

PRESSURE CONVERSIONS

Units of pressure are converted according to the following primary definitions (Ref. 1):

$$\begin{aligned} 1 \text{ atm} &= 760.000 \text{ torr} \\ 1 \text{ bar} &= 100,000 \text{ Pa} \\ 1 \text{ psi} &= 6,894.76 \text{ Pa} \\ 1 \text{ torr} &= 133.322 \text{ Pa} \end{aligned}$$

Units of pressure expressed as water depth below sea-level are converted using the following additional standard definitions as adopted by the Undersea and Hyperbaric Medical Society:

$$\begin{aligned} 1 \text{ bar} &= 32.6457 \text{ fsw (assumes seawater density} = 1.02480 \text{ gm/cc)} \\ 1 \text{ msw} &= 10.0000 \text{ kPa (assumes seawater density} = 1.01972 \text{ gm/cc)} \\ 1 \text{ bar} &= 33.4702 \text{ ffw (assumes freshwater density} = 0.999552 \text{ gm/cc)} \\ 1 \text{ mfw} &= 9.80229 \text{ kPa (assumes freshwater density} = 0.999552 \text{ gm/cc)} \end{aligned}$$

Units of pressure expressed in terms of geometric altitude above sea-level are converted using defining equations for the *U.S. Standard Atmosphere, 1976* (Ref. 2). These equations give pressure P in atmospheres absolute (atm abs) as functions of geometric altitude above sea-level A in kilometers (km):

$$P = \left[\frac{288.15}{288.15 - 6.5A} \right]^{-5.25588} ; A < 11 \text{ km}$$

$$P = 0.22336 \cdot \exp[0.15769 \cdot (11 - A)] ; 20\text{km} > A \geq 11 \text{ km.}$$

These equations are inverted to obtain the following expressions for geometric altitude A in kilometers (km) as functions of pressure P in atmospheres absolute (atm abs):

$$A = \left\{ \frac{288.15 - \exp \left[\ln(288.15) + \frac{\ln(P)}{5.25588} \right]}{6.5} \right\} ; P > 0.22336 \text{ atm abs}$$

$$A = 11 - \left\{ \frac{\ln \left(\frac{P}{0.22336} \right)}{0.15769} \right\} ; 0.05403 \text{ atm abs} < P \leq 0.22336 \text{ atm abs}$$

The above expressions cover the relationship between geometric altitude and atmospheric pressure over the entire physiological range; from below sea-level to above the Armstrong line at 62,800 ft (19.14 km), where atmospheric pressure equals the vapor pressure of water at 37°C (47 mm-Hg). In this physiological region, the *U.S. Standard Atmosphere, 1976*, of the United States Committee on Extension to the Standard Atmosphere (COESA) is the same as COESA's "*U.S. Standard Atmosphere, 1962*," and is identical with the International Civil Aviation Organization (ICAO) "*Manual of the ICAO Standard Atmosphere*," as revised in 1964. The definition of the Standard in this region was also adopted in the *ISO Standard Atmosphere* (ISO 1973) by the International Standards Organization (ISO) in 1973.

Note: 1 atm abs = 1.01325 bar

References:

1) Standard Practice for Use of the International System of Units (SI). Document E380-89a, American Society for Testing and Materials. Philadelphia, PA, 1989.

2) *U.S. Standard Atmosphere, 1976*. United States Committee on Extension to the Standard Atmosphere. National Oceanic and Atmospheric Administration, Washington, D.C. (NOAA-S/T 76-15672): Supt. of Docs., U.S. Govt. Print. Off. (Stock No. 003-017-00323-0), 1976.