SECTION 2
THE TRIDENT SUBMARINE AND MISSILE SYSTEM

2.1 TRIDENT SUBMARINES: MOBILE MISSILE SILOS

In 1967 the US Department of Defense engaged the Institute for Defense Analysis to study all the options for modernizing the strategic triad of nuclear force -- silo-based intercontinental ballistic missiles (ICBMs) on the ground, bombers and bomber-launched nuclear weapons in the air, and submarine-launched ballistic missiles (SLBMs) at sea. This investigation was called Strategic Exercise Study X (Strat-X). In 1968 the Underwater Long-range Missile System (ULMS) emerged as the modification for the sea leg of the triad.

ULMS was later called Trident and in 1970 studies were underway to determine how many warheads of various explosive power would fit onto each missile. It may surprise many that the first Trident concept was the Trident-2, or D-5 as it is also known.

Lockheed and the Navy apparently recognized that the huge D-5, which requires a new submarine, was years away, and something had to be done in the meantime to keep the business going. In 1972 a task force was organized to conceptualize a longer-range version of the current Poseidon C-3 missile, which would be designated C-4. On this Extended-range Poseidon (EXPO) task force, as it was called, only existing or very-near-term technology was considered.

After several months a manual was compiled containing options identified during the EXPO exercise, presuming the Navy would immediately request funding from Congress. But the Navy shelved the report, reasoning that the much-cheaper C-4 which would fit into existing submarines might influence Congress to delay the new Trident submarine program.

Only when Trident submarine construction was well underway did Navy officials dust off the EXPO report to advise legislators that developing D-5 missiles and building new submarines would consume years. Those officials then introduced the C-4 proposal as an interim modernization. C-4 became known as Trident-1. That automatically caused the D-5 to be called Trident-2. In that devious fashion the US Navy secured two missile-development projects and two submarine programs.

A. REFITTED POSEIDON BOATS

The first submarine program involved refitting twelve existing Poseidon submarines to carry Trident-1 (C-4) missiles. A later program was to build a fleet of new Trident submarines to carry the bigger Trident-2 (D-5) missiles. Prior to Trident, submarine-launched missiles were inherently less accurate than missiles launched from silos. That was because the starting point of the SLBM's trajectory was not accurately known. In order to plot missile flight path precisely to a target, one must know from where that missile starts. Missile silo locations are precisely known -- thus the accuracy of ICBMs. Submarines, on the other hand could not be positioned closer than several hundred feet, at the best. For that reason pre-Trident SLBMs were not considered to be

silo-killers.

NAVSTAR satellites have removed the problem of accurately determining the submarine's position. (NAVSTAR will be discussed in Chapter 3.2) From a constellation of these navigation satellites the submarine can obtain its position within about 30-40 feet (9-12 meters) before the missiles are launched. With this technique, submarine-launched missiles achieve accuracy comparable to missiles launched from fixed silos. If the missile, itself, were equipped with a Navstar receiver, the MIRVed warheads would have even greater accuracy.

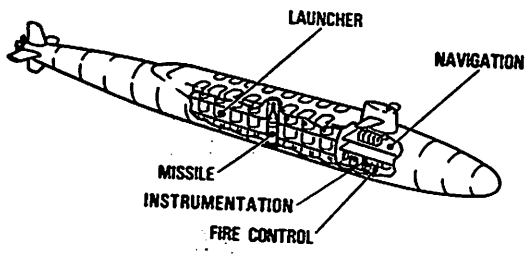

FIGURE 2.1-1
POSEIDON SUBMARINE
Source: Lockheed

There were 41 Polaris ballistic-missile-launching submarines (SSBNs) commissioned between 30 December 1959 and 1 April 1967. The first five were 380 feet long and weighed 6,700 tons. The next five were stretched to 410 feet and 7,900 tons. Then the final 31 were 425 feet (129.5 meters) long, displaced 8,250 tons submerged and 7,320 tons surfaced. All were 33 feet (10 meters) in diameter. (See Figure 2.1-1)

The newest 31 submarines were later refitted to carry Poseidon missiles. During the 1970s, 12 of those 31 were again refitted to carry Trident-1 missiles. All 41 Polaris/Poseidon submarines have now been removed from service and have been decommissioned, or are in the process of being decommissioned.

B. AMERICA'S *OHIO* CLASS

Construction was started in 1976 on the *USS Ohio*, lead ship in the new Trident fleet. (A "class" of identical ships is named after the first, or lead, ship.) These submarines carry 24 missiles each -- half again as many as Poseidon boats. The sub operates on a 100-day cycle -- 70 on patrol and 30 in port for resupply. Each cycle alternates between a gold and a blue crew. Figure 2.1-5 lists the 18 US Trident submarines planned and Figure 2.1-7 presents the US Trident submarine specifications.

There are presently sixteen Trident submarines operational, eight at Sub-Base Bangor and eight at Sub-Base Kings Bay. The schedule is to complete one submarine per year, which means the 18th and last sub will become operational in mid-1997.

It was originally planned that the first eight Trident ships, which operate out of Sub-Base Bangor, would be refitted with Trident-2 missiles during their 10-year overhaul. That has been postponed, but not cancelled: "Backfitting of the C-4 capable SSBNs with the D-5 weapons system has been deferred to 2003. [*ACIS-93*, p. 8] That is the beginning of the second and last round of one-year overhauls.

In September 1994 it was announced that the Pentagon's "Nuclear Posture Review" cut the Trident force from 18 to 14 subs. Each sub will still carry a full compliment of missiles but each missile will be loaded with five warheads instead of four. The submarines to be retired will be four of the eight oldest at Sub-Base Bangor, which carry Trident-1 (C-4) missiles. But they will be preserved in "mothballs" until the START-2

Treaty is fully implemented in 2003. The four remaining oldest subs will be refitted to carry Trident-2 (D-5) missiles. Seven submarines will then be based on each coast.

Reducing the Trident force came about because of public and congressional pressure to save money. But that does not mean the Pentagon intends to curtail nuclear submarine operations. Admiral Bruce DeMars, Director of US Navy Nuclear Propulsion pointed out to Congress that, "in the nuclear deterrent triad, the preponderance has shifted very strongly to the sea-based leg; the nuclear strategic submarines are the only ones that have not been stood down. They continue to make their patrols. And in the future, the plan is to have the majority of our country's strategic deterrent on those submarines..." [HAC-93, Part 6, pp. 1892-1893]

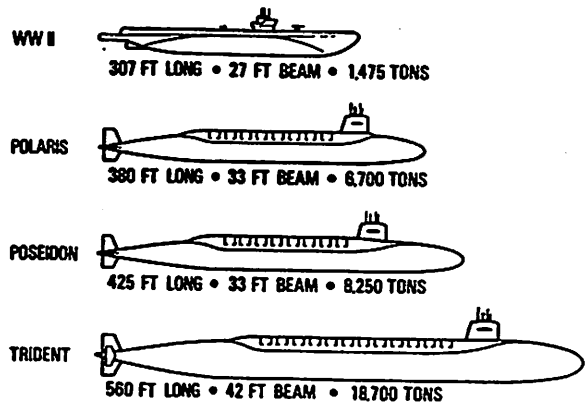

FIGURE 2.1-2
SUBMARINE COMPARISON CHART
Source: Lockheed

According to Vice Admiral Bacon, design of a follow-on nuclear-powered, ballistic missile-launching submarine (SSBN) to Trident will commence in the late 1990s. It will be smaller than Trident and carry fewer missiles with fewer warheads. [Cited in *The Sun*, 31 Oct 91, p. A10.] This is in spite of the fact that Rear Admiral Jones said before the USSR breakup, that *"the Soviets do not currently threaten US SSBNs in the open ocean, nor do we see indications of a future threat."* (Emphasis his.) [SASC-92, Part 2, p. 111.] Because US and British SSBNs only operate in the open ocean, and because any potential threat has been further diminished since the Soviet breakup, there is no military need for a follow-on submarine.

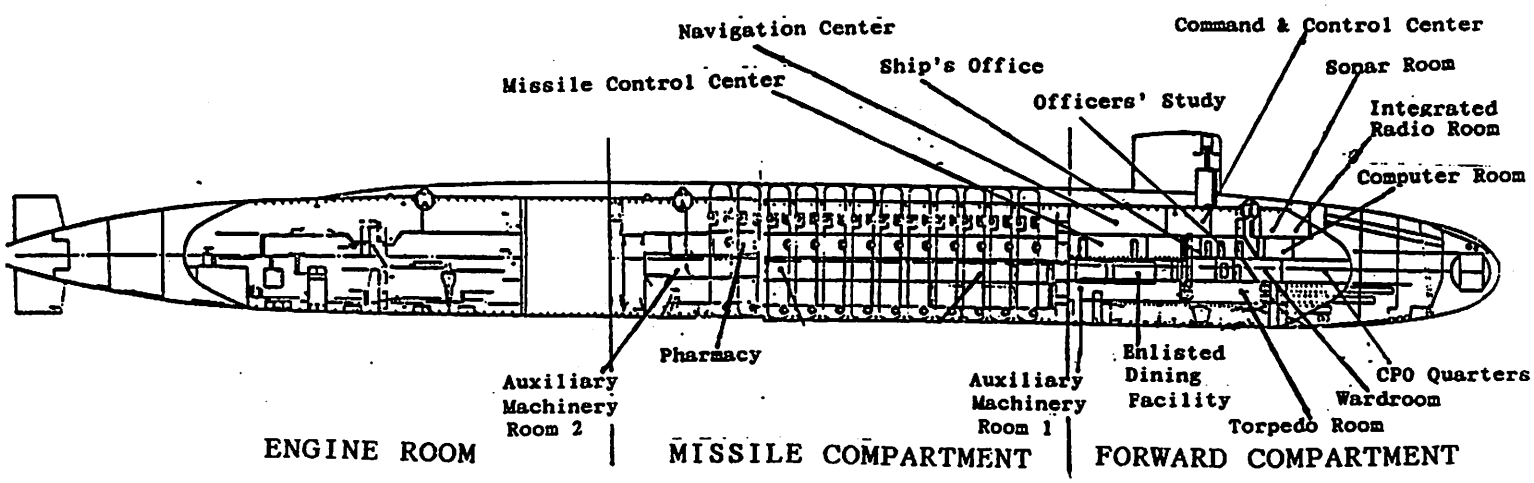

FIGURE 2.1-3
US TRIDENT SUBMARINE LAYOUT
Source: US Navy

That new SSBN program may already be underway. The US Navy is contemplating a replacement for its nuclear-powered attack submarines, designated SSNs. One option being investigated for the New SSN (NSSN) is to have a missile module that can be inserted in the middle. [*The Day*, 17 June 1995, p. 1D] The first Polaris submarines were made in this fashion, by inserting a missile section between two halves of an attack sub.

C. BRITAIN'S *VANGUARD* LINE

USS George Washington, the first nuclear-powered ballistic-missile submarine became operational for the United States in 1960. It carried the first Polaris missiles, known as the A-1, which had a range of 1,200 nautical miles. Two years later, in 1962, that reach was increased to 1,500 nautical miles with the Polaris A-2. In another two years, 1964, the Polaris A-3 became operational with a range of 2,500 nautical miles. Rather than carrying one huge megaton-range bomb, it carried three 200-kiloton bombs which hit the target area in a triangular pattern to distribute the damage more "effectively."

In 1962 Britain decided to de-emphasize its strategic aircraft force and adopt Polaris missiles for the Royal Navy. Four ships of the *HMS Resolution* class were authorized in 1963. *HMS Resolution* was commissioned in October 1967, and the other three followed at approximately one-year intervals. These subs were of British design but carried the new American Polaris A-3 missiles. These missiles later carried British Chevaline warheads. (Chevaline will be discussed in a Chapter 2.3)

1. Britain's Polaris Fleet.

Britain's strategic nuclear arsenal presently includes two of the four original Polaris submarines carrying 16 missiles each, plus one Trident sub also loaded with 16 missiles. This force is assigned to NATO with two restrictions which nullify any real control by NATO : (a) only the British prime minister can order launch of the missiles and (b) Britain retains the right to launch the missiles without consulting with NATO officials. The four Polaris SSBNs are:

HMS Resolution

HMS Repulse

HMS Renown (decommissioned 22 October 1994)

HMS Revenge (decommissioned circa 1992)

In October 1987 *HMS Renown* started what was supposed to be a two-year refit and overhaul. The two years stretched to five. *HMS Revenge* became ready for overhaul but was retired instead of going through another refit. [HC-337, pp. xiii, 30 & 38] A persistent problem with Britain's nuclear-powered submarines seems to be cracking of the nuclear reactor [See *Cracking Under Pressure*].

2. Britain's Trident Subs.

In 1977 the British government set up a secret committee to determine a replacement for the Polaris fleet. That led to building a new fleet of four submarines loaded with missiles leased from the United States. The submarines were designed by the British but the center sections, where the missiles are carried, were based on the design of the *USS*

Ohio-class SSBN. Missile launch tubes for the first boat were made by Westinghouse Marine Division in the United States. The submarine's pressurized water nuclear reactor powerplant is designed to operate seven years without overhaul. The four submarines are listed in Figure 2.1-6.

The first submarine, *HMS Vanguard*, was "rolled out" of its construction hall on 4 March 1992 and slipped into the water the following day. The "naming" ceremony took place on April 30th. Contractor sea trials and Royal Navy contract acceptance trials are now complete. *HMS Vanguard* arrived at Sub-Base Kings Bay on 28 April 1994. Demonstration And Shakedown Operations (DASO) tests, during which test missiles were launched on the US Eastern (Atlantic) Test Range, began on 26 May 1994. *HMS Vanguard* went on its first patrol in international waters on 13 December 1994.

The second submarine, *HMS Victorious*, was rolled into the water early in 1994. By July 1995 the ship was at Kings Bay to fire two missiles during DASO operations. The ship went on its first patrol on 7 January 1996. CND speculates that *HMS Victorious* may assume a tactical role -- that is, each missile armed with one warhead and targeted at regional targets such as in the Persian Gulf. [CND Press Release, 25 July 1995]

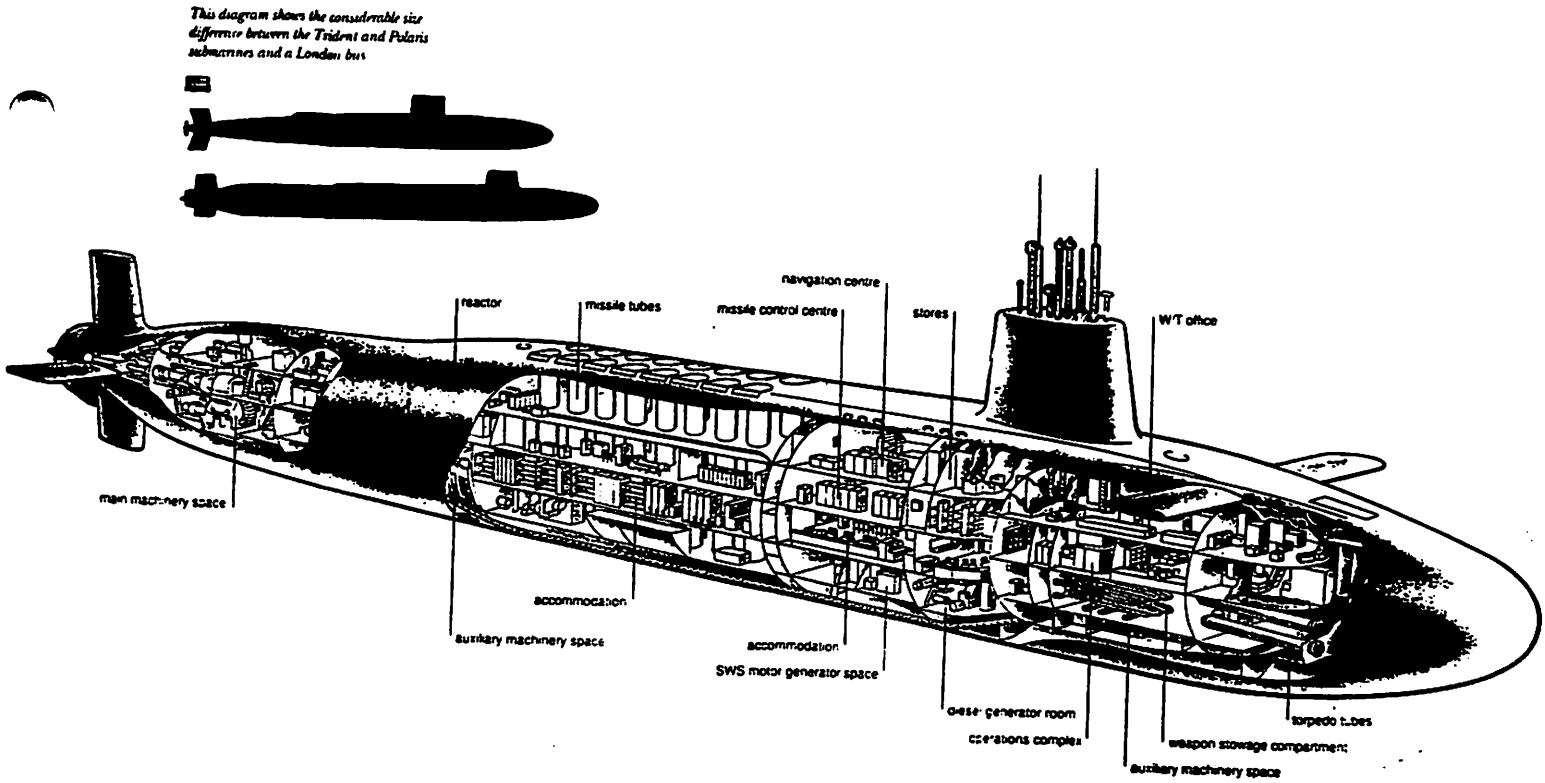

FIGURE 2.1-4
BRITISH TRIDENT SUBMARINE LAYOUT
Source: British Ministry of Defence

The third boat, *HMS Vigilant*, was rolled out of the shed at Barrow-in-Furness on 14 October 1995. CND expects it to arrive at Faslane in 1996, and to go on its first patrol in early 1998. The fourth submarine, *HMS Vengeance*, is still under construction at VSEL-Vickers in Barrow-in-Furness, and expected to go on its first patrol in 2000. Specifications for British Trident submarines are given in Figure 2.1-8.

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FIGURE 2.1-5
US TRIDENT SUBMARINES

SSBN	*USS*	COMMISSION DATE	HOME PORT	MISSILE
726	*Ohio*	Nov 11 81	Bangor	C-4
727	*Michigan*	Sep 11 82	Bangor	C-4
728	*Florida*	Jun 18 83	Bangor	C-4
729	*Georgia*	Feb 11 84	Bangor	C-4
730	*Henry M.Jackson*	Oct 6 84	Bangor	C-4
731	*Alabama*	May 25 85	Bangor	C-4
732	*Alaska*	Jan 25 86	Bangor	C-4
733	*Nevada*	Aug 16 86	Bangor	C-4
734	*Tennessee*	Dec 17 88	Kings Bay	D-5
735	*Pennsylvania*	Sep 9 89	Kings Bay	D-5
736	*West Virginia*	Oct 20 90	Kings Bay	D-5
737	*Kentucky*	Jul 13 91	Kings Bay	D-5
738	*Maryland*	Jun 13 92	Kings Bay	D-5
739	*Nebraska*	Jul 10 93	Kings Bay	D-5
740	*Rhode Island*	Jul 9 94	Kings Bay	D-5
741	*Maine*	Jul 29 95	Kings Bay	D-5
742	*Wyoming*		Kings Bay	D-5
743	*Louisiana*		Kings Bay	D-5

FIGURE 2.1-6
BRITISH TRIDENT SUBMARINES

SSBN	*HMS*	FIRST PATROL	HOME PORT	MISSILE
05	*Vanguard*	13 Dec 94	Faslane	D-5
06	*Victorious*	7 Jan 96	Faslane	D-5
07	*Vigilant*	Early 1998*	Faslane	D-5
08	*Vengeance*	2000*	Faslane	D-5

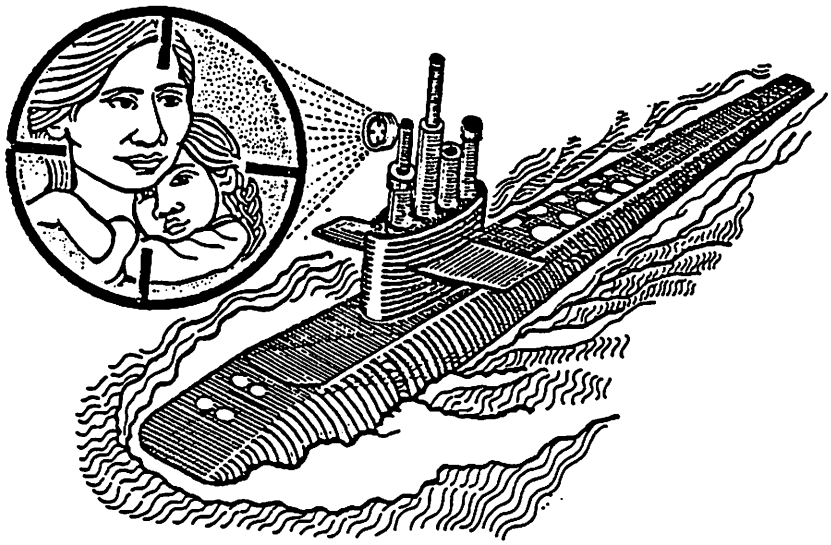
* Expected

FIGURE 2.1-7
US TRIDENT SUBMARINE SPECIFICATIONS

Length	560 feet (170.7 meters)
Hull Diameter	42 feet (12.8 meters)
Height	4 stories
Displacement	16,764 tons surfaced
	18,750 tons submerged
Speed	20 plus knots (US Navy)
	30 knots (non-governmental organizations.)
Power Plant	1 pressurized water nuclear reactor.
	2 geared turbines, 1 shaft.
	90,000 horsepower.
Navigation System	2 Mark-2, Mod-7 Ship Inertial Navigation System (SINS).
	Electrostatically Supported Gyro Navigator (ESGN).
	Satellite Receiver.
Crew	157 with Trident-1 missiles. (15 officers and 142 enlisted men.)
	165 with Trident-2 missiles. (15 officers and 150 enlisted men.)
Armaments	4 torpedo tubes.
	24 Trident SLBMs carrying up to 192 Mk-4/W-76 or Mk-5/W-88 MIRVs.

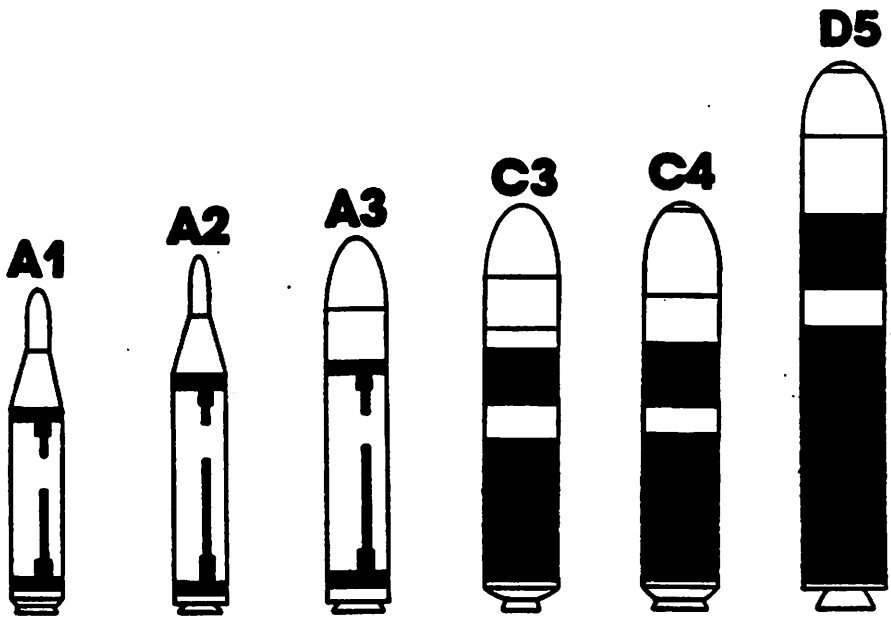
FIGURE 2.1-8
BRITISH TRIDENT SUBMARINE SPECIFICATIONS

Length	491 feet (149.6 meters)
Hull Diameter	43.3 feet (13.2 meters)
Height	4 stories
Displacement	16,000 tonnes submerged
Speed	25 knots submerged
Power Plant	1 pressurized water PWR-2 nuclear reactor.
	Geared steam turbines, 1 shaft
Navigation System	
Crew	132
Armaments	4 torpedo tubes for Spearfish torpedos.
	16 Trident-2 SLBMs carrying up to 128 Mk-4/100-kt MIRVs



2.2 TRIDENT MISSILES: PRECISION DELIVERY VEHICLES

Submarine-launched Trident missiles have important advantages over ICBMs. They can reach their targets in 10-15 minutes as compared to 30 minutes for an ICBM. They can approach those targets from all directions from unknown launch points, as opposed to only over the north pole for ICBMs launched from fixed silos of targeted locations. Those advantages would confuse detection and greatly enhance the element of surprise which is needed for a first strike. On top of that, Trident missiles hold enough warheads to pro-



	Polaris (A1)	Polaris (A2)	Polaris (A3)	Poseidon (C3)	TRIDENT I (C4)	TRIDENT II (D5)
Length (ft.)	28.5	31.0	32.32	34.0	34.0	44.6
Diameter (in.)	54	54	54	74	74	83
Weight (lb.)	28,800	32,500	35,700	64,400+	73,000+	130,000+
No. of motors	2	2	2	2	3	3
Range (naut. mi)	1,200	1,500	2,500	2,500	4,000+	4,000+

FIGURE 2.2-1
SLBM COMPARISON CHART
Source: US Navy

vide a first-strike force all by themselves, against any adversary, while remaining invulnerable to a sneak attack. Trident missiles, supported by extreme low frequency (ELF) submarine communications and NAVSTAR, make ICBMs obsolete. (ELF and NAVSTAR will be discussed in Section 3.)

A. TRIDENT-1 (C-4)

Trident-1 missiles would be key players in a first-strike capability. They are now fully operational with some 192 missiles deployed in the Pacific in 8 Trident submarines. Fiscal year 1984 was the last year Trident-1 missiles were ordered, bringing the total number procured to 570. Fiscal year 1989 was the last year funds were requested for the Trident-1 program.

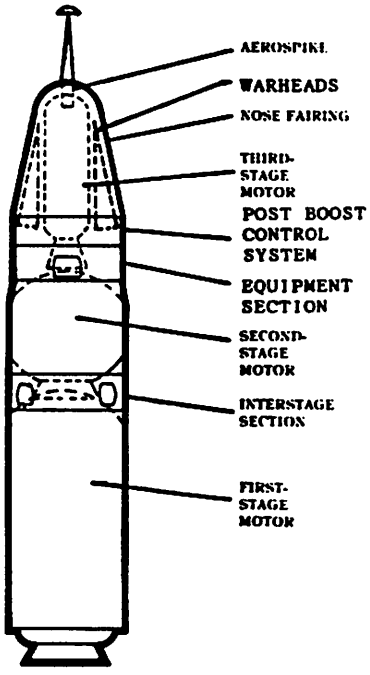


FIGURE 2.2-2
TRIDENT-1 (C-4) MISSILE
Source: US Navy

Each missile can carry eight 100-kiloton Mark-4/W-76 MIRVs. That adds up to 1,536 warheads poised to strike. Even missiles on submarines in port could reach their targets, but because of their longer flight time they would have to carry the second warhead assigned to each silo. Figure 2.2-5 provides the Trident-1 (C-4) missile specifications.

C-4 missiles are not precise enough, and the Mark-4/W-76 warheads not powerful enough, to destroy sufficient silos for a first strike without outside navigation aid. With its one-dimensional stellar inertial guidance (SIG) system the missile follows a single star as a guide toward its target. This system of updating the inertial navigation package provides an accuracy of about 750 feet. But if the missiles, themselves, received in-flight course corrections from NAVSTAR satellites they could deliver the bombs within 300 feet of their targets. By sending two warheads from different missiles to the same target, known as 2-on-1 cross targeting, the probability of destroying a hardened missile silo would be 93 percent. Such a hard-target capability would establish the Trident-1 as a true first-strike weapon, but that is not the end of US overkill in the post-cold-war era.

B. TRIDENT-2 (D-5)

Eight Trident submarines currently operate out of Sub-Base Kings Bay in Georgia, loaded with the new Trident-2 missiles. Two more subs will be delivered by 1997. That will complete the production of 18 subs total. (Later, four of the older subs will be retired bringing the final inventory to 14 subs.) When 21 subs were planned, the Navy wanted 28 development and 871 procurement missiles. For the 14-submarine program the required number of procurement missiles is much lower. If none of the west-coast Trident subs are retrofitted to carry Trident-2 missiles, the 337 missiles delivered by the end of fiscal

year 1995 would be sufficient.

Trident-2s have the accuracy and quick delivery time necessary to decapitate command posts, as well as demolishing silos. The 24 missiles on each submarine can deliver 192 Mark-5/W-88, 475-kiloton warheads. Using the 2-on-1 cross-targeting pattern, 95 percent of hardened command posts or missile silos would be destroyed. However, because of safety and manufacturing problems only about 400 W-88 warheads were produced. Consequently, the Mark-4/W-76 warhead was introduced on Trident-2. Specifications of the Trident-2 (D-5) missile are given in Figure 2.2-6.

Because of the 400-500 foot accuracy possible with the two-dimensional SIG system, which triangulates on two stars to update the inertial guidance package, NAVSTAR in-flight fixes are not necessary for the Trident-2/Mark-5 combination. The increase in silo-kill efficiency for two-on-one cross targeting would be less than one percent. NAVSTAR is still needed, however, to accurately position the submarine while launching missiles.

The Trident-2/Mark-4 combination is not as deadly. Trident-2 missiles could carry 12-14 Mark-4/W-76 warheads but they are limited to eight by the START-1 Treaty. Since this warhead has 100 kilotons yield, rather than 475, the 2-on-1 cross-targeting probability of destroying a hard target would be reduced to 84 percent. For that reason, if the missile carries Mark-4 reentry vehicles it would require in-flight navigation fixes from NAVSTAR to give it a first-strike silo-kill probability of 93 percent. However, for many targets in the post-cold-war era, which are softer, the probability of kill would be more than adequate.

Funded in the Research, Development, Testing and Evaluation (RDT&E) area is the SLBM Effectiveness Enhancement program for Trident missiles. Among other things it addresses the ability to retarget Trident-2 SLBMs in the submarine.

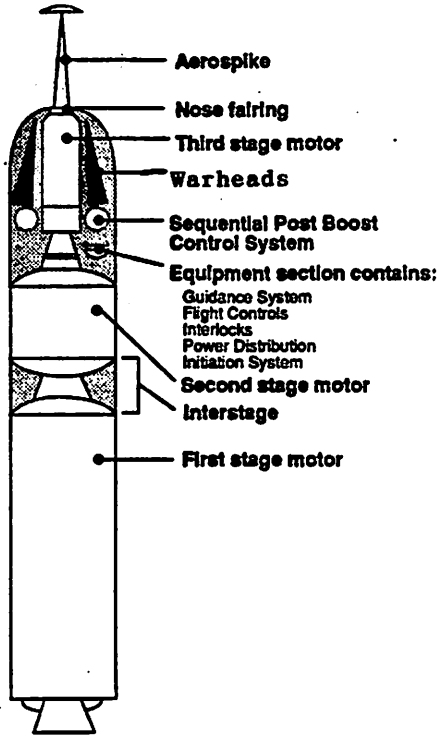


FIGURE 2.2-3
TRIDENT-2 (D-5) MISSILE
Source: US Navy

C. BRITISH MISSILES

The Polaris A-3 is still operational on British missile-launching submarines. It was the first missile with multiple reentry vehicles (MRVs), all of which went to the same target but hit in a triangular pattern to distribute the damage more "effectively." (Not to be confused with MIRVs which can be sent to different targets.) The A-3 is 32.32 feet long, 54 inches diameter, and weighs 35,700 pounds. Its two-stage rocket motors boost the missile to a range of 2,500 nautical miles. The 1962 Nassau Agreement between Prime Minister Harold Macmillan and President John Kennedy provided for purchase of those missiles. It is believed that Britain's share of de-

velopment costs was written off in exchange for a lease on the island of Diego Garcia, which has become the key US base in the Indian Ocean.

On 15 July 1980 British Prime Minister Margaret Thatcher announced that she had arranged with US President Jimmy Carter to purchase Trident-1 (C-4) missiles, along with necessary support equipment, for the new British submarines. Almost two years later, on 11 March 1982, the Reagan administration agreed to furnish the more modern Trident-2 (D-5) missiles. This decision neglected a poll where 63 percent of some 1,040 Britons surveyed were in favor of dismantling their nuclear force. [*New York Times*, 28 February 1982, p. 3] It became public in September of that same year that the missiles would be serviced at US Sub-Base Kings Bay in Georgia, rather than at RNAD Coulport in Scotland. British missiles are ordered and stored with US missiles. They are not assign- ed to Britain until they are drawn out of inventory to in- stall in a submarine. When the British submarine goes into its seven-year, long-term overhaul, the missiles (less their warheads) will be unloaded at Sub-Base Kings Bay in the US. The missiles will normally stay in the submarine for the duration of its seven-year commission, but capabilities will be available if in an emergency the missiles must be removed at RNAD Coulport.

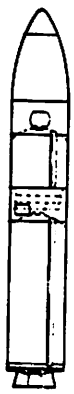


FIGURE 2.2-4
POLARIS (A-3) MISSILE
Source: Lockheed

So far, 44 Trident-2 missiles have been purchased by Britain -- 3 in fiscal year (FY) 1990, 23 in FY 1992, and 18 in FY 1993. (US FYs run from 1 October through 30 September). None were purchased in FYs 1994 through 1996. The total number remaining to be bought is classified in Britain but US sources indicate 21 -- 7 each in FYs 1997, 1998, and 1999. So far, four British missiles have been fired in DASO tests. Others have been drawn out of inventory to equip the first two British submarines. According to Scottish CND the second submarine, *HMS Victorious,* was only outfitted with 12 missiles. The reason for this reduced load is not known.

Figure 2.2-6 can be used as a description of the British Trident-2 missile. The MIRV warhead will have the Mark-4 reentry vehicle shell but the bomb is ostensibly of British manufacture. By a political decision, and not because of capability constraints, the missiles will carry an average of only eight MIRVs each -- no more than 128 warheads on each submarine. In fact, the Ministry of Defence now states that each submarine will carry no more than 96 warheads, and possibly significantly fewer. [Nuclear Weapons section of 1994 Defence White Paper, p. 19]

D. THE TACTICAL TRIDENT

The use of Trident missiles in a regional war as a tactical nuclear weapon has been discussed and speculated on since at least the end of the cold war. And there is

good cause for such discussion and speculation. We still have the same military leaders who planned total thermonuclear war that would incinerate and irradiate the globe. Why wouldn't they now fashion a strategy to nuke a few upstart dictators if it served their national interests -- especially if that strategy justified their favorite weapon, Trident? Let us look a the evidence.

1. American Strategy.

When in late 1991 Air Force General Lee Butler, then director of US nuclear targeting, convened the Joint Strategic Target Planning Advisory Group, he set in motion the crafting of post-cold war nuclear doctrine. Under the chairmanship of former Air Force Secretary Thomas Reed, this so-called Reed Panel made four far-reaching recommendations which point a significant finger toward the tactical use of Trident missiles. These were explained in Chapter 1.1 but will be reviewed here in context.

The first of these was to retain a significant number of strategic nuclear weapons to preserve America's prestige and dissuade nuclear proliferation by countries such as Germany and Japan. This did not relate too much to tactical situations but let us go on.

The second recommendation was that America should rethink its 1979 pledge not to use nuclear weapons against a non-nuclear country. Since chemical and biological armaments are classed as weapons of mass destruction, the Reed Panel's rationale was that nuclear weapons should be used to deter their use, also.

Thirdly, the Reed Panel suggested that nuclear arms be used to protect America's interests through preventing hostilities in the Third World by targeting countries that have never been targeted before. The purpose of this would be to prevent annihilation of states such as Israel and Taiwan, or the seizure of critical raw materials such as oil, or foreign dominance of a sector of space.

The fourth recommendation tied all this revised nuclear doctrine together and pointed to Trident as the centerpiece. The Reed Panel outlined a "Nuclear Expeditionary Force" armed with a few air-launched and submarine-launched strategic weapons. We have heard about a few conventionally-armed air-launched cruise missile being used in the Persian Gulf war. This was certainly a practice exercise for the strategic nuclear version. But the only submarine launched strategic weapon is Trident. What the Reed Panel was refering to was a tactical Trident.

Since the retirement of land-based and sea-based tactical nuclear weapons the US Air Force has held a monopoly in that area. Some 800 tactical B-61bombs make up the entire US inventory of tactical nukes. Nevertheless, it has been difficult for the Navy to regain a footing in that area. But the admirals are trying. And their statements to that effect seem purposely aimed at confusing the public. For instance, in September 1994 during public discussion on how to counter the chemicnd biological threat, Assistant Defense Secretary Ted Warner said that the development of conventional versions of Trident missiles is not at the forefront of Pentagon thinking regarding ways to use strategic assets in a conventional role. [*Defense News*, 19 September 1994, p. 12] Of course itsn't. The Reed Panel wasn't talking about putting conventional bombs on Trident. It was talking about using Trident-delivered nuclear bombs against regional targets. But introducing conventional weapons into the discussion steered the thinking safely away from the real plans. (It should be noted, however, that the 11th DASO test on

18 November 1993 used conventional warheads.)

Threats of atomic, biological and chemical wafare again surfaced in the media during June 1995. This was in the context of fighting a war 20 years from now. Andrew Krepinevich, director of the Defense Budget Project, emphasized the need for long-range precision strikes against missile emplacements and other facilities far behind enemy lines. [*Defense News*, 5 June 1995, p. 1] The capability to do this exceeds the performance record of even the smartest conventional bomb. Effectively destroying those hard-to-reach and hard-to-kill targets requires the destructiveness of nuclear energy.

The debate on how nuclear policy should interact with the threat of chemical and biological weapons really heated up in August 1995 when Tariq Aziz, Iraq's deputy foreign minister, announced that only the threat of nuclear retaliation prevented Sadam Hussein from using chemical weapons during the Persian Gulf war. By September 1995 the Pentagon was under pressure to clarify its nuclear doctrine in this regard, at least publicly -- it has already been spelled it out internally: "The normal peacetime role of the ballistic missile submarine will continue to be nuclear deterrence.... Endurance and responsiveness, coupled with the submarine's survivability, will provide a prevasive threat to *any nation* considering the employment of nuclear, *chemical*, or *biological* weapons against the United States or its allies." [*Submarine Roles in the 1990s and Beyond*, p. 11; emphasis added] Whatever, the pressure is on, and the public will be hearing more about how the US plans to respond to the chemical/biological threat. Don't be surprised when you learn that Trident is the centerpiece of those plans.

2. British Strategy.

Britain has been a little more blatant in acknowledging its intention to use Trident in a tactical role -- which it refers to as sub-strategic. In October 1993 Britain's then Secretary of State for Defence, Malcolm Rifkind, told the House of Commons that the Royal Navy would assume the sub-strategic nuclear role which had previously been Air Force turf. He set the date as 2004 when the Royal Navy will take over this responsibility, and named the Vanguard-class Trident submarines as the dispenser of sub-strategic weapons. [*Defense News*, 19 September 1994, p. 12]

In the Nuclear Weapons Section of its 1994 Defence White Paper, the Ministry of Defence says that a massive nuclear strike is not enough to insure deterrence. It says: "We also need the capability to undertake nuclear action on a more limited scale in order to demonstrate our willingness to defend our vital interests to the utmost, and so induce a political decision to halt aggression without inevitably triggering strategic nuclear exchanges." The MoD further stated: "We also intend to exploit the flexibility of Trident to provide the vehicle for both the sub-strategic and strategic elements of our deterrent." [Nuclear Weapons Section of 1994 Defence White Paper, p. 19] Milan Rai has done an excellent job of documenting British ambitions for a tactical Trident. [See References below]

* * * * *

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FIGURE 2.2-5
TRIDENT-1 MISSILE SPECIFICATIONS

Length	34.0 feet (10.36 meters)
Diameter	74 inches (1.88 meters)
Launch weight	71,000+ pounds (32,000+ kilograms)
No. of motors (stages)	3 plus post-boost control system.
Motor Case Materials	Kevlar/Epoxy.
Propellant	Solid -- Cross-linked double base. Ammonium perchlorate, aluminum, nitrous cellulose-nitroglycerin, and HMX.
Range	4,000+ nautical miles (7,400+ kilometers) with a full load of warheads.
	Up to 6,000+ nautical miles (11,000+ kilometers) with a reduced load of W/Hs.
	An aerospike which telescopes out the tip of the nose fairing after the missile is launched, forms a streamlined air flow to increase range.
Navigation system	One-dimensional stellar inertial guidance (SIG).
	NAVSTAR GPS update to position submarine before launch.
	Possibly NAVSTAR receivers in the missile.
Accuracy	300-400 feet CEP with NAVSTAR receivers in missile.
Max. warhead loading	8 Mark-4/W-76, 100 kt MIRVs.

FIGURE 2.2-6
TRIDENT-2 MISSILE SPECIFICATIONS

Length	44.6 feet (13.75 meters)
Diameter	83 inches (2.13 meters)
Launch weight	130,000 pounds (58,968 kilograms)
No. of motors (stages)	3 plus post-boost control system.
Motor Case Materials	1st Stage -- Graphite/Epoxy 2nd Stage -- Graphite/Epoxy 3rd Stage -- Kevlar/Epoxy
Propellant	Solid -- Nitrate ester plasticized polyethylene glycol.
Range	4,230 nautical miles (7,838 kilometers) with a full load of warheads. Up to 6,000+ nautical miles (11,000+ kilometers) with a reduced load of W/Hs. An aerospike which telescopes out the tip of the nose fairing after the missile is launched forms a streamlined air flow to increase range.
Navigation system	Two-dimensional stellar inertial guidance (SIG). NAVSTAR GPS update to position the submarine before launch.
Accuracy	400-500 feet CEP.
Max. warhead loading	8 Mark-5/W-88, 475 kt. MIRVs, or 12 Mark-4/W-76, 100 kt MIRVs.

FIGURE 2.2-7
TRIDENT-2 MISSILE FLIGHTS
(British flights not included)

FLIGHT	DATE	RESULTS	REMARKS
Dev. #1	Jan 15 1987	Success reported	Launch delayed 2.5 hours due to antenna and computer problems.
Dev. #2	Mar 17 1987	Success reported	
Dev. #3	Apr 30 1987	Success reported	
Dev. #4	Jun 12 1987	Success reported	
Dev. #5	Jul 20 1987	Success reported	
Dev. #6	Sep 8 1987	Success reported	9 Mark-4 RVs plus instrumentation package.
Dev. #7	Oct 6 1987	Failure	Malfunction in PBCS and Electronics Package. Navy claims Success.
Dev. #8	Dec 10 1987	Success reported	
Dev. #9	Jan 21 1988	Failure	Flight Control failure during 3rd stage burn. Navy claims Partial Success.
Dev. #10	Apr 7 1988	Success reported	
Dev. #11	Apr 28 1988	Success reported	
Dev. #12	May 25 1988	Success reported	Mark-4 RVs.
Dev. #13	Jul 7 1988	Failure	Thrust Vector Control System malfunctioned during 1st stage burn.
Dev. #14	Aug 27 1988	Success reported	
Dev. #15	Sep 19 1988	Failure	Missile went off course during 2nd stage burn. Navy claims a No Test.
Dev. #16	Nov 7 1988	Success reported	First stage performance questionable.
Dev. #17	Dec 19 1988	Success reported	
Dev. #18	Jan 9 1989	Unknown	
Dev. #19	Jan 26 1989	Success reported	Possible malfunction of submarine's deployment gas generator.
PEM-1	Mar 21 1989	Failure	Missile cartwheeled immediately after 1st stage ignition.
PEM-2	Aug 2 1989	Success reported	
PEM-3	Aug 15 1989	Failure	Missile exploded 4 seconds after launch.
PEM-4	Dec 4 1989	Success reported	
PEM-5	Dec 13 1989	Success reported	
PEM-6	Dec 15 1989	Success reported	

[MORE]

TRIDENT MISSILES

FLIGHT	DATE	RESULTS	REMARKS
PEM-7	Jan 151990	Success reported	
PEM-8	Jan 16 1990	Success reported	
PEM-9	Feb 12 1990	Success reported	1st of two launches 20 seconds apart. Navy calls this a DASO launch.
DASO #1	Feb 12 1990	Success reported	2nd of two launches 20 seconds apart.
DASO #2	Mar 11 1990	Unknown	
DASO #3	Sep 26 1990	Unknown	
DASO #4	Nov 29 1990	Unknown	
DASO #5	Apr 15 1991	Unknown	
DASO #6	Aug 30 1991	Unknown	
DASO #7	Nov 11 1991	Unknown	
DASO #8	Jul 29 1992	Unknown	
DASO #9	Nov 19 1992	Unknown	
DASO #10	Aug 20 1993	Unknown	
DASO #11	Nov 18 1993	Unknown	Tested with conventional warheads.
DASO #12	Dec 1 1994	Unknown	
DASO #13	Dec 7 1995	Unknown	
CET #1-4	Nov 3 1990	Unknown	4 missiles launched
CET #5-8	Jul 29 1991	Unknown	4 missiles launched
CET #9-12	Nov 11 1991	Unknown	4 missiles launched
CET #13-16	Feb 22 1992	Unknown	4 missiles launched
CET #17-20	Jun 18 1992	Unknown	4 missiles launched
CET #21-24	Aug 4 1992	Unknown	4 missiles launched
CET #25-28	Sep 3 1992	Unknown	4 missiles launched
CET #29-32	Nov 10 1992	Unknown	4 missiles launched
FCET #1-2	Jul 7 1993	Unknown	2 missiles launched
FCET #3-6	Jan 20 1994	Unknown	4 missiles launched
FCET #7-8	Jan 19 1995	Unknown	2 missiles launched
FCET #9-10	Apr 19 1995	Unknown	2 missiles launched

Development tests are pad launch. All others are from a submarine.
The Strategic Submarine Branch of the US Navy states that flight test results from PEM, DASO, CET and FCET are classified and not reportable.

Dev. = Development missile.
PEM = Production Evaluation Missile.
DASO = Demonstration And Shakedown Operations (for new submarines).
CET = Commander-in-chief Evaluation Test (from operational subs).
FCET = Follow-on CET.

FIGURE 2.2-8
BRITISH TRIDENT-2 MISSILE FLIGHTS

FLIGHT	DATE	RESULTS	REMARKS
DASO	May 94	Not Avail.	From *HMS Vanguard*
DASO	June 94	Not Avail.	From *HMS Vanguard*
DASO	25 Jul 95	Not Avail.	From *HMS Victorious*
DASO	Not Avail.	Not Avail.	From *HMS Victorious*

FIGURE 2.2-9
TRIDENT-2 MISSILE PROCUREMENT
ACTUAL AND PLANNED

FISCAL YEAR	US MISSILES ORDERED	BRITISH MISSILES ORDERED	US UNIT PRICE *	BRITISH UNIT PRICE
1987	21		62.6/82.2	
1988	66		30.3/38.3	
1989	66		28.0/34.1	
1990	41	3	32.6/38.3	
1991	52		28.2/32.2	
1992	28	23	35.8/40.0	
1993	21	18	41.5/45.3	
1994	24		46.9/49.7	
1995	18		38.4/39.6 est.	
1996	6		55.3/55.3 est.	
1997	7 planned	7 planned	---/51.3 est.	
1998	7 planned	7 planned	---/51.7 est.	
1999	7 planned	7 planned	---/58.1 est.	
2000	12 planned		---/52.3 est.	
2001	12 planned			
2002	12 planned			
2003	12 planned			
2004	12 planned			
2005	10 planned			

* "Then year" dollars/1966 dollars (both in millions)

Missiles are usually delivered two years after ordering.

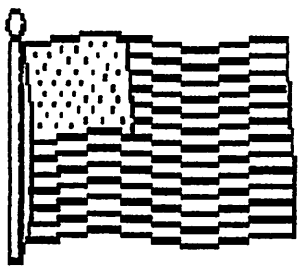
Trident-2 missile production will stop at end of fiscal year 2005 unless service life of Trident submarines is increased to 40 years.

2.3 TRIDENT WARHEADS: FAST, TRICKY, AND BURROWING

Early in the nuclear age, in an effort to insure civilian control over the military, the Atomic Energy Commission was established to take charge of all things nuclear. That commission has now evolved into the Department of Energy (DOE) which has the last say regarding nuclear bombs. But in a bureaucratic struggle the Department of Defense (DOD) became designer and fabricator of the reentry vehicle shells which encase the bombs and protect them from the tremendous heat encountered while reentering the earth's atmosphere. That is why warheads have "Mark" and "W" designations. The "Mark" number is DOD's identification of a specific reentry vehicle shell. The "W" number is DOE's bomb model.

After a DOD contractor fabricates the reentry vehicle shell, it is sent to Pantex, Texas where the DOE agent installs the bomb. The assembled reentry vehicle, with bomb inside, is then sealed and turned over to DOD for deployment. If for any reason the reentry vehicle must be disassembled, it is returned to Pantex.

In this handbook I shall use, for instance, Mark-4 or Mark-5 when referring to reentry vehicle shells. W-76, W-88, and the like will designate bombs. And the Mark-4/W-76 or Mark-5/W-88 assemblies will be called warheads. I may refer to either a reentry body or the total warhead as a MIRV. This terminology is not entirely consistent but it should simplify the language somewhat.



A. AMERICAN WARHEADS

There are currently two warhead sizes for US Trident missiles. The Mark-4/W-76 has 100 kilotons yield and can be carried eight maximum on Trident-1 and 12-14 on Trident-2, but the US is restricted to 8 by START-1. The Mark-5/W-88 warhead has 475 kilotons yield and can be carried eight maximum on Trident-2 only. It is too big to fit on Trident-1.

1. Mark-4 and Mark-5.

Problems at the Rocky Flats plant in Colorado, combined with lack of safety features in the bomb itself, have halted the production line for W-88 bombs. An official production halt was announced by President Bush during his January 1992 State-of-the-Union address. According to Rear Admiral Raymond G.Jones Jr., there are enough Mark-5/W-88 warheads to equip the first four east-coast Trident submarines. From then on Trident-2 missiles will be loaded with the 100-kiloton Mark-4/W-76 war-

heads which became available as refitted Poseidon submarines were deactivated. [SASC-92, Part 2, p. 111.]

Other sources say that only about 400 of the Mark-5/W-88 warheads have been produced. That is enough for two submarines, not four as Admiral Jones indicated. [*The Sun*, 20 December 1991] If the 400 number is correct, then three possibilities could exist: (a) the first four east-coast submarines are not fully loaded with missiles, (b) their missiles do not carry a full load of warheads, or (c) some of the missiles on those submarines are loaded with the smaller Mark-4/W-76 warheads. But there may be another possibility in the offing.

2. A Mark-5/W-89 Warhead?

A likely candidate for Trident is a W-89 bomb in the Mark-5 reentry vehicle. Like the W-87, it has all the latest safety features. The W-89 is not in production or in the stockpile. It was originally slated for the Sea Lance anti-submarine missile and the SRAM-2, both of which have been cancelled. But the W-89 went ahead, anyway, as a technology demonstration program for recycling the "pits" (plutonium triggers) from retired nuclear weapons. This means the W-89 could go into production using the nuclear cores from old warheads, even though Rocky Flats remains closed. Dr. Ray Kidder says this could be accomplished in three years but would require three underground nuclear tests. [See Kidder, pp. 12-14]

Later there appeared in the DOE budget for Lawrence Livermore National Laboratory a line item called "Submarine Launched Ballistic Missile Replacement Warhead." Could this be a continuation of the W-89 pit recycling study? At any rate, the replacement warhead study was completed in fiscal year 1994. [See Beers.]

B. MARVING THE MIRVS

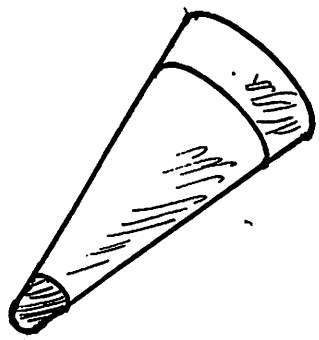
Perhaps another reason the large Trident warhead was cancelled is because new developments are coming to a head. Maneuvering reentry vehicles (MARVs) have been in development and testing for over two decades. A MARV was deployed on the now-deactivated Pershing-2 missiles. An earth-penetrating MARV was also designed for Pershing-2 but never deployed. MARV development dates back to the late 1960s.

1. Chevaline, SRB, and the Mark-500.

Britain started the Chevaline warhead for its Polaris missiles in 1969. Chevaline is a rudimentary MARV. All ground- and flight-test work was done on the US Eastern Test Range and at Cape Canaveral, Florida. [*AW&ST*, 4 February 1980, p. 31; *AW&ST*, 16 Jun 80, p. 263.] The bomb was developed at the Nevada Test Site. It was the mid-1980s before Chevaline warheads were finally installed on all British Polaris missiles. With a price tag of 2-billion pounds, it turned out to be a very long and very expensive program.

The exact number of Chevaline warheads on each missile is not publicly announced. Some observers refer to three and others say two. I believe two is correct.

All Chevalines go to the same target, but they perform pre-programmed maneuvers to confuse interceptor missiles which might be guarding the target city. One might even act as a decoy while the second is aimed at the target.



I also believe Chevaline warheads are in the 75-100 kiloton range because the US Navy had a parallel effort during the late 1960s. It started off as an independent-development project at Lockheed (funds furnished by the DOD for Lockheed to use to enhance their know-how as a Pentagon contractor). This Special Reentry Body (SRB), as it was called, had an asymmetric exterior shape with a bent nose tip that caused the vehicle to ride nose high as it reentered the atmosphere -- what aerodynamicists would call a high angle of attack.

The SRB also had interior weights which could slide from side to side. When the weights shifted to the right, for example, the center of gravity would become misaligned from the center of pressure. Aerodynamic forces would then tend to re-align these centers along the flight path by rolling the SRB clockwise. But, being asymmetric, the SRB would then turn to the right. This can be crudely analogized to maneuvering a surf board by shifting body weight.

By carefully calculating the distance and timing of weight shifts, the SRB can be programmed to perform pre-planned maneuvers, ostensibly to evade interceptor missiles or to confuse the opponent regarding the missile's aim point. Inherently, this system is less accurate than a strictly ballistic reentry vehicle -- to improve accuracy it would require the target-sensing MARV being investigated by other companies. Nevertheless, flight tests of the SRB design would accumulate much data that is directly transferable to a precision MARV.

The SRB evolved into the US Navy's Mark-500 MARV for the Trident-1 missile. It was never deployed but it was flight tested on modified Atlas missiles launched from Vandenberg Air Force Base as well as on some Trident-1 development flight tests from Cape Canaveral. For a while I had design responsibility for both the SRB and the Mark-500. One ground rule was that the Mark-500 use the same warhead as the Mark-400 (now the Mark-4) ballistic MIRV. At the time I left Lockheed that warhead was 75 kilotons. It has since been increased to 100 kilotons.

Since the Chevaline program was also proceeding during the 1970s, I believe it benefitted from the flight tests of the Mark-500 MARV. The last funding for the Mark-500 was in FY 1983, after Chevaline deployment had started. It seems likely that Britain also designed its Chevaline for 75-100 kiloton bombs. If that is true, Chevaline warheads should fit into the Mark-4 reentry vehicle shells being purchased from the US.

2. Mark-6 And Earth Penetrators.

Although development of MARVs began in the 1960s, there has been scant information in the public domain about them since the early 1980s. Evidence does exist, however, that a target-homing MARV is being developed for Trident-2.

The last big flurry on information about MARVs came in 1984. Boeing, Convair Division of General Dynamics, Martin Marietta (now merged with Lockheed), and Bell Aerospace Texron were awarded $5-million each to define a concept for a MARV to be used on the Midgetman small ICBM. Technology was to be drawn from all existing strategic and tactical programs, including cruise missile guidance, to define a target-homing sensor. DOD plans then were to spend $1 billion through FY 1989 to develop a precision MARV with zero-miss capability that could also be used on Trident-2 missiles. [*AW&ST*, 5 March 1984, pp. 14-15]

In 1984 I was supplied with internal budget documents from General Electric's Reentry Systems Operations office in Philadelphia (since assumed by Martin Marietta which in turn has merged with Lockheed). In addition to other reentry vehicle work, that office was also working on a MARV for Trident-2 designated Mark 6. As far as I can translate the acronyms and abbreviations used, the sales projection for Mark-6 MARVs increased from something like $2.5 million in 1984 to at least $78 million in 1989. The scheduled operational date was 1988.

Supplementing the GE papers are the "Approved Parts Vendor List -- Procurement Data" (10 Aug 84) for the Trident-2 Mark-6 MARV. This list was obtained through a Freedom of Information Act request from the technical director of the US Navy's Strategic Systems (Trident) Program Office. The page I received listed 28 reentry vehicle parts, most of which did not have common usage with the Mark-5 MIRV.

Still other documents evincing a Trident-2 MARV came from OECO Corporation in Portland, Oregon (obtained from a public source -- the dumpster outside the plant). One is a handwritten interoffice memo, dated 12 Jun 85, listing schedules for Trident-2 Mark-6 parts. The other, with the same date, is page one of a master schedule for Trident-2 Mark-6 operations.

1987 brought a spattering of information about maneuvering warheads, this time in connection with an earth-penetrating capability. Earth-penetrators have a heavy outer case of specific shape so the bomb will burrow deep in the earth or frozen tundra before exploding. This converts more of the blast into ground shock which is 20-50 times more deadly to underground emplacements than a surface burst. Underground blasts also minimize the fratricide phenomenon whereby early nuclear explosions destroy warheads arriving later. This type of warhead would be especially effective for a tactical Trident.

In February 1987 the Air Force announced a nine-month study to develop a prototype for an earth-penetrating MARV to be used on ICBMs. [*AW&ST*, 16 February 1987, p. 11] By mid-year the Defense Department was embarking on a year-long, highly-classified study to develop earth penetrators. Then Strategic Air Commander, General John T. Chain Jr., maintained that an accurate earth penetrator was a high priority. But to deliver one with a ballistic missile would require a MARV which could be slowed down and glide to its target. [*AW&ST*, 8 June 1987, p. 28]

Also in 1987, the Air Force revealed interest in a hypersonic glide vehicle which would be highly maneuverable and extremely precise to attack high-value targets with non-nuclear warheads. But the top speed of this vehicle was to be Mach 20 and higher -- a speed typical of long-range ballistic missiles. In fact, the missile picked to test this

MARV was a Minuteman-1 ICBM booster. [*Air Force Magazine*, May 1987, pp. 24 & 26]

Later in 1987, Lockheed and General Electric were awarded Air Force contracts to develop prototype designs for an earth-penetrating MARV for use on ICBMs. [*AW&ST*, 10 August 1987, p. 32] Then Department of Energy Assistant Secretary for Defense Programs, retired Admiral Sylvester R. Foley, confirmed that the DOE was looking into the feasibility of a penetrating MARV warhead, to be used with ICBMs and SLBMs as prime candidates. [*Air Force Magazine*, August 87, p. 22] That DOE study, to be completed in early 1989, was looking at two areas: short-term modifications to existing bombs for the early 1990s, and a more intense study of what can be done for the mid to late 1990s. [HAC-89, pp. 779, 830-832, 908-910]

On 28 September 1988, a Genie rocket tested a penetrating warhead which was four feet long and contained a full-scale bomb with mock fissionable material. The first stage carried it up four miles and the second stage drove it back down into volcanic rock at 1,400 miles per hour. The warhead burrowed 22 feet deep and was recovered with the bomb in good condition. [*SJMN*, 20 October 1988, p. 3B]

Probably not the configuration of a Trident-2 MARV, but certainly a prototype to test the concept, is Sandia National Laboratories' SWERVE (Sandia Winged Energetic Reentry Vehicle Experiment). Work on it began in the mid 1970s but I saw studies of this concept back in the late 1960s. This eight-foot-long, two-foot-diameter, cone-shaped vehicle is capable of extensive maneuvering at speeds of Mach 2 to Mach 14. Three tests took place in the mid 1980s but were not announced publicly until 1990. The last was in 1985. Rockets launched from Kauai, Hawaii boosted the SWERVEs to an altitude between 400,000 and 600,000 feet. The impact point was near Johnston Island in mid Pacific. Once the SWERVE reenters the atmosphere it can level off and glide for great distances to sense its target as it slows down, similar to the way a cruise missile operates. This is the desired final flight profile for an earth penetrator. [*AW&ST*, 6 August 1990, pp. 25 & 26]

At the end of 1991, the DOE's W-61 warhead was in development as an earth penetrator.

3. *Micronuke, Mininuke, and Tinynuke.*

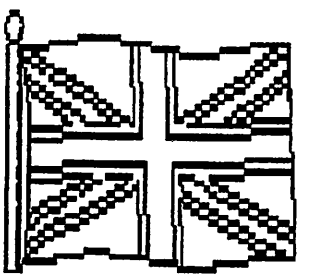
The maneuvering aspect and target sensing of an earth-penetrating MARV will provide

an accuracy of something like 40 feet. That means smaller bombs could be used to offset the added weight of the penetration shell. Such accuracy also means we can forget about complicated probability-of-kill equations -- if the weapon works, the target will be destroyed. Even a sub-kiloton warhead would have the capability to destroy the hardest targets.

According to William Arkin, Los Alamos National Laboratory (LANL) is designing sub-kiloton weapons for wars in the Third World, which might be the real reason the US has so strenuously resisted a nuclear test moratorium. [See Arkin, "Little Nuclear Secrets"] Micronuke is a 10-ton (.01 kiloton) nuclear bomb ten times more powerful than the largest conventional bombs used against Iraq. Its alleged use would be against underground command bunkers. Mininuke has 100 tons (.1 kiloton) yield. And tinynuke is a 1-kiloton warhead to counter attacking ground troops. According to "Inside The Air Force," a private newsletter, the Air Force is quietly researching these weapons under the Precision Low-Yield Weapons Design project (PLYWD -- pronounced plywood). [Arkin, "Little Nuclear Secrets"] Sub-kiloton bombs would be ideal low-weight payloads for an earth penetrating warhead. These warheads on Trident would fit the part of a nuclear expeditionary force employing a tactical Trident.

Development of mini-nukes, earth penetrators, and other exotic things were items in the 1993 DOE budget for the weapons labs. However, it is certain that only paper studies are allowed, not hardware development. A feeling at the national laboratories is that the nuclear weapons business is fading fast and the labs face a very uncertain future.

C. BRITISH WARHEADS



Britain is supposedly developing its own nuclear bomb but it could well be a carbon copy of the US W-76 warhead. British and US scientists work closely together at the Nevada Test Site and it is highly unlikely that the US W-76 bomb features were not duplicated.

Neither does the British government categorically deny that its bomb is a copy of the W-76. They waffle on the subject with such phrases as "not necessarily" or "I don't think you can." On 5 March 1992 Mr. Geoffrey Beaver, Deputy Controller for Nuclear Systems, told the House of Commons that the British warhead "is not necessarily a direct copy or based solely on W-76. Therefore, I do not think you can, even knowing the features of W-76, necessarily read across that those apply directly to the UK weapon..." [HC-337, p. 13] My impression from that statement is that, although not a **direct** copy, the British warhead is pretty much the W-76 design.

Let us review some history. As part of the original agreement to buy Trident-1 missiles, Britain also agreed to buy the reentry vehicles from the US. [*AW&ST*, 21 July 1980, p. 23.] The reentry vehicles Britain agreed to purchase with Trident-1 missiles were the Mark-4.

When the purchase agreement was changed from Trident-1 to Trident-2, Britain was stuck with a 100-kiloton-range bomb it had been working on. Therefore, Britain stayed with the Mark-4 reentry vehicle shell. The British House of Commons Defence

Committee confirmed this: "The reentry bodies we are purchasing from the United States are the Mark-4s, into which British-designed warheads will be incorporated." [HC-286, p. 7; Cited in McHugh, p. 2]

The actual number of warheads on each missile is secret, but official statements indicate a total. The British Secretary of State for Defence, while pointing out that the maximum warhead capacity of each submarine will not be used, restates the government position that each Trident submarine will initially carry no more than 128 warheads. But he modifies that statement: "The exact number deployed will reflect our judgment of the minimum required to constitute a credible and effective deterrent. Over time, we may have reason to revise this assessment: for example, if there are significant developments in anti-ballistic missile systems." [*Statement on the Defence Estimates 1992*, pp. 28 et. seq.] The door is open for change. However, the post-boost control system (PBCS, or "bus") design likely limits the number to eight.

More recently, the Nuclear Weapons Section of the MOD's 1994 Defence White Paper states: "We have long made clear that ... each submarine will carry no more than 128 warheads [an average of eight per missile]. In fact, on the basis of our current assessment of our minimum deterrent needs, each submarine will deploy with no more than 96 warheads [an average of six per missile] and may carry significantly fewer. [p. 19]

Warhead deliveries from AWE Burghfield to RNAD Coulport were to begin toward the end of 1992. And they apparently did as four warhead carriers arrived in the evening of 5 August 1992. [*Campaign*, September 1992, p. 3] Actually, a convoy including four warhead carriers was seen entering the Trident bunkers at RNAD Coulport as early as 10 January 1992. [Nukewatch UK August 1992 Newsletter]

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