/4	7/8	1 1/8	1 1/8	7/8	1 1/8	1 1/8	1 3/8
12,000	1/2	5/8	3/4	3/4	5/8	5/8	3/4	3/4	3/4	7/8	7/8	1 1/8	7/8	7/8	1 1/8	1 1/8	1 1/8	1 1/8	1 3/8	1 3/8
18,000	5/8	3/4	3/4	7/8	3/4	3/4	7/8	7/8	7/8	7/8	1 1/8	1 1/8	7/8	1 1/8	1 1/8	1 3/8	1 1/8	1 3/8	1 5/8	1 5/8
24,000	3/4	3/4	7/8	7/8	3/4	7/8	1 1/8	1 1/8	7/8	1 1/8	1 1/8	1 3/8	1 1/8	1 1/8	1 3/8	1 3/8	1 3/8	1 3/8	1 5/8	1 5/8
30,000	3/4	7/8	7/8	1 1/8	7/8	7/8	1 1/8	1 1/8	1 1/8	1 1/8	1 3/8	1 3/8	1 1/8	1 1/8	1 3/8	1 5/8	1 3/8	1 5/8	1 5/8	2 1/8
36,000	3/4	7/8	1 1/8	1 1/8	7/8	1 1/8	1 1/8	1 1/8	1 1/8	1 1/8	1 3/8	1 5/8	1 1/8	1 3/8	1 5/8	1 5/8	1 3/8	1 5/8	2 1/8	2 1/8
42,000	7/8	7/8	1 1/8	1 1/8	7/8	1 1/8	1 1/8	1 3/8	1 1/8	1 3/8	1 3/8	1 5/8	1 3/8	1 3/8	1 5/8	2 1/8	1 5/8	1 5/8	2 1/8	2 1/8
48,000	7/8	1 1/8	1 1/8	1 1/8	1 1/8	1 1/8	1 3/8	1 3/8	1 3/8	1 3/8	1 5/8	1 5/8	1 3/8	1 5/8	1 5/8	2 1/8	1 5/8	2 1/8	2 1/8	2 1/8
54,000	7/8	1 1/8	1 1/8	1 3/8	1 1/8	1 1/8	1 3/8	1 3/8	1 3/8	1 3/8	1 5/8	1 5/8	1 5/8	1 5/8	2 1/8	2 1/8	1 5/8	2 1/8	2 1/8	2 5/8
60,000	7/8	1 1/8	1 1/8	1 3/8	1 1/8	1 1/8	1 3/8	1 3/8	1 3/8	1 3/8	1 5/8	2 1/8	1 5/8	1 5/8	2 1/8	2 1/8	1 5/8	2 1/8	2 1/8	2 5/8
72,000	1 1/8	1 1/8	1 3/8	1 3/8	1 1/8	1 3/8	1 3/8	1 5/8	1 3/8	1 5/8	1 5/8	2 1/8	1 5/8	1 5/8	2 1/8	2 1/8	2 1/8	2 1/8	2 5/8	2 5/8
90,000	1 1/8	1 1/8	1 3/8	1 5/8	1 1/8	1 3/8	1 5/8	1 5/8	1 5/8	1 5/8	2 1/8	2 1/8	1 5/8	2 1/8	2 1/8	2 5/8	2 1/8	2 1/8	2 5/8	3 1/8
120,000	1 1/8	1 3/8	1 5/8	1 5/8	1 3/8	1 5/8	1 5/8	2 1/8	1 5/8	2 1/8	2 1/8	2 5/8	2 1/8	2 1/8	2 5/8	2 5/8	2 1/8	2 5/8	3 1/8	3 1/8
150,000	1 3/8	1 3/8	1 5/8	2 1/8	1 3/8	1 5/8	2 1/8	2 1/8	1 5/8	2 1/8	2 1/8	2 5/8	2 1/8	2 1/8	2 5/8	2 5/8	2 5/8	2 5/8	3 1/8	3 1/8
180,000	1 3/8	1 5/8	2 1/8	2 1/8	1 5/8	2 1/8	2 1/8	2 1/8	2 1/8	2 1/8	2 5/8	2 5/8	2 1/8	2 5/8	2 5/8	3 1/8	2 5/8	3 1/8	3 5/8	3 5/8
210,000	1 3/8	1 5/8	2 1/8	2 1/8	1 5/8	2 1/8	2 1/8	2 5/8	2 1/8	2 1/8	2 5/8	2 5/8	2 5/8	2 5/8	3 1/8	3 1/8	2 5/8	3 1/8	3 5/8	3 5/8
240,000	1 5/8	1 5/8	2 1/8	2 1/8	1 5/8	2 1/8	2 1/8	2 5/8	2 1/8	2 5/8	2 5/8	3 1/8	2 5/8	2 5/8	3 1/8	3 1/8	3 1/8	3 1/8	3 5/8	4 1/8
300,000	1 5/8	2 1/8	2 1/8	2 5/8	2 1/8	2 1/8	2 5/8	2 5/8	2 1/8	2 5/8	3 1/8	3 1/8	2 5/8	3 1/8	3 1/8	3 5/8	3 1/8	3 5/8	4 1/8	5 1/8

CONVERSION FORMULAE FOR ABOVE CHART AND TABLE

LBS/SQ.IN X 6.895 = kilopascals (kPa)
TONS REFRIG. LOAD X 3.517 = kilowatts (kW)
TONS REFRIG. LOAD X 12000 = BTU's
BTU X .0000833 = TONS REFRIG.
BTU X .0002931 = kW
FEET X .3048 = metres (m)

Suction Temperatures	
°F	°C
40	+ 4.4
20	− 6.7
0	−17.8
−20	−28.9
−40	−40.0

TECHNICAL DATA

recomended. 2,000 – 3500 fpm.

liquid line sizes

Net Evaporator Capacity	Total Equivalent Length of Liquid Line, Feet							
	REFRIGERANT—12				REFRIGERANT—22			
	25	50	100*	150	25	50	100*	150
3000	¼	¼	¼	⅜	¼	¼	¼	¼
4500	¼	¼	⅜	⅜	¼	¼	⅜	⅜
6500	¼	⅜	⅜	⅜	¼	¼	⅜	⅜
8500	⅜	⅜	⅜	½	¼	⅜	⅜	⅜
12,000	⅜	⅜	½	½	⅜	⅜	⅜	½
18,000	⅜	½	½	½	⅜	⅜	½	½
24,000	½	½	½	⅝	⅜	½	½	½
30,000	½	½	⅝	⅝	⅜	½	½	⅝
36,000	½	⅝	⅝	⅝	½	½	⅝	⅝
42,000	½	⅝	⅝	¾	½	½	⅝	⅝
48,000	½	⅝	¾	¾	½	⅝	⅝	¾
54,000	⅝	⅝	¾	¾	½	⅝	⅝	¾
60,000	⅝	⅝	¾	¾	½	⅝	¾	¾
72,000	⅝	¾	⅞	⅞	⅝	⅝	¾	¾
90,000	¾	¾	⅞	⅞	⅝	¾	⅞	⅞
120,000	¾	⅞	1⅛	1⅛	¾	¾	⅞	1⅛
150,000	⅞	⅞	1⅛	1⅛	¾	⅞	1⅛	1⅛
180,000	⅞	⅞	1⅛	1⅛	⅞	⅞	1⅛	1⅛
210,000	1⅛	1⅛	1⅜	1⅜	⅞	⅞	1⅛	1⅛
240,000	1⅛	1⅛	1⅜	1⅜	⅞	1⅛	1⅜	1⅜
300,000	1⅛	1⅛	1⅝	1⅝	1⅛	1⅛	1⅜	1⅜

*Line Sizes Indicated Are Suitable For Condenser to Receiver Applications

discharge line sizes

Net Evaporator Capacity	Total Equivalent Length of Hot Gas Line, Feet							
	R12				R22 & R502			
	25	50	100	150	25	50	100	150
3000	⅜	⅜	½	½	⅜	⅜	⅜	⅜
4500	⅜	½	½	½	⅜	⅜	½	½
6500	½	½	⅝	⅝	⅜	½	½	½
8500	½	½	⅝	⅝	⅜	½	½	⅝
12,000	½	⅝	¾	¾	½	½	⅝	⅝
18,000	⅝	¾	¾	⅞	½	⅝	¾	¾
24,000	⅝	¾	⅞	1⅛	⅝	⅝	¾	⅞
30,000	¾	⅞	1⅛	1⅛	⅝	¾	⅞	⅞
36,000	¾	⅞	1⅛	1⅛	⅝	¾	⅞	⅞
42,000	⅞	⅞	1⅛	1⅛	¾	¾	⅞	1⅛
48,000	⅞	1⅛	1⅛	1⅜	¾	⅞	1⅛	1⅛
54,000	⅞	1⅛	1⅛	1⅜	¾	⅞	1⅛	1⅛
60,000	⅞	1⅛	1⅜	1⅜	¾	⅞	1⅛	1⅛
72,000	1⅛	1⅛	1⅜	1⅜	⅞	1⅛	1⅛	1⅛
90,000	1⅛	1⅜	1⅜	1⅝	⅞	1⅛	1⅛	1⅜
120,000	1⅛	1⅜	1⅝	1⅝	1⅛	1⅛	1⅜	1⅜
150,000	1⅜	1⅜	1⅝	2⅛	1⅛	1⅜	1⅜	1⅝
180,000	1⅜	1⅝	2⅛	2⅛	1⅛	1⅜	1⅝	1⅝
210,000	1⅜	1⅝	2⅛	2⅛	1⅜	1⅜	1⅝	1⅝
240,000	1⅝	1⅝	2⅛	2⅛	1⅜	1⅝	1⅝	2⅛
300,000	1⅝	2⅛	2⅛	2⅝	1⅜	1⅝	2⅛	2⅛

960,000?

hot gas line sizes

Net Evaporator Capacity	Total Equivalent Length of Hot Gas Line, Feet							
	R12				R22 & R502			
	25	50	100	150	25	50	100	150
3000	½	½	⅝	⅝	⅜	⅜	½	½
4500	½	⅝	⅝	¾	½	½	½	⅝
6500	⅝	⅝	¾	¾	½	½	⅝	⅝
8500	⅝	¾	⅞	⅞	½	⅝	¾	¾
12,000	¾	¾	⅞	1⅛	⅝	⅝	¾	⅞
18,000	¾	⅞	1⅛	1⅛	⅝	¾	⅞	1⅛
24,000	⅞	1⅛	1⅛	1⅜	¾	⅞	1⅛	1⅛
30,000	1⅛	1⅛	1⅜	1⅜	¾	⅞	1⅛	1⅛
36,000	1⅛	1⅛	1⅜	1⅜	⅞	1⅛	1⅛	1⅛
42,000	1⅛	1⅜	1⅜	1⅝	⅞	1⅛	1⅛	1⅜
48,000	1⅛	1⅜	1⅜	1⅝	1⅛	1⅛	1⅜	1⅜
54,000	1⅛	1⅜	1⅝	1⅝	1⅛	1⅛	1⅜	1⅜
60,000	1⅛	1⅜	1⅝	1⅝	1⅛	1⅛	1⅜	1⅜
72,000	1⅜	1⅝	1⅝	2⅛	1⅛	1⅜	1⅜	1⅝
90,000	1⅜	1⅝	2⅛	2⅛	1⅛	1⅜	1⅝	1⅝
120,000	1⅝	2⅛	2⅛	2⅛	1⅜	1⅝	1⅝	2⅛
150,000	1⅝	2⅛	2⅛	2⅝	1⅜	1⅝	2⅛	2⅛
180,000	2⅛	2⅛	2⅝	2⅝	1⅝	1⅝	2⅛	2⅛

For Suction Temperatures Less Than —20°F, The Next Larger Line Size Must Be Used.

weight of R-12 in copper lines in operation

(POUNDS PER 100 LINEAR FEET)

Line Size OD Inches	Liquid Line	Hot Gas Line	Suction Line at Evaporator Temperatures				
			40	20	0	20	40
½	8.1	0.34	.02	.04	.06	.09	.13
⅝	12.9	0.54	.04	.06	.10	.14	.20
¾	19.4	0.81	.06	.10	.15	.22	.31
⅞	26.9	1.13	.08	.14	.21	.30	.42
1⅛	45.9	1.93	.15	.23	.33	.51	.72
1⅜	69.9	2.93	.21	.35	.53	.78	1.10
1⅝	99.0	4.15	.30	:50	.75	1.10	1.56
2⅛	172	72.2	.55	.87	1.31	1.92	2.71
2⅝	266	11.14	.82	1.34	2.02	2.95	4.18
3⅛	379	15.90	1.20	1.91	2.89	4.22	5.97
3⅝	513	21.52	1.61	2.59	3.91	5.71	8.08
4⅛	666	27.96	2.09	3.36	5.08	7.42	10.50

NOTE:

Equivalents for R-22 and R-502.

1 Liquid line—Multiply values in table by .91 for R-22, and by .94 for R-502.

2 Hot gas and suction line—Multiply values in table by average values of 1.20 for R-22, and by 1.80 for R-502.

TECH

equivalent feet of pipe

FOR VALVES AND FITTINGS

Line Size, Inches IPS	⅜″	½″	¾″	1″	1¼″	1½″	2″	2½″	3″	3½″	4″	5″	6″	8″	10″	12″
OD	½″	⅝″	⅞″	1⅛″	1⅜″	1⅝″	2⅛″	2⅝″	3⅛″	3⅝″	4⅛″	5⅛″	6⅛″	8⅛″	10½″	12⅛″
Globe Valve (Open)	14	16	22	28	36	42	57	69	83	99	118	138	168	225	280	335
Angle Valve (Open)	7	9	12	15	18	21	28	34	42	49	57	70	83	117	140	165
Standard Elbow —90°	1	2	2	3	4	4	5	7	8	10	12	14	16	20	26	31
Standard Elbow —45°	1	1	1	2	2	2	2	3	4	5	6	7	8	10	13	16
Standard Tee (Thru Side Out.)	3	4	5	6	8	9	12	14	17	20	22	28	34	44	56	65

IPS-iron pipe size. OD-outside diameter of tubing.
Values shown are average values based on standard weight pipe

NOTE: Right angle, forged fittings give a high pressure drop and their use in suction lines should in general be discouraged.

TECHNICAL DATA

CAPILLARY TUBE LENGTH - CONVERSION CHART

"Capillary Tube Length Conversion Chart" is designed to enable users of capillary tubing to use the standard sizes which are readily available through refrigeration wholesalers.

While many original equipment manufacturers and condensing unit manufacturers recommend specific lengths and diameters of capillary tubing for their units, these tube sizes are not always readily available, except on special order.

This conversion chart enables the user to translate the recommended length into that of a tube diameter that can be quickly obtained. In using the chart, it is recommended that conversions be made using factors falling between the heavy black lines. In addition, it is highly recommended that the minimum length of capillary used be 3 feet.

To use Chart :

1. Locate "recommended capillary tube I.D." in left-hand column.
2. Read across and find conversion factor under "available capillary tube" size.
3. Multiply the given length of the recommended tube by the conversion factor of the available tube.
4. The resultant length of tube will give the same flow characteristics as the original recommended tube.

For Example: Recommended capillary tube 6 Ft. of .040"I.D.
Locate .040 in left-hand column and reading across gives the following conversion factors:—
For .036 I.D. tubing – factor 0.62 For .044 I.D. tubing – factor 1.55

Multiply the recommended cap. tube length of 6 Ft. by the conversion factors, which gives the following results:— 3'9" of .036" I.D. and 9'4" of .044 I.D. Either of these two cap. tubes will give the same results as the original cap. tubes will give the same results as the original cap. tube of 6 Ft. of .040 I.D.

Recommended TUBE I.D.	AVAILABLE TUBE I.D.													
	.026	.031	.036	.042	.044	.050	.055	.059	.064	.070	.075	.080	.085	.090
.024	1.44													
.025	1.20													
.026	1.00	2.24												
.028	.72	1.59												
.030	.52	1.16												
.031	.45	1.00	2.00											
.032		.86	1.75											
.033		.75	1.54											
.034		.65	1.35											
.035		.58	1.16	2.31										
.036		.50	1.00	2.10										
.037		.45	.90	1.79	2.22									
.038		.39	.80	1.59	1.92									
.039		.35	.71	1.41	1.75									
.040		.31	.62	1.25	1.55									
.041		.28	.56	1.12	1.38	2.50								
.042		.25	.50	1.00	1.24	2.23								
.043		.23	.45	.87	1.11	1.98								
.044		.20	.39	.81	1.00	1.79								
.045			.35	.73	.90	1.60								
.046			.32	.67	.82	1.47	2.27							
.047				.59	.74	1.31	2.06							
.048				.54	.67	1.20	1.87							
.049				.49	.61	1.09	1.69							
.050				.45	.56	1.00	1.56	2.14						
.051				.41	.51	.93	1.44	1.96						
.052					.47	.85	1.32	1.78						
.053					.43	.78	1.20	1.64						
.054					.39	.70	1.09	1.52	2.18					
.055					.36	.64	1.00	1.38	2.00					
.056						.60	.94	1.27	1.85					
.057						.55	.87	1.17	1.72					
.058						.51	.80	1.07	1.56					
.059						.47	.73	1.00	1.44	2.18				
.060						.43	.67	.93	1.33	2.04				
.064						.32	.50	.69	1.00	1.50	2.07			
.070							.33	.46	.67	1.00	1.37	1.84		
.075									.48	.73	1.00	1.37	1.75	
.080										.54	.74	1.00	1.32	1.71
.085											.57	.76	1.00	1.29
.090											.43	.62	.76	1.00
.095												.46	.60	.79
.100													.48	.62
.105														.49

AIR SUPPLY 100 PSIG – FLOW CUBIC FT. PER MIN.

Capillary Tube I.D.	CAPILLARY TUBE LENGTH				
	8 ft.	10 ft.	12 ft.	14 ft.	16 ft.
.026	.140	.125	.110	.100	.090
.031	.230	.205	.182	.170	.157
.036	.350	.310	.280	.257	.240

AIR SUPPLY 50 PSIG – FLOW CUBIC FT. PER MIN.

Capillary Tube I.D.	CAPILLARY TUBE LENGTH				
	8 ft.	10 ft.	12 ft.	14 ft.	16 ft.
.042	.260	.230	.210	.190	.177
.049	.370	.350	.315	.290	.270
.054	–	–	.412	.380	.355

APPROXIMATE PRESSURE CONTROL SETTINGS FOR VARIOUS TYPES OF APPLICATIONS WHEN USING SO_2, METHYL CHLORIDE, OR R12 REFRIGERANTS

TYPE OF EQUIPMENT	SO_2				METHYL CHLORIDE				R12			
	CUT-IN		CUT-OUT		CUT-IN		CUT-OUT		CUT-IN		CUT-OUT	
	PSI	kPa	"Hg/PSI	kPa	PSI	kPa	PSI	kPa	PSI	kPa	PSI	kPa
Ice Cream Cabinet	0	0	14"	−47	11	76	½	3.5	16½	114	4½	31
Ice Cream and Combination Cabinet (Thermo-Syphon Type)	1	7	14"	−47	11½	76	½	3.5	17½	121	4½	31
Domestic or Household Cabinet with flooded Evaporator	5	35	8"	−27	18	124	3½	24	25	172	9	62
Commercial Food Storage Cabinet with flooded Evaporator of Ice Making Type	5	35	10"	−34	18	124	2½	17	25	172	8	55
Ditto with Cross Fin Evaporator (Non-Ice Making Type)	10	69	8"	−27	24	165	3½	24	32	221	9	62
Bottle Cabinet (Beer) with Cross Fin Evaporator	12	83	6"	−20	28	193	6	41	37	255	12	83
Butcher's Cold Room with Cross Fin Evaporator	10	69	8"	−27	24	165	3½	124	32	221	9	62
Butcher's Cold Room with forced Draught Cooler	10	69	2"	− 7	24	165	8	55	32	221	14	97
Multiple Installations in Flats. (Evaporators flooded Ice Making Type)	4	28	10"	−34	17	117	2½	17	29	200	8	55
Beer Coolers (Beer Coils Submerged in Sweet Water bath with flooded or Dry Evaporators)	15	103	5	−35	32	221	18	124	41	283	25	172
Milk Cooler (Brine Tank in cold room, with circulating system and Aerator flooded or dry system Evaporators)	8	55	0	0	22	152	11	76	30	207	17	117
Instantaneous Beer Cooler	22	152	12	83	42	290	28	193	52	359	37	255

It should be clearly noted that the above approximate settings are for installations which are correctly balanced, i.e. where evaporator coil and condensing unit both have capacity equalling but not exceeding total load, and where balanced conditions do not exist some alteration in pressure control settings may be necessary.

For instance if evaporator does not have capacity equal to load, pressure control settings may have to be lowered. If condensing unit capacity is less than cabinet load, setting may have to be raised.

In the case of multiple installations of cabinets held at different temperatures, and temperature of one cabinet maintained by means of a suction line pressure reducing valve, pressure control maintaining temperature of lowest cabinet and controlling operation of unit may have to be widened to prevent short cycling.

An example would be a multiple installation of an Ice Cream cabinet and Food Storage cabinet; the Food Storage cabinet refrigerated with an ice making coil : For such an installation pressure control setting on an SO_2 machine would probably be about 2 to 3 psi (14 to 21 kPa) Cut-in and 14" vac. (−47kPa) Cut-out.

TECH

APPROXIMATE PRESSURE CONTROL SETTINGS – U.S.A. Data

Vacuum — *Italic Figures* Gage Pressure—Light Figures

APPLICATION	REFRIGERANT					
	12		22		717	
	Out	In	Out	In	Out	In
Ice Cube Maker—Dry Type Coil	4	17	16	37	—	—
Sweet Water Bath—Soda Fountain	21	29	43	56	33	45
Beer, Water, Milk Cooler, Wet Type	19	29	40	56	—	—
Ice Cream Trucks, Hardening Rooms	2	15	13	34	5	24
Eutectic Plates, Ice Cream Truck	1	4	11	16	4	8
Walk In, Defrost Cycle	14	34	32	64	23	55
Reach In, Defrost Cycle	19	36	40	68	30	57
Vegetable Display, Defrost Cycle	13	35	30	66	—	—
Vegetable Display Case—Open Type	16	42	35	77	—	—

Vacuum — *Italic Figures* Gage Pressure—Light Figures

APPLICATION	REFRIGERANT					
	12		22		717	
	Out	In	Out	In	Out	In
Beverage Cooler, Blower Dry Type	15	34	34	64	24	55
Retail Florist—Blower Coil	28	42	55	77	44	67
Meat Display Case, Defrost Cycle	17	35	37	66	—	—
Meat Display Case—Open Type—Time Clock	11	27	27	53	—	—
Dairy Case—Open Type	10	35	26	66	—	—
Frozen Food—Open Type	7	5	4	17	—	—
Frozen Food—Open Type—Thermostat	2°F.	10°F.	—	—	—	—
Frozen Food—Closed Type	1	8	11	22	—	—

COOLROOM DESIGN DATA

BALANCING THE SYSTEM

The application of air cooling lowsides in refrigeration work is basically an air conditioning problem. It so happens that the refrigeration industry has certain standards which make the adaptation fairly easy, as compared to the adaptation of a coil to air conditioning work.

In the proper application of a coil, it is most important to make sure that there is a balance between the condensing unit and the lowside. The temperature difference between the air to be passed over the coil and the refrigerant temperature in the coil is the point which determines the conditions which will be maintained in a given cooler.

For the general purpose refrigerator, involving meats, vegetables and dairy products, it is common procedure to balance the lowside to the condensing unit at a 15°F (8.3°C) temperature difference; that is, they are balanced to maintain a temperature difference between the refrigerant in the coil and the air temperature of 15°F (8.3°C). It has been learned by experience that, if this is done, one may expect to maintain in a cooler 80%—85% relative humidity, which is a good range.

A coil which is selected for a wide temperature difference will therefore maintain a lower relative humidity in service, whereas one which is selected for too close a temperature difference will produce relative humidities which are higher than required for practical operation and surface sliming may result on stored meat products during winter periods when loads are reduced. It has been determined over years of practice that coils should be selected to balance between 12° and 15°F (6.7° and 8.3°C) temperature difference for general purpose refrigerated storage coolers.

On straight vegetable coolers where higher humidities are desired, the coil should be selected to balance the compressor at a 10°F (5.6°C) temperature difference, as such will produce an average relative humidity of 90% within the refrigerated space. The same recommendation applies to florists' display boxes, and in both cases, the maintenance of a high relative humidity in long term storage is beneficial whereas some exception with reference to meat products is noted above.

On low temperature units, if one stops to consider that the amount of dehumidification is in proportion to the temperature difference, it is obvious that the closer the temperature difference, the less frost accumulation. We strongly recommend that coils for low temperature work be selected to balance the condensing unit at a 10°F (5.6°C) temperature difference or less.

PROPER SIZING OF EXPANSION VALVES

The selection and installation of thermal expansion valves is of utmost importance for best coil performance. Valve capacity must be at least equal to the coil load rating and never more than twice that value. Any valve which is substantially oversized will tend to be erratic in operation and this will penalize both coil performance and rated capacity output. Liquid line strainers should always be installed ahead of all thermal expansion valves.

Thermal valves are normally rated with R-12 refrigerant at 40°F (4.4°C) evaporator temperature, 10°F (5.6°C) superheat, and 60psi (414kPa) differential (pressure at valve inlet minus pressure at valve outlet). For capacities at other differentials, or when used with other refrigerants such as R-22 and R-502, the valve manufacturer's ratings must be consulted and closely followed in reference to Capacity Correction Factors.

Although it is frequently assumed that when thermal expansion valves are used in low temperature applications, some increased capacity results due to a higher pressure differential, this is not always true because of variations in valve design. It is always advisable under wide range conditions to secure the valve manufacturer's recommendations.

As a further precautionary note, the power element charges of all thermal expansion valves must be properly selected for operating temperature ranges and the type of refrigerant used in the system.

Thermo valves should be located as close as possible to evaporator inlet and bulbs attached or inserted at a point where refrigerant will not trap in the suction line. Keep bulbs away from tees in common suction lines so that one valve will not affect any other valve.

Externally equalized valves should be used on all multi-circuited evaporators. In general internally equalized valves are applied with single circuited coils except when excessive pressure drops are encountered.

PRODUCT LOAD

Products placed in a refrigerated room at a temperature higher than the storage temperature will lose heat until it reaches the storage temperature. The product load will be affected by one or more of the following factors: (1) Specific Heat (2) Latent Heat of Fusion and (3) Heat of Respiration.

specific heat is the amount of heat removal required to lower 1lb. of product 1°F. It has two values, one above freezing, the other below freezing due to the change in state which occurs. The specific heat of various products are given on next page.

latent heat of fusion is the amount of heat removal required to freeze 1 lb. of product. It should be noted that the latent heat has a definite relationship to the water content of a product. Most food products have a freezing temperature in the range of 26°F (—3.3°C) to 31°F.(—.6°C). If the exact freezing temperature is unknown, it may be assumed to be 28°F.(—2.2°C). Freezing temperatures and latent heats of fusion for various products are given on next page.

heat of respiration is the amount of heat given off by products such as fresh fruits and vegetables during storage. Since the products are alive, they continually undergo a change in which energy is released in the form of heat. The amount of heat liberated varies with the type and temperature of the product. Heat or respiration rates for various products are given on next page.

Miscellaneous All electrical energy dissipated by lights, motors, heaters, and etc., located in the refrigerated area must be included in the heat load. Each watt is equal to 3.42 BTU per hr. An item oftentime overlooked is the fan motor on a unit cooler. Heat equivalents of electric motors vary as to size of motor.

COOLROOM DESIGN DATA

Product Storage Data

Product	Quick Freeze Temp.	Storage Temp. Long	Storage Temp. Short	Humidity % R.H.	Specific Heat Above Freezing	Specific Heat Below Freezing	Latent Heat	Freezing Point	Respiration BTU/lb. Per Day
Apples	—15	30-32	38-42	85-88	0.86	0.45	121	28.4	0.72
Asparagus	—30	32	40	85-90	0.94	0.48	134.0	29.8	5.75
Bacon, Fresh		0-5	36-40	80	0.50	0.30	29	25.0	....
Bananas		56-72	56-72	85-95	0.80	0.42	108.0	28.0	4.18
Beans, Green		32-34	40-45	85-90	0.91	0.47	128	29.7	3.37
Beans, Dried		36-40	50-60	70	0.30	0.24	18	28	....
Beef, Fresh, Fat	—15	30-32	38-42	84	0.60	0.35	79	28	....
Beef, Fresh Lean	—15	30-32	38-42	85	0.77	0.40	100	29	....
Beets,		32-35	45-50	95-98	0.86	0.47	129	31.1	0.91
Blackberries	—15	31-32	42-45	80-85	0.88	0.46	122	28.9	....
Broccoli		32-35	40-45	90-95	0.92	0.47	130	29.2	....
Butter	+15	....	40-45	....	0.64	0.34	15	30.0	....
Cabbage	—30	32	45	90-95	0.94	0.47	132	31.2	....
Carrots,	—30	32	40-45	95-98	0.86	0.45	126	29.6	1.73
Cauliflower		32	40-45	85-90	0.93	0.47	132	30.1	....
Celery	—30	31-32	45-50	90-95	0.95	0.48	135	29.7	2.27
Cheese, American	+15	32-38	39-45	....	0.64	0.36	79	17.0	2.34
Cherries		31-32	40	80-85	0.87	0.45	120	26.0	1.32
Chocolate Coatings		45-50	....	....	0.3	0.55	40	95-85	....
Corn, Green		31-32	45	85-90	0.80	0.43	108	28.9	4.1
Cranberries		36-40	40-45	85-90	0.90	0.46	124	27.3	....
Cream (40%)		34	40-45	....	0.85	0.40	90	28.0	....
Cucumbers		45-50	45-50	80-85	0.97	0.49	137	30.5	....
Dates, Dry Cured		28	55-60	50-60	0.36	0.26	29	4.1	....
Eggs, Fresh	—10	30-31	38-45	....	0.76	0.40	100	27.0	....
Eggplants		45-50	46-50	85-90	0.94	0.47	132	30.4	....
Flowers		35-40	....	85-90	....	....	....	32.0	....
Fish, Fresh, Iced	—15	25	25-30	....	0.76	0.41	101	30.0	....
Fish Dried		30-40	....	60-70	0.56	0.34	65	....	....
Furs		32-34	40-42	40-60	....	0.4	....	....	....
Furs, To Shock		15	15	....	....	....	....	....	....
Grapefruit		32	45-50	85-90	0.91	0.46	126	28.4	0.54
Grapes		30-32	35-40	80-85	0.88	0.44	116	26.3	0.42
Ham, Fresh		28	36-40	80	0.68	0.38	86.7	27.0	....
Honey		31-32	45-50	....	0.35	0.26	26	....	0.71
Ice Cream	—20	....	0-10	....	0.78	0.45	96	27.0	....
Lard		32-34	40-45	80	0.52	0.31	90	....	....
Lamb		32-34	34-42	82	0.67	0.30	83.5	29.0	....
Lemons		32	55-58	80-85	0.92	0.46	127	28.1	0.41
Lettuce		32	45	90-95	0.96	0.48	136	31.2	3.69
Liver, Fresh		32-34	36-38	83	0.72	0.40	93.3	29.0	....
Lobster, Boiled		25	36-40	....	0.81	0.42	105	....	....
Meat, Brined		31-32	40-45	....	0.75	0.36	75.0	....	....
Melons		34-40	40-45	75-85	0.94	0.48	132	29.0	1.74
Milk		34-36	40-45	....	0.93	0.49	124	31.0	....
Mushrooms		32-35	55-60	80-85	0.93	0.47	130	30.2	4.0
Nut Meats		32-50	35-40	65-75	0.29	0.24	14	20.0	0.5
Oleomargarine		34-36	....	....	0.48	0.34	35	15.0	....
Onions		32	50-60	70-75	0.91	0.46	124	30.1	0.5
Oranges		32-34	50	85-90	0.90	0.46	124	28.0	0.7
Oysters, Shell		....	32-35	....	0.83	0.44	116	27.0	....
Parsnips	—30	32-34	34-40	90-95	0.84	0.46	112	28.9	....
Peaches, Fresh		31-32	50	85-90	0.90	0.46	124	29.4	0.87
Pears, Fresh		29-31	40	85-90	0.86	0.45	118	28.5	0.60
Peas, Green		32	40-45	85-90	0.79	0.42	106	30.0	....
Peppers		32	40-45	85-90	0.94	0.47	....	30.1	0.76
Pineapples, Ripe		40-45	50	85-90	0.88	0.45	122	29.4	....
Plums		31-32	40-45	80-85	0.88	0.45	123	28.0	....
Pork, Fresh		30	36-40	85	0.68	0.38	86.5	28.0	....
Potatoes, White	—30	36-50	45-60	85-90	0.82	0.43	111	28.9	0.72
Poultry, Dressed	—10	28-30	29-32	....	0.79	0.37	106	27	....
Pumpkins		50-55	55-60	70-75	0.92	0.47	130	30.1	....
Quinces		31-32	40-45	80-85	0.88	0.45	122	28.1	....
Raspberries		31-32	40-45	80-85	0.85	0.45	122	30.1	2.75
Sausage, Fresh		31-36	36-40	80	0.89	0.56	93	26	....
Sauerkraut		33-36	36-38	85	0.92	0.47	129	26	....
Squash		50-55	55-60	70-75	0.92	0.47	130	30.1	....
Spinach		32	45-50	85	0.94	0.48	132	30.3	....
Strawberries	15	31-32	42-45	80-85	0.92	0.47	129	29.9	3.3
Tomatoes, ripe		40-50	55-70	85-90	0.95	0.48	134	30.4	0.63
Turnips		32	40-45	95-98	0.93	0.40	137	30.5	0.29
Veal	—15	28-30	36-40		0.71	0.39	91	29	....
Vegetables, Mixed		32	40-45	90-95	0.90	0.45	130	30	2.0

TECH

TECHNICAL DATA

WIND CHILL INDEX (CHILL FACTOR)

During the winter months, the chill index temperature, or "chill factor", combines temperature and wind speed.

The chill factor is calculated and released by the United States Weather Bureau through the usual weather forecasting channels. The chill factor is based on both temperature and wind speed. For example, at a temperature of −18°C (0°F) and a wind speed of 16 KPH (10 MPH), the chill index is −30°C (−22°F). Human flesh exposed to the atmosphere freezes at about −32°C (−25°F).

The Table below shows the chill factor in degrees corresponding to the wind speed. Note that, at a temperature of −18°C (0°F), with a wind speed of 64 KPH (40 MPH), the chill factor mounts to −48°C (−54°F). This temperature will quickly freeze exposed flesh.

WIND CHILL INDEX

	AMBIENT TEMPERATURE															
	°C	4	2	−1	−4	−7	−9	−12	−15	−18	−21	−23	−26	−29	−32	−34
	°F	*40*	*35*	*30*	*25*	*20*	*15*	*10*	*5*	*0*	*−5*	*−10*	*−15*	*−20*	*−25*	*−30*
Wind Velocity KPH *MPH*	EQUIVALENT TEMPERATURE IN STILL AIR															
Calm (0)	°C	4	2	−1	−4	−7	−9	−12	−15	−18	−21	−23	−26	−29	−32	−34
	°F	*40*	*35*	*30*	*25*	*20*	*15*	*10*	*5*	*0*	*−5*	*−10*	*−15*	*−20*	*−25*	*−30*
8	°C	3	1	−3	−6	−9	−18	−14	−17	−21	−24	−26	−29	−32	−35	−37
5	*°F*	*37*	*33*	*27*	*21*	*16*	*12*	*7*	*1*	*−6*	*−11*	*−15*	*−20*	*−26*	*−31*	*−35*
16	°C	−2	−6	−9	−13	−17	−19	−23	−26	−30	−33	−35	−39	−43	−47	−50
10	*°F*	*28*	*21*	*16*	*9*	*2*	*−2*	*−9*	*−15*	*−22*	*−27*	*−31*	*−38*	*−45*	*−52*	*−58*
24	°C	−6	−9	−11	−17	−21	−24	−28	−32	−36	−40	−43	−46	−51	−54	−57
15	*°F*	*22*	*16*	*11*	*1*	*−6*	*−11*	*−18*	*−25*	*−33*	*−40*	*−45*	*−51*	*−60*	*−65*	*−70*
32	°C	−8	−11	−16	−20	−23	−27	−31	−36	−40	−43	−47	−51	−56	−60	−63
20	*°F*	*18*	*12*	*3*	*−4*	*−9*	*−17*	*−24*	*−32*	*−40*	*−46*	*−52*	*−60*	*−68*	*−76*	*−81*
40	°C	−9	−14	−18	−22	−26	−30	−34	−38	−43	−47	−50	−55	−59	−64	−67
25	*°F*	*16*	*7*	*0*	*−7*	*−15*	*−22*	*−29*	*−37*	*−45*	*−52*	*−58*	*−67*	*−75*	*−83*	*−89*
48	°C	−16	−15	−19	−24	−22	−32	−36	−41	−45	−49	−53	−57	−61	−66	−70
30	*°F*	*13*	*5*	*−2*	*−11*	*−18*	*−26*	*−33*	*−41*	*−49*	*−56*	*−63*	*−70*	*−78*	*−87*	*−94*
56	°C	−11	−16	−20	−25	−29	−33	−37	−42	−47	−51	−55	−58	−64	−68	−72
35	*°F*	*11*	*3*	*−4*	*−13*	*−20*	*−27*	*−35*	*−43*	*−52*	*−60*	*−67*	*−72*	*−83*	*−90*	*−98*
64	°C	−12	−17	−21	−26	−30	−34	−38	−43	−48	−52	−56	−60	−66	−70	−74
40	*°F*	*10*	*1*	*−6*	*−15*	*−22*	*−29*	*−36*	*−45*	*−54*	*−62*	*−69*	*−76*	*−87*	*−94*	*−101*

COOL — COLD — VERY COLD — BITTER COLD — EXTREME COLD

Wind chill index reveals that increasing the wind velocity greatly increases the chill effect. With a temperature of −18°C (0°F) and a wind velocity of 32 kph (20 mph), the effect on the human body is the same as it would be if the person were in a temperature of −40°C (−40°F).

FREEZING POINT OF COMMON EUTECTIC SOLUTIONS

FREEZING POINT		CALCIUM CHLORIDE		SODIUM CHLORIDE		ALCOHOL (METHYLATED SPIRIT)		ETHYLENE GLYCOL		GLYCERINE	
°F	°C	Lbs. Flake Calcium per gallon (Imp.) of Brine	Specific Gravity	Lbs. Sodium Chloride per gallon (Imp.) of Brine	Specific Gravity	% Alcohol	% Water	%Ethylene Glycol	% Water	% Glycerine	% Water
24	− 4.4	1.30 lbs.	1.070	.766 lbs.	1.050	13%	87%	13%	87%	19%	81%
20	− 6.7	1.77 "	1.095	1.118 "	1.072	18%	82%	17%	83%	24.7%	75.3%
15	− 9.4	2.13 "	1.123	1.485 "	1.095	23.3%	76.7%	21.6%	78.9%	30.0%	70.0%
10	−12.2	2.50 "	1.149	1.866 "	1.118	27.3%	72.7%	25.5%	74.5%	35.0%	65.0%
5	−15.0	2.75 "	1.165	2.187 "	1.138	31.0%	69.0%	29.2%	70.8%	39.4%	60.6%
0	−17.8	3.12 "	1.181	2.535 "	1.157	34.6%	65.4%	32.7%	67.3%	43.9%	56.1%
− 5	−20.6	3.37 "	1.194	2.787 "	1.172	37.7%	62.3%	35.6%	64.4%	48.0%	52.0%
−10	−23.3	3.60 "	1.208			40.8%	59.2%	38.6%	61.4%	51.5%	48.5%
−15	−26.1	3.83 "	1.220			43.5%	56.5%	41.5%	58.5%	55.2%	44.8%
−20	−28.9	4.00 "	1.230			46.4%	53.6%	44.1%	55.9%	59.0%	41.0%
−25	−31.7	4.28 "	1.242			49.0%	51.0%	46.6%	53.4%	60.9%	39.1%

TIME OF FREEZING ICE WITH −10°C (14°F) BRINE

Weight of Blocks	Size of Can	Time of Freezing
50 lbs. (22.7 kg)	6" x 12" x 26"	15 hrs.
100 " (45.4 ")	8" x 16" x 32"	30 "
150 " (68.0 ")	8" x 16" x 42"	30 "
200 " (90.7 ")	11" x 22" x 32"	50 "
300 " (13.6 ")	11" x 22" x 44"	50 "
400 " (181.4 ")	11" x 22" x 57"	50 "

TECHNICAL DATA

QUICK WAY TO ESTIMATE LENGTH OF MATERIAL IN ANY ROLL

Users of material that comes in Rolls are often faced with the problem of estimating how much material remains in a partly used roll or if the original roll contains the full claimed length.

There are numerous formulae for computing lengths in rolls, but most of them are more or less complicated.

Here is a simple solution :

1. Make one measurement "S" (as shown in the diagram).
2. Count the number of turns.
3. Multiply these two together.
4. Then multiply this result by 0.2618.

The result is the length of the roll in feet.

For example, if the distance "S" is 12 inches, and the number of turns is 10, the roll contains $12 \times 10 \times 0.2618 = 31.4$ feet.

This holds true regardless of whether the material is paper, copper tube, leather, or anything else. The thickness of the material does not make any difference. Even if the roll is so tightly wound that there is no visible hole through it, the rule still holds true. The same applies if it is loosely wound.

AIR MIXTURES

1. FOR DRY BULB TEMPERATURES

Problem: What is the final Temperature when 9875 litre/sec of air at 48°C is mixed with 4200 litre/sec of air at 5°C.

Answer: Multiply litre/sec x its temperature in each case – Add these totals and divide by total Volume.
$= (9875 \times 48) + (4200 \times 5) \div (9875 + 4200) = 35.2^{o}C$

Alternatively
$$\left[\frac{9875}{9875+4200} \times 48\right] + \left[\frac{4200}{9875+4200} \times 5\right] = 35.2^{o}C$$

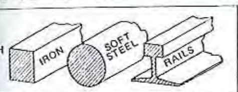
2 FOR DRY BULB AND WET BULB TEMPERATURES

Plot both points on a psychrometric chart – Draw line between them.
Calculate DRY BULB TEMPERATURE as per 1. above.
Project the resulting Dry Bulb Temperature on the psychrometric chart until it intersects the previously drawn line.
The intersection point gives you the Mixture Wet Bulb Temperature.

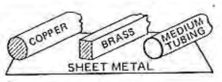
SELECTING THE RIGHT HACKSAW BLADE FOR THE JOB

Blades are made with a varying number of teeth per inch, ranging from 14 to 32. Selection of the blade should be based upon material to be cut. Blades with 18 teeth per inch are the best for general use, but there is no such thing as an "all-purpose" blade.

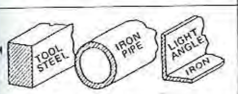
USE 14 TEETH PER INCH



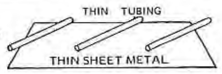
USE 24 TEETH PER INCH



USE 18 TEETH PER INCH



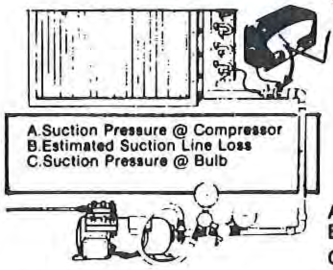
USE 32 TEETH PER INCH



how to determine superheat

1. Determine suction pressure with accurate gauge at evaporator outlet. On close coupled installations, suction pressure may be read at compressor suction connection.
2. From pressure-temperature tables, determine saturation temperature at observed suction pressure.
3. Measure temperature of suction gas at thermo valve remote bulb location.
4. Subtract saturation temperature read from tables in step No. 2 from temperature measured in step No. 3. Difference is superheat of suction gas.

EXAMPLE Refrigerant 12



Temperature here is 45° F
less 37° F
8° F
Superheat

A. 32 psig
B. 2 psig
C. 34 psig

Parker
REFRIGERATION COMPONENTS GROUP

WHAT YOU NEED FOR SERVICING

BASIC TOOLS AND SUPPLIES FOR SERVICING SMALL HERMETIC SYSTEMS

WRENCHES
- Torque handle 3/8" drive.
- Speed handle 3/8" drive.
- Swivel handle 3/8" drive.
- T-handle 3/8" drive for sockets.
- 8" adjustable open end wrench.
- Set of Allen setscrew wrenches.
- Refrigeration ratchet wrench, 3/16", 7/32" and 1/4" with square openings.
- 1/2", 3/4", 7/8" & 1" 15 deg. open-end wrenches.
- 1/2" box wrench.
- 1/2" T-socket wrench.
- Set sockets, 12 point, 7/16" to 1" with 3/8" drive.

PLIERS
- 6" combination.
- Wire cutters.
- Slim nose.

HAMMERS

TUBING TOOLS
- Bending springs for 1/4", 3/8" and 1/2" OD tubing.
- Flaring tool to 1/2" capacity.
- Tube cutter.
- Pinch-off tool.
- Swaging tool.

SCREWDRIVERS
- 3" regular, insulated handle.
- 6" regular, insulated handle.
- 8" regular, insulated handle.
- 3" Phillips, insulated handle.
- 6" Phillips, insulated handle.
- 8" Phillips, insulated handle.

REFRIGERANT TOOLS
- High vacuum pump.
- Service cylinder for R12.
- Service cylinder for R22.
- Service cylinder for R502.
- 1 purging line 1/4" dia. x 4.6 m (15 ft.) equipped with hand shut-off needle valve and check valve.
- Capillary tube cleaner.
- Capillary tube sizing kit.
- Soldering-brazing torch, either LP fuel-air, acetylene-air or oxyacetylene.
- Gauge manifold.
- Process tube adaptors.
- Bending springs.
- Charging hoses (3).

INSTRUMENTS

Many special testing instruments are needed for refrigeration service work. Some of the basic instruments are listed below:

BASIC INSTRUMENTS
- Pressure recorder.
- Temperature recorder.
- Off-on recorder.
- Watt recorder.
- Electronic leak detector.
- Compound gauge (kPa or dual scale).
- Pressure gauge (kPa or dual scale).
- Thermometer –30°C to 100°C.
- Voltmeter
- Ammeter.
- Ohmmeter.

SUPPLIES

Some special supplies will be needed by the service technician who makes house calls answering customer problems. In general, these supplies will include:
- 60-40 & 95-5 wire solder.
- Solder flux.
- Silver brazing rod 45% no cadmium.
- Phosphorous silver wire.
- Silver brazing flux.
- Steel wool.
- Medium grade sandpaper.
- Insulating tape.
- Disposable cylinders, R12, R22, R502.
- Coil of 1/4", 5/16", 3/8", 1/2" soft copper tubing.
- Copper pipe as needed.
- Capillary tubing.
- Filter-drier cartridges.
- Can refrigerant oil (spout type).
- Can refrigerant oil, 300 & 150 viscosity.
- Cleaning cloths.
- Relays, Capacitors & Motor controls.
- Refrigerant controls.
- Overload protectors.
- Light switches.
- Sealing compound.
- Driers (flare and solder fittings).
- Filter-driers (flare and solder fittings).
- Sight glasses (flare and solder fittings).
- Flare fittings (SAE) - all sizes & shapes.
- Solder fittings – all sizes & shapes.
- Piercing valves and valve adaptors.
- Valve cores.

TECH