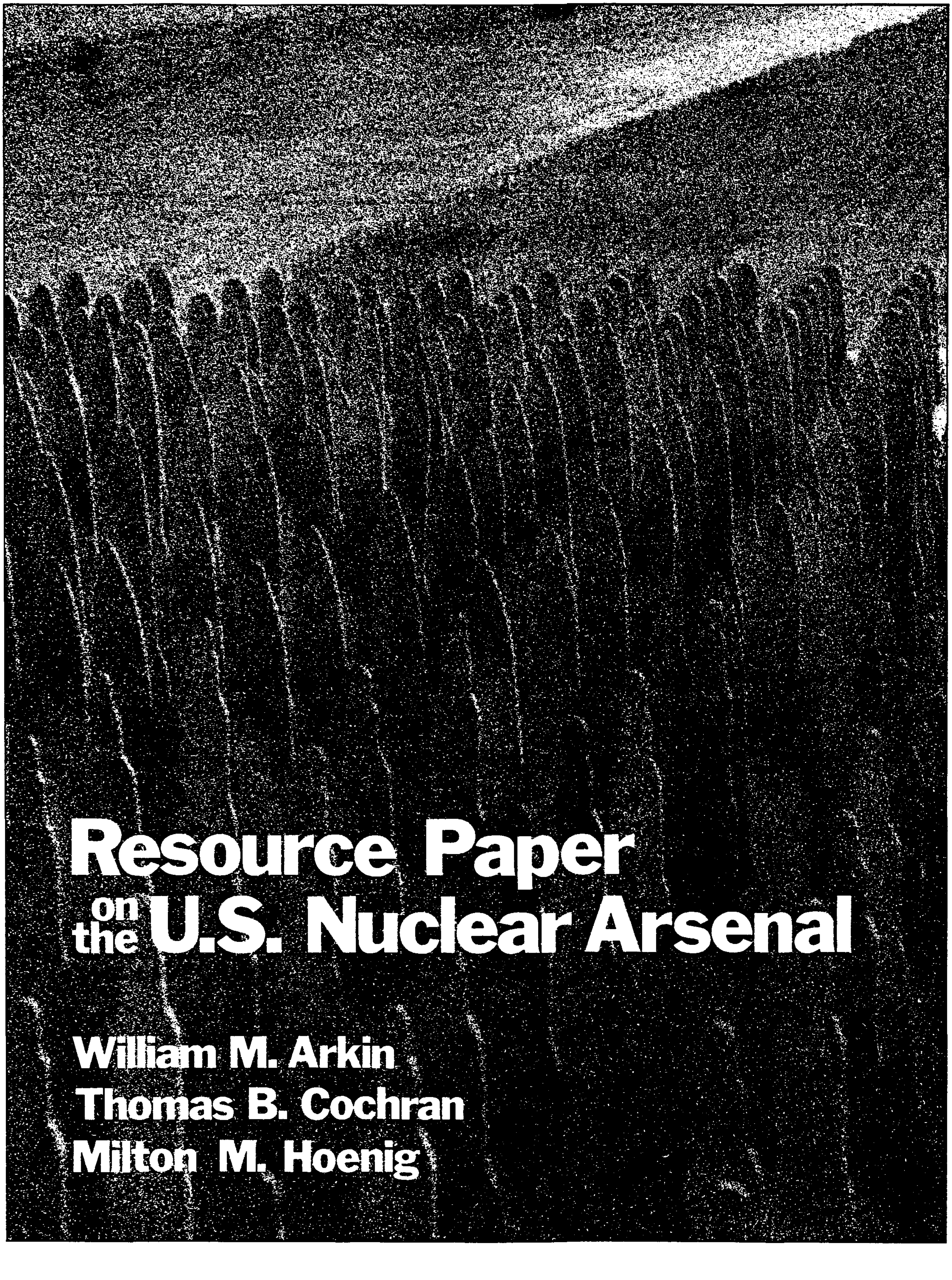

Resource Paper on the U.S. Nuclear Arsenal

William M. Arkin
Thomas B. Cochran
Milton M. Hoenig

Since its inception the Bulletin of the Atomic Scientists *has sought to increase public knowledge of nuclear weapons issues. This supplement—a condensation and updating of the 340-page first volume of the authors'* Nuclear Weapons Databook—*continues that tradition. Published earlier this year under the auspices of the Natural Resources Defense Council, volume one of the* Databook *is a comprehensive and detailed compilation of U.S. nuclear forces and capabilities. (The second volume,* The U.S. Nuclear Weapons Production Complex, *is in preparation.) This condensed version is a concise reference work of nine sections: the Reagan Administration's nuclear weapons buildup; the current U.S. stockpile; the land-based missile force; the sea-based missile force; the strategic bomber force; non-strategic nuclear forces on land; the Navy's non-strategic nuclear weapons; and weapons research and development. The authors conclude by outlining the future shape of U.S. nuclear forces; they note that the Reagan Administration does not appear to consider arms control a viable way of improving U.S. security.*

The Bulletin *acknowledges the support of the Ruth Mott Fund in the preparation of this supplement.*

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Resource Paper on the U.S. Nuclear Arsenal

by William M. Arkin, Thomas B. Cochran and Milton M. Hoenig

THE REAGAN ADMINISTRATION came into office with a goal of achieving nuclear superiority over the Soviet Union. The Administration's view was that the Soviets had outspent and outbuilt the United States during the 1970s, and that the U.S. nuclear arsenal was outdated, vulnerable and ineffective.

Administration officials believed that the restoration of America's strength required numerical superiority in warheads and delivery systems. The objective, however, was not limited to deterring attack. The new government's nuclear war strategy called for U.S. nuclear forces to "prevail" over the Soviet Union, "terminate" war on "terms favorable" to the United States, and emerge with more nuclear weapons than any potential "postwar" enemy.[1]

Weapons programs begun in the Carter Administration were quickly accelerated and development of new weapons was initiated. While ambitious buildup plans encountered political, technical and fiscal problems, the overall pace and direction of nuclear weapons acquisition set in motion three years ago continues.[2] Under current plans the number of warheads will grow from 25,000 to over 29,000 by the end of the decade. In the absence of significant arms control agreements, the size of the stockpile will further increase in the 1990s.

Public concern over this increase has had little real impact. The Administration has responded in part by claiming that the current "buildup" is not a buildup at all. They claim that the retirement of old weapons compensates for new production. Yet their own projections show at least a 13 percent increase in the number of warheads in the nuclear stockpile.[3] They further state that the number of warheads is at its lowest point in more than 15 years and that the total megatonnage is one-fourth of its peak level, implying that the U.S. bomber force of the early 1960s was more capable than today's force of ballistic missiles, bombers and cruise missiles.

Opposition in Congress has not slowed the nuclear weapons buildup, although there have been numerous changes in weapons priorities, schedules and levels of funding. The House of Representatives in 1983 voted for a "nuclear freeze" but later approved funds for almost all of the new nuclear weapons systems. While Congress has decided to delete or reduce funding for a number of new nuclear warheads, it has voted to fund the associated delivery systems in separate bills, with the single exception of the W-82 155-millimeter nuclear artillery shell. Since the delivery systems are being approved the eventual funding and production of warheads is inevitable.

The Administration is, in fact, building new warheads as fast as it can. The Administration has refurbished and expanded the Department of Energy's nuclear weapons production capability. Its production rate is now almost 1,500 new nuclear warheads per year, significantly higher than the rate of the mid-1970s.[4]

What really has limited the pace of the Administration's nuclear buildup has been generally overlooked: It is the size and structure of the nuclear weapons production complex. The pace is constrained chiefly by a combination of three factors: the overall capacity to work on warheads, the supply of materials and the complexity of new warheads.

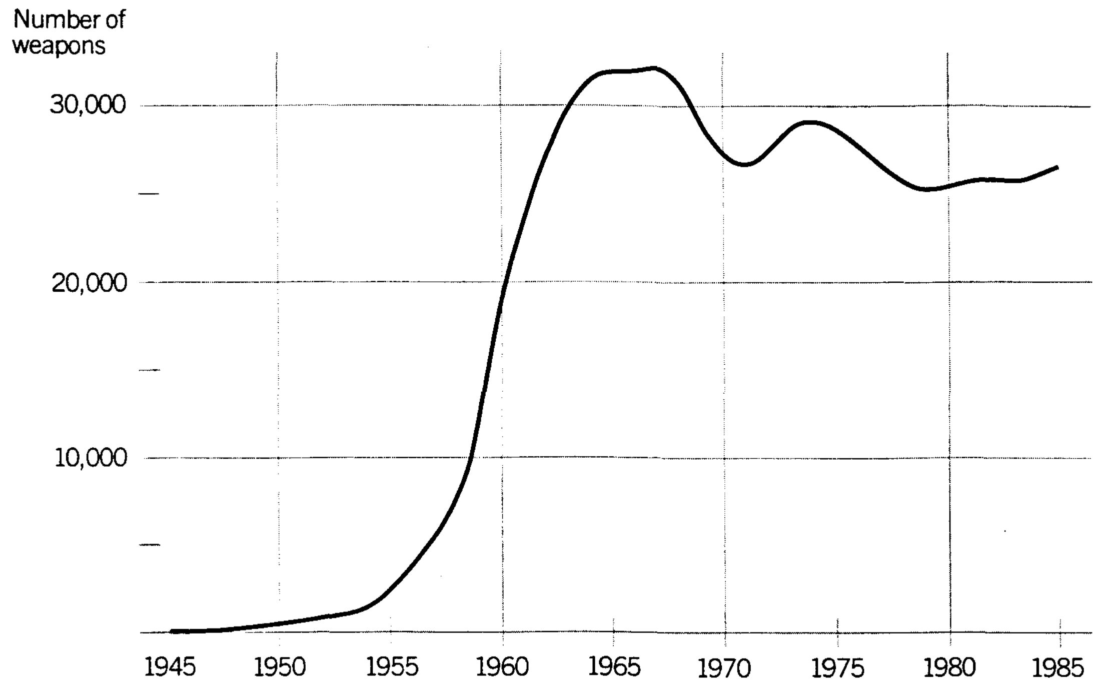
The total capacity of the production complex has been expanded to some 4,000 warheads per year, including new warheads (and inert test mock-ups), retirements, and modifications. Since most of the materials for new warheads come from the retirement of old warheads, a significant fraction of the total capacity must be allocated to retirements. Modifications to existing warheads—for example to improve their safety or reliability—must also be taken into account. In addition, "increased sophistication of the designs" of new warheads requires "greater plant and equipment investment, and significantly more production man-hours."[5] Today, each new warhead requires unique production facilities. It takes about 48 months from start of construction of these special facilities until the first warhead is completed.

Seeking to remove the various currently existing physical constraints, the Reagan Administration has adopted, "as a matter of policy, [that] national security requirements, not arbitrary constraints for nuclear material availability and weapons fabrication capacity shall be the limiting factor in nuclear force structure."[6] To meet increased material needs, the Energy Department has almost doubled its annual rate of plutonium/tritium production since 1979. At the same time the objective of a five-ton "reserve" of plutonium was established.

The Administration has not been able to maintain a balance between retirements and new warhead production,

Fig. 1

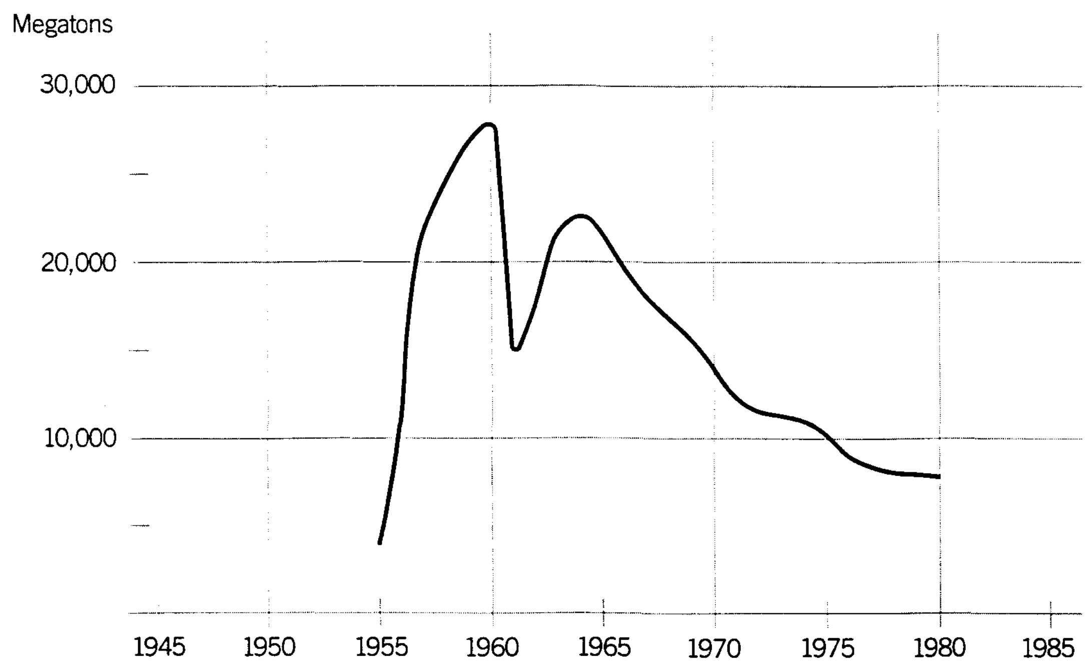
Number of U.S. warheads and bombs, 1945-1984



Based on Department of Defense statistics. For further information, see Cochran, Arkin, Hoenig, *Nuclear Weapons Databook*, 1 (Cambridge: Ballinger Publishing Company, 1984), p. 15.

Fig. 2

The U.S. nuclear stockpile: Yield in megatons, 1955-1980



Informational graphics: Michael Yanoff. Wayne E. Nail assisted in preparing the charts for publication.

Acronyms

AASM	advanced air-to-surface missile
ACM	advanced cruise missile
ALCM	air-launched cruise missile
ASALM	advanced strategic air-launched missile
ASROC	anti-submarine rocket
ASW	anti-submarine warfare
ATB	advanced technology bomber
CEP	circular error probability
CSRL	common strategic rotary launcher
DARPA	Defense Advanced Research Projects Agency
ER	enhanced radiation
ICBM	intercontinental ballistic missile
INC	insertable nuclear components
IOC	initial operational capability
JTACMS	Joint Tactical Missile System
MARV	maneuvering reentry vehicle
MIRV	multiple independently targeted reentry vehicle
NSNF	non-strategic nuclear forces
NWSM	Nuclear Weapons Stockpile Memorandum
PGRV	precision-guided reentry vehicle
SAM	surface-to-air missile
SLBM	submarine-launched ballistic missile
SLCM	sea-launched cruise missile
SRAM	short-range attack missile
SUBROC	submarine-launched rocket
TASM	tactical air-to-surface munition

and has thus not been able fully to achieve its goals.[7] For example, in 1981, it was decided to produce two new enhanced radiation (ER) warheads. The older fission warheads, however, were to be removed from Europe in order to recover their materials. But since the enhanced radiation warheads could not be sent to Europe, the Army refused to surrender the fission warheads. Until the production of new warheads peaks, in about 1987, these production constraints will continue to affect the pace of the nuclear buildup.

The stockpile today

TWENTY-SIX TYPES of nuclear warheads in 28 different delivery systems are currently deployed (Table 1). The number of warheads in the stockpile peaked in 1967 at just over 32,000, then dropped to about 27,000 by 1970. Increasing in the mid-1970s to about 29,000, the number then declined to 24,000 or 24,500 and remained there from the late 1970s to 1982. The largest number of warheads—over 30,000—were produced between 1955 and 1965 (Figure 1). Under current plans, between 1983 and 1993 about 21,000 new warheads will be added to the stockpile.

The Department of Energy plans to spend over $15 billion for nuclear weapons in fiscal years 1984 and 1985. Eight warhead types will be in full-scale production during this period:[8]

- B61–3/4 bomb for tactical air forces
- W76 Trident I warhead
- W79–1 enhanced radiation eight-inch artillery warhead
- W80–0 sea-launched cruise missile warhead
- W80–1 air-launched cruise missile warhead
- B83 "modern strategic bomb"
- W84 ground-launched cruise missile
- W85 Pershing II warhead.

The Department has four more warheads in advanced stages of development which it plans to start deploying in the 1980s. At least 15 additional warheads, in earlier stages of research and development, are planned for deployment in the 1990s (Table 2). The new weapons incorporate technological advances in lightweight materials, miniaturized electronics, safety, design, reliability, and guidance and fusing systems. Enhanced radiation warheads are replacing many small fission warheads, while versatile selectable-yield warheads are replacing older single-yield versions. New, lighter bombs, which can be delivered by planes at supersonic speeds from as low as 150 feet, are replacing older, heavier ones.

The "modernized," more flexible stockpile is influencing changes in the classification of nuclear weapons and in the plans for their use. Distinctions among the traditional categories of weapons—strategic, theater, tactical (or battlefield) and sea control—have become increasingly blurred. Weapons earmarked to destroy fixed targets according to predetermined plans are now being integrated into both strategic and theater scenarios. For instance, new intermediate-range land-based theater weapons, the Pershing II and ground-launched cruise missiles, have roles in the strategic war plan, while strategic systems such as the Poseidon and B-52 are assigned to theater targets. Strategic bombers are also being allocated for tactical targeting of enemy naval assets.

A fourth type of nuclear weaponry, the sea-launched cruise missile, is being added to the strategic "triad" of land-based intercontinental ballistic missiles (ICBMs), submarine-launched ballistic missiles (SLBMs) and bombers. These will become a part of the "strategic reserve force," a set of weapons meant to be withheld from initial nuclear exchanges.

Land-based missiles

THE LAND-BASED MISSILE force currently consists of 1,000 Minuteman missiles (450 Minuteman IIs and 550 Minuteman IIIs), armed with 2,100 warheads; and 34 single-warhead Titan II missiles. Four warhead types are deployed on land-based missiles, ranging from 170 kilotons to nine megatons in yield. The MX missile, labeled "Peacekeeper," is in flight testing. Its warhead is in "engineering development" where it is being prepared for initial production in fiscal 1985. The MX will carry ten W-87 MIRVed warheads, more than three times as many as carried by Minuteman III and each twice as accurate. The emplacement of 100 MX missiles in Minuteman III underground silos

Table 1. The U.S. nuclear stockpile (1984)[a]

Warhead/ Weapon	*Year first deployed*	*Yield (kilotons)*	*User*[c]	*Number in stockpile*	*Status*
W25/Genie[b]	1957	2	AF, C	100	being retired
B28/bomb	1958	70–1,450	AF, MC, N, NATO	1,200	to be replaced by B61 and B83
W31/Nike Hercules[b]	1958	1–20	A, NATO	500	being withdrawn from Europe and retired
/Honest John[b]	1958	1–20	NATO	200	being withdrawn and retired
W33/8-inch artillery[b]	1956	1–12	A, MC, NATO	1,000	some being retired; to be replaced with W79
B43/bomb	1961	500–1,000	AF, MC, N, NATO	700	to be replaced by B83
W44/ASROC	1961	5–10	N	574	to be replaced by ASW Standoff Weapon/VLA
W45/Terrier	1956	1	N	100	to be replaced by Standard-2/ W81
/Medium ADM[b]	1964	1–15	A, MC, NATO	350	to be retired
W48/155mm artillery	1963	0.1	A, MC, NATO	922	to be replaced by W82
W50/Pershing IA[b]	1962	60–400	A, NATO	280	U.S. warheads being replaced with W85
B53/strategic bomb[b]	1962	9,000	AF	50	to be replaced with B83
W53/Titan II[b]	1963	9,000	AF	50	being retired
W54/Special ADM	1964	.01–.1	A, MC, NATO	260	no planned replacement
W55/SUBROC	1965	5–10	N	285	to be replaced by ASW Standoff Weapon
W56/Minuteman II	1966	1,200	AF	480	to be retained at least until 2000
B57/bomb/depth bomb	1964	sub-20	AF, MC, N, NATO	3,100	to be replaced by B61 and ASW Standoff Weapon/NDB
B61/bomb	1968	50–345	AF, MC, N, NATO	2,600	in production, to replace certain B28, B43, B57
W62/MM III (Mk-12)	1970	170	AF	825	to be retained at least until 2000
W/68 Poseidon	1971	40	N	3,300	retirement planned from 1993 to 1999
W69/SRAM	1972	170	AF	1,140	to be replaced by Advance air-to-surface missile
W70/Lance	1972	1–100	A, NATO	1,282	to be replaced by Joint Tactical Missile System
W76/Trident I	1979	100	N	3,000	in production, 3,600 planned
W78/MM III (Mk-12A)	1979	335	AF	1,000	to be retained at least until 2000
W79/8-inch artillery	1981	1	A, MC	500	in production, 800 planned
W80/ALCM	1981	200	AF	1,100	in production, 1,700 planned
/SLCM	1984	5–150	N	50	in production, 758 planned
B83/bomb	1984	1,100	AF, N	200	in production, 2,500 planned, replaces B28, B43 and B53
W84/GLCM	1983	20–150	AF	100	in production, 500 planned
W85/Pershing II	1983	10–80	A	50	in production, approximately 150 planned
Total				**25,298**	

[a] Authors' estimates of stockpile breakdown of 26,000 weapons as of May 1984; not shown are weapons retained on inactive status (110 Sprint/Spartan warheads) and weapons awaiting dismantling, including some warheads for which the delivery systems were long ago retired.
[b] Weapons planned for partial or complete retirement in 1984–1990, as called for in present plans.
[c] AF: Air Force, A: Army, C: Canada, MC: Marine Corps, N: Navy, NATO: North Atlantic Treaty Organization members.

will begin in Nebraska and Wyoming in December 1986. The W-87 warhead is so designed that its "baseline" yield of 300 kilotons can be upgraded to 475 by changing fissile materials, depending on MX accuracy and the hardening of Soviet targets. The weight of the reentry vehicle, however, has its cost in terms of range and may result in some MX missiles carrying fewer than ten warheads, particularly if heavy penetration aids are adopted.

Deployment of at least 100 MXs now seems certain, and the long-term plan of the Joint Chiefs of Staff is reportedly to deploy 200.[9] The Reagan Administration halved the Carter Administration plan for 200 MXs, but it has added the new Small ICBM to its procurement list. With an initial operating capability planned for 1992–1993, Small ICBMs are envisioned as a complement to Minuteman and MX.[10]

In April 1983, the President's Commission on Strategic Forces recommended development of a small, single-warhead ICBM of about 30,000 pounds, to be widely dispersed in super-hardened silos, deep underground shelters or hardened mobile launchers.[11] Each of at least 1,000 missiles would carry one Mk-21 reentry vehicle, with either a W-87 MX or new warhead having a selectable yield from 100 to 500 kilotons.

The Air Force has been removing and dismantling approximately one Titan II missile every 45 days as part of a five-year retirement program begun in October 1982. By 1988, all Titans are to be decommissioned. Congress failed to fund replacement of 50 single-warhead Minuteman IIs with triple-warhead Minuteman IIIs in fiscal 1983.[12] Instead, the Minuteman II force will be upgraded with some accuracy improvements between 1986 and 1991.[13] Minuteman IIs and IIIs will probably remain deployed through the year 2000.

Sea-based systems

THE PRESENT FORCE of strategic ballistic-missile submarines includes four Trident and 31 Poseidon submarines, capable of firing 568 submarine-launched ballistic missiles and carrying 5,344 warheads. The Poseidons, constructed between 1960 and 1967, carry 16 submarine-launched ballistic missiles. Twelve Poseidon boats have been modified to carry the Trident I C4, and 19 carry older Poseidon C3 missiles. The new Ohio class (so-called Trident) submarine has 24 launch tubes and at present carries the Trident I.

Table 2. Nuclear warhead research and development

Weapon	*Phase FY85*	*Production begins*	*Current IOC*	*Number planned[a]*	*Status*
W-81 Standard-2	3/4	1987	1991	500	Terrier replacement, Phase 3 since September 1977
W-82 155mm artillery	3	—	—	(1,000)	W-48 replacement, cancelled in FY 1985 budget, Phase 3 since February 1978
W-87 MX	3/4	1985	1986	1,055	Phase 3 since FY 1981
ASWSOW submarine launched	2	1986	1990	300	SUBROC replacement, Phase 2 since FY 1980
ASWSOW vertical launch ASROC	2	1990s	1990s	300	ASROC replacement, Phase 2 since FY 1980
ASWSOW nuclear depth bomb	1/2	1990s	1990s	900	B-57 replacement, Phase 2 since FY 1980
Trident II	3	1986	1989	4,800	new high yield warhead
Joint tactical missile system	1	1988	1990s	1,000	formerly Corps Support Weapons System, Lance replacement
Advanced air-to-surface missile	2/3	1988	1990	1,600	formerly Advanced Strategic Air Launched Missile, SRAM replacement, Phase 1 in FY 1984
Small ICBM	1	1990	1992	1,000	formerly Advanced ICBM
Tactical air-to-surface munition	1	1990s	1990s	?	new tactical air-launched weapon
Air-to-air intercept missile	1/2	1990s	1990s	?	nuclear warhead for Phoenix, new in FY 1984
Supersonic anti-ship missile	1	1990s	1990s	?	new weapon
Advanced tactical air delivery weapon	—	—	—	?	in Phase 1 in FY 1983
Ballistic missile defense	—	?	?	?	in Phase 2 in FY 1984, formerly Sentry/LoADs, deferred in FY 1985
"3d Generation"	—	1990s	1990s	?	warheads possible in late 1990s
MARV	—	—	1990s	?	in Phase 2 in FY 1983
Advance cruise missile technology	—	—	—	?	in Phase 1 in FY 1983, cancelled in favor of W-80

[a] Numbers planned are authors' estimates as of May 1984.

Congress has authorized funds for 11 Trident submarines and the five-year shipbuilding program proposed by the Navy for fiscal 1985–1989 includes funds for construction of five more Tridents. The original service life of Poseidons, from 20 to 25 years, has been extended. Under current plans Poseidon submarines will be retired as they reach 30 years, between 1993 and 1999.

The Poseidon C3 and Trident I C4 missiles are MIRVed: The Poseidon can carry from six to 14 warheads, averaging about ten; the Trident I carries eight warheads. Trident I missiles have a greater range than the Poseidon and more than double the yield (from 40 to 100 kilotons) but have similar accuracy. The size of the Trident I was restricted to allow its deployment in smaller Poseidon submarine launch tubes. The new Trident II D5 missile, now planned for deployment on the ninth Trident submarine in late 1989, will be larger and more accurate, with greater range and a larger yield. By the late 1990s, at least 20 Trident submarines will be deployed, carrying Trident II missiles with eight warheads each, a minimum of 3,840 highly accurate warheads. Although the ultimate size of the Trident submarine force appears unsettled, recent statements indicate planning for an eventual force of as many as 25.

A high-yield warhead, reported at 475 kilotons, on a new reentry vehicle (Mk-5) with a 480-foot circular error probability will give the Trident II a hard-target kill capability comparable to the lower-yield but more accurate MX. Although the high-yield variant of the MX W-87 warhead was chosen as the developmental baseline for the Trident II, the Energy Department is working on a new warhead for the Trident.[14] In addition, a maneuvering reentry vehicle (Mk-600) is also being considered for the Trident II (as well as for the Small ICBM). The Mk-500 Evader MARV, which completed feasibility demonstrations on the Trident I, could also be converted for the Trident II, but at a greater loss of accuracy.

Strategic bomber force

THE STRATEGIC AIR COMMAND (SAC) operates over 326 strategic bombers, of which 241 B-52s and 56 FB-111s are in the active force; the remainder are designated for backup and training. The bomber force carries six types of nuclear bombs and two missiles: the short-range attack missile (SRAM) and the air-launched cruise missile (ALCM). The bombs have various weights, yields, accuracies and delivery profiles (Table 1).

The number and type of nuclear weapons in the bomber force result from a complex analysis of survivability, penetration and targeting objectives. B-52s carry from as few as 12 nuclear warheads (missiles and bombs) to as many as 26, depending on the nature of their targets and whether they are on alert. Overall some 5,400 warheads are available to the strategic bomber force.[15] Thirty percent of the bombers are currently loaded with some 900 to 1,000 nuclear warheads and are on constant 15-minute alert. On "generated" alerts some 2,000 bomber weapons are loaded.

Bombers can destroy hardened military targets more effectively than land-based or submarine-launched missiles can. The FB-111 currently achieves the best hard-target kill capability of any U.S. strategic weapons.[16] The purchase of at least 4,000 cruise missiles, including 1,739 ALCMs and about 2,400 advanced cruise missiles (ACMs), the new B-83 "modern strategic bomb" (initial deployment in 1984) and a replacement for the short-range attack missile will enhance this capability.[17]

Development of long-range ALCMs is moving ahead rapidly. Full-scale production of the first generation is already being abandoned in favor of an ACM. The advanced model will include increased range, greater use of electronic countermeasures and "reduced observables," new software and better "mission planning flexibility." It will use the W-80-1, the same 200-kiloton warhead that is on the ALCM.[18] An ACM warhead, under development in fiscal 1983, has been cancelled. The Defense Department did not request funds in fiscal 1984 for the ALCM, but Congress, doubting that the advanced missile would be available in 1986, added 240 ALCMs.[19]

A new intercontinental cruise missile with a 6,000–8,000-mile range is being developed under the Advanced Cruise Missile Technology Program of the Defense Advanced Research Projects Agency, right on the heels of ACM. The Program is investigating "unconventional design and launch modes" for future delivery vehicles, by increasing the range, payload and penetration capability of smaller missiles.[20] The new missile would be supersonic, unlike the current ALCM which goes 500 miles per hour. It would be smaller, incorporate Stealth techniques, and have sensors to evade defenses. A new terminal homing unit and navigational aids will improve accuracy, and newer technology will provide increased thrust and reduced fuel consumption.

The B-83 bomb, which entered production in 1983, will eventually replace older B-28, B-43 and B-53 bombs. This new 1.1 megaton-yield bomb allows the pilot to release the weapon at supersonic speeds, from as low as 150 feet, activating a parachute-type (drogue) retard and a time-delay fuse. When delivered at low altitudes, the accuracy of this "laydown" method is equal to or better than that of ICBMs. With its high yield, the B-83 will be able to destroy "hardened Soviet ICBM silo and launch complexes, command, control and communications installations, and nuclear storage sites."[21]

The Air Force also plans a new advanced air-to-surface missile (AASM) to replace the SRAM. The former grew out of the advanced strategic air-launched missile (ASALM), a 15-year-old project to develop a Mach-4 air-to-surface missile. AASM will have longer range, greater accuracy and higher yield than SRAM.[22] A nuclear warhead for this missile will enter engineering development in fiscal 1985. In part through the use of very high-speed integrated circuits, AASMs will also be smaller than SRAMs, allowing each bomber to carry more missiles.[23]

The adoption of ALCMs, new bombs and AASMs in the bomber force will be significantly aided by deployment of the common strategic rotary launcher (CSRL). Each rotary launcher will be capable of carrying either eight ALCMs, SRAMs/AASMs, or bombs, or a mix of these weapons. This will increase the weapons capacity and flexibility of bombers. According to *Air Force Magazine,* CSRL will thus "give the B-52 flexibility in reconstituting for another mission after an ALCM strike."[24]

In addition to increasing their loads, the bombers are themselves in the midst of significant change and improvement. The last of 79 B-52D bombers were withdrawn in 1983, but B-52Gs continue to be modified to carry 12 ALCMs under their wings. (Plans to modify these bombers for internal carriage of eight ALCMs were cancelled.) Starting in 1985, newer B-52Hs, with projected lifespans past the year 2000, will be modified to carry 20 ALCMs both internally and externally.

The first of 100 planned B-1Bs will be deployed in September 1986. B-1Bs are designed to carry ALCMs, SRAMs, and B-61 and B-83 bombs. For standoff missions B-1Bs will carry 20 ALCMs; for penetration missions, 16 bombs and eight SRAMs, and for "shoot and penetrate" missions, eight ALCMs, four bombs and four SRAMs.[25] According to one report, Air Force officials want another 100 B-1s, designated B-1Cs, with further reduction in radar cross section. This would be an alternative to ending B-1 procurement before the advance technology bomber (Stealth) is proven.[26]

The advanced technology bomber (ATB), in development since the late 1970s, is scheduled to fly in December 1987, with an initial operating capability in 1993.[27] Its major feature will be its reduced radar cross section—close to zero, compared to one square meter for B-1B and 10 square meters for B-52s. Active (electronic) and passive (nonmetallic and absorbing materials) measures will decrease radar reflections and energy emissions from the aircraft. The Air Force will deploy some 100 to 150 ATBs under current plans.

Deployment of B-1Bs and ATBs will change the complexion of the entire bomber force. The B-52Gs will be converted to standoff bombers, carrying only ALCMs (no bombs), after deployment of the B-1B. The CSRL may also allow B-52Gs to carry internal bombs which could be retained for follow-on strikes after an ALCM attack. A 1983 Defense Resource Board decision to begin B-52G retirement in 1988 has been rescinded, and current plans are to begin B-52G retirement in the 1990s when ATBs are deployed.[28] FB-111 bombers will be transferred to the tactical inventory as ATBs are deployed. The B-52H force will continue as an ALCM carrier through the end of the century.

A fourth element, nuclear-armed sea-launched cruise missiles, is being added to strategic offensive forces beginning in June 1984. The nuclear-armed SLCMs, with a range in excess of 1,500 miles, are intended for deployment on attack submarines and surface ships; they will form part of a strategic reserve. Management and technical problems have plagued the SLCM program, and work on some conventional versions of the missile has been delayed; but this is not true of the nuclear land-attack version. Current plans are to deploy 758 nuclear versions, a change from earlier plans to deploy about 460 and then 1,000.

Table 3. Strategic nuclear forces (1984)[a]

Delivery System	*Launchers*	*Warheads/ launcher*	*Forces warheads*[b]	*Total warheads*[c]	*Yield (megatons)*	*Forces (megatons)*
Minuteman II	450	1	450	500	1.2	540.0
Minuteman III	550	3	1,650	1,825		429.0
Mk-12	(250)		(750)	(825)	.17	(127.5)
Mk-12A	(300)		(900)	(1,000)	.335	(301.5)
Titan II	34	1	34	50	9.0	306.0
Total ICBMs	*1,034*		*2,134*	*2,375*		*1,275.0*
Poseidon	304	10	3,040	3,500	.05	152.0
Trident I	288	8	2,304	3,000	.1	230.4
Total SLBMs	*592*		*5,344*	*6,500*		*382.4*
B-52G/H	264		3,192	–		
ALCM carriers	(90)	20–24	(1,800)	–	7.08–9.42	637.2–847.8
Non-ALCM carriers	(174)	8–16	(1,392)	–	4.68–16.0+	814.3–2,784+
FB-111	60	6	360	–	4.34	260.4
Total Bombers	*324*		*3,552*	*5,360*		*1,711.9–3,892.2*
Grand total	**1,950**		**11,030**	**14,235**		**3,369.3–5,549.6**

[a] Authors' estimates as of March 1984; numbers exclude sea-launched cruise missiles and Genie missiles.
[b] Force loadings refer to the nominal loading of the total force.
[c] Total warheads refers to all warheads in the stockpile, some of which are spares or extras.

Table 4. Non-strategic nuclear force warheads (1984)[a]

Weapon (warhead)	*United States*	*Europe U.S. use*	*Europe NATO use*	*Deployment Pacific*	*At sea*	*Total*
GLCM/Pershing II (W-84, W-85)	–	150	–	–	–	150
Bombs (B-28, B43, B-57, B-61)	1,210	1,415	320	135	720	3,800
Depth bombs (B-57)	560	130	60	100	45	895
Pershing IA (W-50)	–	180	100	–	–	280
Lance (W-70)	587	325	370	–	–	1,282
8-inch artillery (W-33, W-79)	500	505	430	65	–	1,500
155mm artillery (W-48)	160	592	140	30	–	922
Honest John (W-31)	–	–	200	–	–	200
Nike Hercules (W-31)	–	110	390	–	–	500
Atomic demolition munitions (W-45, W-54)	220	370	–	20	–	610
Terrier (W-45)	64	–	–	–	36	100
ASROC (W-44)	224	–	–	–	350	574
SUBROC (W-55)	110	–	–	–	175	285
Total	3,635	3,777	2,010	350	1,326	11,098

[a] Authors' estimates as of May 1984.

In strategic defensive forces only one nuclear weapon—the Genie air-to-air rocket—is currently deployed. But its primary carrier, the F-106, will soon retire, to be replaced by the F-15. The Air Force will therefore take the Genie out of service and has no plans to replace it. One advanced research and development project under the Defense Advanced Research Projects Agency—the ballistic intercept missile—will examine advanced designs for "a ballistic weapon that could kill inflight bombers."[29]

The standard tallies of strategic warheads, for "balance" assessments or arms control, do not take into consideration the total number of warheads in the stockpile, or even those available for warfare (Table 3). The Defense Department uses many different designations for counting warheads—day-to-day alert, generated alert, maximum alert, force loadings—that include only certain weapons. It is commonly assumed, for instance, that some 50 to 60 percent of strategic submarine warheads are "on station" at any time, ready to deliver some 2,500 warheads. In fact, while 50 to 60 percent are at sea, only 30 percent are counted as being on "day-to-day" alert, with the remainder (in transit or training) on "modified alert."

Bomber counting is even more confusing. Some 30 percent are on "day-to-day" alert, but the number of weapons they carry is only 900, far less than their capacity, even though there are some 5,400 missiles and bombs in the bomber force. "Force loadings," the number of weapons the bombers could carry under theoretical conditions (as opposed to actual plans), include some 3,000 weapons. But they exclude spares as well as "weapons reserved for restrike (reserves) and weapons on inactive status."[30]

Non-strategic nuclear forces

HALF THE NUCLEAR warheads in the stockpile are in the non-strategic nuclear forces (NSNF). These have only begun to receive the attention accorded to strategic nuclear forces, but they are subject to a wider variety of political influences. Most important are the requirements of NATO and the politics of warhead deployments outside the United States.[31]

As with strategic forces, aircraft deliver most of the warheads in non-strategic forces. Four of the six nuclear bomb types—some 4,000 bombs—are assigned to tactical aircraft in the non-strategic nuclear forces (Table 4). Fifteen U.S. and NATO aircraft types are currently modified and "certified" to carry nuclear weapons; 12 of the 15 are land-attack fighter bombers and three are anti-submarine planes. Eight types are operated by NATO allies, including three foreign-built aircraft.

The tactical nuclear bomb stockpile has been significantly improved over the past 15 years. It now contains predominantly newer B-57 and B-61 versions, both of which have selectable yields, weigh under 1,000 pounds and are much more versatile than the heavier, single-yield bombs they replaced. The B-61 has been in continual production since 1968, and has undergone six modifications. The Energy Department fiscal 1985 budget requests contain plans to accelerate new modifications of the B-61 (6, 7 and 8).[32]

Five new nuclear weapons for tactical aircraft are in research and development. A "standoff nuclear depth bomb" is undergoing a feasibility study and is slated to replace the B-57 in the 1990s. A program for a 10-kiloton standoff tactical air-to-surface munition (TASM), with terminal guidance for use against battlefield targets, is being explored. The Joint Tactical Missile System (JTACMS) development program (discussed below) of the Air Force and Army is investigating second-echelon strike missiles that could deliver nuclear warheads. In fiscal 1983, the Joint Chiefs of Staff also reported a study to "assess the military utility of a standoff, air delivered earth penetrator, nuclear weapon system" and a nuclear armed "Advanced Air Delivered Tactical Weapon," which may be the same weapon.[33]

Army missile warheads make up the second largest group of non-strategic nuclear weapons. There are some 2,245 warheads for four different missiles (1,880 in Europe). The newest nuclear missile is the Pershing II, which began production in 1982 and was first deployed in West Germany in December 1983. All 108 U.S. Pershing IA launchers will be converted for the new Pershing II missile, but the Army will deploy some 150 Pershing II warheads. Plans to build additional warheads to provide the launchers with a reload missile have been cancelled for political reasons and warhead production has been "adjusted."[34]

The yield of the W-85 warhead on the Pershing II is selectable up to 80 kilotons. Its accuracy (30-meter CEP) makes it able to destroy any target within its 1,800-kilometer range. Because of production and testing problems full deployment of the Pershing II has been delayed until 1988. The West German government still has to decide on the future of its own Pershing IAs (with 72 launchers), which carry the much less accurate, higher yield W-50 warhead.

The Army has three types of short-range missiles in use: the Lance, Honest John and Nike Hercules. One hundred Lance launchers are deployed in the U.S. Army and seven NATO armies; they are equipped with 1,280 nuclear warheads, 695 of them in Europe. There are two basic warhead types: fission and enhanced radiation. The original fission warheads (the W-70 Mods 1 and 2) have a selectable yield ranging from one to 100 kilotons. The newer enhanced radiation warhead (the W-70 Mod 3), produced between 1981 and 1983, has a yield in the one-to-10 kiloton range. Since these warheads cannot be deployed to Europe, the 380 W-70 Mod 3 warheads are stored in the United States.

A follow-on to the Lance is a dual-capable missile with longer range and greater accuracy. Called the Joint Tactical Missile System (formerly Corps Support Weapon System), it has been in development since 1981. Members of Congress have criticized the nuclear-armed version as incompatible with future conventional capabilities and the "Air-Land battle" doctrine. Initial warhead studies include both fission and enhanced radiation versions.

Greece and Turkey were the only NATO nuclear allies who did not purchase the Lance missile. They still use the Honest John, which was first deployed in 1958 and has a single-yield 20-kiloton nuclear warhead. Its short range and serious operational problems make it the least desirable of any nuclear weapons deployed.[35] Defense Department officials have testified before Congress that they intend to withdraw the 198 Honest John (W-31) warheads from Europe. This would leave the Greek and Turkish armies with no nuclear system other than artillery, which the military considers politically unwise.[36] Nonetheless, the Honest Johns are "dual-capable systems that may no longer be as effective in the conventional mode" and will not able to operate reliably until a Lance replacement is deployed.[37]

Dual-capable Nike Hercules surface-to-air missiles, which are of the same generation as the Honest John and use the same warhead, are also being withdrawn. Before withdrawal began, in 1981, there were some 685 warheads in Europe. Since then, Army officials have stated that the United States has withdrawn at least seven of its 16 batteries (nine launchers each). The nuclear roles of German, Greek and Dutch Nike Hercules have been scaled back, and Belgium has initiated retirement in anticipation of the conventional Patriot, to replace the nuclear missiles starting in late 1984.[38] By 1985, all 144 U.S. launchers will have been withdrawn, and several NATO allies have begun retirement of nuclear warheads.

A third of the nuclear warheads used by Army and Marine Corps ground forces are nuclear artillery shells, consisting of two types. The larger eight-inch shells include both the W-33, the oldest nuclear weapon in the U.S. arsenal, and the W-79, the new enhanced radiation version. According to the Senate Appropriations Committee, significant safety concerns have been voiced about the W-33, but the Army insists that retirement must be linked with deployment of the W-79 to Europe.[39] Since this is not politically feasible at this time, retirement of W-33s is being held up. Nonetheless, 198 W-33s stored in the United States are being retired as new W-79s are built and the Army plans to reduce the stockpile of 940 W-33s in Europe.[40] Production of the W-79, which began in 1981, has slowed down for technical reasons.

About 925 of the smaller 155-millimeter (six-inch) W-48 nuclear artillery shells are deployed; their controversial enhanced radiation replacement (W-82) has been deferred. After Congress cut funds in fiscal 1983 and 1984, the Energy Department did not request money in fiscal 1985 to complete production facilities for the new warhead for three reasons: a cost of some $3.5 billion to produce 1,000 warheads; existing demands on a production complex operating at full capacity; excessive requirements for materials (particularly tritium). Since Army and NATO officials still say they need to replace the W-48, future requests for the W-82, rebuilt as a less expensive fission weapon, are expected.

Finally, there are some 600 atomic demolition munitions of two types in the nuclear stockpile. The larger one, the medium atomic demolition munition, "has limited utility and will be phased out of the NATO inventory," according to Defense officials.[41] Military planners still consider the smaller type, the special atomic demolition munition, to have some usefulness: it can be carried by commandos behind enemy lines, and it has an extremely low yield. The Army will retain it "until the end of its useful stockpile lifetime."[42]

Naval nuclear weapons

THE NAVY'S NON-STRATEGIC nuclear weapons include 2,750 land-attack, anti-submarine and anti-air weapons. About 1,600 are the aircraft-delivered land-attack and depth bombs discussed above. All 12 operational aircraft carriers carry nuclear weapons. Some 700 nuclear bombs are "afloat" on the five or six aircraft carriers at sea at any time.

Nuclear-armed land-attack versions of the Tomahawk sea-launched cruise missile (SLCM) will be deployed in June 1984. The nuclear SLCM, armed with the 150-kiloton W-80-0 warhead, will be deployed initially on recommissioned battleships and attack submarines and eventually on a wide variety of surface ships and attack submarines fitted with the vertical launching system.

In all, there are 1,750 nuclear warheads for anti-submarine warfare (ASW), including 900 B-57 nuclear depth bombs, 575 ship-launched ASROC missiles (W-44) and 285 submarine-launched SUBROCs (W-55). The nuclear depth bombs are used by five different ASW planes—three land-based and two carrier-based. Britain, Italy and the Netherlands have ASW aircraft (Nimrods, Atlantiques and P-3 Orions) which are certified to carry U.S. nuclear depth bombs. Replacements for all three ASW weapons are in development, under the ASW Stand-off Weapon program. Programs for individual warheads for a new submarine weapon, a new vertical ASROC and a nuclear depth bomb are being initiated.

The Navy has one nuclear surface-to-air missile (SAM), the Terrier, for which there are 100 W-45-3 warheads. Nuclear Terriers are now on 31 cruisers and destroyers, and possibly three aircraft carriers. The next generation—long-range, nuclear SAM—is the Standard-2, slated to enter production in fiscal 1987. The nuclear version of the Standard-2, designated SM-2(N), will carry the W-81 fission warhead, now in Phase 3 of its development. Whether to develop a fission (as opposed to enhanced radiation) warhead has been in question by some in Congress, who cite the dangers of nuclear explosions to the launching ships.

Two other nuclear systems are under consideration for future air defense of naval forces. In 1982, the Defense Department revealed the existence of a feasibility study for a nuclear warhead for the Phoenix air-to-air missile, to be used for long-range defense of aircraft carriers against cruise missile attacks. The Navy is also working on a much longer-range anti-air missile, which could be fired from the vertical launching system to extend further the protection of aircraft carriers. The Martin Marietta advanced strategic air-launched missile (ASALM), previously in competition to replace the SRAM on bombers, has been offered as a potential "outer air battle missile." The Navy's Outer Air Battle Program is the umbrella under which SM-2(N) and Phoenix nuclear programs are justified.

Table 5. Deliverable strategic warhead projections (1984–2000)

	1984	*1985*	*1986*
Land-based (ICBMs)[a]			
Titan II	34	22	10
Minuteman II	450	450	450
Minuteman III			
missiles	550	550	540
warheads	1,650	1,650	1,620
MX			
missiles	—	—	10
warheads	—	—	100
Small ICBM	—	—	—
Total land-based ICBM forces			
missiles	1,034	1,022	1,010
warheads	2,134	2,122	2,180
Sea-based (SLBMs)[a]			
Poseidon			
missiles	304	304	304
warheads	3,040	3,040	3,040
Trident I			
missiles	288	336	360
warheads	2,304	2,688	2,880
Trident II			
missiles	—	—	—
warheads	—	—	—
Total sea-based SLBM forces			
missiles	592	640	664
warheads	5,344	5,728	5,920
Air-based[a]			
Bombers			
B-52G/H	264	264	264
FB-111	60	60	60
B-1B	—	—	20
ATB	—	—	—
Total bombers	324	324	344
Weapons			
Bombs	3,250	3,250	3,250
SRAM/AASM	1,140	1,140	1,140
ALCM/ACM	1,100	1,190	1,430
Total air-based weapons	5,490	5,580	5,820
Total warheads	12,968	13,430	13,920

[a] ICBM and SLBM projections include force loadings; bomber weapons include all weapons.

Research and development

IN ADDITION TO SPECIFIC development of nuclear weapons, the laboratories of the Energy and Defense Departments are actively engaged in research leading to future weapons:

• *"Third generation" nuclear weapons.* Approximately $300 million will be spent in fiscal 1985 on development of these weapons, which gained additional support in the Reagan Administration's new Strategic Defense Initiatives. They emphasize "tailored weapons effects" and "single out some particular type of damage, for example, destruction of electronic components" by electromagnetic pulse (EMP) weapons.[43] The key projects in this area are in directed-energy weapons—which direct a fraction of the energy from a nuclear explosion into one or more narrow beams—such as

1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
—	—	—	—	—	—	—	—	—	—	—	—	—	—
450	450	450	450	450	450	450	450	450	450	450	450	450	450
516	480	450	450	450	450	450	450	450	450	450	450	450	450
1,548	1,440	1,350	1,350	1,350	1,350	1,350	1,350	1,350	1,350	1,350	1,350	1,350	1,350
34	70	100	100	100	100	100	100	100	100	100	100	100	100
340	700	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
—	—	—	—	—	—	20	200	500	800	1,000	1,000	1,000	1,000
1,000	1,000	1,000	1,000	1,000	1,000	1,020	1,200	1,500	1,800	2,000	2,000	2,000	2,000
2,338	2,590	2,800	2,800	2,800	2,800	2,820	3,000	3,300	3,600	3,800	3,800	3,800	3,800
304	304	304	304	304	304	288	224	160	96	64	32	—	—
3,040	3,040	3,040	3,040	3,040	3,040	2,880	2,240	1,600	960	640	320	—	—
384	384	384	384	360	336	312	240	216	176	120	32	16	—
3,072	3,072	3,072	3,072	2,880	2,688	2,496	1,920	1,728	1,408	960	256	128	—
—	—	24	72	120	168	216	264	312	360	408	456	480	504
—	—	192	576	960	1,344	1,728	2,112	2,496	2,880	3,264	3,648	3,840	4,032
688	688	712	760	784	808	816	728	688	632	592	520	496	504
6,112	6,112	6,304	6,688	6,880	7,072	7,104	6,272	5,824	5,248	4,864	4,224	3,968	4,032
264	264	264	264	264	264	264	234	174	114	96	96	96	96
60	60	60	60	60	60	60	30	—	—	—	—	—	—
60	90	100	100	100	100	100	100	100	100	100	100	100	100
—	—	—	—	—	—	15	50	80	110	132	132	132	132
384	414	424	424	424	424	439	414	354	324	328	328	328	328
3,350	3,450	3,550	3,650	3,750	3,750	3,850	3,950	3,600	3,300	3,000	2,400	1,800	1,200
1,140	1,140	1,140	1,140	1,140	1,020	820	440	660	1,100	1,540	1,980	2,420	2,800
1,739	1,739	1,739	1,739	1,859	2,099	2,339	2,579	2,819	3,059	3,299	3,539	3,779	4,019
6,629	6,329	6,629	6,529	6,749	6,869	7,009	6,969	7,079	7,459	7,839	7,919	7,999	8,019
14,679	15,031	15,533	16,017	16,429	16,741	16,933	16,241	16,203	16,307	16,503	15,943	15,767	15,851

the nuclear-pumped X-ray laser and microwave generator.[44]

• *Advanced warhead technology.* Research in "compact implosion systems," "lesser weight, smaller diameter" warheads, and high yield-to-weight/volume warheads is going on to improve the current fission and fission-fusion generation of warheads.[45] Also, "modern, small diameter devices for NATO artillery . . . weapons with some intelligence through use of microprocessors . . . [and] smaller and lighter systems which satisfy more stringent requirements" are under development at the laboratories.[46]

• *Insertable nuclear components (INC).* There is a continuing research program, begun over ten years ago, to develop a generic warhead design that could be easily clipped into a dual-capable weapon. These components could be particularly useful aboard submarines where space is limited. The Navy is looking into the feasibility of these designs.[47]

Fig. 3

Strategic warhead count, projected 1984-2000

Year Total	From land	From the sea	From the air
1984 12,968	2,134	5,344	5,490
1985 13,430	2,122	5,728	5,580
1986 13,920	2,180	5,920	5,820
1987 14,679	2,338	6,112	6,229
1988 15,031	2,590	6,112	6,329
1989 15,533	2,800	6,304	6,429
1990 16,017	2,800	6,688	6,529
1991 16,429	2,800	6,880	6,749
1992 16,741	2,800	7,072	6,869
1993 16,933	2,820	7,104	7,009
1994 16,241	3,000	6,272	6,969
1995 16,203	3,300	5,824	7,079
1996 16,307	3,600	5,248	7,479
1997 16,503	3,800	4,864	7,839
1998 15,943	3,800	4,224	7,919
1999 15,767	3,800	3,968	7,999
2000 15,851	3,800	4,032	8,019

Based on Department of Defense statistics.

• *Anti-ballistic missile warhead.* Development of a nuclear "Sentry" low-altitude ABM missile "has been scrapped for the moment" in favor of third generation warhead research (under the Strategic Defense Initiatives). But quick development of an ABM system remains a planning option.[48] Sentry was a part of accelerated ABM research instituted in the October 1981 Strategic Modernization Program, but production plans were cancelled in February 1983. In 1983, the Energy Department stated that there were nine candidates for a nuclear ABM design.

• *Maneuvering reentry vehicles (MARV).* Developmen of advanced MARVs and precision-guided reentry vehicle (PGRVs) began in fiscal 1976. These have had more attentior since the Scowcroft Commission's recommendation to increase development of advanced reentry vehicles and "penetration aids."

Conclusion

As MIGHT BE EXPECTED, many of the early Administration proposals for "quick fixes" to strategic forces hav been abandoned: three Trident submarines every two years Minuteman redeployment in multiple protective structures expanded Trident I deployment on Poseidon submarines, o sea-launched cruise missiles on old Polaris submarines. T the contrary, the Administration is withdrawing old weapon such as B-52Ds, Titan IIs and Polaris submarines on the ra tionale that they are no longer cost effective.[49]

Although new weapons introduced by the Administratio have been portrayed as part of carefully thought out, com prehensive packages, such as the October 1981 Strategi Modernization Program, the Scowcroft Commission and th Nuclear Weapons Employment and Acquisition Master Plan there is no consensus either on the need for individual weap ons or on the scope of grand schemes. The packages ar often for public relations purposes—to find a rationale an build a consensus for weapon systems that have gotten int political trouble.

The many changes in plans for nuclear weapons develop ment and acquisition make clear that, aside from a visio of superiority, there is no coherent plan for the future of th U.S. nuclear arsenal. The last three years have witnessed th following alterations:

• A reduction in the number of planned MX missile wa heads from 2,000 to 1,000;

• The addition of Small ICBMs and B-1Bs to strateg force plans, with the advanced technology (Stealth) bomb er development stretched;

• an increase from 15 to 20 or 25 in the number of Trider submarines to be acquired, with plans to backfit the nint rather than the thirteenth submarine with the Trident I leading to its deployment in 1989 even if the final warhea is not chosen;

• The addition of 1,200 W-70-3 Lance and W-79 eigh inch enhanced radiation warheads;

• an increase in plans for 758 rather than 460 (and pr viously 1,000) W-80-0 SLCM warheads;

• A decrease to 1,739 rather than 3,394 W-80-1 ALC warheads programmed, with a shift to the ACM in the la 1980s;

• A decision to shift from normal fission to enhanc radiation design for 1,000 W-82 155-millimeter warhead followed by cancellation of the program in fiscal 1985;

• Slowing down, changing or cancelling a number programs such as the Standard-2, anti-submarine warfa stand-off weapon, and Sentry.

The Administration's objective of building up nuclear forces is nonetheless being achieved, albeit at a slower pace and with a different mix of weapons than were projected in 1980. The buildup will result in smaller weapons, greater accuracy and higher yield-to-weight ratios. The larger and fundamentally different arsenal will contain weapons far more capable than their predecessors. A larger proportion of the weapons will be deliverable through innovations in MIRVs, selectable yields and smaller sizes. The total yield of the stockpile, now in the range of 5 to 6 billion tons (down from a peak of some 27 to 28 billion tons), will increase as weapons with greater counterforce capability are introduced (Figures 1 and 2).[50]

The Administration's buildup is moving forward irrespective of existing and proposed arms control limitations (Table 5 and Figure 3). The Administration does not view arms control as a practical means to improve U.S. security. "Even if our best efforts at arms control succeed," said Richard Wagner, assistant to the secretary of defense for atomic energy, "we are going to need new nuclear weapon designs in the nineties and beyond."[51] As to whether the Small ICBM violates the SALT II agreement to develop only one new ICBM, Secretary of State George Shultz told the Senate Armed Services Committee, "On our side the new missile would be the Peacekeeper, but that treaty, even if it had been ratified, would have expired at the end of 1985."[52] If arms control didn't exist, it is hard to imagine how the existing weapons acquisition process would be any different. □

1. The Defense Guidance for fiscal 1984 was described in detail in Richard Halloran, "Pentagon Draws Up First Strategy for Fighting a Long Nuclear War," *New York Times* (May 30, 1982), p. 1.

2. Nuclear weapons acquisition plans are determined through a complex bargaining process which begins and ends in the federal bureaucracy. Every year, the President approves a joint Department of Defense/Department of Energy Nuclear Weapons Stockpile Memorandum (NWSM), which specifies nuclear warhead research and development, production, modifications and retirement for the next five years, and projections for 15 years. The Memorandum theoretically takes account of strategic and theater plans, new weapons, the retirement of obsolete weapons and arms control initiatives. These requirements are then translated into budgets, which match resources to plans. Only then does Congress act. It can approve, disapprove or modify the requests. An example of how Congress can indirectly affect the production cycle is seen in U.S. Congress, Senate Appropriations Committee, FY 1984 Energy and Water Development Appropriations, Hearings, Part 2 (hereafter referred to as SAC, FY 1984 EWDA, Part 2), p. 1,187.

3. U.S. Congress, House Armed Services Committee, FY 1984 Atomic Energy Defense Activities (hereafter referred to as HASC, FY 1984 AEDA), p. 19.

4. Office of the Assistant to the Secretary of Defense (Atomic Energy) (hereafter OATSD(AE)), Department of Defense, The Nuclear Weapons Production and RDT&E Complex—Energy Department Support of Defense Department Requirements (Dec. 1982), p. 1; see also SAC, FY 1984 EWDA, Part 2, p. 1,088.

5. The Energy Department has also admitted technical problems with some of its warheads; HASC, FY 1984 AEDA, p. 11; see also OATSD(AE), *op. cit.*, p. 2.

6. Approval Directive for the 1983–1988 NWSM, quoted in affidavit of Herman E. Roser (May 19, 1983), NRDC vs. William A. Vaughn, et. al.

7. SAC, FY 1984 EWDA, Part 2, pp. 1,155, 1,159.

8. SAC, FY 1984 EWDA, Part 2, p. 1,087.

9. George C. Wilson, "Memo Contradicts Reagan on MX Numbers," *Washington Post* (July 2, 1983); it is likely that 150 MXs would be deployed, given that about 150 of the existing Minuteman silos are deep enough to accommodate the MX; U.S. Congress, House Appropriations Committee, FY 1984 Department of Defense Appropriations, Hearings, Part 8, p. 158 (hereafter referred to as HAC, FY 1984 DOD).

10. HAC, FY 1984 DOD, Part 8, p. 125.

11. Defense Department, ICBM Modernization Program Annual Progress Report to the Committees on Armed Services of the Senate and House of Representatives (Jan. 13, 1984).

12. U.S. Congress, Senate Armed Services Committee, FY 1984 Department of Defense Authorizations for Appropriations, Hearings, Part 1, p. 310.

13. House Armed Services Committee, FY 1984 Department of Defense Authorizations for Appropriations, Hearings, Part 2 (hereafter referred to as HASC, FY 1984 DOD), p. 1,008.

14. In 1983, the Director of Los Alamos Laboratory stated that the laboratory had completed development of a high-yield Trident II warhead; SASC, FY 1984 DOE, p. 91.

15. Senate Armed Services Committee, MX Missile Basing System and Related Issues, Hearings, 98th Congress, 1st Session, p. 233.

16. HASC, FY 1984 DOD, Part 5, p. 431.

17. HAC, FY 1984 DOD, Part 8, p. 48.

18. HASC, FY 1984 AEDA, p. 126; SAC, FY 1984 EWDA, Part 2, p. 1,187.

19. SASC, FY 1984 DOE, p. 28.

20. DARPA, FY 1984 Research and Development Program, A Summary Description (April 1983), pp. 3–4.

21. Arms Control and Disarmament Agency, FY 1984 Arms Control Impact Statements, p. 70.

22. HASC, FY 1984 AEDA, p. 126.

23. "USAF Nears Air-to-Surface Missile Start," *Aviation Week & Space Technology* (Feb. 20, 1984), pp. 29–30.

24. John T. Correll, "Deterrence Today," *Air Force Magazine* (Feb. 1984), p. 43.

25. U.S. Congress, Senate Armed Services Committee, Strategic Modernization Programs, Hearings, 1981, pp. 91–92.

26. "Stealthy B-1," *Aviation Week & Space Technology* (Feb. 20, 1984), p. 15.

27. *Ibid.*

28. John T. Correll, *op. cit.*; *Air Force Magazine* (March 1984), p. 28.

29. DARPA, *op. cit.*, pp. 10–11.

30. Arms Control and Disarmament Agency, FY 1979 Arms Control Impact Statements, p. 31.

31. SAC, FY 1984 EWDA, Part 2, p. 1,155.

32. Department of Energy, Congressional Budget Request, FY 1985, Vol. 1: Atomic Energy Defense Activities (Feb. 1984), pp. 241–44.

33. Office of the Secretary of Defense, Justification of Estimates for FY 1984, submitted to Congress, Jan. 1983, p. 29.

34. HASC, FY 1984 AEDA, p. 31.

35. One DOD official referred to them as "the essentially unusable Honest Johns;" SAC, FY 1984 EWDA, Part 2, p. 1,215.

36. SAC, FY 1984 EWDA, Part 2, p. 1,155.

37. *Ibid.*, p. 1,174.

38. HASC, FY 1984 DOD, Part 3, p. 679.

39. SAC, *loc. cit.*, p. 1,174.

40. *Ibid.*

41. SAC, *loc. cit.*, p. 1,188.

42. *Ibid.*

43. HASC, FY 1984 AEDA, p. 27.

44. *Ibid.*, p. 86.

45. SAC, *loc. cit.*, p. 1,176.

46. DOE, FY 1985 Justification, p. 70.

47. Department of the Navy RDT&E Descriptive Summary, FY 1984, p. 703.

48. SASC, FY 1984 DOE, p. 28.

49. SASC, MX Missile Basing, *op. cit.*, pp. 180, 218, 498. Though the Administration justifies new systems because of "dire" conditions, routine retirements will continue. General Charles Gabriel, Chief of Staff of the Air Force, revealed the prevailing pattern of policy: "If we get the MX and those other systems and . . . find the Minuteman is not going to be worth the expense, we will phase it out."

50. Yield estimates reflect uncertainties about individual warheads, particularly about bombs (SASC, Strategic Force Modernization, *op. cit.*, p. 80). MX triples the yield of Minuteman III. Trident II, when deployed on 20 submarines, will have the explosive power of approximately 2,000 megatons, six times the strategic submarine megatonnage today.

51. HASC, FY 1984 AEDA, p. 26.

52. SASC, MX Missile Basing, *op. cit.*, pp. 110, 204.