

P, MPa (T_{sat} , °C)	Temperature, °C													
	400	450	500	550	600	650	700	750	800	850	900	950	1000	
15 (342.2)	v , m ³ /kg	0.01565	0.01845	0.02080	0.02293	0.02491	0.02680	0.02861	0.03037	0.03210	0.03379	0.03546	0.03711	0.03875
	u , kJ/kg	2740.7	2879.5	2996.5	3104.7	3208.6	3310.4	3410.9	3511.0	3611.0	3711.2	3811.9	3913.2	4015.4
	h , kJ/kg	2975.4	3156.2	3308.5	3448.6	3582.3	3712.3	3840.1	3966.6	4092.4	4218.0	4343.8	4469.9	4596.6
	s , kJ/(kg · K)	5.8819	6.1412	6.3451	6.5207	6.6784	6.8232	6.9580	7.0848	7.2048	7.3192	7.4288	7.5340	7.6356
20 (365.8)	v , m ³ /kg	0.00994	0.01270	0.01477	0.01656	0.01818	0.01969	0.02113	0.02251	0.02385	0.02516	0.02645	0.02771	0.02897
	u , kJ/kg	2619.2	2806.2	2942.8	3062.3	3174.0	3281.5	3386.5	3490.0	3592.7	3695.1	3797.4	3900.0	4003.1
	h , kJ/kg	2818.1	3060.1	3238.2	3393.4	3537.6	3675.3	3809.1	3940.3	4069.8	4198.3	4326.4	4454.3	4582.5
	s , kJ/(kg · K)	5.5548	5.9025	6.1409	6.3356	6.5056	6.6591	6.8002	6.9317	7.0553	7.1723	7.2839	7.3907	7.4933
22.088 (374.136)	v , m ³ /kg	0.00818	0.01104	0.01305	0.01475	0.01627	0.01768	0.01901	0.02029	0.02152	0.02272	0.02389	0.02505	0.02619
	u , kJ/kg	2552.9	2772.1	2919.0	3043.9	3159.1	3269.1	3376.1	3481.1	3585.0	3688.3	3791.4	3894.5	3998.0
	h , kJ/kg	2733.7	3015.9	3207.2	3369.6	3518.4	3659.6	3796.0	3929.2	4060.3	4190.1	4319.1	4447.9	4576.6
	s , kJ/(kg · K)	5.4013	5.8072	6.0634	6.2670	6.4426	6.5998	6.7437	6.8772	7.0024	7.1206	7.2330	7.3404	7.4436
30	v , m ³ /kg	0.00279	0.00674	0.00868	0.01017	0.01145	0.01260	0.01366	0.01466	0.01562	0.01655	0.01745	0.01833	0.01920
	u , kJ/kg	2067.3	2619.3	2820.7	2970.3	3100.5	3221.0	3335.8	3447.0	3555.6	3662.6	3768.5	3873.8	3978.8
	h , kJ/kg	2151.0	2821.4	3081.0	3275.4	3443.9	3598.9	3745.7	3886.9	4024.3	4159.0	4291.9	4423.6	4554.7
	s , kJ/(kg · K)	4.4736	5.4432	5.7912	6.0350	6.2339	6.4066	6.5614	6.7030	6.8341	6.9568	7.0726	7.1825	7.2875
40	v , m ³ /kg	0.00191	0.00369	0.00562	0.00698	0.00809	0.00906	0.00994	0.01076	0.01152	0.01226	0.01296	0.01365	0.01432
	u , kJ/kg	1854.5	2365.1	2678.4	2869.7	3022.6	3158.0	3283.6	3402.9	3517.9	3629.8	3739.4	3847.5	3954.6
	h , kJ/kg	1930.8	2512.8	2903.3	3149.1	3346.4	3520.6	3681.3	3833.1	3978.8	4120.0	4257.9	4393.6	4527.6
	s , kJ/(kg · K)	4.1143	4.9467	5.4707	5.7793	6.0122	6.2063	6.3759	6.5281	6.6671	6.7957	6.9158	7.0291	7.1365
60	v , m ³ /kg	0.00163	0.00208	0.00296	0.00396	0.00483	0.00560	0.00627	0.00689	0.00746	0.00800	0.00851	0.00900	0.00948
	u , kJ/kg	1745.3	2053.9	2390.5	2658.8	2861.1	3028.8	3177.2	3313.6	3441.6	3563.6	3681.0	3795.0	3906.4
	h , kJ/kg	1843.4	2179.0	2567.9	2896.2	3151.2	3364.5	3553.6	3726.8	3889.1	4043.3	4191.5	4335.0	4475.2
	s , kJ/(kg · K)	3.9325	4.4128	4.9329	5.3449	5.6460	5.8838	6.0832	6.2569	6.4118	6.5523	6.6814	6.8012	6.9135
80	v , m ³ /kg	0.00152	0.00177	0.00219	0.00276	0.00339	0.00398	0.00452	0.00502	0.00548	0.00591	0.00632	0.00671	0.00709
	u , kJ/kg	1687.0	1944.9	2218.9	2483.9	2711.8	2904.7	3073.2	3225.3	3365.7	3497.3	3622.3	3742.1	3857.8
	h , kJ/kg	1808.3	2086.9	2393.9	2704.9	2982.7	3222.8	3434.7	3626.6	3803.8	3970.1	4127.9	4279.1	4425.2
	s , kJ/(kg · K)	-3.8338	4.2328	4.6432	5.0331	5.3609	5.6284	5.8521	6.0445	6.2137	6.3652	6.5026	6.6289	6.7459

Note: Saturated liquid entropies have been adjusted to make the Gibbs functions of the liquid and vapor phases exactly equal. For this reason, there are some small differences between values presented here and the original tables. Sources: Reprinted by permission from Reynolds, W. C., Perkins, H. C. *Engineering Thermodynamics*, second ed., 1977, McGraw-Hill, New York. Recalculated from equations given in Keenan, J. H., Keyes, F. G., Hill, P. G., Moore, J. G. *Steam Tables*. Wiley, New York, 1969. Reprinted by permission of John Wiley & Sons, Inc.

Table C.4a Compressed Liquid Water (English Units)

Temp. °F	v ft ³ /lbm	u Btu/lbm	h Btu/lbm	s Btu/(lbm · R)	v ft ³ /lbm	u Btu/lbm	h Btu/lbm	s Btu/(lbm · R)	v ft ³ /lbm	u Btu/lbm	h Btu/lbm	s Btu/(lbm · R)
	$p = 500$ psia (467.13°F)				$p = 1000$ psia (544.75°F)				$p = 1500$ psia (596.39°F)			
Sat	0.019 748	447.70	449.53	0.649 04	0.021 591	538.39	542.38	0.743 20	0.023 461	604.97	611.48	0.808 24
32	0.015 994	0.00	1.49	0.000 00	0.015 967	0.03	2.99	0.000 05	0.015 939	0.05	4.47	0.000 07
50	0.015 998	18.02	19.50	0.035 99	0.015 972	17.99	20.94	0.035 92	0.015 946	17.95	22.38	0.035 84
100	0.016 106	67.87	69.36	0.129 32	0.016 082	67.70	70.68	0.129 01	0.016 058	67.53	71.99	0.128 70
150	0.016 318	117.66	119.17	0.214 57	0.016 293	117.38	120.40	0.214 10	0.016 268	117.10	121.62	0.213 64
200	0.016 608	167.65	169.19	0.293 41	0.016 580	167.26	170.32	0.292 81	0.016 554	166.87	171.46	0.292 21
250	0.016 972	217.99	219.56	0.367 02	0.016 941	217.47	220.61	0.366 28	0.016 910	216.96	221.65	0.365 54
300	0.017 416	268.92	270.53	0.436 41	0.017 379	268.24	271.46	0.435 52	0.017 343	267.58	272.39	0.434 63
350	0.017 954	320.71	322.37	0.502 49	0.017 909	319.83	323.15	0.501 40	0.017 865	318.98	323.94	0.500 34
400	0.018 608	373.68	375.40	0.566 04	0.018 550	372.55	375.98	0.564 72	0.018 493	371.45	376.59	0.563 43
450	0.019 420	428.40	430.19	0.627 98	0.019 340	426.89	430.47	0.626 32	0.019 264	425.44	430.79	0.624 70
500	–	–	–	–	0.020 36	483.8	487.5	0.6874	0.020 24	481.8	487.4	0.6853
550	–	–	–	–	–	–	–	–	0.021 58	542.1	548.1	0.7469
	$p = 2000$ psia (636.00°F)				$p = 3000$ psia (695.52°F)				$p = 5000$ psia			
Sat	0.025 649	662.40	671.89	0.862 27	0.034 310	783.45	802.50	0.973 20	0.015 755	0.11	14.70	–0.000 01
32	0.015 912	0.06	5.95	0.000 08	0.015 859	0.09	8.90	0.000 09	0.015 773	17.67	32.26	0.035 08
50	0.015 920	17.91	23.81	0.035 75	0.015 870	17.84	26.65	0.035 55	0.015 897	66.40	81.11	0.126 51
100	0.016 034	67.37	73.30	0.12839	0.015 987	67.04	75.91	0.127 77	0.016 376	164.32	179.47	0.288 18
200	0.016 527	166.49	172.60	0.291 62	0.016 476	165.74	174.89	0.290 46	0.017 110	263.25	279.08	0.428 75
300	0.017 308	266.93	273.33	0.433 76	0.017 240	265.66	275.23	0.432 05	0.018 141	364.47	381.25	0.555 06
400	0.018 439	370.38	377.21	0.562 16	0.018 334	368.32	378.50	0.559 70	0.018 803	416.44	433.84	0.614 51
450	0.019 191	424.04	431.14	0.623 13	0.019 053	421.36	431.93	0.620 11	0.019 603	469.8	487.9	0.6724
500	0.020 14	479.8	487.3	0.6832	0.019 944	476.2	487.3	0.6794	0.020 835	536.7	556.0	0.7411
560	0.021 72	551.8	559.8	0.7565	0.021 382	546.2	558.0	0.7508	0.021 91	584.0	604.2	0.7876
600	0.023 30	605.4	614.0	0.8086	0.022 74	597.0	609.6	0.8004	0.023 34	634.6	656.2	0.8357
640	–	–	–	–	0.024 75	654.3	668.0	0.8545	0.025 35	690.6	714.1	0.8873
680	–	–	–	–	0.028 79	728.4	744.3	0.9226	0.026 76	721.8	746.6	0.9156
700	–	–	–	–	–	–	–	–	–	–	–	–

Source: Reprinted from Van Wylen, G. J., Sonntag, R. E., 1986. *Fundamentals of Classical Thermodynamics*, third ed. Wiley, New York. Reprinted by permission of John Wiley & Sons, Inc.

Table C.4b Compressed Liquid Water (Metric Units)

Temp. °C	v m ³ /kg	u kJ/kg	h kJ/kg	s kJ/(kg · K)	v m ³ /kg	u kJ/kg	h kJ/kg	s kJ/(kg · K)	v m ³ /kg	u kJ/kg	h kJ/kg	s kJ/(kg · K)
	$p = 5$ MPa (263.99°C)				$p = 10$ MPa (311.06°C)				$p = 15$ MPa (342.24°C)			
Sat.	.001 285 9	1147.8	1154.2	2.9202	.001 452 4	1393.0	1407.6	3.3596	.001 658 1	1585.6	1610.5	3.6848
0	.000 997 7	.04	5.04	.0001	.000 995 2	.09	10.04	.0002	.000 992 8	.15	15.05	.0004
20	.000 999 5	83.65	88.65	.2956	.000 997 2	83.36	93.33	.2945	.000 995 0	83.06	97.99	.2934
40	.001 005 6	166.95	171.97	.5705	.001 003 4	166.35	176.38	.5686	.001 001 3	165.76	180.78	.5666
60	.001 014 9	250.23	255.30	.8285	.001 012 7	249.36	259.49	.8258	.001 010 5	248.51	263.67	.8232
80	.001 026 8	333.72	338.85	1.0720	.001 024 5	332.59	342.83	1.0688	.001 022 2	331.48	346.81	1.0656
100	.001 041 0	417.52	422.72	1.3030	.001 038 5	416.12	426.50	1.2992	.001 036 1	414.74	430.28	1.2955
120	.001 057 6	501.80	507.09	1.5233	.001 054 9	500.08	510.64	1.5189	.001 052 2	498.40	514.19	1.5145
140	.001 076 8	586.76	592.15	1.7343	.001 073 7	584.68	595.42	1.7292	.001 070 7	582.66	598.72	1.7242
160	.001 098 8	672.62	678.12	1.9375	.001 095 3	670.13	681.08	1.9317	.001 091 8	667.71	684.09	1.9260
180	.001 124 0	759.63	765.25	2.1341	.001 119 9	756.65	767.84	2.1275	.001 115 9	753.76	770.50	2.1210
200	.001 153 0	848.1	853.9	2.3255	.001 148 0	844.5	856.0	2.3178	.001 143 3	841.0	858.2	2.3104
220	.001 186 6	938.4	944.4	2.5128	.001 180 5	934.1	945.9	2.5039	.001 174 8	929.9	947.5	2.4953
240	.001 226 4	1031.4	1037.5	2.6979	.001 218 7	1026.0	1038.1	2.6872	.001 211 4	1020.8	1039.0	2.6771
260	.001 274 9	1127.9	1134.3	2.8830	.001 264 5	1121.1	1133.7	2.8699	.001 255 0	1114.6	1133.4	2.8576
280	–	–	–	–	.001 321 6	1220.9	1234.1	3.0548	.001 308 4	1212.5	1232.1	3.0393
300	–	–	–	–	.001 397 2	1328.4	1342.3	3.2469	.001 377 0	1316.6	1337.3	3.2260
320	–	–	–	–	–	–	–	–	.001 472 4	1431.1	1453.2	3.4247
340	–	–	–	–	–	–	–	–	.001 631 1	1567.5	1591.9	3.6546

(Continued)

Table C.4b Compressed Liquid Water (Metric Units) *continued*

Temp. °C	v m ³ /kg	u kJ/kg	h kJ/kg	s kJ/(kg · K)	v m ³ /kg	u kJ/kg	h kJ/kg	s kJ/(kg · K)	v m ³ /kg	u kJ/kg	h kJ/kg	s kJ/(kg · K)
	$p = 20$ MPa (365.81 °C)				$p = 30$ MPa				$p = 50$ MPa			
Sat.	.002 036	1785.6	1826.3	4.0139	–	–	–	–	–	–	–	–
0	.000 990 4	.19	20.01	.0004	.000 985 6	.25	29.82	.0001	.000 976 6	.20	49.03	–.0014
20	.000 992 8	82.77	102.62	.2923	.000 988 6	82.17	111.84	.2899	.000 980 4	81.00	130.02	.2848
40	.000 999 2	165.17	185.16	.5646	.000 995 1	164.04	193.89	.5607	.000 987 2	161.86	211.21	.5527
60	.001 008 4	247.68	267.85	.8206	.001 004 2	246.06	276.19	.8154	.000 996 2	242.98	292.79	.8052
80	.001 019 9	330.40	350.80	1.0624	.001 015 6	328.30	358.77	1.0561	.001 007 3	324.34	374.70	1.0440
100	.001 033 7	413.39	434.06	1.2917	.001 029 0	410.78	441.66	1.2844	.001 020 1	405.88	456.89	1.2703
120	.001 049 6	496.76	517.76	1.5102	.001 044 5	493.59	524.93	1.5018	.001 034 8	487.65	539.39	1.4857
140	.001 067 8	580.69	602.04	1.7193	.001 062 1	576.88	608.75	1.7098	.001 051 5	569.77	622.35	1.6915
160	.001 088 5	665.35	687.12	1.9204	.001 082 1	660.82	693.28	1.9096	.001 070 3	652.41	705.92	1.8891
180	.001 112 0	750.95	773.20	2.1147	.001 104 7	745.59	778.73	2.1024	.001 091 2	735.69	790.25	2.0794
200	.001 138 8	837.7	860.5	2.3031	.001 130 2	831.4	865.3	2.2893	.001 114 6	819.7	875.5	2.2634
220	.001 169 3	925.9	949.3	2.4870	.001 159 0	918.3	953.1	2.4711	.001 140 8	904.7	961.7	2.4419
240	.001 204 6	1016.0	1040.0	2.6674	.001 192 0	1006.9	1042.6	2.6490	.001 170 2	990.7	1049.2	2.6158
260	.001 246 2	1108.6	1133.5	2.8459	.001 230 3	1097.4	1134.3	2.8243	.001 203 4	1078.1	1138.2	2.7860
280	.001 296 5	1204.7	1230.6	3.0248	.001 275 5	1190.7	1229.0	2.9986	.001 241 5	1167.2	1229.3	2.9537
300	.001 359 6	1306.1	1333.3	3.2071	.001 330 4	1287.9	1327.8	3.1741	.001 286 0	1258.7	1323.0	3.1200
320	.001 443 7	1415.7	1444.6	3.3979	.001 399 7	1390.7	1432.7	3.3539	.001 338 8	1353.3	1420.2	3.2868
340	.001 568 4	1539.7	1571.0	3.6075	.001 492 0	1501.7	1546.5	3.5426	.001 403 2	1452.0	1522.1	3.4557
360	.001 822 6	1702.8	1739.3	3.8772	.001 626 5	1626.6	1675.4	3.7494	.001 483 8	1556.0	1630.2	3.6291
380	–	–	–	–	.001 869 1	1781.4	1837.5	4.0012	.001 588 4	1667.2	1746.6	3.8101

Source: Reprinted from Van Wylen, G. J., Sonntag, R. E., 1986. *Fundamentals of Classical Thermodynamics*, third ed. Wiley, New York. Reprinted by permission of John Wiley & Sons, Inc.

Table C.5a Saturated Ammonia (English Units)

Temp. °F	Abs. Press. psia p	Specific Volume ft ³ /lbm			Enthalpy Btu/lbm			Entropy Btu/(lbm · R)		
		Sat. Liquid v_f	Evap. v_{fg}	Sat. Vapor v_g	Sat. Liquid h_f	Evap. h_{fg}	Sat. Vapor h_g	Sat. Liquid s_f	Evap. s_{fg}	Sat. Vapor s_g
-60	5.55	0.022 80	44.707	44.73	-21.2	610.8	589.6	-0.0517	1.5286	1.4769
-55	6.54	0.022 90	38.357	38.38	-15.9	607.5	591.6	-0.0386	1.5017	1.4631
-50	7.67	0.023 00	33.057	33.08	-10.6	604.3	593.7	-0.0256	1.4753	1.4497
-45	8.95	0.023 10	28.597	28.62	-5.3	600.9	595.6	-0.0127	1.4495	1.4368
-40	10.41	0.023 22	24.837	24.86	0	597.6	597.6	0.000	1.4242	1.4242
-35	12.05	0.023 33	21.657	21.68	5.3	594.2	599.5	0.0126	1.3994	1.4120
-30	13.90	0.023 50	18.947	18.97	10.7	590.7	601.4	0.0250	1.3751	1.4001
-25	15.98	0.023 60	16.636	16.66	16.0	587.2	603.2	0.0374	1.3512	1.3886
-20	18.30	0.023 70	14.656	14.68	21.4	583.6	605.0	0.0497	1.3277	1.3774
-15	20.88	0.023 81	12.946	12.97	26.7	580.0	606.7	0.0618	1.3044	1.3664
-10	23.74	0.023 93	11.476	11.50	32.1	576.4	608.5	0.0738	1.2820	1.3558
-5	26.92	0.024 06	10.206	10.23	37.5	572.6	610.1	0.0857	1.2597	1.3454
0	30.42	0.024 19	9.092	9.116	42.9	568.9	611.8	0.0975	1.2377	1.3352
5	34.27	0.024 32	8.1257	8.150	48.3	565.0	613.3	0.1092	1.2161	1.3253
10	38.51	0.024 46	7.2795	7.304	53.8	561.1	614.9	0.1208	1.1949	1.3157
15	43.14	0.024 60	6.5374	6.562	59.2	557.1	616.3	0.1323	1.1739	1.3062
20	48.21	0.024 74	5.8853	5.910	64.7	553.1	617.8	0.1437	1.1532	1.2969
25	53.73	0.024 88	5.3091	5.334	70.2	548.9	619.1	0.1551	1.1328	1.2879
30	59.74	0.025 03	4.8000	4.825	75.7	544.8	620.5	0.1663	1.1127	1.2790
35	66.26	0.025 18	4.3478	4.373	81.2	540.5	621.7	0.1775	1.0929	1.2704
40	73.32	0.025 33	3.9457	3.971	86.8	536.2	623.0	0.1885	1.0733	1.2618
45	80.96	0.025 48	3.5885	3.614	92.3	531.8	624.1	0.1996	1.0539	1.2535
50	89.19	0.025 64	3.2684	3.294	97.9	527.3	625.2	0.2105	1.0348	1.2453
55	98.06	0.025 81	2.9822	3.008	103.5	522.8	626.3	0.2214	1.0159	1.2373
60	107.6	0.025 97	2.7250	2.751	109.2	518.1	627.3	0.2322	0.9972	1.2294
65	117.8	0.026 14	2.4939	2.520	114.8	513.4	628.2	0.2430	0.9786	1.2216
70	128.8	0.026 32	2.2857	2.312	120.5	508.6	629.1	0.2537	0.9603	1.2140
75	140.5	0.026 50	2.0985	2.125	126.2	503.7	629.9	0.2643	0.9422	1.2065
80	153.0	0.026 68	1.9283	1.955	132.0	498.7	630.7	0.2749	0.9242	1.1991
85	166.4	0.026 87	1.7741	1.801	137.8	493.6	631.4	0.2854	0.9064	1.1918
90	180.6	0.027 07	1.6339	1.661	143.5	488.5	632.0	0.2958	0.8888	1.1846
95	195.8	0.027 27	1.5067	1.534	149.4	483.2	632.6	0.3062	0.8713	1.1775
100	211.9	0.027 47	1.3915	1.419	155.2	477.8	633.0	0.3166	0.8539	1.1705
105	228.9	0.027 69	1.2853	1.313	161.1	472.3	633.4	0.3269	0.8366	1.1635
110	247.0	0.027 90	1.1891	1.217	167.0	466.7	633.7	0.3372	0.8194	1.1566
115	266.2	0.028 13	1.0999	1.128	173.0	460.9	633.9	0.3474	0.8023	1.1497
120	286.4	0.028 36	1.0186	1.047	179.0	455.0	634.0	0.3576	0.7851	1.1427
125	307.8	0.028 60	0.9444	0.973	185.1	448.9	634.0	0.3679	0.7679	1.1358

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Table C.5b Saturated Ammonia (Metric Units)

Temp. °C	Abs. Press. kPa p	Specific volume m ³ /kg			Enthalpy kJ/kg			Entropy kJ/(kg · K)		
		Sat. Liquid v_f	Evap. v_{fg}	Sat. vapor v_g	Sat. Liquid h_f	Evap. h_{fg}	Sat. Vapor h_g	Sat. Liquid s_f	Evap. s_{fg}	Sat. Vapor s_g
-50	40.88	0.001 424	2.6239	2.6254	-44.3	1416.7	1372.4	-0.1942	6.3502	6.1561
-48	45.96	0.001 429	2.3518	2.3533	-35.5	1411.3	1375.8	-0.1547	6.2696	6.1149
-46	51.55	0.001 434	2.1126	2.1140	-26.6	1405.8	1379.2	-0.1156	6.1902	6.0746
-44	57.69	0.001 439	1.9018	1.9032	-17.8	1400.3	1382.5	-0.0768	6.1120	6.0352
-42	64.42	0.001 444	1.7155	1.7170	-8.9	1394.7	1385.8	-0.0382	6.0349	5.9967
-40	71.77	0.001 449	1.5506	1.5521	0.0	1389.0	1389.0	0.0000	5.9589	5.9589
-38	79.80	0.001 454	1.4043	1.4058	8.9	1383.3	1392.2	0.0380	5.8840	5.9220
-36	88.54	0.001 460	1.2742	1.2757	17.8	1377.6	1395.4	0.0757	5.8101	5.8858
-34	98.05	0.001 465	1.1582	1.1597	26.8	1371.8	1398.5	0.1132	5.7372	5.8504
-32	108.37	0.001 470	1.0547	1.0562	35.7	1365.9	1401.6	0.1504	5.6652	5.8156
-30	119.55	0.001 476	0.9621	0.9635	44.7	1360.0	1404.6	0.1873	5.5942	5.7815
-28	131.64	0.001 481	0.8790	0.8805	53.6	1354.0	1407.6	0.2240	5.5241	5.7481
-26	144.70	0.001 487	0.8044	0.8059	62.6	1347.9	1410.5	0.2605	5.4548	5.7153
-24	158.78	0.001 492	0.7373	0.7388	71.6	1341.8	1413.4	0.2967	5.3864	5.6831
-22	173.93	0.001 498	0.6768	0.6783	80.7	1335.6	1416.2	0.3327	5.3188	5.6515
-20	190.22	0.001 504	0.6222	0.6237	89.7	1329.3	1419.0	0.3684	5.2520	5.6205
-18	207.71	0.001 510	0.5728	0.5743	98.8	1322.9	1421.7	0.4040	5.1860	5.5900
-16	226.45	0.001 515	0.5280	0.5296	107.8	1316.5	1424.4	0.4393	5.1207	5.5600
-14	246.51	0.001 521	0.4874	0.4889	116.9	1310.0	1427.0	0.4744	5.0561	5.5305
-12	267.95	0.001 528	0.4505	0.4520	126.0	1303.5	1429.5	0.5093	4.9922	5.5015
-10	290.85	0.001 534	0.4169	0.4185	135.2	1296.8	1432.0	0.5440	4.9290	5.4730
-8	315.25	0.001 540	0.3863	0.3878	144.3	1290.1	1434.4	0.5785	4.8664	5.4449
-6	341.25	0.001 546	0.3583	0.3599	153.5	1283.3	1436.8	0.6128	4.8045	5.4173
-4	368.90	0.001 553	0.3328	0.3343	162.7	1276.4	1439.1	0.6469	4.7432	5.3901
-2	398.27	0.001 559	0.3094	0.3109	171.9	1269.4	1441.3	0.6808	4.6825	5.3633
0	429.44	0.001 566	0.2879	0.2895	181.1	1262.4	1443.5	0.7145	4.6223	5.3369
2	462.49	0.001 573	0.2683	0.2698	190.4	1255.2	1445.6	0.7481	4.5627	5.3108

Temp. °C	Abs. Press. kPa p	Specific volume m ³ /kg			Enthalpy kJ/kg			Entropy kJ/(kg · K)		
		Sat. Liquid v_f	Evap. v_{fg}	Sat. vapor v_g	Sat. Liquid h_f	Evap. h_{fg}	Sat. Vapor h_g	Sat. Liquid s_f	Evap. s_{fg}	Sat. Vapor s_g
4	497.49	0.001 580	0.2502	0.2517	199.6	1248.0	1447.6	0.7815	4.5037	5.2852
6	534.51	0.001 587	0.2335	0.2351	208.9	1240.6	1449.6	0.8148	4.4451	5.2599
8	573.64	0.001 594	0.2182	0.2198	218.3	1233.2	1451.5	0.8479	4.3871	5.2350
10	614.95	0.001 601	0.2040	0.2056	227.6	1225.7	1453.3	0.8808	4.3295	5.2104
12	658.52	0.001 608	0.1910	0.1926	237.0	1218.1	1455.1	0.9136	4.2725	5.1861
14	704.44	0.001 616	0.1789	0.1805	246.4	1210.4	1456.8	0.9463	4.2159	5.1621
16	752.79	0.001 623	0.1677	0.1693	255.9	1202.6	1458.5	0.9788	4.1597	5.1385
18	803.66	0.001 631	0.1574	0.1590	265.4	1194.7	1460.0	1.0112	4.1039	5.1151
20	857.12	0.001 639	0.1477	0.1494	274.9	1186.7	1461.5	1.0434	4.0486	5.0920
22	913.27	0.001 647	0.1388	0.1405	284.4	1178.5	1462.9	1.0755	3.9937	5.0692
24	972.19	0.001 655	0.1305	0.1322	294.0	1170.3	1464.3	1.1075	3.9392	5.0467
26	1033.97	0.001 663	0.1228	0.1245	303.6	1162.0	1465.6	1.1394	3.8850	5.0244
28	1098.71	0.001 671	0.1156	0.1173	313.2	1153.6	1466.8	1.1711	3.8312	5.0023
30	1166.49	0.001 680	0.1089	0.1106	322.9	1145.0	1467.9	1.2028	3.7777	4.9805
32	1237.41	0.001 689	0.1027	0.1044	332.6	1136.4	1469.0	1.2343	3.7246	4.9589
34	1311.55	0.001 698	0.0969	0.0986	342.3	1127.6	1469.9	1.2656	3.6718	4.9374
36	1389.03	0.001 707	0.0914	0.0931	352.1	1118.7	1470.8	1.2969	3.6192	4.9161
38	1469.92	0.001 716	0.0863	0.0880	361.9	1109.7	1471.5	1.3281	3.5669	4.8950
40	1554.33	0.001 726	0.0815	0.0833	371.7	1100.5	1472.2	1.3591	3.5148	4.8740
42	1642.35	0.001 735	0.0771	0.0788	381.6	1091.2	1472.8	1.3901	3.4630	4.8530
44	1734.09	0.001 745	0.0728	0.0746	391.5	1081.7	1473.2	1.4209	3.4112	4.8322
46	1829.65	0.001 756	0.0689	0.0707	401.5	1072.0	1473.5	1.4518	3.3595	4.8113
48	1929.13	0.001 766	0.0652	0.0669	411.5	1062.2	1473.7	1.4826	3.3079	4.7905
50	2032.62	0.001 777	0.0617	0.0635	421.7	1052.0	1473.7	1.5135	3.2561	4.7696

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Table C.6a Superheated Ammonia Vapor (English Units)

Abs. Press. psia (Sat. Temp.)	Temperature, °F												
	0	20	40	60	80	100	120	140	160	180	200	220	
10 (-41.34)	<i>v</i>	28.58	29.90	31.20	32.49	33.78	35.07	36.35	37.62	38.90	40.17	41.45	–
	<i>h</i>	618.9	629.1	639.3	649.5	659.7	670.0	680.3	690.6	701.1	711.6	722.2	–
	<i>s</i>	1.477	1.499	1.520	1.540	1.559	1.578	1.596	1.614	1.631	1.647	1.664	–
15 (-27.29)	<i>v</i>	18.92	19.82	20.70	21.58	22.44	23.31	24.17	25.03	25.88	26.74	27.59	–
	<i>h</i>	617.2	627.8	638.2	648.5	658.9	669.2	679.6	690.0	700.5	711.1	721.7	–
	<i>s</i>	1.427	1.450	1.471	1.491	1.511	1.529	1.548	1.566	1.583	1.599	1.616	–
20 (-16.64)	<i>v</i>	14.09	14.78	15.45	16.12	16.78	17.43	18.08	18.73	19.37	20.02	20.66	21.3
	<i>h</i>	615.5	626.4	637.0	647.5	658.0	668.5	678.9	689.4	700.0	710.6	721.2	732.0
	<i>s</i>	1.391	1.414	1.436	1.456	1.476	1.495	1.513	1.531	1.549	1.565	1.582	1.598
25 (-7.96)	<i>v</i>	11.19	11.75	12.30	12.84	13.37	13.90	14.43	14.95	15.47	15.99	16.50	17.02
	<i>h</i>	613.8	625.0	635.8	646.5	657.1	667.7	678.2	688.8	699.4	710.1	720.8	731.6
	<i>s</i>	1.362	1.386	1.408	1.429	1.449	1.468	1.486	1.504	1.522	1.539	1.555	1.571
30 (-.57)	<i>v</i>	9.25	9.731	10.20	10.65	11.10	11.55	11.99	12.43	12.87	13.30	13.73	14.16
	<i>h</i>	611.9	623.5	634.6	645.5	656.2	666.9	677.5	688.2	698.8	709.6	720.3	731.1
	<i>s</i>	1.337	1.362	1.385	1.406	1.426	1.446	1.464	1.482	1.500	1.517	1.533	1.550
35 (5.89)	<i>v</i>	–	8.287	8.695	9.093	9.484	9.869	10.25	10.63	11.00	11.38	11.75	12.12
	<i>h</i>	–	622.0	633.4	644.4	655.3	666.1	676.8	687.6	698.3	709.1	719.9	730.7
	<i>s</i>	–	1.341	1.365	1.386	1.407	1.427	1.445	1.464	1.481	1.498	1.515	1.531
40 (11.66)	<i>v</i>	–	7.203	7.568	7.922	8.268	8.609	8.945	9.278	9.609	9.938	10.27	10.59
	<i>h</i>	–	620.4	632.1	643.4	654.4	665.3	676.1	686.9	697.7	708.5	719.4	730.3
	<i>s</i>	–	1.323	1.347	1.369	1.390	1.410	1.429	1.447	1.465	1.482	1.499	1.515
45 (16.87)	<i>v</i>	–	6.363	6.694	7.014	7.326	7.632	7.934	8.232	8.528	8.822	9.115	9.406
	<i>h</i>	–	618.8	630.8	642.3	653.5	664.6	675.5	686.3	697.2	708.0	718.9	729.9
	<i>s</i>	–	1.307	1.331	1.354	1.375	1.395	1.414	1.433	1.450	1.468	1.485	1.501
50 (21.67)	<i>v</i>	–	–	5.988	6.280	6.564	6.843	7.117	7.387	7.655	7.921	8.185	8.448
	<i>h</i>	–	–	629.5	641.2	652.6	663.7	674.7	685.7	696.6	707.5	718.5	729.4
	<i>s</i>	–	–	1.317	1.340	1.361	1.382	1.401	1.420	1.437	1.455	1.472	1.488
60 (30.21)	<i>v</i>	–	–	4.933	5.184	5.428	5.665	5.897	6.126	6.352	6.576	6.798	7.019
	<i>h</i>	–	–	626.8	639.0	650.7	662.1	673.3	684.4	695.5	706.5	717.5	728.6
	<i>s</i>	–	–	1.291	1.315	1.337	1.358	1.378	1.397	1.415	1.432	1.449	1.466

Abs. Press. psia (Sat. Temp.)		Temperature, °F											
		60	80	100	120	140	160	180	200	240	280	320	360
70 (37.7)	v	4.401	4.615	4.822	5.025	5.224	5.420	5.615	5.807	6.187	6.563	–	–
	h	636.6	648.7	660.4	671.8	683.1	694.3	705.5	716.6	738.9	761.4	–	–
	s	1.294	1.317	1.338	1.358	1.377	1.395	1.413	1.430	1.463	1.494	–	–
80 (44.4)	v	3.812	4.005	4.190	4.371	4.548	4.722	4.893	5.063	5.398	5.73	–	–
	h	634.3	646.7	658.7	670.4	681.8	693.2	704.4	715.6	738.1	760.7	–	–
	s	1.275	1.298	1.320	1.340	1.360	1.378	1.396	1.414	1.447	1.478	–	–
90 (50.47)	v	3.353	3.529	3.698	3.862	4.021	4.178	4.332	4.484	4.785	5.081	–	–
	h	631.8	644.7	657.0	668.9	680.5	692.0	703.4	714.7	737.3	760.0	–	–
	s	1.257	1.281	1.304	1.325	1.344	1.363	1.381	1.400	1.432	1.464	–	–
100 (56.05)	v	2.985	3.149	3.304	3.454	3.600	3.743	3.883	4.021	4.294	4.562	–	–
	h	629.3	642.6	655.2	667.3	679.2	690.8	702.3	713.7	736.5	759.4	–	–
	s	1.241	1.266	1.289	1.310	1.331	1.349	1.368	1.385	1.419	1.451	–	–
140 (74.79)	v	–	2.166	2.288	2.404	2.515	2.622	2.727	2.830	3.030	3.227	3.420	–
	h	–	633.8	647.8	661.1	673.7	686.0	698.0	709.9	733.3	756.7	780.0	–
	s	–	1.214	1.240	1.263	1.284	1.305	1.324	1.342	1.376	1.409	1.440	–
180 (89.78)	v	–	–	1.720	1.818	1.910	1.999	2.084	2.167	2.328	2.484	2.637	–
	h	–	–	639.9	654.4	668.0	681.0	693.6	705.9	730.1	753.9	777.7	–
	s	–	–	1.999	1.225	1.248	1.269	1.289	1.308	1.344	1.377	1.408	–
220 (102.42)	v	–	–	–	1.443	1.525	1.601	1.675	1.745	1.881	2.012	2.140	2.265
	h	–	–	–	647.3	662.0	675.8	689.1	701.9	726.8	751.1	775.3	779.5
	s	–	–	–	1.192	1.217	1.239	1.260	1.280	1.317	1.351	1.383	1.413
240 (108.09)	v	–	–	–	1.302	1.380	1.452	1.521	1.587	1.741	1.835	1.954	2.069
	h	–	–	–	643.5	658.8	673.1	686.7	699.8	725.1	749.8	774.1	798.4
	s	–	–	–	1.176	1.203	1.226	1.248	1.268	1.305	1.339	1.371	1.402
260 (113.42)	v	–	–	–	1.182	1.257	1.326	1.391	1.453	1.572	1.686	1.796	1.904
	h	–	–	–	639.5	655.6	670.4	684.4	697.7	723.4	748.4	772.9	797.4
	s	–	–	–	1.162	1.189	1.213	1.235	1.256	1.294	1.329	1.361	1.391
280 (118.45)	v	–	–	–	1.078	1.151	1.217	1.279	1.339	1.451	1.558	1.661	1.762
	h	–	–	–	635.4	652.2	667.6	681.9	695.6	721.8	747.0	771.7	796.3
	s	–	–	–	1.147	1.176	1.201	1.224	1.245	1.283	1.318	1.351	1.382

Note: Units are v – ft³/lbm, h – Btu/lbm, s – Btu/(lbm · R).

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Table C.6b Superheated Ammonia Vapor (Metric Units)

Abs. Press. kPa (Sat. Temp.) °C	Temperature, °C												
	-20	-10	0	10	20	30	40	50	60	70	80	100	
50 (-46.54)	v	2.4474	2.5481	2.6482	2.7479	2.8473	2.9464	3.0453	3.1441	3.2427	3.3413	3.4397	-
	h	1435.8	1457.0	1478.1	1499.2	1520.4	1541.7	1563.0	1584.5	1606.1	1627.8	1649.7	-
	s	6.3256	6.4077	6.4865	6.5625	6.6360	6.7073	6.7766	6.8441	6.9099	6.9743	7.0372	-
75 (-39.18)	v	1.6233	1.6915	1.7591	1.8263	1.8932	1.9597	2.0261	2.0923	2.1584	2.2244	2.2903	-
	h	1433.0	1454.7	1476.1	1497.5	1518.9	1540.3	1561.8	1583.4	1605.1	1626.9	1648.9	-
	s	6.1190	6.2028	6.2828	6.3597	6.4339	6.5058	6.5756	6.6434	6.7096	6.7742	6.8373	-
100 (-33.61)	v	1.2110	1.2631	1.3145	1.3654	1.4160	1.4664	1.5165	1.5664	1.6163	1.6659	1.7155	1.8145
	h	1430.1	1452.2	1474.1	1495.7	1517.3	1538.9	1560.5	1582.2	1604.1	1626.0	1648.0	1692.6
	s	5.9695	6.0552	6.1366	6.2144	6.2894	6.3618	6.4321	6.5003	6.5668	6.6316	6.6950	6.8177
125 (-29.08)	v	0.9635	1.0059	1.0476	1.0889	1.1297	1.1703	1.2107	1.2509	1.2909	1.3309	1.3707	1.4501
	h	1427.2	1449.8	1472.0	1493.9	1515.7	1537.5	1559.3	1581.1	1603.0	1625.0	1647.2	1691.8
	s	5.8512	5.9389	6.0217	6.1006	6.1763	6.2494	6.3201	6.3887	6.4555	6.5206	6.5842	6.7072
150 (-25.23)	v	0.7984	0.8344	0.8697	0.9045	0.9388	0.9729	1.0068	1.0405	1.0740	1.1074	1.1408	1.2072
	h	1424.1	1447.3	1469.8	1492.1	1514.1	1536.1	1558.0	1580.0	1602.0	1624.1	1646.3	1691.1
	s	5.7526	5.8424	5.9266	6.0066	6.0831	6.1568	6.2280	6.2970	6.3641	6.4295	6.4933	6.6167
200 (-18.86)	v	-	0.6199	0.6471	0.6738	0.7001	0.7261	0.7519	0.7774	0.8029	0.8282	0.8533	0.9035
	h	-	1442.0	1465.5	1488.4	1510.9	1533.2	1555.5	1577.7	1599.9	1622.2	1644.6	1689.6
	s	-	5.6863	5.7737	5.8559	5.9342	6.0091	6.0813	6.1512	6.2189	6.2849	6.3491	6.4732
250 (-13.67)	v	-	0.4910	0.5135	0.5354	0.5568	0.5780	0.5989	0.6196	0.6401	0.6605	0.6809	0.7212
	h	-	1436.6	1461.0	1484.5	1507.6	1530.3	1552.9	1575.4	1597.8	1620.3	1642.8	1688.2
	s	-	5.5609	5.6517	5.7365	5.8165	5.8928	5.9661	6.0368	6.1052	6.1717	6.2365	6.3613
300 (-9.23)	v	-	-	0.4243	0.4430	0.4613	0.4792	0.4968	0.5143	0.5316	0.5488	0.5658	0.5997
	h	-	-	1456.3	1480.6	1504.2	1527.4	1550.3	1573.0	1595.7	1618.4	1641.1	1686.7
	s	-	-	5.5493	5.6366	5.7186	5.7963	5.8707	5.9423	6.0114	6.0785	6.1437	6.2693
350 (-5.35)	v	-	-	0.3605	0.3770	0.3929	0.4086	0.4239	0.4391	0.4541	0.4689	0.4837	0.5129
	h	-	-	1451.5	1476.5	1500.7	1524.4	1547.6	1570.7	1593.6	1616.5	1639.3	1685.2
	s	-	-	5.4600	5.5502	5.6342	5.7135	5.7890	5.8615	5.9314	5.9990	6.0647	6.1910
400 (-1.89)	v	-	-	0.3125	0.3274	0.3417	0.3556	0.3692	0.3826	0.3959	0.4090	0.4220	0.4478
	h	-	-	1446.5	1472.4	1497.2	1521.3	1544.9	1568.3	1591.5	1614.5	1637.6	1683.7
	s	-	-	5.3803	5.4735	5.5597	5.6405	5.7173	5.7907	5.8613	5.9296	5.9957	6.1228
450 (1.26)	v	-	-	0.2752	0.2887	0.3017	0.3143	0.3266	0.3387	0.3506	0.3624	0.3740	0.3971
	h	-	-	1441.3	1468.1	1493.6	1518.2	1542.2	1565.9	1589.3	1612.6	1635.8	1682.2
	s	-	-	5.3078	5.4042	5.4926	5.5752	5.6532	5.7275	5.7989	5.8678	5.9345	6.0623

Abs. press. kPa (Sat. temp.) °C		Temperature, °C											
		20	30	40	50	60	70	80	100	120	140	160	180
500 (4.14)	v	0.2698	0.2813	0.2926	0.3036	0.3144	0.3251	0.3357	0.3565	0.3771	0.3975	–	–
	h	1489.9	1515.0	1539.5	1563.4	1587.1	1610.6	1634.0	1680.7	1727.5	1774.7	–	–
	s	5.4314	5.5157	5.5950	5.6704	5.7425	5.8120	5.8793	6.0079	6.1301	6.2472	–	–
600 (9.29)	v	0.2217	0.2317	0.2414	0.2508	0.2600	0.2691	0.2781	0.2957	0.3130	0.3302	–	–
	h	1482.4	1508.6	1533.8	1558.5	1582.7	1606.6	1630.4	1677.7	1724.9	1772.4	–	–
	s	5.3222	5.4102	5.4923	5.5697	5.6436	5.7144	5.7826	5.9129	6.0363	6.1541	–	–
700 (13.81)	v	0.1874	0.1963	0.2048	0.2131	0.2212	0.2291	0.2369	0.2522	0.2672	0.2821	–	–
	h	1474.5	1501.9	1528.1	1553.4	1578.2	1602.6	1626.8	1674.6	1722.4	1770.2	–	–
	s	5.2259	5.3179	5.4029	5.4826	5.5582	5.6303	5.6997	5.8316	5.9562	6.0749	–	–
800 (17.86)	v	0.1615	0.1696	0.1773	0.1848	0.1920	0.1991	0.2060	0.2196	0.2329	0.2459	0.2589	–
	h	1466.3	1495.0	1522.2	1548.3	1573.7	1598.6	1623.1	1671.6	1719.8	1768.0	1816.4	–
	s	5.1387	5.2351	5.3232	5.4053	5.4827	5.5562	5.6268	5.7603	5.8861	6.0057	6.1202	–
900 (21.54)	v	–	0.1488	0.1559	0.1627	0.1693	0.1757	0.1820	0.1942	0.2061	0.2178	0.2294	–
	h	–	1488.0	1516.2	1543.0	1569.1	1594.4	1619.4	1668.5	1717.1	1765.7	1814.4	–
	s	–	5.1593	5.2508	5.3354	5.4147	5.4897	5.5614	5.6968	5.8237	5.9442	6.0594	–
1000 (24.91)	v	–	0.1321	0.1388	0.1450	0.1511	0.1570	0.1627	0.1739	0.1847	0.1954	0.2058	0.2162
	h	–	1480.6	1510.0	1537.7	1564.4	1590.3	1615.6	1665.4	1714.5	1763.4	1812.4	1861.7
	s	–	5.0889	5.1840	5.2713	5.3525	5.4292	5.5021	5.6392	5.7674	5.8888	6.0047	6.1159
1200 (30.96)	v	–	–	0.1129	0.1185	0.1238	0.1289	0.1338	0.1434	0.1526	0.1616	0.1705	0.1792
	h	–	–	1497.1	1526.6	1554.7	1581.7	1608.0	1659.2	1709.2	1758.9	1808.5	1858.2
	s	–	–	5.0629	5.1560	5.2416	5.3215	5.3970	5.5379	5.6687	5.7919	5.9091	6.0214
1400 (36.28)	v	–	–	0.0944	0.0995	0.1042	0.1088	0.1132	0.1216	0.1297	0.1376	0.1452	0.1528
	h	–	–	1483.4	1515.1	1544.7	1573.0	1600.2	1652.8	1703.9	1754.3	1804.5	1854.7
	s	–	–	4.9534	5.0530	5.1434	5.2270	5.3053	5.4501	5.5836	5.7087	5.8273	5.9406
1600 (41.05)	v	–	–	–	0.0851	0.0895	0.0937	0.0977	0.1053	0.1125	0.1195	0.1263	0.1330
	h	–	–	–	1502.9	1534.4	1564.0	1592.3	1646.4	1698.5	1749.7	1800.5	1851.2
	s	–	–	–	4.9584	5.0543	5.1419	5.2232	5.3722	5.5084	5.6355	5.7555	5.8699
1800 (45.39)	v	–	–	–	0.0739	0.0781	0.0820	0.0856	0.0926	0.0992	0.1055	0.1116	0.1177
	h	–	–	–	1490.0	1523.5	1554.6	1584.1	1639.8	1693.1	1745.1	1796.5	1847.7
	s	–	–	–	4.8693	4.9715	5.0635	5.1482	5.3018	5.4409	5.5699	5.6914	5.8069
2000 (49.38)	v	–	–	–	0.0648	0.0688	0.0725	0.0760	0.0824	0.0885	0.0943	0.0999	0.1054
	h	–	–	–	1476.1	1512.0	1544.9	1575.6	1633.2	1687.6	1740.3	1792.4	1844.1
	s	–	–	–	4.7834	4.8930	4.9902	5.0786	5.2371	5.3793	5.5104	5.6333	5.7499

Note: Units are $v - m^3/kg$, $h - kJ/kg$, $s - kJ/(kg \cdot K)$.

Source: Reprinted from Van Wylen, G. J., Sonntag, R. E., 1986. *Fundamentals of Classical Thermodynamics*, third ed. Wiley, New York. Reprinted by permission of John Wiley & Sons, Inc.

Table C.7a Saturated Refrigerant-134a Temperature Table (English Units)

Temp. °F <i>T</i>	Press. psia <i>P</i> _{sat}	Specific Volume ft ³ /lbm		Internal Energy Btu/lbm			Enthalpy Btu/lbm		Entropy Btu/(lbm · R)	
		Sat. Liquid <i>v</i> _f	Sat. Vapor <i>v</i> _g	Sat. Liquid <i>u</i> _f	Sat. Vapor <i>u</i> _g	Sat. Liquid <i>h</i> _f	Evap. <i>h</i> _{fg}	Sat. Vapor <i>h</i> _g	Sat. Liquid <i>s</i> _f	Sat. Vapor <i>s</i> _g
-40	7.490	0.011 30	5.7173	-0.02	87.90	0.00	95.82	95.82	0.0000	0.2283
-30	9.920	0.011 43	4.3911	2.81	89.26	2.83	94.49	97.32	0.0067	0.2266
-20	12.949	0.011 56	3.4173	5.69	90.62	5.71	93.10	98.81	0.0133	0.2250
-15	14.718	0.011 63	3.0286	7.14	91.30	7.17	92.38	99.55	0.0166	0.2243
-10	16.674	0.011 70	2.6918	8.61	91.98	8.65	91.64	100.29	0.0199	0.2236
-5	18.831	0.011 78	2.3992	10.09	92.66	10.13	90.89	101.02	0.0231	0.2230
0	21.203	0.011 85	2.1440	11.58	93.33	11.63	90.12	101.75	0.0264	0.2224
5	23.805	0.011 93	1.9208	13.09	94.01	13.14	89.33	102.47	0.0296	0.2219
10	26.651	0.012 00	1.7251	14.60	94.68	14.66	88.53	103.19	0.0329	0.2214
15	29.756	0.012 08	1.5529	16.13	95.35	16.20	87.71	103.90	0.0361	0.2209
20	33.137	0.012 16	1.4009	17.67	96.02	17.74	86.87	104.61	0.0393	0.2205
25	36.809	0.012 25	1.2666	19.22	96.69	19.30	86.02	105.32	0.0426	0.2200
30	40.788	0.012 33	1.1474	20.78	97.35	20.87	85.14	106.01	0.0458	0.2196
40	49.738	0.012 51	0.9470	23.94	98.67	24.05	83.34	107.39	0.0522	0.2189
50	60.125	0.012 70	0.7871	27.14	99.98	27.28	81.46	108.74	0.0585	0.2183
60	72.092	0.012 90	0.6584	30.39	101.27	30.56	79.49	110.05	0.0648	0.2178
70	85.788	0.013 11	0.5538	33.68	102.54	33.89	77.44	111.33	0.0711	0.2173
80	101.37	0.013 34	0.4682	37.02	103.78	37.27	75.29	112.56	0.0774	0.2169
85	109.92	0.013 46	0.4312	38.72	104.39	38.99	74.17	113.16	0.0805	0.2167
90	118.99	0.013 58	0.3975	40.42	105.00	40.72	73.03	113.75	0.0836	0.2165
95	128.62	0.013 71	0.3668	42.14	105.60	42.47	71.86	114.33	0.0867	0.2163
100	138.83	0.013 85	0.3388	43.87	106.18	44.23	70.66	114.89	0.0898	0.2161
105	149.63	0.013 99	0.3131	45.62	106.76	46.01	69.42	115.43	0.0930	0.2159
110	161.04	0.014 14	0.2896	47.39	107.33	47.81	68.15	115.96	0.0961	0.2157
115	173.10	0.014 29	0.2680	49.17	107.88	49.63	66.84	116.47	0.0992	0.2155
120	185.82	0.014 45	0.2481	50.97	108.42	51.47	65.48	116.95	0.1023	0.2153
140	243.86	0.015 20	0.1827	58.39	110.41	59.08	59.57	118.65	0.1150	0.2143
160	314.63	0.016 17	0.1341	66.26	111.97	67.20	52.58	119.78	0.1280	0.2128
180	400.22	0.017 58	0.0964	74.83	112.77	76.13	43.78	119.91	0.1417	0.2101
200	503.52	0.020 14	0.0647	84.90	111.66	86.77	30.92	117.69	0.1575	0.2044
210	563.51	0.023 29	0.0476	91.84	108.48	94.27	19.18	113.45	0.1684	0.1971

Source: Adopted from Moran, M. J., Shapiro, H. N., 1992. *Fundamentals of Engineering Thermodynamics*, second ed., Wiley, New York, pp. 754–758. Originally based on equations from Wilson, D. P., Basu, R. S., 1988. *Thermodynamic properties of a new stratospherically safe working fluid—refrigerant 134a*. ASHRAE Trans. 94 (Pt. 2), 2095–2118.

Table C.7b Saturated Refrigerant-134a Pressure Table (English Units)

Press. psia P	Temp. °F T_{sat}	Specific Volume ft ³ /lbm		Internal Energy Btu/lbm			Enthalpy Btu/lbm		Entropy Btu/(lbm · R)	
		Sat. Liquid v_f	Sat. Vapor v_g	Sat. Liquid u_f	Sat. Vapor u_g	Sat. Liquid h_f	Evap. h_{fg}	Sat. Vapor h_g	Sat. Liquid s_f	Sat. Vapor s_g
5	-53.48	0.011 13	8.3508	-3.74	86.07	-3.73	97.53	93.79	-0.0090	0.2311
10	-29.71	0.011 43	4.3581	2.89	89.30	2.91	94.45	97.37	0.0068	0.2265
15	-14.25	0.011 64	2.9747	7.36	91.40	7.40	92.27	99.66	0.0171	0.2242
20	-2.48	0.011 81	2.2661	10.84	93.00	10.89	90.50	101.39	0.0248	0.2227
30	15.38	0.012 09	1.5408	16.24	95.40	16.31	87.65	103.96	0.0364	0.2209
40	29.04	0.012 32	1.1692	20.48	97.23	20.57	85.31	105.88	0.0452	0.2197
50	40.27	0.012 52	0.9422	24.02	98.71	24.14	83.29	107.43	0.0523	0.2189
60	49.89	0.012 70	0.7887	27.10	99.96	27.24	81.48	108.72	0.0584	0.2183
70	58.35	0.012 86	0.6778	29.85	101.05	30.01	79.82	109.83	0.0638	0.2179
80	65.93	0.013 02	0.5938	32.33	102.02	32.53	78.28	110.81	0.0686	0.2175
90	72.83	0.013 17	0.5278	34.62	102.89	34.84	76.84	111.68	0.0729	0.2172
100	79.17	0.013 32	0.4747	36.75	103.68	36.99	75.47	112.46	0.0768	0.2169
120	90.54	0.013 60	0.3941	40.61	105.06	40.91	72.91	113.82	0.0839	0.2165
140	100.56	0.013 86	0.3358	44.07	106.25	44.43	70.52	114.95	0.0902	0.2161
160	109.56	0.014 12	0.2916	47.23	107.28	47.65	68.26	115.91	0.0958	0.2157
180	117.74	0.014 38	0.2569	50.16	108.18	50.64	66.10	116.74	0.1009	0.2154
200	125.28	0.014 63	0.2288	52.90	108.98	53.44	64.01	117.44	0.1057	0.2151
220	132.27	0.014 89	0.2056	55.48	109.68	56.09	61.96	118.05	0.1101	0.2147
240	138.79	0.015 15	0.1861	57.93	110.30	58.61	59.96	118.56	0.1142	0.2144
260	144.92	0.015 41	0.1695	60.28	110.84	61.02	57.97	118.99	0.1181	0.2140
280	150.70	0.015 68	0.1550	62.53	111.31	63.34	56.00	119.35	0.1219	0.2136
300	156.17	0.015 96	0.1424	64.71	111.72	65.59	54.03	119.62	0.1254	0.2132
350	168.72	0.016 71	0.1166	69.88	112.45	70.97	49.03	120.00	0.1338	0.2118
400	179.95	0.017 58	0.0965	74.81	112.77	76.11	43.80	119.91	0.1417	0.2102
450	190.12	0.018 63	0.0800	79.63	112.60	81.18	38.08	119.26	0.1493	0.2079
500	199.38	0.020 02	0.0657	84.54	111.76	86.39	31.44	117.83	0.1570	0.2047

Source: Adopted from Moran, M. J., Shapiro, H. N., 1992. *Fundamentals of Engineering Thermodynamics*, second ed., Wiley, New York, pp. 754–758. Originally based on equations from Wilson, D. P., Basu, R. S., 1988. *Thermodynamic properties of a new stratospherically safe working fluid—refrigerant 134a*. ASHRAE Trans. 94 (Pt. 2), 2095–2118.

Table C.7c Saturated Refrigerant-134a Temperature Table (Metric Units)

Temp. °C T	Press. MPa P_{sat}	Specific Volume m ³ /kg		Internal Energy kJ/kg			Enthalpy kJ/kg		Entropy kJ/(kg · K)	
		Sat. Liquid v_f	Sat. Vapor v_g	Sat. Liquid u_f	Sat. Vapor u_g	Sat. Liquid h_f	Evap. h_{fg}	Sat. Vapor h_g	Sat. Liquid s_f	Sat. Vapor s_g
−40	0.051 64	0.000 705 5	0.3569	−0.04	204.45	0.00	222.88	222.88	0.0000	0.9560
−36	0.063 32	0.000 711 3	0.2947	4.68	206.73	4.73	220.67	225.40	0.0201	0.9506
−32	0.077 04	0.000 717 2	0.2451	9.47	209.01	9.52	218.37	227.90	0.0401	0.9456
−28	0.093 05	0.000 723 3	0.2052	14.31	211.29	14.37	216.01	230.38	0.0600	0.9411
−26	0.101 99	0.000 726 5	0.1882	16.75	212.43	16.82	214.80	231.62	0.0699	0.9390
−24	0.111 60	0.000 729 6	0.1728	19.21	213.57	19.29	213.57	232.85	0.0798	0.9370
−22	0.121 92	0.000 732 8	0.1590	21.68	214.70	21.77	212.32	234.08	0.0897	0.9351
−20	0.132 99	0.000 736 1	0.1464	24.17	215.84	24.26	211.05	235.31	0.0996	0.9332
−18	0.144 83	0.000 739 5	0.1350	26.67	216.97	26.77	209.76	236.53	0.1094	0.9315
−16	0.157 48	0.000 742 8	0.1247	29.18	218.10	29.30	208.45	237.74	0.1192	0.9298
−12	0.185 40	0.000 749 8	0.1068	34.25	220.36	34.39	205.77	240.15	0.1388	0.9267
−8	0.217 04	0.000 756 9	0.0919	39.38	222.60	39.54	203.00	242.54	0.1583	0.9239
−4	0.252 74	0.000 764 4	0.0794	44.56	224.84	44.75	200.15	244.90	0.1777	0.9213
0	0.292 82	0.000 772 1	0.0689	49.79	227.06	50.02	197.21	247.23	0.1970	0.9190
4	0.337 65	0.000 780 1	0.0600	55.08	229.27	55.35	194.19	249.53	0.2162	0.9169
8	0.387 56	0.000 788 4	0.0525	60.43	231.46	60.73	191.07	251.80	0.2354	0.9150
12	0.442 94	0.000 797 1	0.0460	65.83	233.63	66.18	187.85	254.03	0.2545	0.9132
16	0.504 16	0.000 806 2	0.0405	71.29	235.78	71.69	184.52	256.22	0.2735	0.9116
20	0.571 60	0.000 815 7	0.0358	76.80	237.91	77.26	181.09	258.36	0.2924	0.9102
24	0.645 66	0.000 825 7	0.0317	82.37	240.01	82.90	177.55	260.45	0.3113	0.9089
26	0.685 30	0.000 830 9	0.0298	85.18	241.05	85.75	175.73	261.48	0.3208	0.9082
28	0.726 75	0.000 836 2	0.0281	88.00	242.08	88.61	173.89	262.50	0.3302	0.9076
30	0.770 06	0.000 841 7	0.0265	90.84	243.10	91.49	172.00	263.50	0.3396	0.9070
32	0.815 28	0.000 847 3	0.0250	93.70	244.12	94.39	170.09	264.48	0.3490	0.9064
34	0.862 47	0.000 853 0	0.0236	96.58	245.12	97.31	168.14	265.45	0.3584	0.9058
36	0.911 68	0.000 859 0	0.0223	99.47	246.11	100.25	166.15	266.40	0.3678	0.9053
38	0.962 98	0.000 865 1	0.0210	102.38	247.09	103.21	164.12	267.33	0.3772	0.9047
40	1.016 4	0.000 871 4	0.0199	105.30	248.06	106.19	162.05	268.24	0.3866	0.9041
42	1.072 0	0.000 878 0	0.0188	108.25	249.02	109.19	159.94	269.14	0.3960	0.9035
44	1.129 9	0.000 884 7	0.0177	111.22	249.96	112.22	157.79	270.01	0.4054	0.9030
48	1.252 6	0.000 898 9	0.0159	117.22	251.79	118.35	153.33	271.68	0.4243	0.9017
52	1.385 1	0.000 914 2	0.0142	123.31	253.55	124.58	148.66	273.24	0.4432	0.9004
56	1.527 8	0.000 930 8	0.0127	129.51	255.23	130.93	143.75	274.68	0.4622	0.8990
60	1.681 3	0.000 948 8	0.0114	135.82	256.81	137.42	138.57	275.99	0.4814	0.8973
70	2.116 2	0.001 002 7	0.0086	152.22	260.15	154.34	124.08	278.43	0.5302	0.8918
80	2.632 4	0.001 076 6	0.0064	169.88	262.14	172.71	106.41	279.12	0.5814	0.8827
90	3.243 5	0.001 194 9	0.0046	189.82	261.34	193.69	82.63	276.32	0.6380	0.8655
100	3.974 2	0.001 544 3	0.0027	218.60	248.49	224.74	34.40	259.13	0.7196	0.8117

Source: Adapted from Moran, M. J., Shapiro, H. N., 1992. *Fundamentals of Engineering Thermodynamics*, second ed. Wiley, New York, pp. 710–715. Originally based on equations from Wilson, D. P., Basu, R. S., 1988. *Thermodynamic properties, of a new stratospherically safe working fluid—refrigerant 134a*. ASHRAE Trans. 94 (Pt. 2), 2095–2118.

Table C.7d Saturated Refrigerant-134a Pressure Table (Metric Units)

Press. MPa P	Temp. °C T_{sat}	Specific Volume m^3/kg		Internal Energy kJ/kg			Enthalpy kJ/kg		Entropy $\text{kJ}/(\text{kg} \cdot \text{K})$	
		Sat. Liquid v_f	Sat. Vapor v_g	Sat. Liquid u_f	Sat. Vapor u_g	Sat. Liquid h_f	Evap. h_{fg}	Sat. Vapor h_g	Sat. Liquid s_f	Sat. Vapor s_g
0.06	-37.07	0.000 709 7	0.3100	3.41	206.12	3.46	221.27	224.72	0.0147	0.9520
0.08	-31.21	0.000 718 4	0.2366	10.41	209.46	10.47	217.92	228.39	0.0440	0.9447
0.10	-26.43	0.000 725 8	0.1917	16.22	212.18	16.29	215.06	231.35	0.0678	0.9395
0.12	-22.36	0.000 732 3	0.1614	21.23	214.50	21.32	212.54	233.86	0.0879	0.9354
0.14	-18.80	0.000 738 1	0.1395	25.66	216.50	25.77	210.27	236.04	0.1055	0.9322
0.16	-15.62	0.000 743 5	0.1229	29.66	218.32	29.78	208.18	237.97	0.1211	0.9295
0.18	-12.73	0.000 748 5	0.1098	33.31	219.94	33.45	206.26	239.71	0.1352	0.9273
0.20	-10.09	0.000 753 2	0.0993	36.69	221.43	36.84	204.46	241.30	0.1481	0.9253
0.24	-5.37	0.000 761 8	0.0834	42.77	224.07	42.95	201.14	244.09	0.1710	0.9222
0.28	-1.23	0.000 769 7	0.0719	48.18	226.38	48.39	198.13	246.52	0.1911	0.9197
0.32	2.48	0.000 777 0	0.0632	53.06	228.43	53.31	195.35	248.66	0.2089	0.9177
0.36	5.84	0.000 783 9	0.0564	57.54	230.28	57.82	192.76	250.58	0.2251	0.9160
0.4	8.93	0.000 790 4	0.0509	61.69	231.97	62.00	190.32	252.32	0.2399	0.9145
0.5	15.74	0.000 805 6	0.0409	70.93	235.64	71.33	184.74	256.07	0.2723	0.9117
0.6	21.58	0.000 819 6	0.0341	78.99	238.74	79.48	179.71	259.19	0.2999	0.9097
0.7	26.72	0.000 832 8	0.0292	86.19	241.42	86.78	175.07	261.85	0.3242	0.9080
0.8	31.33	0.000 845 4	0.0255	92.75	243.78	93.42	170.73	264.15	0.3459	0.9066
0.9	35.53	0.000 857 6	0.0226	98.79	245.88	99.56	166.62	266.18	0.3656	0.9054
1.0	39.39	0.000 869 5	0.0202	104.42	247.77	105.29	162.68	267.97	0.3838	0.9043
1.2	46.32	0.000 892 8	0.0166	114.69	251.03	115.76	155.23	270.99	0.4164	0.9023
1.4	52.43	0.000 915 9	0.0140	123.98	253.74	125.26	148.14	273.40	0.4453	0.9003
1.6	57.92	0.000 939 2	0.0121	132.52	256.00	134.02	141.31	275.33	0.4714	0.8982
8	62.91	0.000 963 1	0.0105	140.49	257.88	142.22	134.60	276.83	0.4954	0.8959
2.0	67.49	0.000 987 8	0.0093	148.02	259.41	149.99	127.95	277.94	0.5178	0.8934
2.5	77.59	0.001 056 2	0.0069	165.48	261.84	168.12	111.06	279.17	0.5687	0.8854
3.0	86.22	0.001 141 6	0.0053	181.88	262.16	185.30	92.71	278.01	0.6156	0.8735

Source: Adapted from Moran, M. J., Shapiro, H. N., 1992. *Fundamentals of Engineering Thermodynamics*, second ed. Wiley, New York, pp. 710–715. Originally based on equations from Wilson, D. P., Basu, R. S., 1988. *Thermodynamic properties, of a new stratospherically safe working fluid—refrigerant 134a*. ASHRAE Trans. 94 (Pt. 2), 2095–2118.

Table C.8a Superheated Refrigerant-134a Vapor (English Units)

T °F	v ft ³ /lbm	u Btu/lbm	h Btu/lbm	s Btu/(lbm · R)	v ft ³ /lbm	u Btu/lbm	h Btu/lbm	s Btu/(lbm · R)
	$P = 10$ psia ($T_{\text{sat}} = -29.71^\circ\text{F}$)				$P = 15$ psia ($T_{\text{sat}} = -14.25^\circ\text{F}$)			
Sat.	4.3581	89.30	97.37	0.2265	2.9747	91.40	99.66	0.2242
-20	4.4718	90.89	99.17	0.2307	–	–	–	–
0	4.7026	94.24	102.94	0.2391	3.0893	93.84	102.42	0.2303
20	4.9297	97.67	106.79	0.2472	3.2468	97.33	106.34	0.2386
40	5.1539	101.19	110.72	0.2553	3.4012	100.89	110.33	0.2468
60	5.3758	104.80	114.74	0.2632	3.5533	104.54	114.40	0.2548
80	5.5959	108.50	118.85	0.2709	3.7034	108.28	118.56	0.2626
100	5.8145	112.29	123.05	0.2786	3.8520	112.10	122.79	0.2703
120	6.0318	116.18	127.34	0.2861	3.9993	116.01	127.11	0.2779
140	6.2482	120.16	131.72	0.2935	4.1456	120.00	131.51	0.2854
160	6.4638	124.23	136.19	0.3009	4.2911	124.09	136.00	0.2927
180	6.6786	128.38	140.74	0.3081	4.4359	128.26	140.57	0.3000
200	6.8929	132.63	145.39	0.3152	4.5801	132.52	145.23	0.3072
	$P = 20$ psia ($T_{\text{sat}} = -2.48^\circ\text{F}$)				$P = 30$ psia ($T_{\text{sat}} = -15.38^\circ\text{F}$)			
Sat.	2.2661	93.00	101.39	0.2227	1.5408	95.40	103.96	0.2209
0	2.2816	93.43	101.88	0.2238	–	–	–	–
20	2.4046	96.98	105.88	0.2323	1.5611	96.26	104.92	0.2229
40	2.5244	100.59	109.94	0.2406	1.6465	99.98	109.12	0.2315
60	2.6416	104.28	114.06	0.2487	1.7293	103.75	113.35	0.2398
80	2.7569	108.05	118.25	0.2566	1.8098	107.59	117.63	0.2478
100	2.8705	111.90	122.52	0.2644	1.8887	111.49	121.98	0.2558
120	2.9829	115.83	126.87	0.2720	1.9662	115.47	126.39	0.2635
140	3.0942	119.85	131.30	0.2795	2.0426	119.53	130.87	0.2711
160	3.2047	123.95	135.81	0.2869	2.1181	123.66	135.42	0.2786
180	3.3144	128.13	140.40	0.2922	2.1929	127.88	140.05	0.2859
200	3.4236	132.40	145.07	0.3014	2.2671	132.17	144.76	0.2932
220	3.5323	136.76	149.83	0.3085	2.3407	136.55	149.54	0.3003
	$P = 40$ psia ($T_{\text{sat}} = 29.04^\circ\text{F}$)				$P = 50$ psia ($T_{\text{sat}} = 40.27^\circ\text{F}$)			
Sat.	1.1692	97.23	105.88	0.2197	0.9422	98.71	107.43	0.2189
40	1.2065	99.33	108.26	0.2245	–	–	–	–
60	1.2723	103.20	112.62	0.2331	0.9974	102.62	111.85	0.2276
80	1.3357	107.11	117.00	0.2414	1.0508	106.62	116.34	0.2361
100	1.3973	111.08	121.42	0.2494	1.1022	110.65	120.85	0.2443
120	1.4575	115.11	125.90	0.2573	1.1520	114.74	125.39	0.2523
140	1.5165	119.21	130.43	0.2650	1.2007	118.88	129.99	0.2601
160	1.5746	123.38	135.03	0.2725	1.2484	123.08	134.64	0.2677
180	1.6319	127.62	139.70	0.2799	1.2953	127.36	139.34	0.2752
200	1.6887	131.94	144.44	0.2872	1.3415	131.71	144.12	0.2825
220	1.7449	136.34	149.25	0.2944	1.3873	136.12	148.96	0.2897
240	1.8006	140.81	154.14	0.3015	1.4326	140.61	153.87	0.2969
260	1.8561	145.36	159.10	0.3085	1.4775	145.18	158.85	0.3039
280	1.9112	149.98	164.13	0.3154	1.5221	149.82	163.90	0.3108