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Assessing Potential Capability Enhancements of Hand Grenades Filled with CL-20 Compared to Current Mk3A2 & M67 Hand Grenades

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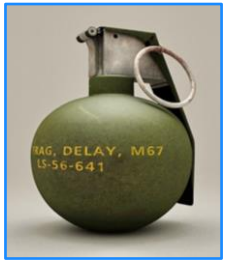
ARA

Abstract

- Hand grenades have served the US Military as essential offensive and defensive weapons for decades.
- CL-20 has shown significant potential as an advanced explosive material for both US and foreign applications.
- We modeled a comparison between well-known and currently used hand grenades of the US military against a hypothetical CL-20 fill.
- Calculations performed show up to 52% increase in lethal fragmentation radius.
- The net result is a potential doubling of Lethal Area by using a CL-20 formulation fill versus a current formulation fill.

An ARA Model of M67 Capability, A Look at Current Comp B Fill Versus Potential CL-20 Fill

Current Fill
Comp B
TNT + RDX



CL-20 Fill
95% CL-20
5% Viton

Current Comp B (TNT + RDX)
5.0 meters Lethality Radius
75 square meters Lethality Area
Relative Lethal Area = **X**

CL-20 (95% CL-20 + 5% Viton)
7.6 meters Lethality Radius
180 square meters Lethality Area
Relative Lethal Area = **2X**

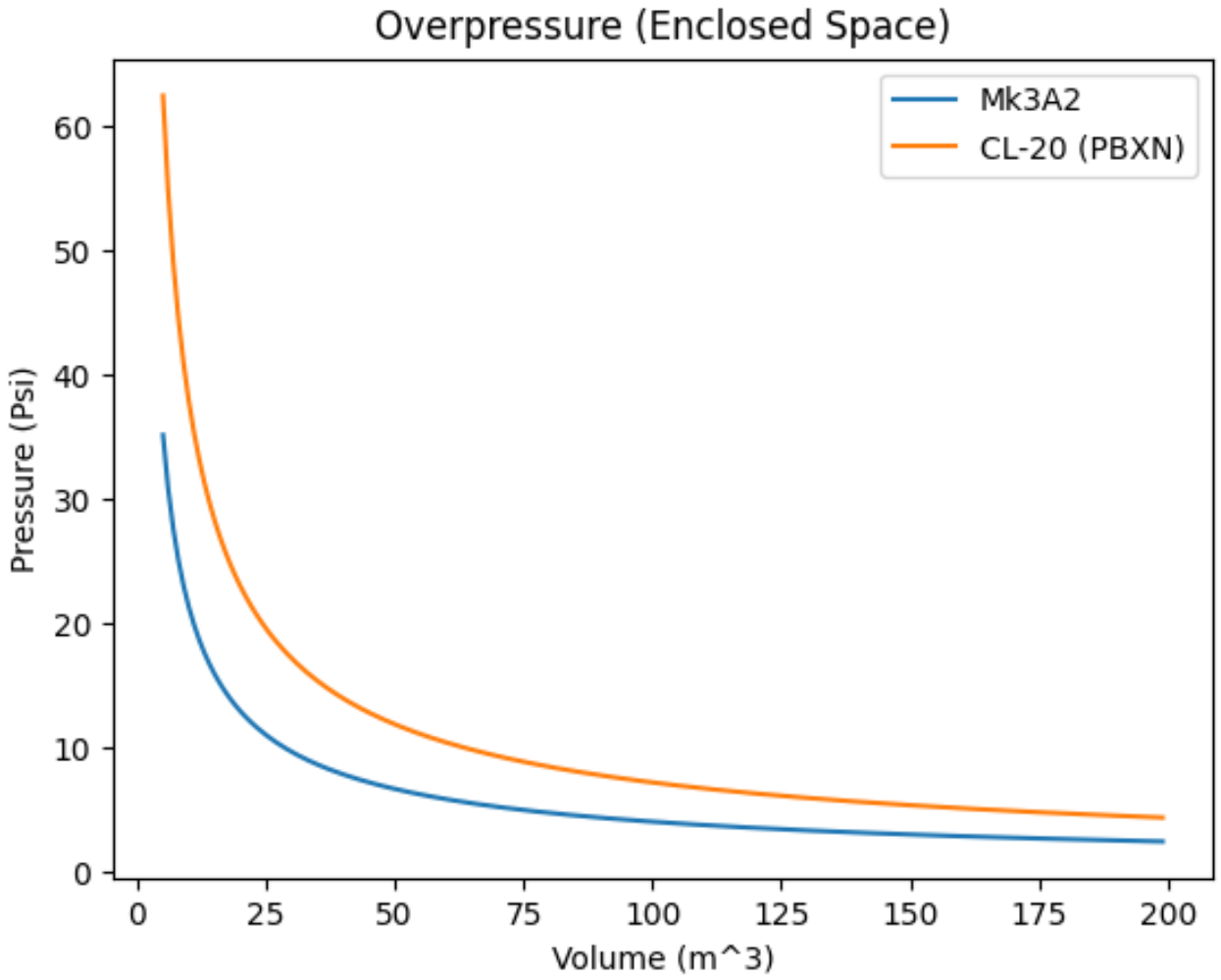
Results and Discussion

In the next few charts, we present the following modeling results:

- Overpressure Comparison (Mk3A2 vs CL-20)
- Overpressure Effects
- Peak Underwater Pressure
- M67 Fragmentation Velocity
- Energy of Fragments
- Lethality and Injury from Fragments
- Lethal Area Comparison

Please also find a link to our underpinning paper in the Summary and Conclusion chart.

Overpressure Comparison (Mk3A2 vs CL-20)



Overpressure Effects

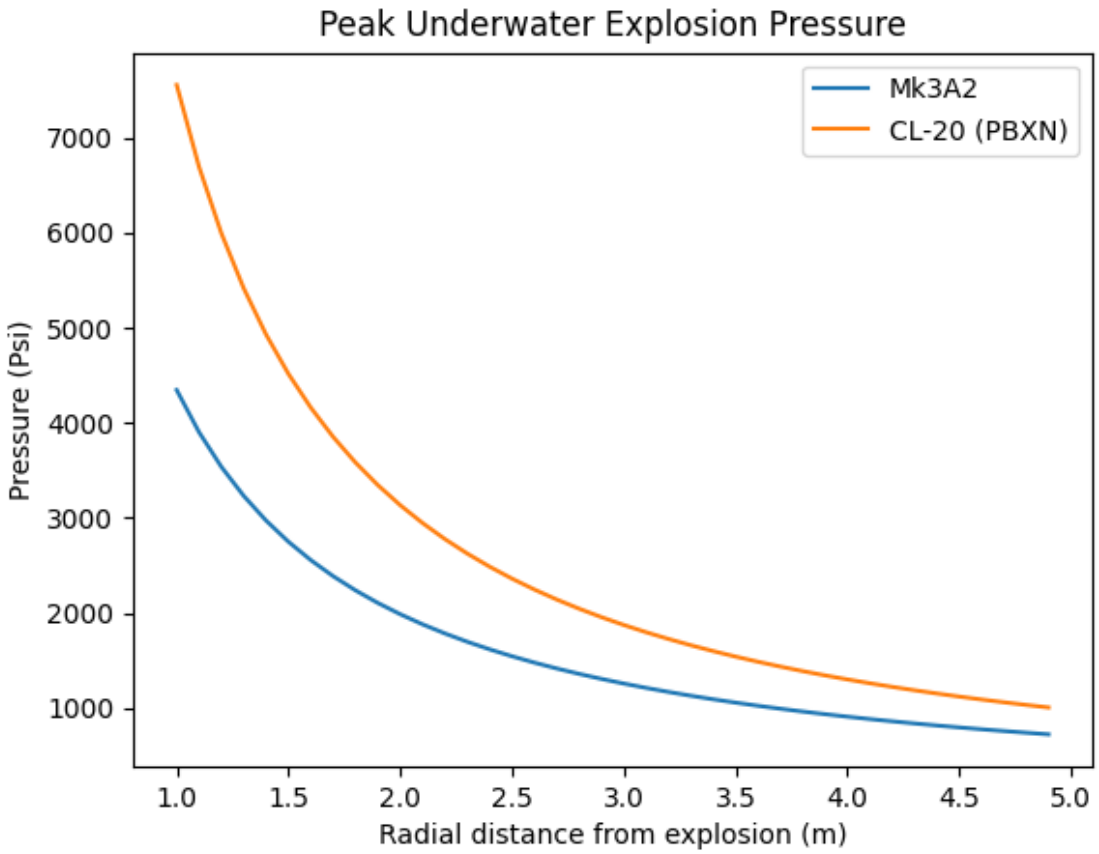
Peak Overpressure	Max Wind Speed	Effects on Structures	Effect on Human Body
1 psi	38 mph	Window glass shatters	Light injuries from fragments
2 psi	70 mph	Moderate damage to houses	Injuries common
3 psi	102 mph	Residential Structures Collapse	Fatalities may occur
5 psi	163 mph	Most buildings collapse	Injuries are universal, fatalities occur
10 psi	294 mph	Reinforced concrete buildings are severely damaged	Most people are killed

Improvements with CL-20

122% Volume increase over Mk3A2 to reach same overpressure effects

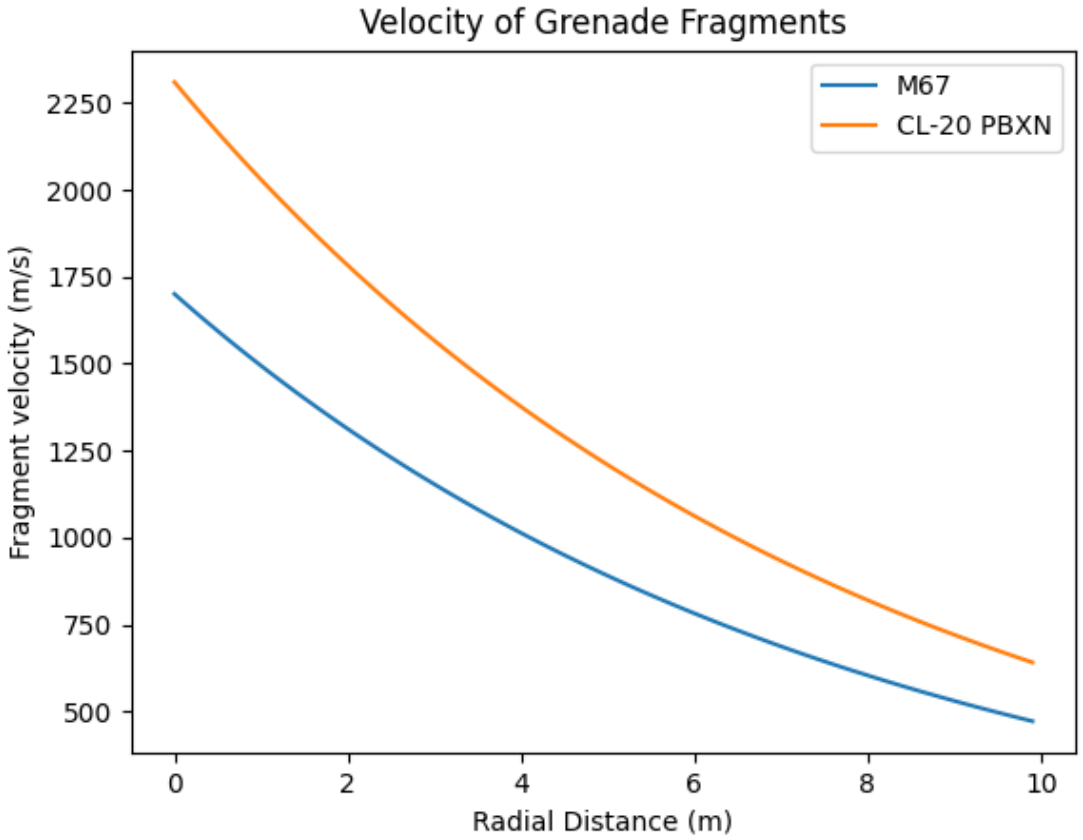
Underwater Application

51% Increase in Average Pressure (0 - 5 m)



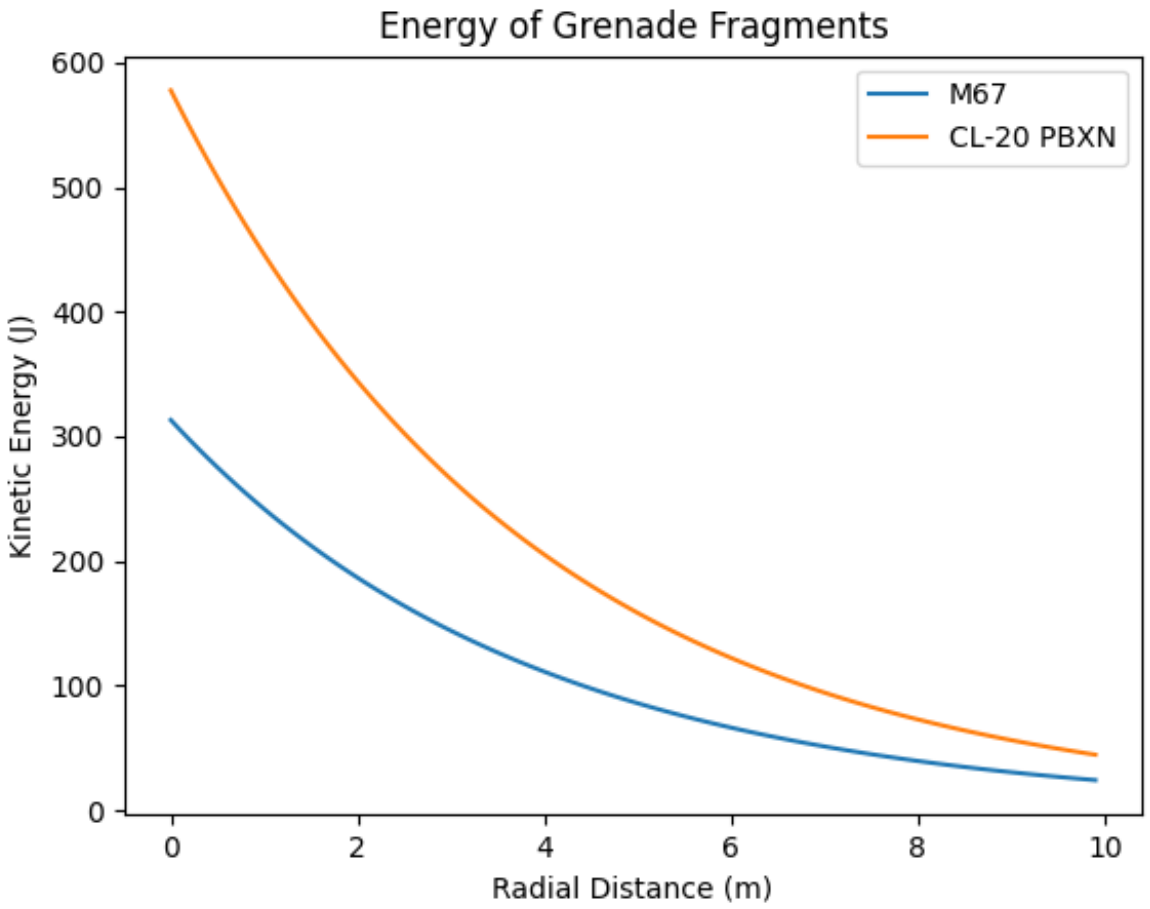
M67 Fragmentation Velocity

Initial Velocity		Increase
M67	1700.66 m/s	35.8%
CL-20	2309.97 m/s	



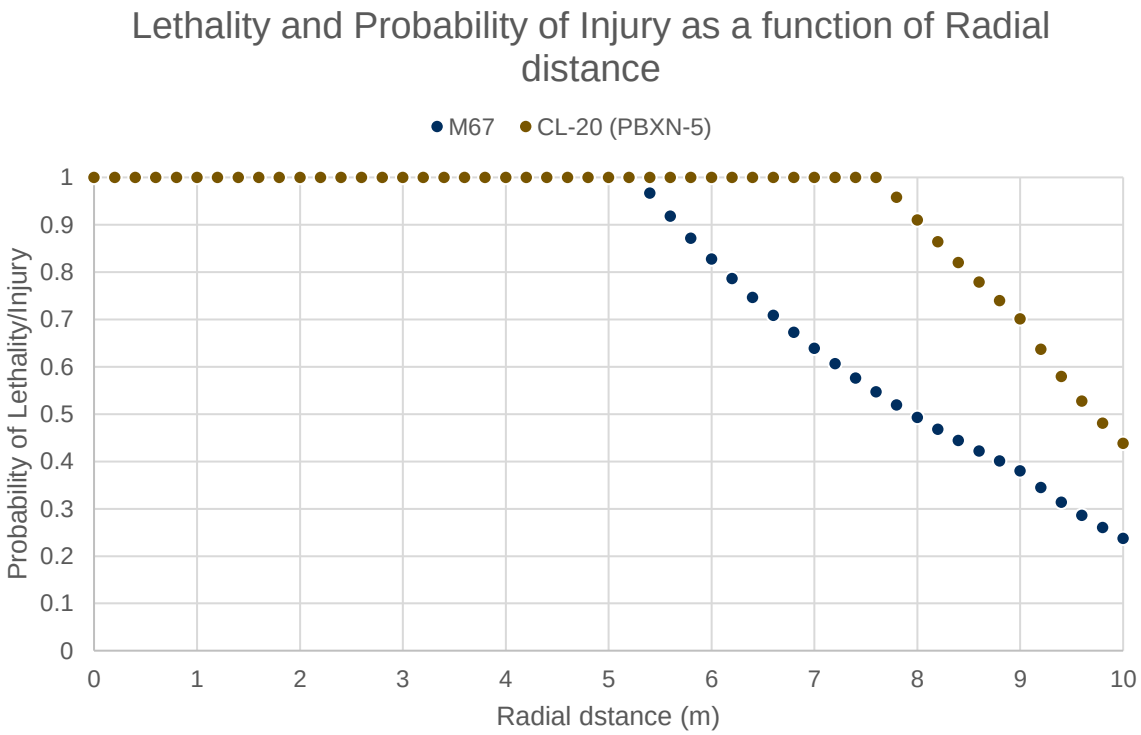
Energy of Fragments

84.5% Increase in Fragment Energy



Lethality and Injury from Fragments

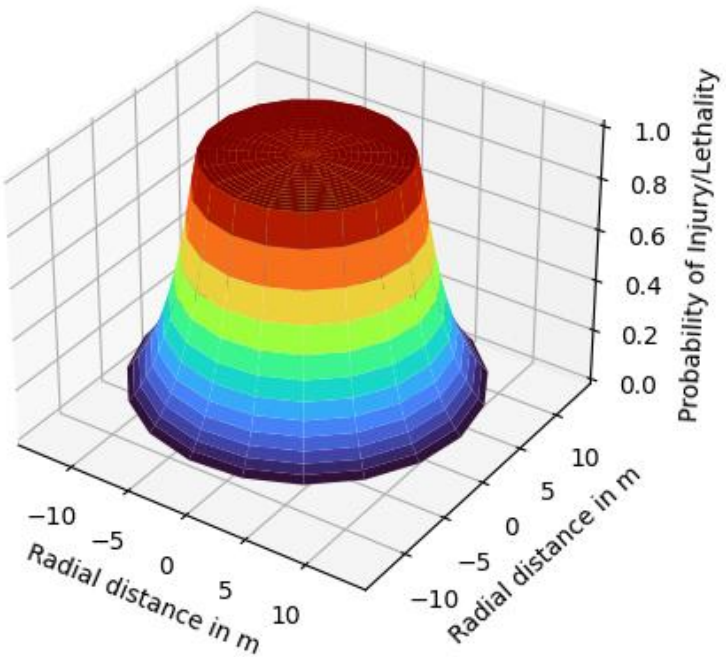
- Only Lethal if graph is equal to 1 (> 80 J and > 1 Fragment/m^2)
  - Otherwise probability of Injury



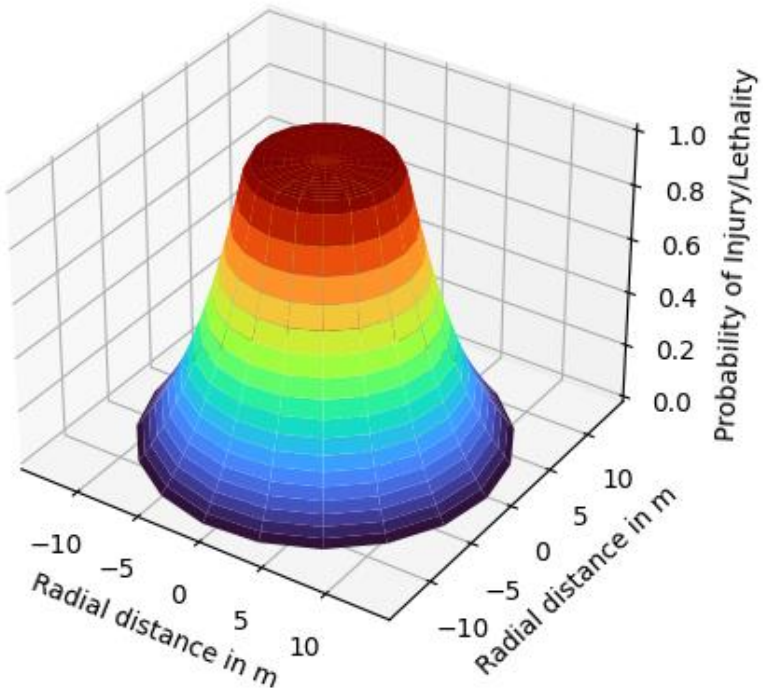
Lethal Area Comparison

Lethal Area		Increase
M67 (R = 5 m)	78.54 m^2	131%
CL-20 (R = 7.6 m)	181.46 m^2	

CL-20 (PBXN-5)



M67



Summary and Conclusion

- In our modeling of a comparison between well-known and currently used hand grenades of the US military against a hypothetical CL-20 fill, we found the potential for a 52% increase in lethal fragmentation radius.
- The net result is a potential doubling of Lethal Area by using a CL-20 formulation versus a current formulation.
- Costs for upgrade would be relatively small for capability afforded.
- The results of modeling suggest the appropriateness for taking next steps.

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ARA Paper on "Assessing Potential Capability Enhancements of Hand Grenades Filled with CL-20 Compared to Current Mk3A2 & M67 Hand Grenades": https://acrobat.adobe.com/link/review?uri=urn:aaid:scds:US:c44f0204-bcc9-374c-83e1-197513c91b0c

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