Encyclopedia of Military Science

Bombs, Nuclear.

The first nuclear weapons were gravity bombs dropped from heavy bomber aircraft. Aerial bombs have continued to have a role in nuclear arsenals even after ballistic missiles were developed and assumed a more primary role in worldwide arsenals. In the sense used here, nuclear bombs are nuclear weapons delivered by means of gravity bombs from aircraft, and are differentiated from nuclear missiles or other delivery mechanisms.

US Cold War nuclear bombs and bombers

The initial fission bombs developed by the United States during World War II were exceptionally unwieldy one-off devices. The state of the art for nuclear weapons design was fairly primitive, and the final configurations of their nuclear components were not fully determined until only weeks before their actual combat use. The “Little Boy” design bomb used on Hiroshima combined two sub-critical amounts of highly enriched uranium in a “gun-type” arrangement that fired one mass of uranium into the other. The “Fat Man” design bomb dropped on Nagasaki used an elaborate array of chemical explosives to symmetrically compress a sphere of plutonium to high densities, setting off a chain reaction. Both weapons were extremely large and heavy even by World War II standards, and required the use of specially modified B-29s to accommodate their large sizes. For maximum destructive power, both weapons were detonated around 550 m above their targets. The "Little Boy" weapon had a yield equivalent to around 15 thousand tons (kilotons) of TNT, and the "Fat Man" had yield of 18-20 kilotons.

In the years immediately after World War II, the American military services struggled to incorporate the atomic bomb into its battle plans. The Strategic Air Command was created in March 1946 for conducting long-range airborne bombing operations. But for the first years of the bomb's existence, the American ability to use the bomb effectively was small. As late as 1948, jurisdiction for assembling and using the bombs was spread out amongst multiple bureaucratic agencies, the number of B-29s and crews that could use atomic bombs were small, and the total stockpile size was small. Military planners were themselves generally unaware of stockpile sizes and assumed that the number of bombs would be low and their availability would be limited.

In the spring of 1948, new bomb designs tested as part of Operation Sandstone, in the Bikini Atoll, dramatically changed America's atomic capabilities. These new developments allowed for greater yield from existing fissionable material (double the explosive power of the bombs used during World War II), and therefore the use of substantially less fissionable material (increasing the total stockpile size). They also allowed the development of mass-produced bombs that required less substantial technical expertise to use or assemble than the World War II models. Newer, lighter bombs were also possible, which allowed for the possibility of their use on a more varied set of bombers. Additionally, in the wake of the detection of the first Soviet atomic bomb in 1949, and the beginning of the Korean War in 1950, U.S. production of plutonium and

uranium was dramatically increased, and the bureaucratic mechanisms for deploying the bomb were considerably eased. The development of thermonuclear weapons in the early 1950s produced bomb designs of unprecedented size, weight, and yield, while at the same time increased miniaturization of weapons design allowed for bombs to be carried by fighter aircraft in a variety of different combat scenarios.

Technically, the bomb designs developed by the US during the Cold War were extremely varied. They ranged from immensely heavy strategic bombs like the Mk-41 bomb, which weighed some 4,800 kg and had a predicted yield of 25 million tons of TNT (megatons) to smaller, tactical weapons like the Mk-57, which weighed around 225 kg and had an adjustable yield from 5 to 20 kilotons. Many American warhead designs were created to be paired with specific delivery systems: the W-7 warhead, for example, was used for air-to-surface missiles, surface-to-surface missiles, surface-to-air missiles, and the Betty Mk-90 anti-submarine depth bomb. Individual bomb designs could have many variants, including modified aerodynamic properties and modified yields, for use in a variety of tactical or strategic situations.

American bomber strategy was initially hampered by lack of bombers and lack of bombs. By 1952, however, the Strategic Air Command was capable of providing nuclear strikes at a moment's notice. This was accomplished both by the development of new, long-range and re-fuelable strategic bombers—the B-36, the B-47, and finally the B-52—and by the aforementioned increase in stockpile size. Bombers remained the backbone of the US deterrent until the 1960s. Emphasis on the development of long-range missiles capable of delivering nuclear weapons did not begin in full until after the Soviet launch of Sputnik in 1957. The shift towards missiles was due in part to a perceived need for parity with the USSR, but also as a means to counteract the possibility of anti-bomber defenses and the threat that bombers might be destroyed before takeoff. The development of a continuous airborne alert strategy in 1959, under which a number of bombers would at all times be deployed in the air, supported by refueling planes, and ready to attack whenever the order was given, further guarded against the concern that bombers might be destroyed on the ground.

US bomber deployment peaked in 1958 with over 1,600 planes. The decline in strategic bombers was directly related to the deployment of ICBMs and SLBMs, which were deployed by the hundreds beginning in the early and mid-1960s. The USSR, by contrast, deployed around 160 strategic bombers annually throughout the entire Cold War period, only beginning to deploy ICBMs in great numbers in the mid-1960s, reaching a peak of 1,500 by the early 1970s.

From 1945 through 1998, the United States developed twelve different models of nuclear-capable bombers, and a total of 4,680 individual planes were purchased. In the United States, advanced bomb technology has been extraordinarily expensive. The B-2A Spirit cost nearly $2.6 billion per plane, whereas the B-1B Lancer cost around $300 million per plane. By comparison, the Minuteman III had an average unit cost of only $37 million, and the LGM-118 Peacekeeper missile average cost is $189 million. It is

worth noting, however, that bombers can and have been used in conventional (non-nuclear) operations as well.

Soviet Cold War nuclear bombs and bombers

The USSR detonated its first implosion weapon in August 1949, and began serial production of weapons based on this design (RDS-1) immediately afterwards, though they continued to have a small stockpile through the early 1950s. Further Soviet testing in 1951 and 1953 facilitated the production of more advanced designs (the RDS-2, an improved implosion bomb, and the RDS-6, a sub-megaton range thermonuclear device, in particular). In 1955, the USSR detonated its first two-stage thermonuclear design (RDS-37). In many respects, warhead development in the USSR appears to have followed a similar progression to than of the United States.

Development in the USSR followed a different path, however, owing to technological, geographical, and bureaucratic factors. Unlike the United States, which had use of bases in Europe and Asia and had developed long-range strategic bombing as part of the US campaigns in World War II, the USSR had no forward bases that would allow it to strike the mainland United States easily with World War II-era bomber technology. During World War II, Soviet air forces had been subordinate to Soviet ground forces as a rule, and existed primarily to repel enemy air attacks; the USSR did not develop strategic bombing to any considerable degree during the war years.

In the postwar period, the Soviet military put intense emphasis on developing intercontinental platforms for the delivery of strategic weapons to North America. After their first nuclear test in 1949, Soviet design bureaus were charged with developing bombers with a range of 12,000 km, and worked to use aerial refueling to extend the range of existing bombers. By 1956, the 3M (Bison) and Tu-95 (Bear) bombers had entered into service, the former with a range of 11,850 km and a 5,000 kg payload, the latter with a range of range of 13,200 km and a payload of 9,000 kg. In practice, the bombers had considerably shorter ranges with full payloads.

By 1957, however, developments in Soviet rocketry had convinced Soviet leadership that intercontinental ballistic missiles (ICBMs) and submarine-launched ballistic missiles (SLBMs) were more promising means for the Soviet Union to project a strategic force. In 1959, the Strategic Rocket Forces was made a separate division of the Soviet armed forces. Missiles became the primary focus of the Soviet long-range strategic forces and brought work on new intercontinental bombers to a near halt. (Work continued to develop improved bombers for the European theatre, however.) Existing bombers were modified and augmented to be used as platforms for air-launched cruise missiles (ALCM). Bomber development began again in the 1970s, producing a number of new, modern bombers by the mid-to-late 1980s, and culminating in the deployment of the Tu-160 (Blackjack).

The breakup of the Soviet Union in 1991 left a number of bombers in post-Soviet republics. Kazahkstan agreed to move its former Soviet bombers to Russia; Ukraine, however, claimed 44 planes as its own. Further negotiations, however, resulted in the

transfer of about a quarter of that number to Russia in 1999. Russia stopped producing new bombers at the end of the Cold War. As of 2001, it still maintained 80 strategic bombers manufactured in the late 1980s (65 Tu-95MS, 15 Tu-160). These were capable of carrying 900 cruise missiles.

Modern weapons systems

The United Kingdom and France both initially deployed strategic aircraft for their nuclear forces, a feat made easier by their comparative proximity to the Soviet Union. The UK has since converted into a wholly missile-based arsenal, launching from submarine platforms. France has the majority of its forces in submarine-based missiles, as well as in cruise missiles on Mirage 2000 aircraft. China's primary strategic bombing capability lies in its Hong-6 bombers, an antiquated strike force based on the Soviet Tu-16 (Badger). The majority of Chinese nuclear weapons are apparently ballistic missiles. The capabilities of Israel, Pakistan, and India are unknown, but these states are believed to have the technical means to use bombers to cover the distances to their potential enemies.

As of this writing, the US nuclear arsenal contains only two air-dropped nuclear bombs, the B-61 and the B-83. The B-61 is a family of bomb designs that allows for both tactical and strategic use. According to some sources, the warheads have variable yield from the sub-kiloton range up to, in some modifications, around 340 kilotons. The B-61 is deployable on many different US military aircraft, including the US long-range strategic bombers, the B-1B Lancer, the B-2A Spirit, and the B-52. The B-61 Mod 11 is mentioned as a probable candidate for a "bunker-busting" nuclear bomb, meant to allow for the destruction of underground facilities. The B-83 is a strategic bomb with a maximum yield of 1.2 megatons. The missile systems make up the vast preponderance of the US nuclear stockpile. The exact composition of Russian nuclear forces is not entirely known, but Russia seems to rely more heavily on air-launched cruise missiles for its long-range strategic aircraft. Other nuclear powers appear to rely much more heavily on land- and submarine-based delivery platforms in the post-Cold War era.

The clear advantage of bomb delivery for an aspiring or new nuclear power is that existing, conventional bombing systems can be made to deliver nuclear weapons short-to-moderate distances without imposing radically new technical requirements. Conventional missile systems, by contrast, require much more work in order to support the high weights of early generation nuclear weapons. The disadvantage of using bombs and bombers is the problem of range—most countries lack long-range strategic bombing capability, and it is not a trivial technology to develop—and the fact that bombers are more vulnerable to detection and interception than missiles. Bombers are also thought to be more vulnerable to a debilitating first-strike attack than missiles based on continuously mobile or hardened platforms.

Alex Wellerstein

References

Borgiasz, William S. *The Strategic Air Command: Evolution and Consolidation of Nuclear Forces, 1945-1955*. Westport, CT: Praeger, 1996.

Hansen, Chuck. *The Swords of Armageddon: U.S. Nuclear Development Since 1945*. Sunnyvale, CA: Chukelea Publications, 1995.

Norris, Robert S., and Thomas B. Cochran, "U.S.-U.S.S.R./Russian Strategic Offensive Nuclear Forces, 1946-1996," Nuclear Weapons Databook Working Paper 97-1 (Washington, D.C.: Natural Resources Defense Council, January 1997).

Podvig, Pavel, ed. *Russian Strategic Nuclear Forces.* Cambridge, MA: MIT Press, 2001.

Schwartz, Stephen I., ed. *Atomic Audit: The Costs and Consequences of U.S. Nuclear Weapons Since 1940.* Washington, D.C.: Brookings Institute Press, 1998.

Figures

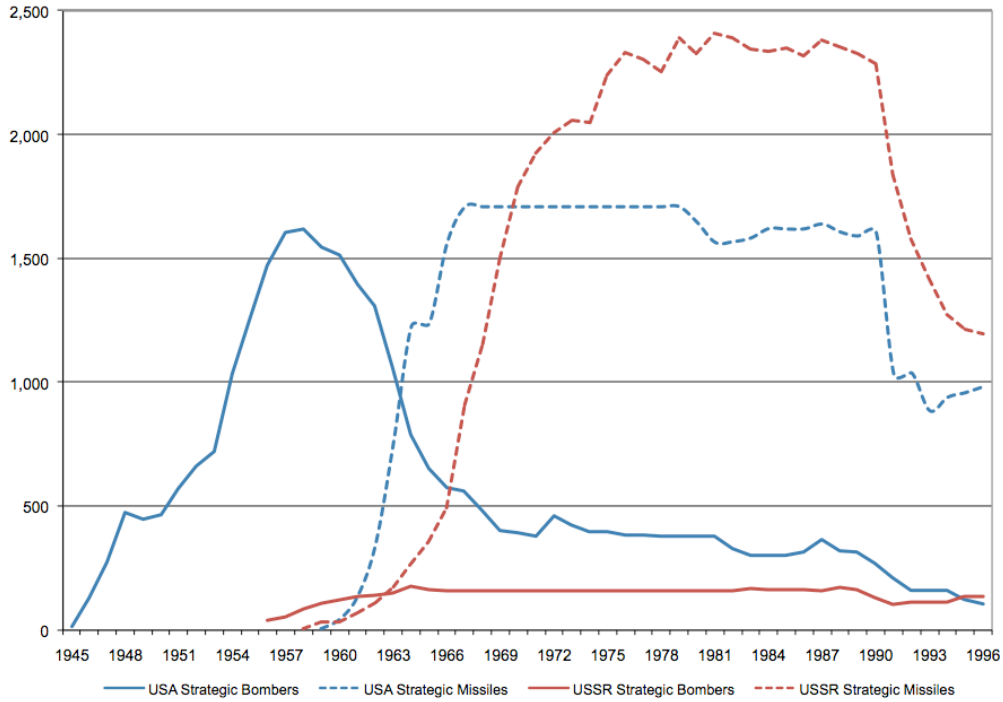

Figure 1. US and Soviet-Russian strategic (nuclear) bomber and missile delivery vehicles, 1945-1996. Note that this graph does not indicate the number of warheads per delivery vehicle, which increases dramatically in the period from 1970 onwards. *Source:* Data from Norris and Cochran 1997.

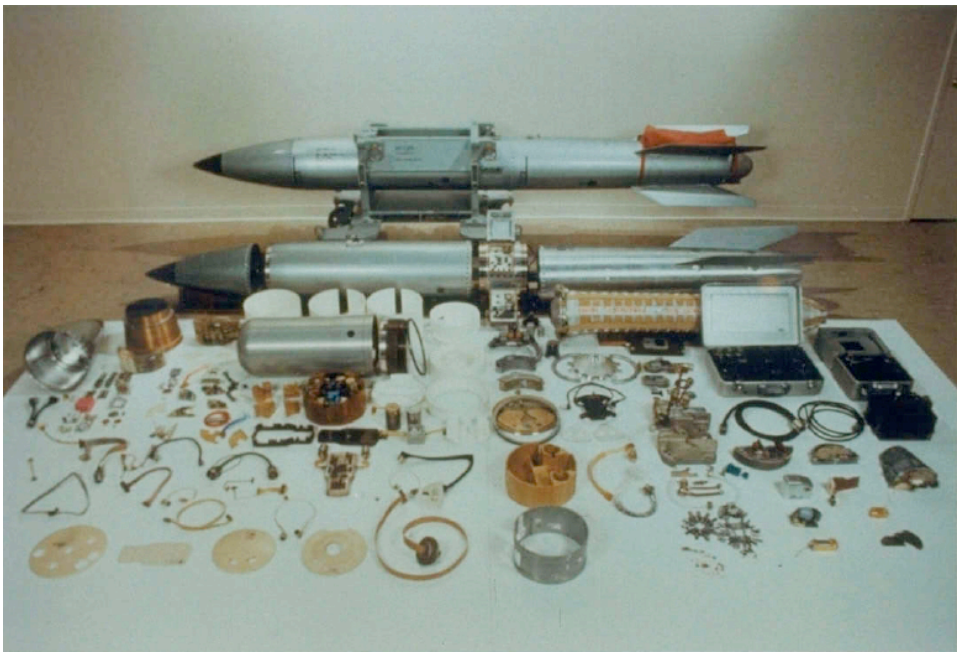

Figure 2. A disassembled U.S. B-61 bomb, displaying some of its over 6,000 parts. The nuclear warhead is the bullet-shaped cylinder in the middle-left of the photograph. *Source:* National Nuclear Security Administration (U.S.).