Adapting SMAW to Urban Fighting Again

A densified propellant for firing from enclosures

by Diana Bragunier & Matthew J. Sanford

> ***"With bullets flicking by, the SMAW team set up. Rokos tapped the gunner to take the shot. Just as the rocket was fired, Rokos looked around, saw a Marine crouching in the backblast area, and dove backwards, knocking the Marine clear. The platoon commander was amazed to see SMAW team after SMAW team repeating what Rokos had done: breaking cover, kneeling in the street, taking a shot and then ducking back inside."[1]***
>
> **–*Bing West***
> **No True Glory**

Once, small units primarily needed supporting arms to destroy buildings. That changed with the shoulder-launched multipurpose assault weapon with novel explosive, or SMAW NE. It's a capability with an even greater potential that small units will need in tomorrow's urban warfare. But, realizing this and other shoulder-launched munitions' potential depends on developing them to fire from buildings and enclosures.

A technological solution—a densified propellant—is being developed by propulsion scientists and engineers at Naval Surface Warfare Center Indian Head Explosive Ordnance Disposal Technology Division (NSWC IHEODTD) in Maryland. Not only can this propellant help small units fight from more places in urban areas, it also offers advantages for other weapons systems. It's just one development indicative of a very intense competition facing U.S. warfighters and scientists.

A Growing Need

In urban warfare, "Direct fires sometimes become the firepower means of choice," states *Joint Publication 3-06: Joint Urban Operations*.[2] "In urban battles since World War II, artillery, anti-tank weapons, and anti-aircraft weapons have proven more valuable in a direct fire role against targets than in their primary roles."[3] That's seen with tanks, once thought vulnerable in cities. In Fallujah[4] and Sadr City, tanks with advancing infantry destroyed enemy-held buildings, saving U.S. warfighters from bloody fights to clear them.[5]

However, there are some things that big, direct fire systems can't do in cities. For example, in Grozny, Russian tanks could not lower their main guns and coaxial machineguns to shoot into Chechen-defended basements[6] nor could tank guns elevate and hit forces when firing from tall buildings. In Fallujah, very narrow streets permitted only foot-mobile infantry,[7] and only infantry could wage the three-dimensional fights that occurred between densely packed houses.[8] In these and other situations, destruction of fortified positions greatly depends on infantry-carried, direct-fire systems.

The SMAW NE gave Marine small units dramatically increased, direct firepower. Developed by NSWC IHEODTD for Marines, the munition disperses and ignites a cloud of combustible material. This produces a devastating heat and overpressure in a room and adjacent rooms,[9] often collapsing buildings. At Fallujah, 3d Bn, 1st Marines exhausted its supply of SMAW NE, flattening structures.[10] Reportedly, in one day, one Marine crumbled 12 buildings with 14 SMAW NEs.[11] "Bunker-busting weap-

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ons are invaluable for urban combat," found the Marine Corps in its earlier analysis of Grozny.[12] The SMAW NE validated that finding.

There are two big reasons why Marine small units will need the SMAW NE and other shoulder-launched munitions even more in the future. First, more urban warfare is likely, states the *2010 Joint Operating Environment* (Suffolk, VA: Joint Forces Command,) "By the 2030s, five billion of the world's eight billion people will live in cities. Fully two billion of them will inhabit the great urban slums of the Middle East, Africa, and Asia."[13] This is a "recipe for conflict," as Dr. David Kilcullen wrote on this urbanization.[14] Operations in such cities will require infantry battalions to disaggregate into small units.[15] Consider, as an example, Dhaka, Bangladesh, with 15 million people in a 590 square kilometer area with 1.4 million buildings.[16]

An explosive charge set by Marines with 8th Engineer Support Battalion, 2d MLG, detonates against a wall during a field operation, Camp Lejeune, NC. *(Photo by Cpl Sullivan Laramie.)*

The second reason is hybrid warfare—non-state adversaries fighting asymmetrically with increasingly sophisticated weapons. Indications were seen in the 2008 Israeli advance into Gaza.[17] Hamas turned urban areas into deadly mazes of tunnels, booby traps, and sophisticated roadside bombs.[18] Supported by indirect fire systems, Hamas' small teams employed antitank guided munitions, rocket propelled grenades (RPGs), including RPG-29s; MANPADS (man portable air defense systems), machine guns, sniper rifles, mines, and explosively formed projectiles.[19] Today, with more advanced weapons, Ukraine separatists wage hybrid warfare on steroids.[20]

In such urban warfare, Marine small units will need to fire SMAW and other shoulder-launched munitions not just from open areas but from concealed, confined, and enclosed spaces. The problem, though, is sound and backblast. I "immediately felt this insane concussion which seemed like an earthquake," as one Marine described firing the SMAW.[21] Sound levels hit 186 decibels, requiring double hearing protection for gunners and limiting training to five rounds a days. Backblasts are lethal at 30 meters and dangerous to 100. Fired from a room, reverberating sound and overpressure will likely seriously injure or kill those within.

Marines from 2dBn, 2d Marines practice dry runs with the SMAW. *(Photo by Cpl Phillip Clark.)*

A Propellant That Doesn't Burn

War involves problem solving, as Dr. Paul Kennedy wrote in *Engineers of Victory: The Problem Solvers Who Turned the Tide in the Second World War.* That's what naval warfare centers do. They understand Navy and Marine Corps warfighting problems and systematically develop technical solutions for them.

Such is the case with NSWC IHEODTD. Within the naval science and technology enterprise, NSWC IHEODTD researches and develops energetics—energy releasing, chemical materials for propellants, explosives, and pyrotechnics—as well as counters for them. In warfighting parlance, NSWC IHEODTD personnel are the rocket scientists, explosive experts, and counter bomb technologists who create technical solutions in these areas.

The SMAW's continuing development exemplifies this problem solving. When Marines sought an improved SMAW for coming urban warfare in Iraq, NSWC IHEODTD scientists and engineers understood their needs, and the science and technology likely meeting them. They had already extensively researched thermobarics, or novel explosive, and therein lies the value of naval warfare centers. They often research areas for potential warfighting advantages, thus reducing development and fielding times when requirements do eventually emerge. As a result, the SMAW NE was developed in nine months.

Today, Marines seek a SMAW that can fire from enclosures and confined spaces—considered a future naval capability for operations in urbanized littorals. It means reducing sound and backblast, a problem which naval energetics scientists and engineers also have investigated. Initial study found that a SMAW rocket uses almost a pound of propellant, all burning in the tube, with almost 90 percent of the energy going out the back. The remaining energy pushes the rocket forward.

The problem required scientists and engineers to figure out how to get less energy going backward and more energy going forward. But, other factors impacted the problem. Costs had to be kept down for a munition used extensively in training and combat. And, then there is the Marine adage: "Ounces equal pounds, pounds equal pain."[22] A fix could not increase size and carry weight which ruled out a solution based on the Davis Gun—a recoilless rifle, firing heavier and longer shells than rockets. Scientists and engineers, therefore, focused on changing the propellant and retained the compact, elegant form of a rocket motor.

Important to problem solving is "a culture of encouragement," wrote Kennedy in *Engineers of Victory*, one encouraging "problem solvers to tackle large, intractable problems." Kennedy singled out the post-1919 Marine Corps as such an organization. Despite many naysayers, the Corps had "enough freedom to develop its own ideas on advanced naval bases."[23] That culture of encouragement applies to technology development, as many initiatives also face disbelief and doubt. Such encouragement is found in naval warfare centers.

Less backblast is the goal. *(Photo courtesy NSWC.)*

A densified propellant with Tungsten may provide an answer. *(Photo courtesy NSWC.)*

The proposed solution for the SMAW's backblast problem initially defied conventional wisdom. It is a propellant that has less burning material, and more material that doesn't. Termed "densified propellant," it consists of 10 to 85 percent Tungsten—that doesn't burn.

It Works

Think of swimming in a pool—kicking water pushes you, but kicking off a pool wall pushes you more. Similarly, in densified propellant, the burning material's energy develops gas pressure, which pushes against the inertia of the non-burning Tungsten; this accelerates the particles in the nozzle while at the same time pushing the motor case and warhead forward. The resulting backblast has less hot turbulent expanding gas and many sound dampening Tungsten particles, mostly between 10 to 45 microns in size, which accelerate out the back of the tube and rapidly dissipate.

The percentage of Tungsten varies with applications. For shoulder-launched munitions, like SMAW, densified propellant has a higher percentage of Tungsten so as to reduce peak sound and overpressure. Conceivably, for aircraft-fired missiles and rockets, densified propellants would have lower percentages of Tungsten because more impulse and minimal weight gain would be required.

This densified propellant is proving itself in tests, garnering support from Office of Naval Research, Marine Corps, Joint Insensitive Munitions Program, and industry. Densified propellant has been tested in over 100 static firings in six different rocket motors; flight demonstrated in TOW missiles;

and flight demonstrated in multiple SMAW firings. These tests show that densified propellant:

- Reduced peak sound pressure level by at least 10 decibels, relative to fielded SMAWs (significant as decibels decrease/increase logarithmically and not linearly);
- Drastically reduced overpressure and fireball;
- Reduced structural damage when fired from enclosures and confined spaces; and
- Increased impulse, or push forward, by up to 35 percent per unit volume, allowing a reduction in propulsion system size and weight.

Potential to Do More

The big task ahead is to finalize the propellant mix, notably determining the measure of Tungsten that best reduces sound and overpressure while increasing push or impulse for the rocket and minimizing added mass. This includes evaluating densified propellant munitions fired from enclosures and confined spaces. The goal is to demonstrate the SMAW with densified propellant as a future naval capability in 2018.

The propellant offers other potential advantages beyond the SMAW in warfighting. Eventually, the motors in the present inventory of SMAW rockets must be swapped out, as propellants destabilize over time. Replacing them with densified propellant motors is estimated to provide a 5 to 10 percent savings. The cost of Tungsten is relatively low, so changing the propellant means relatively minimal cost.

Densified propellant also has potential applicability to other weapons systems, as well. It could reduce backblast sound and overpressures for other shoulder-launched munitions. The propellant was also used in TOW missile demonstration, helping double its range—a research initiative earning the densified propellant team the Department of the Navy's 2011 Dr. Delores M. Etter Top Scientist and Engineers of the Year award. Additionally, it could benefit air-launched, 2.75-inch rockets in the Advanced Precision Kill Weapon System. Additionally, it offers advantages for cartridge- and propellant-actuated (CAD/PAD) systems that use small propellant volumes to move large masses, like rocket-assisted aircraft, canopy removal systems, and ejection seats, and jet-assisted take-off for heavily loaded aircraft.

Adapting With a Vengeance

Weapons must fit the environment. The SMAW was changed to give small units more direct firepower in urban warfare, and it will be changed again to allow them to fight from more confined urban spaces. Not surprisingly, though, it won't be the end of solving problems for the SMAW—or any other U.S. weapons system.

The SMAWs adaptations are part of a much bigger and very intense competition facing Defense. "Our enemies have gone to school on us," stated Deputy Secretary of Defense Robert Work, "and they have adapted with a vengeance. They spent the past few decades investing heavily in capabilities that counter our own."[24] In the world ahead, our challenge will be adapting forces and weapons to their environments, faster than adversaries. It's a contest that demands warfighters and scientists work much closer than they ever have before.

Marines from 2d Bn, 4th Marines preparing to fire a SMAW during live fire training exercise in the Northern Territory, Australia, September 2013. *(Photo by Cpl M.S. Orton.)*

Notes

1. Bing West, *No True Glory: A Frontline Account of the Battle for Fallujah,* (New York: Bantam Books, 2005), 280–81.

2. Joint Staff, *Joint Publication 3-06 (JP 3-06), Joint Urban Operations,* (Washington, DC: 20 November 2013), IV-6

3. Ibid., I-7

4. Kendall D. Gott, *Breaking the Mold: Tanks in The Cities,* (Fort Leavenworth, KS: Army Command and General Staff College, Combat Studies Institute Press, 2006), 99–100

5. CPT John C. Moore, USA, "Sadr City: The Armor Pure Assault in Urban Terrain," *Armor,* (Fort Benning, GA: November–December 2004), 34.

6. Timothy L. Thomas, "The Battle of Grozny: Deadly Classroom for Urban Combat," *Parameters,* (Carlisle, PA: Strategic Studies Institute, Summer 1999).

7. "Infantry Squad Tactics," *Marine Corps Gazette*, (Quantico, VA: November 2005), accessed at http://www.military.com.

8. West, 280.

9. Description of thermobaric effects is from *Leatherneck,* "Son of SMAW," (September 2008.), accessed at http://www.leatherneck.com. It states, "Thermobaric warheads, when

A Marine with 8th Engineer Support Battalion fires SMAW during a field operation, Camp Lejeune, NC. ***(Photo by Cpl Sullivan Laramie.)***

detonating in a room, first disperse a combustible mist, which is then ignited, producing an enormous explosion that often destroys small buildings and kills everyone in the room and adjacent rooms and hallways."

10. Nathaniel Helms, *My Men are My Heroes: The Brad Kasal Story*, (Annapolis, MD: U.S. Naval Institute Press, 2012).

11. Owen West and Bing West, "Lessons from Iraq," *Popular Mechanics,* (New York: August, 2005), 112.

12. U.S. Army, *Field Manual 03.6 11, Combined Arms Operations in Urban Terrain*, (Washington, DC: June 2011), Appendix H, "Lessons Learned from Modern Urban Combat," under "Russia and the War in Chechnya," see "Marine Corps Analysis."

13. *JP 3-06*, I-4

14. Dr. David Kilcullen, "The City as a System: Future Conflict and Urban Resilience," *The Fletcher Forum of World Affairs*, (Medford, MA: Tufts University, Summer 2012), 22.

15. The wide dispersal or disaggregation of battalions into small units regularly occurred in Afghanistan. Deputy Secretary of Defense Robert Work, Speech to Army War College Strategy Conference, 8 April 2015. (Hereinafter Work Speech.)

16. Chief of Staff of the U.S. Army, Strategic Studies Group, *Megacities and the United States Army: Preparing for a Complex and Uncertain Future,* (Washington, DC: June 2014), 9, 20.

17. David E. Johnson, *Military Capabilities for Hybrid War: Insights from the Israel Defense Forces Lebanon and Gaza*, RAND, 2010

18. Steven Erlanger, "A Gaza War Full of Traps and Trickery," *The New York Times*, (New York: 10 January 2009).

19. David E. Johnson, *Hard Fighting Israel in Lebanon and Gaza,* RAND, 2011, 109.

20. Deputy Secretary of Defense Robert Work, Speech to Army War College Strategy Conference, 8 April 2015.

21. See "My Second Week as an 0351 at SOI," *Leatherneck* Magazine blog, accessed at www.leatherneck.com, (Quantico, VA: October 2007), 12:20.

22. "Ounces Equal Pounds and Pounds Equal Pain," embedded in Afghanistan blog, accessed at http:// llbc235blogspot.com, February 17, 2009

23. Dr. Paul Kennedy, *Engineers of Victory: The Problem Solvers Who Turned the Tide in the Second World War,* (New York, NY: Random House, 2013), 36
9.

24. Work Speech.