USE OF BULLET TRAPS AND STEEL TARGETS

U.S. DEPARTMENT OF ENERGY
Office of Health, Safety and Security

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CERTIFICATION

This supplement contains the currently approved document, *Use of Bullet Traps and Steel Targets*.

Larry D. Wilcher
Director
Office of Security
Office of Health, Safety and Security

6/4/2012
Date

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Section A. – USE OF BULLET TRAPS

1. PURPOSE. This section contains design criteria and deployment specifications of bullet traps on U.S. Department of Energy (DOE) live-fire ranges. Deviation from these design and deployment criteria must be formally documented and approved by the local DOE site office.

2. BULLET TRAPS.

   (1) General Information.

      (a) Targets used in live fire shoot houses must be placed so that fire is directed into a bullet trap designed to capture the rounds.

      (b) Bullet traps must be constructed to contain the most energetic projectile to be fired into them without dimpling/pitting the steel and contain splatter and fragments in all directions. The size and shape of a bullet trap may be altered, but materials may not be substituted.

   (2) Specifications for construction and use:

      (a) 5.56mm conventional ammunition must not be used when shooting into bullet traps without further testing and development of containment materials. Only 5.56mm non-toxic frangible ammunition can be used.

      (b) Bullet trap steel must be set at a minimum 7 degree angle off vertical based on the most probable line of flight of the bullet. The greater the angle of the bullet trap, the less the deterioration on the steel plate. A bullet trap constructed according to the DOE National Training Center (NTC) design (see Figure 1) and then leaned against the wall of the shoot house with the base of the trap out approximately 1 foot provides adequate angle of the steel backing.

      (c) Bullet trap steel must be constructed of a minimum $^{3}/_{8}$-inch thick, and be 500 Brinell hardness or equivalent rifle-grade steel. Quality assessment and ballistic test sheets certifying the grade and quality of the steel backing plate must accompany every steel backing plate utilized. See Figure 1 for construction details.

      (d) Bullet traps must be constructed to facilitate easy inspection of the inside of the fascia material and the front of the steel plate. Frequent inspection of the interior of the bullet traps must be conducted when rounds are fired into one general area. Bullet traps will be checked for function and condition before and after each day's qualification/training activity or at any time damage is suspected.

(e) The fascia material must be inspected, replaced or repaired when the integrity of the fascia material allows the round to start dimpling the steel backing plate.

(f) The bullet trap steel backing plate, when used in the standard bullet trap design, must be replaced when 50 percent of the material in one general area has been chipped away.

(g) The requirement to remove from service any steel target when dimples exceed 1/16 inch does not apply. Steel backing plates must have a protective cover installed between the plate and the shooter that protects the shooter from backsplash.

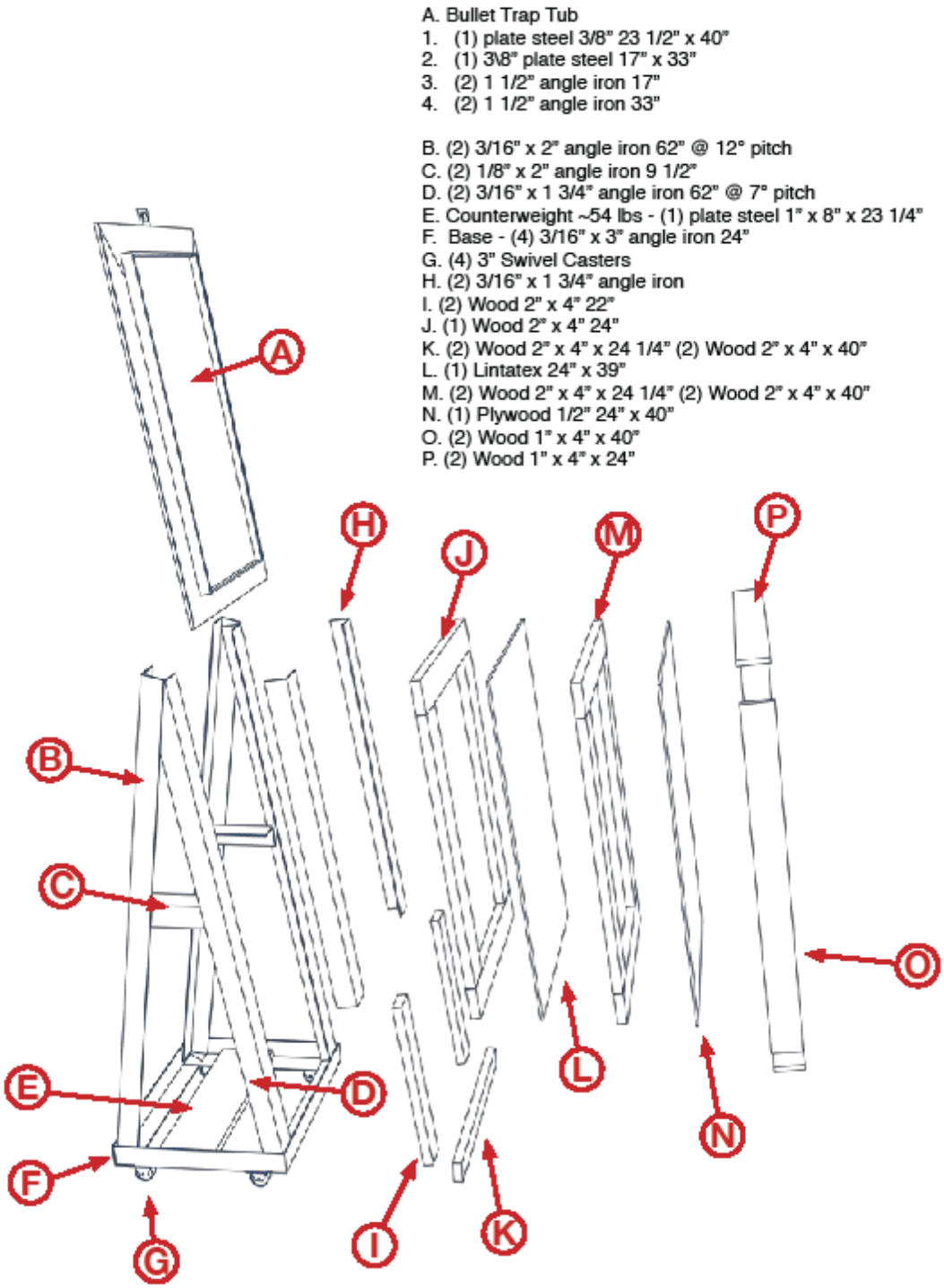

Figure 1 – Live-Fire Shoot House Bullet Trap Design

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Section B. – USE OF STEEL TARGETS

1. PURPOSE. This section contains design criteria and deployment specifications for steel targets on DOE live-fire ranges for use in planning new facilities and major rehabilitation of existing facilities. Deviation from these design and deployment criteria must be formally analyzed, documented, and approved by the local DOE site office.

2. DESIGN AND DEPLOYMENT. The design and method of deployment of steel targets are approved by the range master. Lesson plans required for all training will include information on training safely by conducting a documented risk analysis of the training activity. A sample risk analysis format for shooting steel targets is provided in Attachment 1, and examples of types of steel targets are contained in Attachment 2.

   a. Steel Target Design and Construction.

      (1) The following fundamentals should be considered in steel target design and construction.

         (a) Safety. Targets will be capable of withstanding direct fire and either containing the effects or directing them in a safe, predictable direction.

         (b) Simplicity. Simple designs generally function more reliably than complex designs. Targets that rely on gravity and/or kinetic energy to function are preferable to targets powered by electricity, pneumatics, or hydraulics.

         (c) Durability. The training environment subjects the targets to extreme weather conditions, rough handling, and repeated impacts by high-energy projectiles. The design and construction of the steel target should maximize reliable functioning under all normal operating conditions.

      (2) Steel Target Hazards and Precautions.

         (a) Instructors or range personnel at the firing line should position themselves directly behind the shooter or in such a manner to be able to observe and control the shooter safely. Personnel should never stand directly above, or beside a live weapons fire target. All participating personnel (shooters, evaluators, observers controllers, safety, and support personnel) are required to be in long sleeve shirts and full length pants.

(b) The shooter must shoot as straight "downrange" as is practical because shooting steel at an angle increases the danger of ricochets and directs the fragments primarily in one direction.

(c) A minimum of 4 inches of absorbent material extending out to at least 35 degrees should be placed at the base of all steel targets to absorb fragments and to prevent ricocheting towards the shooter.

(d) Safe use of steel targets also requires studying the angles and fabrication concepts of the structural supports for the target and ensuring that projectile fragments and/or ricochets will be safely directed away from the firing line.

(e) Steel targets will be checked for function and condition before and after each day's qualification/training activity or at any time damage is suspected.

(f) Firearms instructors must continuously observe the results of firing on steel targets, particularly checking for any splatter back to the firing line area or any other areas used by personnel. If splatter is observed, firing will be halted immediately and the cause corrected before firing is resumed.

(3) The following guidelines will be used to select the appropriate steel for target surfaces.

(a) 500 Brinell Hardness (BHN) will be used for steel targets at DOE ranges.

(b) Armor-piercing ammunition must not be used on any type of steel plate or target unless that target has been permanently relegated to long-range use (minimum distance of 100 yards up to and including .338 Lapua caliber and minimum distance of 500 yards for calibers above .338 Lapua). Such use must be in accordance with an approved risk analysis.

(4) The ballistic properties of the weapon system (the firearm and the ammunition) must be thoroughly understood and considered, coupled with the training objective, when determining the appropriateness of using steel plate targets.

b. Structural Supports for Steel Targets.

(1) Support structures should be located where they are not likely to be struck by projectiles or splatter, be designed to direct ricochets or splatter downrange, or be protected by deflectors that direct ricochets or splatter downrange. Structural supports must be shielded by a material (e.g., sandbags) capable of absorbing direct fire and splatter.

(2) Steel targets and their structural support systems may tilt toward or away from the firing line directing the splatter into the ground near the target or downrange away from the firing line.

c. Target Condition.

(1) Steel targets will be examined for deterioration (e.g., dimpling or cratering; concave or convex warping; cracks, joints and/or holes in the target surface) before and after each day's use and at any time during use that damage is suspected. A chip on the edge of a steel target strike plate should not be considered a crater as a chipped target edge causes deflection away from the shooter.

(2) A deteriorated target should be removed from use or permanently relegated to long-range use (see above, section 2.a.(3)(b)) that has been approved through a risk analysis.

(3) Steel targets that have one dimple or crater must be regarded as a hazard. Targets that contain dimples larger than 1/16-inch deep should be removed from use or may only be used according to section 2.a.(3)(b). They can be repaired by using the proper techniques.

(4) Concave Bowing.

(a) Targets that bow more than 10 degrees should not be used. Instructors may use the following calculation to determine target bow. A straight edge is placed on the face of a steel target ensuring contact at the top and bottom of the target. The point on the target face that affords the maximum air space bowing away from the straight edge is determined, and this distance is then measured. The formula to determine the maximum allowable depth of the bow for any specific length is: half the length of bowed portion of target x tangent 10 degrees = allowable depth. (Tangent 10 degrees = .17632). See Figures 2 and 3 for an illustration of the measurement procedure.

(b) The target should not be used if the space between the straight edge and the face of the target exceeds the following examples:

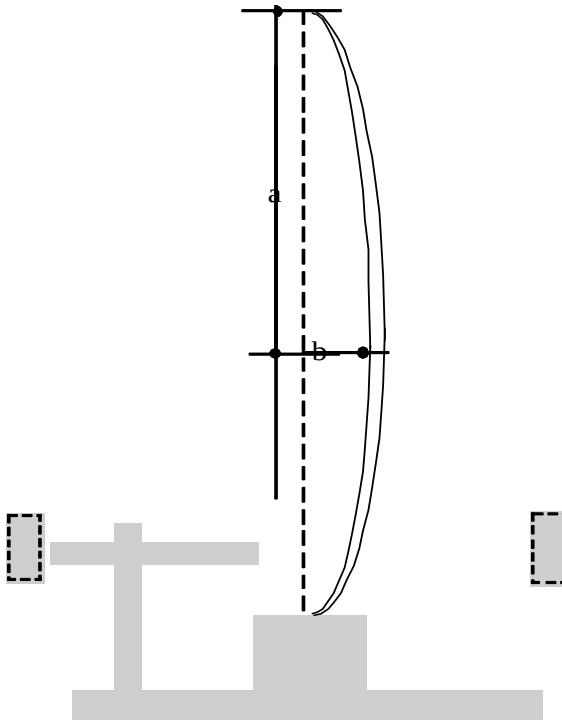

Figure 2

The formula to use to determine the maximum allowable depth of a target that is completely bowed is:

half the length of the target (a) x the tangent of 10 degrees = allowable bow (b).

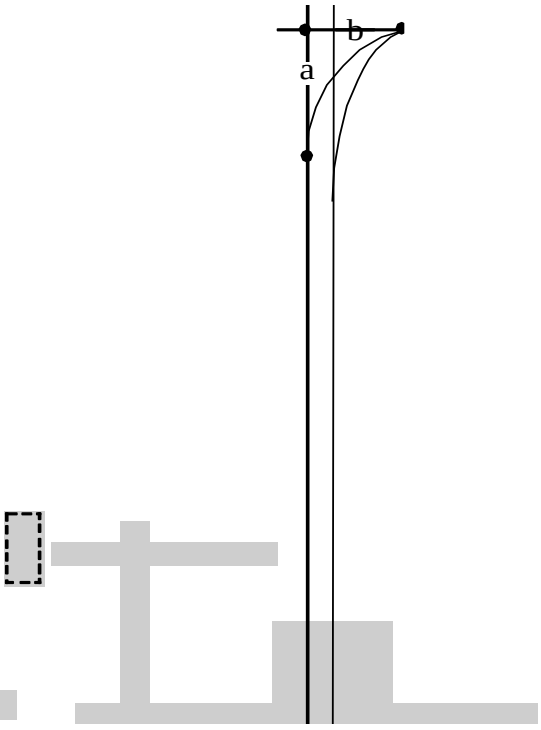

Figure 3

The formula to use to determine the maximum allowable depth of the bow for any specific length of the bowed portion is:

length of bowed portion of target (a) x tangent of 10 degrees = allowable bow (b).

TARGET HEIGHT (inches)	TARGET BOW (inches)
20	1.7
38	2.9
42	3.7

A target that has less than a 10-degree bow may be reversed 180 degrees to the shooter and retained for use. Targets that bow 10 degrees or more will be removed from service.

(5) Cracks, Joints, or Welds.

(a) Some steel targets are designed with target elements that move independently of the main target (e.g., "flip-away" areas). If a hinge or joint is exposed, a target will be evaluated carefully to determine potential splatter zones. They should be monitored closely to ensure that fragments are not reaching the firing line and may require minimum shooter-to-target distances greater than other targets.

(b) Hardened steel plate requires special welding techniques to attach brackets, hinges, and pivot points. Such attachment points will be protected by shields, sandbags, or other means and designed to minimize splatter.

3. AMMUNITION USE GUIDELINES. No incendiary or RAUFOSS ammunition may be shot on steel targets at any distance.

a. Use of .50BMG ammunition requirements. (See Attachment 3 for the NTC's evaluation report.)

(1) Minimum engagement distance of 300 yards.

(2) Target steel 500BHN at least .75 of an inch thick.

(3) Target face should incorporate a 10-30 degree downward angle to the bullet path.

(4) Target should incorporate a design feature that allows the target face to move upon impact (swinger, hinged) to absorb energy.

(5) Target face should shield all of the target fixtures from bullet impact or exposed apparatus should be of light material that will not fragment the .50BMG projectile, if struck.

(6) Target splatter area should be "soft" such as sand, fine gravel, loose dirt, grass, or coated concrete extending 35 degrees relative to the surface of the target.

(7) Steel targets that exceed 1/16 of an inch cratering may only be used at 500 yards or beyond.

(8) Splatter zone of 35 degrees must be free of secondary deflection surfaces.

(9) Targets may not exhibit bowing of greater than 10 degrees.

(10) Minor chipping that does not constitute a crater on the edge of a steel target strike plate does not render a target unserviceable.

b. Use of 5.56mm/.223 caliber and handgun ammunition requirements. (See Attachment 4 for the NTC's evaluation report.) Analysis identifying the suitability of any ammunition should be forwarded to the Office of Security Policy for subsequent revisions of this document.

(1) Placement of secondary surfaces (e.g., other targets, range fixtures) in an area exceeding 35 degrees relative to the surface of the target.

(2) Exposed target apparatus beneath the target must be sandbagged and range surface area in the splatter zone inside 35 degrees relative to the surface of the target must be "soft" (soil, fine gravel, sand, grass or concrete with appropriate coating).

(3) The use of jacketed frangible rifle ammunition.

(4) The use of non-jacketed frangible rifle ammunition is prohibited until analysis of new non-jacketed frangible rifle ammunition technology documents it can be used safely.

(5) Minimum distances for non-jacketed frangible, jacketed frangible and jacketed ball or duty handgun ammunition is 7 yards.

(6) Minimum distances for jacketed frangible rifle ammunition on steel is 7 yards if the particular ammunition item passes the DOE NTC test protocol (See Attachment 4).

(7) Minimum distances for 5.56/.223 ball, duty, or untested jacketed frangible on steel is 50 yards.

c. 7.62x51mm.

(1) Use of jacketed frangible rifle ammunition is not authorized until further analysis is completed.

(2) Use of non-jacketed frangible rifle ammunition is not authorized until further analysis is completed.

d. The minimum distance for use of 7.62x51 is 50 yards.

e. Note: Use of other calibers of ammunition requires site specific safety analysis and approval by site safety and the Official Designated Federal Security Authority (ODFSA).

4. TARGET PLACEMENT.

a. Distance of the participants and bystanders from the target. An observer area, if required, will be established in a safe area on the range. All movement by personnel on the firing range must be monitored strictly by instructors. The

shooter-to-steel target distances identified above in the *Ammunition Use Guidelines* section will be used.

b. Location of participants and bystanders relative to the target. Participants, observers, and bystanders will be located outside the splatter zone(s). To minimize the likelihood of injury, all personnel on the range should be behind the shooter(s) and as close to the gun-to-target line(s) as practicable.

c. Distance and angle of multiple targets relative to each other. When using multiple targets, each target will be placed outside the splatter zone of every other target, positioned to prevent splatter, or shielded to prevent secondary splatter. Instructors will review the course of fire for any potential signs of splatter hazards that will require increased shooter distances. Instructors must ensure physical controls are in place for identified hazards. One option is to place barricades (e.g., wood) between the targets.

d. The ability of the targets to move on projectile impact. When using targets that move or that may be struck by follow-up shots, instructors must ensure that the angle does not change in a direction that causes the splatter to come back up range or ricochet toward other occupied areas.

5. PERSONAL PROTECTIVE EQUIPMENT (PPE). Additional PPE should be required for all personnel when firing on steel targets. Hats with brims should be worn in addition to approved eye and hearing protection unless wearing approved goggles or night vision goggles and/or tactical helmets. Use of long sleeves and pants is required.

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Attachment 1. SAMPLE OF HAZARDS REVIEW FORMAT

NOTE: THIS SAMPLE FORMAT ONLY ADDRESSES HAZARDS ASSOCIATED WITH FIRING AT STEEL TARGETS. IT IS NOT INTENDED TO BE VIEWED AS REPRESENTING A COMPLETE HAZARDS REVIEW. ADDITIONALLY HAZARDS ASSOCIATED WITH USE OF FIREARMS OR A SPECIFIC COURSE OF FIRE MUST ALSO BE ASSESSED.

CONDITION/TASK	HAZARD/RISK	RECOMMENDED CONTROL
Firing specified handgun and rifle caliber firearms at steel targets	Regardless of the precise nature of the hazard, the risk is that participants, observers, or bystanders are struck by bullet fragments causing serious to minor injuries.	The following precautions are required anytime steel targets are used: Participants, observers, or bystanders must wear eye protection with side protection and hats/caps with brims/bills. If shooters are wearing goggles or night vision equipment, additional headgear is not required. Participants, observers, or bystanders must be positioned outside of splatter zone. If possible due to design, target surface angled slightly toward shooter to direct fragments downward.
Firing specified rifle caliber firearms at steel targets	As above	Participants (other than the shooter and one/instructor/controller), observers, and bystanders may be no closer to target than 30 feet, more than 50 feet either side of the gun to target line, and not forward of the weapon's muzzle.

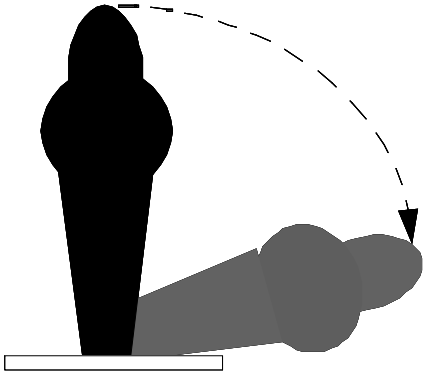
CONDITION/TASK	HAZARD/RISK	RECOMMENDED CONTROL
Firing specified handgun and rifle caliber firearms at steel targets	Due to target design or construction, bullet dimples, cracks, or penetrates steel target surface. Subsequent bullets impact surface defect and fragments are directed back up range. As above.	Steel used to make targets must be hard enough and thick enough to prevent dimpling or penetration and must be sufficiently malleable to prevent cracking. Only weapon systems and ammunition compatible with the specific target design/construction may be used. Participants (other than the shooter and one/instructor/controller), observers, and bystanders may be no closer to target than 30 feet, more than 50 feet either side of the weapon to target line, and not forward of the weapon's muzzle.
	Due to target design, bullet strikes structural support (other than target surface), and fragments are directed back up range. Due to target design or construction, bullet dimples, cracks, or penetrates steel target surface. Subsequent bullets impact surface defect and fragments are directed back up range.	Target design minimizes structural supports within splatter zone; Deflective surfaces minimized or shielded when target surface has reacted (if applicable); Structural supports protected by deflectors that direct bullets and fragments downrange; Otherwise, structural supports are shielded by material capable of absorbing bullet fragments (i.e., sandbags). Steel used to make targets must be hard enough and thick enough to prevent dimpling or penetration and must be sufficiently malleable to prevent cracking. Only weapon systems and ammunition compatible with the specific target design/construction may be used. Design of steel targets must be approved by the range master.

CONDITION/TASK	HAZARD/RISK	RECOMMENDED CONTROL
	Due to damaged target, bullet strikes dimple, crack, or hole and fragments are directed back up range. Due to target design, bullet strikes structural support (other than target surface), and fragments are directed back up range.	Steel targets must be examined before use: Targets with holes or cracks, with dimples deeper than 1/16-inch, or with a bow greater than 10 degrees must not be used as targets for handgun caliber weapon systems or rifles. (They may be used for rifle targets at established minimum distances.) Target design minimizes structural supports within splatter zone; Deflective surfaces minimized or shielded when target surface has reacted (if applicable); Structural supports protected by deflectors that direct bullets and fragments downrange; Otherwise, structural supports are shielded by material capable of absorbing bullet fragments (e.g., sandbags).
	Due to damaged target, bullet strikes dimple, crack, or hole and fragments are directed back up range.	Steel targets must be examined before use: Targets with holes or cracks, with dimples deeper than 1/16-inch, or with a bow greater than 10 degrees must not be used as targets for handgun caliber weapon systems or rifles. (They may be used for rifle targets at established minimum distances.)

CONDITION/TASK	HAZARD/RISK	RECOMMENDED CONTROL
	Bullet strikes surface of properly designed, properly built, and properly shielded target; Fragments splatter off target surface, strike structural supports or other surfaces on range.	For splatter off target surface: If possible due to design, target surface angled slightly toward shooter to direct fragments downward. For ricochet off structural support: Design of target minimizes structural supports within splatter zone; Structural supports within splatter zone are shielded/padded (e.g., using sandbags).
Multiple targets – multiple shooters	One or more shooters address multiple steel targets, fragments splatter from target surfaces, strike adjacent targets or deflective surfaces on the range, and are directed back up range.	In multiple steel target scenarios, targets must be placed so that no target is within the splatter zone of any other target in the array, or is shielded from the splatter from other targets. Shielding must be angled to deflect splatter downrange. Other deflective surfaces must be eliminated or shielded. Participants, observers, and bystanders must be positioned outside the splatter zone of every target in the array.
Moving shooters	As above	Movement of shooters must be controlled to prevent them from entering the splatter zone(s) of the target(s).

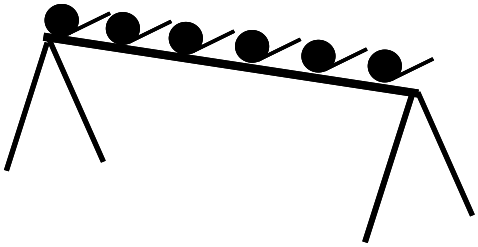
Attachment 2. EXAMPLES OF STEEL TARGETS

The depicted target types are representative of the styles and types available from steel target manufacturers. They are not to be construed as the only styles authorized for protective force use.



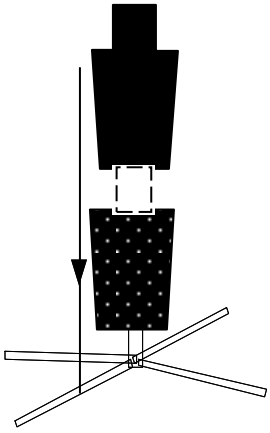
Pepper Poppers

These steel targets are made in different sizes and are used to represent the head and body of a human. Pepper popper targets are adjustable and designed to pivot on a support base and fall rearward when struck by a projectile. (Plans available from the DOE NTC.)



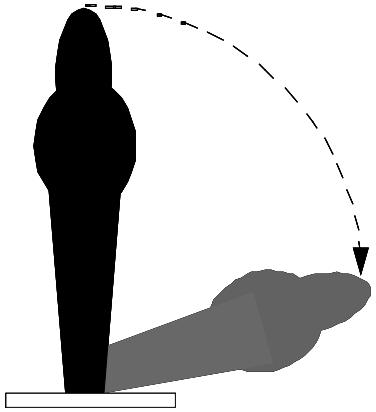
Round Plates

These steel plates vary in size, stand on a base or hang on a rack, and are used to simulate head shots.



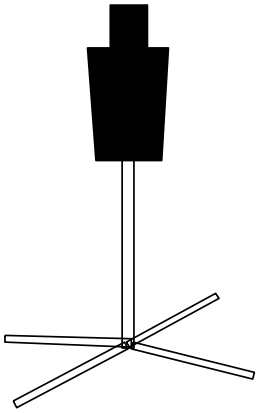
Droppers

These steel targets represent the head and upper torso of the human silhouette. Most dropper targets stand about 5 feet tall and consist of the steel target and a pole for the target to slide down. They are called dropper targets because they drop quickly down the pole when struck by a projectile.



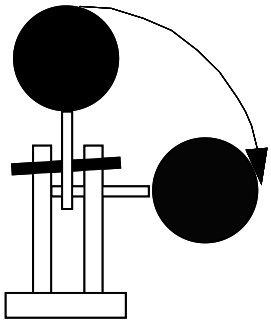
Davis Poppers

These steel targets are similar to the pepper popper steel targets but are larger and squarer. They pivot to the rear on a support base but are usually used as stationary targets with a forward tilt of approximately 15 degrees to help direct rounds downward into the ground. Because of their size and weight, they are usually permanently located on the range and also used extensively for shooting with shotguns firing buckshot. (Plans available from the DOE NTC.)



Standing Silhouette

These targets are a steel version of the International Practical Shooting Course cardboard target. These targets sit on a stationary stand making the targets about 5½ feet tall. They are useful for firing at greater distances and are generally painted to enable the hits to be seen.



Swinging Targets

These are a swinging version of the round steel plates used for head shots during rifle training. When set at greater distances (100 yards and beyond), the targets can be seen swinging when they are hit. The 4-inch targets normally swing all the way around, and the 10-inch targets move a few inches rearward.

Attachment 3. .50BMG Steel Target Test Evaluation Report

.50BMG Steel Target Test

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The U.S. Department of Energy National Training Center

.50BMG Steel Target Test

1.0 Test Conduct

On April 3, 2012 a live fire test was conducted at the Hanford Patrol Academy range #9. The test was conducted in accordance with the .50BMG Steel Target Test Plan dated 3-23-2012.

2.0 Attendees

Howard Terry, DOE NTC Senior Instructor

Loren Rodgers, DOE Richland

Bruce Cameron, Hanford Patrol

Dave Ewer, Hanford Patrol Armorer

William Brisco, Hanford Patrol ES&H

Christopher Derrick, Hanford Patrol Safety

Douglas Evansik, INL

Brian Cook, INL ES&H

3.0 Test Results

At approximately 0930 hours a live fire test was conducted and the results recorded. As indicated in the table below a Hanford site supplied target was shot once with a Barrett M82-A1 .50 Caliber rifle with a Leupold MK IV 3.5X10 Mil dot reticle scope mounted (see photo 1). The ammunition used was Barrett M33 661 grain full metal jacket lot #0300/k (see photo 2). The test target was constructed and supplied by the Hanford Patrol Academy (see photo 3 and 4). The supplied target met all best practice recommendations listed in the .50BMG Steel Target Test Plan dated 3-23-2012. The target was evaluated at a distance of three hundred yards. The splatter area beneath the target was prepared to provide a "soft" impact area for bullet fragments. The splatter zone preparation consisted of fine sand approximately 4 to 6 inches deep. Prior to shooting the target it was insured that there were no secondary deflection surfaces in the splatter zone (see photo 5). The first impact caused a crater of 0.003 inch (see photo 6). To put this measurement in perspective the layer of spray paint on this target caused a surface disruption of 0.002 inch. The crater was barely discernable by touch and was measured with a micrometer (see photo 7). The *Protective Force Firearms Qualifications Courses Section B Use of Steel Targets* dated July 2011 allows for cratering up to 1/16 inch or 0.0625 inch. After the first impact was evaluated twenty more shots were taken with the shooter attempting to strike the edge of the target. The target was truck 17 times. A measurement was taken after the 17 impacts and cratering of 0.006 of an inch was recorded at the deepest point (see photo 8). When the "best practices" stipulated in the .50BMG test plan

dated 3-23-2012 are applied it is feasible and appropriate to apply the 1/16th of an inch cratering standard.

Test specifics

Date	4-3-2012	Muzzle Velocity	2,750 Feet Per Second
Time	0930 hours	Target distance	300 yards
Location	Hanford Patrol Range #9	Target material	500 Brinell 1'
Conditions	Fair, Winds 0/3 M.P.H.	Strike plate angle	20 degrees
Temperature	54 degrees Fahrenheit	Target design feature	Pinned swinger
Test Weapon	Barrett M82-A1	Crater depth impact #1	0.003 inch
Sight	Leupold MK IV 3.5X10 Mil Dot reticle	Crater depth impact #1 thru #17	0.003 to 0.006 inch
Ammunition	Barrett M33 FMJ 661 grain lot #00300/k	General comments	Test results indicate that the test plan goals met

4.0 Additional recommendations

The *Protective Force Firearms Qualifications Courses Section B Use of Steel Targets* dated July 2011 make a distinction as to what constitutes "long range" when shooting steel targets with smaller caliber rifle cartridges. The *Protective Force Firearms Qualifications Courses Section B Use of Steel Targets* dated July 2011 stipulates that steel targets no longer meeting the steel surface condition requirements (cratering, bowing) may be used at "long range" (100 yards or greater). As The *Protective Force Firearms Qualifications Courses Section B Use of Steel Targets* dated July 2011 does not address the .50 BMG there has never been a definition as to what constitutes "long range" with the .50BMG cartridge. It is probable that the results of this test will be used to establish policy regarding the .50BMG. It is appropriate to make a distinction between short and long range as they apply to the .50BMG in this document. Based on the results of this test and research of D.O.E. and military sources in preparation for this test it is recommended that distances short of 500 yards be considered short range and distances of 500 yards and beyond be considered long range. The results of this test support the recommendation that steel targets no longer meeting the 1/16th of an inch cratering requirement only be used at long range (500 yards or greater).

A second issue that this test should address is the definition of a crater verses a chip when evaluating steel targets for serviceability. For the purposes of steel target serviceability a crater is a depression in the steel target strike surface that is circular in shape. A feature as described presents the potential for bullet fragmentation to return in the direction of the shooter. A chip on the edge of a steel target strike plate should not be considered a crater (see photo 9). A

chipped target edge causes deflection away from the shooter. Target chipping as described should not be considered cause to take a target out of service at short range.

The U.S. Department of Energy National Training Center

Photo 1

Photo 2

Photo 3 (20 degrees)

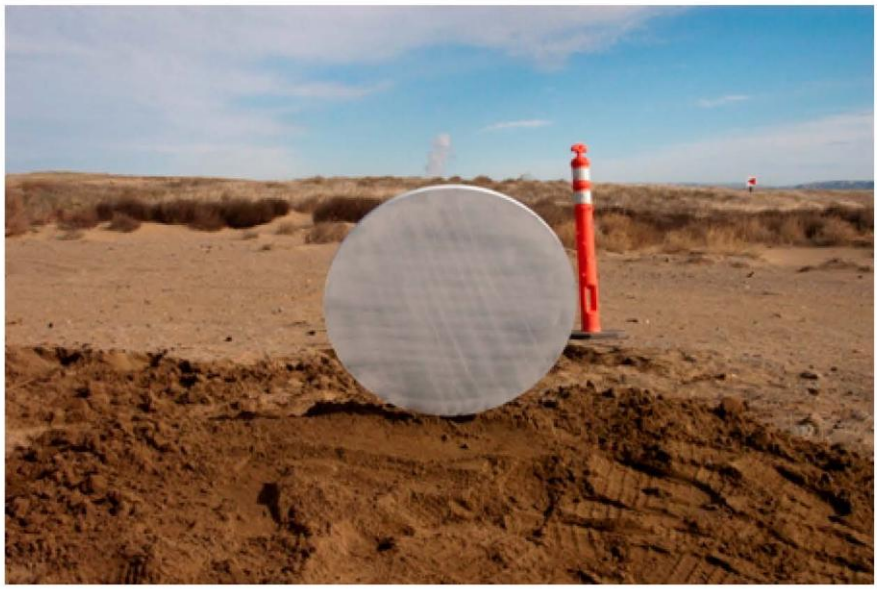

Photo 4

The U.S. Department of Energy National Training Center

Photo 5

Photo 6

Photo 7

Photo 8

The U.S. Department of Energy National Training Center

Photo 9

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Attachment 4. 5.56/.223 Rifle Evaluation Report

Appendix D – Evaluation of Safe Engagement Distances to Steel Targets with Frangible 5.56mm/.223 Ammunition

NATIONAL TRAINING CENTER

"Excellence Through Training"

Protective Force Training Department

Evaluation of Safe Engagement Distances to Steel Targets with Frangible 5.56mm/.223 Ammunition

Prepared for the National Training Center

Protective Force Training Department

Evaluation of Safe Engagement Distances to Steel Targets with Frangible 5.56mm/.223 Ammunition

Signature Page

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CONTENTS

EXECUTIVE SUMMARY

The Department of Energy (DOE) National Training Center (NTC) has received numerous requests from the Protective Force complex to evaluate the minimum safe distance for shooting steel targets with frangible 5.56mm/.223 ammunition. Trainers throughout the DOE complex would like the ability to train on steel targets with the 5.56mm/.223 ammunition at distances closer than that prescribed in the *Protective Force Firearms Qualification Courses*. This evaluation was conducted to address those requests.

Protective Force Firearms Qualification Courses, Section B, Use of Steel Targets, Part 3.a.(3) states:

> *"(3) Shooter-to-steel target distances for frangible ammunition will be established in consideration of the manufacturer's recommendation."*

Because ammunition manufacturers do not make recommendations for minimum engagement distances with their 5.56mm/.223 frangible ammunition, the above cited clause is of limited value. In the absence of a manufacturer's recommendation, the minimum distance applied to service (ball) ammunition (50 yards) was applied to frangible ammunition.

This evaluation analyzes the results of shooting steel targets at a variety of ranges and angles. Steel target surface disruption, splatter angle, and target trap particle escape are also evaluated.

Individual items of 5.56mm/.223 frangible ammunition are introduced and dropped from production as technology changes. This evaluation establishes a testing methodology that can be applied by end users within the DOE complex so that newly introduced 5.56mm/.223 frangible ammunition items may be evaluated as they appear. This information can then be posted and shared throughout the complex, reducing duplication of effort.

The following items are included in the evaluation:

- Pertinent ammunition manufacturer and nomenclature information
- Rifle nomenclature and serial number
- Date, time, temperature, and location
- Muzzle velocity
- 50-yard control group
- 50-yard frangible ammunition group
- Bullet stability evaluation results

- 50-yard steel target penetration evaluation results (on 500 Brinnell Hardness [500 BHN] 3/8") (must be less than .0625")
- 7-yard steel target penetration evaluation results (500 BHN 3/8") (must be less than .0625")
- Splatter evaluation results at 30, 60, and 90 degrees (500 BHN 3/8") (must be 20 degrees or less)
- Bullet trap escape evaluation results from 1 foot at 30, 60, and 90 degrees (must have no particulate escape)
- Overall pass or fail determination
- Evaluator's signature and date

After conducting the above evaluation on seven (7) 5.56mm/.223 frangible ammunition items currently in use, we recommend a minimum engagement distance of 7 yards. A detailed explanation of the evaluation process and results follows.

INTRODUCTION

The DOE NTC and a majority of DOE sites throughout the complex use steel targets in live fire training. Specifically, these targets are used with both handgun-caliber ammunition and rifle-caliber ammunition. Distances to the steel targets are established using the current DOE target placement guidelines, found in *Protective Force Firearms Qualification Courses*, Section B, Use of Steel Targets. The DOE minimum target distance guidelines are based on the use of ball ammunition.

Frangible projectiles are designed to fragment into extremely small pieces upon impact with a hard surface. The .223 Remington or 5.56 NATO cartridge is the predominant rifle cartridge used throughout the DOE complex. The AR-15 or M16/M4 pattern rifle chambered in 5.56mm is widely used by DOE Protective Forces.

The Code of Federal Regulations (CFR) (specifically, 10 CFR 1046 Subpart B, Appendix B, Section [9][e]) requires that DOE Security Police Officers (SPO) qualify with the same weapon and with ammunition that is equivalent in recoil and trajectory to that used on duty.

The objective of this evaluation is to determine what the safe distance would be for the engagement of steel targets using frangible ammunition. Although both handgun and rifle frangible ammunition is used within the DOE system, the current distance for handgun ammunition to steel is applicable for both frangible and ball ammunition; this test and evaluation, therefore, will focus only on the 5.56mm/.223 caliber ammunition. The current DOE steel target placement guidelines were established using ball ammunition and thus are not a good representation of the capabilities of more modern (that is, frangible) ammunition.

The DOE steel target placement guidelines [*Protective Force Firearms Qualification Courses*, Section B, Use of Steel Targets] do address minimum target engagement distance with frangible rifle ammunition:

> *"(3) Shooter-to-steel target distances for frangible ammunition will be established in consideration of the manufacturer's recommendation."*

This guideline, however, does not adequately address the topic. In most cases ammunition manufactures are hesitant to put such recommendations in writing, and it would be inadvisable to take such a recommendation (if offered) at face value.

The NTC conducted an evaluation of 5.56mm frangible ammunition on May 12, 2005. That evaluation resulted in an internal policy change at the NTC, changing the minimum steel target engagement distance from the nonexistent manufacturer's recommendations to 7 yards for the two types of frangible 5.56mm ammunition tested.

In the six years since the 2005 evaluation was completed, however, the two tested types of ammunition have been discontinued, rendering the evaluation obsolete.

In January, 2011, a new test was conducted to establish safe minimum steel engagement distances with frangible 5.56mm/.223 ammunition. A test methodology was also established that sites could apply to 5.56mm/.223 ammunition not tested in this evaluation.

The following objectives have been outlined as part of this test plan:

1) Conduct an evaluation of the 5.56mm frangible ammunition currently in use in the DOE system. This evaluation will include:

   - Contacting the manufacturer of the specific rounds of ammunition tested and determining whether they recommend a minimum safe distance for shooting 500 BHN 3/8".
   - Determining whether the accuracy and stability of the tested types of 5.56mm/.223 frangible ammunition is acceptable for qualification/training purposes.
   - Evaluating the impact signature of the evaluated types of 5.56mm/.223 frangible ammunition on steel targets at specified distances.
   - Determining (by use of witness panels) the splatter pattern of frangible ammunition on steel at various angles to determine whether that splatter pattern falls within the accepted 20-degree arc.
   - Determining (by use of witness panels) whether the fragmentation of the evaluated types of 5.56mm/.223 frangible ammunition is contained by the standard DOE target trap.

- Determining the minimum safe distance for specific types of 5.56mm/.223 frangible ammunition on steel targets based on the collected data.

2) Establish an evaluation methodology for new frangible 5.56mm/.223 ammunition that can be conducted at site level.

3) Provide evaluation forms for sites to conduct evaluation of new or different examples of frangible 5.56mm/.223 ammunition as it becomes available.

The data gathered from this evaluation was collected and presented in a form that will allow DOE Headquarters and key field personnel (management, safety, and operations) to make informed decisions regarding the use of 5.56mm/.223 frangible ammunition on steel targets and the appropriate distances for engagement. This data can also be used in formulating risk assessments and appropriate safety standards for 5.56mm/.223 frangible cartridges.

The evaluation collected specific data on the ammunition types tested. This data included bullet weight/construction, muzzle velocity, 50-yard accuracy/stability, penetration depth on 500 BHN at 50 and 7 yards, splatter angle from exposed steel, and material escape from a standard DOE bullet trap.

The ammunition tested in this evaluation included those rounds of 5.56mm/.223 ammunition identified as being currently in use in the DOE system. The intent of this evaluation, however, was not to create an all-inclusive list of frangible 5.56mm/.223 ammunition available, but, more importantly, to establish a testing methodology that can be conducted at the site level and referred to by all parties concerned, thus minimizing duplication of effort.

BACKGROUND

The NTC and protective forces throughout the DOE complex have a longstanding and clear requirement for frangible small arms ammunition. Suitable frangible ammunition is briefly defined as ammunition that:

- Replicates the short-range ballistics of service ammunition;
- Functions in the weapon in the same manner as service/training ammunition;
- Is designed to rapidly fragment into very small pieces upon striking a hard surface (such as steel targets, bullet traps, armored walls in shoot houses, or on other hard surfaces in sensitive facilities where penetration is not desired), thus limiting transfer of kinetic energy and damage to these surfaces;
- Utilizes a projectile that contains little or no lead and/or other hazardous components (limiting health hazards in training facilities); and
- Provides a greater margin of safety in steel target training and indoor training facilities than the use of service ammunition.

Frangible ammunition in pistol calibers has been in use in the live fire indoor training facilities/shoot houses at the NTC and other DOE sites for over 10 years. The use of frangible ammunition has been proven to:

- Provide realistic training;
- Increase safety margins when used on steel targets, bullet traps, and safety walls in a dynamic environment; and
- Virtually eliminate lead contamination and related clean-up issues in indoor training facilities/shoot houses.

The 5.56mm/.223 M4/M16 pattern weapon system is virtually universally accepted as the system of choice for close quarters battle (CQB) applications, including all special response team/tactical response force applications. This system is also the primary weapon of many SPO functions. With this in mind, there is a clear and substantial need for training and qualification applications using the 5.56mm/.223 and steel targets.

The following issues are specific to 5.56mm/.223 ammunition and steel target shooting:

- 5.56mm/.223 denotes a small diameter frontal area on the projectile (.224").
- Muzzle velocities for 5.56mm/.223 weapons may range from 2400 feet per second (fps) to 3600 fps at the muzzle.
- Projectile revolutions per second (RPS) can exceed 5,000.

The facts listed above dictate that the 5.56mm/.223 cartridge delivers a great deal of kinetic energy into a small area with the potential of significant steel target damage. This damage can be mitigated by the following;

- Frangible bullet construction–Materials, binders, and sectional density all affect the potential for a frangible 5.56mm/.223 round to damage a steel target. In general, the more likely a bullet is to fragment into small pieces upon striking a steel target, the less likely significant damage is to occur.
- Muzzle velocity–As a general rule, the lower the velocity, the lower the potential that target damage will occur.
- Bullet rotation speed–RPS is dependent upon muzzle velocity and rate of twist. As a general rule, the slower the rate of twist, the lower the RPS and the less likely that steel target damage will occur (Appendix A).
- Impact angle–The maximum likelihood for target damage occurs when the impact occurs at 90 degrees. At lesser angles, energy is dissipated over a larger surface area with a subsequent reduction in penetration potential.

- Target construction–Target construction plays a major role in the likelihood that target damage will occur. *Protective Force Firearms Qualification Courses*, Section B, Use of Steel Targets dictates the use of 500 BHN 3/8" for rifles. The softer and thinner the steel of the targets, the more likely damage is to occur. Targets that have been welded may lose temper on points where the target becomes superheated; those heat spots potentially will be the softest portion of the target and the point at which damage is most likely to occur.

With the above listed factors in mind, this evaluation will be conducted in the following manner:

EVALUATION CONTROL WEAPONS

To ensure that the results of this test withstand scrutiny, the test rifle will be conducted with a "worst case scenario approach". The M4/M16 CQB system that gives the highest velocity and highest RPS will be utilized; that combination is a 14.5" barrel with a 1/7 rate of twist. Although higher velocities may be obtained with a 16" or 20" barrel, there are none currently in the system that use the longer barrel with a 1/7 rate of twist. The rate of twist will influence penetration to a greater extent than an additional 1.5" of barrel length and subsequent increase in muzzle velocity. The test rifle will be equipped with a suitable optic to enhance precision (Leupold CQT). The major variation that currently exists regarding 5.56mm CQB weapons is direct gas impingement systems (M4) versus piston systems (HK416). This difference is insignificant, as projectile velocity does not fluctuate appreciably when the respective systems are compared. With the above factors in mind, a 14.5" 1/7" M4 test rifle will be used.

STEEL TARGETS AND AMMUNITION

- The steel targets used in this evaluation will be 500 BHN 3/8" as mandated in the *Protective Force Firearms Qualification Courses*, Section B, Use of Steel Targets.
- The targets used to evaluate projectile penetration will be the standard format "dropper" target. This particular target has a bracket welded to the back of it. The target will be shot on its face where the weld is most likely to have compromised the hardness of the steel. The distances at which the targets are tested are 50 and 7 yards.
- The targets used to evaluate the splatter area angle will be the dropper targets with witness panels placed in the path of splatter to measure its angle. These targets will be shot at 7 yards.
- A standard DOE bullet trap will be used to evaluate its ability to contain bullet fragments, indicating its suitability in a shoot house environment. The steel

utilized in the standard DOE bullet trap is 500 BHN 3/8". These targets will be shot at 1 foot.

- Manufacturer, item number, and lot number of the different frangible ammunition cartridges evaluated are listed on the attached data sheets (see Appendix C).

EVALUATION CONDUCT

Physical Inspection of Cartridges

Each box or lot of the test cartridges will be physically inspected as the first step of the evaluation. The cartridges will be inspected for dents to the case and/or damage to the projectile, uniform overall length of the loaded cartridge, uniform seating depth of the projectile, and uniform seating of primers.

Feeding and Functioning

During the course of the evaluation, notations will be made during each firing sequence when a round fails to feed, extract, or eject.

Muzzle Velocity

This portion of the evaluation is designed to measure the average muzzle velocity of the various cartridges. The chronograph should be set up approximately 10 feet from the muzzle.

Short Range Accuracy Observation

This portion of the evaluation is conducted to provide an indication of the accuracy of the frangible cartridges relative to that of service ammunition. This portion of the evaluation is not meant to be a comprehensive accuracy test but an observation of the suitability of the cartridges in terms of accuracy for the close/distant training environment. The test rifle will be zeroed at 50 yards with control ammunition. A five-round group will be fired with the control ammunition and the group size recorded in inches. The evaluated rounds of frangible ammunition will then be fired at 50 yards and a five-round group measured with calipers (Figure 1). This evaluation of accuracy will not be considered criteria for passing or failing a particular round of ammunition. This evaluation of accuracy will be considered by the end user and their particular accuracy requirements.

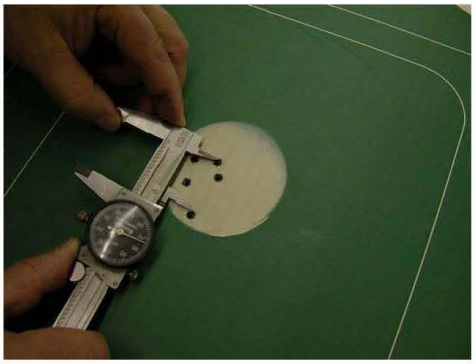

Figure 1

Projectile Stability Observations

The stability of the tested projectiles should be assessed at this point also. The impacts on targets should be inspected for elongated bullet holes or bullets striking the target sideways. The weight of projectiles and the rate of rifling twist vary considerably with 5.56mm ammunition and weapons. It is advised that considerable attention be paid to bullet stability to ensure ammunition and weapon compatibility.

Close-Range Ballistic Impact Observations

This series of firing tests are designed to determine the effect of the specified frangible 5.56mm cartridges on ballistic steel targets used during training and competition activities at NTC and DOE sites. The evaluated rounds of ammunition will be fired at 50 yards on NTC dropper targets. These targets are 500 BHN 3/8" and have brackets welded to the back of the target. The heat-affected area associated with the welds will be marked by paint on the face of the target. The marked area will be point of impact on the target face (Figure 2).The projectile impact will be measured for depth with a depth micrometer (Figure 3). The depth of the impact must be less than .0625". The depth of surface disruption should be evaluated for estimated target life. The process will be repeated at 7 yards and evaluated.

The pass/fail criteria for this portion of the evaluation process will be surface disruption depth. To be acceptable, it must be less than .0625".

Figure 2

Figure 3

Splatter Angle Evaluation

This evaluation will determine if the splatter area associated with individual rounds of frangible 5.56mm/.223 ammunition fall with the acceptable 20 degree arc specified in the *Protective Force Firearms Qualification Courses*, Section B, Use of Steel Targets. Witness panels of cardboard will be placed in close proximity to the steel target above and in the direction of splatter (Figure 4). Angle of fire will be determined with an angle finder. Angled shots from a distance of 7 yards will be

taken at 30, 60, and 90 degrees. After firing the shot at the specified angle, the witness panels will be inspected for any significant splatter and the angle of splatter will be measured with an angle finder.

To meet the pass criteria for this phase of the evaluation, the measured angle of splatter must be 20 degrees or less, as specified in the *Protective Force Firearms Qualification Courses*, Section B, Use of Steel Targets.

Note: Occasionally, the lighter jacket material may come off the target at an angle that exceeds the 20 degree rule of thumb by a few degrees. This is commonly experienced with conventional jacketed pistol ammunition (ball).This jacket material can be identified as linear cuts in the witness panels. With frangible rifle ammunition, these cuts are usually no more than 3mm in length, much smaller than pistol jacket material that can exceed 15mm in length. If the vast majority of core material leaves the target face at 20 degrees or less, the pass criteria has been met.

Figure 4

Bullet Trap Evaluation

This evaluation will test the ability of the standard DOE bullet trap to contain projectile fragmentation. A serviceable standard DOE bullet trap will be engaged from 1 foot at the following angles; 30, 60, and 90 degrees. The angle of fire will be determined with an angle finder. Witness panels of cardboard will be placed above, below, and in the direction of splatter. After a shot has been taken at the specified angle, the witness panels will be inspected for the escape of fragmentation impacting the witness panels.

The pass criteria associated with this phase of the evaluation is the absence of fragmentation escape. If observation determines that fragmentation escapes the trap and leaves a discernable mark on the witness panel it is an automatic failure.

Frangible Ammunition Evaluation Sheet

Below is a sample Frangible Ammunition Evaluation. This sheet is intended to provide a vehicle for the standardized recording of evaluation results. See Appendix C for evaluation sheets completed during this evaluation.

5.56mm/.223 Frangible Ammunition Evaluation				
Ammunition Manufacturer		Manufacturer Recommended Minimum Steel Distance		
		Evaluation	Results	Pass/Fail
Item #		50 Yard group size control ammunition		N/A
Lot #		50 Yard group size frangible ammunition		N/A
Bullet Construction		Bullet stability		
Time		50 yard penetration depth		
Temperature		7 yard penetration depth		
Chronograph		Splatter angle @ 90°		
Distance		Splatter angle @ 60°		
Rifle model		Splatter angle @ 30°		
Rifle Serial #		Trap 1 ft. @ 90°		
Barrel Length Twist Rate		Trap 1 ft. @ 60°		
Muzzle Velocity		Trap 1 ft. @ 30°		
Notes:				

Requirements:		
• Penetration depth must be less than .0625" • Splatter angle must be 20° or less • No fragmentation may exit standard DOE bullet trap • Projectile must be stable	Overall Pass/Fail	
	Location/Site	
	Evaluator	
	Date	

SUMMARY

This evaluation was conducted because there was a desire to enhance live fire training with frangible ammunition on steel targets by reducing the minimum engagement distance allowed by the *Protective Force Firearms Qualification Courses*, Section B, Use of Steel Targets.That minimum distance was based on ammunition manufacture's recommendations that did not exist. A previous study conducted on May 12, 2005, recommended a minimum engagement distance of 7 yards for two 5.56mm/.223 rounds of frangible ammunition tested at that time. Those 5.56mm/.223 frangible ammunition items are no longer in production, making the 2005 study obsolete.

The current evaluation was conducted with the intention of evaluating currently used 5.56mm/.223 frangible ammunition items and establishing a test protocol for additional 5.56mm/.223 frangible ammunition items. This testing protocol will allow sites to conduct evaluations on new 5.56mm/.223 frangible ammunition items as they become available, and will prevent the obsolescence of the evaluation as 5.56mm/.223 frangible ammunition items go out of production.

This evaluation identified several 5.56mm/.223 frangible ammunition items that may be safely used at a minimum distance of 7 yards on 500 BHN 3/8" steel targets. The splatter angle for the 5.56mm/.223 frangible ammunition items that passed the evaluation criteria was 20 degrees or less, and target surface disruption for those items was less than .0625".

APPENDIX A: FORMULA FOR DETERMINING ROTATIONAL VELOCITY

Rotational Velocity = Muzzle Velocity X Twelve (12) X Twist Rate

Where:

a. Rotational velocity is expressed in revolutions per second (rev/sec)

b. Muzzle velocity is expressed in feet per second (fps)

c. Barrel twist rate is expressed as a fraction (ex. 1/7 or 1/9). Twist rate is defined as one 360 degree revolution of the bullet in a given number of inches. Example: 1/9 Twist equals one 360 degree revolution of the bullet for every 9 inches of the barrel.

Example Calculation:

- Colt Carbines in 5.56mm with 16" barrels.
- Carbine One with a 1/9 twist barrel.
- Carbine Two with a 1/7 twist barrel.
- Muzzle velocity = 3050 fps (There will be a very minor decrease in velocity with the 1/7 twist barrel versus the 1/9 twist barrel. A decrease of 30 fps will be used in this example.)

1/9 = .1111

1/7 = .1428

Carbine One – 3050 x 12 x .1111 = 4,066.26 Revolutions per Second

Carbine Two – 3020 x 12 x .1428 = 5,175.07 Revolutions per Second

Difference in Rotational Velocity: 1,108.81 Revolutions per Second

NOTE: The additional rotational velocity imparted to a projectile by the faster twist rate is a reasonable explanation for the additional wear and/or ability to penetrate softer steels caused by 5.56mm weapons with the 1/7 twist barrels as opposed to the 1/9 twist or slower barrels. The additional rotational energy of the faster twist rate must be dissipated or absorbed by the steel in the target or trap, and may explain the observations on wear rate in this evaluation and those of other Range Masters and maintenance personnel at other government and commercial firearms training facilities across the nation.

APPENDIX B: EVALUATION SHEET

5.56mm/.223 Frangible Ammunition Evaluation				
Ammunition Manufacturer		Manufacturer Recommended Minimum Steel Distance		
		Evaluation	Results	Pass/Fail
Item #		50 Yard group size control ammunition		N/A
Lot #		50 Yard group size frangible ammunition		N/A
Bullet Construction		Bullet stability		
Time		50 yard penetration depth		
Temperature		7 yard penetration depth		
Chronograph		Splatter angle @ 90°		
Distance		Splatter angle @ 60°		
Rifle model		Splatter angle @ 30°		
Rifle Serial #		Trap 1 ft. @ 90°		
Barrel Length Twist Rate		Trap 1 ft. @ 60°		
Muzzle Velocity		Trap 1 ft. @ 30°		
Notes:				

Requirements:		
• Penetration depth must be less than .0625" • Splatter angle must be 20° or less • No fragmentation may exit standard DOE bullet trap • Projectile must be stable	Overall Pass/Fail	
	Location/Site	
	Evaluator	
	Date	

APPENDIX C: DATA SHEETS

Data Sheet 1

5.56mm/.223 Frangible Ammunition Evaluation				
Ammunition Manufacturer	Remington 223	Manufacturer Recommended Minimum Steel Distance		No Recommendation
		Evaluation	Results	Pass/Fail
Item #	JPMF LF223RA 45 gr.	50 yard group size control ammunition	1.574" Federal 69 gr.	N/A
Lot #	G58196448	50 yard group size frangible ammunition	1.44"	N/A
Bullet Construction	Jacketed HP	Bullet stability	Stable	Pass
Time	1000	50 yard penetration depth	.002"	Pass
Temperature	32° F	7 yard penetration depth	.003"	Pass
Chronograph	Chrony F-1	Splatter angle @ 90°	20° minor jacket shards	Pass
Distance	10 Ft.	Splatter angle @ 60°	20° minor jacket shards	Pass
Rifle model	M4	Splatter angle @ 30°	20° minor jacket shards	Pass
Rifle Serial #	AO196629	Trap 1 ft. @ 90°	No escape	Pass
Barrel Length Twist Rate	14.5" 1/7	Trap 1 ft. @ 60°	No escape	Pass
Muzzle Velocity	2858 fps	Trap 1 ft. @ 30°	No escape	Pass
Notes: Ammunition quality appeared satisfactory, no malfunctions incurred during evaluation.				
Requirements: • Penetration depth must be less than .0625" • Splatter angle must be 20° or less • No fragmentation may exit standard DOE bullet trap • Projectile must be stable		Overall Pass/Fail	Pass	
		Location/Site	DOE NTC LFR	
		Evaluator	H. Terry	
		Date	2-10-2011	

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Data Sheet 2

5.56mm/.223 Frangible Ammunition Evaluation				
Ammunition Manufacturer	Black Hills/ Elmer Arms 5.56mm	Manufacturer Recommended Minimum Steel Distance		No Recommendation
		Evaluation	Results	Pass/Fail
Item #	EA556RRLP 62 gr.	50 yard group size control ammunition	1.574" Federal 69 gr.	N/A
Lot #	E051	50 yard group size frangible ammunition	.740"	N/A
Bullet Construction	Jacketed HP	Bullet stability	Stable	Pass
Time	0900	50 yard penetration depth	.005"	Pass
Temperature	36° F	7 yard penetration depth	.002"	Pass
Chronograph	Chrony F-1	Splatter angle @ 90°	20° minor jacket shards	Pass
Distance	10 Ft.	Splatter angle @ 60°	20° minor jacket shards	Pass
Rifle model	M4	Splatter angle @ 30°	20° minor jacket shards	Pass
Rifle Serial #	AO196629	Trap 1 ft. @ 90°	No escape	Pass
Barrel Length Twist Rate	14.5" 1/7	Trap 1 ft. @ 60°	No escape	Pass
Muzzle Velocity	2827 fps	Trap 1 ft. @ 30°	No escape	Pass
Notes: Ammunition appeared to be of high quality. Bullet had good feed profile, No malfunctions occurred during testing.				

Requirements:		
• Penetration depth must be less than .0625" • Splatter angle must be 20° or less • No fragmentation may exit standard DOE bullet trap • Projectile must be stable	Overall Pass/Fail	Pass
	Location/Site	DOE NTC LFR
	Evaluator	H. Terry
	Date	2-10-2011

Data Sheet 3

5.56mm/.223 Frangible Ammunition Evaluation				
Ammunition Manufacturer	Winchester 5.56mm	Manufacturer Recommended minimum steel distance		No Recommendation
		Evaluation	Results	Pass/Fail
Item #	ZGQ3302 55 gr.	50 Yard group size control ammunition	1.574" Federal 69 gr.	N/A
Lot#	18N80K	50 Yard group size Frangible ammunition	2.411"	N/A
Bullet Construction	Composite truncated cone	Bullet Stability	Stable	Pass
Time	0920	50 Yard Penetration Depth	.010"	Pass
Temperature	37° F	7 Yard Penetration Depth	.0055"	Pass
Chronograph model	Chrony F-1	Splatter angle@ 90°	20° dust size particles	Pass
Distance	10 Ft.	Splatter angle@ 60°	20° dust size particles	Pass
Rifle model	M4	Splatter angle@ 30°	20° dust size particles	Pass
Rifle Serial #	AO196629	Trap 1 ft. @ 90°	No escape	Pass
Barrel Length Twist Rate	14.5" 1/7	Trap 1 ft. @ 60°	No escape	Pass
Muzzle Velocity	2955 fps	Trap 1 ft. @ 30°	No escape	Pass
Notes Ammunition appeared to be of high quality. Bullet had blunt feed profile, No malfunctions occurred during testing.				

Requirements:		
• Penetration depth must be less than .0625"	Overall Pass/Fail	Pass
• Splatter angle must be 20° or less	Location/Site	DOE NTC LFR
• No fragmentation may exit standard DOE bullet trap	Evaluator	H. Terry
• Projectile must be stable	Date	2-10-2011

Data Sheet 4

5.56mm/.223 Frangible Ammunition Evaluation				
Ammunition Manufacturer	Winchester 5.56mm	Manufacturer Recommended Minimum Steel Distance		No Recommendation
		Evaluation	Results	Pass/Fail
Item #	RA556JF 45 Gr.	50 yard group size control ammunition	1.574" Federal 69 Gr.	N/A
Lot #	47XD40	50 Yard group size frangible ammunition	2.397"	N/A
Bullet Construction	Jacketed semi-spitzer	Bullet stability	Stable	Pass
Time	0930	50 yard penetration depth	.0055"	Pass
Temperature	38° F	7 yard penetration depth	.002"	Pass
Chronograph	Chrony F-1	Splatter angle@ 90°	20° minor jacket shards	Pass
Distance	10 Ft.	Splatter angle@ 60°	20° minor jacket shards	Pass
Rifle model	M4	Splatter angle@ 30°	20° minor jacket shards	Pass
Rifle Serial #	AO196629	Trap 1 ft. @ 90°	No escape	Pass
Barrel Length Twist Rate	14.5" 1/7	Trap 1 ft. @ 60°	No escape	Pass
Muzzle Velocity	3121 fps	Trap 1 ft. @ 30°	No escape	Pass
Notes Ammunition appeared to be of high quality. Bullet had blunt feed profile, No malfunctions occurred during testing.				

Requirements:		
• Penetration depth must be less than .0625" • Splatter angle must be 20° or less • No fragmentation may exit standard DOE bullet trap • Projectile must be stable	Overall Pass/Fail	Pass
	Location/Site	DOE NTC LFR
	Evaluator	H. Terry
	Date	2-10-2011

Data Sheet 5

5.56mm/.223 Frangible Ammunition Evaluation				
Ammunition Manufacturer	Black Hills	Manufacturer Recommended Minimum Steel Distance		No Recommendation
		Evaluation	Results	Pass/Fail
Item #	C-227 62 gr.	50 yard group size control ammunition	1.574" Federal 69 gr.	N/A
Lot #	1823142850	50 yard group size frangible ammunition	.941"	N/A
Bullet Construction	Jacketed HP	Bullet stability	Stable	Pass
Time	1030	50 yard penetration depth	.005"	Pass
Temperature	30° F	7 yard penetration depth	.002"	Pass
Chronograph	Chrony F-1	Splatter angle@ 90°	20° minor jacket shards	Pass
Distance	10 Ft.	Splatter angle@ 60°	20° minor jacket shards	Pass
Rifle model	M4	Splatter angle@ 30°	20° minor jacket shards	Pass
Rifle Serial #	AO196629	Trap 1 ft. @ 90°	No escape	Pass
Barrel Length Twist Rate	14.5" 1/7	Trap 1 ft. @ 60°	No escape	Pass
Muzzle Velocity	2777 fps	Trap 1 ft. @ 30°	No escape	Pass
Notes: Ammunition appeared to be of high quality. Bullet had good feed profile, No malfunctions occurred during testing. Very accurate.				

Requirements:		
• Penetration depth must be less than .0625" • Splatter angle must be 20° or less • No fragmentation may exit standard DOE bullet trap • Projectile must be stable	Overall Pass/Fail	Pass
	Location/Site	DOE NTC LFR
	Evaluator	H. Terry
	Date	2-10-2011

Data Sheet 6

5.56mm/.223 Frangible Ammunition Evaluation				
Ammunition Manufacturer	Winchester .223	Manufacturer Recommended Minimum Steel Distance		No Recommendation
		Evaluation	Results	Pass/Fail
Item #	55gr. RA223SF.	50 yard group size control ammunition	1.574" Federal 69 gr.	N/A
Lot #	050cl21	50 yard group size frangible ammunition	.2.398"	N/A
Bullet Construction	Composite truncated cone	Bullet stability	Stable	Pass
Time	0840	50 yard penetration depth	.009"	Pass
Temperature	38° F	7 yard penetration depth	.0155"	Pass
Chronograph	Chrony F-1	Splatter angle@ 90°	20° dust size particles	Pass
Distance	10 Ft.	Splatter angle@ 60°	20° dust size particles	Pass
Rifle model	M4	Splatter angle@ 30°	20° dust size particles	Pass
Rifle Serial #	AO196629	Trap 1 ft. @ 90°	No escape	Pass
Barrel Length Twist Rate	14.5" 1/7	Trap 1 ft. @ 60°	No escape	Pass
Muzzle Velocity	2705fps	Trap 1 ft. @ 30°	No escape	Pass
Notes: Ammunition appeared to be of high quality. Bullet had blunt feed profile. No malfunctions occurred during testing.				

Requirements:		
• Penetration depth must be less than .0625" • Splatter angle must be 20° or less • No fragmentation may exit standard DOE bullet trap • Projectile must be stable	Overall Pass/Fail	Pass
	Location/Site	DOE NTC LFR
	Evaluator	H. Terry
	Date	2-10-2011