

Precision:

In this artist's conception, a B-2 drops a load of Joint Direct Attack Munitions. The JDAM is now the gold standard of guided weapons—widely available and offering near-precision accuracy. In September, the B-2 demonstrated its ability to release 80 independently targeted 500-pound JDAMS.

Smaller, highly accurate, designer weapons will increase the lethality of USAF aircraft.

The Next Generation

By John A. Tirpak, Executive Editor

IN THE rapid US victories in Afghanistan and Iraq, precision weapons were a major factor—both operationally and psychologically.

Operationally, the accuracy of new satellite guided munitions expanded the effectiveness of each strike aircraft and dramatically accelerated the pace of the ground advance. Psychologically, guided munitions demolished the enemy's confidence, replacing it with the certain knowledge that American bombs would find their targets even at night, in bad weather, or through smoke or blowing sand.

Now, the Air Force is about to usher in a new generation of precision weapons that will even further expand its power. Smaller, more accurate bombs with tailorable explosive effects will nearly quadruple the number of targets that a single aircraft can destroy in one mission. Stealthy, longer-ranged weapons will extend USAF's reach through rings of heavy anti-aircraft defenses, making it possible to strike high-value targets without undue risk to aircraft.

USAF expects this new generation of weaponry—coupled with advances in networking of sensors and instantaneous distribution of information to the warfighter—to carry it through the next two decades.

In the world of guided weapons, today's gold standard is the Joint Direct Attack Munition. The JDAM, which is guided by signals from Global Positioning System satellites, was a direct outgrowth of Gulf War I. In 1991, when a target area was obscured by smoke or bad weather, pilots often would abandon laser guided bomb attacks, returning to base with their ordnance. Before that brief war ended, USAF leaders decided the service must develop a precision or near-precision weapon that would work in any weather.

Instant Star

JDAM was ready for Operation Allied Force, the 1999 Balkans conflict. However, quantities were limited, and, at that time, it could only be used on the B-2 stealth bomber. The JDAM became an instant star and was so highly sought by strike planners that USAF quickly ran through its available stock.

By 2001, JDAM was certified on practically all combat aircraft in the fleet and was available in 1,000-pound and 2,000-pound versions. It was used extensively in Operation Enduring Freedom in Afghanistan and in Operation Iraqi Freedom in Iraq, where it took away most of the enemy's traditional defenses—weather, darkness, and camouflage.



Laser guided bombs still edged out JDAMs as the most-used guided weapons in Gulf War II and are as yet unmatched for accuracy. This is a GBU-28 “bunker buster” LGB being released from an F-15E.

Moreover, it was able to take advantage of information from airborne sensors, satellites, and special operations forces on the ground.

“The rapid collapse [of the Taliban and al Qaeda] across Afghanistan ... was a direct result of being able to tie incredibly precise applications of airpower to incredibly brave people on the ground, with the capabilities to bring JDAM and [laser guided] weapons to bear on a very mobile and elusive opponent,” said Gen. T. Michael Moseley, who commanded coalition air forces in both conflicts.

In Afghanistan, JDAM greatly impressed the Northern Alliance fighters, part of the anti-Taliban coalition. Gen. Charles F. Wald, who was the air boss when operations got under way in Afghanistan, said that the Afghan allies were amazed that US special operations forces could call in air strikes on advancing Taliban units and get precise results in hours or even minutes.

“The idea of bombs coming from way up in nowhere, ... at night, through the weather, is all of a sudden a psychological tool,” said Wald, who is now vice commander of US European Command.

In Iraq, the JDAM effect was even more pronounced. Moseley said that, by using JDAM and other guided weapons, planners could designate air strikes against urban targets that otherwise would have been off-limits for fear of collateral damage. The ability to dismantle the Iraqi regime

building by building had a powerful effect on the enemy, he said.

Throughout the theater, said Moseley, JDAMs and other guided weapons were “the primary preferred munitions.”

The reason was clear. JDAM routinely exceeded its established parameters. Requirements call for the munition to hit within 43 feet of a target. Brig. Gen. Stephen M. Goldfein, USAF director of operational capability requirements, was circumspect in his praise. He said the munition was “a little bit better” than expected.

Moseley put it in more concrete terms: “The average miss distance on the JDAM has been about the length of the bomb.” (JDAM is 10 to 12 feet long, depending on the variant.)

To be considered a “precision” weapon, a munition must be capable of hitting within 9.9 feet of the aim point. If it hits outside that circle, but closer than 66 feet, it is called a “near-precision” weapon. (Based on its specified circular error probable of 42.9 feet, that puts JDAM in the near-precision class, despite its performance in combat.)

During OIF, coalition forces released 29,199 bombs and missiles against Iraqi targets. About 68 percent of those munitions were guided. Of the overall total, 22.4 percent were JDAMs, and 29.5 percent were laser guided bombs. The next most-used munition was the unguided 500-pound Mk 82 general-purpose bomb.

In what has been described as a turning point in the war, the Iraqis found that there is no safety in a sandstorm. Late in March, coalition aircraft, cued by E-8C Joint STARS radar airplanes, were able to attack Iraqi forces either hunkered down or marching through a sandstorm in the belief that it was concealing them. They were wrong. While coalition ground forces slowed to a crawl, air attacks with JDAM systematically destroyed the Iraqi Republican Guard right through the storm.

A prime concern for the Air Force,



Armed with lasers and handheld GPS units, Air Force controllers are able to call in close air support strikes from 40,000 feet and hit targets that are mere feet away from their own positions with ground forces.

as it developed its new weaponry, has been weapons that could limit any collateral damage.

Enemies know that they cannot “take us on” conventionally—because that’s “commonly not in their ballpark,” said Goldfein. “So the thing they want to do is make things very difficult for us, by putting targets in difficult places.” Those places may be near schools, religious sites, or civilian neighborhoods, all of which offer a high risk of collateral damage.

Going Smaller

The solution is to use smaller weapons with less explosive effect, Goldfein said. The weapons might have delayed fuzes causing them to explode underground, thus limiting damage, or they might have no warhead at all but derive a destructive effect just from being dropped from high altitude.

The latter tactic was used on occasion in OIF. So-called “concrete” bombs—inert training shapes fitted with real guidance kits—were dropped into areas where even a small explosion could have done too much damage to civilian structures nearby. The force of the bomb’s physical impact was sufficient in those cases to achieve the desired effect.

With a smaller munition—but one “very precise and very focused”—the question is whether you can achieve the same effect as with “a larger boom,” said Goldfein.

The Air Force believes the answer is yes. In late August, the service selected Boeing as the developer of the Small Diameter Bomb, which likely will be one of the primary weapons for US airpower for the next 20 years.

Initially, Boeing will produce about 24,000 SDBs and 2,000 “smart racks” to carry them. Officials expect those numbers to go quite a bit higher. (The initial production run for JDAM was 88,000 units, but the new production target—amended several times in the last two years—is now more than 230,000.) The SDB is a 250-pound-class weapon. Four of them will hang from a smart rack fitted in place of a combat aircraft’s pylon that normally would house a single 1,000- or 2,000-pound bomb. (Some aircraft will also carry them internally.)

The SDB will be a highly flexible munition because it can handle a range of dissimilar targets, accord-

ing Dan Jaspering, SDB program manager at Boeing.

The company had to test the munition against 14 representative targets, Jaspering said. The toughest test called for the SDB to penetrate three feet of steel-reinforced concrete, while the easiest demonstrated a blast/fragmentation effect against a softer target, such as rocket launchers and artillery.

The bomb will have wings that, after release from the aircraft, pop out to provide a standoff range of up to 46 miles when dropped from altitude. It will be guided by an advanced, antijam GPS-aided inertial navigation system. It can further refine its GPS satellite location information by getting data from ground-based differential GPS units around the world—giving the bomb an accuracy of within 13.2 feet.

Jaspering said that all the stores management functions will be done on the SDB’s rack itself, which has its own avionics system and four pneumatic weapon ejectors. Both features simplify aircraft integration, enabling it to work easily with various platforms.

The F-15E, in 2006, will be the first aircraft to receive SDB. Eventually, nearly all combat aircraft in the USAF inventory will be certified for the weapon.

Before the SDB, though, USAF will field another small, guided weapon—a JDAM-equipped 500-pound bomb.

In Gulf War II, the B-2 flew mis-

sions in which it dropped 80 Mk 82 500-pound bombs against clustered Iraqi forces. Those bombs were unguided. In September, USAF tested a B-2 dropping 80 of the 500-pound JDAM bombs. It worked. Gen. John P. Jumper, Air Force Chief of Staff, said of the test: “Each of these bombs guided to individual targets. Not one bomb was more than 10 feet away from its target.” The service plans soon to certify the capability for B-2 combat operations. The stealthy bomber will be able to strike—with near precision—80 different targets on a single sortie.

The JDAM is also getting more accurate, according to Boeing’s JDAM program manager, Rick Heerdt.

Heerdt said that USAF has funded a program to give all JDAMs selective availability antispoof modules and antijam electronics—capabilities that will make it harder to jam a JDAM trying to obtain position information from GPS satellites. JDAM also will be able to take advantage of the differential GPS system that SDB will use, he added.

“JDAM will be as accurate as Small Diameter Bomb,” Heerdt asserted.

Goldfein said the service accelerated the 500-pound JDAM buy, and, as a result of that, USAF will buy “a little less” of the 2,000-pound version. “And, obviously, as SDB comes on, you’ll see additional adjustments” to the number purchased.

Another major advancement in

Continued on p. 50



Boeing photo

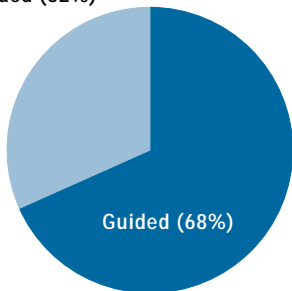
Small Diameter Bombs (red) likely will become the most ubiquitous ground attack weapons in the arsenal. Shown here in an F/A-22, the SDB will quadruple the number of targets each aircraft can hit on a single sortie.



Extending the reach of bombers and fighters alike, the stealthy Joint Air-to-Surface Standoff Missile is already available on the B-52. It will go after heavily defended targets deep in enemy territory. (An F-16 flies chase during a test.)

Iraq—Munitions Expended

Unguided (32%)



Guided	19,948
Unguided	9,251
Total	29,199

precision attack—the Joint Air-to-Surface Standoff Missile—began operational service on the B-52 bomber in September.

Long-Range Penetrator

The objective for JASSM—a stealthy, long-range missile—is to penetrate highly defended airspace and hit fixed or moving high-value targets. It is meant to be fired well outside enemy air defenses. A decision to go into full-rate production of JASSM was expected soon.

JASSM can autonomously fly an evasive route to a target more than 230 miles away. It has a 1,000-pound penetrating and blast/fragmentation warhead and uses both GPS/INS and

an imaging infrared seeker for terminal guidance.

Like JDAM and SDB, JASSM's accuracy will be improved by GPS enhancements. It also has a unique feature that the Air Force may incorporate in its other high-value munitions, said Randall K. Bigum, Lockheed Martin vice president for strike weapons.

Just before impact, JASSM will feed an image of the target back to its launch aircraft, said Bigum. This will help war planners with the always-vexing problem of bomb damage assessment. If JASSM calls in and shows that it's about to hit the target, "it's a pretty good bet" that target will be destroyed, he said.

With many other cruise missiles, there's no feedback after the weapon has left the launch area, so the Air Force has to wait for poststrike reconnaissance to find out if the target was destroyed. The call-back feature will speed up the decision about whether the target has to be struck again.

Lockheed Martin also is developing an extended-range version called JASSM-ER. It will have "two to three times greater range," Bigum said. Lockheed expects to add fuel capacity without changing the outer shape of the missile, simply by changing the packaging and the engine—neither of which will slow certification of the weapon. JASSM-ER should enter production in four years, with deliveries the year after that.

USAF expects JASSM-ER to replace the Conventional Air Launched Cruise Missile, supplies of which are dwindling with each new operation. CALCMs were converted from the nuclear version AGM-86B ALCM, and, officials said, USAF has reached the end of its stock of ALCMs available for conversion.

Two other new munitions—the Joint Standoff Weapon and the Wind-Corrected Munitions Dispenser—were also used successfully in Gulf War II.

The Navy is the lead service on JSOW, an unpowered, stealthy glide vehicle that dispenses submunitions. In 1999, shortly after the Navy declared it operational, the GPS/INS-guided weapon was used by aircraft patrolling the southern Iraq no-fly zone to strike Iraqi air defenses. It was also used for Operation Allied Force in the Balkans. JSOW is already in full-rate production.

The Air Force plans to develop an advanced version of the Wind-Corrected Munitions Dispenser. The WCMD, first used in Afghanistan, is a tail kit attached to existing munitions, such as the sensor fuzed weapons, to make them steerable via INS. It also adjusts for windage on its way down. The Air Force plans to develop an extended-range WCMD by installing a wing set and GPS.

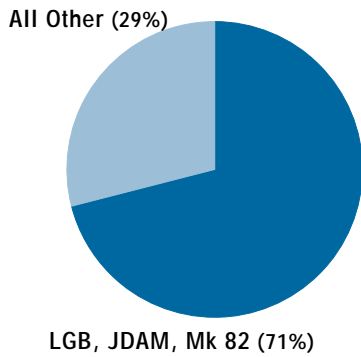
Small and Powered

Lockheed Martin independently developed the Low Cost Autonomous Attack System submunition, a small, powered missile—about three feet—that carries a laser-radar seeker in its nose. Bigum said that LOCAAS can fly "for about 45 minutes," loitering over and scanning the target area. If it sees something that matches the target it's been programmed to find, it attacks and, like JASSM, relays a message to its launch aircraft that it is doing so.

Should it not find the target, or if the attack is aborted, Bigum said, the weapon will fly high and destroy itself, rather than cause unintended destruction on the ground. At its self-destruct altitude, the blast dispersion from the small missile is so great there would be no risk to those below.

The Air Force now has funded LOCAAS as a research project that it has dubbed the Autonomous Wide-Area Search Munition. Initially, the service expected to put three AWASMs

Iraq—Most Popular Munitions



Iraq—Munitions Use By Type

LGB	8,618	29.51%
GPS-JDAM	6,542	22.40%
Mk 82	5,504	18.85%
Mk 83	1,692	5.79%
M117	1,625	5.57%
Maverick	918	3.14%
GPS-WCMD	908	3.11%
TLAM	802	2.75%
Allied guided	679	2.33%
Hellfire	562	1.92%
HARM	408	1.40%
JSOW	253	0.87%
CBU-99	182	0.62%
CALCM	153	0.52%
Allied unguided	124	0.42%
CBU-87	118	0.40%
GPS-LGB	98	0.34%
Other guided	7	0.025%
Mk 84	6	0.021%
Total	29,199	

How Many PGMs USAF Plans To Buy

System	Number
JASSM	2,853
JASSM-ER	1,426
JDAM	240,882
JSOW	3,000
SDB	24,000
WCMD	24,644
WCMD-ER	7,500

in one dispenser, but that plan may change since tests of the weapon have shown such high reliability. “You probably only need one per target,” Bigum said. (The AWASM project has led the Air Force to consider adding a terminal seeker to the SDB, giving it the capability to search the target area for a moving object.)

Although there is no formal requirement for a weapon like LOCAAS yet, Goldfein said, “I think that the ability to get into a very difficult, anti-access area, to loiter and then have the sort of guidance where you can find and geo-locate targets is clearly ... attractive.”

It is so attractive that USAF has given Boeing a three-year contract to work on a similar idea—a 1,000-mile-range cruise missile that could fit in the space of a 1,000-pound JDAM. Once over its target area, the missile would drop to low altitude and begin a search of up to 15 minutes to find its moving or relocatable target. It would carry three submunitions.

Goldfein believes USAF will find itself “with weaponry that has that sort of ability.” One reason, he said, is that the “art of the possible helps drive your concept of operations.” He said another reason is one of the “likely lessons” from the global war on terror: USAF needs to be able to strike moving targets with the same sort of precision it employs against fixed targets. In many circumstances, “the ability to get at that fleeting,

moving target is going to be critical,” said Goldfein.

Asked if weapons today—particularly through the employment of GPS guidance—are as accurate as they need to be, Goldfein hedged. On the one hand, he said, it would be “extremely wise” for the Air Force to take advantage of miniaturized technologies which could, in a few years, put multiple types of seekers on virtually all munitions, adding to their capability and flexibility.

On the other hand, there is a point in time when capabilities are “exceeding your real need,” he said. “Clearly, we need to balance the available dollars and make sure we don’t waste any.”

Goldfein also pointed out that the Air Force plans to ensure it is not exclusively dependent on GPS to preclude being shut down if a GPS jamming threat succeeds. The service must start thinking about operating without GPS “just in case,” he said. “You wouldn’t want that to be such a long pole in our tent that you couldn’t act if there was some issue with GPS.”

Now that most of the munitions niches have been filled, Goldfein said, the Air Force will shift emphasis toward obtaining fine-grained, real-time battlefield knowledge to provide the new munitions with targeting information. Without real-time information, he said, no matter how good the weapon is, “it’s a waste.” ■



Smaller, smarter, and able to loiter—that’s the future of PGMs. Lockheed Martin’s tiny LOCAAS attacks in swarms and ignores targets other than its own. If it can’t strike its designated target, it destroys itself in air, avoiding collateral damage.

Lockheed Martin photo