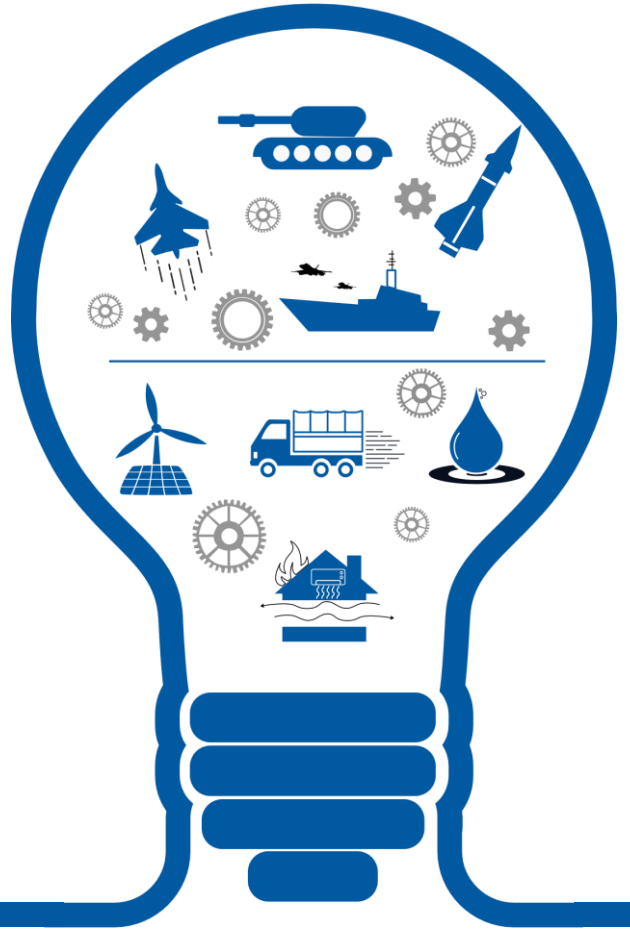
ZEUSNUMERIX

Missile Lethality

REFERENCE MANUAL



http://labs.zeusnumerix.com/missile-lethality/

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Introduction

- To determine the lethality of the missile such as fragment velocity, probability of kill, penetration,etc.
- The outputs reveals the effectiveness of the missile on the target
- Blast and fragment penetration is effective at small miss distance
- Maximum total fragment kinetic energy requires high Charge-to-Metal ratio
- Multiple impacts are effective against threat vulnerable area
- Kinetic energy, warhead density, length, and velocity provide enhanced Penetration

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Governing Equations

- Overpressure at distance r from explosion:

$$\Delta p / p_0 = 37.95 / (z\, p_0^{1/3}) + 154.9 / (z\, p_0^{1/3})^2 + 203.4 / (z\, p_0^{1/3})^3 + 403.9 / (z\, p_0^{1/3})^4$$

$$z = r / c^{1/3}$$

- Total Fragment Kinetic Energy: $KE = (1 / 2) M_m V_f^2 = E_c M_c / (1 + 0.5\, M_c / M_m)$
- Probability of Kill: $P_K = 1 - (1 - A_v / A_{to})^{n_{hits}}$
- Fragment Velocity: $V_f = (2 E_c)^{1/2} [(M_c / M_m) / (1 + 0.5\, M_c / M_m)]^{1/2}$
- Total Energy on Target: $E_T / E_C = [(1 / 2) (W_{Missile} / g_c) V^2 + E_C (W_C / g_c)] / [E_C (W_C / g_c)]$
- Penetration: $P / d = [(l / d) - 1] (\rho_P / \rho_T)^{1/2} + 3.67 (\rho_P / \rho_T)^{2/3} [(\rho_T V^2) / \sigma_T]^{1/3}$

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Web App - Usage

- User needs to enter all the input parameter details of missile lethality. Each parameter is described in next slide
- Upon execution, following output is generated:
  1. Overpressure at distance r from explosion
  2. Total Fragment Kinetic Energy and Fragment Velocity
  3. Probability of Kill
  4. Total Energy on Target
  5. Penetration

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Input File Description

Parameter	Default	Unit	Description
gravitational constant	9.81	m/s^2	gravitational constant
altitude	6096	m	Altitude at which the missile is
missile velocity	609.6	m/s	Velocity of the missile
missile weight	166.47	kg	Weight of the missile
distance from center of explosion	3.048	m	distance from the center of explosion
explosive weight	17.6	kg	Weight of the explosive
Total Mass Metal Fragments	17.615	kg	Total Mass of the Metal Fragments
Average fragment weight	0.0032	kg	Average Weight of the Metal Fragments
Mass of warhead Charge	17.615	kg	Mass of the warhead Charge
Energy Per Unit Mass Charge	4.86e6	J/kg	Energy of the warhead Charge Per Unit Mass
Target vulnerable area/Target presented area	0.9	-	Ratio of target vulnerable area to target presented area
Target presented area	1.858	m^2	area of target presented
Miss distance	7.62	m	Miss distance

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Input File Description – Contd.

Parameter	Default	Unit	Description
Penetrator length	1.2192	m	Length of the Penetrator
Penetrator diameter	0.12192	m	Diameter of the Penetrator
Penetrator density	7833.41	kg/m^3	Density of the Penetrator
Target density	2076	kg/m^3	Density of the target
Target ultimate stress	3.45e7	N/m^2	ultimate stress of the target
impact velocity	1219.2	m/s	impact velocity

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Output File Description

- These output summarizes the lethality of the missile

Output Parameter	Unit	Description
overpressure at a distance from explosion	psi	Drag coefficient of the body at zero lift
Total Fragment Kinetic Energy	N-m	Normal Force coefficient of the body
Probability of Kill	-	Lift by Drag Ratio of the body
Fragment Velocity	m/s	Aerodynamic Centre of the body
Total Energy on Target	N-m	Normal Force coefficient of the flare
Penetration	m	Aerodynamic Centre of the flare

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Thank You !

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