History of the Fragment Impact STANAG

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Purpose

- This review was done to support a revised edition of NATO STANAG 4496 Fragment Impact Munitions Test Procedure
- Areas for Consideration
  - Fragment Threats
  - Fragment Velocity
  - Fragment Geometry
  - Multiple Fragments

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Policy and Procedure Requirements (2001)

	NATO	France Light Fragment	France Heavy Fragment	UK	US Preferred	US Alt #1
Geometry	Conical Tipped cylinder	Cube (NATO fragment used)	Parallelepiped (sphere is used)	Cylinder Ø 12.7mm h=12.7mm	12. 7 mm cube	Conical tipped cylinder
Mass, g	16	20 (16)	250	13.5	16	16
# of Frags	1	3 (1)	1	1	2-5	1
Launcher Type	Undefined	Undefined (gun)	Smooth bore gun	RARDEN gun	Fragment Projector	Undefined (gun)
Velocity Range, m/s	2000	0<v<2000	0<v<1600	400<v<2500	2530 ± 90	1830 ± 60

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Representative Frag Velocities

Table III: Computed Fragments Characteristics (Mott &Gurney)

Threat Weapon	Mass	Ø	Source Velocity		Nominal Range [1]		Avg. Frag. Mass [2]	Frag. > 15g [3]	Cube Velocity of cube at Nominal Range	
	kg	cm	ft/s	(m/s)	ft	(m)	g	%	ft/s	(m/s)
Grenade	1.46	7.6	3700	(1128)	31	(9.4)	2.3	1.4	3191	(973)
Missile	32.8	17	5000	(1524)	125	(38.1)	3.0	2.6	2763	(842)
Artillery/ Missile	41.8	17	3890	(1186)	80	(24.4)	10.4	21.5	3216	(980)
Missile	100.4	32	5939	(1810)	135	(41.1)	4.3	5.5	3125	(952)
Missile/ Artillery	118.2	32	4920	(1500)	100	(30.5)	14.0	15.1	3876	(1181)
Missile	365.5	50	5188	(1581)	111	(33.8)	29.9	29.7	4235	(1291)
Missile	1003.	75	5814	(1772)	140	(42.7)	38.0	47.6	4500	(1372)

(1) Range at which main fragment beam delivers 3 fragments per square foot
(2) About 26% of fragments are larger than the average mass for each warhead
(3) Comparable to Army IM test fragment or Navy IM test fragment (16g)

- When looking at primarily ground launched systems fragments do not reach even 1830 m/s in velocity

Representative Frag Velocities

Munition	Design fragment	
	Mass (g)	Velocity (m/s)
Mk81	12.76	2396
Mk82	18.43	2402
Mk117	38.61	2386
Mk83	52.16	2259
Mk84	63.79	2365
155mm M107	64.55	1030
8" M106	97.52	1152
105mm M1	13.13	1237

- Compiled by MSIAC (NIMIC at the time) to support the original STANAG
- Additionally, the fragment velocity, as defined in MIL-STD-2105B and STANAG-4240, Draft 10, originated from a US Navy survey dated 1987. The velocity chosen for the ½-inch steel cube was 8300 ft/s (2530 m/s) because it represented the upper range of the threat fragment velocity

Fragment Shape Pros and Cons

- The cube shape resembles a preformed fragment
  - angle of attack is not repeatable
  - Flat impact is anomalous
- Sphere shape is used in characterizing explosive formulations.
  - Repeatable
  - Not threat representative
- Conical type cylinder was created to allow easier launch from a fragment gun.
  - More repeatable than cube
  - Eliminates flat impacts

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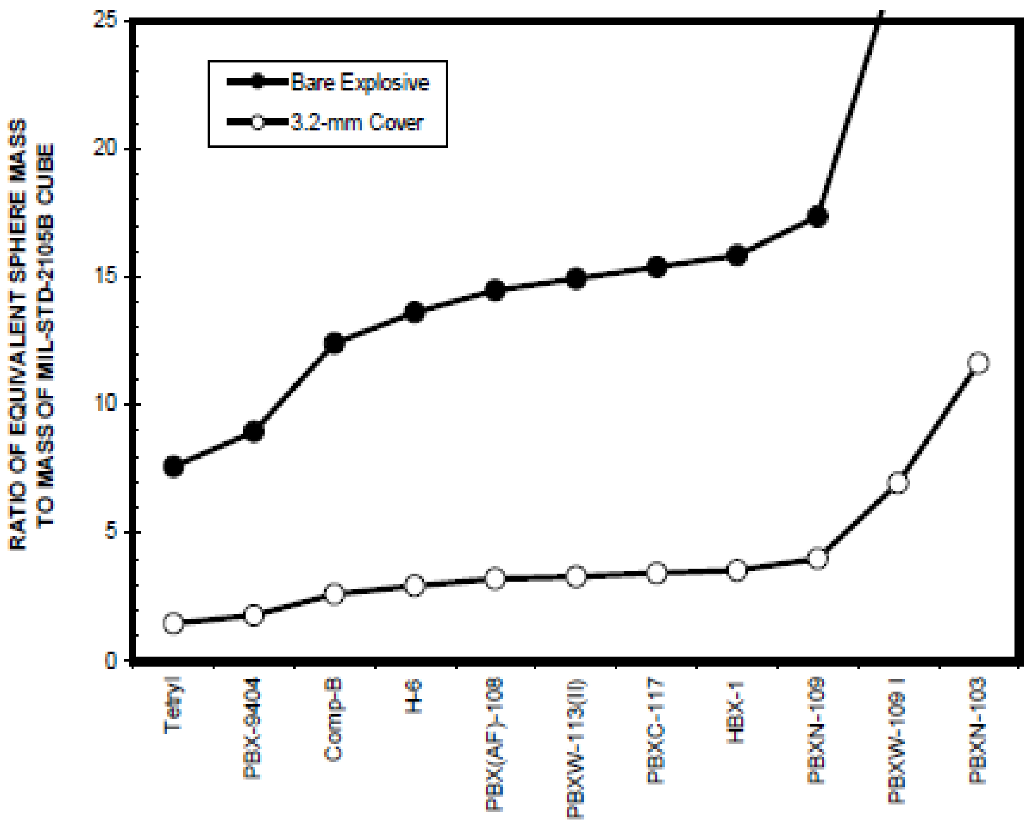
Sphere versus Cube

- Spherical fragments also require either a higher initial velocity or greater mass for the same input of shock duration to the target
- Equivalent sphere must be 5x more massive than cube



- An equivalent sphere is defined as that sphere that will give the same detonation threshold velocity as a cube at 10° yaw

Conical vs Cube

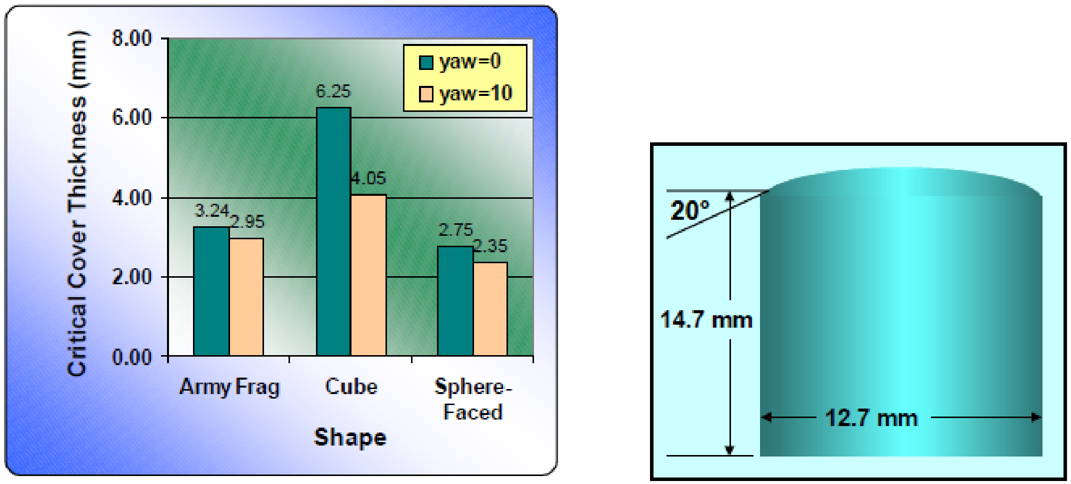


Figure 5. Critical cover thickness as computed by CTH for a Comp-B target impacted at 1830 m/s [18].

- Conical tip on the end of a cylinder reduces yaw effects compared to the cube.
- An edge-on cube at 10° yaw has a 35% drop in critical thickness, much larger than the conical-tipped fragment.

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Fragment Weight/Shape Factor

- Maintain the cube’s stimulus at 10° yaw
- Give the same critical cover thickness of the cube at 10° impact a Comp-B charge covered with a mild-steel plate (18.6g conical cylinder)
- 95.6% of the fragments in zones with velocities faster than 1830 m/s are smaller than the recommended fragment
  - Looked at as the high end of credible threat spectrum

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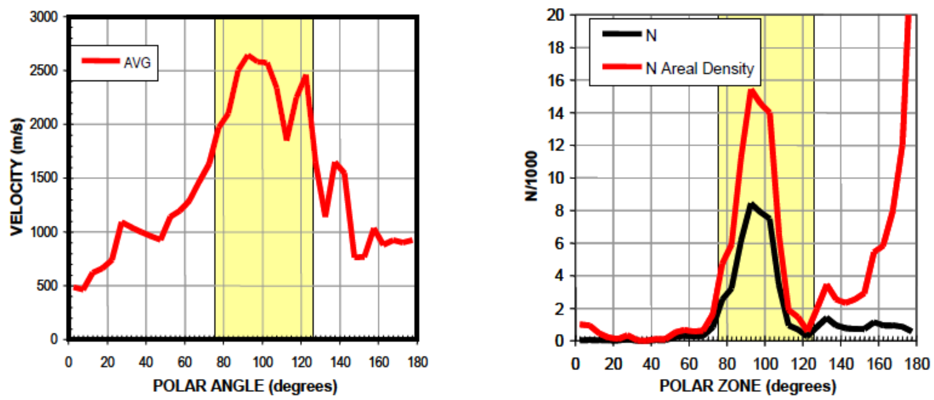
Multiple Fragments

- For Non-detonation reactions, effect of multiple fragments unpredictable
- For SDT of damaged material
  - Complex issue
  - Multiple fragment impact test not repeatable enough
  - Multiple impacts at a single velocity do not represent reality.
- Finally, for SDT of neat material
  - Effects of multiple fragment impact are unlikely since the fragments space out very rapidly and then slow rapidly with distance.



(a) (b)

Figure 6. (a)Velocity vs. polar zone and (b) number of fragments vs. polar zone for a particular analog system.

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