MNGN 444 – Blast Overpressure and Positive Pulse Duration Curves


![Graph showing blast overpressure and positive pulse duration curves](image)

Overpressure Ratio, $P^0/P_a$

Scaled Distance $Z = R/(WT_a/P_a)^{1/3}$

- $R$ = distance from center of charge (m)
- $W$ = weight of charge (kg)
- $P^0$ = peak overpressure (bars)
- $P_a$ = ambient pressure (bars)
- $T_a$ = ambient temperature (Kelvin)
Scaled Positive Pulse Duration, \( t_d \) (ms)

TNT fire-ball radius

No negative pulse

\[ R = \text{distance from center of charge (m)} \]
\[ W = \text{weight of charge (kg)} \]
\[ t_d = \text{scaled positive pulse duration (ms)} \]
\[ P_a = \text{ambient pressure (bars)} \]
\[ T_a = \text{ambient temperature (Kelvin)} \]

Scaled Distance
\[ Z = R / (WT_a / P_a)^{1/3} \]

Explosive Charge
Distance = R
mass = W

Shock Front
Peak Overpressure = P

ambient pressure = \( P_a \)
ambient air density = \( \rho_a \)
MGN 444 – Equations I


Shock Velocity:

\[ U_x = C_a \cdot \sqrt{1 + \frac{6P_x}{7P_a}} \]

Mach number:

\[ M_x = \frac{U_x}{C_a} \]

Blast Overpressure:

\[ P_x = \frac{7(M_x^2 - 1)}{6} \cdot P_a \]

Angle of incidence:

\[ \beta_{min} = \frac{1.75}{(M_x - 1)} + 39 \]

Mach stem number:

\[ M_{stem} = \frac{M_{in}}{\sin \beta} \]

Ca is speed of sound in air (sea level)

Pa is atmospheric pressure (sea level)

Subscript x means general (Incident/Mach Stem).
MNGN 444 – Equations II


Gurney Equation:

\[ \frac{V_0}{\sqrt{2E}} = \left( \frac{M}{C} + \frac{1}{2} \right)^{-1/2} \]

M: mass of metal cylinder (kg)
C: mass of explosive (kg)
\( \sqrt{2E} \): Gurney constant (m/s)

Mott Equation:

\[ m = \left[ M_k \ln \left( \frac{M_0}{2M_k} \right) \right]^2 \]

Mo: mass of metal cylinder (lb)
Mk: distribution factor

\[ M_k = B \cdot t^{5/3} \cdot d^{1/3} \cdot \left( 1 + \frac{t}{d} \right) \]

B: Mott coefficient for given explosive-metal pair
T: wall thickness (in)
D: inside diameter of metal cylinder (in)

Fragment Size:

\[ D = 0.186 \text{ lb/in}^3 \]
\[ W_f = 0.186d^3 \]
\[ A = \pi d^2/4 \]
Drag Attenuation Equation:

\[ V_s = V_0 \cdot e^{-\left(\frac{A}{W_f}\right)\gamma_0 C_D R} \]

or

\[ R = \frac{m}{A\gamma_0 C_D} \cdot \ln \left(\frac{V_0}{V_s}\right) \]

A: fragment area (m²)
Wf: fragment mass (kg)
\(\gamma_0\): specific weight of air (kg/m³)
C_D: Drag coefficient (0.6)
MNGN 444 – Blast Damage Curves


Lung Damage:

Ear Damage:
Secondary Blast Damage:

Tertiary Blast Damage: