AIR LIQUIDE

Data Book

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Industrial & Specialty Gas Data Book

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INTRODUCTION

This book is designed to provide a convenient source of information for anyone who works with or studies industrial gases. It is published by Air Liquide America, a subsidiary of Air Liquide, the world's largest industrial gas company. Through Air Liquide America, Air Liquide markets tonnage and merchant gases to industrial, commercial, and public facilities throughout North America. Air Liquide is active in more than 60 countries around the world.

The data is based on sources using standard industry references. It is believed to be accurate, but is recommended for use as a guideline only. More detailed information can be obtained by contacting your Air Liquide America representative.

Put Safety First!
In handling industrial gases or working in environments where they are present, beware of confined spaces where there is a limited oxygen supply. Confined spaces that may present a danger include:

- Tanks on railroad cars and highway vehicles, storage tanks, mixing tanks
- Air separation cold boxes and similar insulated cavities, silos, furnace boxes, combustion chambers, etc.
- Pits and deep depressions, sewers, etc.
- Reaction kettles, stills, receivers, steam drums
- Acetylene generators and gas holders

In situations where atmospheric air is not provided or where breathing equipment is not available, you should follow the Tank Procedures of Air Liquide America or other organizations.

All data set forth herein is provided for general information only and is based on generally accepted tests and on published data from standard technical reference works. The accuracy or completeness of any such information, test, or data is not warranted in any way.

OXYGEN CONVERSION DATA

	Weight		Gas		Liquid	
	pounds (lb)	kilograms (kg)	cubic feet (scf)	cu meters (nm^3)	gallons (gal)	liters (l)
1 pound	1.0	0.4536	12.076	0.3174	0.105	0.3977
1 kilogram	2.205	1.0	26.62	0.6998	0.2316	0.8767
1 scf gas	0.08281	0.03756	1.0	0.02628	0.008691	0.0329
1 nm^3 gas	3.151	1.4291	38.04	1.0	0.3310	1.2528
1 gallon liquid	9.527	4.322	115.1	3.025	1.0	3.785
1 liter liquid	2.517	1.1417	30.38	0.7983	0.2642	1.0
1 ton	2000	907.2	24,160	635	209.9	794.5

NITROGEN CONVERSION DATA

	Weight		Gas		Liquid	
	pounds (lb)	kilograms (kg)	cubic feet (scf)	cu meters (nm^3)	gallons (gal)	liters (l)
1 pound	1.0	0.4536	13.803	0.3627	0.1481	0.5606
1 kilogram	2.205	1.0	30.42	0.7996	0.3262	1.2349
1 scf gas	0.07245	0.03286	1.0	0.02628	0.01074	0.04065
1 nm^3 gas	2.757	1.2506	38.04	1.0	0.4080	1.5443
1 gallon liquid	6.745	3.06	93.11	2.447	1.0	3.785
1 liter liquid	1.782	0.8083	24.60	0.6464	0.2642	1.0
1 ton	2000	907.2	27,605	725.4	296.2	1121

Scf (standard cubic foot) gas measured at 1 atmosphere and 70°F. Nm^3 (normal cubic meter) gas measured at 1 atmosphere and 0°C.
Liquid measured at 1 atmosphere and boiling temperature. All values rounded to nearest 4/5 significant numbers.

ARGON CONVERSION DATA

	Weight		Gas		Liquid	
	pounds (lb)	kilograms (kg)	cubic feet (scf)	cu meters (nm^3)	gallons (gal)	liters (l)
1 pound	1.0	0.4536	9.671	0.2543	0.08600	0.3255
1 kilogram	2.205	1.0	21.32	0.5605	0.18957	0.7176
1 scf gas	0.1034	0.04690	1.0	0.02628	0.008893	0.03366
1 nm^3 gas	3.933	1.7840	38.04	1.0	0.3382	1.2802
1 gallon liquid	11.630	5.276	112.5	2.957	1.0	3.785
1 liter liquid	3.072	1.3936	29.71	0.7812	0.2642	1.0
1 ton	2000	907.2	19,342	508.6	172	651.0

NEON CONVERSION DATA

	Weight		Gas		Liquid	
	pounds (lb)	kilograms (kg)	cubic feet (scf)	cu meters (nm^3)	gallons (gal)	liters (l)
1 pound	1.0	0.4536	19.18	0.504	0.09928	0.3758
1 kilogram	2.205	1.0	42.27	1.1112	0.2191	0.8292
1 scf gas	0.05215	0.02366	1.0	0.02628	0.005177	0.019594
1 nm^3 gas	1.984	0.8999	38.04	1.0	0.1971	0.7462
1 gallon liquid	10.065	4.565	193.2	5.077	1.0	3.785
1 liter liquid	2.661	1.207	51.03	1.341	0.2642	1.0

Scf (standard cubic foot) gas measured at 1 atmosphere and 70°F. Nm^3 (normal cubic meter) gas measured at 1 atmosphere and 0°C. Liquid measured at 1 atmosphere and boiling temperature. All values rounded to nearest 4/5 significant numbers.

HELIUM CONVERSION DATA

	Weight		Gas		Liquid	
	pounds (lb)	kilograms (kg)	cubic feet (scf)	cu meters (nm^3)	gallons (gal)	liters (l)
1 pound	1.0	0.4536	96.71	2.542	0.95930	3.631
1 kilogram	2.205	1.0	213.2	5.603	2.115	8.006
1 scf gas	0.01034	0.00469	1.0	0.02628	0.009919	0.03754
1 nm^3 gas	0.3935	0.1785	38.04	1.0	0.3775	1.4289
1 gallon liquid	1.042	0.4728	100.8	2.649	1.0	3.785
1 liter liquid	0.2754	0.1249	26.63	0.6998	0.2642	1.0

HYDROGEN CONVERSION DATA

	Weight		Gas		Liquid	
	pounds (lb)	kilograms (kg)	cubic feet (scf)	cu meters (nm^3)	gallons (gal)	liters (l)
1 pound	1.0	0.4536	192.00	5.047	1.6928	6.408
1 kilogram	2.205	1.0	423.3	11.126	3.733	14.128
1 scf gas	0.005209	0.002623	1.0	0.02628	0.008820	0.03339
1 nm^3 gas	0.19815	0.08988	38.04	1.0	0.3355	1.2699
1 gallon liquid	0.5906	0.2679	113.41	2.981	1.0	3.785
1 liter liquid	0.15604	0.07078	29.99	0.7881	0.2642	1.0

Scf (standard cubic foot) gas measured at 1 atmosphere and 70°F. Nm^3 (normal cubic meter) gas measured at 1 atmosphere and 0°C.
Liquid measured at 1 atmosphere and boiling temperature. All values rounded to nearest 4/5 significant numbers.
Hydrogen gas values expressed in the stable condition 75% ortho, 25% para. Hydrogen liquid values expressed in the stable para condition.

KRYPTON CONVERSION DATA

	Weight		Gas		Liquid	
	pounds (lb)	kilograms (kg)	cubic feet (scf)	cubic meters (nm^3)	gallons (gal)	liters (l)
1 pound	1.0	0.4536	4.604	0.12098	0.04967	0.188
1 kilogram	2.205	1.0	10.147	0.2667	0.10939	0.4141
1 scf gas	0.2172	0.09582	1.0	0.02628	0.010773	0.04078
1 nm^3 gas	8.266	3.7490	38.04	1.0	0.4101	1.5525
1 gallon liquid	20.130	9.131	92.69	2.436	1.0	3.785
1 liter liquid	5.318	2.412	24.51	0.6441	0.2642	1.0

XENON CONVERSION DATA

	Weight		Gas		Liquid	
	pounds (lb)	kilograms (kg)	cubic feet (scf)	cubic meters (nm^3)	gallons (gal)	liters (l)
1 pound	1.0	0.4536	2.93	0.07692	0.03921	0.1484
1 kilogram	2.205	1.0	6.451	0.16958	0.08642	0.3271
1 scf gas	0.3416	0.15495	1.0	0.02628	0.013392	0.05069
1 nm^3 gas	13	5.897	38.04	1.0	0.5096	1.9291
1 gallon liquid	25.51	11.572	74.67	1.9623	1.0	3.785
1 liter liquid	6.738	3.056	19.726	0.5185	0.2642	1.0

Scf (standard cubic foot) gas measured at 1 atmosphere and 70°F. Nm^3 (normal cubic meter) gas measured at 1 atmosphere and 0°C. Liquid measured at 1 atmosphere and boiling temperature. All values rounded to nearest 4/5 significant numbers.

OZONE CONVERSION DATA

	Weight		Gas		Liquid	
	pounds (lb)	kilograms (kg)	cubic feet (scf)	cubic meters (nm^3)	gallons (gal)	liters (l)
1 pound	1.0	0.4536	8.060	0.2118	0.089	0.3355
1 kilogram	2.205	1.0	17.77	0.4671	0.1954	0.7397
1 scf gas	0.12406	0.05626	1.0	0.02628	0.011862	0.0449
1 nm^3 gas	4.720	2.141	38.04	1.0	0.4525	1.7127
1 gallon liquid	11.283	5.117	84.3	2.21	1.0	3.785
1 liter liquid	2.981	1.352	22.28	0.5857	0.2642	1.0

CARBON MONOXIDE CONVERSION DATA

	Weight		Gas		Liquid	
	pounds (lb)	kilograms (kg)	cubic feet (scf)	cubic meters (nm^3)	gallons (gal)	liters (l)
1 pound	1.0	0.4536	13.793	0.3629	0.1475	0.5583
1 kilogram	2.205	1.0	30.414	0.8001	0.3252	1.2309
1 scf gas	0.0725	0.0329	1.0	0.02628	0.0106	0.0401
1 nm^3 gas	2.75	1.2474	38.04	1.0	0.4056	1.5352
1 gallon liquid	6.78	3.075	93.516	2.4605	1.0	3.785
1 liter liquid	1.791	.8125	24.703	0.6499	0.2642	1.0

Scf (standard cubic foot) gas measured at 1 atmosphere and 70°F. Nm^3 (normal cubic meter) gas measured at 1 atmosphere and 0°C.
Liquid measured at 1 atmosphere and boiling temperature. All values rounded to nearest 4/5 significant numbers.

CARBON DIOXIDE CONVERSION DATA

	Weight			Gas		Liquid		Solid
	pounds	tons	kilograms	cubic feet	cubic meters	gallons	liters	cubic feet
	lb	t	kg	scf	nm^3	gal	l	cu ft
1 pound	1.0	0.0005	0.4536	8.741	0.2294	0.11806	0.4469	0.010246
1 ton	2000.0	1.0	907.2	17,483	458.8	236.1	893.9	20.49
1 kilogram	2.205	0.0011023	1.0	19.253	0.5058	0.2603	0.9860	0.226
1 scf gas	0.1144	–	0.05189	1.0	0.02628	0.013508	0.05113	0.0011723
1 nm^3 gas	4.359	0.00218	1.9772	38.04	1.0	0.5146	1.948	0.04468
1 gallon liquid	8.470	0.004235	3.842	74.04	1.9431	1.0	3.785	0.08678
1 liter liquid	2.238	0.0011185	1.0151	19.562	0.5134	0.2642	1.0	0.02293
1 cu ft solid	97.56	0.0488	44.25	852.8	22.38	11.518	43.60	1.0

Scf (standard cubic feet) gas measured at 1 atmosphere and 70°F. Nm3 (normal cubic meter) gas measured at 1 atmosphere and 0°C. Liquid measured at 21.42 atmospheres and 1.7°F. Solid measured at –109.25° F. All values rounded to nearest 4/5 significant numbers.

PROPYLENE CONVERSION DATA

	pounds	cubic feet
1 pound	–	8.89
1 gallon	4.35	–

*Vapor pressure @ 70°F and 130 psi

	pounds	cubic feet
1 pound	–	8.62
1 gallon	4.23	–

*Vapor pressure @ 70°F and 120 psi

METHANOL AND DISSOCIATED METHANOL CONVERSION DATA

	Weight		Gas (Dissociated)		Gas (Undissociated)		Liquid	
	pounds lb	kilograms kg	cubic feet scf	cu meters nm^3	cubic feet scf	cu meters nm^3	gallons gal	liters l
1 pound	1.0	0.4536	36.1423	0.94982	12.04744	0.3166	0.151315	0.5727
1 kilogram	2.205	1.0	79.6788	2.09396	26.55961	0.6980	0.3336	1.2626
1 scf gas dissociated	0.0277	0.01255	1.0	0.02628	0.3333	0.00876	0.004187	0.0158
1 nm^3 gas dissociated	1.0528	0.4776	38.04	1.0	12.68	0.3333	0.1593	0.6030
1 scf gas undissociated	0.0830	0.0377	3	0.07884	1.0	0.02628	0.01256	0.048
1 nm^3 gas undissociated	3.1585	1.4327	114.16	3	38.04	1.0	0.47927	1.8090
1 gas liquid	6.609	2.9977	238.855	6.277106	79.61828	2.09	1.0	3.785
1 liter liquid	1.7460	0.7920	63.1056	1.658416	21.03521	0.55	0.2642	1.0

AMMONIA AND DISSOCIATED AMMONIA CONVERSION DATA

	Weight		Gas (Dissociated)		Gas (Undissociated)		Liquid	
	pounds lb	kilograms kg	cubic feet scf	cu meters Nm^3	cubic feet scf	cu meters nm^3	gallons gal	liters l
1 pound	1.0	0.4536	45.3318	1.19132	22.6659	0.5957	0.1467	0.5552
1 kilogram	2.2050	1.0	99.9378	2.62636	49.9689	1.3132	0.3234	1.2240
1 scf gas dissociated	0.0221	0.0100	1.0	0.02628	0.50	0.0131	0.0032	0.0122
1 nm^3 gas dissociated	0.8394	0.3808	38	1.0	19.03	0.5	0.1231	0.466
1 scf gas undissociated	0.0441	0.0200	2.00	0	1.0	0.02628	0.0065	0.0240
1 nm^3 gas undissociated	1.679	0.7615	76.100	2.0	38.04	1.0	0.24626	0.9321
1 gas liquid	6.8170	3.0923	309.042	8.12162	154.521	4.06	1.0	3.785
1 liter liquid	1.8011	0.817	81.6491	2.14574	40.8246	1.07	0.2642	1.0

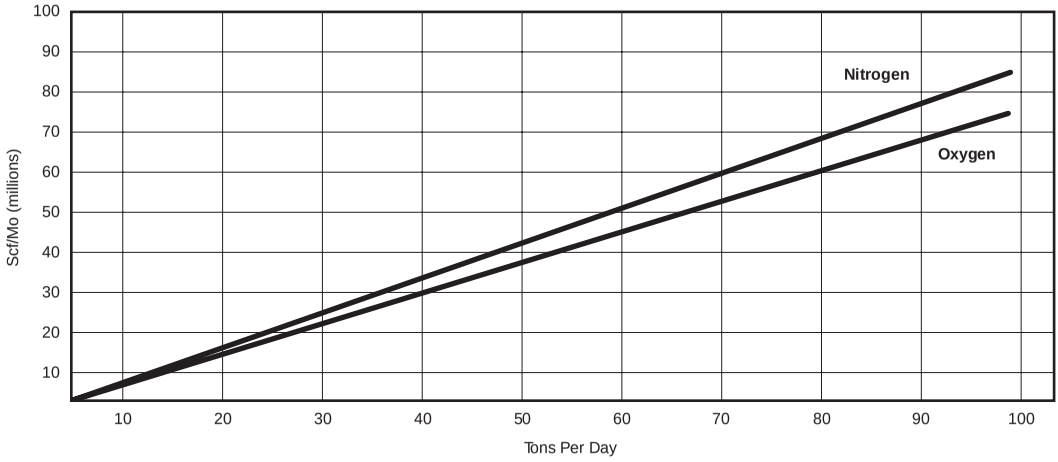
TONNAGE CONVERSION FACTORS*

Oxygen		Nitrogen		Hydrogen	
1 lb gaseous oxygen = 12.08 scf @ 14.7 psia and 70°F		1 lb gaseous nitrogen = 13.80 scf @ 14.7 psia and 70°F		1 lb gaseous hydrogen = 192.0 scf @ 14.7 psia and 70°F	
1 ton gaseous oxygen = 24,160 scf @ 14.7 psia and 70°F		1 ton gaseous nitrogen = 27,605 scf @ 14.7 psia and 70°F		1 ton gaseous hydrogen = 383,950 scf @ 14.7 psia and 70°F	
scf/mo (millions)	**ton/day**	**scf/mo (millions)**	**ton/day**	**scf/mo (millions)**	**ton/day**
1	1.38	1	1.21	1	0.087
2	2.76	2	2.42	2	0.174
3	4.14	3	3.62	3	0.26
4	5.52	4	4.83	4	0.35
5	6.90	5	6.04	5	0.43
6	8.28	6	7.25	6	0.52
7	9.66	7	8.45	7	0.61
8	11.04	8	9.66	8	0.69
9	12.42	9	10.87	9	0.78
10	13.80	10	12.08	10	0.87
20	27.59	20	24.15	20	1.74
30	41.39	30	36.23	30	2.60
40	55.19	40	48.30	40	3.47
50	69.98	50	60.38	50	4.34
ton/day	**scf/mo (millions)**	**ton/day**	**scf/mo (millions)**	**ton/day**	**scf/mo (millions)**
10	7.25	10	8.28	10	115.2
12.5	9.06	12.5	10.35	12.5	114
25	18.12	25	20.70	25	288
50	36.24	50	41.41	50	575
75	54.36	75	62.11	75	864
100	72.5	100	82.82	100	1,152

*Based on a 30-day month.

TONNAGE CONVERSION CHART

To obtain values for plants of larger size, multiply each value by the same factor.



AREA CONVERSION FACTORS

Area	Multiply units in left column by proper factor below:							
	sq in	sq ft	acre	sq mile	sq cm	sq m	hectare	
1 sq inch	1	0.0069	–	–	6.452	–	–	
1 sq foot	144	1	–	–	929.0	0.0929	–	
1 acre	–	43,560	1	0.001563	–	4047	0.4047	
1 sq mile	–	27,878,400	640	1	–	2,590,000	259.0	
1 sq centimeter	0.1550	0.001076	–	–	1	0.0001	–	
1 sq meter	1550	10.76	0.000247	–	10,000	1	–	
1 hectare	–	–	2.471	–	–	10,000	1	

VOLUME CONVERSION FACTORS

Volume	Multiply units in left column by proper factor below:							
	cu in	cu ft	cu yd	cu cm	cu meter	liter	US gallon	Imp gal
1 cu inch	1	–	–	16.387	–	0.0164	0.00433	–
1 cu foot	1728	1	0.0370	28,317	0.0283	28.32	7.481	6.229
1 cu yard	46,656	27	1	–	0.7646	764.6	202.0	168.2
1 cu centimeter	0.0610	–	–	1	–	0.001	–	–
1 cu meter	61,024	35.31	1.308	1,000,000	1	1,000	264.2	220.0
1 liter	61.024	0.0353	–	1,000	0.001	1	0.2642	0.2200
1 US gallon	231	0.1337	–	3785.4	–	3.785	1	0.8327
1 Imperial gallon	227.4	0.1605	–	4546.10	–	4.546	1.201	1

LENGTH CONVERSION FACTORS

Length	Multiply units in left column by proper factor below:							
	in	ft	yd	mile	mm	cm	m	km
1 inch	1	0.0833	0.0278	–	25.4	2.54	0.0254	–
1 foot	12	1	0.3333	–	304.8	30.48	0.3048	–
1 yard	36	3	1	–	914.4	91.44	0.9144	–
1 mile	–	5280	1760	1	–	–	1069.3	1.609
1 millimeter	0.0394	0.0033	–	–	1	0.1	0.001	–
1 centimeter	0.3937	0.03281	0.0109	–	10	1	0.01	–
1 meter	39.37	3.281	1.094	–	1000	100	1	0.001
1 kilometer	–	3281	1094	0.6214	–	–	1000	1

1 micron = 0.001 millimeter

WEIGHT CONVERSION FACTORS

Weight	Multiply units in left column by proper factor below:							
	grain	oz	lb	ton	gram	kg	metric ton	
1 grain	1	–	–	–	0.0648	–	–	
1 ounce	437.5	1	0.0625	–	28.35	0.02835	–	
1 pound	7000	16	1	0.0005	453.6	0.4536	–	
1 ton	–	32,000	2000	1	–	907.2	0.9072	
1 gram	15.43	0.0353	–	–	1	0.001	–	
1 kilogram	–	35.274	2.205	–	1000	1	0.001	
1 metric ton	–	35,274	2205	1.102	–	1000	1	

DENSITY CONVERSION FACTORS

Density	Multiply units in left column by proper factor below:				
	lb/cu in	lb/cu ft	lb/gal	g/cu cm	g/liter
1 pound/cu in	1	1728	231.0	27.68	27,680
1 pound/cu ft	–	1	0.1337	0.016	16.019
1 pound/gal	0.00433	7.481	1	0.1198	119.83
1 gram/cu cm	0.03613	62.43	8.345	1	1,000
1 gram/liter	–	0.06243	0.008345	0.001	1

PRESSURE CONVERSION FACTORS

Pressure	Multiply units in left column by proper factor below:						
	lb/sq in	int atm	kg/cm^2	mm Hg at 32°F	in Hg at 32°F	ft water at 39.2°F	bar
1 pound/sq in	1	0.06804	0.0703	51.713	2.0359	2.307	0.06896
1 int atmosphere	14.696	1	1.0333	760	29.921	33.90	1.01325
1 kilogram/sq cm	14.223	0.9678	1	735.56	28.958	32.81	0.9806
1 mmHg (Torr)	0.0193	0.00132	0.00136	1	0.0394	0.0446	0.00133
1 inch mercury	0.4912	0.0334	0.0345	25.400	1	1.133	0.03386
1 foot water	0.4335	0.0295	0.0305	22.418	0.8826	1	0.02989
1 bar	14.5	0.987	1.0198	750.06	29.529	33.455	1

ENERGY CONVERSION FACTORS

Energy	Multiply units in left column by proper factor below:					
	ft-lb	Btu	g-cal	Joule	kw-hr	hp-hr
1 foot–pound	1	0.001285	0.3239	1.3558	–	–
1 Btu	778.2	1	252.00	1053.1	–	–
1 gram–calorie	3.0880	0.003968	1	4.1868	–	–
1 int Joule	0.7376	0.000948	0.2388	1	–	–
1 int kilowatt–hour	2,655,000	3412.8	859,845	–	1	1.3410
1 horsepower–hour	1,980,000	2545	641,186	–	0.7457	1

SPECIFIC ENERGY CONVERSION FACTORS

Specific Energy	Multiply units in left column by proper factor below:				
	absolute Joule/g	int Joule/g	cal/g	int cal/g	Btu/lb
1 absolute Joule/gram	1	0.99984	0.23901	0.23885	0.42993
1 int Joule/gram	1.000165	1	0.23904	0.23892	0.43000
1 calorie/gram	4.1840	4.1833	1	0.99935	1.7988
1 int calorie/gram	4.1867	4.1860	1.00065	1	1.8000
1 Btu/lb	2.3260	2.3256	0.55592	0.55556	1

POWER CONVERSION FACTORS

Power (rate of energy use)	Multiply units in left column by proper factor below:								
	hp	watt	kw	Btu/min	Btu/hr	ft-lb/sec	ft-lb/min	g-cal/sec	metric hp
1 horsepower	1	745.7	0.7457	42.41	2545	550	33,000	178.0	1.014
1 watt	–	1	0.001	0.057	3.412	0.7376	44.25	0.2388	0.00136
1 kilowatt	1.3410	1000	1	56.87	3412.1	737.6	44,254	238.8	1,360
1 Btu per minute	–	–	–	1	60	12.97	778.2	4.199	0.0239
1 metric hp	0.9863	735.5	0.7355	41.83	2509.6	542.5	32.550	175.7	1

REFRIGERATION CONVERSION FACTORS

Refrigeration	Multiply units in left column by factor below:					
	Btu (IT)/min	Btu (IT)/hr	kg cal/hr	ton (US) comm	ton (Brit) comm	frigorie/hr
1 ton (US) comm	200	12,000	3025.9	1	0.8965	3025.9
1 ton (British) comm	223.08	13,385	3375.2	1.1154	1	3375.2
1 frigorie/hr	0.06609	3.9657	1	0.0003305	0.0002963	1

Btu is International Steam Table Btu (IT). 1 frigorie = 1 kg cal (NOT IT)

One ton of refrigeration is the heat required to melt one ton (2000 lbs) of ice at 32°F to water at 32°F during 24 hours.

REFRIGERATION VALUES TO +40°F FOR EXPENDABLE REFRIGERANTS

Refrigerant	Refrigerant Temp °F	Pressure psia	Latent Heat Btu/Lb	Sensible Heat Btu/Lb	Total Heat Btu/Lb
Ice (H_2O)	32	14.7	144	8	152
Liquid CO_2 (flashed to snow)	–109	14.7	113.0*	29.8	149.8
Dry Ice	–109	14.7	246.3	29.8	276.1

Ice (H_2O) has a liquid residue while remaining refrigerants are converted to the gas phase. CO_2 snow is flashed from liquid CO_2 at 314.7 psia storage pressure. Snow yield is 46% by weight. Liquid carbon dioxide is stored at zero degrees and maintained at zero degrees by a mechanical refrigerator. This permits storage of liquid carbon dioxide without loss. Dry ice pellets are manufactured by compressing CO_2 snow in an extrusion machine.

*This latent heat value is Btu per pound of liquid CO_2

NITROGEN REFRIGERATION CONVERSION FACTORS

PSIG	Refrigerant Temp °F	Pressure psia	Latent Heat Btu/Lb	Sensible Heat Btu/Lb	Total Heat Btu/Lb
0 at 1 atm	–320.4	14.7	85.4	90.8	176.2
15 at 30 psia	–308.6	30	81.5	88.9	170.4
26 at 40 psia	–303.2	40	79.8	87.9	167.7
36 at 50 psia	–298.7	50	77.7	87.4	165.1
56 at 70 psia	–291.3	70	74.7	86.4	161.5

VELOCITY CONVERSION FACTORS

Multiply	By	To Obtain
Feet Per Minute	0.01136	Miles per hour
	0.01829	Kilometers per hour
	0.508	Centimeters per second
	0.01667	Feet per second
Feet Per Second	0.6818	Miles per hour
	1.097	Kilometers per hour
	30.48	Centimeters per second
	0.3048	Meters per second
	0.5921	Knots
Meters Per Second	3.281	Feet per second
	2.237	Miles per hour
	3.6	Kilometers per hour
Miles Per Hour	1.467	Feet per second
	0.447	Meters per second
	1.609	Kilometers per hour
	0.8684	Knots

MISCELLANEOUS CONVERSION FACTORS

Multiply	By	To Obtain
Atmospheres	33.94	Feet of H_2O (x 12 = Inches of H_2O)
Atmospheres	29.92	Inches of mercury
Atmospheres	14.7	Pounds per square inch
Barrels (oil)	5.6146	Cubic feet
Barrels (oil)	42	Gallons
Barrels per hour	0.7	Gallons per minute
Cubic feet	0.1781	Barrels
Cubic feet	7.4805	Gallons (U.S.)
Feet	0.3048	Meters
Feet of water at 60°F	0.4331	Pounds per square inch
Feet per second	0.68182	Miles per hour
Gallons (U.S.)	0.02381	Barrels
Gallons (U.S.)	0.1337	Cubic feet
Gallons (U.S.)	231	Cubic inches
Gallons per minute	1.429	Barrels per hour
Parts per million	8.337	Pounds per million gallons
Pounds per square inch	2.309	Feet of water at 60°F (x 12 = inches of H_2O)
Pounds per square inch	2.036	Inches of mercury at 32°F
Pounds per million gallons	0.11982	Parts per million
Water (U.S. gallon)	8.337	Pounds per gallon of water
Water (U.S. gallon)	62.365	Pounds per cubic feet of water

DEWPOINT TO PPM CONVERSION TABLE

Dew Point (F)	PPM H_2O	Percent H_2O	Dew Point (F)	PPM	Percent H_2O	Dew Point (F)	PPM H_2O	Percent H_2O
83	38727	3.8727	62	18917	1.8917	41	9272	0.9272
82	37432	3.7432	61	18336	1.8336	40	8874	0.8874
81	36138	3.6138	60	17754	1.7754	39	8475	0.8475
80	34844	3.4844	59	17174	1.7174	38	8077	0.8077
79	33842	3.3842	58	16593	1.6593	37	7679	0.7679
78	32840	3.2840	57	16011	1.6011	36	7281	0.7281
77	31838	3.1838	56	15430	1.5430	35	6883	0.6883
76	30836	3.0836	55	14849	1.4849	34	6633	0.6633
75	29833	2.9833	54	14268	1.4268	33	6383	0.6383
74	28831	2.8831	53	13687	1.3687	32	6133	0.6133
73	27829	2.7829	52	13329	1.3329	31	5883	0.5883
72	26827	2.6827	51	12971	1.2971	30	5633	0.5633
71	25825	2.5825	50	12613	1.2613	29	5383	0.5383
70	25057	2.5057	49	12255	1.2255	28	5133	0.5133
69	24290	2.4290	48	11898	1.1898	27	4883	0.4883
68	23522	2.3522	47	11540	1.1540	26	4633	0.4633
67	22755	2.2755	46	11182	1.1182	25	4453	0.4453
66	21987	2.1987	45	10824	1.0824	24	4274	0.4274
65	21220	2.1220	44	10466	1.0466	23	4094	0.4094
64	20452	2.0452	43	10068	1.0068	22	3915	0.3915
63	19685	1.9685	42	9670	0.9670	21	3735	0.3735

*10,000 PPM = 1.0%

DEWPOINT TO PPM CONVERSION TABLE

Dew Point (F)	PPM H_2O	Percent H_2O	Dew Point (F)	PPM H_2O	Percent H_2O	Dew Point (F)	PPM H_2O	Percent H_2O
20	3556	0.3556	–1	1220	0.1220	–22	378	0.0378
19	3376	0.3376	–2	1153	0.1153	–23	359	0.0359
18	3197	0.3197	–3	1087	0.1087	–24	330	0.0330
17	3017	0.3017	–4	1020	0.1020	–25	317	0.0317
16	2897	0.2897	–5	970	0.0970	–26	300	0.0300
15	2776	0.2776	–6	920	0.0920	–27	283	0.0283
14	2656	0.2656	–7	870	0.0870	–28	265	0.0265
13	2535	0.2535	–8	820	0.0820	–29	250	0.0250
12	2415	0.2415	–9	780	0.0780	–30	235	0.0235
11	2294	0.2294	–10	740	0.0740	–31	222	0.0222
10	2174	0.2174	–11	700	0.0700	–32	210	0.0210
9	2053	0.2053	–12	660	0.0660	–33	196	0.0196
8	1933	0.1933	–13	630	0.0630	–34	105	0.0105
7	1854	0.1854	–14	590	0.0590	–35	174	0.0174
6	1775	0.1775	–15	560	0.0560	–36	164	0.0164
5	1695	0.1695	–16	530	0.0530	–37	153	0.0153
4	1616	0.1616	–17	500	0.0500	–38	144	0.0144
3	1537	0.1537	–18	475	0.0475	–39	136	0.0136
2	1458	0.1458	–19	448	0.0448	–40	128	0.0128
1	1378	0.1378	–20	422	0.0422	–41	119	0.0119
0	1299	0.1299	–21	400	0.0400	–42	113	0.0113

*10,000 PPM = 1.0%

DEWPOINT TO PPM CONVERSION TABLE

Dew Point (F)	PPM H_2O	Percent H_2O	Dew Point (F)	PPM H_2O	Percent H_2O	Dew Point (F)	PPM H_2O	Percent H_2O
–43	105	0.01050	–59	36.5	0.00365	–75	11.4	0.00114
–44	98	0.00980	–60	34.0	0.00340	–76	10.5	0.00105
–45	92	0.00920	–61	31.7	0.00317	–77	9.8	0.00098
–46	87	0.00870	–62	29.4	0.00294	–78	9.1	0.00091
–47	82	0.00820	–63	27.5	0.00275	–79	8.4	0.00084
–48	76	0.00760	–64	25.6	0.00256	–80	7.8	0.00078
–49	72	0.00720	–65	23.6	0.00236	–81	7.2	0.00072
–50	67	0.00670	–66	22.1	0.00221	–82	6.6	0.00066
–51	62	0.00620	–67	20.6	0.00206	–83	6.2	0.00062
–52	59	0.00590	–68	19.2	0.00192	–84	5.7	0.00057
–53	55	0.00550	–69	17.9	0.00179	–85	5.3	0.00053
–54	51	0.00510	–70	16.6	0.00166	–86	4.78	0.000478
–55	48	0.00480	–71	15.4	0.00154	–87	4.50	0.00045
–56	44.6	0.00446	–72	14.3	0.00143	–88	4.15	0.000415
–57	41.8	0.00418	–73	13.3	0.00133	–89	3.84	0.000384
–58	39.0	0.00390	–74	12.3	0.00123	–90	3.53	0.000353

*10,000 PPM = 1.0%

PHYSICAL PROPERTIES (ENGLISH)

Substance	Chem. Symbol	Molecular Weight	Liquid Phase Liquid @ B.P. & @1 atm		Boiling Point @ 1 atm		Gaseous Phase Gas @ 32°F & @1 atm			Triple Point		Critical Point			Thermal Conductivity
			Specific Gravity	Specific Heat Cp	Temp.	Latent Heat of Vaporization	Specific Gravity	Specific Heat Cp	Density	Temp.	Pressure	Temp.	Pressure	Density	@ 80° F
			Water=1	BTU/lb °F	° F	BTU/lb	Air=1	BTU/lb°F	lb/cu. ft	°F	psia	°F	psia	lb/cu ft	BTU/ft h °F
Helium	He	4.00	0.124	1.086	-452.06	8.72	0.139	1.25	0.01114	NONE	NONE	-450.31	33	4.347	0.0906
Neon	Ne	20.18	1.207	0.4483	-410.9	37.08	0.701	0.25	0.05621	-415.4	6.29	-379.8	384.9	30.15	0.01385
Argon	Ar	39.95	1.4	0.2575	-302.6	69.8	1.39	0.125	0.11135	-308.8	9.99	-188.1	711.5	33.44	0.01035
Krypton	Kr	83.80	2.41	0.1273	-244	46.2	2.887	0.06	0.2315	-251.3	10.6	-82.8	798	56.7	0.0055
Xenon	Xe	131.30	3.06	0.08121	-162.6	41.4	4.55	0.038	0.365	-169.2	11.84	61.9	847	68.67	0.00317
Hydrogen	H_2	2.02	0.071	2.309	-423	191.7	0.06998	3.425	0.005611	-434.6	1.045	-399.93	190.8	1.88	0.1081
Nitrogen	N_2	28.01	0.808	0.4877	-320.4	85.6	0.9737	0.249	0.07807	-346.0	1.81	-232.4	493	19.6	0.01503
Oxygen	O_2	32.00	1.14	0.4058	-297.3	91.7	1.113	0.2197	0.089212	-361.8	0.02147	-181.43	731.4	27.22	0.0152
Ozone	O_3	47.99	1.352	-	-168.3	6530	1.656	9.41	-	-314.5	1.65	10.13	808.1	33.71	-
Air	-	28.98	0.873	0.4454	-317.8	88.2	1	0.241	0.08018	-352.1	-	-221.1	547	21.9	0.0151
Carbon Monoxide	CO	28.01	0.79	-	-312.7	92.79	0.9736	0.2478	0.07806	-337.1	2.2	-220.4	507.5	18.79	0.01445
Water	H_2O	18.02	0.95855	1.007	212	970.6	-	0.8784****	0.0368****	32.0	0.088	705.182	3200.5	20.1	0.01081
Hydrogen Sulfide	H_2S	34.08	0.9136	-	-76.4	235.6	1.198	0.245	0.09608	-	-	212.9	1306.5	21.6	0.0844
Sulfur Dioxide	SO_2	64.06	1.46	-	14	167.5	2.279	0.149	0.18272	-103.9	0.2429	315.4	1143	32.6	0.00555
Carbon Dioxide	CO_2	44.01	1.18***	-	-109.3*	245.5**	1.524	0.199	0.12341	-69.9	75.1	87.9	1070.6	29.2	0.00971
Ammonia	NH_3	17.03	0.6819	-	-28	589.3	0.6003	0.520	0.04813	-107.9	0.88	271.4	1657	14.7	0.0141
Methane	CH_4	16.04	0.425	0.8314	-258.68	219.22	0.559	0.593	0.0448	-296.5	1.69	-115.78	673.1	10.09	0.0197
Ethane	C_2H_6	30.07	0.546	-	-127.53	210.41	1.056	0.386	0.08469	-297.9	14.70	86.96	708.35	12.67	0.0123
Ethylene(Ethene)	C_2H_4	28.05	0.567	-	-154.8	208	0.978	0.399	0.07868	-272.5	1.0146	49.82	745	14.2	0.0119
Acetylene	C_2H_2	26.04	0.613	-	-118.4*	264***	0.906	0.383	0.07314	-116.0	17.7	96.8	907	14.4	0.0124
Propane	C_3H_8	44.10	0.58	-	-43.67	183.05	1.573	0.388	0.1261	-	-	206.01	616.3	13.5	0.0104
Propylene	C_3H_6	42.08	0.61	-	-53.9	188.18	1.481	0.355	0.11249	-	-	197.2	670	14.5	0.0104
Methanol	CH_3OH	32.04	0.795	0.6055	148.2	473	-	0.3274	49.44****	-143.4	-	464.1	1154.2	16.981	0.0081

*Sublimation point ** Sublimation Enthalpy *** Triple point **** Boiling point

PHYSICAL PROPERTIES (METRIC)

Substance	Chem. Symbol	Molecular Weight	Liquid Phase Liquid@B.P, &@101.325 kPa		Boiling Point @ 101.325 kPa		Gaseous Phase Gas @ 0° C & @ 101.325 kPa			Triple Point		Critical Point			Thermal Conductivity
			Specific Gravity	Specific Heat Cp	Temp.	Latent Heat of Vaporization	Specific Gravity	Specific Heat Cp	Density	Temp.	Pressure	Temp.	Pressure	Density	@ 300° K
			Water=1	kJ/kg ° C	° C	kJ/kg	Air=1	kJ/kg ° C	kg/m³	° C	kPa abs	° C	kPa abs	kg/m³	W/m °K
Helium	He	4.00	0.124	4.545	-268.9	20.28	0.139	5.19	0.17585	NONE	NONE	-267.9	227	69.64	0.1567
Neon	Ne	20.18	1.207	1.877	-246.0	86.3	0.701	1.05	0.9004	-248.6	43.4	-228.8	2654	483	0.0498
Argon	Ar	39.95	1.40	1.078	-185.9	162.3	1.39	0.523	1.7837	-199.3	68.9	-122.3	4905	535.6	0.0179
Krypton	Kr	83.80	2.41	0.533	-153.4	107.5	2.887	0.251	3.708	-157.4	73.2	-63.8	55402	908	0.0095
Xenon	Xe	131.30	3.06	0.34	-108.2	96.3	4.55	0.269	5.85	-111.8	81.6	16.6	5840	1100	0.0055
Hydrogen	H_2	2.02	0.071	9.668	-252.8	446.0	0.06998	14.34	0.08988	-259.2	7.205	-239.96	1315	30.12	0.1869
Nitrogen	N_2	28.01	0.808	2.042	-195.8	199.1	0.9737	1.04	1.2506	-210	12.5	-146.9	3399	314.9	0.026
Oxygen	O_2	32.00	1.14	1.669	-182.96	213.0	1.113	0.9191	1.429	-218.8	0.148	-188.57	5043	436.1	0.0263
Ozone	O_3	47.99	1.352	-	-111.3	151.9	1.656	39.37	-	-192.5	11.4	-12.15	55.73	540	-
Air	-	28.98	0.873	1.865	-194.3	205.0	1	1.01	1.2929	-213.4	-	-140.6	3771	351	0.0262
Carbon Monoxide	CO	28.01	0.79	-	-191.5	215.8	0.9736	1.037	1.2504	-205.1	15.2	-140.2	3499	301	0.025
Water	H_2O	18.02	0.95855	4.216	100.0	2256.9	-	2.0418****	.58958***	0.01	101.9	373.99	22064	322	0.0187
Hydrogen Sulfide	H_2S	34.08	0.9136	-	-60.2	547.83	1.198	0.147	1.539	-	-	100.5	9008	346	0.0146
Sulfur Dioxide	SO_2	64.06	1.46	-	-10.0	389.3	2.279	0.622	2.9269	-75.5	1.675	157.4	7866.9	520	0.0096
Carbon Dioxide	CO_2	44.01	1.18***	-	-78.5	571.3	1.539	0.85	1.9769	-56.6	517.3	31.1	7382	468	0.0168
Ammonia	NH_3	17.03	0.6819	-	-33.3	1371.0	0.6003	2.191	0.771	-77.7	6.1	133	11350	235	0.0244
Methane	CH_4	16.04	0.425	3.481	-161.49	509.91	0.559	2.207	0.717	-182.5	11.65	-82.1	4640.86	161.63	0.0341
Ethane	C_2H_6	30.07	0.546	-	-88.63	489.41	1.056	1.715	1.3566	-183.3	101.325	32.2	4883.9	203	0.0213
Ethylene (Ethene)	C_2H_4	28.05	0.567	-	-103.8	484.0	0.978	1.516	1.2604	-169.2	0.1014	9.9	5041	228	0.0205
Acetylene	C_2H_2	26.04	0.613	-	-83.3	614.0***	0.906	1.6	1.1716	-82.2	122	36	6250	231	0.0214
Propane	C_3H_8	44.10	0.58	-	-42.04	425.77	1.573	1.625	2.02	-	-	96.672	4249.24	216.25	0.018
Propylene	C_3H_6	42.08	0.61	-	-47.72	437.71	1.481	1.486	1.769	-	-	91.77	4619.49	232.27	0.014
Methanol	CH_3OH	32.04	0.795	2.533	148.2	473.0	-	0.3274	0.089****	-143.4	-	464.1	1154.2	16.981	0.014

* Sublimation point ** Sublimation Enthalpy *** Triple point **** Boiling point

FLAMMABILITY CHARACTERISTICS OF COMMON GASES AND LIQUIDS

Product	Boiling Point °F (1)	Flash Point °F (2)	Auto-Ignition Temp. °F (3)	Flammability Limit in Air Volume % (4)		Max. Oxygen Content Vol % (5)
				Lean	Rich	
Acetaldehyde	70	36	365	4.1	55	12
Acetone	133	0	1000	2.6	12.8	11.6
Acetylene	–119	–	571	2.5	81	–
Alkyl chloride	113	-25	737	3.3	11.1	12.6
Ammonia	–28	–	1204	16	25	15
Benzene	176	12	1044	1.4*	7.1	11.2
1-3 Butadiene	24	–	804	2	11.5	10.4
Butane	32	–	761	1.9	8.5	12.1
1-Butene	20	–	723	1.6	9.3	11.4
2-Butene	34	–	615	1.8	9.7	11.7
n- Butyl formate	225	64	612	1.7	8	12.4
Carbon disulfide	115	–22	212	1.3	44	5.4
Carbon monoxide	–310	–	1128	12.5	74	5.6
Cyclopropane	–27.4	–	928	2.4	10.4	11.7
1–1 Dischloroethylene	99	–5	856	5.6	11.4	10
Dimethyl 2–2 butane	121	–54	797	1.2	7	12.1

1. Boiling point temperature at standard atmospheric pressure.
2. Flash point minimum temperature at which the vapors of a combustible liquid will be ignited by a flame in certain experimental conditions.
3. Auto-ignition temperature: minimum temperature at which a product will spontaneously oxidize in air.
4. Flammability limit: volume percentage of combustible gas in air such that below the lean limit or above the rich limit, the mixture is non-flammable.
5. Maximum oxygen content: oxygen percentage in a combustible gas mixture below which the mixture is non-flammable at 212°F.

FLAMMABILITY CHARACTERISTICS OF COMMON GASES AND LIQUIDS

Product	Boiling Point °F (1)	Flash Point °F (2)	Auto-Ignition Temp. °F (3)	Flammability Limit in Air Volume % (4)		Max. Oxygen Content Vol % (5)
				Lean	Rich	
Ethane	–127	–	959	3	12.5	11
Ethanol	173	–55	793	4.3	19	10.6
Ethyl bromide	101	–	952	6.7	11.3	14
Ethyl chloride	54	–58	966	3.8	15.4	13
Ethylene	–152	–	842	3.1	32	10
Ethylene oxide	56.4	<0	804	3	100	–
Ethyl ether	94	–49	356	1.9	48	–
Ethyl formate	130	–4	851	2.7	13.5	10.4
Gasoline (octane 60)	–45	536	1.4	7.6	11.6	–
Gasoline (octane 92)	734	1.5	7.6	11.6	–	–
Gasoline (octane 100)	–36	853	1.4	7.4	11.6	–
Heptane	209	25	433	1.2	6	11.6
Hexane	156.2	–7	453	1.2	7.5	11.9
Hydrogen	–422	–	1085	4	75	5
Isobutane	11	–	864	1.8	8.4	12
Isopropyl ether	154.4	–18	830	1.4	21	10

1. Boiling point temperature at standard atmospheric pressure.
2. Flash point minimum temperature at which the vapors of a combustible liquid will be ignited by a flame in certain experimental conditions.
3. Auto-ignition temperature: minimum temperature at which a product will spontaneously oxidize in air.
4. Flammability limit: volume percentage of combustible gas in air such that below the lean limit or above the rich limit, the mixture is non-flammable.
5. Maximum oxygen content: oxygen percentage in a combustible gas mixture below which the mixture is non-flammable at 212°F.

FLAMMABILITY CHARACTERISTICS OF COMMON GASES AND LIQUIDS

Product	Boiling Point °F (1)	Flash Point °F (2)	Auto-Ignition Temp. °F (3)	Flammability Limit in Air Volume % (4)		Max. Oxygen Content Vol % (5)
				Lean	Rich	
Methane	–263	–	999	5.3	14	12.1
Methanol	151	52	867	7.3	35	9.7
Methyl acetate	135	14	935	3.1	16	10.9
Methylamine	19.4	–	806	4.9	20.7	10.7
Methyl butene	87.4	<20	–	–	–	11.4
Methyl chloride	–11	–	1170	10.7	17.4	15
Methyl formate	89.6	–2	853	5.9	20	10.1
Pentane	97	<–40	588	1.5	7.8	12.1
Propane	–44	–	871	2.2	10	11.4
Propylene	–54.4	–	770	2.4	10.3	11.5
Vinyl chloride	9	–	882	4	22	9

1. Boiling point temperature at standard atmospheric pressure.
2. Flash point minimum temperature at which the vapors of a combustible liquid will be ignited by a flame in certain experimental conditions.
3. Auto-ignition temperature: minimum temperature at which a product will spontaneously oxidize in air.
4. Flammability limit: volume percentage of combustible gas in air such that below the lean limit or above the rich limit, the mixture is non-flammable.
5. Maximum oxygen content: oxygen percentage in a combustible gas mixture below which the mixture is non-flammable at 212°F.

COMBUSTION CONSTANTS OF HYDROCARBON GASES (WEIGHT)

Name of Gas	Symbol	Mol Weight	Heat of Combustion Btu per Lb		Pound per Pound of Combustible Gas					
					Required for Combustion			Products of Combustion		
			Gross	Net	O_2 +	N_2 =	Air	CO_2	H_2O	N_2
Carbon solid	C	12.011	14,093	14,093	2.664	8.863	11.527	3.664	–	8.863
Hydrogen	H_2	2.016	61,100	51,623	7.900	26.407	34.344	–	8.937	26.407
Carbon monoxide	CO	28.010	4,347	4,347	0.600	1.900	2.471	1.571	–	1.900
Methane	CH_4	16.043	23,879	21,520	4.000	13.257	17.265	2.744	2.246	13.275
Ethane	C_2H_6	30.070	22,320	20,432	3.700	12.394	16.119	2.927	1.798	12.394
Propane	C_3H_8	44.097	21,661	19,994	3.600	12.074	15.703	2.994	1.634	12.074
Ethylene	C_2H_4	28.054	21,644	20,295	3.400	11.385	14.807	3.138	1.285	11.385
Propylene	C_3H_6	42.081	21,041	19,691	3.400	11.385	14.807	3.138	1.285	11.385
Acetylene	C_2H_2	26.038	21,500	20,776	3.100	10.224	13.297	3.381	0.692	10.224

COMBUSTION CONSTANTS OF HYDROCARBON GASES (VOLUME)

Name of Gas	Symbol	Mol Weight	Heat of Combustion Btu per cu ft @ 60°F		Cubic Feet per Cubic Feet of Combustible Gas					
					Required for Combustion			Products of Combustion		
			gross	net	O_2 +	N_2 =	Air	CO_2	H_2O	N_2
Hydrogen	H_2	2.016	325.0	275.0	0.5	1.882	2.382	–	1.0	1.882
Carbon monoxide	CO	28.010	321.8	321.8	0.5	1.882	2.382	1.0	–	1.882
Methane	CH_4	16.043	1,013.2	913.1	2.0	7.528	9.528	1.0	2.0	7.528
Ethane	C_2H_6	30.070	1,792.0	1,641.0	3.5	13.175	16.675	2.0	3.0	13.175
Propane	$C3H_8$	44.097	2,590.0	2,385.0	5.0	18.821	23.821	3.0	4.0	18.821
Ethylene	C_2H_4	28.054	1,613.8	1,513.2	3.0	11.293	14.293	2.0	2.0	11.293
Propylene	$C3H_6$	42.081	2,336.0	2,186.0	4.5	16.939	21.439	3.0	3.0	16.939
Acetylene	C_2H_2	26.038	1,499.0	1,448.0	2.5	9.411	11.911	2.0	1.0	9.411

COMBUSTION REQUIREMENTS OF TYPICAL FUELS

Name of Fuel	Analysis				Heat of Combustion			Required for Combustion		
	% S	% C	% H	% Ash	lbs/gas	net Btu/lb	Btu/gal	lbs Air/lb	scf Air/gal	scf O_2/gal
No. 2 Fuel Oil	0.1	86.8	13.0	–	7.18	19214	138000	14.46	1381	291
No. 4 Fuel Oil	0.3	87.6	12.0	0.10	7.6	18821	143000	14.22	1437	302
No. 6 Fuel Oil	0.5	88.2	11.0	0.30	8.15	18400	150000	13.96	1513	319
Bituminous Coal	1.78	75.3	5.0	8.00	–	13500	–	10.22	Air required 136 scf/lb	
Natural Gas	CH_4 90% C_2H_6 5%				Specific Grav. 0.6		1000 Btu/ft^3		Air required 9.56 scf/ft^3	O_2 required 2 scf/ft^3

METERED GAS CONVERSION FACTORS

Calibrated For	Specific Gravity	Air	D.A.	Argon	Endo or Ammonia	Helium	Hydrogen	Natural Gas	Nitrogen	Oxygen	Propane
Air	1.00	1.00	1.841	0.851	1.302	2.692	3.793	1.240	1.021	0.951	0.811
D.A.	0.295	0.543	1.00	0.462	0.707	1.462	2.060	0.674	0.554	0.517	0.440
Argon	1.38	1.175	2.163	1.00	1.529	3.162	4.456	1.457	1.199	1.118	0.952
Endo or Ammonia	0.59	0.768	1.414	0.654	1.00	2.068	2.914	0.953	0.784	0.731	0.623
Helium	0.138	0.371	0.684	0.316	0.484	1.00	1.409	0.461	0.379	0.353	0.301
Hydrogen	0.0695	0.264	0.485	0.224	0.343	0.710	1.00	0.387	0.269	0.251	0.214
Natural Gas	0.65	0.806	1.484	0.686	1.050	2.170	3.058	1.00	0.823	0.767	0.654
Nitrogen	0.96	0.980	1.804	0.834	1.276	2.638	3.717	1.215	1.00	0.932	0.794
Oxygen	1.105	1.051	1.935	0.895	1.369	2.830	3.987	1.304	1.073	1.00	0.852
Propane	1.522	1.234	2.271	1.050	1.606	3.321	4.680	1.530	1.259	1.174	1.00

Example: If the flowmeter is calibrated for air and argon is being metered, multiply the reading with .851 to get the actual argon flow.
If the actual pressure is different from the calibration pressure, use the correction factor from the calibration pressure chart.

GAS CONVERSION FACTORS

Actual	Calibration Pressure												
PSIG	0	0.5	1	2	3	4	5	10	15	20	30	40	50
0.5	1.01	1	0.98	0.95	0.93	0.90	0.88	0.78	0.71	0.66	0.58	0.53	0.48
1.0	1.03	1.02	1	0.97	0.94	0.92	0.89	0.80	0.73	0.67	0.59	0.54	0.49
2.0	1.06	1.05	1.03	1	0.97	0.94	0.92	0.82	0.75	0.69	0.61	0.55	0.51
3.0	1.1	1.08	1.06	1.03	1	0.97	0.95	0.85	0.77	0.71	0.63	0.57	0.52
4.0	1.13	1.11	1.09	1.06	1.03	1	0.97	0.87	0.79	0.73	0.65	0.58	0.54
5.0	1.16	1.14	1.12	1.09	1.05	1.03	1	0.89	0.81	0.75	0.66	0.60	0.55
10.0	1.3	1.27	1.25	1.22	1.18	1.15	1.12	1	0.91	0.84	0.74	0.67	0.62
15.0	1.42	1.40	1.38	1.33	1.29	1.26	1.23	1.1	1	0.92	0.82	0.74	0.68
20.0	1.53	1.51	1.49	1.44	1.40	1.36	1.33	1.18	1.08	1	0.88	0.8	0.73
30.0	1.75	1.71	1.69	1.64	1.59	1.55	1.51	1.34	1.22	1.13	1	0.9	0.83
40.0	1.93	1.90	1.87	1.81	1.76	1.71	1.67	1.49	1.36	1.25	1.11	1	0.92
50.0	2.1	2.06	2.03	1.97	1.91	1.86	1.81	1.62	1.47	1.36	1.2	1.09	1

Conversion factor = $(P\ actual + 14.7/P\ cal + 14.7)^{0.5}$

Where: P actual = actual pressure, psig

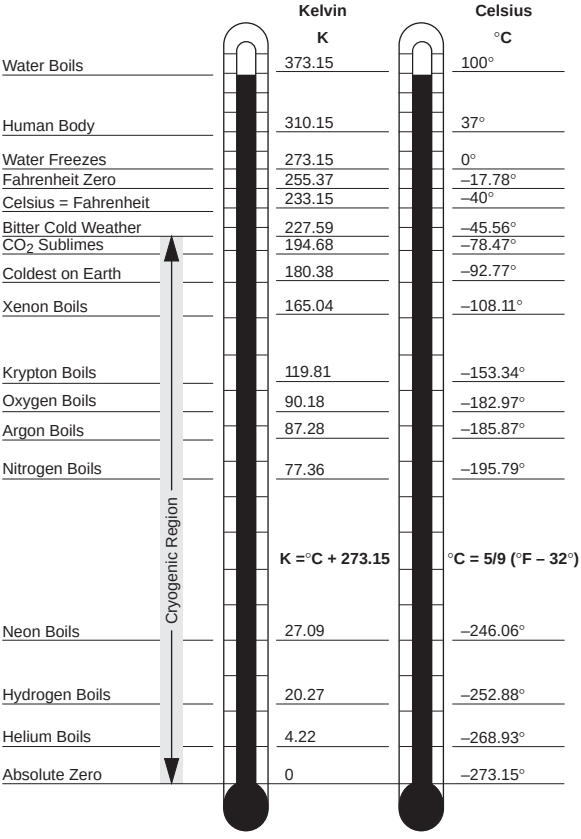
P cal = calibrated pressure, psig

Example: If the flowmeter is calibrated for 50 psig and the actual pressure is 10 psig, multiply the reading with 0.62 to get the actual flow. If in addition, the flowmeter is calibrated for a different gas than the gas being measured, multiply this number with the correction factor from the metered gas conversion factor.

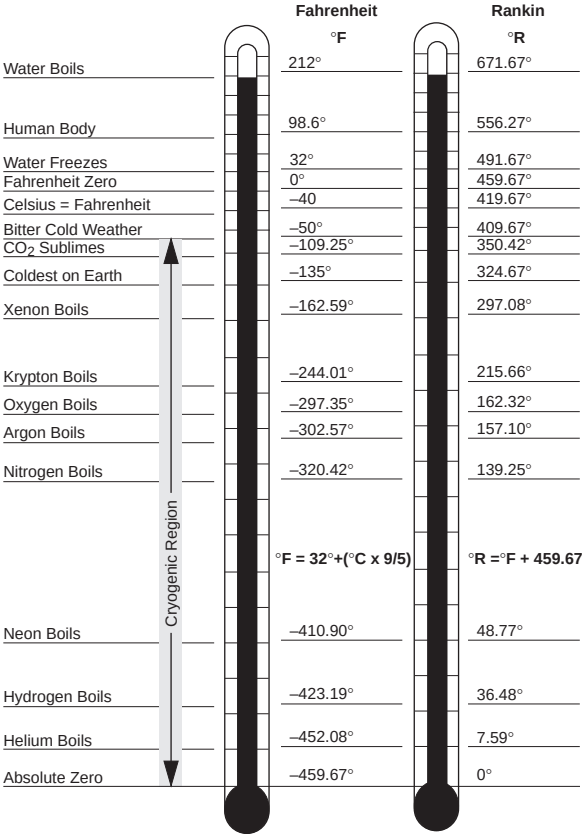
AIR PRESSURE DROP IN PIPE

Compressed Air at		Air pressure drop in pounds per square inch per 100 feet of Schedule 40 pipe for air at 100 psig and 60°F							
60°F & 14.7 psia	60°F & 100 psig	**1/4"**	**3/8"**	**1/2"**	**3/4"**	**1"**	**1-1/4"**	**1-1/2"**	**2"**
1	0.128	0.083	0.018						
2	0.256	0.285	0.064	0.020					
3	0.384	0.605	0.133	0.042					
4	0.153	1.04	0.226	0.071					
5	0.641	1.58	0.343	0.106	0.027				
6	0.769	2.23	0.408	0.148	0.037				
8	1.025	3.89	0.848	0.255	0.062	0.019			
10	1.282	5.96	1.26	0.356	0.094	0.029			
15	1.922	13.0	2.73	0.334	0.201	0.062			
20	2.563	22.8	4.76	1.43	0.345	0.102	0.026		
25	3.204		7.34	2.21	0.526	0.156	0.039	0.019	
30	3.845		10.5	3.15	0.748	0.219	0.055	0.026	
35	4.486		14.2	4.24	1.00	0.293	0.073	0.035	
40	5.126		18.4	5.49	1.30	0.379	0.095	0.044	
45	5.767		23.1	6.90	1.62	0.474	0.116	0.555	
50	6.408			8.49	1.99	0.578	0.149	0.067	0.019
60	7.690	**2-1/2"**		12.2	2.85	0.819	0.200	0.094	0.027
70	8.971			16.5	3.83	1.10	0.270	0.126	0.036
80	10.25	0.019		21.4	4.96	1.43	0.350	0.162	0.046
90	11.53	0.023		27.0	6.25	1.80	0.437	0.203	0.058
100	12.82	0.029	**3"**		7.69	2.21	0.534	0.247	0.070
125	16.02	0.044			11.9	3.39	0.825	0.380	0.107
150	19.22	0.062	0.021		17.0	4.87	1.17	0.537	0.151
175	22.43	0.083	0.028		23.1	6.60	1.58	0.727	0.205
200	25.63	0.107	0.036		30.0	8.54	2.05	0.937	0.264
225	28.84	0.134	0.045			10.8	2.59	1.19	0.331
250	32.04	0.164	0.055			13.3	3.18	1.45	0.404
275	35.24	0.191	0.666			16.0	3.83	1.75	0.484
300	38.45	0.232	0.078			19.0	4.56	2.07	0.573
325	41.65	0.270	0.090			22.3	5.32	2.42	0.673
350	44.87	0.313	0.104			25.8	6.17	2.80	0.776
375	48.06	0.356	0.119			29.6	7.05	3.20	0.887
400	51.26	0.402	0.134			33.6	8.02	3.64	1.00
425	54.47	0.452	0.151			37.9	9.01	4.09	1.13
450	57.67	0.507	0.168				10.2	4.59	1.26
475	60.88	0.562	0.187				11.3	5.09	1.40
500	64.08	0.623	0.206				12.5	5.61	1.55
550	70.49	0.749	0.248				15.1	6.79	1.87
600	76.90	0.887	0.293				18.0	8.04	2.21
650	83.30	1.04	0.342				21.1	9.43	2.60
700	89.71	1.19	0.395				24.3	10.9	3.00
750	96.12	1.36	0.451				27.9	12.6	3.44
800	102.5	1.56	0.513				31.8	14.2	3.90
850	108.9	1.74	0.576				35.9	16.0	4.40
900	115.3	1.95	0.642				40.2	18.0	4.91
950	121.8	2.18	0.715					20.0	5.47
1,000	128.2	2.40	0.788					22.1	6.06
1,100	141	2.89	0.948					26.7	7.29
1,200	153.8	3.44	1.13					31.8	8.63
1,300	166.6	4.01	1.32					37.3	10.1
1,400	179.4	4.65	1.52						11.8
1,500	192.2	5.31	1.74						13.5
1,600	205.1	6.04	1.97						15.3
1,800	203.7	7.65	2.50						19.3
2,000	256.3	9.44	3.06						23.9

ABSOLUTE TEMPERATURE CHART



ABSOLUTE TEMPERATURE CHART

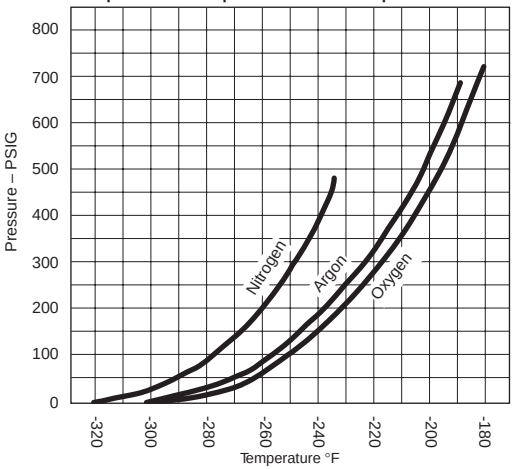


DENSITIES AT VARIOUS SATURATION PRESSURES

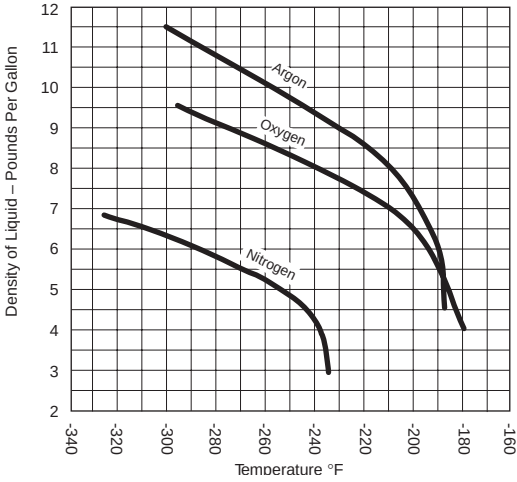
Saturation Pressure psig	Oxygen		Nitrogen		Argon	
	Liquid Density lbs/ft^3	Gas Density scf/gal	Liquid Density lbs/ft^3	Gas Density scf/gal	Liquid Density lbs/ft^3	Gas Density scf/gal
0	71.17	115.10	50.44	93.11	87.51	112.50
5	70.42	113.72	49.62	91.55	85.77	110.89
10	69.80	112.73	49.00	90.40	84.77	109.60
25	67.86	109.59	47.50	87.63	82.46	106.61
50	65.55	105.86	45.69	84.18	79.90	103.31
75	63.76	102.97	44.19	81.53	77.90	100.71
100	62.43	100.82	42.88	79.12	76.15	98.45
150	59.80	96.57	40.70	75.08	73.16	94.59
200	57.62	93.05	38.76	71.51	70.28	90.87
250	55.60	89.79	36.83	67.95	67.79	87.65

PRESSURE, TEMPERATURE AND DENSITY RELATIONSHIPS

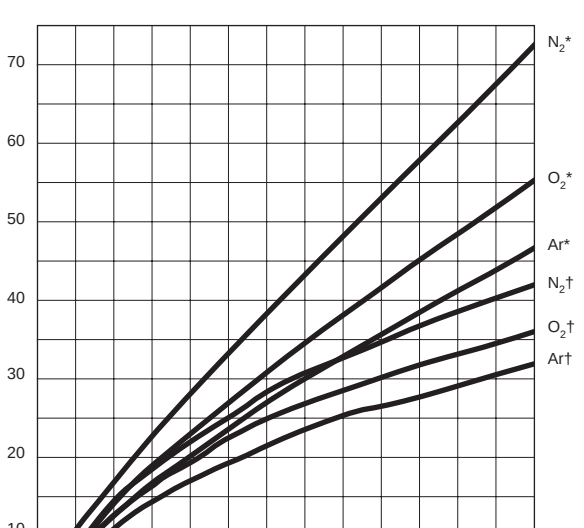
Pressure Over Liquid Oxygen, Nitrogen and Argon Compared with Temperature at Which Liquids Boil



Density–Temperature Relationships for Liquid Oxygen, Nitrogen and Argon



FLASH FROM SATURATED PRESSURIZED LIQUIDS



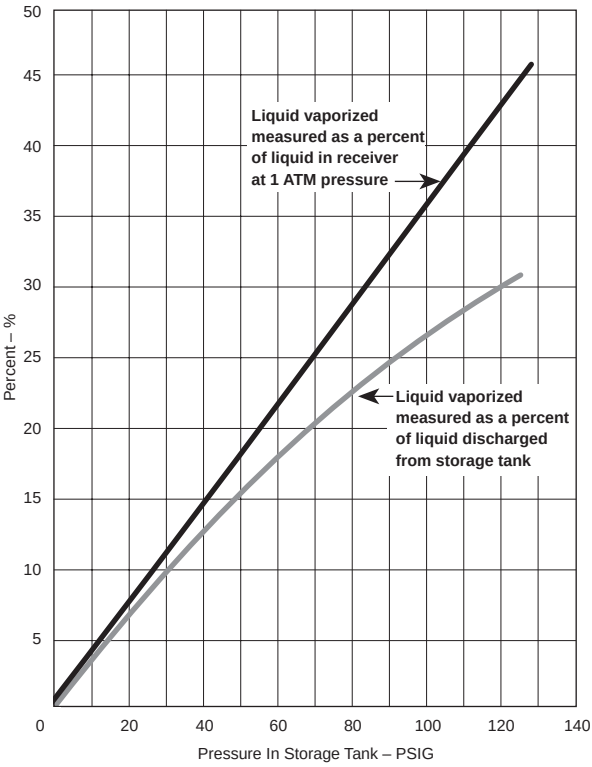
*Flash gas as a percentage of liquid after depressurization to atmospheric pressure.

† Flash gas as a percentage of saturated pressurized liquid.

Example: Estimate how much vapor is released when 1000 gallons of liquid nitrogen at 80 psig is withdrawn from a vessel into a transport trailer at atmospheric pressure.

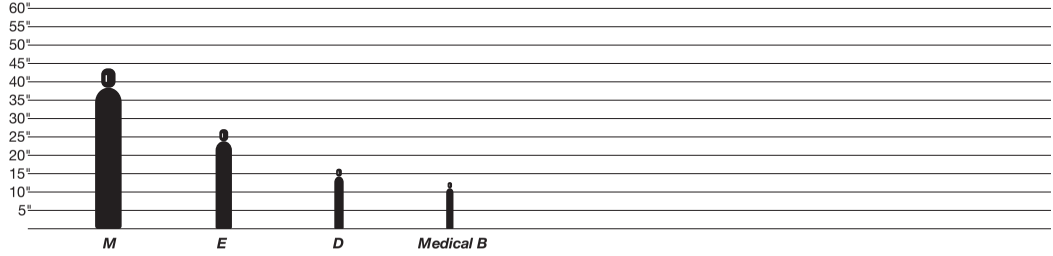
Solution: From the chart above, using the lower line with the storage tank pressure of 80 psig, the vapor released in 18% of the liquid discharged.

VAPOR RELEASE LIQUID HYDROGEN



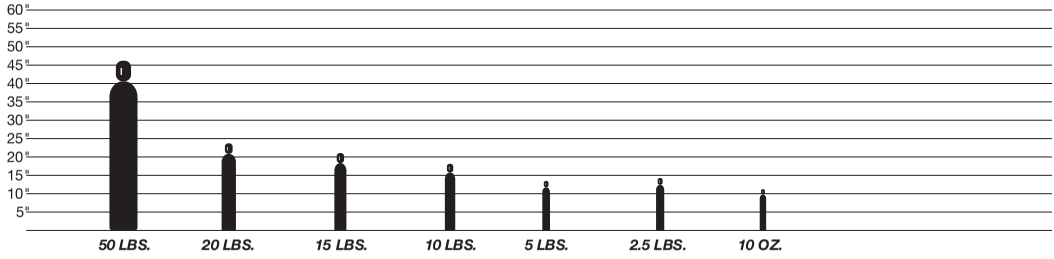
MEDICAL CYLINDER SPECIFICATIONS

Cylinder Model		M	E	D	Medical B
DOT Spec		3AA 2015	3AA 2015	3AA 2015	3AA 2015
Dimentions	inches	7 x 43	4.18 x 25.75	4.18 x 16.75	3.31 x 13.125
	cm	178 x 109.2	10.6 x 65.4	10.6 x 42.5	8.4 x 33.3
Nominal Weight	lbs.	61.3	10.5	7.5	4.18
	kg.	27.8	4.76	3.39	1.89
Service Pressure	psi	2015	2015	2015	2015
	bars	138.9	138.9	138.9	138.9
Water Capacity (volume)	cu. in.	1345	295	180	88
	liters	22.04	4.84	2.95	1.44



CARBON DIOXIDE CYLINDER SPECIFICATIONS

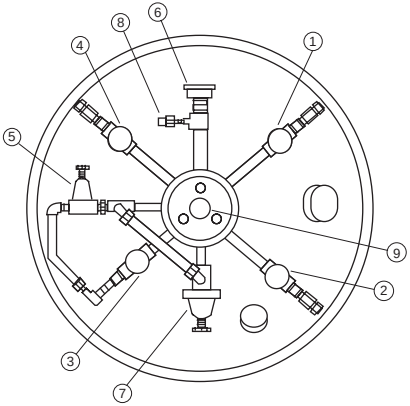
Cylinder Model		50 LBS.	20 LBS.	15 LBS.	10 LBS.	5 LBS.	2.5 LBS.	10 OZ.
DOT Spec		3AA 1800	3AA 1800	3AA 1800	3AA 1800	3AA 1800	3AA 1800	3E 1800
Dimentions	inches	8.625 x 45.38	7.75 x 23.25	7.0 x 22.88	7.0 x 18.0	5.73 x 14.0	3.56 x 14.62	1.94 x 11.88
	cm	21.908 x 115.2	19.685 x 59.0	17.78 x 58.115	17.78 x 45.72	13.385 x 35.6	9.042 x 37.135	4.928 x 30.175
Nominal Weight	lbs.	84.9	31.2	30	23	10.1	5.25	2.3
	kg.	38.5	14.95	13.61	10.43	4.58	2.38	1.04
Service Pressure	psi	1800	1800	1800	1800	1800	1800	1800
	bars	124.1	124.1	124.1	124.1	124.1	124.1	124.1
Water Capacity (volume)	cu. in.	2160	840	644	495	221	108	25.5
	liters	35.4	13.77	10.55	8.11	3.62	1.77	0.418



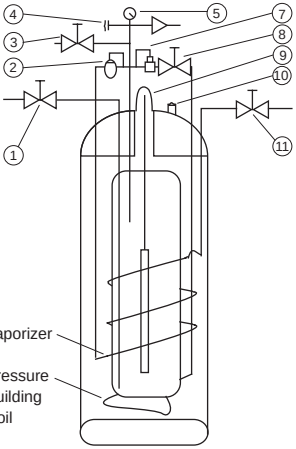
CGA VALVE SPECIFICATIONS

Gas	CGA#	Outlet Connections	PSI
Acetylene (commercial)	300	.825-14NGO-RH-EXT (flat nipple)	3000
Acetylene	510	.885-14NGO-LH-INT(bullet nipple)	500
Acetylene (B)	520	.895-18NGO-RH-EXT	500
Acetylene (MC)	200	.625-20NGO-RH-EXT (conical nipple)	500
Air (industrial)	590	.965-14NGO-LH-INT	3000
Air (breathing)	346	.825-14NGO-RH-EXT (large round nipple)	3000
Air (to 5500 psig)	347	.825-14NGO-RH-EXT (long round nipple)	5500
Ammonia	240	3/8-18NGT-RH-INT	500
Argon	580	.965-14NGO-RH-INT	3000
Argon (to 5500 psig)	680	1.045-14NGO-RH-INT	5500
Butane	510	.885-14NGO-LH-INT (bullet nipple)	500
Carbon Dioxide	320	.825-14NGO-RH-EXT (flat nipple)	3000
Carbon Monoxide	350	.825-14NGO-LH-EXT (round nipple)	3000
Corrosive	660	1.030-14NGO-RH-EXT (face washer)	3000
Ethane	350	.825-14NGO-LH-EXT (round nipple)	3000
Fuel Gas	350	.825-14NGO-LH-EXT (round nipple)	3000
Fuel Gases (to 5500 psi)	695	1.045-14NGO-LH-INT	5500
Helium	580	.965-14NGO-RH-INT	3000
Helium (to 5500 psig)	680	1.045-14NGO-RH-INT	5500
Hydrogen	350	.825-14NGO-LH-EXT (round nipple)	3000
Hydrogen (to 5500 psig)	695	1.045-14NGO-LH-INT	5500
Medical Mixtures	500	.885-14NGO-RH-INT (bullet nipple)	3000
Methane	350	.825-14NGO-LH-EXT (round nipple)	3000
Methane (to 5500 psig)	695	1.045-14NGO-LH-INT	5500
Nitrogen	580	.965-14NGO-RH-INT	3000
Nitrogen (to 5500 psig)	680	1.045-14NGO-RH-INT	5500
Nitrous Oxide	326	.825-14NGO-RH-EXT (small round nipple)	3000
Oxygen	540	.903-14NGO-RH-EXT	3000
Oxygen (to 4000 psig)	577	.960-14NGO-RH-EXT	4000
Oxygen (to 5500 psig)	701	1.103-14NGO-RH-EXT	5500
Ozone	755	1.125-14UNS-2A-LH-EXT (short nipple)	3000
Propane	510	.885-14NGO-LH-INT (bullet nipple)	500
Propane Butane	555	.903-14NGO-LH-EXT	3000
Sulfur Hexafluoride	590	.965-14NGO-LH-INT	3000

VGL PARTS DESCRIPTION



1 Gas Use Valve with Fitting
2 Liquid Valve with Fitting
3 Pressure Building Valve
4 Vent Valve with Fitting
5 Pressure Building Regulator
6 Pressure Gauge
7 Economizer



1 Liquid Valve
2 Economizer Regulator
3 Vent Valve
4 Burst Disc
Dura-Cyl: 400 Psig
Dura Max: 500 Psig
5 Pressure Gauge
7 Pressure Building Regulator
8 Pressure Building Valve
9 Liquid Level Gauge
10 Vacuum Casing Burst Disc
11 Gas Use Valve

DURA-LINE SPECIFICATIONS

Specifications	DURA-LO*	DURA-CYL	DURA-5100	DURA-5500	DURA-MAX*	DURA-TECH HPG	DURA-MITE
Diameter (inches)	20	20	20	20	20	24	16
Height (inches)	60	61	63.5	62.5	61	61.5	50
Empty Weight (lbs)	210	250	260	255	280	310	165
DOT 4L Service	100	200	200	200	292	200	392
Normal Evaporation Rate (%/day)							
Nitrogen	1.5	2.2	1.9	1.85	2.2	2.2	2.8
Oxygen or Argon	1	1.5	1.3	1.25	1.5	1.5	1.6
CO_2 or N_2O	N/A	See Note	See Note	See Note	0.5	See Note	0.6
Gross Capacity (liters)	176	176	196	209	176	240	85
Storage Capacity, Liquid (liters) (25 psig or less)							
Nitrogen	160	165	184	196	165	230	80
Oxygen	160	165	185	196	165	230	80
Argon	160	165	187	196	165	230	80
CO_2	N/A	See Note	See Note	See Note	N/A	See Note	N/A
N_2O	N/A	See Note	See Note	See Note	N/A	See Note	N/A
Storage Capacity, Gas (cu ft)							
Nitrogen	N/A	3700	4114	4400	3440	5030	1545
Oxygen	N/A	4590	5112	5450	4300	6250	2041
Argon	N/A	4470	4971	5300	4200	6075	1992
CO_2	N/A	See Note	See Note	See Note	3352	See Note	1547
N_2O	N/A	See Note	See Note	See Note	3223	See Note	1472
Normal Operating Pressure (psig)	22	75–175	75–175	75–175	100–350	75–175	75–175
Gas Delivery Rate (scfh)	50	325	325	400	325 scfh2	350	100

Note: The DURA-CYL, DURA-5500, DURA-5100, and DURA-TECH HPG are not approved for use with CO_2 or N_2O. All units equipped with fittings that conform to industry standards. Fill contents based on 230 relief valve setting for DURA-CYL, DURA-5500 and DURA-TECH HPG, and 350 relief valve setting for DURA-MAX and DURA-MAX 55. *Also available in 196 and 209 liter capacities.

TUBE TRAILER VOLUME CAPACITIES

Trailer			Oxygen	Nitrogen	Argon	Hydrogen	Helium	Breathing Air
Number of Tubes	Length of Tube	O.D. of Tube	scf	scf	scf	scf	scf	scf
30	21'	9 5/8"	43,322	45,623	45,330	43,038	43,670	46,361
34	21'	9 5/8"	48,066	50,619	50,294	47,751	48,453	51,438
38	21'	9 5/8"	53,516	56,359	55,996	53,165	53,947	57,270
49	21'	9 5/8"	69,604	73,302	72,830	69,147	70,164	74,486
55	34'	9 5/8"	127,881	134,675	133,808	127,043	128,910	136,852
10	34'4"	22"	127,881	134,761	133,894	127,124	128,993	–
7	40'	22"	108,510	114,275	112,539	–	109,383	116,122
9	40'	22"	139,372	146,776	145,832	–	140,494	149,149

Capacities shown are trailers filled at 2640 psig and 70°F.

GENERIC VESSEL INFORMATION

Size gallons	Diameter inches	Height inches	Tare Wt lbs	Filled Wt O_2 (lbs)	Filled Wt N_2 (lbs)	Filled Wt Ar (lbs)	Net Cap gallons	MAWP psi	Pad Size	Top Rebar	Bottom Rebar
1500 MVE (SS)	66	180	7,400	22,081	17,797	25,332	1,541	250/400/600	14' x 14' x 15"	#4 @ 12"	#6 @ 12"
3000 MVE (SS)	96	194	16,600	45,181	36,841	51,490	3,000	250/400/600	18' x 14' x 15"	#4 @ 12"	#7 @ 10"
6000 MVE (NP)	96	330	28,800	85,962	69,282	98,580	6,000	250/400/600	16' x 16' x 18"	#4 @ 12"	#7 @ 8"
9000 VCS (NP)	114	372	46,700	132,443	107,423	151,370	9,000	250/400/600	36' x 20' x 18"	#4 @ 12"	#8 @ 8"
11,000 MVE (NP)	114	433	57,681	162,478	131,876	185,611	11,000	250/400/600	36' x 20' x 21"	#4 @ 10"	#8 @ 11"

Note 1: For oxygen vessel pads an apron of 12' x 12' must be added.

Note 2: This table is not for construction use.

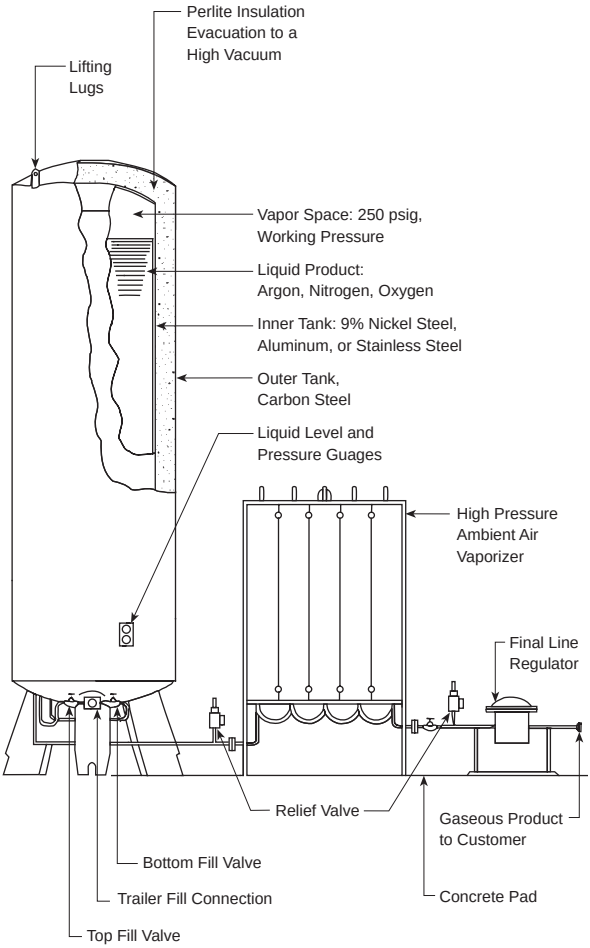
Note 3: For 3,000–11,000 gallon vessel standard vaporization is 5,000 scfh.

For 1,500-gallon vessel standard vaporization is 2,000 scfh.

Note 4: Taylor Wharton numbers are slightly different.

Note 5: For total volume in scf mulitiply gallons times 93.11 for N_2, 115.1 for O_2, and 112.5 for Ar.

TYPICAL LIQUID CUSTOMER STATION



ELECTRIC VAPORIZER SPECIFICATIONS

Kw	In	Out	Volts	Amps	BC	Lb/Hr CO_2	Scfh N_2, O_2, A	Wt lbs
15	¾	¾	220/440	40/20	6	375	4000	100
30	¾	¾	220/440	80/40	8⅛	750	7500	150
45	¾	¾	220/440	120/60	10¼	1125	11500	180
60	¾	¾	220/440	160/80	13	1500	15000	210
75	¾	1"	220/440	200/100	15¼	1875	19000	240
90	¾	1"	440	120	17½	2250	22500	275
105	¾	1"	440	140	19¾	2625	26500	310
120	¾	1"	440	160	22	3000	30000	345
135	1"	1"	440	180	24⅛	3375	33750	375
150	1"	1½"	440	200	26⅜	3750	37500	405
165	1"	1½"	440	220	28½	4125	41500	440
180	1"	1½"	440	240	30¾	4500	45000	575
195	1"	1½"	440	260	33	4875	49000	605

STEAM VAPORIZER SPECIFICATIONS

Flow scfh	Fluid	MAWP psig	N_2 Inlet	N_2 Outlet	Steam Required lbs/hr	Steam Pressure	Steam Inlet psig	Condensate Out	Fluid Inlet	Fluid Outlet
50,000	N_2/O_2	500	1" Mueller Flange	2" Mueller Flange	700	250 Max 15 Min	2" Female Pipe	2" Male Pipe	–320 °F	70°F
100,000	N_2/O_2	500	1.5" Mueller Flange	3" 300 lb ANSI Flange	1400	250 Max 15 Min	2" Female Pipe	2" Male Pipe	–320 °F	70°F

AMBIENT VAPORIZER SPECIFICATIONS

Model	Dimensions	Rating—8 Hr	Rating—Continuous
A2SSEG-10X1	23 x 10 x 165	1428 scfh	400 scfh
A4SSEG-10X1	23 x 23 x 165	2856 scfh	800 scfh
A6SSEG-10X1	23 x 36 x 165	4284 scfh	1200 scfh
A8SSEG-10X1	23 x 49 x 165	5712 scfh	1600 scfh
A10SSEG-10X1	23 x 62 x 165	7140 scfh	2000 scfh
A12SSEG-10X1	36 x 49 x 165	8568 scfh	2400 scfh
A16SSEG-10X1	49 x 49 x 165	11424 scfh	3200 scfh
A20SSEG-10X1	49 x 62 x 165	14280 scfh	4000 scfh
A24SSEG-10X1	49 x 75 x 165	17136 scfh	4800 scfh
A30SSEG-10X1	62 x 75 x 165	21420 scfh	6000 scfh
A36SSEG-10X1	75 x 75 x 165	25704 scfh	7200 scfh

*Gap or space between the extrusions is 5" for improved resistance to ice bridging.

MINIMUM SAFE DISTANCE FOR LIQUID PETROLEUM GAS

Safe distance from:	ASME Containers	
	0–500 gal w.c.	501–1000 gal w.c.
Central A/C compressor (any electrical service)	10 feet	15 feet
Perimeter of the building	10 feet	15 feet
Nearest line of adjoining property	10 feet*	15 feet

*LP-gas container(s) of 500 gallon aggregate capacity or less in vapor service is exempt from adjoining property line requirements.
Note: Proximity of power lines cannot reach vessel if broken.

MINIMUM SAFE DISTANCE FOR LIQUID OXYGEN

Minimum Distance (ft) from Bulk Oxygen Systems to Exposures

Type of Exposure	Total Line of Sight Distance
1. Building structures	
*a) Wood frame construction	50ft
*b) Other than wood frame construction	1ft
c) Confining areas	75ft/35ft
2. Wall openings	10ft
* 3. All classes of flammable and combustible liquid storage	
a) Above-ground storage	
0–1000 gallons	25ft
>1000 gallons	50ft
Distance may be reduced to 15 ft for Class III b combustible liquids	
b) Below ground storage	
Horizontal: Distance between tanks	15ft
Distance between O_2 and tank openings	25ft
* 4. Flammable gases above ground	
a) Liquified hydrogen	75ft
b) Other liquified gases	
0–1000 gallons	25ft
>1000 gallons	50ft
c) Non-liquified or dissolved gases	
0–25,000 scf	25ft
>25,000 scf	50ft
* 5. Rapid burning solid materials (paper, excelsior,etc.)	50ft
* 6. Slow burning solid materials (coal, heavy timber)	25ft
7. Place of public assembly	50ft
8. Piping outlets and vent/fill connections from areas occupied by non-ambulatory patients	50ft
* 9. Public sidewalks or parked vehicles	10ft
* 10. Nearest property line	5ft

*These distances do not apply where protective structures having a minimum fire resistance of two hours interrupt the line-of-sight between uninsulated portions of the bulk oxygen storage installation and the exposure. In such cases, the minimum distance required should be that required for system maintenance.

For SI units: 1 ft = 0.305M; 1 gallon = 3.785 L

MINIMUM SAFE DISTANCE FOR LIQUID HYDROGEN

Minimum Distance (ft) from Liquefied Hydrogen Systems to Exposures[4]			
	Total Liquefied Hydrogen Storage (cap in gal)		
Type of Exposure	**39.63–3,500**	**3501–15,000**	**15,001–75,000**
1. Building Structure			
(a) Wall(s) adjacent to system constructed of noncombustible or limited-combustible materials.			
(1) Sprinklered building/structure or unsprinklered building/structure having noncombustible contents.	5[1,3]	5[1,3]	5[1,3]
(2) Unsprinklered building/structure with combustible contents. Adjacent wall(s) with fire-resistance rating less than 3 hours[2]	25	50	75
Adjacent wall(s) with fire-resistance rating of 3 hours or greater[2]	5	5	5
(b) Wall(s) adjacent to system constructed of combustible materials			
(1) Sprinklered building/structure	50	50	50
(2) Unsprinklered building/structure	50	75	100
2. Wall openings			
(a) Openable	75	75	75
(b) Unopenable	25	50	50
3. Air compressor intakes, inlets for air-conditioning or ventilating equipment	75	75	75
4. All classes of flammable and combustible liquids (above ground and vent or fill openings if below ground) (See NFPA 50B, 5-1.3) Exception: Distances may be reduced to 15 ft for Class IIIB combustible liquids	50	75	100
5. Between stationary liquefied hydrogen containers	5	5	5
6. Flammable gas storage (other than hydrogen)	50	75	75
7. Liquid oxygen storage and other oxidizers (See NFPA 50B, 5-1.3)	75	75	75
8. Combustible solids	50	75	100
9. Open flames and welding	50	50	50
10. Places of public assembly	75	75	75
11. Public ways, railroads and property lines	25	50	75
12. Protective structures	5[3]	5[3]	5[3]

1. Portions of wall less than 10 ft (measured horizontally) from any part of a system shall have a fire resistance rating of at least ½ hour.

2. Exclusive of windows and doors.

3. Where protective structures are provided, ventilation and confinement of product shall be considered. The 5-ft distance in Nos. 1 and 12 facilitates maintenance and enhances ventilation.

4. The distances in Nos. 1,2,6,7,8 and 11 may be reduced where protective structures have a minimum fire resistance rating of two hours interrupt the line of sight between uninsulated portions of the liquefied hydrogen storage system and the exposure.

TYPICAL CO_2 VESSEL (HORIZONTAL)

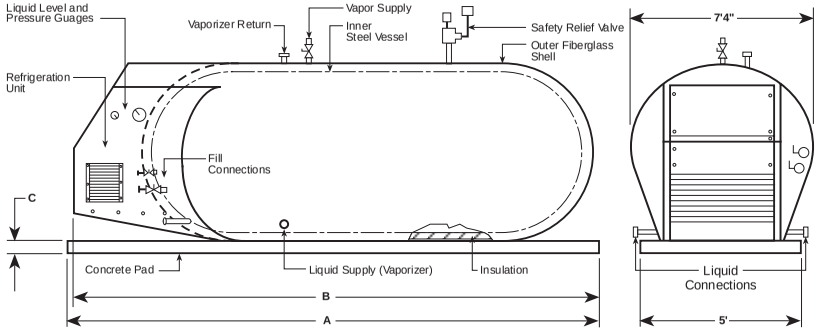
Capacity (tons)	Empty Weight* (lbs)	Dim. A	Dim. B	Dim. C
13	11,500	19'	18'	6"
14	12,500	24'	19' 10"	6"
24	18,600	30'	29'	6"
31	23,500	37'	36'	6"
34	30,000	44'	39' 11"	8"
45	34,500	50'	50'	8"
50	40,000	60'	55' 11"	12"

*Estimate only—*See Tech Specs 1067 and 1016*
* All concrete pads are 11' wide x "A" long

TYPICAL CO_2 VESSEL (VERTICAL)

Capacity (tons)	Empty Weight* (lbs)	Height	Dia.	Pad Dimensions
14	15,500	19'9"	7'4"	9' x 9'
30	30,000	35'9"	7'4"	10' x 10'
50	40,000	39'5"	8'8"	13' x 13'

*Estimate only—See *Tech Specs 1068*
* All concrete pad thickness = 24"



HOW TO PURGE WITH NITROGEN

Nitrogen purging is easily adapted to any process installation. Different methods are used depending on the type and shape of the equipment to be purged and on the location of the purging inlets and outlets.

1. Displacement Purging

This method is used for equipment with simple cross sections such as pipelines. The volume of nitrogen required corresponds to the physical volume of the pipe. In many pipelines, a rubber scraping piston, or "pig," is introduced and propelled through the pipe by the nitrogen pressure to clean the line.

The nitrogen volume required to purge equipment with a simple cross section is determined using the following formula:

$$V = V_o P/14.7$$

Where:

V = Total nitrogen volume required (scf)
V_o = Water volume of pipeline (cf)
P = Absolute pressure of nitrogen in the pipeline during purging (psia)

2. Pressurization Purging

This method is used when conditions do not permit a sweeping action of nitrogen through the vessel. The vessel is repeatedly pressurized and mixed with nitrogen gas and then the mixture is exhausted. The total volume of nitrogen depends on the number of pressurizing purges required to reduce the contaminant to an acceptable level and can be determined by using this formula:

$$V = 1.2nV_oP/P_a$$

Where:

V = Total nitrogen volume required (scf)
V_o = Water volume of pipeline (cf)
P = Absolute pressure of nitrogen in the pipeline during purging (psia)
P_a = Absolute pressure after exhaust (psia)
n = Number of purges = $(\log C - \log C_o)/(\log P_a - \log P)$
C_o = Initial content of gas to be removed
C = Final content of gas to be removed

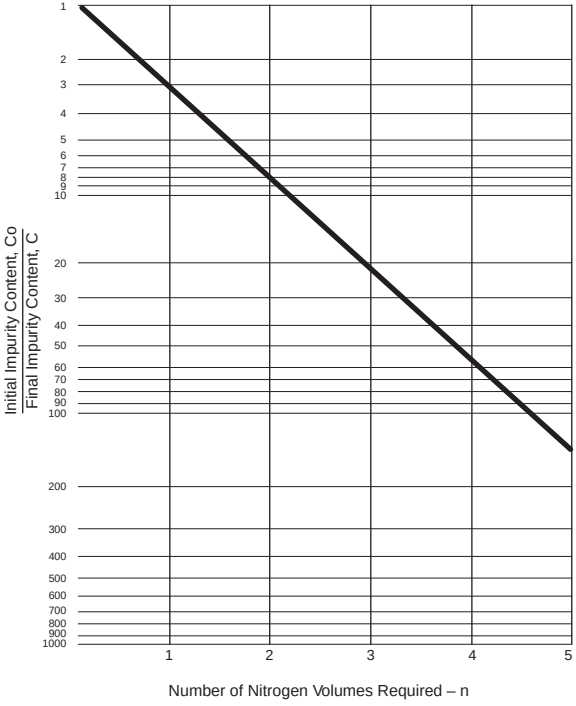
3. Dilution Purging

This method is used for equipment cross sections such as distillation columns, kilns, reactors, etc. Nitrogen partially mixes with the gas to be purged out, and then the mixture exits through an outlet located as far as possible from the inlet. The nitrogen required to reduce a contaminate to a desired level can be found using the graph below and the total volume of nitrogen needed can be computed from the following formula:

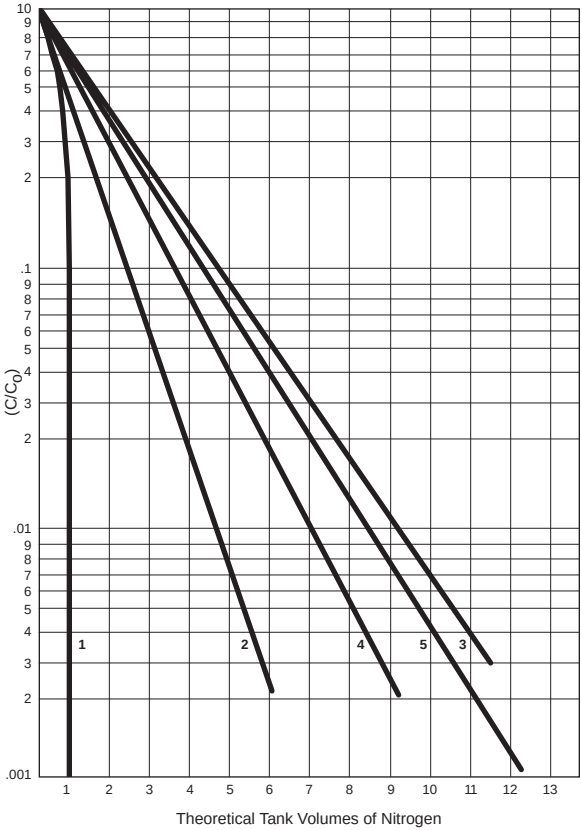
$$V = nV_o$$

Where:

V = Total nitrogen volume required (scf)
V_o = Water volume of pipeline (cf)
n = Number of nitrogen volumes required



PURGING EFFICIENCY (C/Co) AS A FUNCTION OF NITROGEN VOLUME (TANK VOLUMES) FOR VARIOUS PURGING TECHNIQUES



Purging Technique:

1. Displacement
2. Dilution Pf = Pi = 14.7
3. Dilution Pi = 14.7; Pf = 29.4
4. Pressure Purge Pi = 19.7; Pf = 24.7
5. Pressure Purge Pi = 19.7; Pf = 34.7

Where Pf = pressure final
Pi = pressure initial

GAS TURBINE CAPACITY TABLE

Manufacturer	Model	Simple Cycle			Combined Cycle			Base Steam, KPPH		Remarks
		kw Output	Heat Rate btu/kw	MMbtu Input	kw Output	Heat Rate btu/kw	MMbtu Input	240# Sat	600# 600F	
ABB	GT 35	16900	10670	180.3	22800	7880	179.7	60.5	42.0	1, 2
ABB	GT 10	24630	9970	245.6	35500	6755	239.8	108.0	98.0	1, 2
ABB	GT 8C	52800	9920	523.8	77700	6640	515.9	234.6	200.0	1, 2
ABB	GT11N	83800	10370	869.0	125400	6825	855.9	397.2	335.9	2
ABB	GT 13D	97700	10564	1032.1	147100	6920	1017.9	466.6	390.0	3, 4
ABB	GT 11N2	109300	9977	1090.5	163.800	6550	1072.9	490.0	430.0	
General Electric	LM1600PA	13425	9560	128.3	18700	6870	128.5	53.1	44.3	
General Electric	LM2500	22800	9273	211.4	30900	6850	211.7	92.2	79.0	1, 2
General Electric	PG5371PA	26300	11990	315.3	38700	8146	315.3	143.4	119.6	1, 2
General Electric	LM2500+	27040	9330	252.3	38480	6637	255.4	100.7	84.6	1
General Electric	LM5000	34450	9180	316.3	44600	7094	316.4	259.9	238.0	1, 2
General Electric	LM6000	36970	8795	325.2	53000	6620	350.9	132.9	109.5	1
General Electric	PG6541B	38340	10880	417.1	59200	7020	415.6	193.2	168.8	1, 2
General Electric	PG6101FA	70150	9980	700.1	108400	6440	698.1	330.7	293.9	
General Electric	PG7111EA	83500	10480	875.1	128700	6800	875.2	399.8	343.8	1, 2
General Electric	PG7161EC	116000	9890	1147.2	177800	6460	1148.6	517.2	450.0	1, 2
General Electric	PG9171E	123400	10100	1246.3	188400	6610	1245.3	707.8	621.7	2, 3
Pratt & Whitney	FT 8	25420	8950	227.5	32280	7010	226.3	85.0	67.0	1
Pratt & Whitney	FT 8 Twin	51100	8905	455.0	65310	6930	452.6	190.0	134.0	1
Siemens	V64.3A	70000	9270	648.9	101000	6230	629.2	296.8	260.0	1

GAS TURBINE CAPACITY TABLE (continued)

Manufacturer	Model	Simple Cycle			Combined Cycle			Base Steam, KPPH		Remarks
		kw Output	Heat Rate btu/kw	MMbtu Input	kw Output	Heat Rate btu/kw	MMbtu Input	240# Sat	600# 600F	
Siemens	V84.2	106180	10120	1074.5	151000	6625	1000.4	512.3	442.9	
Siemens	V84.3A	170000	8980	1526.6	254000	6890	1750.1	602.9	589.1	1, 2
Solar	Mars 100S	10695	10505	112.4	28700	7750	222.4	48.9	40.8	2
Westinghouse	251B12	47680	10670	508.7	69800	7230	504.7	233.0	200.0	2
Westinghouse	Trent	48690	8570	417.3	61788	6778	418.8	145.0	110.0	1
Westinghouse	501D5A	119200	9910	1181.3	168070	7024	1180.5	530.0	450.0	2
Westinghouse	501F	162410	9660	1568.9	236200	6425	1517.6	750.0	660.0	2

Notes:

This information is for preliminary estimating only. Accurate estimations require a detailed set of site conditions.

Simple cycle output is at ISO conditions with no HRSG and with DLN burner technology where available.

Combined cycle kw output is using most favorable steram generation conditions for equipment. ISO conditions and inlet and outlet drops of 4.0 and 10 inches respectively.

Some machines can use water or steam injection for NO_x control or power augmentation. Such injection may substantially alter kw output.

Base steam is at GTG base rate, open cycle, open cycle, with no supplemental firing for two points only for illustration. Most any combination of pressure and temperature is available.

Remarks:

1. 50 Hz configuration available with no appreciable change in output.
2. Can be steam or water injected for additional power output and/or NO_x control.
3. 50 Hertz only.
4. Burns heavy oil fuel only.

STEAM TABLE (SATURATION:TEMPERATURE)

Temp.	Abs. Press.	Specific Volume			Enthalpy			Entropy		
° Fahr.	Lb/Sq In	Sat. Liquid	Evap.	Sat. Vapor	Sat. Liquid	Evap.	Sat. Vapor	Sat. Liquid	Evap.	Sat. Vapor
t	p	v_f	v_{fg}	v_g	h_f	h_{fg}	h_g	s_f	s_{fg}	s_g
32	0.08854	0.01602	3306	3306	0.00	1075.8	1075.8	0.0000	2.1877	2.1877
35	0.09995	0.01602	2947	2947	3.02	1074.1	1077.1	0.0061	2.1709	2.1770
40	0.12170	0.01602	2444	2444	8.05	1071.3	1079.3	0.0162	2.1435	2.1597
45	0.14752	0.01602	2036.4	2036.4	13.06	1068.4	1081.5	0.0262	2.1167	2.1429
50	0.17811	0.01603	1703.2	1703.2	18.07	1065.6	1083.7	0.0361	2.0903	2.1264
60	0.2563	0.01604	1206.6	1206.7	28.06	1059.9	1088.0	0.0555	2.0393	2.0948
70	0.3631	0.01606	867.8	867.9	38.04	1054.3	1092.3	0.0745	1.9902	2.0647
80	0.5069	0.01608	633.1	633.1	48.02	1048.6	1096.6	0.0932	1.9428	2.0360
90	0.6982	0.01610	468.0	468.0	57.99	1042.9	1100.9	0.1115	1.8972	2.0087
100	0.9492	0.01613	350.3	350.4	67.97	1037.2	1105.2	0.1295	1.8531	1.9826
110	1.2748	0.01617	265.3	265.4	77.94	1031.6	1109.5	0.1471	1.8106	1.9577
120	1.6924	0.01620	203.25	203.27	87.92	1025.8	1113.7	0.1645	1.7694	1.9339
130	2.2225	0.01625	157.32	157.34	97.90	1020.0	1117.9	0.1816	1.7296	1.9112
140	2.8886	0.01629	122.99	123.01	107.89	1014.1	1122.0	0.1984	1.6910	1.8894
150	3.718	0.01634	97.06	97.07	117.89	1008.2	1126.1	0.2149	1.6537	1.8685
160	4.741	0.01639	77.27	77.29	127.89	1002.3	1130.2	0.2311	1.6174	1.8485
170	5.992	0.01645	62.04	62.06	137.90	996.3	1134.2	0.2472	1.5822	1.8293
180	7.510	0.01651	50.21	50.23	147.92	990.2	1138.1	0.2630	1.5480	1.8109
190	9.339	0.01657	40.94	40.96	157.95	984.1	1142.0	0.2785	1.5147	1.7932
200	11.526	0.01663	33.62	33.64	167.99	977.9	1145.9	0.2938	1.4824	1.7762
210	14.123	0.01670	27.80	27.82	178.05	971.6	1149.7	0.3090	1.4508	1.7598
212	14.696	0.01672	26.78	26.80	180.07	970.3	1150.4	0.3120	1.4446	1.7566
220	17.186	0.01677	23.13	23.15	188.13	965.2	1153.4	0.3239	1.4201	1.7440
230	20.780	0.01684	19.365	19.382	198.23	958.8	1157.0	0.3387	1.3901	1.7288
240	24.969	0.01692	16.306	16.323	208.34	952.2	1160.5	0.3531	1.3609	1.7140

STEAM TABLE (SATURATION:TEMPERATURE)

Temp.	Abs. Press.	Specific Volume			Enthalpy			Entropy		
° Fahr.	Lb/Sq In	Sat. Liquid	Evap.	Sat. Vapor	Sat. Liquid	Evap.	Sat. Vapor	Sat. Liquid	Evap.	Sat. Vapor
t	p	v_f	v_{fg}	v_g	h_f	h_{fg}	h_g	s_f	s_{fg}	s_g
250	29.825	0.01700	13.804	13.821	218.48	945.5	1164.0	0.3675	1.3323	1.6998
260	35.429	0.01709	11.746	11.763	228.64	938.7	1167.3	0.3817	1.3043	1.6860
270	41.858	0.01717	10.044	10.061	238.84	931.8	1170.6	0.3958	1.2769	1.6727
280	49.203	0.01726	8.628	8.645	249.06	924.7	1173.8	0.4096	1.2501	1.6597
290	57.556	0.01735	7.444	7.461	259.31	917.5	1176.8	0.4234	1.2238	1.6472
300	67.013	0.01745	6.449	6.446	269.59	910.1	1179.7	0.4369	1.1980	1.6350
310	77.68	0.01755	5.609	5.626	279.59	902.6	1182.5	0.4504	1.1727	1.6231
320	89.66	0.01765	4.896	4.914	290.28	894.9	1185.2	0.4637	1.1478	1.6115
330	103.06	0.01776	4.289	4.307	300.68	887.0	1187.7	0.4769	1.1233	1.6002
340	118.01	0.01787	3.770	3.788	311.13	879.0	1190.1	0.4900	1.0992	1.5891
350	134.63	0.01799	3.324	3.342	321.63	870.7	1192.3	0.5029	1.0754	1.5783
360	153.04	0.01811	2.939	2.957	332.18	862.2	1194.4	0.5158	1.0519	1.5677
370	173.37	0.01823	2.606	2.625	342.79	853.5	1196.3	0.5286	1.0287	1.5573
380	195.77	0.01836	2.317	2.335	353.45	844.6	1198.1	0.5413	1.0059	1.5471
390	220.37	0.01850	2.0651	2.0836	364.17	835.4	1199.6	0.5539	0.9832	1.5371
400	247.31	0.01864	1.8447	1.8633	374.97	826.0	1201.0	0.5664	0.9608	1.5272
410	276.75	0.01878	1.6512	1.6700	385.83	816.3	1202.1	0.5788	0.9386	1.5174
420	308.83	0.01894	1.4811	1.5000	396.77	806.3	1203.1	0.5912	0.9166	1.5078
430	343.72	0.01910	1.3308	1.3499	407.79	796.0	1203.8	0.6035	0.8947	1.4982
440	381.59	0.01926	1.1979	1.2171	418.90	785.4	1204.3	0.6158	0.8730	1.4887
450	422.6	0.0194	1.0799	1.0993	430.1	774.5	1204.6	0.6280	0.8513	1.4793
460	466.9	0.0196	0.9748	0.9009	441.4	763.2	1204.6	0.6402	0.8298	1.4700
470	514.7	0.0198	0.8811	0.9009	452.8	751.5	1204.3	0.6523	0.8083	1.4606
480	566.1	0.0200	0.7972	0.8172	464.4	739.4	1203.7	0.6645	0.7868	1.4513
490	621.4	0.0202	0.7221	0.7423	476.0	726.8	1202.8	0.6766	0.7653	1.4419

STEAM TABLE (SATURATION:TEMPERATURE)

Temp.	Abs. Press.	Specific Volume			Enthalpy			Entropy		
° Fahr.	Lb/Sq In	Sat. Liquid	Evap.	Sat. Vapor	Sat. Liquid	Evap.	Sat. Vapor	Sat. Liquid	Evap.	Sat. Vapor
t	p	v_f	v_{fg}	v_g	h_f	h_{fg}	h_g	s_f	s_{fg}	s_g
500	680.8	0.0204	0.6545	0.6749	487.8	713.9	1201.7	0.6887	0.7438	1.4325
520	812.4	0.0209	0.5385	0.5594	511.9	686.4	1198.2	0.7130	0.7006	1.4136
540	962.5	0.0215	0.4434	0.4649	536.6	656.6	1193.2	0.7374	0.6568	1.3942
560	1133.1	0.0221	0.3647	0.3868	562.2	624.2	1186.4	0.7621	0.6121	1.3742
580	1325.8	0.0228	0.2989	0.3217	588.9	588.4	1177.3	0.7872	0.5659	1.3532
600	1542.9	0.0236	0.2432	0.2668	617.0	548.5	1165.5	0.8131	0.5176	1.3307
620	1786.6	0.0247	0.1955	0.2201	646.7	503.6	1150.3	0.8398	0.4664	1.3062
640	2059.7	0.0260	0.1538	0.1798	678.6	452.0	1130.5	0.8679	0.4110	1.2789
660	2365.4	0.0278	0.1165	0.1442	714.2	390.2	1104.4	0.8987	0.3485	1.2472
680	2708.1	0.0305	0.0810	0.1115	757.3	309.9	1067.2	0.9351	0.2719	1.2071
700	3093.7	0.0369	0.0392	0.0761	823.3	172.1	995.4	0.9905	0.1484	1.1389
705.4	3206.2	0.0503	0	0.0503	902.7	0	902.7	1.0580	0	1.0580

STEAM TABLE (SATURATION:PRESSURE)

Abs. Press.	Temp	Specific Volume		Enthalpy			Entropy			Internal Energy	
Lb/Sq In	°Fahr.	Sat. Liquid	Sat. Vapor	Sat. Liquid	Evap.	Sat. Vapor	Sat. Liquid	Evap.	Sat. Vapor	Sat. Liquid	Sat. Vapor
p	t	v_f	v_g	h_f	h_{fg}	h_g	s_f	s_{fg}	s_g	u_f	u_g
1.0	101.74	0.01614	333.6	69.70	1036.3	1106.0	0.1326	1.8456	1.9782	69.70	1044.3
2.0	126.08	0.01623	173.73	93.99	1022.2	1116.2	0.1749	1.7451	1.9200	93.98	1051.9
3.0	141.48	0.01630	118.71	109.37	1013.2	1122.6	0.2008	1.6855	1.8863	109.36	1056.7
4.0	152.97	0.01636	90.63	120.86	1006.4	1127.3	0.2198	1.6427	1.8625	120.85	1060.2
5.0	162.24	0.01640	73.52	130.13	1001.0	1131.1	0.2347	1.6094	1.8441	130.12	1063.1
6.0	170.06	0.01645	61.98	137.96	996.2	1134.2	0.2472	1.5820	1.8292	137.94	1065.4
7.0	176.85	0.01649	53.64	144.76	992.1	1136.9	0.2581	1.5586	1.8167	144.74	1067.4
8.0	182.86	0.01653	47.34	150.79	988.5	1139.3	0.2674	1.5383	1.8057	150.77	1069.2
9.0	188.28	0.01656	42.40	156.22	985.2	1141.4	0.2759	1.5203	1.7962	156.19	1070.8
10	193.21	0.01659	38.42	161.17	982.1	1143.3	0.2835	1.5041	1.7876	161.14	1072.2
14.696	212.00	0.01672	26.80	180.07	970.3	1150.4	0.3120	1.4446	1.7566	180.02	1077.5
15	213.03	0.01672	26.29	181.11	969.7	1150.8	0.3135	1.4415	1.7549	181.06	1077.8
20	227.96	0.01683	20.089	196.16	960.1	1156.3	0.3356	1.3962	1.7319	196.10	1081.9
25	240.07	0.01692	16.303	208.42	952.1	1060.6	0.3533	1.3606	1.7139	208.34	1085.1
30	250.33	0.01701	13.746	218.82	945.3	1164.1	0.3680	1.3313	1.6993	218.73	1087.8
35	259.28	0.01708	11.898	227.91	939.2	1167.1	0.3807	1.3063	1.6870	227.80	1090.1
40	267.25	0.01715	10.498	236.03	933.7	1169.7	0.3919	1.2844	1.6763	235.90	1092.0
45	274.44	0.01721	9.401	243.36	928.6	1172.0	0.4019	1.2650	1.6669	243.22	1093.7
50	281.01	0.01727	8.515	250.09	924.0	1174.1	0.4110	1.2474	1.6585	249.93	1095.3
55	287.07	0.01732	7.787	256.30	919.6	1175.9	0.4193	1.2316	1.6509	256.12	1096.7
60	292.71	0.01738	7.175	262.09	915.5	1177.6	0.4270	1.2168	1.6438	261.90	1097.9
65	297.97	0.01743	6.655	267.50	911.6	1179.1	0.4342	1.2032	1.6374	267.29	1099.1
70	302.92	0.01748	6.206	272.61	907.9	1180.6	0.4409	1.1906	1.6315	272.38	1100.2
75	307.60	0.01753	5.816	277.43	904.5	1181.9	0.4472	1.1787	1.6259	277.19	1101.2

STEAM TABLE (SATURATION:PRESSURE)

Abs. Press.	Temp	Specific Volume		Enthalpy			Entropy			Internal Energy	
Lb/Sq In	°Fahr.	Sat. Liquid	Sat. Vapor	Sat. Liquid	Evap.	Sat. Vapor	Sat. Liquid	Evap.	Sat. Vapor	Sat. Liquid	Sat. Vapor
p	t	v_f	v_g	h_f	h_{fg}	h_g	s_f	s_{fg}	s_g	u_f	u_g
80	312.03	0.01757	5.472	282.02	901.1	1183.1	0.4531	1.1676	1.6207	281.76	1102.1
85	316.25	0.01761	5.168	286.39	897.8	1184.2	0.4587	1.1571	1.6158	286.11	1102.9
90	320.27	0.01766	4.896	290.56	894.7	1185.3	0.4641	1.1471	1.6112	290.27	1103.7
95	324.12	0.01770	4.652	294.56	891.7	1186.2	0.4692	1.1376	1.6068	294.25	1104.5
100	327.81	0.01774	4.432	298.40	888.8	1187.2	0.4740	1.1286	1.6026	298.08	1105.2
110	334.77	0.01782	4.049	305.66	883.2	1188.9	0.4832	1.1117	1.5948	305.30	1106.5
120	341.25	0.01789	3.728	312.44	877.9	1190.4	0.4916	1.0962	1.5878	312.05	1107.6
130	347.32	0.01796	3.455	318.81	872.9	1191.7	0.4995	1.0817	1.5812	318.38	1108.6
140	353.02	0.01802	3.220	324.82	868.2	1193.0	0.5069	1.0682	1.5751	324.35	1109.6
150	358.42	0.01809	3.015	330.51	863.6	1194.1	0.5138	1.0556	1.5694	330.01	1110.5
160	363.53	0.01815	2.834	335.93	859.2	1195.1	0.5204	1.0436	1.5640	335.39	1111.2
170	368.41	0.01822	2.675	341.09	854.9	1196.0	0.5266	1.0324	1.5590	340.52	1111.9
180	373.06	0.01827	2.532	346.03	850.8	1196.9	0.5325	1.0217	1.5542	345.42	1112.5
190	377.51	0.01833	2.404	350.79	846.8	1197.6	0.5381	1.0116	1.5497	350.15	1113.1
200	381.79	0.01839	2.288	355.36	843.0	1198.4	0.5435	1.0018	1.5453	354.68	1113.7
250	400.95	0.01865	1.8438	3760.0	825.1	1201.1	0.5675	0.9588	1.5263	375.14	1115.8
300	417.33	0.01890	1.5433	393.84	809.0	1202.8	0.5879	0.9225	1.5104	392.79	1117.1
350	431.72	0.01913	1.3260	409.69	794.2	1203.9	0.6056	0.8910	1.4966	408.45	1118.0
400	444.59	0.0193	1.1613	424.0	780.5	1204.5	0.6214	0.8630	1.4844	422.6	1118.5
450	456.28	0.0195	1.0320	437.2	767.4	1204.6	0.6356	0.8378	1.4734	435.5	1118.7
500	467.01	0.0197	0.9278	449.4	755.0	1204.4	0.6487	0.8147	1.4634	447.6	1118.6
550	476.94	0.0199	0.8424	460.8	743.1	1203.9	0.6608	0.7934	1.4542	458.8	1118.2
600	486.21	0.0201	0.7698	471.6	731.6	1203.2	0.6720	0.7734	1.4454	469.4	1117.7
650	494.90	0.0203	0.7083	481.8	720.5	1202.3	0.6826	0.7548	1.4374	479.4	1117.1

STEAM TABLE (SATURATION:PRESSURE)

Abs. Press.	Temp	Specific Volume		Enthalpy			Entropy			Internal Energy	
Lb/Sq In	°Fahr.	Sat. Liquid	Sat. Vapor	Sat. Liquid	Evap.	Sat. Vapor	Sat. Liquid	Evap.	Sat. Vapor	Sat. Liquid	Sat. Vapor
p	t	v_f	v_g	h_f	h_{fg}	h_g	s_f	s_{fg}	s_g	u_f	u_g
700	503.10	0.0205	0.6554	491.5	709.7	1201.2	0.6925	0.7371	1.4296	488.8	1116.3
750	510.86	0.0207	0.6092	500.8	699.2	1200.0	0.7019	0.7204	1.4223	498.0	1115.4
800	518.23	0.0209	0.5687	509.7	688.9	1198.6	0.7108	0.7045	1.4153	506.6	1114.4
850	525.26	0.0210	0.5327	518.3	678.8	1197.1	0.7194	0.6891	1.4085	515.0	1113.3
900	531.98	0.0212	0.5006	526.6	668.8	1195.4	0.7275	0.6744	1.4020	523.1	1112.1
950	538.43	0.0214	0.4717	534.6	659.1	1193.7	0.7355	0.6602	1.3957	530.9	1110.8
1000	544.61	0.0216	0.4456	542.4	649.4	1191.8	0.7430	0.6467	1.3897	538.4	1109.4
1100	556.31	0.0220	0.4001	557.4	630.4	1187.8	0.7575	0.6205	1.3780	552.9	1106.4
1200	567.22	0.0223	0.3619	571.7	611.7	1183.4	0.7711	0.5956	1.3667	566.7	1103.0
1300	577.46	0.0227	0.3293	585.4	593.2	1178.6	0.7840	0.5719	1.3559	580.0	1099.4
1400	587.10	0.0231	0.3012	598.7	574.7	1173.4	0.7963	0.5491	1.3454	592.7	1095.4
1500	596.23	0.0235	0.2765	611.6	556.3	1167.9	0.8082	0.5269	1.3351	605.1	1091.2
2000	635.82	0.0257	0.1878	671.7	463.4	1135.1	0.8619	0.4230	1.2849	662.2	1065.6
2500	668.13	0.0287	0.1307	730.6	360.5	1091.1	0.9126	0.3197	1.2322	717.3	1030.6
3000	695.36	0.0346	0.0858	802.5	217.8	1020.3	0.9731	0.1885	1.1615	783.4	972.7
3206.2	705.40	0.0503	0.0503	902.7	0	902.7	1.0580	0	1.0580	872.9	872.9

SUPERHEATED VAPOR

Abs. Press lb/sq in Sat. Temp.		Temperature—Degrees Fahrenheit												
		200°	300°	400°	500°	600°	700°	800°	900°	1000°	1100°	1200°	1400°	1600°
	v	392.6	452.3	512.0	571.6	631.2	690.8	750.4	809.9	869.5	929.1	988.7	1107.8	1227.0
1	h	1150.4	1195.8	1241.7	1288.3	1335.7	1383.8	1432.8	1482.7	1533.5	1585.2	1637.7	1745.7	1857.5
(101.74)	s	2.0512	2.1153	2.1720	2.2233	2.2702	2.3137	2.3542	2.3923	2.4283	2.4625	2.4952	2.5566	2.6137
	v	78.16	90.25	102.26	114.22	126.16	138.10	150.03	161.95	173.87	185.79	197.71	221.6	245.4
5	h	1148.8	1195.0	1241.2	1288.0	1335.4	1383.6	1432.7	1482.6	1533.4	1585.1	1637.7	1745.7	1857.4
(162.24)	s	1.8718	1.9370	1.9942	2.0456	2.0927	2.1361	2.1767	2.2148	2.2509	2.2851	2.3178	2.3792	2.4363
	v	38.85	45.00	51.04	57.05	63.03	69.01	74.98	80.95	86.92	92.83	98.84	110.77	122.69
10	h	1146.6	1193.9	1240.6	1287.5	1335.1	1383.4	1432.5	1482.4	1533.2	1585.0	1637.6	1745.6	1857.3
(193.21)	s	1.7927	1.8595	1.9172	1.9689	2.0160	2.0596	2.1002	2.1383	2.1744	2.2086	2.2413	2.3028	2.3598
	v	–	30.53	34.68	38.78	42.86	46.94	51.00	55.07	59.13	63.19	67.25	75.37	83.48
14.696	h	–	1192.8	1239.9	1287.1	1334.8	1383.2	1432.3	1482.3	1533.1	1584.8	1637.5	1745.5	1857.3
(212.00)	s	–	1.8160	1.8743	1.9261	1.9734	2.0170	2.0576	2.0958	2.1319	2.1662	2.1989	2.2603	2.3174
	v	–	22.36	25.43	28.46	31.47	34.47	37.46	40.45	43.44	46.42	49.41	55.37	61.34
20	h	–	1191.6	1239.2	1286.6	1334.4	1382.9	1432.1	1482.1	1533.0	1584.7	1637.4	1745.4	1857.2
(227.96)	s	–	1.7808	1.8396	1.8918	1.9392	1.9829	2.0235	2.0618	2.0978	2.1321	2.1648	2.2263	2.2834
	v	–	11.040	12.628	14.168	15.688	17.198	18.702	20.20	21.70	23.20	24.69	27.68	30.66
40	h	–	1186.8	1236.5	1284.8	1333.1	1381.9	1431.3	1481.4	1532.4	1584.3	1637.0	1745.1	1857.0
(267.25)	s	–	1.6994	1.7608	1.8140	1.8619	1.9058	1.9467	1.9850	2.0212	2.0555	2.0883	2.1498	2.2069
	v	–	7.259	8.357	9.403	10.427	11.441	12.449	13.452	14.454	15.453	16.451	18.446	20.44
60	h	–	1181.6	1233.6	1283.0	1331.8	1380.9	1430.5	1480.8	1531.9	1583.8	1636.6	1744.8	1856.7
(292.71)	s	–	1.6492	1.7135	1.7678	1.8162	1.8605	1.9015	1.9400	1.9762	2.0106	2.0434	2.1049	1.1621
°	v	–	–	6.220	7.020	7.797	8.562	9.322	10.077	10.830	11.582	12.332	13.830	15.325
80	h	–	–	1230.7	1281.1	1330.5	1379.9	1429.7	1480.1	1531.3	1583.4	1636.2	1744.5	1856.5
(312.03)	s	–	–	1.6791	1.7346	1.7836	1.8281	1.8694	1.9079	1.9442	1.9787	2.0115	2.0731	2.1303

SUPERHEATED VAPOR

Abs. Press lb/sq in Sat. Temp.		Temperature—Degrees Fahrenheit												
		200°	300°	400°	500°	600°	700°	800°	900°	1000°	1100°	1200°	1400°	1600°
	v	–	–	4.937	5.589	6.218	6.835	7.446	8.052	8.656	9.259	9.860	11.060	12.258
100	h	–	–	1227.6	1279.1	1329.1	1378.9	1428.9	1479.5	1530.8	1582.9	1635.7	1744.2	1856.2
(327.81)	s	–	–	1.6518	1.7085	1.7581	1.8029	1.8443	1.8829	1.9193	1.9538	1.9867	2.0484	2.1056
	v	–	–	4.081	4.636	5.165	5.683	6.195	6.702	7.207	7.710	8.212	9.214	10.213
120	h	–	–	1224.4	1277.2	1327.7	1377.8	1428.1	1478.8	1530.2	1582.4	1635.3	1743.9	1856.0
(341.25)	s	–	–	1.6287	1.6869	1.7370	1.7822	1.8237	1.8625	1.8990	1.9335	1.9664	2.0281	2.0854
	v	–	–	3.468	3.954	4.413	4.861	5.301	5.738	6.172	6.604	7.035	7.895	8.752
140	h	–	–	1221.1	1275.2	1326.4	1376.8	1427.3	1478.2	1529.7	1581.9	1634.9	1743.5	1855.7
(353.02)	s	–	–	1.6087	1.6683	1.7190	1.7645	1.8063	1.8451	1.8817	1.9163	1.9493	2.0110	2.0683
	v	–	–	3.008	3.443	3.849	4.244	4.631	5.015	5.396	5.775	6.152	6.906	7.656
160	h	–	–	1217.6	1273.1	1325.0	1375.7	1426.4	1477.5	1529.1	1581.4	1634.5	1743.2	1855.5
(363.53)	s	–	–	1.5908	1.6519	1.7033	1.7491	1.7911	1.8301	1.8667	1.9014	1.9344	1.9962	2.0535
	v	–	–	2.649	3.044	3.411	3.764	4.110	4.452	4.792	5.129	5.466	6.136	6.804
180	h	–	–	1214.0	1271.0	1323.5	1374.7	1425.6	1476.8	1528.6	1581.0	1634.1	1742.9	1855.2
(373.06)	s	–	–	1.5745	1.6373	1.6894	1.7355	1.776	1.8167	1.8534	1.8882	1.9212	1.9831	2.0404
	v	–	–	2.361	2.726	3.060	3.380	3.693	4.002	4.309	4.613	4.917	5.521	6.123
200	h	–	–	1210.3	1268.9	1322.1	1373.6	1424.8	1476.2	1528.0	1580.5	1633.7	1742.6	1855.0
(381.79)	s	–	–	1.5594	1.6240	1.6767	1.7232	1.7655	1.8048	1.8415	1.8763	1.9094	1.9713	2.0287
	v	–	–	2.125	2.465	2.772	3.066	3.352	3.634	3.913	4.191	4.467	5.017	5.565
220	h	–	–	1206.5	1266.7	1320.7	1372.6	1424.0	1475.5	1527.5	1580.0	1633.3	1742.3	1854.7
(389.86)	s	–	–	1.5453	1.6117	1.6652	1.7120	1.7545	1.7939	1.8308	1.8656	1.8987	1.9607	2.0181
	v	–	–	1.9276	2.247	2.533	2.804	3.068	3.327	3.584	3.839	4.093	4.597	5.100
240	h	–	–	1202.5	1264.5	1319.2	1371.5	1423.2	1474.8	1526.9	1579.6	1632.9	1742.0	1854.5
(397.37)	s	–	–	1.5319	1.6003	1.6546	1.7017	1.7444	1.7839	1.8209	1.8558	1.8889	1.9510	2.0084

SUPERHEATED VAPOR

Abs. Press lb/sq in Sat. Temp.		Temperature—Degrees Fahrenheit												
		200°	300°	400°	500°	600°	700°	800°	900°	1000°	1100°	1200°	1400°	1600°
	v	–	–	–	2.063	2.330	2.582	2.827	3.067	3.305	3.541	3.776	4.242	4.707
260	h	–	–	–	1262.3	1317.7	1370.4	1422.3	1474.2	1526.3	1579.1	1632.5	1741.7	1854.2
(404.42)	s	–	–	–	1.5897	1.6447	1.6922	1.7352	1.7748	1.8118	1.8467	1.8799	1.9420	1.9995
	v	–	–	–	1.9047	2.156	2.392	2.621	2.845	3.066	3.286	3.504	3.938	4.370
280	h	–	–	–	1260.0	1316.2	1369.4	1421.5	1473.5	1525.8	1578.6	1632.1	1741.4	1854.0
(411.05)	s	–	–	–	1.5796	1.6354	1.6834	1.7265	1.7662	1.8033	1.8383	1.8716	1.9337	1.9912
	v	–	–	–	1.7675	2.005	2.227	2.442	2.652	2.859	3.065	3.269	3.674	4.078
300	h	–	–	–	1257.6	1314.7	1368.3	1420.6	1472.8	1525.2	1578.1	1631.7	1741.0	1853.7
(417.33)	s	–	–	–	1.5701	1.6268	1.6751	1.7184	1.7582	1.7954	1.8305	1.8638	1.9260	1.9835
	v	–	–	–	1.4923	1.7036	1.8980	2.084	2.266	2.445	2.622	2.798	3.147	3.493
350	h	–	–	–	1251.5	1310.9	1365.5	1418.5	1471.1	1523.8	1577.0	1630.7	1740.3	1853.1
(431.72)	s	–	–	–	1.5481	1.6070	1.6563	1.7002	1.7403	1.7777	1.8130	1.8463	1.9086	1.9663
	v	–	–	–	1.2851	1.4770	1.6508	1.8161	1.9767	2.134	2.290	2.445	2.751	3.055
400	h	–	–	–	1245.1	1306.9	1362.7	1416.4	1469.4	1522.4	1575.8	1629.6	1739.5	1852.5
(444.59)	s	–	–	–	1.5281	1.5984	1.6398	1.6842	1.7247	1.7623	1.7977	1.8311	1.8936	1.9513

SUPERHEATED VAPOR

Abs. Press. lb/sq in Sat. Temp.		Temperature–Degrees Fahrenheit													
		500°	550°	600°	620°	640°	660°	680°	700°	800°	900°	1000°	1200°	1400°	1600°
	v	1.1231	1.2155	1.3005	1.3332	1.3652	1.3967	1.4278	1.4584	1.6074	1.7516	1.8928	2.170	2.443	2.714
450	h	1238.4	1272.0	1302.8	1314.6	1326.2	1337.5	1348.8	1359.9	1414.3	1467.7	1521.0	1628.6	1738.7	1851.9
(456.28)	s	1.5095	1.5437	1.5735	1.5845	1.5951	1.6054	1.6153	1.6250	1.6699	1.7108	1.7486	1.8177	1.8803	1.9381
	v	0.9927	1.0800	1.1591	1.1893	1.2188	1.2478	1.2763	1.3044	1.4405	1.5715	1.6996	1.9504	2.197	2.442
500	h	1231.3	1266.8	1298.6	1310.7	1322.6	1334.2	1345.7	1357.0	1412.1	1466.0	1519.6	1627.6	1737.9	1851.3
(467.01)	s	1.4919	1.5280	1.5588	1.5701	1.5810	1.5915	1.6016	1.6115	1.6571	1.6982	1.7363	1.8056	1.8683	1.9262
	v	0.8852	0.9686	1.0431	1.0714	1.0989	1.1259	1.1523	1.1783	1.3038	1.4241	1.5414	1.7706	1.9957	2.219
550	h	1223.7	1261.2	1294.3	1306.8	1318.9	1330.8	1342.5	1354.0	1409.9	1464.3	1518.2	1626.6	1737.1	1850.6
(476.94)	s	1.4751	1.5131	1.5451	1.5568	1.5680	1.5787	1.5890	1.5991	1.6452	1.6868	1.7250	1.7946	1.8575	1.9155
	v	0.7947	0.8753	0.9463	0.9729	0.9988	1.0241	1.0489	1.0732	1.1899	1.3013	1.4096	1.6208	1.8279	2.033
600	h	1215.7	1255.5	1289.9	1302.7	1315.2	1327.4	1339.3	1351.1	1407.7	1462.5	1516.7	1625.5	1736.3	1850.0
(486.21)	s	1.4586	1.4990	1.5323	1.5443	1.5558	1.5667	1.5773	1.5875	1.6343	1.6762	1.7147	1.7846	1.8476	1.9056
	v	–	0.7277	0.7934	0.8177	0.8411	0.8639	0.8860	0.9077	1.0108	1.1082	1.2024	1.3853	1.5641	1.7405
700	h	–	1243.2	1280.6	1294.3	1307.5	1320.3	1332.8	1345.0	1403.2	1459.0	1513.9	1623.5	1734.8	1848.8
(503.10)	s	–	1.4722	1.5084	1.5212	1.5333	1.5449	1.5559	1.5665	1.6147	1.6573	1.6963	1.7666	1.8299	1.8881
	v	–	0.6154	0.6779	0.7006	0.7223	0.7433	0.7635	0.7833	0.8763	0.9633	1.0470	1.2088	1.3662	1.5214
800	h	–	1229.8	1270.7	1285.4	1299.4	1312.9	1325.9	1338.6	1398.6	1455.4	1511.0	1621.4	1733.2	1847.5
(518.23)	s	–	1.4467	1.4863	1.5000	1.5129	1.5250	1.5366	1.5476	1.5972	1.6407	1.6801	1.7510	1.8146	1.8729
	v	–	0.5264	0.5873	0.6089	0.6294	0.6491	0.6680	0.6863	0.7716	0.8506	0.9262	1.0714	1.2124	1.3509
900	h	–	1215.0	1260.1	1275.9	1209.9	1305.1	1318.8	1332.1	1393.9	1451.8	1508.1	1619.3	1731.6	1846.3
(531.98)	s	–	1.4216	1.4653	1.4800	1.4938	1.5066	1.5187	1.5303	1.5814	1.6257	1.6656	1.7371	1.8009	1.8595
	v	–	0.4533	0.5140	0.5350	0.5546	0.5733	0.5912	0.6084	0.6878	0.7604	0.8294	0.9615	1.0893	1.2146
1000	h	–	1198.3	1248.8	1265.9	1281.9	1297.0	1311.4	1325.3	1389.2	1448.2	1505.1	1617.3	1730.0	1845.0

SUPERHEATED VAPOR

Abs. Press. lb/sq in Sat. Temp.		Temperature—Degrees Fahrenheit													
		500°	550°	600°	620°	640°	660°	680°	700°	800°	900°	1000°	1200°	1400°	1600°
	v	–	–	0.4532	0.4738	0.4929	0.5110	0.5281	0.5445	0.6191	0.6866	0.7503	0.8716	0.9885	1.1031
1100	h	–	–	1236.7	1255.3	1272.4	1288.5	1303.7	1318.3	1384.3	1444.5	1502.2	1615.2	1728.4	1843.8
(556.31)	s	–	–	1.4251	1.4425	1.4583	1.4728	1.4862	1.4989	1.5535	1.5995	1.6405	1.7130	1.7775	1.8363
	v	–	–	0.4016	0.4222	0.4410	0.4586	0.4752	0.4909	0.5617	0.6250	0.6843	0.7967	0.9046	1.0101
1200	h	–	–	1223.5	1243.9	1262.4	1279.6	1295.7	1311.0	1379.3	1440.7	1499.2	1613.1	1726.9	1842.5
(567.22)	s	–	–	1.4052	1.4243	1.4413	1.4568	1.4710	1.4843	1.5409	1.5879	1.6293	1.7025	1.7672	1.8263
	v	–	–	0.3174	0.3390	0.3580	0.3753	0.3912	0.4062	0.4714	0.5281	0.5805	0.6789	0.7727	0.8640
1400	h	–	–	1193.0	1218.4	1240.4	1260.3	1278.5	1295.5	1369.1	1433.1	1493.2	1608.9	1723.7	1840.0
(587.10)	s	–	–	1.3639	1.3877	1.4079	1.4258	1.4419	1.4567	1.5177	1.5666	1.6093	1.6836	1.7489	1.8083
	v	–	–	–	0.2733	0.2936	0.3112	0.3271	0.3417	0.4034	0.4553	0.5027	0.5906	0.6738	0.7545
1600	h	–	–	–	1187.8	1215.2	1238.7	1259.6	1278.7	1358.4	1425.3	1487.0	1604.6	1720.5	1837.5
(604.90)	s	–	–	–	1.3489	1.3741	1.3952	1.4137	1.4303	1.4964	1.5476	1.5914	1.6669	1.7328	1.7926
	v	–	–	–	–	0.2407	0.2597	0.2760	0.2907	0.3502	0.3986	0.4421	0.5218	0.5968	0.6693
1800	h	–	–	–	–	1185.1	1214.0	1238.5	1260.3	1347.2	1417.4	1480.8	1600.4	1717.3	1835.0
(621.03)	s	–	–	–	–	1.3377	1.3638	1.3855	1.4044	1.4765	1.5301	1.5752	1.6520	1.7185	1.7786
	v	–	–	–	–	0.1936	0.2161	0.2337	0.2489	0.3074	0.3532	0.3935	0.4668	0.5352	0.6011
2000	h	–	–	–	–	1145.6	1184.9	1214.8	1240.0	1335.5	1409.2	1474.5	1596.1	1714.1	1832.5
(635.82)	s	–	–	–	–	.2945	1.3300	1.3564	1.3783	1.4576	1.5139	1.5603	1.6384	1.7055	1.7660
	v	–	–	–	–	–	–	0.1484	0.1686	0.2294	0.2710	0.3061	0.3678	0.4244	0.4784
2500	h	–	–	–	–	–	–	1132.3	1176.8	1303.6	1387.8	1458.4	1585.3	1706.1	1826.2
(668.13)	s	–	–	–	–	–	–	1.2687	1.3073	1.4127	1.4772	1.5273	1.6088	1.6775	1.7389
	v	–	–	–	–	–	–	–	0.0984	0.1760	0.2159	0.2476	0.3018	0.3505	0.3966
3000	h	–	–	–	–	–	–	–	1060.7	1267.2	1365.0	1441.8	1574.3	1698.0	1819.9
(695.36)	s	–	–	–	–	–	–	–	1.1966	1.3690	1.4439	1.4984	1.5837	1.6540	1.7163

SUPERHEATED VAPOR

Abs. Press. lb/sq in Sat. Temp.		Temperature—Degrees Fahrenheit													
		500°	550°	600°	620°	640°	660°	680°	700°	800°	900°	1000°	1200°	1400°	1600°
	v	–	–	–	–	–	–	–	–	0.1583	0.1981	0.2288	0.2806	0.3267	0.3703
3206.2	h	–	–	–	–	–	–	–	–	1250.5	1355.2	1434.7	1569.8	1694.6	1817.2
(705.40)	s	–	–	–	–	–	–	–	–	1.3508	1.4309	1.4874	1.5742	1.6452	1.7080
	v	–	–	–	–	–	–	–	0.0306	0.1364	0.1762	0.2058	0.2546	0.2977	0.3381
3500	h	–	–	–	–	–	–	–	780.5	1224.9	1340.7	1424.5	1563.3	1689.8	1813.6
	s	–	–	–	–	–	–	–	0.9515	1.3241	1.4127	1.4723	1.5615	1.6336	1.6968
	v	–	–	–	–	–	–	–	0.0287	0.1052	0.1462	0.1743	0.2192	0.2581	0.2943
4000	h	–	–	–	–	–	–	–	763.8	1174.8	1314.4	1406.8	1552.1	1681.7	1807.2
	s	–	–	–	–	–	–	–	0.9347	1.2757	1.3827	1.4482	1.5417	1.6154	1.6795
	v	–	–	–	–	–	–	–	0.0276	0.0798	0.1226	0.1500	0.1917	0.2273	0.2602
4500	h	–	–	–	–	–	–	–	753.5	1113.9	1286.5	1388.4	1540.8	1673.5	1800.9
	s	–	–	–	–	–	–	–	0.9235	1.2204	1.3529	1.4253	1.5235	1.5990	1.6640
	v	–	–	–	–	–	–	–	0.0268	0.0593	0.1036	0.1303	0.1696	0.2027	0.2329
5000	h	–	–	–	–	–	–	–	746.4	1047.1	1265.5	1369.5	1529.5	1665.3	1794.5
	s	–	–	–	–	–	–	–	0.9152	1.1622	1.3231	1.4034	1.5066	1.5839	1.6499
	v	–	–	–	–	–	–	–	0.0262	0.0463	0.0880	0.1143	0.1516	0.1825	0.2106
5500	h	–	–	–	–	–	–	–	741.3	985.0	1224.1	1349.3	1518.2	1657.0	1788.1
	s	–	–	–	–	–	–	–	0.9090	1.1093	1.2930	1.3821	1.4908	1.5699	1.6369

COMPRESSED GAS CYLINDERS

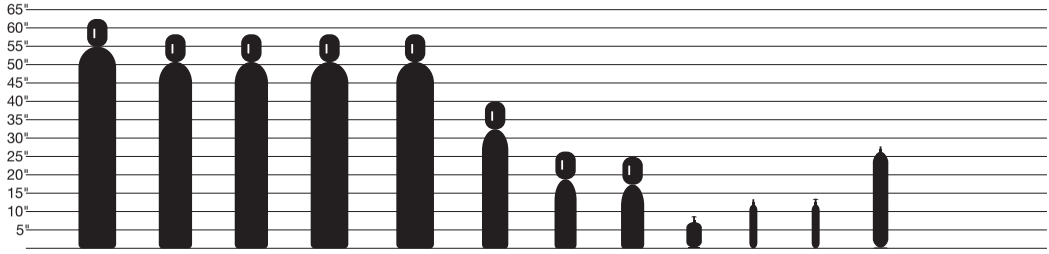
High Pressure Mild Steel

Cylinder Size		49	44L	44	44H	44HH	16	7	3	1"	LB"	LBX"	Med E
Service Pressure	psig	2400	2015	2265	3500	6000	2015	2015	2015	2200	1800	1800	2015
Approximate Capacity*	liters	8071	5976	6740	9487	13990	2181	934.6	396.5	147	53.8	53.8	566
	cu. ft.	285	211	238	335	494	77	33	14	5.2	1.9	1.9	20
Outside Diameter	inches	9.25	9	9	10	10	7	6.25	4.25	4.2	2	2	4
Height w/o Valve	inches	55	51	51	51	51	32.5	18.5	16.75	7.25	12	12	26
Tare Weight w/ Valve	lbs.	143	112	133	189	303	63	28	11	6	3.5	4.5	14
Internal Water Volume	liters	49	44	44	44	42.9	16	7	3	0.98	0.44	0.44	4.5
	cu. in.	2990	2685	2685	2607	2383	976	427	183	60	27	27	275

* Ideal Gas at STP

** Non-returnable cylinder. Price of cylinder included in the price of the gas.

Note: LBX is an LB cylinder with a CGA valve other than 170 or 180

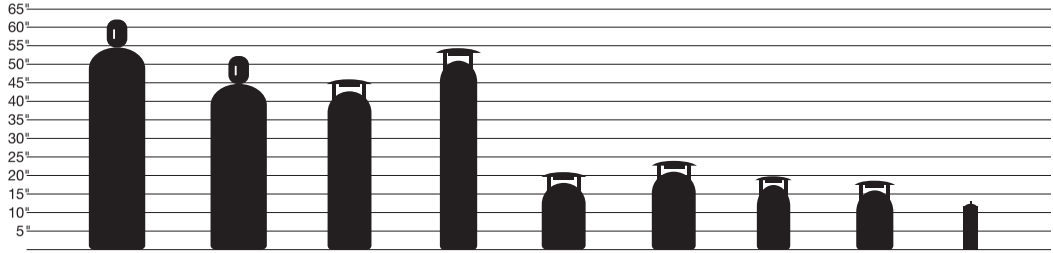


COMPRESSED GAS CYLINDERS

Low Pressure Cylinders

Cylinder Size		125	110	70**	55	22 UP	22 LP AL	11 LP	11 LP AL	4D***
Service Pressure	psig	480	260	250	300	240	240	240	240	240
Approximate Capacity*	liters	4076	1982	11894	1121	368	368	200	200	20
	cu. ft.	144	70	420	39.6	13	13	7	7	0.7
Outside Diameter	inches	15	15	12	10	12	12	9	10	3
Height w/o Valve	inches	54.5	45	43..5	51	18	21	17	16	12
Tare Weight w/ Valve	lbs.	159	73	187	56	21	14	16	11	2.5
Internal Water Volume	liters	125	110	70	55	22	22	12	12	1.16
	cu. in.	7628	6712	4271	3356	1342	1342	732	732	71

* Ideal Gas at STP
** Acetylene Cylinder with acetone
*** Non-returnable cylinder

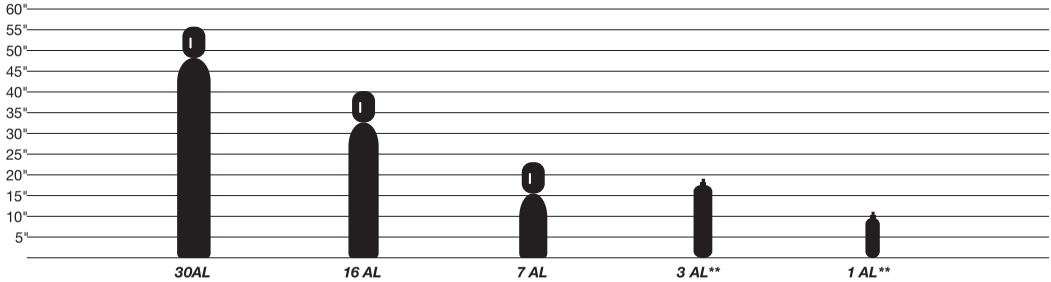


COMPRESSED GAS CYLINDERS

High Pressure Aluminum

Cylinder Size		30 AL	16 AL	7 AL	3 AL**	1 AL**
Service Pressure	psig	2015	2216	2216	2216	2216
Approximate Capacity*	liters	4088	2350	934.6	595	195
	cu. ft.	144	83	33	21	6.9
Outside Diameter	inches	8	7.25	6.9	5.2	4.4
Height w/o Valve	inches	47.9	33	15.6	17.1	9.3
Tare Weight w/ Valve	lbs.	48.5	31	15.6	9.7	4.8
Internal Water Volume	liters	29.4	15.7	6.6	3.9	1.3
	cu. in.	1800	840	360	244	80

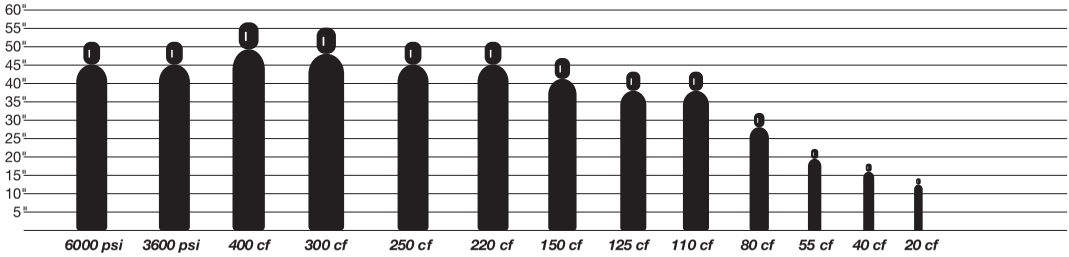
* Ideal Gas at STP
** Resale Cylinder Only



COMPRESSED GAS CYLINDERS

High Pressure Steel

Cylinder Model		6000 psi	3600 psi	400 cf	300 cf	250 cf	220 cf	150 cf	125 cf	110 cf	80 cf	55 cf	40 cf	20 cf
DOT Spec		3AA 6000	3AA 3600	3AA 2400	3AA 2400	3AA 2265	3AA 2015	3AA 2015	3AA 2265	3AA 2015	3AA 2015	3AA 2015	3AA 2015	3AA 2015
Dimentions	inches	9.28x51	9.31x51	10.51x56	9.27x55	9.04x51	8.99x51	7x46.25	7x43	7x43	7x32.38	7x22.88	7x18	5.27x14
	cm	23.5x129.5	23.6x129.5	26.7x142.2	23.5x139.7	23x129.5	22.8x129.5	17.8x117.5	17.8x109.2	17.8x109.2	17.8x82.2	17.8x58.1	17.8x45.7	13.4x35.6
Nominal Weight	lbs.	267	180	190	135	115	114	59	55	55	42	30	23	10.1
	kg.	121.1	81.6	86.2	61.2	52.2	51.7	26.76	24.94	24.94	19.05	13.61	10.43	4.58
Service Pressure	psi	6000	3600	2400	2400	2265	2015	2015	2265	2015	2015	2015	2015	2015
	bars	413.7	248.2	165.5	165.5	156.2	138.9	138.9	156.2	138.9	138.9	138.9	138.9	138.9
Water Capacity	cu. in.	2285	2640	3960	2980	2640	2640	1660	1345	1345	985	644	495	221
(volume)	liters	37.4	43.3	64.9	48.4	43.3	43.3	27.2	22.0	22	16.1	10.6	8.1	3.6



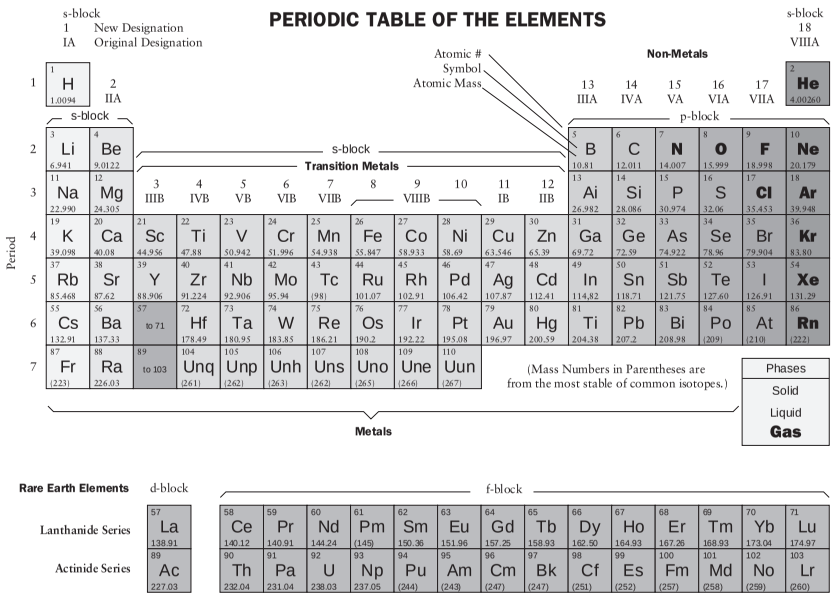
COMPRESSED GAS CYLINDERS

High Pressure Aluminum

Cylinder Model		AL-150	AL-88	AL-33
DOT Spec		3AL 2015	3AL 2216	3AL 2216
Dimentions	inches	8 x 48	7 x 33	7 x 16
	cm	22 x 122	18 x 84	18 x 41
Nominal Weight	lbs.	50	32	16
	kg.	23	15	7
Service Pressure	psi	2015	2216	2216
	bars	139	153	153
Water Capacity (volume)	cu. in.	1831	976	366
	liters	30	16	6

SCFH assist gas flow rates through a circular nozzle aperture (1 SCFH = 0.47 L/min – 1 bar = 14.7 psi)

Nozzle Diameter	(inch)	0.040		0.050		0.060		0.070		0.080		0.090		0.100		0.110		0.120	
	(mm)	1		1.25		1.5		1.75		2		2.25		2.5		2.75		3	
	Pressure Bar	O_2	N_2	O_2	N_2	O_2	N_2	O_2	N_2	O_2	N_2	O_2	N_2	O_2	N_2	O_2	N_2	O_2	N_2
Subsonic Regime	0.54	25	–	40	–	57	–	78	–	101	–	128	–	158	–	192	–	228	–
	0.75	29	–	45	–	65	–	88	–	115	–	145	–	179	–	217	–	258	–
	0.89	32	–	51	–	73	–	99	–	130	–	164	–	202	–	245	–	292	–
Supersonic Regime	P>0.89	18 *t*		29 *t*		41 *t*		56 *t*		73 *t*		93 *t*		115 *t*		139 *t*		165 *t*	
	$t = P+1$ for N_2 and $t = 0.9x(P+1)$ for O_2																		


PERIODIC TABLE OF THE ELEMENTS
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NOTES