



Developing Non-Lethal Weapons

The Human Effects Characterization Process

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U.S. Air Force photo by Senior
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Armed only with lethal force, and facing vehicles that didn't stop, U.S. warfighters manning a checkpoint in Iraq were left with a difficult choice—engagement with lethal force against an unknown entity or risk being attacked. Tragically, some drivers didn't comprehend warnings.

To help resolve this dilemma, warfighters were equipped with non-lethal weapons, including a dazzling laser that got drivers' attention and indicated a need to stop. Using these capabilities helped differentiate combatants and noncombatants and reduced checkpoint shootings.

Non-lethal weapons are needed where conflict and disasters occur within population centers. They fill the space between “shouting and shooting” and their use often has prevented the worsening of bad situations. Non-lethal weapons like blunt-impact rounds, pepper spray and others stopped and/or dispersed noncombatants who posed a threat to forces in Kosovo, Iraq, Haiti and Afghanistan. They also helped determine the intentions of

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operators of small boats that were nearing U.S. Navy and Coast Guard vessels.

As these examples highlight, non-lethal weapons provide options to commanders on the escalation and de-escalation of force continuum, enhancing their capability sets in various environments. While the benefit of these options may seem self-evident, it may not be as obvious how the Department of Defense (DoD) defines a non-lethal weapon and procures systems which meet that definition.

The need for non-lethal weapons was recognized with the 1996 establishment of the DoD Non-Lethal Weapons Program. This followed the asymmetric warfare experience in Somalia. Here, rock- and Molotov-cocktail-throwing crowds and open looting of military equipment were undeterred until U.S. forces adopted non-lethal weapons during the 1995 United Nations withdrawal from Somalia.

Though their use was limited, U.S. forces made these non-lethal capabilities known to the Somali population in advance,

DoD Directive 3000.03E, DoD Executive Agent for Non-Lethal Weapons and Non-Lethal Weapons Policy, defines non-lethal weapons as:

Weapons, devices, and munitions that are explicitly designed and primarily employed to incapacitate targeted personnel or materiel immediately, while minimizing fatalities, permanent injury to personnel, and undesired damage to property in the target area or environment. NLW [non-lethal weapons] are intended to have reversible effects on personnel and materiel.

The directive also states it is DoD policy that:

Developers of NLW will conduct a thorough human effects characterization in accordance with DoD Instruction (DoDI) 3200.19 to help understand the full range of effects and limitations prior to operational employment of the NLW.

In effect, development and acquisition must include a process, unique to non-lethal weapons, which accounts for the effects of the system on human targets. It is important to note that



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detering hostile crowds who initially were bent on “driving the Americans back into the sea.”

Since then, this program has sought to facilitate development and fielding of non-lethal weapons to meet U.S. forces’ requirements. And, by 2011, needs had grown to the point that then-Assistant Commandant of the Marine Corps Gen. Joseph Dunford stated, “The demand for non-lethal weapons exceeds the inventory,” as reported by the *Marine Corps Times*.

What Is Non-lethality in DoD?

“Non-lethal” means something that produces more nuanced effects to achieve a given purpose. For countering personnel, examples of non-lethal effects include electromuscular incapacitation that disables, glaring light that obscures vision, and millimeter wave energy that heats nerve endings, repelling individuals. The term “non-lethal” is subject to varying interpretations—and, while examples help elicit the scope of effects included in the non-lethal spectrum, the topic is defined more clearly by DoD policy.

while human effects on the target must be characterized for non-lethal weapons, they are not required to have a zero probability of producing adverse effects.

Instead, the human effects on the target are an inherent attribute that will influence heavily the design of any non-lethal weapons system: Achieving the desired effectiveness with an acceptable injury risk often is the crux of their development. From the onset, programs should incorporate human effects into their overall risk management approach similar to other aspects of the development. In fact, DoDI 3200.19, Non-Lethal Weapons Human Effects Characterization, published in 2012, requires the human effects of a required non-lethal capability be designated as a Key Performance Parameter (KPP) or Key System Attribute (KSA).

Characterizing Human Effects in Non-Lethal Weapons Acquisition

Whether forces are rapidly fielding commercial off-the-shelf (COTS) items or addressing a capability gap with a

development program of record, characterizing the human effects in non-lethal weapons acquisition is critical to the warfighters who face complex engagement scenarios. The warfighters must have confidence in the effectiveness of a non-lethal weapon and understand the risk of adverse effects. This need was identified early in the Non-Lethal Weapons Program. The human effects characterization process has since matured and is one of the aspects of non-lethal weapons acquisitions that make it unique from other weapons.

In some cases, non-lethal weapons have been rapidly developed and/or fielded to meet urgent warfighting needs. These efforts have been informed by the DoD

Non-Lethal Weapons Program, quickly drawing on experts and past research. Such was the case with dazzling lasers, urgently needed in Iraq and Afghanistan. Experts from the Air Force Research Laboratory, Naval Surface Warfare Center Dahlgren, and the Army's Communications-Electronics Research, Development and Engineering Center collectively assessed considerable research on lasers' ocular effects. They determined factors impacting effectiveness and injury risks, thereby informing laser use and future development.

For programs of record, the process starts with a capability requirement defined by combat developers—driven by the needs of our warfighters. As with other acquisitions, the definition of requirements is critical to a program's success. Here, requirements must be written in terms of the consequences for a human target both for effectiveness and risk. This, therefore, demands early involvement of subject-matter experts on non-lethal weapons human effects.

The importance is amplified when one considers that, for non-lethal weapons, human effects may be the most constraining attribute. The feasibility of delivering a human effect at desired ranges is good for many systems. However, doing so may incur great risk of inflicting injuries. Thus, in designing non-lethal weapons, trade-offs often are necessary between the weapons' effectiveness and the risks of injuries. Adding to this complexity, consideration must be given to testing a system prototype against a new human effects capability requirement.

The importance of insightful and clear requirement definition cannot be overstated. Here is an example of considerations for a non-lethal, counter-personnel capability, which will heavily influence system design:



A screen shot of a human effect computer modeling tool for non-lethal weapons
Department of Defense photo illustration.

- **Task:** Is the non-lethal capability intended to deny individuals access to areas, move them from areas, disable and/or render them unable to perform, or suppress and/or reduce performance? This addresses the system's desired effect on a target's behavior and how it enables mission accomplishment. However, a measurable requirement for behavioral effectiveness is difficult to define. In the past, human effects experts necessarily have interpreted and defined these desired effects in terms of the more measurable physiological effects of the stimulus caused by the system.
- **Conditions:** These include the intended domain for the capability—land, air or maritime; types of weather—day and/or night; open or confined spaces; involvement of one or several targeted persons; and whether these persons are moving. Conditions can have significant effects on a system's performance—for example, the glare effects of dazzling lasers and flash bangs are highly variable depending on ambient lighting.
- **Parameters:** What is the desired range to targeted personnel? Is the target a point or area? What is the duration of the effect? How long should reversal take?

After defining a requirement, it may be found that a 40-millimeter projectile is deliverable to a needed range beyond 100 meters—but could inflict unacceptable injuries, thus necessitating design modifications and/or trade-offs. Also, well-defined non-lethal capability requirements may drive applied research. For example, technically it is possible to achieve extended human electromuscular incapacitation (effects similar to those caused by TASER devices used by law enforcement). However, confidence must be assessed about



A U.S. soldier signals for an incoming vehicle to halt. If the vehicle does not stop, dazzling lasers that disrupt the driver's vision may provide a non-lethal way to enforce the order without firing a shot.

Department of Defense photograph.

the ability to incapacitate targets for longer than 15 seconds with acceptable risk.

Defining a requirement for a non-lethal capability also includes determining an acceptable Risk of Significant Injuries (RSI). This is the DoD-defined metric to measure the non-lethality of a weapon system. Warfighters, through combat developers, determine this risk based on a concept of operations for a non-lethal capability. DoDI 3200.19 defines significant injuries as those that result from proper employment and require health care beyond the field or self-aid, permanent functional impairments, and fatalities. It is often expressed as a percentage, such as a 5 percent probability of significant injury at defined ranges. This determination is deliberative, driven by the intended mission use, and informed by human-effects experts. Risk of Significant Injuries is, therefore, the build-to DoD specification for non-lethality. Describing the trade space between risk of significant injuries and effectiveness is paramount in non-lethal weapons development.

An example of user requirements may be to hail and warn individuals, and also temporarily suppress vision. Translated into a measurable human effect, the requirement may call for specific irradiance levels at ranges, which vary depending on the desired effect and distance. The human effects role continues throughout the acquisition process and should be integrated fully into the system engineering process to ensure informed characterization planning, prioritization and programmatic risk management.

The DoD Non-Lethal Weapons Program, Human Effects Office, manages a portfolio of science and technology efforts to understand the relevant human impacts of emerging tech-

nologies in terms of their effectiveness and risk. Examples of such efforts include examining novel stimuli for applicable effects, determining stimuli doses for achieving those effects, and developing a framework for assessing behavioral effectiveness. The results of these efforts establish the human impacts of these technologies in terms of their effectiveness and risks and contribute to the development of models and surrogates for testing.

Robust engagement between materiel and combat developers, testers and human effects personnel ensures integration of technology development, human effects and test and evaluation plans and investment strategies—managing cost, schedule and technical risk due to human effects characterization.

Meeting the DoD Definition of Non-Lethal

Within the DoD acquisition system, non-lethal weapons are treated the same as other weapons programs, with the addition of a target human effects review. DoDI 3200.19 requires non-lethal acquisition programs to undergo this independent DoD review, called a Human Effects Review Board (HERB). The board provides Non-Lethal Weapons Program Managers and Milestone Decision Authorities with:

- An assessment of the quality and completeness of human effects information
- Potential human effects risks
- Recommendations to mitigate these risks

The HERB consists of representatives from the Surgeon General and safety offices of the military Services (including the Marine Corps' medical officer), U.S. Special Operations

Command and U.S. Coast Guard. The DoD Instruction states that "... the HERB review ensures human effects of NLWs are evaluated consistently."

In addition to the HERB, from the early phases of materiel development onward, the DoD Non-Lethal Weapons Program identifies technologies or systems to undergo independent scientific assessment by Human Effects Advisory Panels. These panels consist of scientific experts from industry, academia and government who review the current state of a human effects characterization effort, offering a critical peer review of the available research data, models and research plans. Such a review can shape and validate the human effects characterization and technology development going forward.


Ultimately, human effects characterization and peer review processes provide decision makers, commanders and users with confidence that the system will work as intended—and a firm understanding of the risk of employing it. They also may inform legal and policy reviews, development of rules of engagement governing non-lethal weapons use, and contribute to training on non-lethal weapons.

Conclusion

In 2014, a U.S. Marine convoy in southwest Afghanistan encountered more than a dozen, rock-throwing locals. After a Marine fired a 12-gauge, non-lethal warning munition, the

rock throwers fled. Similarly, in eastern Afghanistan, a U.S. Air Force security patrol observed local people attempting to cut concertina wire on the perimeter of a U.S. base. When the locals persisted after visual warnings to stop and leave, the patrol initiated two non-lethal, sting-ball grenades, causing the intruders to flee, evidently unharmed. Had the Marines or Airmen been equipped only to respond with lethal force, the engagements and/or their abilities to accomplish the mission might have been changed.

Non-lethal weapons provide commanders options for escalation and de-escalation of force, making them more effective in similar situations that arise almost daily in typical recent operations.

The characterization of non-lethal weapons human effects has become more defined and advanced, building on knowledge and lessons learned. Today, it is guiding non-lethal weapons development in its earliest stages, focused first and foremost on warfighter needs as expressed by combat developers. And this human effects characterization is informing development of far more sophisticated non-lethal technologies needed by warfighters today and needed even more tomorrow. This continually improving human effects characterization process is key to improving non-lethal weapons. 

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