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# Joint Fire Support in Urban Warfare: Weapon Platform Selection Criteria

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# Joint Fire Support in Urban Warfare: Weapon Platform Selection Criteria

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# ABSTRACT

Given the demographic and economic trends of urbanization and globalization, the future battlefield for most modern military forces is an urban one.[1] Joint publications have failed to prescribe any doctrinal decision making tools for the comparative employment of Field Artillery and Air Force assets in urban operational environments. This paper comparatively analyzes Field Artillery and Air Force delivered fire support during the joint targeting process as applied in urban terrain with the aim of discovering the doctrinal principles or variables that should underlie weapon platform selection.


[1] United States Joint Forces Command. *The JOE 2010 Joint Operating Environment.* (Suffolk, VA: Joint Futures Group, 2010), 57.

# CHAPTER: I

# INTRODUCTION

## Overview

"Asked why he continually robbed banks, Willy Sutton said, 'That's where the money is.' One could answer the question of 'why fight in cities?' with the equivalent answer: 'That's where the people are!'"[2]

— Michael C. Desch, *Associate Director of the Patterson School of Diplomacy and International Commerce*

Even before the advent of the Global War on Terror, which war saw American forces diffused throughout the Middle Eastern cities of Baghdad and Kabul and several in between, American military forces struggled to operate in the urban terrain of Mogadishu and Sarajevo. Russian troops, confirming the near universal difficulty of conventional forces operating in the urban environment, bloodied themselves as much as their enemies in their hardscrabble, brutal attempts to seize Grozny, Chechnya.[3] The last 20 years of military conflict have involved urban operations at the tactical and operational levels of war. More to the point, these observations ignore the classical historical record of cities being "closely associated with strategic objectives in most of history's conflicts."[4] Given the increasing interconnectedness of states, peoples, and the instruments of national power due to globalization, military planners can expect a major contingent of their forces to operate in and around enemy cities during the conduct of even limited hostilities. The precursor to modern limited engagements, OPERATION ALLIED FORCE, heralded the revelation that applying joint fire support in urban terrain would be

[2] Michael C Desch, *Soldiers in Cities: Military Operations on Urban Terrain* (Carlisle, PA: Strategic Studies Institute, U.S. Army War College, 2001), 3.
[3] Ibid., 1.
[4] Chairman of the Joint Chiefs of Staff. *Joint Publication 3-06 Joint Urban Operations*. (Washington DC: Chairman of the Joint Chiefs of Staff, 2013), I-1.

difficult even in relatively permissive operational environments with material advantages over a technologically inferior enemy:

> Kosovo also revealed a broader problem in dealing with urban warfare and built-up areas. Episodes like the strike on the Chinese embassy reveal a need for fully up-to-date maps of urban and built-up areas that reliably show the location of all sensitive collateral damage targets. It was equally clear that NATO intelligence and targeteers [had] major problems in learning enough about Serbian cities and the facilities in these cities to know what targets were really important, to plan strikes to produce the right level of damage, and then to assess battle damage. NATO found that such target[ing] is extremely difficult to improvise, particularly when minimizing collateral damage is at an absolute premium.[5]

Cities are mazes of men, material, and motivations: elements whose influences extend past neat boundaries and whose precise locations are often in flux. Joint doctrine, though extensively rewritten to reflect America's recent counterinsurgency experience, has failed to address all the specific problems associated with employing specific joint fire support platforms in the Joint Targeting Cycle in urban operational environments.

## Background

The urban environment is unique in the variety and intensity of the challenges it presents to military forces.[6] The counterinsurgency struggles of the last 13 years dominated the wars in Afghanistan and Iraq to the point that it inspired wholesale rewrites of the Army and Marine's counterinsurgency manuals.[7] Targeting, "the process of selecting and prioritizing targets and matching the appropriate response to them, considering operational requirements and

[5] Anthony H Cordesman. *The Lessons and Non-Lessons of the Air and Missile Campaign of Kosovo* (Westport, CT: Praeger, 2001), 324.
[6] Chairman of the Joint Chiefs of Staff. *Joint Publication 3-06 Joint Urban Operations*. (Washington DC: Chairman of the Joint Chiefs of Staff, 2013), I-6.
[7] Headquarters, Department of the Army. *FM 3-24/MCWP 3-33.5 Insurgencies and Countering Insurgencies* (Washington DC: HQDA, 2014), 2-2.

capabilities," is more difficulty given the complexity of the urban environment.[8] Military planners often face the difficult question of how to pair appropriate assets to potentially mobile targets that often camouflage and disguise themselves in the local population of the urban environment. Figure 1-1 compares some of the operational and mission variables amongst different operating environments.

Comparison of Operations in Urban and Other Environments

| Aspect | Urban | Desert | Jungle | Mountain |
|---|---|---|---|---|
| Number of civilians | High | Low | Low | Low |
| Amount of valuable infrastructure | High | Low | Low | Low |
| Multidimensional operational environment | Yes | No | Some | Yes |
| Restrictive rules of engagement | Yes | Some | Some | Some |
| Detection, observation, engagement ranges | Short | Long | Short | Medium |
| Avenues of approach | Many | Many | Few | Few |
| Freedom of vehicular movement and maneuver | Low | High | Low | Medium |
| Communications functionality | Degraded | Fully Capable | Degraded | Degraded |
| Logistics requirements | High | High | High | Medium |

Figure 1-1. Comparison of Operations in Urban and Other Environments[9]

Unfortunately, current demographic trends portend that the military's urban experience in Iraq and Afghanistan will come to typify modern war. The future battlefield is an urban one where, "[b]y the 2030s, five billion of the world's eight billion people will live in cities," and Joint Force Commanders (JFCs) will have to plan operations to account the influence of urban

[8] Chairman of the Joint Chiefs of Staff. *Joint Publication 3-60 Joint Targeting*. (Washington DC: Chairman of the Joint Chiefs of Staff, 2013), I-1.
[9] Chairman of the Joint Chiefs of Staff. *Joint Publication 3-06 Joint Urban Operations*. (Washington DC: Chairman of the Joint Chiefs of Staff, 2013), I-6.

terrain.[10] This situation, specifically the specter of increasingly likely and constraining urban operational environments, begs the question of how Joint Force Commanders (JFCs) and their staff will employ joint force fires in those circumstances. This is a pressing question because urban terrain complicates the execution and constrains the application of joint fires, which fires aid maneuver forces "control territory populations, airspace, and key waters in support of the JFC's scheme of maneuver."[11]

## Scope

Accordingly, the primary question this author will attempt to answer is, "due to increasingly urbanized battlefields of the future, what evaluation criteria should be considered during the joint targeting process in the selection of future US Army artillery and US Air Force weapon platforms?"

## Theoretical Framework

The pneumonic acronym, F2T2EA, which stands for the iterative, parallel, and sequential decision steps of Find, Fix, Track, Target, Engage, and Assess, describes the joint targeting process.[12] It is the decision-making process by which joint forces prosecute planned or unplanned lethal or nonlethal targets. Given the limited scope of this paper, the author's research will deliberately exclude discussing the prosecution of nonlethal targets, though future or follow research may explore the topic. Additionally, given the joint force's bifurcated organization of

[10] United States Joint Forces Command. *The JOE 2010 Joint Operating Environment.* (Suffolk, VA: Joint Futures Group, 2010), 57.
[11] Chairman of the Joint Chiefs of Staff. *Joint Publication 3-09 Joint Fire Support*. (Washington DC: Chairman of the Joint Chiefs of Staff, 2010), I-2.
[12] Chairman of the Joint Chiefs of Staff. *Joint Publication 3-60 Joint Targeting*. (Washington DC: Chairman of the Joint Chiefs of Staff, 2013), II-22.

the fire support systems among the air, land, and naval components, this research will avoid cross boundary coordination issues except as related to the responsiveness of fire support in urban terrain.

Though joint doctrine comprehensively describes its preferred and the service components' (Army, Marine, and Air Force) preferred targeting methodologies (Decide, Detect Deliver, Assess: D3A and the Air Tasking Cycle, respectively), it fails to prescribe a decision making tool for weapons selection or employment in urban environments. Admittedly, this is partly out of principle where targeting focuses on producing the joint force commander's desired effects in the most expeditious fashion without regard to weapon platform.[13] In practice, however, the Air Component has dominated joint targeting efforts in urban environments, sometimes to the detriment of other services, their end force ground level users, and the Joint Force Commander's intent.[14] This myopia sometimes occurs because "the [Joint Force Air Component Commander] JFACC has some limitations in control of all joint fires resources (e.g., [Tomahawk Land Attack Missile] TLAM, [Army Tactical Missile System] ATACMS) and awareness of special operations and nonlethal strategies, thus an opportunity may exist not to consider all joint fires aspects during the development of the air plan."[15] Lieutenant Colonel Michael Wastila made a similar observation 14 years after the *Joint Fires Coordinator Study* about the continuing disconnect between land and air component joint fire support because of doctrinal ambiguity for the responsibility of implementing the Joint Force Commander's concept

[13] Ibid., ix.
[14] United States Chairman of the Joint Chiefs of Staff. *Joint Force Fires Coordinator Study*. (Washington DC: Joint Chiefs of Staff, 1997), III-1.
[15] Ibid., III-2.

of fires.[16] Applying joint fires in urban terrain is an enduring problem with a doctrinal provenance, and the failure to select, properly consider, or comparatively evaluate the right weapon systems during urban operations in joint doctrine could cause tactical overreliance on specific weapon systems, allow targets to escape unprosecuted, or cause excessive collateral damage. Any of the aforementioned consequences could spell strategic disaster for joint operations in today's networked, media saturated environments.

## Importance

The challenge of urban terrain means that the military targeting team must get weapon system selection guidance correct at the doctrinal level. The Fires war fighting function is deficient in this regard. Prescriptive decision making tools exist to rank, prioritize, validate, and vet targets and their susceptibility to attack in the Fires war fighting function—the CARVER (Criticality, Accessibility, Recuperability, Vulnerability, Effect, and Recognizability) decision making tool, for example—but none exist to guide weapon selection whether in general or in urban terrain.

The Intelligence war fighting function applies specific criteria according the principles of Feasibility, Acceptability, Suitability, Distinguishability, and Completeness in assessing and evaluating the severity, probability, and propinquity of enemy courses of action. This author will examine whether a similar intellectual approach in developing weapon platform selection criteria for joint fire support in urban environments is feasible. A preliminary graphic depiction of such an analysis of hypothesized variables might look like the following, with the final dependent

[16] Lt. Col Michael Wastila, "Improving Joint Fires for Special Operations A Mandate for the Joint Force Fires Coordinator," *JFQ: Joint Force Quarterly* 63 (2011): 157.

variables and weights to be selected and explored during the course of the author's methodology and analysis:

| Weight | | | | | | |
|---|---|---|---|---|---|---|
| Criteria | Effect | Responsiveness | Collateral Damage | Risk | Range | Total Score |
| Field Artillery | | | | | | |
| Fixed Wing | | | | | | |

Table 0-1: Preliminary Comparative Variables

These are the preliminary variables this author has discovered in cursory research, seen combat leaders use to evaluate attack system engagement decisions in personal combat experience, and believes are potentially useful in differentiating Field Artillery and Fixed Wing weapon systems. Effect refers to the munitions purpose; responsiveness to the timeliness of the munition and or the weapon system; collateral damage to the unintended or accidental injury to non-targeted structures and personnel; risk to the probability and severity of operational loss due to hazards; and range to the geographical distance reach of the round and or platform. The noncontiguous nature of operations across functionally discrete areas in urban terrain also suggests that cross boundary coordination of land and air fire support systems may be an issue. This, too, is a thread that others may explore in follow-on research.

## Key Terms

The following terms and phrases are not all necessarily defined by common English language usage and represent functional ideas in the application of joint fire support.

1. Target Location Error: A radius defining a circle that represents the mean (50%) or majority (90%) error of the delta between the actual and the perceived target location. These are the accuracies associated with an acquisition system (man or machine) and or a geo-spatial reference system data.[17]
2. Circular Error Probable: A radius defining a circle within which 50% of weapons will impact, an accuracy of weapon system use. This can also be expressed at 90%. [18]
3. Urban Environment: An environment where complex, man-made physical terrain predominates, a population of significant size and density abounds, and there is infrastructure upon which the area functionally and civically depends. Doctrine metaphorically refers to these three constituent elements as the Urban Triad.[19]
4. Joint Fires: "Joint fires are defined as fires delivered during the employment of forces from two or more components in coordinated action to produce desired effects in support of a common objective."[20]
5. Collateral Damage: "Unintentional or incidental injury or damage to persons or objects that would not be lawful military targets in the circumstances ruling at the time."[21]

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[17] Chairman of the Joint Chiefs of Staff. *Chairman of the Joint Chiefs of Staff Instruction 3160.01A No-Strike and the Collateral Damage Estimation Methodology*. (Washington DC: Chairman of the Joint Chiefs of Staff, 2012), GL-7.
[18] Ibid., D-A-5.
[19] Chairman of the Joint Chiefs of Staff. *Joint Publication 3-06 Joint Urban Operations*. (Washington DC: Chairman of the Joint Chiefs of Staff, 2013), I-2.
[20] Chairman of the Joint Chiefs of Staff. *Joint Publication 3-09 Joint Fire Support*. (Washington DC: Chairman of the Joint Chiefs of Staff, 2010), I-2.

6. Collateral Effects Radius: "A radius representing the largest collateral hazard distance for a given warhead, weapon, or weapon class considering predetermined, acceptable collateral damage thresholds that are established for each CDE level. A CER value contains the total error associated with a specific munition and method of employment as well as the radius of dominant warhead effects."[22]
7. Collateral Hazard Area: "An area formed by measuring a CER from either the edge of a target facility outline, the aim point for a point target, or the edge of an engagement zone or artillery sheaf for an area target."[23]
8. Time Sensitive Target (TST): "A joint force commander validated target or set of targets requiring immediate response because it is a highly lucrative, fleeting target of opportunity or it poses (or will soon pose) a danger to friendly forces."[24]

## Limitations

This paper will limit itself to an examination of US Army Field Artillery and US Air Force Fixed Wing platforms as applied in urban operations in the context of the joint targeting cycle. Nonlethal targeting and cross boundary coordination issues will be avoided for the sake of time. Moreover, not every Field Artillery and Air Force Fixed Wing munition is suitable for employment in urban terrain. This paper will avoid examining weapons with warheads larger than 500 pounds, which have limited urban utility for a number of tactical reasons.[25]

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[21] Chairman of the Joint Chiefs of Staff. *Chairman of the Joint Chiefs of Staff Instruction 3160.01A No-Strike and the Collateral Damage Estimation Methodology*. (Washington DC: Chairman of the Joint Chiefs of Staff, 2012), GL-3.
[22] Ibid., GL-4.
[23] Ibid., GL-4.
[24] Chairman of the Joint Chiefs of Staff. *Joint Publication 3-60 Joint Targeting*. (Washington DC: Chairman of the Joint Chiefs of Staff, 2013), I-9.
[25] United States Air Force Scientific Advisory Board. *Air Force Operations in Urban Environments Volume 1: Executive Summary and Annotated Brief*. (Washington D.C.: Government Printing Office, 2005), 13.

## Summary

This paper's author will qualitatively examine joint and service doctrine to discover if there are appropriate prescriptive and or decision making enabling criteria against which to evaluate Field Artillery and Air Force fire support in joint operations in urban terrain. This paper's author may also query the Joint Lessons Learned Library to catalogue and index instances of lessons learned as it applies to joint fire support in urban terrain. Given the abundance of prescriptive tools in the Intelligence war fighting function as it relates to evaluating and prioritizing possible enemy courses of action and the availability of some Fires war fighting function tools to rank and prioritize targets and their general suitability to friendly attack—Criticality, Accessibility, Recuperability, Vulnerability, Effect, and Recognizability, CARVER—this paper's author will also apply the same kinds of decision matrices to quantify fire support decision making variables.

Given the demographic trends of a more urban world and recent United States military experience in Afghanistan and Iraq, the challenge of getting joint fire support right in urban operations will only grow more acute. Leveraging the full complement of fire support assets will also become more challenging as urban terrain requires the synchronization of all Field Artillery, Intelligence Reconnaissance and Surveillance (ISR), and Air Force aviation assets, where "the nature of operations in urban environments places a premium on decentralized command and control, ISR, fire support, and aviation."[26] The crucible of combat of urban terrain will force front line leaders to rely on the decision-making tools, education, and training that joint doctrine establishes.

[26] United States Joint Forces Command. *The JOE 2010 Joint Operating Environment.* (Suffolk, VA: Joint Futures Group, 2010), 58.

## CHAPTER: II

## LITERATURE REVIEW

### Doctrinal Overview

"What's the point of having this superb military that you're always talking about if we can't use it?"[27]

— Madeline Albright, *64th Secretary of State*

Joint doctrine makes clear that there are varieties of strategic, operational, and tactical challenges associated with employing joint fires in urban operations. Some exist because of the complicating political environment associated with military operations other than war and the alacrity undergirding the use of military force as a tool of statecraft; many of these missions require stability tasks to "to maintain or reestablish a safe and secure environment, provide essential government services, emergency infrastructure reconstruction, and humanitarian relief."[28] Other traditional operations still suffer because of inherent factors in the urban operational environment itself, "in an urban environment, both the ability to use fires to support missions and the ability to synchronize and integrate fires are considerably more difficult than in other operations."[29] The abundance of super, surface, and subsurface areas, diversity of different structure types, heights, and densities, and frequent proximity of collateral concerns all conspire to frustrate the easy employment of joint fires.[30] Nontraditional military operations in the heart of an urban environment are doubly difficult for the employment of fire support in that the Joint Force Commander's intent often demands the preservation of civilian infrastructure for future

[27] Michael C Desch, *Soldiers in Cities: Military Operations on Urban Terrain* (Carlisle, PA: Strategic Studies Institute, U.S. Army War College, 2001), 9.
[28] Army Doctrine Reference Publication 3-07 Stability Operations. (Washington DC: Department of the Army, 2013), 1-1.
[29] Chairman of the Joint Chiefs of Staff. *Joint Publication 3-06 Joint Urban Operations*. (Washington DC: Chairman of the Joint Chiefs of Staff, 2013), IV-16.
[30] Ibid., IV-16.

follow on operations.[31] Targets inhabiting urban terrain often diffuse themselves among the constituent elements of the urban triad described earlier. Employing fire support in urban areas requires that commanders and staffs forecast the unintended, cumulative, and cascading effects of fires in such a dynamic system composed of disparate parts. Figures 2-1 and 2-2 graphically depict a prototypical urban surface environment and functionally discrete urban zones.

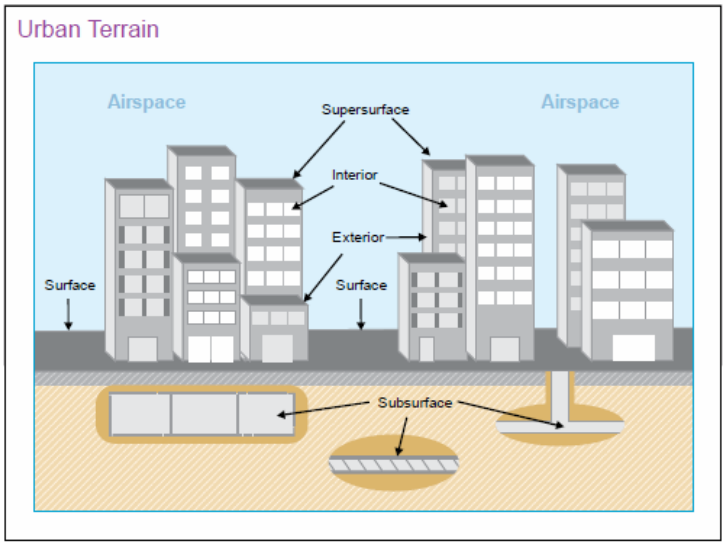


Figure 2-1. Urban Terrain.[32]


Figure 2-2. Urban Functional Zones.[33]

[31] Ibid., IV-16.
[32] Ibid., II-11.

**Urban Field Artillery**

Field Artillerymen face grave operating challenges in urban terrain due to the prevalence of dead space. Dead space entails "that area along either the observer-target line or the gun-target line beyond an object such as a crest or building where the rounds either cannot be observed or cannot impact" and often prohibits the effective use of Field Artillery fires.[34] Solutions include high-angle fire—"firing at an elevation (angle) greater than is required for […] maximum range"—and or dedicated observer support but their implementation is not always feasible.[35] Dead space can obscure observers the same as the firing unit and prolonged high angle fire can damage cannon platforms. Thus, urban terrain can hamstring the Field Artillery's primary means of observation and alternate method of target engagement.[36]

Relocating the firing field artillery unit, another potential solution to the problem of urban terrain, is also not without problems. Displacement of a firing unit puts it at risk to attack and necessitates emplacement at another firing location.[37] This can also be a time consuming process during which highly mobile, fleeting targets can escape the battlefield. This dovetails with another difficult urban artillery issue: hitting a moving target with traditional ballistic artillery requires a tremendous amount of coordination, computation, and a certified Forward Observer.

Engaging a moving target through urban terrain with a purely ballistic round requires an observer to calculate an intercept point on the predicted path in front of the target. The observer must first estimate or measure the speed of the moving target and relate the target's distance

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[33] Ibid., II-12.
[34] Headquarters, Department of the Army. *FM 3-09 Field Artillery Operations and Fire Support* (Washington DC: HQDA, 2014), 1-28.
[35] Ibid., 1-28.
[36] Ibid., 1-28.
[37] Ibid., 1-52.

travel to a specified time interval (meters per second). He must then request the time of flight from the Fire Direction Center, add that time to predetermined target category mission processing time, and multiply that sum by the target speed.[38] The product is the intercept point, a point at which the observer decides to engage the target.[39] The next calculation in the process is determining the trigger point, the point at which the observer must tell the firing unit to fire. Computing this point requires adding transmission time to the previously requested time of flight and "multiplying this sum by the target speed."[40] The observer then plots this point along the projected target path and conducts terrain association to visually anchor the trigger point to a graphic reference. Moving targets are typically dynamic targets or targets of opportunity but their dynamism mimetically echoes the dynamism inherent in the urban environment, "An urban area is dynamic—in a constant state of motion. Understanding the urban environment requires continuous study and analysis as it is complex, dynamic, and perpetually evolving."[41] Thus, it is of no small consequence that improperly planned or inadequately resourced Field Artillery can struggle to provide timely, accurate, and responsive effects in urban terrain.

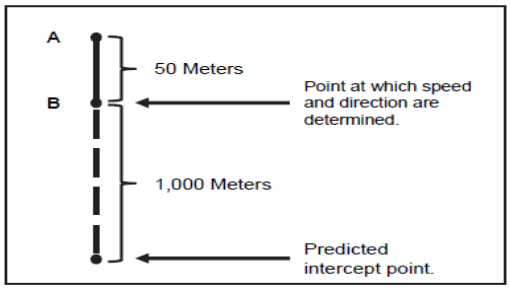


Figure 3-1. Determining an Intercept Point.[42]

[38] Headquarters, Department of the Army. *FM 6-30 Tactics, Techniques, and Procedures for Observed Fire* (Washington DC: HQDA, 1991), 5-24.
[39] Ibid., 5-24.
[40] Ibid., 5-24.
[41] Chairman of the Joint Chiefs of Staff. *Joint Publication 3-06 Joint Urban Operations*. (Washington DC: Chairman of the Joint Chiefs of Staff, 2013), I-3.
[42] Headquarters, Department of the Army. *ATP 3-09.30 Techniques for Observed Fire. (*Washington DC: HQDA, 2013), 5-32.

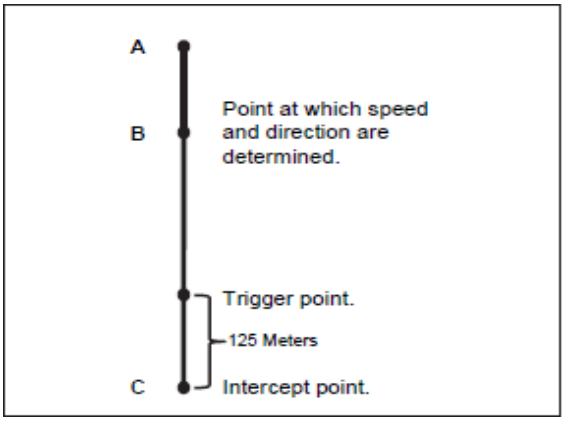


Figure 3-2. Determining a Trigger Point.[43]

Figures 3-1 and 3-2 graphically depict the process by which an observer would determine an intercept and trigger point for a moving target in urban terrain, though the simple linear depictions belie the complicated coordination that must occur for timely and effective moving target prosecution.

**Urban Fixed Wing Fire Support**

Urban terrain also presents dire challenges to air power, however. This occurs despite Air Force doctrine representing air power as fundamentally different from the other services—"With its speed, range, and three-dimensional perspective, airpower operates in ways that are fundamentally different from other forms of military power."[44] Urban terrain bounds military force and can prohibit massing. The physical closeness and density of its varied structures can asymmetrically bypass the high technology advantages of attacking forces whatever the service,

> A very small area can contain a large adversary force and a large number of neutrals, arrayed in three-dimensional depth. For instance, depth may

[43] Ibid., 5-32.
[44] *Air Force Doctrine Document 1* (Maxwell Air Force Base: LeMay Center for Doctrine Development, 2011), 14.

> need to be measured in city blocks instead of kilometers. Airspace will consist of layers, with the lower layer perhaps punctured by high-rise buildings or canalized by 'urban canyons.' […] A 10-story building may take up the same linear space on a two dimensional map as a small field, but the building has eleven times the actual defensible space—10 floors plus the roof and any associated subterranean structures.[45]

The speed and flexibility air power prides itself on can hamstring its employment in an environment that is denser than it is extensive. Airspace requirements for civil aircraft, field artillery assets, other military users, and super surface structures users can exacerbate the problem of airspace congestion.[46] Moreover, although far faster and more mobile than many of the weapon systems of other services, fixed wing aircraft employment in urban terrain still requires a suppressed enemy defense, time-consuming inter-service coordination, and favorable weather conditions to ingress the airspace of an urban environment. The depth of the urban environment also presents a variety of opportunities for enemy air defense artillery measures; therefore, air supremacy is unlikely. This is a prohibitive threat to the fixed wing platform itself that does not exist in large measure for Field Artillery forces.

At bottom, dead space and moving targets present similar tactical and munitions delivery problems to fixed wing platforms. Interrupted electronic and visual sight lines from clustering urban buildings can cause fixed wing platforms to lose target tracks and or funnel those platforms into delivery headings inside urban canyons that can double as ambush corridors for adaptive urban targets.[47] Super surface structures can interfere with optimal observation flight

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[45] Chairman of the Joint Chiefs of Staff. *Joint Publication 3-06 Joint Urban Operations*. (Washington DC: Chairman of the Joint Chiefs of Staff, 2013), I-3.
[46] "Gap Analysis Report No. 08-14 Joint Fires" *Joint Lessons Learned Information System* Internet, available from https://www.jllis.mil/?cdrid=39245&doit=view&disp=cdrview, 6, accessed 4 November 2014.
[47] United States Air Force. *AFTTP 3-2.29 Aviation Operations Multi Service Tactics, Techniques, and Procedures for Aviation Urban Operations*. (Joint Base Langley-Eustis, VA: Air Land Sea Application Center, 2013), 44.

paths and engagement headings. Figures 4-1 and 4-2 depict a low angle line of sight track in an urban canyon and a look angle-structure height relationship summary:

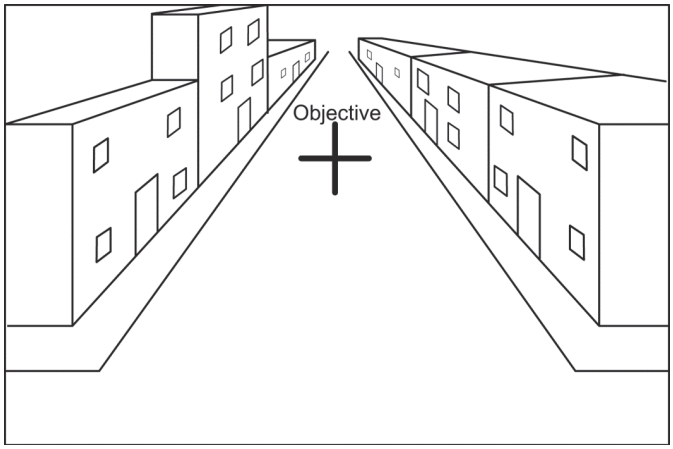


Figure 4-1. Low Angle View.[48]

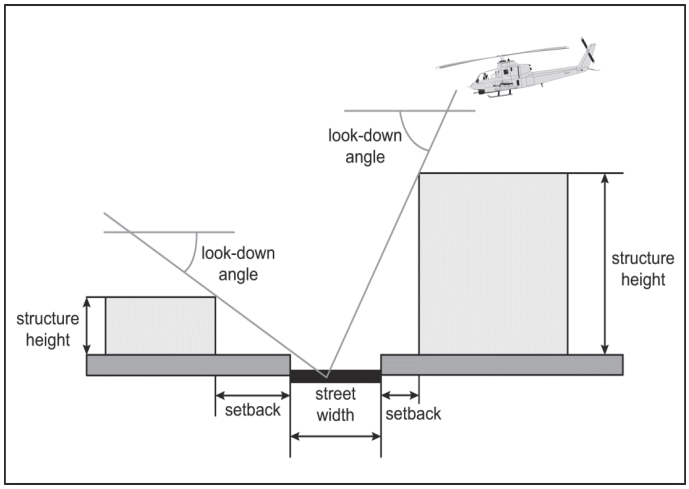


Figure 4-2. Look Down Angle.[49]

Precision guided munitions and standoff weapons have improved the ability of both Army Field Artillery and Air Force fixed wing aircraft to prosecute targets in urban terrain, but Joint doctrine does not offer any prescriptive tools to guide decision making in for their comparative employment.[50] The closest joint doctrine gets is a general discussion of the lethal

[48] Ibid., 44.
[49] Ibid., 45.
[50] Ibid., https://www.jllis.mil/?cdrid=39245&doit=view&disp=cdrview, 30.

fire supports assets available to the Joint Force Commander in *Joint Publication 3-09 Joint Fire Support* which covers the basic characteristics of Fixed Wing Aircraft, Attack Helicopters, Unmanned Aerial Systems, Missiles (Army Tactical Missile Systems [ATACMS]; Tomahawk Land Attack Missiles [TLAMS]; Conventional Air Launched Cruise Missiles [CALCMS]; and Joint Air to Surface Standoff Missiles [JASSM]), rockets, cannon artillery and mortars, and naval surface fire support.[51] An analysis of the employment considerations for these various weapons systems in the joint targeting process as executed in urban terrain may facilitate future targeting operations in urban environments.

**The Joint Targeting Process**

*Joint Publication 3-60 Joint Targeting* describes how the joint forces' planning decision steps of Find, Fix, Track, Target, Engage, and Assess (F2T2EA) pair fire support assets against planned and unplanned military targets. As this publication fails to address targeting challenges in urban terrain specifically, it implicates itself as part of the doctrinal problem giving short shrift to urban land and air weaponeering. Its discussion of dynamic targets—"Dynamic targeting has often been called F2T2EA […] and has also been used for specifically engaging [Time Sensitive Targets] TSTs. […] Targets of opportunity have been the traditional focus of dynamic targeting because decisions on whether and how to engage must be made quickly"— thematically echo the problems of operating in complex, multifaceted urban environments, however.[52] Therefore, the failure to document prescriptive weaponeering tools leaves too many questions for commanders

[51] Chairman of the Joint Chiefs of Staff. *Joint Publication 3-09 Joint Fire Support*. (Washington DC: Chairman of the Joint Chiefs of Staff, 2010), III-17-III-19.
[52] Chairman of the Joint Chiefs of Staff. *Joint Publication 3-06 Joint Urban Operations*. (Washington DC: Chairman of the Joint Chiefs of Staff, 2013), I-3.

and staffs when applying joint fire support in urban operations and against highly lucrative, fleeting targets.

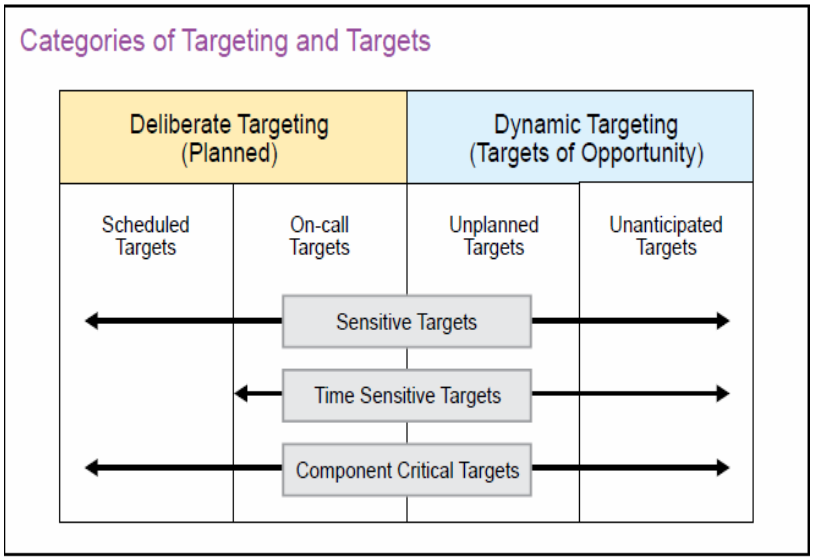


Figure 5-1. Categories of Targeting and Targets.[53]

Evaluating the integration of Field Artillery and US Air Force fixed winged assets in the joint targeting process in urban terrain also requires an explanation of the joint targeting process steps.

"Find" occurs as the first step in the process and is where and when assets, observers, and sensors detect targets and initially classify them.[54] Joint Force Commander (JFC) targeting guidance, priorities, intent and the Joint Force Commander's (JFC's) staff Joint Intelligence Preparation of the Operational Environment (JIPOE) focus, inform, and direct the Find step.[55] Field Artillery Weapon Locating Radars (Q36s, Q37s, Q50s, and Q53s, to name some), Forward Observers and their associated equipment, and Fixed Wing aircraft targeting pods "may provide

[53] Chairman of the Joint Chiefs of Staff. *Joint Publication 3-60 Joint Targeting*. (Washington DC: Chairman of the Joint Chiefs of Staff, 2013), II-2.
[54] Ibid., II-22.
[55] Ibid., II-22.

initial detection of a potential target for both deliberate and dynamic targeting."[56] Besides listing both Field Artillery and Fixed Wing aircraft targeting pods as potential detectors of targets in the joint targeting process, doctrine fails to comparatively analyze these assets to determine their usefulness in facilitating joint fire support in the joint targeting process and this much less while in urban terrain.

The Fix step occurs next and is where sensors identify potential targets and confirm their "precise" locations.[57] Field Artillery Weapon Locating Radars (WLRs), however, give precise target locations and target classification simultaneously and coincident with the Find step after detecting indirect and small arms fire targets with a ballistic trajectory, "These provide the WLR with the information required to mathematically extrapolate a predicted launch and impact point."[58] Joint doctrine stresses the utility of Aircraft targeting pods and Fixed Wing Unmanned Aircraft Systems (UASs) as especially useful in fixing target locations in urban terrain, however. *Joint Publication 3-06 Urban Operations* explains,

> Unmanned aircraft systems (UASs) play a major role in JUOs [Joint Urban Operations] and provide a distinct advantage over other airborne collection assets. Their longer loiter times, persistent surveillance, ability to downlink directly to maneuver elements, and point targeting capabilities enable increased situational awareness to the commander.[59]

From a targeting process perspective, doctrine treats Fixed Wing aircraft system sensors more extensively than Field Artillery Weapon Locating Radars but both are able to provide the required outputs of the Find step, "positive target identification; target location accuracy refined

[56] Ibid., II-22.
[57] Ibid., II-25.
[58] Headquarters, Department of the Army. *ATTP 3-09.12 Field Artillery Target Acquisition (*Washington DC: HQDA, 2011), 3-2.
[59] Chairman of the Joint Chiefs of Staff. *Joint Publication 3-06 Joint Urban Operations*. (Washington DC: Chairman of the Joint Chiefs of Staff, 2013), IV-10.

to level required for target engagement; and a determination or estimation of target time characteristics."[60]

The Track step occurs as the joint forces' sensors maintain persistent monitoring while command makes tactical and technical engagement decisions.[61] Field Artillery Weapon Locating Radars compress the Find, Fix, and Track phases into a singular decision event, while Fixed Wing Aircraft and Unmanned Aerial Systems' sensors have the flexibility to maintain continuous collection on a wider range of targets and visually follow their associated displacement movements throughout the maze of urban terrain. The Track step as applied by traditional and non-traditional Intelligence Reconnaissance and Surveillance (ISR) sensors outputs target vulnerability from visual acquisition. This is vitally important in urban terrain where current experience shows that "many adversaries will be non-uniformed irregular forces, employing nonmilitary vehicles."[62] Joint doctrine misses an opportunity to distinguish between Field Artillery Weapon Locating Radar and Fixed Wing targeting pod (and Unmanned Aerial System) ability to discriminate between legitimate targets and collateral damage concerns in an urban environment.

The Target phase completes the tactical and technical engagement decisions commanders and their staffs make against targets. While joint doctrine clearly states that these decisions are to be made in accordance with Joint Force Commander guidance, doctrine is less clear on describing prescriptive weaponeering principles for that guidance on targets in urban terrain. Joint doctrine does list, however, asset "deconfliction," target area clearance and collateral

[60] Chairman of the Joint Chiefs of Staff. *Joint Publication 3-60 Joint Targeting*. (Washington DC: Chairman of the Joint Chiefs of Staff, 2013), II-26.
[61] Ibid., II-27.
[62] Chairman of the Joint Chiefs of Staff. *Joint Publication 3-06 Joint Urban Operations*. (Washington DC: Chairman of the Joint Chiefs of Staff, 2013), IV-10.

damage estimation, and assessment collection requirements as general Target phase planning considerations for tactical and technical engagement decisions.[63]

Engaging the urban target in the joint targeting process involves the actual action the selected asset and munitions takes against the target. Joint doctrine describes the process as component agnostic, noting that whatever component the joint staff tasks, the "engaging component manages and monitors the actual target engagement."[64] Considering "the effects of weapons and munitions in urban areas can be significantly different from the effects in other environments," this agnosticism is potentially problematic.[65] Joint doctrine notes that specific weapon effect characteristics and engagement criteria can wildly affect the effectiveness of joint urban fires but does not examine, explain, or list those criteria.

Assessing the effects of target engagement is the last step in the joint targeting process. Field Artillery and Fixed Wing aircraft sensors gauge the effectiveness of engagements against targets to provide operational Battle Damage Assessments (BDA) on target sets, Munitions Effectiveness Assessments (MEA) against target types, re attack recommendations for targets insufficiently engaged, or end of mission reports to the controlling component and or joint staff.[66] While assessing the effectiveness of urban strikes can be difficult, ground level assessments can dispel the ambiguity inherent in either Field Artillery or Fixed Wing aircraft sensor assessments.[67] Assessments validate the results of the engagement and catalyze or inform the beginning or course of a new or parallel targeting cycle. Figure 5-2 summarizes the joint

[63] Chairman of the Joint Chiefs of Staff. *Joint Publication 3-60 Joint Targeting*. (Washington DC: Chairman of the Joint Chiefs of Staff, 2013), II-29.
[64] Ibid., II-29.
[65] Chairman of the Joint Chiefs of Staff. *Joint Publication 3-06 Joint Urban Operations*. (Washington DC: Chairman of the Joint Chiefs of Staff, 2013), IV-18.
[66] Ibid., IV-17.
[67] Ibid., IV-18.

targeting process as whole, breaks down the subtasks of the decision steps, and generally depicts the sequence of planning events.

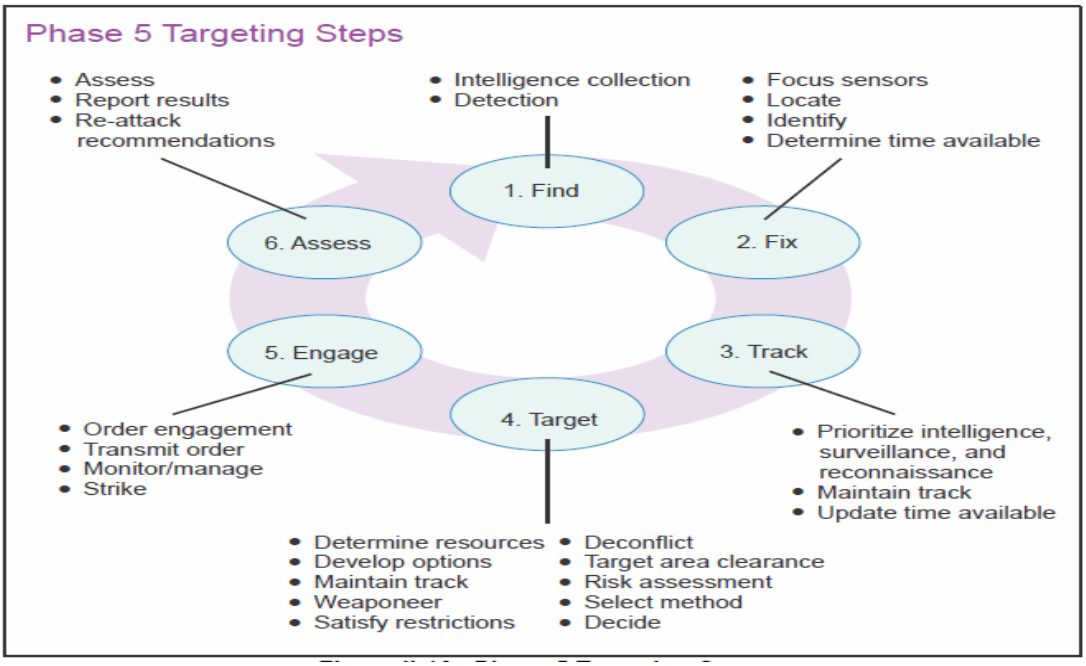


Figure 5-2: The Joint Targeting Process[68]

Major Henry T. Rogers III's *Army Tactical Missile System and Fixed-Wing Aircraft Capabilities in the Joint Time-Sensitive Targeting Process*[69] comparatively analyzed the Army Tactical Missile System and various fixed wing aircraft and their sensor suites and weapon load-outs during the prosecution of Time Sensitive Targets (TSTs) during the joint targeting process, F2T2EA (Find, Fix, Track, Target, Engage Assess). His thesis came to the limited conclusion:

> Fixed-wing aircraft employing joint direct attack munition (JDAM), laser-guided bombs (LGBs) and cannon, can engage a much wider variety of targets and their sensors are useful in the other five phases. ATACMS and GMLRS Unitary are more survivable and have the potential to be more responsive. A joint TST process needs both weapon systems, but TST

[68] Chairman of the Joint Chiefs of Staff. *Joint Publication 3-60 Joint Targeting*. (Washington DC: Chairman of the Joint Chiefs of Staff, 2013), II-23.
[69] Henry T. Rogers. *Army Tactical Missile System and Fixed-Wing Aircraft Capabilities in the Joint Time-Sensitive Targeting Process*. (Ft. Belvoir: Defense Technical Information Center, 2006).

> planners should expect fixed-wing aircraft to engage the majority of TSTs.[70]

Major Henry Rogers' work is compelling but stilted and ultimately less than useful in that he deliberately excluded Field Artillery target acquisition and mission processing assets from his analysis. In essence, he compared a suite of Air Force weapon systems, aircraft, sensors, and communication systems in all phases of the joint targeting process against a single Army munition in a single phase. Considering that the joint targeting process, as just described, is a multifaceted and layered process with several sequential, simultaneous, parallel, and interlocking steps, this is hardly a fair intellectual comparison. Expanding on his analysis to include the full suite of Field Artillery target acquisition systems would give a fuller, fairer analysis of the comparative value of Field Artillery and Fixed Winged fire support not only in the context of urban terrain but also in the joint targeting process. Major Henry Roger's use of Time Sensitive Targets is an appropriate analogue for the complications of all targets in urban terrain because both require detailed coordination and a high number of complications.

**Munition Weight Class Thresholds**

Major Carter Roger's *Army Tactical Missile System: Revolutionary Impact on Deep Operations*[71] makes the case that Army Tactical Missile Systems (ATACMS) revolutionized the way the Army and Air Force cooperatively prosecuted deep targets. While deep targeting may sound counterintuitive vice urban terrain, the Major Carter Roger's analysis of the low collateral damage of ATACMS strikes during Operation Iraqi Freedom will provide this paper a way to examine their potential utility in urban operations. Furthermore, given the relatively large Risk

[70] Ibid., iii.
[71] Carter L Rogers. *Army Tactical Missile System: Revolutionary Impact on Deep Operations*. (Ft. Belvoir: Defense Technical Information Center, 2004).

Estimate Distances and increased probabilities of incapacitation for weapons with explosive warheads larger than 1000 pounds used in close proximity to friendly troops, the ATACMS and corresponding fixed winged ordinance represents the upper threshold for explosives used in urban terrain.[72] Moreover, urban operational experience has proven that 500 pound warheads are effective weapons "for applications in [the urban operational environment] UOE."[73]

**Recap**

As superb as the United States military is, the problems of urban terrain can offset the Joint Force Commander's (JFC's) staggering advantages in firepower and technology if military leaders do not conduct detailed planning to integrate fire support into urban operations.[74] Dead space, structure and population density and diversity, the military aspects of terrain, collateral damage concerns, and the difficulty of positively identifying and tracking the urban target amidst civil clutter can all confound Field Artillerymen and US Air Force Airmen in their application of joint fires in the urban operational environment. Joint doctrine's deficiencies in fixing criteria for urban target engagement during the joint targeting process leaves the joint staff's weapon selection analysis dangerously ambiguous. This paper's methodology will propose a way to dispel that doctrinal ambiguity.

[72] Headquarters, Department of the Army. *ATP 3-09.32 JFIRE Multiservice Tactics, Techniques, and Procedures for the Joint Application of Firepower (*Washington DC: HQDA, 2014), 145.
[73] "Gap Analysis Report No. 08-14 Joint Fires" *Joint Lessons Learned Information* Internet, available from https://www.jllis.mil/?cdrid=39245&doit=view&disp=cdrview, 37, accessed 4 November 2014
[74] Ibid., 27.

# CHAPTER: III

# METHODOLOGY

## Methodology Overview

"Everything is very simple in war, but the simplest thing is difficult."[75]

— Carl Von Clausewitz, *Prussian Military Theorist*

The primary research question that informed the author's methodology is, "due to increasingly urbanized battlefields of the future, what evaluation criteria should be considered during the joint targeting process in the selection of future US Army artillery and US Air Force weapon platforms?" Accordingly, the methodology requires a comparative analysis of Field Artillery and US Air Force fixed wing aircraft targeting capabilities and an assessment of each component during the six steps of the targeting process. The comparative analysis requires a qualitative review of the engagement criteria (variables) each component establishes before urban target prosecution. As such, the research methodology will also collate the selected variables, cull the most important ones, and examine them with subjective weights in a doctrinal decision and or comparison matrix in order to determine a prescriptive attack guidance matrix for urban targets. The research methodology will also support the attack guidance matrix with observations, insights, and lessons gleaned from the Joint Lessons Learned Information System to anchor the attack guidance matrix with case study real world referents or vignettes. The author's personal experience as an enlisted Forward Observer during Operation Iraqi Freedom in Baghdad of 2007 and Al Anbar in 2009 will also inform the comparison matrix's subjective weights. The analysis resulting from this methodology will be more than a capabilities and limitations comparison; the analysis will lead to a doctrinal decision making tool that should

[75] Carl Von Clausewitz, *On War* (London: Penguin, 1982), 164.

guide the platform weapon selection and engagement criteria for staff planners of forces operating in urban terrain.

**Army Field Artillery Requirements for Accurate Fire**

Examining the Field Artillery first, *FM 3-09 Field Artillery Operations and Fire Support*, *ATTP 3-21.90/MCWP 3-15.2 Tactical Employment of Mortars, ATP 3-09.32 JFIRE Multiservice Tactics, Techniques, and Procedures for the Joint Application of Firepower, ATP 3-09.60 Techniques for Multiple Launch Rocket System (MLRS) and High Mobility Artillery Rocket System (HIMARS) Operations,* all describe essential trigger requirements for the engagement of urban targets. *FM 3-09,* specifically, lists five requirements for accurate Field Artillery fires: accurate target location and size, accurate firing unit location, accurate weapons and munitions information, accurate meteorological information, and accurate computational procedures.[76] Meeting these requirements ensures the ability of the Field Artillery to engage targets effectively in support of maneuver elements.

Determining an accurate target location and size does several things for Field Artillery effectiveness: it minimizes Target Location Error in the deviation, range, and vertical axes of physical space; it decreases the distance between the target surface and munition blast and fragmentation radius; and, finally, it increases the chance for first round target effects.[77] Doctrine further stipulates that Field Artillery units must determine target locations with a 1 meter precision when "using a target mensuration system ("mensuration is the process of measurement of a feature or location on the earth to determine an absolute latitude, longitude, and elevation")

[76] Headquarters, Department of the Army. *FM 3-09 Field Artillery Operations and Fire Support* (Washington DC: HQDA, 2014), I-40.
[77] Ibid., 1-41.

and must determine target locations with a 10 meter precision at all other times.[78] Figure 5-1 graphically depicts the effectiveness of traditional ballistic Field Artillery in terms of mission effectiveness relative to adjustment rounds—a prime indicator of accurate target location and size:

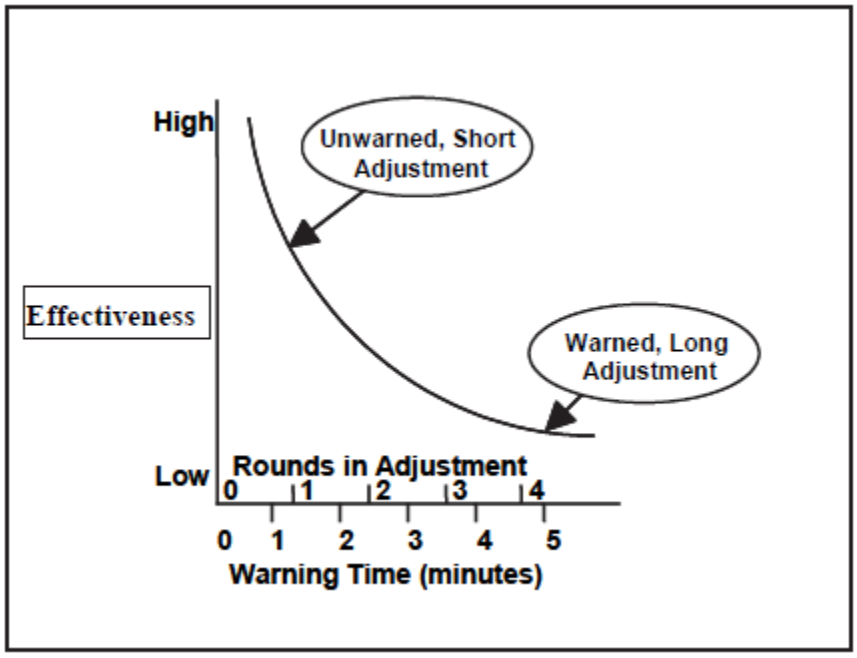


Figure 6-1. Effectiveness compared to length of adjustment.[79]

With many classes of urban targets having a doctrinal dwell time (emplacement and displacement times) of just several minutes according to the *Worldwide Equipment Guide,*[80] one can see that Field Artillery units must have an accurate target location and use the fewest amount of adjustment rounds as possible to be effective.

Furthermore, the Chief of the Field Artillery and Commandant of the U.S. Army Field Artillery School, Brigadier General Christopher Bentley, recently issued amplifying guidance to

[78] Ibid., 1-41.
[79] Headquarters, Department of the Army. *ATP 3-09.30 Techniques for Observed Fire. (*Washington DC: HQDA, 2013), 1-3.
[80] Headquarters, Department of the Army, *Worldwide Equipment Guide Volume 1: Ground Systems.* (Washington DC: HQDA, 2012), 1-541.

Army Field Artillerymen that updates expected target acquisition accuracy (TLE) standards and ties Army doctrine to joint force expectations for fires. Figure 6-2 describes the Field Artillery standards for target accuracy, coordinate precision, measurement category frequency, and the mensuration methods by which Field Artillerymen are able to achieve all of the aforementioned:

| | | | | |
|---|---|---|---|---|
| **Standards** | Delivery of Precision Grid | | Delivery of Near Precision Grid | Unaided Non-Precision Grid |
| | Frequency | 80% | 10% | 10% |
| | Accuracy | 10m TLE (T) CAT II<br>6.0m TLE (O) CAT I | 50m TLE<br>CAT IV | 200M TLE<br>CAT V/VI |
| **Material Enablers** | Current Systems:<br>FS3 (Fire Support Sensor System) [Exclusive to Armored and Stryker Brigade Combat Teams]<br>PSS-SOF (Precision Strike Suite for Special Operations Forces)<br>PFED/PFIG (Pocket Forward Entry Device and Precision Fires Image Generator)<br>LLDR-2H (Lightweight Laser Designator Range Finder with High Accuracy)<br><br>Future Systems:<br>JETS (Joint Effects Targeting System)<br>PFED Inc II with PFW (Pocket Forward Entry Device with Precision Fires Warrior)<br>DPSS/DIEE (Digital Precision Strike Software/ Digital Image Exploitation Image<br><br>Emerging Technologies:<br>Unmanned Aerial Systems<br>Satellites<br>Global/Expeditionary Fire Support Centers | | Current Systems:<br>FS3 (Fire Support Sensor System)<br>LLDR (Lightweight Laser Designator Rangefinder)<br>Vector 21<br>Mark VII<br>PFED (Pocket Forward Entry Device) | Current Systems:<br>Binoculars<br>Map<br>Compass<br>Protractor<br>Observed Fire Fan |

Figure 6-2. 80-10-10 Targeting Standards.[81]

The 80-10-10 Targeting Standards reference the Target Location Error categories (CAT I, CAT II, etcetera) that joint doctrine uses to categorize the accuracy and precision of targeting location information and precision guided munition terminal ballistic condition. Precision guided and

[81] Headquarters, Department of the Army. "DIVARTY: Division Artillery" *Fort Sill Fires Center of Excellence* Internet, available from http://sill-www.army.mil/USAFAS/_img/801010.png, accessed 16 November 2014

near precision munitions of all branches have varying Target Location Error requirements. CAT I coordinates, however, have become synonymous with location accuracy requirements for precision guided munition employment.[82] Thus, in deference to the catastrophic potential for collateral damage in urban terrain, Field Artillerymen strive to provide accurate fires in accordance with the 80-10-10 standard.

Having an accurate firing unit location supports effective Field Artillery fires in urban terrain by ensuring "all firing and target acquisition elements" are oriented in position, altitude, and direction—in whichever specified three dimensional datum and ellipsoid—on a common grid.[83] This common grid reduces the need for datum conversions during mission processing and increases mission reaction time and asset responsiveness. Accurate firing unit location information reduces positional error at the weapon platform source.

The last three accuracies—accurate weapon and ammunition information, accurate meteorological information, and accurate computational procedures—all reduce errors associated with the mission processing and actual engagement of targets with ballistic seeking projectiles. They ensure the technical and tactical firing solution is properly generated and executed through the gamut of mission processing steps, from electronic data entry to manual gunnery to firing point reconnaissance, selection, and occupation.[84] Army precision guided munitions are less dependent on meteorological information than other artillery munitions, however.[85]

An analysis of the Army Requirements for Accurate Fire reveals that the Field Artillery values "Accuracy" and "Responsiveness" as two of the most important engagement criteria in prosecuting urban targets. One may also add the variable of "Range" by default; it goes without

[82] Headquarters, Department of the Army. *FM 3-09 Field Artillery Operations and Fire Support* (Washington DC: HQDA, 2014), 2-20.
[83] Ibid., I-42-1-43.
[84] Ibid., 1-43.
[85] Ibid., 1-43.

saying that if a munition cannot reach a target, then it cannot prosecute it. Of the three variables, *FM 3-09's* anaphoric repetition of the Accuracy concept elevates it as the most important variable. Responsiveness follows subjectively as the next most important variable given the Field Artillery's support relationships are designed to organize and standardize mission reaction times.

| ***If Army Support Relationship is –*** | | ***Then Field Artillery Inherent Responsibilities Are –*** | | | |
|---|---|---|---|---|---|
| | | ***Answers Calls for Fire in Priority From:*** | ***Has as Its Zone of Fire:*** | ***Is Positioned By:*** | ***Has Its Fires Planned By:*** |
| ***Army Support Relationship*** | ***Direct Support*** | 1. Supported unit.<br>2. Own observers.[1]<br>3. Force field artillery headquarters.[2] | Area of operations of supported unit. | Supported unit. | Supported unit. |
| | ***Reinforcing*** | 1. Reinforced field artillery.<br>2. Own observers.[1]<br>3. Force field artillery headquarters.[2] | Zone of fire of reinforced field artillery unit. | Reinforced field artillery unit HQ. | Reinforced field artillery unit HQ. |
| | ***General Support-Reinforcing*** | 1. Supported unit.<br>2. Force field artillery headquarters.[2]<br>3. Reinforced unit.<br>4. Own observers.[1] | Area of operations of supported unit to include zone of fire of reinforced field artillery unit. | 1. Supported unit.<br>2. Force field artillery headquarters.[2] | 1. Supported unit.<br>2. Force field artillery headquarters.[2] |
| | ***General Support*** | 1. Supported unit.<br>2. Force field artillery headquarters.[2]<br>3. Own observers.[1] | Area of operations of supported unit. | 1. Supported unit.<br>2. Force field artillery headquarters.[2] | 1. Supported unit.<br>2. Force field artillery headquarters.[2] |
| ***Note:*** (1). Includes all target acquisition means not deployed with the supported unit (radar, unmanned aircraft systems), vehicles, air observers, survey parties. In the NATO, the gaining unit may not task-organize.<br>***Note:*** (2). If designated by the supported commander. | | | | | |
| NATO – North Atlantic Treaty Organization | | | | | |

Figure 7-1. Field Artillery Responsibilities.[86]

*ATP 3-09.30 Techniques for Observed Fire* also issues prescriptive planning guidance for Field Artillery mission reaction times based on target precedence; Field Artillery units must process priority targets, on call targets, and targets of opportunity in 30 to 60 seconds, 90 to 120 seconds, and 150 to 180 seconds, respectively; these times do not include time of flight.[87]

[86] Ibid., 1-34.
[87] Headquarters, Department of the Army. *ATP 3-09.30 Techniques for Observed Fire. (*Washington DC: HQDA, 2013), 5-33.

**Air Force System Requirements for Operations in Urban Environments**

*Air Force Tactics, Techniques, and Procedures 3-2.29, Aviation Operations, Multi Service Tactics, Techniques, and Procedures for Aviation Urban Operations* describes the primary operating tactical principles for the effective use of airpower in the urban operational environment and specify "airspace limitations, target area threats, location of friendly forces/civilians, onboard sensors, weapon activity, CDE, and target geometry" as munition terminal guidance considerations. *Air Force Doctrine Document 1* lists "speed, range, flexibility, and versatility" as air power's "outstanding attributes" and contributions to the Joint Force Commander.[88] The United States Air Force Scientific Advisory Board's *Air Force Operations in Urban Environments Volume 1: Executive Summary and Annotated Brief* list "persistence, flexibility, responsiveness, and precision fires" as "traits of systems that can be successful in the urban environment."[89]

Air Force doctrine lists most of these traits as tenets based on common English language usage and forgoes an in-depth, idiomatic discussion of their operating requirements, unlike Army doctrine. However, Air Force doctrine is no less clear on the challenges urban terrain presents to effective and timely airpower support:

> In an urban scenario, many of the advantages of airpower are significantly diminished. The ability to use standoff precision weapons is compromised because of severe physical and operational constraints, including buildings that constrain weapon flight trajectories and frequently block target designation.[90]

[88] United States Air Force. *Air Force Doctrine Document 1* (Maxwell Air Force Base: LeMay Center for Doctrine Development, 2011), 14.
[89] United States Air Force Scientific Advisory Board. *Air Force Operations in Urban Environments Volume 1: Executive Summary and Annotated Brief*. (Washington D.C.: Government Printing Office, 2005), 10.
[90] Ibid., V.

The Air Force system requirements for operations in urban terrain seek to leverage airpower's third dimensional vertical focus.[91] Urban terrain encroaches on the air domain's breadth, depth, and omnipresence by compressing the generally unencumbered air medium into a comparatively small area of operations with a number of complicating tactical variables.

**Culling the Comparative Variables**

This author's research methodology will defer to Air Force doctrine and advisory board agreement on airpower's flexibility and include it as a variable in the comparison matrix analysis. Given the dynamism of targets and dynamism of the urban environment itself as described in joint doctrine, this is an appropriate inclusion.[92] Army and Air Force doctrine agreement on the value of precision fires (accuracy) and responsiveness also demand each of those variables' inclusion in this paper's analysis. This author's analysis will include the factor of range by default of the aforementioned reason: if a weapon system and or munition cannot reach a target, then it cannot prosecute it. Given the variety of urban targets and structures, this paper will also examine Field Artillery and Air Force munitions based on weapon's effect, specifically whether a munition is antipersonnel, anti-material, or dual purpose in nature. Moreover, in deference to the number of hazards urban operations present to joint force personnel, civilian noncombatants and civil infrastructure, and the mission itself in the case of collateral damage, this paper's research will include the final variable of risk.[93]

In the final doctrinal determination, Accuracy, Responsiveness, Range, Effect, Flexibility, and Risk are the variables this research will use when evaluating Field Artillery and

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[91] Ibid., 3.
[92] Chairman of the Joint Chiefs of Staff. *Joint Publication 3-06 Joint Urban Operations*. (Washington DC: Chairman of the Joint Chiefs of Staff, 2013), I-3.
[93] "Gap Analysis Report No. 08-14 Joint Fires" *Joint Lessons Learned Information System* Internet, available from https://www.jllis.mil/?cdrid=39245&doit=view&disp=cdrview, 28, accessed 4 November 2014.

Fixed Wing air platforms during urban target engagement. "Gap Analysis Report No. 08-14: Joint Fires" noted the lack of comparative data for land and air component fire support systems across these categories (save for Effect, which that report eschewed and did not consider).[94]

Accuracy and Responsiveness appear to be the most important criteria across both individual service, multiservice, and joint doctrine. Range, however, weights just as important in this methodology because it is a prerequisite for target engagement. Effect, Flexibility, and Risk are comparatively less important given that a platform or munition's effect can largely depend on the aforementioned variables and the joint force operational imperatives prioritize mission accomplishment (target hits) ahead of protecting the force and limiting collateral damage, which is not to say that these variables are unimportant but comparatively less so in the case of lethal, urban targeting.[95] Table 1-1 depicts the research variables and their final subjective weights based on the aforementioned discussion:

| Weight | 2 | 2 | 2 | 1 | 1 | 1 | |
|---|---|---|---|---|---|---|---|
| Criteria | Accuracy | Responsiveness | Range | Effect | Flexibility | Risk | Total Score |
| Field Artillery | | | | | | | |
| | | | | | | | |
| Fixed Wing | | | | | | | |
| | | | | | | | |

In accordance with *ATTP 5-0.1 Commander and Staff Officer Guide*, this comparative decision matrix lists criteria, variables, and weights to help dispel the doctrinal ambiguity regarding the

[94] Ibid., 28.
[95] Chairman of the Joint Chiefs of Staff. *Chairman of the Joint Chiefs of Staff Instruction 3160.01A No-Strike and the Collateral Damage Estimation Methodology*. (Washington DC: Chairman of the Joint Chiefs of Staff, 2012), A-6.

proper considerations for weapon system selection for urban targets.[96] For the purpose of this research, lower values in the Weight row represent subjectively less important criteria. This research will numerically score the Field Artillery and Fixed Wing air platforms a score of "1" or "2" after an analysis of each criterion; a lower score is "better" and means the component branch is more effective for attacking urban targets. The author will vertically multiply the criteria's weight by the Field Artillery and Fixed Wing air platform's raw score to determine a weighted and, in the case of subjectively less important criteria, an un-weighted score. The author will horizontally add both the weighted and un-weighted scores to determine a subjective best urban engagement option, which, again, is the lower score.

After this, the author will evaluate Field Artillery and Fixed Wing air platforms in all phases of the joint targeting cycle to determine their suitability for prosecuting urban targets in each phase of the process. This F2T2EA capabilities analysis will give the reader and doctrine writer a holistic view of Field Artillery and Fixed Wing air platform solutions to the problems of lethal targeting in urban terrain.

[96] Headquarters, Department of the Army. *ATTP 5-01. Commander and Staff Officer Guide.* (Washington DC: HQDA, 2011), 4-36.

# CHAPTER: IV

# ANALYSIS

## Analysis Overview

"No War is commenced, or, at least, no War should be commenced, if people acted wisely, without first seeking a reply to the question, 'what is to be attained and how?' "[97]

— Carl Von Clausewitz, *Prussian Military Theorist*

Chapter III outlined a research methodology consisting of the following variables: Accuracy, Responsiveness, Range, Effect, Flexibility, and Risk. Additionally, the research methodology and literature review discussed the decision steps of F2T2EA, and the analysis must cover Field Artillery and Fixed Wing aircraft performance in the joint target process as applied in urban terrain to complete the analytical picture. The analysis will attempt to answer the research question, "Due to increasingly urbanized battlefields of the future, what evaluation criteria should be considered during the joint targeting process in the selection of future US Army artillery and US Air Force weapon platforms?"

## Accuracy

Firstly, joint doctrine does not precisely define the term "precision-guided munition" in terms of technical accuracy. The joint definition of the term, "A guided weapon intended to destroy a point target and minimize collateral damage," is tautologically circular and specifies nothing about the target location error required to guide or the expected circular error probable during precision guided munition employment.[98] The Air Force also fails to issue a formal definition for what it terms precision guided munitions. Its weaponeering school, however,

[97] Carl Von Clausewitz, *On War* (London: Penguin, 1982), 367.
[98] Chairman of the Joint Chiefs of Staff. *Joint Publication 1-02 Department of Defense Dictionary of Military and Associated Terms*. (Washington DC: Chairman of the Joint Chiefs of Staff, 2014), 202.

"focuses its definition of precision on the accuracy of the guidance system by teaching that a *precision weapon* impacts within a three-meter CEP as compared to an *accurate weapon*, which hits within a 10-meter CEP. These are not, however, official USAF definitions."[99] Through analysis of commensurate Target Location Error Categories from *Joint Publication 3-09.3 Close Air Support*, the air and land components have come up with slightly varying conceptions regarding the doctrinal specifications inherent in the term "precision guided munition."

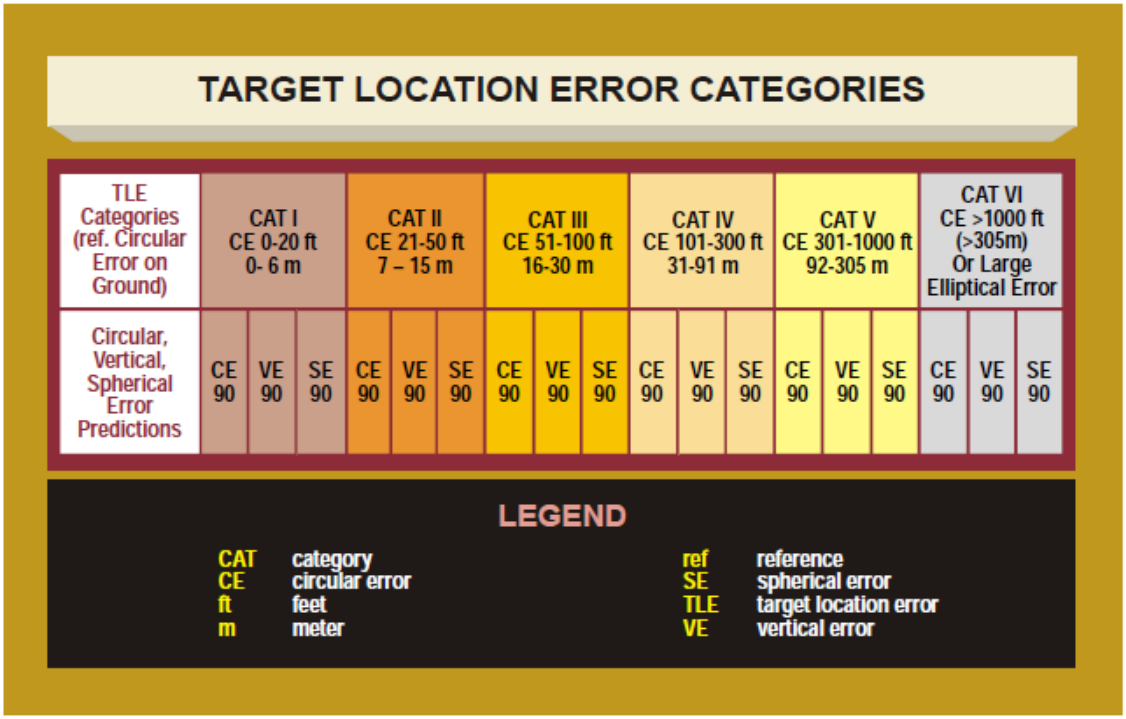


Figure 8-1. Target Location Error Categories.[100]

The Army, by contrast, formally defines precision in its doctrine, precision munitions have circular errors probable less than 10 meter and "munitions with a near-precision capability have a

[99] Maj Jack Sine, "Defining the 'Precision Weapon' in Effect-Based Terms," *Air & Space Power Journal 20* (2006): 82.
[100] Chairman of the Joint Chiefs of Staff. *Joint Publication 3-09.3 Close Air Support*. (Washington DC: Chairman of the Joint Chiefs of Staff, 2009), V-4.

circular error probable between 10 and 50 meters."[101] Thus, the Army definition of precision is more expansive than the Air Force's stringent standard, but the Air Force standard is undefined formally. Doctrinal ambiguities notwithstanding, the actual weapon system delivery and munition performance, circular errors probable, will determine whether the Field Artillery or US Air Force fixed wing platforms are more accurate in urban environments.

In cases where weapon and munitions' circular errors probable are classified, the author research will use doctrinal Risk Estimate Distances—the horizontal distance at which a supported commander "accepts a 1 in 1,000 chance of a friendly casualty as a result of a supporting arms attack"—to determine Field Artillery and Fixed Wing weapon accuracies.[102] Risk Estimate Distances inductively take weapon and munition circular error probable into account and analyzing the size of the distances listed for different weapons in the multiservice *Army Techniques Publication 3-09.32 JFIRE Multiservice Tactics, Techniques, and Procedures for the Joint Application of Firepower* deductively estimates the circular error probable used in the first place.

**Fixed Wing Accuracy**

Aircraft weapons generally fall into four categories: guns, general-purpose bombs, cluster bombs, and precision guided munitions. Air Force fixed wing precision guided munitions are either infrared, laser designated, Global Positioning System (GPS) and Inertial Navigational System (INS) aided bombs or missiles. (Cluster bombs are not normally suitable for urban target engagement and thus this analysis will exclude them.) The only aircraft guns primarily designed

[101] Headquarters, Department of the Army. *FM 3-09 Field Artillery Operations and Fire Support* (Washington DC: HQDA, 2014), 2-24.
[102] Headquarters, Department of the Army. *ATP 3-09.32 JFIRE Multiservice Tactics, Techniques, and Procedures for the Joint Application of Firepower (*Washington DC: HQDA, 2014), 143.

for the air to ground combat inherent in urban operational environments are the 25, 30, and 40mm rotating, cannon, and Gatling guns of the A-10 Warthog and AC 130 gunships.[103] General-purpose bombs are guidance system configurable air to surface bomb bodies. The largest air to surface bomb body suitable for discussion here given the collateral concerns of urban terrain is the 500-pound Mark 82 unguided bomb.[104] The Air Force employs either laser designation (in which case the Air Force designates the bomb a GBU 12) or GPS navigational aiming (a GBU 38 designation) for Mark 82s in their precision guided configurations. The largest air to ground missile suitable for discussion here given the collateral concerns of urban terrain is the 125-pound Maverick air ground missile.

Table 2-1 depicts the Circular Error Probable and or Risk Estimate Distance for the most common and representative air to ground fixed wing weapons used in urban terrain given that terrain's tactical variables and corresponding restrictions. The table derives all figures from the *JFIRE* multiservice manual unless otherwise noted:

[103] United States Air Force. *AFTTP 3-2.29 Aviation Operations Multi Service Tactics, Techniques, and Procedures for Aviation Urban Operations*. (Joint Base Langley-Eustis, VA: Air Land Sea Application Center, 2013), 55.
[104] Ibid., 53-54.

| Weapon | Maximum CEP | Risk Estimate Distance | Guidance |
|---|---|---|---|
| 25mm Cannon | N/A | 75m | N/A |
| 30mm Cannon | N/A | 65m | N/A |
| 40mm Cannon | N/A | 65m | N/A |
| MK 82 | N/A | 255m (airburst) / 185m (contact) | N/A |
| GBU 12 | 9m (Designated)[105] | 150m | Laser |
| GBU 38 | 5m (GPS) 30m (INS only)[106] | 90m (airburst) / 65m (contact) | GPS (INS) |
| AGM 65 | 3m | 80m | Infrared, GPS, Laser |

Table 2-1. Fixed Wing CEP, Risk Estimate Distance, and Guidance.[107]

A look at the table makes a few things readily apparent, laser-seeking weapon accuracies are weather, structure, and designator dependent, GPS guided weapons are coordinate and satellite dependent, and unguided weapon and guns are directional heading, mission, and tactical variable dependent.[108] Most fixed wing weapons are highly accurate and regardless of guidance system, however, and United States Airmen can employ them in close proximity to friendly troops with relatively low odds of fratricide.

[105] "Guided Bomb Unit 12 (GBU-12) Paveway II-Smart Weapons," *Global Security.org* , Internet, available from http://www.globalsecurity.org/military/systems/munitions/gbu-12.htm., accessed 4 December 2014.
[106] "Joint Direct Attack Munition GBU-31/32/38 Fact Sheet," *U.S. Air Force*, Internet, available from http://www.af.mil/AboutUs/FactSheets/Display/tabid/224/Article/104572/joint-direct-attack-munition-gbu-313238.aspx., accessed 4 December 2014.
[107] Headquarters, Department of the Army. *ATP 3-09.32 JFIRE Multiservice Tactics, Techniques, and Procedures for the Joint Application of Firepower (*Washington DC: HQDA, 2014), 148.
[108] United States Air Force. *AFTTP 3-2.29 Aviation Operations Multi Service Tactics, Techniques, and Procedures for Aviation Urban Operations*. (Joint Base Langley-Eustis, VA: Air Land Sea Application Center, 2013), 44-67.

**Field Artillery Accuracy**

Army Field Artillery precision guided and near precision munitions can also accurately service urban targets. Field Artillery weapons generally consist of mortars, cannon projectiles, rockets, and missiles. Unlike Fixed Wing weapons, however, Field Artillery munitions guidance systems consists of GPS (INS) navigational aids or nothing at all, and, because of this, the *JFIRE* lists the unguided Field Artillery Risk Estimate distances under the assumption that a Forward Observer or some other asset has already adjusted (corrected) rounds onto the target area.[109] Unguided Field Artillery accuracies are highly correlated to target range and, near max rocket assisted projectile ranges, circular errors probable can reach 260 meters for purely ballistic 155mm rounds.[110] As such, Table 2-2 will depict only the most common Field Artillery weapon systems with precision or near precision accuracies and exclude area servicing munitions.

| Weapon | Maximum CEP | Risk Estimate Distance | Guidance |
|---|---|---|---|
| 120mm XM395 | 10 m | 105m (airburst) / 80m (contact) | GPS (INS) |
| 155mm M795 w/ M1156 PGK (Precision Guidance Kit) | 50m | TBP (To be published) | GPS (INS) |
| 155mm M982 | 10m | 115m (airburst) / 90m (contact) | GPS (INS) |
| M31 GMLRS Unitary | 5m[111] | 170m (airburst) / 130m (contact) | GPS (INS) |
| M48 ATACMS QRU | Classified | 115m (contact) | GPS (INS) |

[109] Headquarters, Department of the Army. *ATP 3-09.32 JFIRE Multiservice Tactics, Techniques, and Procedures for the Joint Application of Firepower (*Washington DC: HQDA, 2014), 145.
[110] Barry Watts, "The Evolution of Precision Strike," *Center for Strategic and Budgetary Assessments* (2013): 26.
[111] Headquarters, Department of the Army. *FM 3-09 Field Artillery Operations and Fire Support* (Washington DC: HQDA, 2014), 2-24.

| | | | |
|---|---|---|---|
| M57 ATACMS | Classified | 60m (contact) | GPS (INS) |

Table 2-2. Artillery CEP, Risk Estimate Distance, and Guidance.[112]

**Accuracy Assessment**

A few analytical observations are readily apparent from this table and its comparison with Table 2-1: Field Artillery precision guided weapons are slightly less accurate overall than Fixed Wing aircraft munitions. The difference is not material, however. Fixed Winged missiles are minimally more accurate and have smaller circular errors probable than any published Field Artillery weapon's, but considering the smaller Risk Estimate Distance of the ATACMS Q57 compared to any Fixed Wing munition and the fact the ATACMS possess a 500 pound warhead compared to the maximum 125 pounds in the air to ground missile warhead in the Fixed Wing table, one realizes that for all practical purposes, the varying accuracies between the air and land components are differences without distinction. Both components, for planning purposes, are equally accurate.

**Responsiveness**

Field Artillery and Fixed Wing aircraft responsiveness is more than just a function of system performance speed and munition time of flight, though these are important considerations this research will explore. Both components' responsiveness is subject to restrictions and procedural clearances in the Airspace Control Plan. Both components' responsiveness also depends on force protection considerations and the time to integrate with the supported force.

[112] Headquarters, Department of the Army. *ATP 3-09.32 JFIRE Multiservice Tactics, Techniques, and Procedures for the Joint Application of Firepower (*Washington DC: HQDA, 2014), 147.

**Fixed Wing Responsiveness**

The slowest useful urban air to ground fixed wing aircraft, the AC 130, flies at 380 (mph) miles per hour.[113] While this is substantially faster than any Field Artillery platform or weapon system, the AC 130, like every other fixed wing aircraft, cannot enter the operational area until it has checked in on station with the supported ground team, received a situation updated is relatively sure that the area is clear of air to surface threats. There is no doctrinal guideline to describe how long this can take it, but it is a time consuming process even in permissive environments.[114]

Weather and JFACC aircraft allocation can also substantially affect fixed wing responsiveness.[115] Fixed Wing response times can significantly increase if severe weather prevents electronic or visual confirmation of friendly and enemy forces or if the JFACC has not tasked air support to the needing unit in contact.

**Field Artillery Responsiveness**

The Army's doctrinal prescriptions on reaction time aside, most of the impediments to the responsive use of the Field Artillery in recent operations came from clearing airspace.[116] Air clearance issues aside, the Field Artillery being organic to Army units and having times of the flight for all weapon systems, even at max ranges, of only a few minutes, greatly increases its responsiveness in urban engagement.[117] Even in the case of inaccurately located targets, the

[113] Lieutenant Colonel Greg "Skidder" DeFore, "Aircraft and Aircraft Weapons," PowerPoint slides, 18 October, 2013, slide 14.
[114] Gap Analysis Report No. 08-14 Joint Fires" *Joint Lessons Learned Information* Internet, available from https://www.jllis.mil/?cdrid=39245&doit=view&disp=cdrview, 35, accessed 6 November 2014
[115] Ibid., 35.
[116] Ibid., 35, 140.
[117] Carter L Rogers. *Army Tactical Missile System: Revolutionary Impact on Deep Operations*. (Ft. Belvoir: Defense Technical Information Center, 2004). 50.

coordination necessary for the Army to use its Field Artillery is primarily intra-service. A clearly defined Air Space Control plan and practiced tactics, techniques, and procedures to de-conflict aircraft from the gun target lines of Field Artillery units will increase the responsiveness of both branches.

**Responsiveness Assessment**

Given the myriad of operational and organizational variables, it is impossible to state definitively which component is more responsive in urban operational environments. Nonetheless, the Field Artillery potentially has less coordinating complications and liaising requirements and has the potential to be "more responsive."[118]

**Range Assessment**

Fixed wing aircraft easily outclass any Field Artillery asset with regard to range. The A-10 Warthog has the smallest range of urban suitable fixed wing aircraft, and its range is 2580 miles.[119] The Army Tactical Missile System, by contrast, can only reach 300 kilometers or 186 miles.[120] If one generously includes the driving range of the two ATACMS launching platforms, the HIMARS 142A and MLRS 270A1, in the assessment, then the ATACMS range increases to a comparatively paltry 784 kilometers or 487 miles.[121] Given the geographic density of urban spaces, both components are likely to be able to service targets throughout the area of operations;

[118] Henry T. Rogers. *Army Tactical Missile System and Fixed-Wing Aircraft Capabilities in the Joint Time-Sensitive Targeting Process*. (Ft. Belvoir: Defense Technical Information Center, 2006), 63.
[119] Lieutenant Colonel Greg "Skidder" DeFore, "Aircraft and Aircraft Weapons," PowerPoint slides, 18 October, 2013, slide 12.
[120] Headquarters, Department of the Army. *FM 3-09 Field Artillery Operations and Fire Support* (Washington DC: HQDA, 2014), 2-24.
[121] Gap Analysis Report No. 08-14 Joint Fires" *Joint Lessons Learned Information* Internet, available from https://www.jllis.mil/?cdrid=39245&doit=view&disp=cdrview, 31, accessed 6 November 2014

nonetheless, the hard data is clear: the shortest ranging fixed wing aircraft system has more reach than the Army's longest ranging missile system.

**Effect**

Effect refers to a munition's purpose, specifically whether it is antipersonnel, anti-material, dual purpose. Additionally, *Chairman of the Joint Chiefs of Staff Instruction 3160.01A No-Strike and the Collateral Damage Estimation Methodology* identifies five warhead considerations commanders must take into account when employing weapons: fragmentation, blast, debris, penetration, and thermal.[122] The *CJCSI 3160.01A* also describes a methodology to assess, refine, and mitigate the risk of collateral damage based on those weapon effects. In general, larger warheads have greater weapon effects and have the potential for more collateral damage:

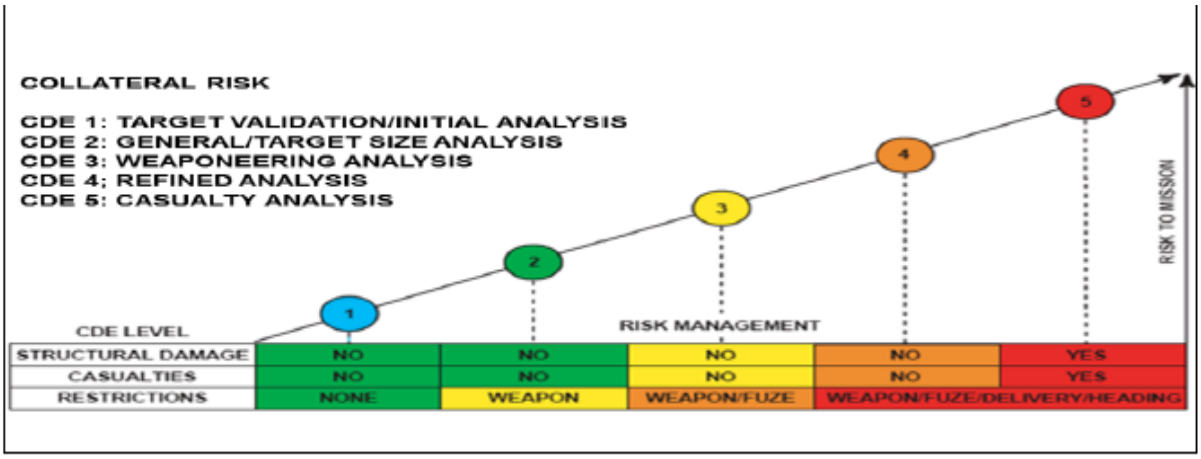


Figure 9-1. Risk and the Collateral Damage Estimation Methodology.[123]

[122] Chairman of the Joint Chiefs of Staff. *Chairman of the Joint Chiefs of Staff Instruction 3160.01A No-Strike and the Collateral Damage Estimation Methodology*. (Washington DC: Chairman of the Joint Chiefs of Staff, 2012), D-A-26.
[123] Ibid., D-A-2.

Weapons having a wider range of effects can be more useful in urban terrain but are also more cumbersome to plan for because of the increased potential of collateral risk. The CDE methodology describes five threshold levels—CDE level 1 through CDE level 5—with each successive level requiring higher commander approval authority.

**Fixed Wing Effect**

The fixed wing weapons referenced in Table 2-1 have a wide range of effects. Fixed wing guns come in the, high explosive, high explosive incendiary, armor-piercing incendiary, and the laterally enhanced penetrator variety for anti-material, antipersonnel, and dual-purpose effects.[124] Aircraft general purpose and precision guided munitions possess point detonating, delay, electromechanical time, variable time, and penetrator fuses.[125]

**Field Artillery Effect**

Field Artillery munitions can have high explosive, antipersonnel, incendiary, dual-purpose anti-armor and antipersonnel effects.[126] Field Artillery munitions have point detonating, delay, electromechanical, and variable time fuses. Army doctrine is generally narrower than the Air Force's or the *CJCSI 3160.01A* in describing weapon munition effects.

**Effect Assessment**

Fixed wing aircraft are capable of delivering a wider range of effects on targets in urban terrain. Fixed wing aircraft's higher number of fusing options and their munitions' generally higher net explosive weights—a GBU 38 has 300 pounds of net explosive weight compared to

[124] Headquarters, Department of the Army. *ATP 3-09.32 JFIRE Multiservice Tactics, Techniques, and Procedures for the Joint Application of Firepower (*Washington DC: HQDA, 2014), 118.
[125] Ibid., 113.
[126] Headquarters, Department of the Army. *FM 3-09 Field Artillery Operations and Fire Support* (Washington DC: HQDA, 2014), 2-21.

215 pounds for the ATACMS—means that fixed wing aircraft can achieve greater effects on targets.[127] These facts also reflect in the Collateral Damage Estimation methodology where the process prohibits analysts from classifying surface-to-surface ballistic munitions and surface-to-surface precision guided munitions as below grade bomb burial options in CDE level 3.[128] There are no artillery fuses in existence that allow their comparatively fragile bomb bodies to achieve complete subsurface detonation except in the case of target buildings or structures, and structural damage considerations require at least a CDE level 4 analysis.[129] Fixed wing fusing variety gives fixed wing aircraft an edge with respect to target effects.

**Flexibility Assessment**

Fixed wing aircraft are more flexible than Field Artillery systems in engaging urban targets because of their ability quickly shift their "attack axis" or engagement delivery headings.[130] Altering delivery heading is the primary mitigation technique for controlling total error in urban target engagement.[131] Fixed Wing fusing variety also presents more engagement opportunities, subject to platform and munition availability, for urban fire support planners.

**Risk Assessment**

Assessing risk is highly situational but there are less existential threats to the Field Artillery platforms and munitions in urban terrain than there are to fixed wing aircraft.[132] Fixed wing aircraft's greater flexibility and wider range of effects superficially suggests a lower

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[127] *Weapons File.* 2012 14th ed. Eglin (AFB, FL: Life Cycle Management Center, 2012), 4-17.
[128] Chairman of the Joint Chiefs of Staff. *Chairman of the Joint Chiefs of Staff Instruction 3160.01A No-Strike and the Collateral Damage Estimation Methodology*. (Washington DC: Chairman of the Joint Chiefs of Staff, 2012), D-A-26.
[129] Ibid., D-A-2.
[130] "Gap Analysis Report No. 08-14 Joint Fires" *Joint Lessons Learned Information* Internet, available from https://www.jllis.mil/?cdrid=39245&doit=view&disp=cdrview, 31, accessed 4 November 2014
[131] Chairman of the Joint Chiefs of Staff. *Chairman of the Joint Chiefs of Staff Instruction 3160.01A No-Strike and the Collateral Damage Estimation Methodology*. (Washington DC: Chairman of the Joint Chiefs of Staff, 2012), D-A-26.
[132] Carter L Rogers. *Army Tactical Missile System: Revolutionary Impact on Deep Operations*. (Ft. Belvoir: Defense Technical Information Center, 2004). 47.

mission risk, weather, response time, and enemy air defense artillery permitting. In the final estimate, however, it appears precision guided Field Artillery weapons are inherently less risky than fixed wing aircraft because there are fewer intervening variables qualifying Field Artillery use, survivability being the uppermost consideration.

**The Final Table**

| Weight | 2 | 2 | 2 | 1 | 1 | 1 | |
|---|---|---|---|---|---|---|---|
| Criteria | Accuracy | Responsiveness | Range | Effect | Flexibility | Risk | Total Score |
| Field Artillery | 1 | 1 | 2 | 2 | 2 | 1 | 9 |
| | 2 | 2 | 4 | | | | 13 |
| Fixed Wing | 1 | 2 | 1 | 1 | 1 | 2 | 8 |
| | 2 | 4 | 2 | | | | 12 |

Table 3-1. The Final Table

In keeping with the *ATTP 5-0.1 Commander and Staff Officer Guide* methodology for decision matrixes, a lower values equals a "better" score. Thus, fixed wing aircraft are slightly more useful in urban target prosecution than the Field Artillery. Accordingly, the final table and answers the research question of "Due to increasingly urbanized battlefields of the future, what evaluation criteria should be considered during the joint targeting process in the selection of future US Army artillery and US Air Force weapon platforms?" The precision fires gap is narrower than some airpower proponents would allege and the specific limitations of both components will insure the continuing mutual interdependence of both in support of a ground force commander and his forces operating in urban terrain.

No one component has a monopoly on all the tools needed to execute joint fires in urban terrain as applied in the joint targeting process. Fixed wing aircrafts greater range, flexibility, and

wider range of effects suggest it might be more useful against non-artillery target sets in the Find, Fix, Track, Target and Assess stages of the process. Field Artillery's greater potential responsiveness, lower risk, and organic embedded ground based observers suggests it might be more useful in the Engage phase and can be equally as useful against optimal target sets in the Find, Fix, and Assess phases.

## CHAPTER: V

## SUMMARY

Summary Overview

"While it has taken U.S. ground forces longer to migrate to precision-centric operations than American fixed-wing air and naval forces, the U.S. Army and Marine Corps appear to be well down this path.' "[133]

— Barry D Watts, *Senior Fellow at the Center for Strategic and Budgetary Assessments*

Recent operational experience in urban terrain has proven the need for close, continuing cooperation between the Field Artillery and Air Force fixed wing assets in prosecuting urban targets.[134] The Iraqi high payoff targets dispersed in and around Baghdad and other key cities could not be destroyed by either component alone as the following figure makes clear:

| Key Target | Prewar On Hand | Destroyed by Air | Percentage Destroyed |
|---|---|---|---|
| Surface-to-Surface Missiles | 153 | 46 | 30% |
| Artillery Pieces | 843 | 424 | 50% |
| Tanks | 660 | 421 | 64% |
| Other Armored Vehicles | 859 | 107 | 12% |
| Air Defense Artillery Systems | 159 | 76 | 48% |
| Vehicles | 2000+ | 1,144 | N/A |

Figure 10-1. Iraqi targets struck by the 4th Air Support Operations Group.[135]

The Field Artillery's usefulness in attacking enemy air defense artillery systems and surface-to-surface missiles sites allows Air Force fixed wing aircraft the freedom of maneuver needed to perform the variety of missions the joint force demands of it. The greater number of targets sets that fixed wing aircraft can attack provides commanders more tools to accomplish their mission.

[133] Barry Watts, "The Evolution of Precision Strike," *Center for Strategic and Budgetary Assessments* (2013): 17.
[134] Charles Edward Kirkpatrick, *Joint Fires as They Were Meant to Be: V Corps and the 4th Air Support Operations Group during Operation Iraqi Freedom*. (Arlington, VA.: Institute of Land Warfare, Association of the United States Army, 2004), 11.
[135] Ibid., 12.

**Recommendations for Future Research**

In an era of fiscal austerity and sequestration, future researchers could explore the financial consequences of fitting Field Artillery unguided bomb bodies with precision guidance and joint directional attack kits.[136] Field Artillery advocates and technical specialists could research different fusing technologies to enable Field Artillery munitions to have the same effects as some air to surface bomb body production lines. Future military leaders could also research ways to decrease air clearance times between the land and air component to ensure the quicker use both service's precision guided munitions. In short, future research can address a number of avenues with respect to integrating Field Artillery and Fixed Wing precision guided munitions in different operational areas.

[136] Barry Watts, "The Evolution of Precision Strike," *Center for Strategic and Budgetary Assessments* (2013): 17.

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