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**Bunker-Busting Bombs in the US–Israel and Iran War: Operational, Legal, and Geopolitical Implications**

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**Abstract**

*This study examines the role of Bunker-Busting Bombs in the context of the US-Israel and Iran war. Theoretical frameworks such as Deterrence Theory, Strategic Ambiguity, and Nuclear Diplomacy Framework are applied with a focus on the role of earth-penetrating or Bunker-Busting Bombs namely GBU-28, GBU-72, and GBU-57, in a practical and symbolic sense through military signaling. Employing a qualitative research design, the study draws on secondary sources from existing literature. The patterns of operational logic, legal rationale, and geopolitical implications of the use of Bunker buster bombs, based on the literature, are identified in the course of the analysis. In addition, the relationship between military strategy and international humanitarian law, especially with reference to the principles of distinction and proportionality, is also examined in the course of the study. The study argues that the use of bunker bombs offers certain operational advantages but also raises a number of legal and ethical issues at the same time. In addition, it also has the potential to create instability in the region, especially in the Middle East. The study concludes with a strong emphasis on the need for international intervention, the creation of civilian protection, and the resumption of diplomatic efforts.*

**Keywords:** Bunker bombs, United State, Israel-Iran conflict, Strategic warfare, Military escalation, International Humanitarian Law

**Introduction**

Bunker-Busting Bombs is also known as bunker busters or earth-penetrating bombs. It was designed to destroy heavily fortified underground military installations such as command centers, missile silos, and storage facilities. The development of Bunker-Busting Bombs dates back to World War II, during which the British Royal Air Force, led by engineer Barnes Wallis, designed and developed bombs such as the Tallboy and Grand Slam bombs. These bombs were designed to penetrate deep into the ground before exploding to cause maximum damage to structures (Spencer, 2003). The first use of Bunker-Busting Bombs in modern times was during Operation Desert Storm, in which the US military deployed and utilized a GBU-28, a type of

laser-guided bomb designed to destroy heavily fortified underground command centers of enemy forces. This was in response to Iraq's heavily buried command and control centers in Baghdad (FAS, 1998).

The United States military again made use of GBU-28 and other earth-penetrating bombs to destroy underground military facilities and suspected locations containing weapons during the Iraq War in 2003. These bombs were used in the “shock and awe” campaign to incapacitate key command centers where Saddam Hussein and other Iraqi leaders might be hiding (Cordesman, 2003). During the early stages of Operation Enduring Freedom, the United States military made use of precision earth-penetrating bombs, including GBU-24 and GBU-28, to attack Al-Qaeda’s cave hideouts and bunkers in the Tora Bora region. These precision-guided earth-penetrators played a crucial role in eliminating Al-Qaeda’s underground hideouts and bunkers, where Taliban and Al-Qaeda fighters hid in the mountainous terrain of Afghanistan (Donnelly, 2002).

It was stated that the United States and coalition forces carried out bunker-busting missions in Syria to attack ISIS’s underground command centers and bunkers containing ammunition, mainly in Raqqa and Deir ez-Zor. While there are varying reports, satellite images and analysis suggested the use of earth-penetrating bombs (Binnie, 2016). Israel also made use of deep penetration ordnance, including bunker busters from the United States, during the conflict with Hezbollah in Lebanon. The ordnance was aimed at Hezbollah’s underground bunkers in southern Lebanon and the Dahiya region in Beirut (Norton, 2007).

The GBU-57 Massive Ordnance Penetrator (MOP), developed in the early 2000s, can penetrate up to 60 meters of earth or 18 meters of reinforced concrete. This has made it a key component in U.S. and Israeli planning for attacking hardened targets like Iran’s underground nuclear facilities (Kristensen & McKinzie, 2012). These weapons remain crucial to deterrence strategies today. Currently, bunker bombs are both important military assets and subjects of international legal debates due to concerns about civilian safety, proportionality, and the risks of escalation in conflicts involving fortified targets.

Bunker-Busting Bombs are designed to damage an enemy’s command structure, nuclear facilities, or underground weapon depots targets that are otherwise resistant to standard bombs (Kristensen & McKinzie, 2012). Their inclusion in national military policies, particularly by the U.S. and Israel, has become essential for strategic deterrence and preemptive actions. For

example, Israel's purchase of GBU-28 bombs is closely linked to its view of the threat from Iran's nuclear program (Binnie, 2016).

Technological improvements have greatly increased the effectiveness of bunker bombs. Modern systems incorporate GPS, laser guidance, and inertial navigation, making them more precise and deadly. The GBU-57 Massive Ordnance Penetrator (MOP) can penetrate up to 60 meters of earth, allowing it to reach facilities like Iran's Fordow nuclear site (Kristensen & McKinzie, 2012). Scholars argue that these tools reflect a shift towards precise strategic warfare, which aims for strategic outcomes with minimal surface damage (Freedman, 2013).

Despite their accuracy, the use of bunker bombs raises issues under International Humanitarian Law (IHL). The principles of distinguishing military from civilian targets and maintaining proportionality are often challenged when these weapons are deployed in urban or crowded areas (Sassòli, 2019). Moreover, secondary effects like underground shockwaves and structural collapses can result in unexpected civilian casualties, as seen in critiques of their use in Afghanistan and Lebanon (Norton, 2007). The existence and potential use of bunker bombs play a significant role in strategic signaling and deterrence. Their actual deployment, or even the mere threat of it, can change diplomatic relations, especially in regions like the Middle East. Scholars such as Schelling (1966) stress that strategic weapons serve military and political purposes, influencing enemy calculations and public opinion without needing actual use.

In conclusion, while there is considerable research on the technological and tactical aspects of bunker bombs, fewer studies look at post-strike evaluations, civilian impacts, or long-term psychological effects on affected populations. Additionally, legal discussions often remain theoretical, lacking detailed analysis of specific instances involving bunker bomb use in current conflicts like those in Syria, Yemen, or Iran.

### **Conceptual Review: Strategic warfare**

Strategic warfare refers to planning and executing large-scale military operations that aim to achieve long-term national security goals by targeting an enemy's critical capabilities. Unlike tactical warfare, which focuses on immediate battlefield victories, strategic warfare tries to shape the overall outcome of a conflict by influencing the opponent's political, economic, and military structures (Gray, 1999). It consists of military actions intended to weaken or destroy an adversary's ability to wage war. These actions include long-range bombing campaigns, cyber warfare, nuclear deterrence, economic sanctions, and information warfare (Freedman, 2013).

Strategic warfare operates at the highest levels of military command, often involving national leadership and grand strategy.

Strategic warfare has several interconnected dimensions: Military Strategy involves using armed forces to achieve broad national objectives, such as deterring aggression or exercising power. Economic Strategy focuses on disrupting the enemy's economic base via blockades, sanctions, or attacks on industrial infrastructure. Psychological Operations work to shape public opinion and morale using propaganda, misinformation, and psychological deterrence. Technological Superiority relies on advanced weapons systems, like precision-guided munitions, cyber tools, and bunker busters, to maintain strategic advantage.

From Clausewitz's classical idea of war as a continuation of politics by other means, strategic warfare has changed significantly in the nuclear age. The Cold War introduced doctrines such as Mutually Assured Destruction (MAD) and deterrence theory, which are still important for understanding modern strategic thinking (Schelling, 1966). In today's context, strategic warfare includes not only conventional and nuclear weapons but also asymmetric methods like cyber-attacks, drone warfare, and precision strikes on critical infrastructure. Examples include U.S. drone operations against terrorist networks, Russia's hybrid warfare in Ukraine, and Israel's preemptive strikes on Iranian military sites.

Strategic warfare raises serious questions under international humanitarian law, particularly regarding proportionality and distinction. Large-scale military strategies that affect civilian populations or infrastructure can violate the Geneva Conventions, making the legal regulation of these methods crucial (Sassòli, 2019). In the modern era, strategic warfare increasingly mixes kinetic and non-kinetic methods. Cyber warfare, economic pressure, and information operations have become effective statecraft tools for achieving strategic goals without full-scale war. Countries like China, the United States, Iran, and Russia use hybrid strategies that combine conventional force with cyber and informational methods to gain strategic advantage (Mazarr, 2015).

Finally, strategic warfare is a dynamic concept that encompasses top-level military planning. It involves not only using force but also integrating political, economic, and technological tools to secure national objectives. As global threats grow more complex and multidimensional, understanding strategic warfare is vital for developing effective defense and foreign policies.

## **Theoretical Perspective**

This study combines Deterrence Theory, the idea of Strategic Ambiguity, and the Nuclear Diplomacy Framework. Together, these theories provide a strong way to analyze the strategic use of bunker bombs in the ongoing triangle between Israel, Iran, and the United States. These theories shed light on how states use military power not just for immediate success but also to influence their opponents' actions, negotiate goals, and manage escalating conflicts.

Deterrence Theory, based in the realist view of international relations, suggests that states can stop unwanted actions by their opponents. They can do this by credibly threatening to impose unacceptable costs in response (Schelling, 1966). For U.S. and Israeli military planning, the development and readiness to use bunker bombs serve as a deterrent against Iran's ongoing uranium enrichment and the possible creation of nuclear weapons. Munitions like the GBU-28 and GBU-57 Massive Ordnance Penetrator (MOP) are meant to target hardened and deeply buried nuclear sites such as Fordow, Natanz, and Esfahan. These sites are critical for Iran's strategic infrastructure (Kristensen & McKinzie, 2012).

Strategic ambiguity closely relates to deterrence. This involves maintaining intentional vagueness about a state's capabilities, limits, or intentions. Israel uses this strategy by neither confirming its nuclear arsenal nor detailing its military capabilities. At the same time, it signals a willingness to act preemptively when necessary (Freedman, 2013). This ambiguity complicates how adversaries plan, increases uncertainty in Tehran, and strengthens Israel's deterrence.

This ambiguity complicates how adversaries plan, increases uncertainty in Tehran, and strengthens Israel's deterrence. Similarly, the U.S. deployment of bunker bombs and its refusal to reveal operational limits for their use add to this unclear environment. Analysts suggest that this uncertainty prevents Iran from confidently expanding its nuclear program, fearing it might provoke a significant response (Binnie, 2016).

The 2015 Joint Comprehensive Plan of Action (JCPOA) is a key example of Nuclear Diplomacy Framework highlights how military power integrates into diplomatic strategies. While the deal focused on verifiable limitations to Iran's nuclear activities, its success was likely backed by the threat of military action, particularly strikes using precise bunker-busting munitions (Sanger, 2015). After the U.S. left the JCPOA in 2018, this strategic logic remained. As Iran resumed uranium enrichment and diplomatic talks stalled, military options regained importance. By 2025, following Israel's preemptive strike on June 13 and the U.S. follow-up strike on June 21, the

implied threat of military action turned into actual strategic behavior. This series of events shows how diplomacy, deterrence, and military force often connect, especially in unstable areas like the Middle East.

These theoretical perspectives clarify the strategic reasons behind the use and threat of bunker bombs in the Israel–Iran conflict. Deterrence Theory explains why these weapons are produced and showcased; Strategic Ambiguity reveals how they are used without being weaponized; and the Nuclear Diplomacy Framework shows how military power can influence negotiation results. Together, these theories guide the study’s exploration of how bunker bomb deployment reflects broader trends of coercion, security signaling, and power projection in conflicts that involve asymmetry and nuclear risks.

### **The History of Bunker-Buster bomb**

The idea behind bunker-busting weapons (munitions) that can defeat hardened or deeply buried targets is nearly as old as modern fortified construction itself. Across the twentieth and twenty-first centuries, advances in metallurgy, aerodynamics, explosives, and guidance gradually transformed the concept from crude, high-mass bombs and artillery shells into precision-guided penetrators capable of reaching tens of metres below the surface. The history of bunker-busters traces technological innovation, tactical necessity, and changing strategy from the Second World War to the present day.

Before the era of precision air-delivered penetrators, militaries sought ways to defeat fortifications with specially designed artillery and heavy shells. During the Second World War, German engineers developed high-sectional-density artillery shells intended to penetrate fortifications, and the Luftwaffe experimented with rocket-assisted, armor-piercing aerial munitions for naval and concrete targets (U.S. Naval History, n.d.). These early efforts established two important points: penetration requires both high kinetic energy and strong casings, and defeating hardened targets often meant designing weapons tailored to specific structural challenges.

The origins of modern bunker bombs date back to World War II. Britain used “Tallboy” and “Grand Slam” bombs to penetrate German fortifications (Spencer, 2003). The most influential conceptual precursors to modern bunker-busters were Barnes Wallis’s British “earthquake” bombs such as the Tallboy (12,000 lb) and the Grand Slam (22,000 lb) deployed late in World War II (1st Line Defence, 2020). Rather than merely striking and blowing a hole through

concrete, Wallis intended these bombs to penetrate the ground near a target and create a subterranean shock (a “camouflet”) that undermined foundations and caused collapse or catastrophic structural failure. These weapons had hardened casings, streamlined shapes to attain very high impact speeds, and were explicitly designed to defeat heavily protected targets such as viaducts, U-boat pens, and fortified industrial facilities. A related British innovation was the “Disney” concrete-piercing/rocket-assisted bomb, built to penetrate thick reinforced concrete roofs such as those on U-boat pens; the Disney used a hardened case and rocket assist to reach supersonic impact velocities and could punch through many feet of concrete when dropped correctly (1st Line Defence, 2020).

However, during the 1991 Gulf War when the U.S. quickly developed the GBU-28 laser-guided bunker buster to target Iraqi command bunkers (Federation of American Scientists, 1998). In the 1991 Persian Gulf War planners identified Iraqi command bunkers that were deeper and more protected than current 2,000–5,000-lb penetrators could reliably defeat. In response, the U.S. rapidly engineered the GBU-28 (a 5,000-lb) class penetrator initially built from surplus 8-inch artillery barrels and fitted with a delayed fuze and guidance package to reach and destroy those underground command facilities. The GBU-28’s improvised genesis turning artillery barrels into bomb casings illustrates how urgent operational needs can accelerate weapons innovation.

Moreover, scholars note that these weapons played a key role in establishing air superiority and showcasing technological dominance as part of broader U.S. military strategies (Cordesman, 2003). Also, attention turned to defeating deeply buried command centers and potential nuclear storage or production sites. Some concepts even proposed nuclear earth-penetrator weapons so-called “robust nuclear earth penetrators” to neutralize extremely deep or hardened facilities (U.S. Naval History, n.d). These proposals sparked intense debate about escalation, environmental contamination, and the legal/ethical consequences of subterranean nuclear detonations, and most such concepts remained constrained by political and arms-control considerations.

Following the Gulf War, research on the use of bunker buster bomb continued on stronger casings, improved fuzing, and better explosive formulations to deliver more destructive internal effects after penetration. The BLU-109 (a hardened 2,000–3,000-lb warhead) and later the BLU-122 and BLU-137 family members represent iterations focused on a balance between penetrative mass and explosive yield for aircraft-delivered precision strikes (Wired, 2008). These

developments emphasized improved steel alloys, warhead geometries, and “hard target fuzes” capable of surviving impact and detonating at the correct subterranean depth.

By the early 2000s, concern about clandestine, deeply buried facilities especially potential nuclear-related sites drove the United States to develop a new class of super-penetrator: the Massive Ordnance Penetrator (GBU-57). Boeing won program contracts in the mid-2000s to build a ~30,000-lb weapon intended to reach tens of metres of overburden under favourable conditions; its development combined lessons from earlier penetrators with modern guidance and high-energy explosive fills (Defence Today, 2025; Channel NewsAsia explainer, 2025). The GBU-57 program reflected a strategic shift: rather than accept that very hard underground capacities were beyond conventional reach, state actors invested in very large conventional ordnance capable of delivering destructive effects at depth.

On the whole, the GBU-57 reportedly saw its first combat use in June 2025 when U.S. bombers struck deeply buried Iranian nuclear-related facilities, a high-profile operation widely covered by international media and military sources (AP News, 2025; Business Insider, 2025). That strike underscored both the technological maturity of bunker-buster design and the political and legal controversies such weapons provoke questions about effectiveness in fully destroying complex underground programs, risks of collateral damage, environmental consequences, and escalation dynamics.

### **Technical Evolution and Performance of Penetrator Munitions**

Bunker-busting bombs are specialized conventional weapons designed to defeat hardened, fortified, or deeply buried military targets, including underground command posts, nuclear facilities, and storage bunkers. Unlike ordinary aerial bombs, these weapons are engineered to survive impact with dense materials, penetrate layers of soil, rock, or reinforced concrete, and detonate at depth to destroy internal structures and equipment (HowStuffWorks, n.d.; U.S. Air Force, n.d.).

The effectiveness of bunker-busting bombs depends on three main design elements: hardened casings, delayed fuzing systems, and powerful explosive charges. The hardened casing allows the munition to maintain its structural integrity on impact with reinforced concrete or rock. Delayed fuzes ensure detonation occurs inside the target rather than on the surface, maximizing internal destruction. Finally, the explosive payload is optimized to generate high overpressure and shock waves within confined underground spaces (HowStuffWorks, n.d.).

Guidance systems such as GPS/INS (Global Positioning System and Inertial Navigation System) allow precise targeting, ensuring the bomb strikes directly above critical points of underground structures. This combination of accuracy and penetrative capacity makes bunker-busters uniquely suited for strategic strikes on facilities deliberately buried to evade conventional attacks (U.S. Air Force, n.d.).

The most advanced bunker-buster currently in service is the GBU-57A/B Massive Ordnance Penetrator (MOP). Developed by the United States, the MOP weighs approximately 30,000 pounds (13,600 kg), measures over 6 meters in length, and carries more than 5,000 pounds of high explosive (Defence Today, 2025). It is designed to penetrate up to 60 meters of earth or 18 meters of reinforced concrete before detonation. Due to its enormous size, only strategic bombers such as the B-2 Spirit can deliver it.

In June 2025, the MOP was reportedly used in combat for the first time, when U.S. B-2 bombers struck Iranian nuclear facilities at Fordow, Natanz, and Isfahan. The bombs were aimed at disabling underground centrifuge halls and ventilation systems. This marked a significant operational milestone, demonstrating the MOP's role as a tool of both military and political signaling (Business Insider, 2025; AP News, 2025).

When successfully deployed, bunker-busters can collapse underground tunnels, sever ventilation shafts, and destroy command centers. They can render nuclear enrichment facilities or storage depots inoperable by damaging sensitive machinery and infrastructure. However, their effectiveness depends on precise intelligence regarding the depth and layout of the target. Even with advanced penetrators, some deeply buried or geologically shielded facilities may survive (Defence Today, 2025; AP News, 2025).

Despite their destructive potential, bunker-busters face limitations. Geological conditions significantly affect penetration: certain rock formations may blunt their effectiveness, and excessive burial depth can render targets survivable. The need for large bombers restricts deployment flexibility. In addition, humanitarian concerns arise, as underground detonations may destabilize civilian infrastructure above or nearby. Environmental risks include soil and groundwater contamination from explosive residues (HowStuffWorks, n.d.).

From a legal and ethical standpoint, the use of bunker-busters must comply with international humanitarian law principles of distinction, proportionality, and necessity. Attacks on deeply buried facilities located near civilian areas pose significant risks of collateral damage, raising

debates about the lawful and proportional use of such powerful munitions (ICRC, 2022).

Bunker-busting bombs represent one of the most specialized tools in modern conventional warfare. Their design hardened casings, delayed fuzing, and precision guidance makes them uniquely capable of neutralizing hardened and deeply buried targets. The GBU-57 Massive Ordnance Penetrator demonstrates the height of current technology in this field, combining massive destructive potential with strategic significance. Yet these weapons are not invincible, and their use carries operational, humanitarian, and legal challenges that must be carefully weighed before deployment. As warfare increasingly shifts underground, bunker-busters will remain both a critical military asset and a subject of ethical debate.

### **Bunker-Buster Bombs: Strategic and Tactical Implications in Modern Warfare**

Bunker-Busting Bombs are munitions engineered to penetrate reinforced concrete, soil, or rock and detonate within protected internal spaces that have emerged as decisive instruments in modern warfare. Their value extends beyond mere destructive capacity, shaping doctrines of deterrence, escalation, and military planning. While they provide capabilities unavailable to typical general-purpose munitions, their utility depends on a constellation of factors: precise intelligence, weapon-to-target fit, delivery platform constraints, and legal considerations.

The development and deployment of these weapons carry profound strategic implications. The very existence of bunker-busters signals to adversaries that underground fortifications do not guarantee invulnerability. This forces states to reconsider the efficacy of investing heavily in subterranean command-and-control facilities or hardened shelters (Cordesman, 2002). However, this capability also raises risks of escalation. The United States' introduction of the GBU-28 during the Gulf War demonstrated a clear intent to strike hardened targets, altering the strategic calculus for opponents.

During Operation Desert Storm in 1991, the U.S. Air Force used the hastily developed GBU-28 to penetrate Iraq's deeply buried command bunkers. Confronted with targets that exceeded the capability of then-fielded guided bombs, U.S. engineers improvised the weapon from available materials. This rapid fielding illustrated how tactical necessity spurs accelerated development. The successful strikes neutralized leadership and communication nodes critical to Iraqi war operations, showcasing how precision-guided bunker busters could achieve decisive effects (Atkinson, 1993; National Research Council, 2005). Tactically, the GBU-28 demonstrated that a tailored penetrator could yield results against key command-and-control nodes, but only when

paired with accurate intelligence on roof thickness, structural layout, and geology. The operation set a precedent: no underground facility was fully secure from aerial bombardment, exerting a psychological as well as a military effect (Lambeth, 1993).

In Operation Enduring Freedom (2001–2002), U.S. forces relied on the GBU-37 and later the Massive Ordnance Penetrator (MOP) to target Taliban and al-Qaeda cave complexes in Tora Bora, Afghanistan. This campaign highlighted a different tactical problem set: natural subterranean geometry and irregular geology. While the strategic goal was to deny safe havens in rugged terrain, the environment exposed the limits of relying on penetrating aerial bombs alone (Biddle, 2004). Caves feature variable overburden and branching galleries, meaning single penetrative explosions often failed to collapse entire networks. Tactically, forces found success only when strikes were carefully sequenced and combined with persistent intelligence, surveillance, and reconnaissance (ISR) and rapid ground exploitation by special operations units. In these irregular terrains, bunker-busters functioned as an enabler of ground action rather than a solitary decisive tool (U.S. Senate, 2009).

The 2003 invasion of Iraq again saw the use of Bunker-Busting Bombs against suspected weapons of mass destruction (WMD) storage sites and hardened command bunkers. Although no WMD stockpiles were discovered, the inclusion of these weapons emphasized their deterrent role, compelling adversaries to disperse or conceal critical assets (Cordesman & Wagner, 2003). This evolution in capability has altered military doctrines, allowing conventional forces to achieve missions that might previously have required nuclear strikes. However, this blurs the line between conventional and nuclear deterrence, as seen in early 2000s debates over the Robust Nuclear Earth Penetrator (RNEP), raising the risk of miscalculation (Sokolski, 2005).

One of the most geopolitically sensitive applications of this technology centers on Iran's nuclear facilities at Fordow and Natanz. These deeply buried sites have been cited as requiring advanced penetrators like the GBU-57A/B Massive Ordnance Penetrator (MOP). The MOP represents the modern apex of conventional deep-strike capability, designed to be carried by strategic platforms like the B-2 bomber. Media and official reporting in June 2025 indicated that multiple MOPs were employed against Iranian nuclear sites—the first combat use of the weapon—illustrating both operational reach and tactical complexity (AP News, 2025; Business Insider, 2025). The strategic implication is profound: bunker-busters form part of coercive diplomacy by signaling credible military options against otherwise "immune" facilities (Katzman, 2010). Tactically,

however, the MOP concentrates risk; mission success relies on extremely accurate geotechnical intelligence, and battle damage assessment for subterranean strikes remains inherently uncertain (DOT&E, 2012).

While effective, the deployment of bunker-busters carries humanitarian and political consequences. Strikes on fortified sites often occur in urban areas, raising risks of collateral damage, as seen in the controversial 1991 Amiriyah shelter bombing in Baghdad where hundreds of civilians were killed (Human Rights Watch, 1991). Such incidents complicate legitimacy, as adversaries can exploit civilian casualties for propaganda. Consequently, legal and collateral constraints materially limit tactical freedom, imposing restrictive rules of engagement (ICRC, 2022).

Across these conflicts, several tactical implications are clear. First, intelligence mostly geotechnical and structural intelligence is decisive; success is far more sensitive to accurate knowledge of overburden and internal layout than to sheer explosive mass (National Research Council, 2005). Second, platform-weapon fit shapes options: smaller penetrators provide distribution and tempo, while very large weapons like the MOP require strategic platforms and concentrate both capability and risk. Third, combined-arms integration is essential; penetrators create tactical opportunities that must be exploited by ground forces or follow-on strikes to convert transient structural damage into sustained denial (Biddle, 2004).

In conclusion, Bunker-Busting Bombs have reshaped the strategic landscape of modern warfare. By rendering underground fortifications vulnerable, they undermine traditional deterrence assumptions and enable states to contemplate strikes against deeply buried assets. However, they are not a panacea. Their tactical utility emerges most clearly when weapons, platforms, and intelligence are matched to the target and embedded within broader operational designs. Moving forward, their continued development highlights the delicate balance between military effectiveness, deterrence credibility, and the ethical challenges of modern warfare.

### **The Deployment of Bunker Bombs in the United States, Israel–Iran War**

The proliferation of Hard and Deeply Buried Targets (HDBTs) has fundamentally altered the strategic calculus of modern warfare, particularly within the volatile context of the United States and Israel's military posturing regarding Iran. As Iran's nuclear program and regional proxy networks have retreated underground, the reliance on "bunker busters" which is a massive ordnance penetrator like the GBU-57 Massive Ordnance Penetrator (MOP), GBU-72 and the

GBU-28 has become a cornerstone of operational planning. The deployment of these munitions in the context of United State, Israel-Iran war represents a convergence of advanced military engineering and contentious legal frameworks. While bunker bombs offer undeniable operational benefits by neutralizing assets that conventional munitions cannot destroy, their utilization triggers complex debates regarding International Humanitarian Law (IHL), specifically the principles of distinction and proportionality, and risks exacerbating regional instability.

The operational logic driving the deployment of bunker bombs is rooted in the necessity to disable high-value targets that are shielded by vast amounts of earth and reinforced concrete. For both the United States and Israel, the primary strategic objective in a potential conflict with Iran is the degradation of the Iranian nuclear infrastructure, such as the Natanz and Fordow enrichment facilities, which are buried deep beneath mountains to withstand conventional airstrikes (Cordesman, 2021). The GBU-57, carried by U.S. B-2 bombers, and the GBU-28, utilized by Israeli F-15Is, are engineered to penetrate these defenses before detonating, utilizing a delayed fuse to ensure the explosion occurs within the protected space. This capability provides a distinct tactical advantage: it allows belligerents to target an adversary's strategic "center of gravity" without the necessity of a ground invasion, thereby aiming for a rapid, air-centric resolution to the conflict (Levy, 2020). The logic is purely counter-force, designed to eliminate military capability while minimizing the exposure of friendly forces.

However, the intersection of this military strategy with International Humanitarian Law creates a landscape fraught with legal and ethical peril. The principle of distinction, which requires combatants to distinguish between military objectives and civilian objects, is complicated by the nature of HDBTs. Often, these facilities are dual-use or located near civilian populations to deter strikes. While the weapon itself is not indiscriminate, the intelligence guiding it must be flawless; a targeting error regarding the function of a bunker could result in a strike on a civilian shelter, constituting a grave breach of the Geneva Conventions (ICRC, 2019).

More contentious is the principle of proportionality, which prohibits attacks expected to cause incidental loss of civilian life "which would be excessive in relation to the concrete and direct military advantage anticipated" (Article 51(5)(b) of Additional Protocol I). The use of bunker bombs against deeply buried targets often requires massive yields to ensure destruction. Even with precision guidance, the kinetic energy released by a 30,000-pound bomb can cause significant seismic shock, potentially collapsing civilian infrastructure located in close proximity

to the target. Furthermore, striking a nuclear facility poses the risk of radiological dispersion. Legal scholars argue that the "military advantage" of setting back a nuclear program by a few years must be weighed against the potential for massive civilian casualties and long-term environmental damage, a calculation that often renders the legal justification for such strikes precarious (Dill, 2020).

The broader geopolitical effects of deploying bunker bombs in United State-Israel and Iran war extend far beyond the immediate battlefield. The utilization of such heavy ordnance signifies a commitment to total degradation of the enemy's strategic assets, which may compel Iran to escalate asymmetrically. Rather than capitulating, Iran might respond by targeting U.S. bases in the region or launching ballistic missiles at Israeli cities, thereby widening the conflict (Byman, 2022). Moreover, the perceived normalization of using high-yield penetrators against sovereign states could trigger a regional arms race, where neighboring states seek similar deterrent capabilities or deeper fortification of their own strategic assets. This dynamic destabilizes the security architecture of the Middle East, eroding norms regarding the use of force and potentially lowering the threshold for nuclear proliferation as states seek the ultimate deterrent against deep-strike capabilities.

In conclusion, the deployment of bunker bombs by the United States and Israel in the war with Iran illustrates the persistent tension between technological efficacy and legal/ethical constraints. It is argued here that while these munitions are operationally unmatched in their ability to threaten HDBTs, their use is fraught with legal ambiguity regarding distinction and proportionality. The risk of disproportionate collateral damage, particularly when striking nuclear or dual-use facilities, presents a significant moral hurdle. Geopolitically, the use of these weapons is likely to act as a catalyst for escalation rather than a resolution, deepening the security dilemma in the region. Therefore, military strategies relying on bunker bombs must be rigorously scrutinized not only for their tactical effectiveness but also for their potential to violate international law and destabilize the already fragile Middle East.

## **Conclusion**

Bunker-busting bombs remain an indispensable tool in modern military arsenals, offering commanders the means to neutralize hardened and deeply buried targets that would otherwise be immune to conventional strikes. The case studies of the GBU-28 in Iraq, the Afghanistan cave campaigns, and the GBU-57 Massive Ordnance Penetrator illustrate both the potential and the

constraints of these weapons. Tactically, they demonstrate that while penetrator bombs can deliver decisive effects against fortified positions, their success depends heavily on accurate intelligence, appropriate delivery platforms, and integration with ground or follow-on operations. Furthermore, their deployment raises complex challenges relating to collateral damage, legal proportionality, and strategic escalation. Finally, bunker-busting bombs are not silver bullets; rather, they are niche but powerful instruments that, when employed within a coordinated operational framework, can yield significant battlefield advantages against adversaries relying on subterranean protection.

### Recommendations

- a. Military planners should invest in improved geotechnical and structural intelligence to maximize the effectiveness of bunker-busting operations.
- b. Forces should integrate bunker-busting strikes with ground exploitation and ISR assets to convert damage into lasting tactical gains.
- c. Air forces should diversify delivery platforms to reduce operational risk concentration in a few high-value assets.
- d. Commanders should weigh legal and humanitarian considerations carefully, ensuring compliance with international law when using penetrators near civilian areas.
- e. Defense establishments should balance procurement between large, specialized penetrators and smaller, flexible variants to adapt to varied tactical contexts.

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