



Marine & Offshore Technical Basic Conversions

VOLUME

<u>Convert From</u>	<u>Into</u>	<u>Multiply By</u>	
Acre-feet	Cu feet	43560	
	Cu meters	1233.482	
	Cu yards	1613.33	
Cu Centimeters	Gallons (US)	3.259 x 10 ⁵	
	Cu feet	3.5315 x 10 ⁻⁵	
	Cu inches	0.06102	
	Cu meters	1 x 10 ⁻⁶	
	Cu yards	1.308 x 10 ⁻⁶	
	Gallons (US liq)	0.00026	
	Liters	0.00099	
	Ounces (US liq)	0.03381	
	Pints (US liq)	0.00211	
	Quarts (US liq)	0.00106	
Cu Feet	Acre-feet	2.296 x 10 ⁻⁵	
	Cu centimeters	28316.8	
	Cu inches	1728.0	
	Cu meters	0.02832	
	Cu yards	0.03704	
	Gallons (US liq)	7.48052	
	Liters	28.316	
	Ounces (US liq)	957.506	
	Pints (US liq)	59.8442	
	Quarts (US liq)	29.922	
Cu Inches	Acre-feet	1.329 X 10 ⁻⁸	
	Cu centimeters	16.3871	
	Cu feet	0.000579	
	Cu meters	1.639 X 10 ⁻⁵	
	Cu yards	2.143 X 10 ⁻⁵	
	Gallons (US liq)	0.00433	
	Liters	0.01639	
	Ounces (US liq)	0.55411	
	Pints (US liq)	0.03463	
	Quarts (US liq)	0.01732	
Cu Meters	Acre-feet	0.00081	
	Cu centimeters	1 x 106	
	Cu feet	35.147	
	Cu inches	61023.7	
	Cu yards	1.30795	
	Gallons (US liq)	264.172	
	Liters	999.97	
	Pints (US liq)	2113.38	
	Quarts (US liq)	1056.69	
	Cu Yards	Acre-feet	6.198 X 10 ⁻⁴
Cu centimeters		764554.9	
Cu feet		27	
Cu inches		46656	
Cu meters		0.76455	
Gallons (US liq)		201.974	
Liters		764.553	
Quarts (US liq)		807.896	
Gallons (US liq)		Acre-feet	3.068 X 10 ⁻⁶
		Cu centimeters	3785.41
	Cu feet	0.13368	
	Cu inches	231	
	Cu meters	0.00378	
	Cu yards	0.00495	
	Liters	3.7853	
	Ounces (US liq)	128	
	Pints (US liq)	8	
	Quarts (US liq)	4	
Liters	Acre-feet	8.106 X 10 ⁻⁷	
	Cu centimeters	1.000.03	
	Cu feet	0.03532	

VOLUME - continued

<u>Convert From</u>	<u>Into</u>	<u>Multiply By</u>
Ounces (US liq)	Cu inches	61.002
	Cu meters	0.00100003
	Cu yards	0.00131
	Gallons (US liq)	0.26148
	Ounces (US liq)	33.81497
	Pints (US liq)	2.1134
	Quarts (US liq)	1.0567
	Cu Centimeters	29.5737
	Cu inches	1.80469
	Cu meters	2.957 x 10 ⁻⁵
	Gallons (US liq)	0.00781
	Liters	0.02957
	Pints (US liq)	0.0625
	Quarts (US liq)	0.0312
	Cu Centimeters	473.176
	Cu feet	0.01671
	Cu inches	28.875
Cu yards	0.000619	
Gallons (US liq)	0.125	
Liters	0.47316	
Quarts (US liq)	0.5	

PRESSURE

<u>Convert From</u>	<u>Into</u>	<u>Multiply By</u>
Atmospheres	BAR	1.01325
	Ft H ₂ O @ 68°F	33.96
	Grams/sq cm	1033.23
	In Hg @ 32°F	29.9213
	In H ₂ O @ 68°F	407.5
	Kg/sq cm	1.03322
	Kg/sq meter	10332
	kilo Pascals	101.3
	mm Hg @ 32°F	760
	Pounds/sq ft	2116
	Pounds/sq in	14.6960
	Atmospheres	0.98692
	Ft H ₂ O @ 68°F	33.51
	Grams/sq cm	1019.72
	In Hg @ 32°F	29.530
	In H ₂ O @ 68°F	407.5
	Kg/sq cm	1.01972
	Kg/sq meter	10197
	kilo Pascals	100
	mm Hg @ 32°F	0.1333
Pounds/sq ft	2089.0	
Pounds/sq in	14.5038	
Atmospheres	0.98692	
BAR	2.984 X 10 ⁻²	
In Hg @ 32°F	0.8812	
In H ₂ O @ 68°F	12	
Kg/sq cm	3.043 X 10 ⁻²	
Kg/sq meter	304.3	
kilo Pascals	2.984	
mm Hg @ 32°F	22.38	
Pounds/sq ft	62.32	
Pounds/sq in	0.4328	
Atmospheres	0.00097	
BAR	0.00098	
In Hg @ 32°F	0.02896	
Kg/sq cm	1.01972	
Kg/sq meter	1000	
kilo Pascals	100	
mm Hg @ 32°F	0.73556	

Marine & Offshore Technical Basic Conversions



PRESSURE - continued

Convert From	Into	Multiply By	
In Hg @32°F	Pounds/sq ft	2.0481	
	Pounds/sq in	0.01422	
	Atmospheres	0.03342	
	BAR	0.03386	
	Ft H ₂ O @ 68°F	1.135	
	Grams/sq cm	34.532	
	In H ₂ O @ 68°F	13.62	
	Kg/sq cm	3.453 X 10 ⁻²	
	Kg/sq meter	345.3	
	kilo Pascals	3.386	
	mm Hg @ 32°F	25.4	
	Pounds/sq ft	70.73	
	Pounds/sq in	0.4912	
	In H ₂ O @ 68°F	Atmospheres	2.454 X 10 ⁻³
		BAR	2.49 X 10 ⁻³
		Ft H ₂ O @ 68°F	8.333 X 10 ⁻²
		In Hg @ 32°F	7.343 X 10 ⁻²
Kg/sq cm		2.53 X 10 ⁻³	
Kg/sq meter		25.38	
kilo Pascals		0.249	
mm Hg @ 32°F		1.865	
Pounds/sq ft		5.197	
Pounds/sq in		3.609 X 10 ⁻²	
Atmospheres		0.9678	
Kg/sq cm	BAR	0.98066	
	Ft H ₂ O @ 68°F	32.87	
	In Hg @ 32°F	28.959	
	In H ₂ O @ 68°F	394.4	
	Kg/sq meter	1 X 10 ⁴	
	kilo Pascals	98.07	
	mm Hg @ 32°F	735.6	
	Pounds/sq ft	2048	
	Pounds/sq in	14.22	
	Kg/sq meter	Atmospheres	9.678 X 10 ⁻⁵
		BAR	9.807 X 10 ⁻⁵
Ft H ₂ O @ 68°F		3.287 X 10 ⁻³	
Grams/sq cm		0.1	
In Hg @32°F		0.0029	
In H ₂ O @ 68°F		3.944 X 10 ⁻²	
Kg/sq cm		0.001	
kilo Pascals		9.807 X 10 ⁻³	
mm Hg @32°F		0.07356	
Pounds/sq ft		0.20482	
kilo Pascals		Pounds/sq in	1.422 X 10 ⁻³
	Atmospheres	9.869 X 10 ⁻³	
	BAR	0.01	
	Ft H ₂ O@68°F	0.3351	
	In Hg @32°F	0.2953	
	In H ₂ O @ 68°F	4.022	
	Kg/sq cm	1.02 X 10 ⁻²	
	Kg/sq meter	102	
	mm Hg @32°F	7.501	
	Pounds/sq ft	20.89	
	mm Hg @32°F	Pounds/sq in	0.145
Atmospheres		1.316 X 10 ⁻³	
BAR		1.333 X 10 ⁻³	
Ft H ₂ O@68°F		4.468 X 10 ⁻³	
Grams/sq cm		1.3595	
In Hg @32°F		3.937 X 10 ⁻²	
In H ₂ O @ 68°F		0.5362	
Kg/sq cm		1.36 X 10 ⁻³	
Kg/sq meter		13.595	
kilo Pascals		0.1333	

PRESSURE - continued

Convert From	Into	Multiply By	
Pounds/sq ft	Pounds/sq ft	2.7845	
	Pounds/sq in	0.0193	
	Atmospheres	4.73 X 10 ⁻⁴	
	BAR	4.79 X 10 ⁻⁴	
	Ft H ₂ O@68°F	1.605 X 10 ⁻²	
	Grams/sq cm	0.48824	
	In Hg @32°F	2.036	
	In H ₂ O @ 68°F	0.1926	
	Kg/sq cm	4.88 X 10 ⁻⁴	
	Kg/sq meter	4.882	
	kilo Pascals	4.79 X 10 ⁻²	
	mm Hg @32°F	0.3591	
	Pounds/sq in	6.945 X 10 ⁻³	
	Pounds/sq in	Atmospheres	6.805 X 10 ⁻²
		BAR	6.895 X 10 ⁻²
		Ft H ₂ O @ 68°F	1.605 X 10 ⁻²
		Grams/sq cm	70.307
In Hg @ 32°F		2.036	
In H ₂ O @ 68°F		27.73	
Kg/sq cm		7.031 X 10 ⁻²	
Kg/sq meter		703.1	
kilo Pascals		6.895	
mm Hg @ 32°F		51.72	
Pounds/sq ft		144	

VELOCITY (Distance-time)

Convert From	Into	Multiply By
Feet/day	Feet/ second	1.157 X 10 ⁻⁵
	Kilometers/hour	1.27 X 10 ⁻⁵
	Meters/second	3.528 X 10 ⁻⁶
	Miles/hour	7.891 X 10 ⁻⁶
	Feet/ second	Feet/ day 8.64 X 10 ⁴
Kilometers/hour	Kilometers/hour	1.097
	Meters/second	0.3048
	Miles/hour	0.6818
	Feet/day	7.874 X 10 ⁴
	Feet/ second	0.9113
Meters/second	Meters/second	0.2778
	Miles/hour	0.6214
	Feet/day	2.835 X 10 ⁵
	Feet/ second	3.281
	Kilometers/hour	3.6
Miles/hour	Miles/hour	2.237
	Feet/day	1.267 X 10 ⁵
	Feet/ second	1.467
	Kilometers/hour	1.609
	Meters/second	0.447

DISCHARGE RATES (Volume-time)

Convert From	Into	Multiply By
Acre-feet/day	Cu feet/second	0.5042
	Cu meters/day	1234
	Gallons/minute	226.3
	Liters/second	14.28
	Acre-feet/day	1.983
Cu feet/second	Cu meters/day	2447
	Gallons/minute	448.8
	Liters/second	28.32
	Acre-feet/day	6.051 X 106
	Cu feet/second	3.051 X 106
Cu meters/day	Gallons/minute	1.369 X 10 ⁹
	Liters/second	8.64 X 10 ⁷



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DISCHARGE RATES - continued

<u>Convert From</u>	<u>Into</u>	<u>Multiply By</u>
Gallons/minute	Acre-feet/day	4.419 X 10 ⁻³
	Cu feet/second	2.228 X 10 ⁻³
	Cu meters/day	5.45
	Liters/second	6.309 X 10 ⁻²
Liters/second	Acre-feet/day	7.005 X 10 ⁻²
	Cu feet/second	3.531 X 10 ⁻²
	Cu meters/day	86.4
	Gallons/minute	15.85

TORQUE

<u>Convert From</u>	<u>Into</u>	<u>Multiply By</u>
Foot-pounds	Inch-pounds	12
	KF force-meters	1382.552 X 10 ⁻⁴
	Newton-meters	1.356
Inch-pounds	Foot-pounds	0.8333
	KF force-meters	11547.344 X 10 ⁻⁶
	Newton-meters	11559.357 X 10 ⁻⁵
KF force-meters	Foot-pounds	7.233
	Inch-pounds	86.8
	Newton-meters	9.807
Newton-meters	Foot-pounds	7374.631 X 10 ⁻⁴
	Inch-pounds	8.651
	KF force-meters	10196.798 X 10 ⁻⁵

DENSITY

<u>Convert From</u>	<u>Into</u>	<u>Multiply By</u>
Pounds/Cu inch	Pounds/Cu feet	1728
	Pounds/gallon	231
	Grams/Cu cm	27.68
Pounds/Cu feet	Grams/liter	2.768 X 10 ⁴
	Pounds/Cu inch	5.787 X 10 ⁻⁴
	Pounds/gallon	0.1337
Pounds/gallon	Grams/Cu cm	1.6 X 10 ⁻²
	Grams/liter	16.02
	Pounds/Cu inch	4.33 X 10 ⁻³
Grams/Cu cm	Pounds/Cu feet	7.481
	Grams/Cu cm	0.1198
	Grams/liter	119.8
Grams/liter	Pounds/Cu inch	3.61 X 10 ⁻²
	Pounds/Cu feet	62.43
	Pounds/gallon	8.345
Grams/liter	Grams/liter	1000
	Pounds/Cu inch	3.61 X 10 ⁻⁵
	Pounds/Cu feet	6.24 X 10 ⁻²
Grams/liter	Pounds/gallon	8.35 X 10 ⁻³
	Grams/Cu cm	0.001

ENERGY

<u>Convert From</u>	<u>Into</u>	<u>Multiply By</u>
British Thermal Unit (BTU)	Foot-pound	777.9
	Horsepower-hr	3.929 X 10 ⁻⁴
	Joules	1055
	Calorie	252
	Kilowatt-hr	2.93 X 10 ⁻⁴
Foot-pound	BTU	1.285 X 10 ⁻³
	Horsepower-hr	5.051 X 10 ⁻⁷
	Joules	1.356
	Calorie	0.3239
	Kilowatt-hr	3.766 X 10 ⁻⁷
Horsepower-hr	BTU	2545
	Foot-pound	1.98 X 10 ⁶
	Joules	2.685 X 10 ⁶
	Calorie	6.414 X 10 ⁵

ENERGY - continued

<u>Convert From</u>	<u>Into</u>	<u>Multiply By</u>
Joules	Kilowatt-hr	0.7457
	BTU	9.481 X 10 ⁻⁴
	Foot-pound	0.7376
	Horsepower-hr	3.725 X 10 ⁻⁷
	Calorie	0.2389
	Kilowatt-hr	2.778 X 10 ⁻⁷
	BTU	3.968 X 10 ⁻³
	Foot-pound	3.087
	Horsepower-hr	1.559 X 10 ⁻⁶
	Joules	4.186
Calorie	Kilowatt-hour	1.163 X 10 ⁻⁶
	BTU	3413
	Foot-pound	2.655 X 10 ⁶
	Horsepower-hr	1.341
Kilowatt-hr	Joules	3.6 X 10 ⁶
	Calorie	8.601 X 10 ⁵

MASS

<u>Convert From</u>	<u>Into</u>	<u>Multiply By</u>
Ounce	Pound	0.0625
	Kilogram	0.02834952
	Short ton	3.125 X 10 ⁻⁵
	Long ton	2.79 X 10 ⁻⁵
	Metric ton	2.835 X 10 ⁻⁵
	Ounce	16
	Kilogram	0.4536
	Short ton	0.0005
	Long ton	0.0004464
	Metric ton	0.0004536
Pound	Ounce	35.27396
	Pound	2.20462
	Short ton	0.001102
	Long ton	0.00098
	Metric ton	0.091
	Ounce	32000
	Pound	2000
	Kilogram	907.18
	Long ton	0.89266
	Metric ton	0.90718
Kilogram	Ounce	35840
	Pound	2240
	Kilogram	1016.05
	Short ton	1.12
	Long ton	1.10605

MASS - continued

<u>Convert From</u>	<u>Into</u>	<u>Multiply By</u>
Metric ton	Ounce	35273.98
	Pound	2204.62
	Kilogram	1000
	Short ton	1.1023
	Long ton	0.98421



Pressure Rating

$$P = \frac{2St}{D-t} \quad S = \frac{P(D-t)}{2t}$$

P is the pressure rating in psi.

S is the Hydrostatic Design Basis (usually 4000 psi) divided by the safety factor (which is 2 for the three standards).

DR is the Dimension Ratio for D2241 and C905 but is OD/t for D1785

Where:

P = Pressure, psi

S = Circumferential stress, psi

D = Outside diameter of pipe, inches

d = Inside diameter of pipe, inches (average based on mean wall)

t = Average wall thickness, inches

Volume capacity-gallons per ft. length = $VG = V \times 0.004329$

Volume capacity-cubic inches per ft. length = $V = 0.7854 \times d^2 \times 12$

Outside pipe surface, sq. ft per ft. length = $AO = \frac{D^2 \pi}{12}$

Inside pipe surface, sq. ft. per ft. length = $A_i = \frac{d\pi}{12}$

Cross-sectional plastic area, sq. in. = $A = \frac{(D^2 - d^2)\pi}{4}$

Cross sectional flow area, sq. in. = $A_F = \frac{d^2 \pi}{4}$

Weight of CPVC pipe, lb. per ft. length = $W_{CPVC} = .705 \times A$

Weight of water in pipe, lb. per ft. length = $W_w = 0.433 A_F$

Weight of water filled pipe, lb. per ft. length = $W_{WFP} = W_{PVC} \text{ (or } W_{CPVC}) + W_w$

Radius of gyration, inches = $r_g = \sqrt{\frac{D^2 + d^2}{4}}$

Moment of inertia, inches fourth = $I = Ar_g^2 = .0491(D^4 - d^4)$

Section modulus, inches cube = $Z = \frac{2I}{D} = 0.0982 \times \frac{(D^4 - d^4)}{D}$

Thermal Expansion and Contraction

$$\Delta L = 12 yL (\Delta T)$$

Where:

ΔL = Expansion or contraction of pipe in inches

y = Coefficient of thermal expansion

(see CPVC material Thermal properties) L = Length of pipe run in feet

ΔT = Temperature change °F (Maximum temperature - Temperature @ Installation or maximum system temperature - lowest system temperature, whichever is greater)



Friction Loss (Hazen-Williams equations)

$$f = .2083 \times (100/C)^{1.852} \times \frac{G^{1.852}}{di^{4.8655}}$$

Where:

- f = Friction head of feet of water per 100' for the specific pipe size and I.D.
- C = A constant for internal pipe roughness (=150 for thermoplastic pipe)
- G = Flow rate of U.S. gallons per minute
- di = Inside diameter of pipe in inches

Water Velocities

$$V = .3208 \times \frac{G}{A}$$

Where:

- V = Velocity in feet per second
- G = Gallons per minute
- A = Inside cross sectional area in square inches

Gallons Per Minute Through Pipe

$$GPM = 0.0408 \times \text{Pipe Diameter Inches}^2 \times \text{Feet Per Minute Velocity}$$

Pressure Drop in Valves

$$P = \frac{G^2 \times S_g}{CV^2}$$

Where:

- P = Pressure drop in PSI; feet of water = PSI/.4332
- G = Gallons per minute
- S_g = Specific gravity of liquid
- C_v = Gallons per minute per 1 PSI pressure drop (see Valve product Cv from manufacturer)

Water Conversions

- 1 foot of head = 0.434 PSI
- 1 gallon = 231 cubic inch = 8.333 pounds
- 1 pound water = 27.7 cubic inches
- 1 cubic foot water = 7.5 gallon = 62.5 pounds (salt water = 64.3 pounds)
- 1 miner's inch = 9 to 12 gallons per minute
- Horsepower to Raise Water = $\frac{\text{Gallons Per Minute} \times \text{Total Head in Feet}}{3960}$