

# PLRC *Pacific Life Research Center*

631 Kiely Boulevard \* Santa Clara, CA 95051 \* Phone 408/248-1815 \* Fax 408/985-9716 \* E-mail bob@plrc.org  
PLRC-011117D This paper is current only to 16 November 2002

## U.S. TRIDENT SUBMARINE & MISSILE SYSTEM: THE ULTIMATE FIRST-STRIKE WEAPON

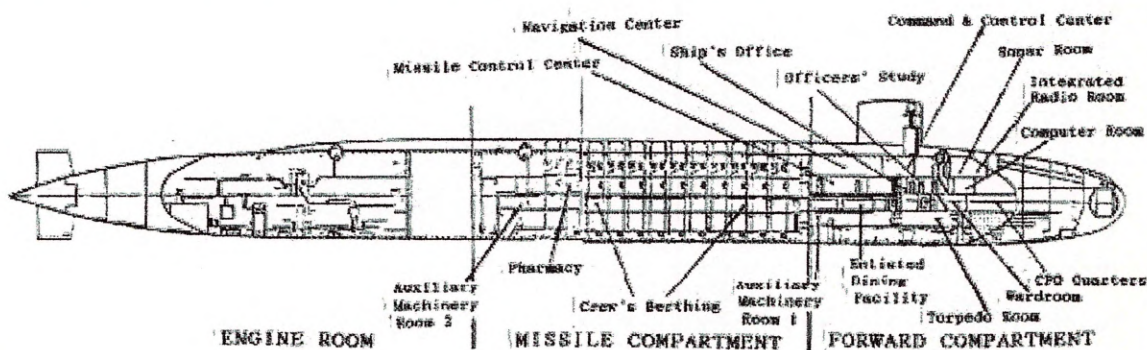
Compiled by Bob Aldridge

In 1967 the US Department of Defense engaged the Institute for Defense Analysis to study all options for modernizing the strategic triad of nuclear forces -- silo-based intercontinental ballistic missiles, bombers and bomber-launched nuclear weapons, and the submarine-launched ballistic missiles (SLBMs). 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.

### I. U.S. TRIDENT SUBMARINES.

The US currently has 18 Trident submarines but four will be retired from strategic service soon. All carry Trident submarine-launched ballistic missiles (SLBMs). Trident submarines are designated by the letters SSBN, followed by the serial number -- the "SS" indicates a submarine, the "B" tells that it carries ballistic missiles, and the "N" means it is nuclear powered.

Construction was started in 1976 on the *USS Ohio*, lead ship in the new Trident fleet. These submarines carry 24 missiles each and normally operate on a 100-day cycle -- 70 on patrol and 30 in port for resupply and refit. Blue and gold crews alternate on the patrol cycles. By mid-1997 the final total of 18 US Trident submarines became operational. Appendix-A lists the 18 US Trident submarines and Appendix-B presents the US Trident submarine specifications.



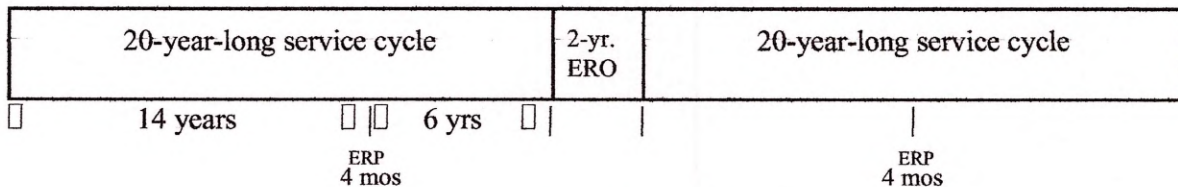
US TRIDENT SUBMARINE LAYOUT

Source: US Navy

The eight oldest Trident subs have been based in the Pacific with their home port at Bangor, Washington, and originally carried Trident-1 (C-4) missiles. It is four of these oldest subs that will be retired from strategic service, possibly to be converted to cruise missile launch platforms. The other four are being retrofitted to carry the larger Trident-2 (D-5) missiles. In addition, two submarines already outfitted with Trident-2 missiles have been transferred from Kings Bay (see below) to Bangor. This will result in a total of six submarines at Bangor, all equipped with Trident-2 missiles.

The newest ten were originally based in the Atlantic with their home port at Kings Bay, Georgia. They were all equipped with Trident-2 (D-5) missiles from the time of their commissioning. Two of these subs have been transferred to Bangor on the west coast to compensate for the subs being removed from strategic service. That leaves eight Trident submarines left at Kings Bay.

In early 1998 the service life of all Trident submarines was extended from 30 years to 42 years -- two 20-year service periods with a 2-year-long Engineered Refueling Overhaul (ERO) in the middle.<sup>1</sup> However, a 4-month-long Extended Refit Period (ERP), in addition to the normal 35-day-long refits between patrols, is still considered necessary to perform once during each 20-year service stint. All of this is shown below.



**Life Cycle of Trident SSBN**

(Source: Final Report, p. 1-3)

The specific point at which the ERP occurs during the second 20-year cycle has not been determined

**HOME PORTS.**

US Trident submarines are based at two locations -- Sub-Base Bangor in Washington state on the west coast, and Sub-Base Kings Bay in southern Georgia on the east coast.

Sub-Base Bangor on the Hood Canal was the first Trident home port established. It is located in Kitsap County across Puget Sound from Seattle. Submarine access to the base is from the Pacific Ocean through the Strait of Juan de Fuca and down the Hood Canal. The first Trident submarine, *USS Ohio*, arrived at Sub-Base Bangor on 12 August 1982. Appendix-C provides a map of Sub-Base Bangor.

Sub-Base Kings Bay, the east-coast home port for US Tridents, is on the Cumberland Sound -- in Camden County of Georgia, a short distance from the town of St. Marys. Submarine access to the base is from the Atlantic Ocean through Cumberland Sound. The first submarine at this base was the *USS Tennessee* which arrived on 15 January 1989. Appendix-D provides a map of Sub-Base Kings Bay.

---

<sup>1</sup>A Lockheed Martin publication states that the submarine service life has been extended to 44 years. Nuclear Notebook in the May/June issue of *Bulletin of the Atomic Scientists* also states the service life has been extended to 44 years. The 44-year service life figure may have derived from two of the submarines going through two 2-year stints in the shipyard -- one for the D-5 backfit and another for nuclear refueling. This will be discussed later in this paper.

## **EXTENDED SSBN OPERATIONS.**

Trident's presence has or will spread to the southwest Pacific and Indian Oceans. The additional ocean area in which the submarine can operate has always been the paramount justification for the Trident system. Covering more of the globe has become even more compelling with the strategic policy now leaning toward regional wars and nuclear expeditionary forces. But when patrolling off the Bay of Bengal or the Arabian Sea in crisis times, for instance, the Navy certainly wouldn't want to send the submarine all the way back to Bangor, Washington for periodic resupply and refit. There would have to be means of forward servicing.

Longer-range missiles do allow the sub to be on-station as soon as it leaves port, but full flexibility is not achieved if the submarine is always at arms reach. So common sense tells us that the sub isn't going to hang around its own doorstep. We don't even have to rely on common sense because naval exercises point to the same conclusion. In a program called SSBN Continuity Of Operation Program (SCOOP), various Trident subs have been refitted at remote locations. In May 1986 the *USS Georgia* went through a nine-day full refit at Guam.

Another refit of the *USS Georgia* took place at Guam in February 1987, to work out some problems encountered during the previous exercise. Following that, the *USS Nevada* was turned around at Sitka, Alaska. In July 1989 the *USS Alabama* went through refit at Astoria, Oregon. Rear Admiral George W. Davis, former commander of Sub-Base Bangor, said that changing crews, replenishing supplies, and performing needed repairs could be done in Mexico. Trident subs underway in the open ocean have reloaded torpedoes from tender ships and taken on supplies from helicopters and supply ships.

Trident submarines have visited other ports. TV news on 7 August 1995 showed the *USS Michigan* in San Francisco Bay. The *USS Henry M. Jackson* also visited San Francisco Bay during Fleet Week in October 1995. SCOOP operations can take place alongside any ship or at any wharf, as long as missiles are not exchanged.

It has now been revealed that three-day-long SCOOP operations have been practiced extensively during the cold war under the heading of Extended SSBN Operations.<sup>2</sup> Rather than the normal 77-day patrols interspaced with 35-day refits, every other refit is replaced by a 3-day crew exchange and replenishment at a remote site.

## **II. U.S. TRIDENT MISSILES.**

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 known & 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 provide 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 Global Positioning System (GPS) satellite navigation corrections, make ICBMs obsolete.

All Trident subs do not carry the same type of missile. The eight oldest in the Pacific originally carried the Trident-1 (C-4) missiles. The Bangor base was originally only equipped to service and maintain submarines carrying Trident-1 missiles. Meanwhile, the ten newest Trident subs

---

<sup>2</sup>*Analysis of Converting Trident-Class Ballistic Missile Submarines (SSBNs) to Nuclear-Powered Guided-Missile Submarines (SSGNs)*, p. 1-4.

originally in the Atlantic are loaded with longer range and more deadly Trident-2 (D-5) missiles. Kings Bay is equipped to handle submarines carrying Trident-2 missiles.

Each missile -- either C-4 or D-5 -- carries up to eight warheads. D-5 missiles were first intended to carry the 475-kiloton W88 warheads encased in Mark-5 reentry vehicles.<sup>3</sup> But less than 400 of these warheads were manufactured (some sources say the number is 384). These are distributed among several submarines but not mixed with other warheads on the same missile. Most of the warheads carried on Trident-2 missiles are the same as those carried on Trident-1 -- that is, 100-kiloton W76 warheads encased in Mark-4 reentry vehicles.

### TRIDENT-1 (C-4)

Trident-1 missiles, also known as C-4, would be key players in a first-strike capability. They are now fully operational with some 168 missiles deployed in the Pacific in 7 Trident submarines. Fiscal year 1984 was the last year Trident-1 missiles were ordered, and the total number procured is 570. Fiscal year 1989 was the last year funds were requested for the Trident-1 program.

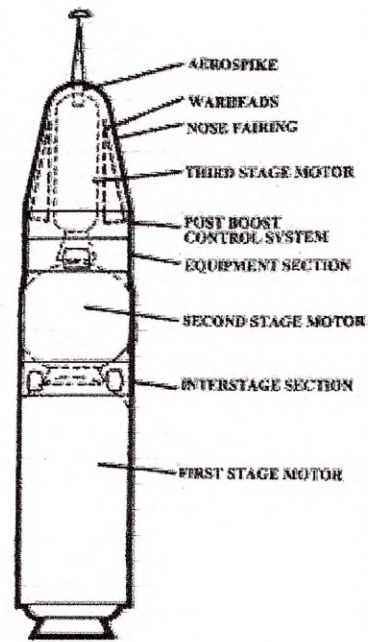
Each C-4 missile can carry eight 100-kiloton Mark-4/W76 multiple independently-targeted reentry vehicles (MIRVs). To comply with START-1 Treaty requirements, the number of warheads on each C-4 has been downloaded to 6. That adds up to 1,008 warheads poised to strike. Even missiles on submarines in port could reach their targets. Appendix-E provides the Trident-1 (C-4) missile specifications.

C-4 missiles are not precise enough, and the Mark-4/W76 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.

Trident-1 (C-4) missiles are in the process of being replaced with Trident-2 (D-5) missiles.

### TRIDENT-2 (D-5)

The ten Trident submarines which originally operated out of Sub-Base Kings Bay in Georgia were all loaded with the Trident-2 missiles, also known as D-5. Trident-2s have the accuracy and quick delivery time necessary to decapitate underground command posts, as well as demolishing silos. The 24 missiles on each submarine can deliver 192 Mark-5/W88, 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 encountered, only about 400



Trident-1 (C-4) Missile  
Source: US Navy

<sup>3</sup>The terms "reentry vehicle" and "reentry body" are used interchangeably.

of the W88 warheads were produced. Consequently, the Mark-4/W76 warhead was introduced on Trident-2. Specifications of the Trident-2 (D-5) missile are given in Appendix-F. Appendix-G shows the procurement schedule.

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.

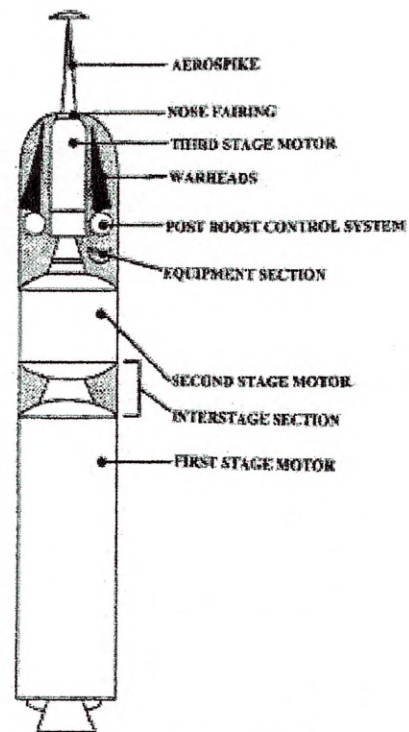
The Trident-2 equipped with less powerful Mark-4/W76 warheads is not as deadly. Trident-2 missiles could carry 12-14 Mark-4/W76 warheads but they are limited to eight by the START-1 Treaty. Since this warhead has 100 kilotons yield, rather than 475, the 2-on-1 cross-targeting probability of destroying 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 the NAVSTAR GPS 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 84 percent probability of kill would be adequate.

The Navy is now involved with a D-5 service life extension (D5-LE) program to make the Trident-2 missile operational to as long as 2040. D5-LE is to extend the missile's service life to 40 years to match the submarine life extension. This effort will primarily involve installing new rocket motors and recertifying components and parts that were originally certified for a 30-year life cycle. The Selected Acquisition Reports dated 31 December 2001 (SAR-011231) reports that, in addition to increasing the total D-5 missile production to 568, this life extension will also include replacement of Mark-6 guidance systems and missile electronics (\$3.9 billion), additional production support for extending production to fiscal year 2013 (\$749 million), and a revised estimate for test flight instrumentation hardware (\$1.1 billion).

### TRIDENT WARHEADS

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 a "Mark" and a "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 agency installs the bomb. The assembled reentry vehicle, with the bomb inside, is then



Trident-2 (D-5) Missile  
Source: US Navy

sealed and turned over to the DOD for deployment. If for any reason the reentry vehicle shell must be disassembled, it is returned to Pantex.

In this paper I shall use Mark-4 or Mark-5 when referring to reentry vehicle shells. W76, W88, and the like will designate nuclear bombs. And the assemblies, such as Mark-4/W76 or Mark-5/W88, 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.

### ***1. Mark-4/W76 and Mark-5/W88 Warheads.***

There are currently two warhead sizes for US Trident missiles. The Mark-4/W76 has 100 kilotons yield and has a START-1 restriction of six maximum on Trident-1 and eight maximum on Trident-2. The Mark-5/W88 warhead has 475 kilotons yield and can be carried eight maximum on Trident-2. It is too big to fit on Trident-1.

Problems at the Rocky Flats plant in Colorado have halted the production line for W88 bombs. An official production halt was announced by President Bush (Sr.) during his January 1992 State-of-the-Union address. According to Rear Admiral Raymond G. Jones Jr., there are enough Mark-5/W88 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/W76 warheads which became available as refitted Poseidon subs were deactivated.<sup>4</sup>

Other sources say that only about 400 of the Mark-5/W88 warheads have been produced. That is enough for two submarines, not four as Admiral Jones indicated.<sup>5</sup> If the 400 number is correct, and that number is spread among four submarines, then some of the missiles are loaded with the smaller Mark-4/W76 warheads.

### ***2. The W76-1 Warhead.***

The Selected Acquisition Reports dated 31 December 2001 (SAR-011231, mentioned above) also reports \$361 million as the revised estimate for replacing Mark-4 reentry vehicle parts and the arming, fuzing & firing systems (AF&F). Although the W76 is going through a life extension program conducted by the DOE,<sup>6</sup> it appears that the modification referred to in SAR-011231 is in connection with providing a surface burst capability which, although not as destructive as an earth-penetrating bomb, would be more deadly to hardened targets than the present air burst of the W76 warhead. In fiscal year 2001, Sandia National Laboratory "successfully completed calculation of contact fuze electromechanical operation during target impact at termination of flight for a W76 reentry body."<sup>7</sup> The warhead with this capability has been designated W76 Mod-1, or W76-1.

The main modification in connection with a surface burst capability seems to be the AF&F package (with a contact fuze) which is the control center for detonating the hydrogen bomb. This package is located in the nose section of the Mark-4 reentry vehicle, in what is referred to as the forward shell assembly. That assembly is likely the reentry vehicle part referred to in SAR-011231 that needs replacing.

---

<sup>4</sup>SASC-92, Part 2, p. 111.

<sup>5</sup>*The Sun*, 20 December 1991.

<sup>6</sup>See Campaigns Program Mission, pp. 36, 42, 44, 45, & 105-107.

<sup>7</sup>Lab Accomplishments 2002, p. 2.

The W76-1 warhead is currently in the Development Engineering Phase and the first flight test was scheduled in May 2002.<sup>8</sup> It is likely that this first flight test took place from the *USS Alaska* which has been going through demonstration and shakedown operations (DASO) in the Atlantic after being backfitted with Trident-2 (D-5) missiles. The flight test was part of the DASO-18 launch.<sup>9</sup> The W76-1 will then go into the production engineering phase during fiscal year 2003, with a follow-on flight test during fiscal year 2004.<sup>10</sup> The first production unit will be available in the fiscal year 2007-2008 time frame.<sup>11</sup>

3. *A Mark-5/W89 Warhead?*

If the safety of Trident warheads should ever heat up again and become a serious issue, or if US nuclear war planners decide they want more of the more powerful warheads, the likely replacement candidate will be a W89 bomb in the Mark-5 reentry vehicle. The W89 has all the latest safety features, although not currently in production or in the stockpile. It was originally slated for the Sea Lance anti-submarine missile and the Short Range Attack Missile-2 (SRAM-2), both of which have been canceled. But the W89 went ahead anyway as a technology demonstration for recycling the "pits" (plutonium triggers) from retired nuclear weapons. This means that the W89 could go into production using the nuclear cores from old warheads, even though Rocky Flats remains closed. Dr. Ray Kidder, a nuclear physicist with Lawrence Livermore National Laboratory, said in 1992 that this could be accomplished in three years but would require four nuclear tests.<sup>12</sup>

Later there appeared in the DOE budget for Lawrence Livermore National Laboratory a line item called "Submarine Launched Ballistic Missile Replacement Warhead." The replacement warhead study was completed in 1994.<sup>13</sup>

### **III. THE TRIDENT D-5 BACKFIT.**

When the Soviet Union collapsed, then US President George Bush (Sr.) and then Russian President Boris Yeltsin went through several unilateral steps to eliminate many nuclear weapons which were not needed or would not work properly. These initiatives evolved into the START-1 and START-2 Treaties. START-1 is still in effect but START-2 was scuttled by the meaningless Strategic Offensive Reductions Treaty (SORT). Toward the end of the Bush (Sr.) administration it was decided that the US did not need 18 Trident submarines to carry the number of SLBM warheads that were planned under START-2. That administration then prepared to reduce the fleet to 10.<sup>14</sup> But after the Pentagon's 1994 nuclear posture review, the Clinton administration raised the number

---

<sup>8</sup>SAND2002-0253, pp. 13-14.

<sup>9</sup>Performance Measures for FY 2003, p. 10.

<sup>10</sup>Performance Measures for FY 2003, pp. 9 & 10.

<sup>11</sup>Campaigns Program Mission, p. 77.

<sup>12</sup>See Kidder, pp. 12-14.

<sup>13</sup>See Beers.

<sup>14</sup>Pincus.

of required Trident submarines to 14.<sup>15</sup> The above discussion illustrates the first axiom to be learned: ***The number of Trident submarines operational is a political decision, not one of national security.***

Disregarding all logical and economic opposition, the US Navy started backfitting Trident-2 (D-5) missiles into four Trident submarines in May 2000. This is ahead of the plans previously advertised for accomplishing this backfit during the Engineered Refueling Overhaul. It gives two of these submarines two 2-year stints in the shipyard -- one for backfitting and the second for a refueling overhaul. The only obvious reason for this accelerated schedule is to get a foot in the door before public opinion catches up. Keeping all of the foregoing discussion in mind, let us look at what can be gained if those four submarines are decommissioned and disassembled, instead of backfitted.

### **THE D-5 BACKFIT SCHEDULE**

When the first submarine, *USS Ohio*, reached 14 years of use the Navy deemed that an extended refit was necessary, but refueling was not. The first 6 Trident submarines, all based at Bangor, went through this 4-month-long Extended Refit Period (ERP) after 14 years of service. The remaining two -- *USS Alaska* and *USS Nevada* -- came due in 2000 and 2001. It is the 4-month-long ERP for these two subs that is now being changed to a 2-year-long D-5 backfit, as will be discussed below. The Navy has conveniently extended these ERPs from a length of 4 months to 2 years, and renamed them Engineered Overhauls (EOHs) in order to accommodate doing the D-5 backfit on those ships earlier. Then in less than 5 years they must go back in for another 2.5-year shipyard refueling overhaul and recertification. There is no threat that warrants such an expensive acceleration of schedule. This is nothing more than cavalier use of taxpayers money to enhance a political objective.

According to Navy plans, the four Trident submarines that would remain in strategic service in the Pacific, and be upgraded to carry Trident-2 missiles, are the *USS Henry M. Jackson* (SSBN-730), the *USS Alabama* (SSBN-731), the *USS Alaska* (SSBN-732), and the *USS Nevada* (SSBN-733). In late autumn of 2002, the Navy transferred the *USS Pennsylvania* (SSBN-735) and the *USS Kentucky* (SSBN-737) from Kings Bay to Bangor, making a total of six strategic SSBNs in the Pacific and leaving eight in the Atlantic.<sup>16</sup> That ratio between the east and west coasts is subject to additional juggling at a later date.<sup>17</sup>

A June 1999 Navy report entitled *Analysis of Converting Trident-Class Ballistic Missile Submarines (SSBNs) to Nuclear-Powered Guided-Missile Submarines (SSGNs)*, referred to herein as the Final Report, focused on the practicability of converting Tridents to carry cruise missiles. However, it gave some overall schedules on actual Navy plans, although some of the intricacies have not been explained to the public. For instance, Congress and the public have been led to believe that the D-5 Backfits would all take place during the scheduled 2-year-long refueling overhaul after the sub completes 20 years of service. These begin in 2005. As mentioned above, the *USS Alaska* and

---

<sup>15</sup>Greenhouse.

<sup>16</sup>The *USS Pennsylvania* arrived at Bangor on 17 October 2002. The *USS Kentucky* left Kings Bay for a 70-day patrol on 25 August 2002, and will arrive at Bangor at the completion of that patrol.

<sup>17</sup>For the record, the submarines that would remain in the Atlantic are *USS Tennessee* (SSBN-734), *USS West Virginia* (SSBN-736), *USS Maryland* (SSBN-738), *USS Nebraska* (SSBN-739), *USS Rhode Island* (SSBN-740), *USS Maine* (SSBN-741), *USS Wyoming* (SSBN-742), and *USS Louisiana* (SSBN-743).



the *USS Nevada* are receiving an *extra* 2-year visit to the shipyard to be backfitted with D-5 missiles -- the *USS Alaska* began backfit early in 2000 and the backfit has now been completed. The *USS Nevada* entered the shipyard in February 2001. Both submarines are now back in service carrying D-5 missiles. Their actual refueling overhaul will take place a few years later. Meanwhile, the *USS Henry M. Jackson* and the *USS Alabama* are actually scheduled for backfit during their refueling overhauls. This is depicted below.





	Fiscal Year 2000	Fiscal Year 2001	Fiscal Year 2002	Fiscal Year 2003	Fiscal Year 2004	Fiscal Year 2005	Fiscal Year 2006	Fiscal Year 2007	Fiscal Year 2008	Fiscal Year 2009	Fiscal Year 2010
<i>USS Henry M. Jackson</i>						Engineering Refueling Overhaul and D-5 Backfit simultaneously (2 years)	Engineering Refueling Overhaul and D-5 Backfit simultaneously (2 years)	Recertification after refueling (6 months)			
<i>USS Alabama</i>							Engineering Refueling Overhaul and D-5 Backfit simultaneously (2 years)	Engineering Refueling Overhaul and D-5 Backfit simultaneously (2 years)	Recertification after refueling (6 months)		
<i>USS Alaska</i>		D-5 Backfit only (2 years)	D-5 Backfit only (2 years)					Engineering Refueling Overhaul only (2 years)	Engineering Refueling Overhaul only (2 years)	Recertification after refueling (6 months)	
<i>USS Nevada</i>		D-5 Backfit only (2 years)	D-5 Backfit only (2 years)					Engineering Refueling Overhaul only (2 years)	Engineering Refueling Overhaul only (2 years)	Recertification after refueling (6 months)	

**Trident SSBN Overhaul/Backfit Schedule**

(Source: Final Report, p. 1-2)

Fiscal Years begin on October 1st

**Legend:**

-  D-5 Backfit only (2 years)
-  Engineering Refueling Overhaul only (2 years)
-  Engineering Refueling Overhaul and D-5 Backfit simultaneously (2 years)
-  Recertification after refueling (6 months)

**COST SAVINGS IN CANCELING D-5 BACKFIT AND SCRAPPING THE SUBMARINES.**

The planned START-2 level of 1728 SLBM warheads could be carried on nine Trident submarines. The ten SSBNs based at Kings Bay are more than necessary. All eight Trident-1 subs, rather than just four, could be safely decommissioned. With the George W. Bush administration's negotiations to drastically reduce the nuclear weapons inventory, decommissioning the eight oldest Trident subs should be high on the agenda.

There are still unknowns and uncertainties in cost estimates, at least as far as the public is concerned. However, from what we know at present the total savings from stopping the D-5 backfit and retiring the two remaining candidate submarines would be at least the following (In millions of fiscal year 2002 dollars):

- Subs not converted to carry D-5 missiles<sup>18</sup> \$ 269.2
- Eliminating shipyard costs for two 2-year overhauls.<sup>19</sup> 209.5(estimated)

<sup>18</sup>\$257 million would be the cost of backfitting 2 subs based on the \$513 million for 4 subs given in "Assumed in the FY 2000 Budget Submission." The money for backfitting the *USS Alaska* and *USS Nevada* has already been appropriated. \$257 million converted to 2002 dollars is \$269.2 million.

<sup>19</sup>This involves work other than the D-5 upgrade.

-- No Department of Energy costs for two reactor fuelings. <sup>20</sup>	484.0
-- Not buying 53 D-5 missiles for the subs not converted <sup>21</sup>	2,438.0
-- Eliminating 80 submarine years of operation, maintenance and support costs (includes 2 crews/submarine but not maintenance & support costs for missiles) <sup>22</sup>	6,291.8
	<hr/>
TOTAL	\$9,692.5

The savings totals \$9.7 billion. Some proponents for the backfit say that the real backfit cost is less because money would not have to be spent to deactivate the submarines. That is a misleading notion because deactivation will have to be done eventually. To use the Pentagon's persistent reasoning for cost savings, it would cost less to decommission those subs today than it will 20-25 years from now.

#### **ENVIRONMENTAL PROBLEMS WITH THE D-5 BACKFIT.**

Seventeen separate construction projects were once identified as required for the D-5 upgrade, which include:<sup>23</sup>

- Clearing 58 acres for construction.
- Expansion of an existing missile transfer facility.
- Addition to the inert component processing building.
- Building a second explosives handling wharf.
- Building some 55 new magazines and modifying 32 others to store nuclear warheads.
- Constructing a third missile assembly building and adding onto the two existing.
- Five new buildings for the storage, testing and assembly of various components.
- A 35,000 square foot addition to the Trident training facility.
- Additions to the missile container storage building, reentry body buildings, missile parts warehouse, launcher equipment processor building, and the dockside handling building.

The Navy reports that this list of projects has been scaled down, and that the earlier \$248 million price tag advertised for base-expansion has been reduced to \$189 million. Other than that, the Navy has been reluctant to divulge information on what it actually intends to do. It is also possible that base upgrade plans include a Tomahawk cruise missile handling capability (another Navy aspiration is to modify the four oldest Trident subs, which otherwise would be retired, to carry up to 152 Tomahawk cruise missiles each. See PLRC-990610).

---

<sup>20</sup>CAIG Report, Table A-1, converted to fiscal year 2002 dollars.

<sup>21</sup>Cost based on fiscal year 2001 contract of \$541 million for 12 missiles, converted to 2002 dollars. That is a unit price of \$45.1 million (\$46 million in 2002 dollars).

<sup>22</sup>My estimate based on GAO/NSIAD-89-40, p. 31, converted to year 2002 dollars and calculated for 80 submarine years.

<sup>23</sup>Offley, 9 September 1988. Also see Broom.

To assure that construction projects will not cause irreparable environmental damage, the National Environmental Policy Act requires an Environmental Impact Statement (EIS) with wide public participation in its preparation. For original construction of the Bangor base, the Navy prepared an EIS in 1974 with a supplement in 1977. In 1989 the Navy performed a \$68,000 Environmental Assessment Report (EAR), claiming that the original EIS and its supplement covered most of the environmental problems and that the base has an excellent environmental record. The EAR stated there are no significant environmental concerns. An EAR is prepared by the Navy with little or no public participation and is not as comprehensive as an EIS. It relies heavily on the outdated 1974 EIS.

The Washington Environmental Council and Greenpeace were quick to point out the fallacy of relying on outdated and incomprehensive studies. They claimed the EAR only skimmed the surface and that the original EIS and supplement are not only out of date but based on what are now known to be faulty assumptions. They also pointed out that many things have changed since those original documents were generated, including environmental laws and the understanding of how the environment can be harmed. Those arguments by the critics are as valid today as they were when made a decade ago.

Besides the inadequacy of the EAR, and contrary to Navy claims, the base does **not** have a good track record regarding pollution. In spite of Bangor's 1989 recognition by the Secretary of Navy as having the most outstanding environmental program sponsored by a naval industrial facility, the base has 21 hazardous waste sites which have put the entire 7,000 acre Bangor base on the federal Superfund list of America's most hazardous cleanup sites. Another 20 suspected sites exist on the base.<sup>24</sup> The addition of tons of explosives and their handling will only aggravate that problem.<sup>25</sup> The probability of creating further environmental hazards will be greatly reduced if the Bangor submarines are retired.

## **SUMMARY**

Although a total savings of \$9.7 billion would be realized if the four submarines scheduled for overhaul were retired, and an even greater savings if all eight Bangor-based submarines were taken out of service, the major obstacle to stopping the D-5 backfits is vested monetary interests in the areas that will get the work. The people living in those areas, and their representatives in the Legislature, will pressure unrelentingly to modify Trident subs. The motivation behind this pressure for keeping Tridents submarines in operation are local jobs, which in turn provide increased markets for local businesses. This is a formidable obstacle for those opposed to pork-barrel projects and increased weapons production to overcome.

Another serious obstacle to overcome in resisting the continuation of Trident is the lobbying efforts and other activity of the weapons makers, to protect their profits. They have the ability to pressure legislators and influence the public through the media. Trident critics will have to be well informed on the issues and work diligently to counter these corporate resources.

## **IV. THE TACTICAL TRIDENT**

The use of Trident missiles in a regional war as a tactical nuclear weapon has been a point of speculation since at least the end of the cold war. And there is good cause for such speculation.

---

<sup>24</sup>Shulman, p. 183. Cited in Milner.

<sup>25</sup>For a more thorough treatment of the environmental effects of the Trident backfit see Milner.

## THE REED PANEL

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.

**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 weapons are now 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 or Taiwan, or the seizure of critical raw materials such as oil, or foreign dominance in 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 nuclear weapons. What the Reed Panel was referring to regarding the latter 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 B61 bombs of various modifications make up the entire US Tactical nuclear arsenal. It has been difficult for the US Navy to regain a footing in that area but they are trying.<sup>26</sup> The 11th demonstration and shakedown operation (DASO) flight of a Trident-2 missiles on 18 November 1993 was a tactical Trident test, reportedly with conventional warheads.

Atomic, biological and chemical warfare again surfaced in the media in June 1995 as a threat after 2010. Defense Budget Director at the time, Andrew Krepinevich, emphasized the need for long-range precision strikes against missile emplacements and other facilities far behind enemy lines.<sup>27</sup> The capability to do this exceeds the performance record of even the smartest conventional bombs.

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 Saddam Hussein from using chemical weapons during the Persian Gulf war. By September 1995 the Pentagon, under pressure to clarify its nuclear doctrine in this regard, at least publicly, stated: "The normal peacetime role of the ballistic missile submarine will continue to be nuclear deterrence... Endurance and responsiveness, coupled with the

---

<sup>26</sup>The nuclear Tomahawk sea-launched cruise missile is still considered an option for use although they are now in storage. In his fiscal year 2000 *Annual Report to the President and the Congress*, then Defense Secretary William Cohen states: "Nuclear weapons capability on surface ships has been eliminated, but the capability to deploy Tomahawk Land Attack Missiles armed with a nuclear warhead on submarines has been maintained."

<sup>27</sup>*Defense News*, 5 June 1995, p. 1.

submarine's survivability, will provide a pervasive threat to any nation considering the employment of nuclear, chemical or biological weapons against the United States or its allies."<sup>28</sup>

The above discussion illustrates that targeting non-nuclear countries with nuclear weapons is not something new. Chemical and biological weapons have been added to the "weapons of mass destruction" list, and the publicly-announced US policy has for more than a decade been that nuclear weapons will be used to deter *any* weapon of mass destruction. Neither is it new that America will use nuclear weapons to retaliate against something other than a nuclear, chemical, biological attack. In consistently refusing to take the "no first use" pledge, America and NATO have always kept the option open to employ nuclear weapons to stop a massive conventional attack by Warsaw Pact nations against western Europe.

What is new, as we shall see below, is the public unveiling of a more complete list of non-nuclear countries being targeted by US nuclear weapons. Also new, at least publicly, and what will also become apparent below, is that nuclear weapons will be used to stop any attack with conventional weapons which is against a country important to US interests. These two things follow the Welch Panel recommendations and significantly lower the threshold for nuclear weapons use. In actuality, all four of the Welch Panel recommendations have been or are being implemented. Our world has become significantly more dangerous.

### **THE WAR ON TERRORISM**

In September 2000 Congress commissioned the second Nuclear Posture Review (NPR) -- the first by this name took place in 1994, although the Reed Panel certainly qualified as such a review. This second NPR was completed after the 9/11 terrorist attacks on New York and the Pentagon, and the secret report was submitted to Congress on 8 January 2002.

The March 11<sup>th</sup> issue of *Time* magazine published an article about a terrorist alert the previous October (2001). According to a report by the DOE's top secret Nuclear Emergency Search Team, presumably leaked to *Time*, that an intelligence agent of "undetermined" reliability said a 10-kiloton nuclear bomb missing from the Russian arsenal was in the hands of terrorists. The report went on to say that terrorists planned to smuggle that bomb into New York City.<sup>29</sup>

Almost simultaneous with the DOE report being leaked to *Time* magazine, another secret document -- the NPR report -- was leaked to the *Los Angeles Times* newspaper.<sup>30</sup> The secret NPR report named seven countries as potential targets for tactical nuclear weapons -- Russia, China, Iran, Iraq, North Korea, Syria, and Libya. Three conditions were listed that could call for the use of nuclear weapons: 1) to destroy targets invulnerable to conventional weapons, 2) in retaliation to a nuclear, chemical, or biological weapons attack, and 3) in the event of a "surprising military development." It almost seemed that the scare of nuclear weapons in the hands of terrorists was used to justify an escalation in US nuclear doctrine. Two secret reports conveniently leaked to the mainstream media with such precise timing should raise critical questions.

When asked about the leaked information from the NPR, President George W. Bush on 13 March 2002 answered: "We've got all options on the table, because we want to make it very clear

---

<sup>28</sup>*Submarine Roles in the 1990s and Beyond*, p. 11.

<sup>29</sup>See Calabresi and Ratnesar.

<sup>30</sup>Richter.

to nations that you will not threaten the United States or use weapons of mass destruction against us, or our allies or friends.”<sup>31</sup> General Richard Meyers, chairman of the Joint Chiefs of Staff, further confirmed the accuracy of the leaked information -- the NPR “preserves for the president all the options that a president would want in case this country or our friends and allies were attacked by weapons of mass destruction.”<sup>32</sup> Meyers also alluded to what a “surprising military development” might be -- something like Iraq attacking Israel, North Korea attacking South Korea, or China attacking Taiwan.<sup>33</sup>

President Bush was asked at the 13 March 2002 White House Press Conference what his feelings were on building smaller nuclear weapons. In six paragraphs of transcript he waffled all over the place -- covering everything from nuclear deterrence foolishness and warhead reduction negotiations to political gibberish and patriotic propaganda. He avoided a recognizable answer. The closest he came was: “[T]he more firm we are and the more determined we are to take care of al Qaeda and deal with terrorism in all its forms, particularly that of global reach, that we have a very good chance of solving some difficult problems -- including the Middle East and the subcontinent.”<sup>34</sup>

## **THE NUCLEAR EXPEDITIONARY FORCE.**

We have now seen the evolution of everything recommended by the Reed Panel except for the “Nuclear Expeditionary Force, especially the submarine-launched element of that force. That leads directly to Trident. The utility of Trident missiles in a regional war would be a small nuclear bomb in an earth-penetrating reentry body shell. These are not new concepts.

### ***1. Sub-Kiloton Yield Warheads.***

Shortly after the end of the cold war in the early 1990s, America’s national laboratories -- Lawrence Livermore National Laboratory, Los Alamos National Laboratory, and Sandia -- started work on small nuclear warheads under a program code-named “Plywood.”<sup>35</sup> Among the concepts studied was a modification to the strategic nuclear gravity bomb designated B61, Mod-7. This warhead has a selectable yield on from 0.3 kilotons to 340 kilotons. Looking at the low level of that yield range (0.3 kilotons, or 300 tons, of conventional explosives), and realizing that this bomb was first deployed in 1985, it is apparent that low-yield technology has been around for some time. The new weapon being developed was deployed in 1997 as the B61, Mod-11 strategic/tactical bomb. As we shall see below, there was more to the modification than just a low-yield warhead. The point being made here is that the technology for low yield warheads has already been developed. This would be the most appropriate weapon for the air-delivered element of a Nuclear Expeditionary Force. Now let us turn to Trident.

Most of the warheads on Trident missiles are the W76 bomb in the Mark-4 reentry body shell. These bombs are generally advertised as having 100 kilotons yield, but there is evidence that the W76

---

<sup>31</sup>White House Press Conference, 13 March 2002. Also cited in Stober

<sup>32</sup>Cited in Norton-Taylor.

<sup>33</sup>Listed in Norton-Taylor

<sup>34</sup>White House Press Conference, 13 March 2002.

<sup>35</sup>Cited in Stober.

is also capable of a reduced yield. British and American scientists have worked side-by-side in developing their nuclear bombs. British bombs are tested at US test sites. Consequently, the nuclear bomb carried on the British Trident submarines is thought to be a carbon copy of the W76. It is also packaged in the Mark-4 reentry body shell which Britain has purchased from the US.

Britain is a little more blatant than the US in acknowledging its intention to use Trident in a tactical role, which it refers to as sub-strategic. Way back 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 Royal Air Force turf. He set the date as 2004 when the Royal Navy would take over that responsibility, and named the *Vanguard*-class Trident submarines as the dispenser of sub-strategic weapons.<sup>36</sup>

In the Nuclear Weapons Section of the 1994 Defense White Paper, the Ministry of Defence (MOD) 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 sub-strategic and strategic elements of our deterrent."<sup>37</sup> Milan Rei has done an excellent job of documenting British ambitions for a tactical Trident.<sup>38</sup>

On 19 March 1998 a member of the British Parliament, Ms. Roseanna Cunningham, asked the question: "To ask the Secretary of State for Defence if he will make a statement on the development of a lower-yield variant of the Trident warhead for the sub-strategic role?" The answer from Mr. George Robertson, then Secretary of State for Defence, was: "The UK has some flexibility in the choice of yield for the warheads on its Trident missiles."<sup>39</sup>

From this testimony it is evident that the British Trident warhead has a reduced yield capability, although how much it can be reduced is still unknown. It is now assumed that a yield reduction will be obtained by using only the primary of the nuclear bomb, thus making it an atom bomb rather than a hydrogen bomb. Considering that the British warhead is a clone of the W76, and considering that the B61, Mod 11 can go as low as 0.3 kilotons, it is reasonable to conclude that US capabilities are as good as or better than Britain's. William Arkin reported in 1992 that Los Alamos National Laboratory was working on a very small nuclear bomb in the range of 0.01 kilotons -- equivalent to ten tons of conventional explosives. A reduced yield may be part of the refurbishment of the W76-1 warhead with a surface burst (described above). I consider a sub-kiloton warhead for Trident as well within current capabilities.

## **2. *Earth-penetrating Reentry Vehicle Shells.***

Some sources say that US interests in earth-penetrating warheads dates back to the 1950s. When I was a design engineering group leader in the late 1960s and early 1970s at Lockheed Missiles & Space Company (Now Lockheed Martin Space Systems Company), I had charge of investigating

---

<sup>36</sup>*Defense News*, 19 September 1994, p. 12.

<sup>37</sup>Nuclear Weapons Section of the 1994 defence White Paper, p. 19.

<sup>38</sup>Rai, Milan.

<sup>39</sup>This information was furnished by e-mail from John Ainslie, administrator for Scottish CND, to Bob Aldridge.

several advanced concepts. Besides various maneuvering reentry bodies for precision accuracy, defensive-interceptor evasion, and low-level run in, I also had earth penetrating warheads on my agenda. The earth penetrating warhead was eventually dropped from my studies because of its size and weight. The priority at that time was small and light bombs so that many could be placed on one missile.

On 28 September 1988 a Genie rocket tested a penetrating warhead which was four feet long and contained a full scale bomb with mock nuclear components. 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.<sup>40</sup>

The kinetic energy KE2 warhead for the Tactical Tomahawk Penetrator variant has been tested on rocket sleds since 1999. It is designed to plow through layers of steel-reinforced concrete before exploding. Development of this warhead is funded through 2002 by the Defense Threat Reduction Agency (Dulles, VA). Navy funded procurement will start in 2003.

Neither should we forget the B61, Mod-11 bomb discussed above. Besides being reduced yield it was also designed as an earth penetrator. The problem is that it is still a glide bomb and it does not have the velocity or structural strength for deep penetration. To attain the depth needed to destroy very deeply buried targets the penetrator would have to come from a high-velocity missile with a very hard warhead, or be driven into the ground by a rocket motor. Trident is the system capable of providing the deepest penetration because of its tremendous velocity. And since the missile would be carrying very few warheads -- likely only one -- the added weight of a heavy earth-penetrating reentry body shell would pose no problem. Trident emerges as the optimum component of a Nuclear Expeditionary Force.

During Fiscal Year 2001, the Pentagon and the Energy Department were studying a new low-yield nuclear bomb that could be used in a regional war to penetrate deeply-buried command bunkers.<sup>41</sup> This study is mandated by a provision buried in the 2001 Defense Authorization Bill by Senators John Warner and Wayne Allard. A 1994 law currently forbids research and development on nuclear weapons of less than 5 kilotons yield because "low-yield nuclear weapons blur the distinction between nuclear and conventional war."<sup>42</sup> This law would have to be overturned before the low-yield bombs can progress beyond the study stage.

Nevertheless, in compliance with the Bush administration's Nuclear Posture Review, the national laboratories have been ordered to perform a \$45 million feasibility study on low-yield, earth-penetrating nuclear weapons. Called the "Robust Nuclear Earth Penetrator," Work, which will last several years, began in April 2002. Scientists of the national laboratories agreed that it is more favorable to look at modifications of existing weapons that starting from scratch. Lawrence Livermore National Laboratory looking at modifying the B-83 hydrogen bomb. Los Alamos National Laboratory is investigating further modifications to the B-61 bomb.

For fiscal year 2003, which begins 1 October 2002, the House approved \$15 million to continue studies of the Robust Nuclear Earth Penetrator. The Senate approved nothing. Status as of 6 September 2002 is that the House-Senate conferees will try to reach a compromise.

---

<sup>40</sup>*Mercury News*, 20 October 1988, p. 38.

<sup>41</sup>See Nelson. Also Pincus, 15 April 2001.

<sup>42</sup>Cited in Nelson.



## V. CONCLUSION.

Trident D-5 missiles are the backbone of America's nuclear arsenal and have become the "enforcer of foreign policy." Tridents, the ultimate first-strike weapons and now the optimum tactical nuclear weapons, back US diplomatic efforts. They are the threat of retaliation if Western interests are too seriously threatened, and they are the insurance against unacceptable resistance when Western troops step in to protect those interests.

But these weapons are having a much more subtle and extremely devastating effect on America's culture. People tacitly accept that it is OK to bully weaker nations if that sustains our lifestyle. It is considered acceptable to wage a war as long as there are no, or very few, American casualties. In effect, the American people now tolerate a permanent state of war. The culture of violence is brewing in our country with a particularly devastating effect on our younger generation.

This culture of violence took a savage turn for the worse after the 9/11 terrorist attack. Fanned by the flames of indignant nationalism, the people of this country have approved a war that will likely engulf the world. President Bush has even commented that he sees this activity more as a parallel to World War 2 than to the Vietnam war.<sup>43</sup> The killing fever is running high today. We have even sold our civil liberties in order to prove that we are the world's biggest bully. We have sacrificed our human dignity in order to protect our selfish arrogation of this planet's resources.

Helping restore feeling and compassion and reason to America's sensibilities, now seemingly numbed by the expediency of a military solution, will perhaps be the greatest advantage of all from scrapping Trident in all its nuances.

It is probably through contact with the public, and by motivating people to make their desires known, that Trident resisters will reap the most success. People have been and will continue to be bombarded with propaganda advocating bigger and better weapons. They have been intimidated on everything from jobs and the economy to national security, from protecting our vital interests to saving the huge investment in Trident by spending more money. It will take resourcefulness, ingenuity, perseverance, knowledge, integrity and many other positive traits to sway the American public away from false delusions and back to hope for the future. There will be rewards reaped, however, from stopping Trident. The greatest of these is the reward of reducing and someday eliminating the culture of violence that has infested our society, and of achieving a wholesome atmosphere in which our children and grandchildren can grow.

In 1990 the Navy was faced with a lawsuit because it hadn't provided public scoping of the base upgrade, as called for in the National Environmental Protection Act. That was not the last. On 26 June 2001, a coalition of three peace and environmental groups filed a citizens suit in federal court charging Naval Submarine Base Bangor with violations of the Endangered Species Act and the National Environmental Policy Act. These violations stem from rework of the base for the Trident-2 missile backfit without prior consultation under Section 7(a) of the ESA, and failure to document environmental impacts in an Environmental Impact Statement. It is also believed that the accelerated schedules for the *USS Kentucky* and *USS Pennsylvania* arriving at Subbase Bangor was to get Trident-2 missiles in place before the lawsuit gets to trial.

This whole wasteful, dangerous, unnecessary, and immoral process of the Trident system is something that citizens in a democracy should take very seriously, and then do something about.

#####

---

<sup>43</sup>White House Press Conference, 13 March 2002.

## REFERENCES.

*Analysis of Converting Trident-Class Ballistic Missile Submarines (SSBNs) to Nuclear-Powered Guided-Missile Submarines (SSGNs)*, Navy Report dated 14 June 1999.

Anderson, Rick; "Bangor Environmentally Sound; Sound is Tick, Tick, Tick." *The Seattle Times* (Seattle, WA), 4 September 1989, p. C1.

"Assumed in the FY 2000 Budget Submission," document prepared by Department of Navy Strategic Systems Programs, 26 September 1999.

*AW&ST -- Aviation Week & Space Technology*, various issues.

Baron, Chris; "D-5 Subs To Arrive Earlier Than Expected," Bremerton (WA) *Sun*, 23 February 2002.

Beers, Charles J. Jr., Rear Admiral US Navy, Deputy Secretary of Energy for Defense Programs, letter to Robert C. Aldridge dated 21 March 1995.

BOOJ/000671 -- Freedom Of Information Act response to Glen Milner from US Naval Base Bangor, signed by Lt. A.K. Minami and dated 20 June 2000.

Broom, Jack; "Navy Plan May Be Hit With Suit," *The Seattle Times* (Seattle, WA), 9 May 1990, p. A1 & A.

CAIG Report -- *Life-Cycle Cost Estimate for Trident Ballistic Missile Submarine Tactical Conversion*, report of the Cost Analysis Improvement Group (CAIG) of the Office of the Secretary of Defense in response to a requirement of the Fiscal year 1999 Defense Authorization Act, dated January 1999. (Published as Annex-A of the Final report.)

Calabresi, Massimo and Ratnesar, Romesh; "Can We Stop The Next Attack?," *Time*, Vol. 159 No. 10, 11 March 2002.

Campaigns Program Mission, Part of the Weapons Activities section of the fiscal year 2003 DOE budget. Available on the internet at <http://www.mbe.doe.gov/budget/03budget/content/weapons/campaign.pdf>

Cohen-1999 -- *Annual Report to the President and the Congress*, by William S. Cohen, Secretary of Defense, 1999.

CRS-1B73001, Trident Program, Congressional Research Service Issue Brief by Jonathan E. Medalia, Foreign Affairs and National Defense Division, updated 22 March 1991.

"D-5 Missile Information: Planned Procurement Rate (434 US + 21 UK)," chart published by the US Strategic Command, 1995.

*Day*, *The* (New London, CT.), various issues.

*Defence White Paper* 1994, Nuclear Weapons section (British Defence policy published by the Ministry of Defence).

*Defense News*, (6883 Commercial Street, Springfield, VA ), various issues.

*FBM Facts/Chronology -- Polaris, Poseidon, Trident*, Strategic Systems Project Office, US Navy, 1982.

Final Report -- *Analysis of Converting Trident-Class Ballistic Missile Submarines (SSBNs) to Nuclear-Powered Guided-Missile Submarines (SSGNs)*, report by US Navy mandated by the Fiscal Year 1999 Defense Authorization Act, transmitted to Congress on 14 June 1999..

Fritz, John; "Kings Bay Could Lose 2 Subs," *The Times-Union* (Jacksonville, FL), 2 March 1999.

Fuhrman, R.A., Lockheed Missiles & Space Company , *Fleet Ballistic Missiles: Polaris to Trident*, (AIAA paper, Washington, D.C., February 1978).

GAO/NSIAD-89-40, *Navy Strategic Forces: Trident-2 Proceeding Toward Deployment*, US General Accounting Office report, November 1988.

GAO/NSIAD-92-134 -- *Nuclear Submarines: Navy Efforts to Reduce Inactivation Costs*, US General Accounting Office Report, July 1992.

Greenhouse, Steven, "US Arsenal To Take More Cuts," *New York Times*. Published in *Mercury News* (San Jose, CA), 23 September 1994, p. 18A.

HAC-93 -- *Energy and Water Development Appropriations for 1993*, transcript of hearings before a subcommittee of the House Appropriations Committee, Part 6, 1992.

Hall, Raymond J., *Selected Weapons Cost for the Administration's 1996 Program*, a Congressional Budget Office report, 19 June 1995.

Hall, Raymond J., *Tables of Actual and Projected Weapons Purchases 1974-1997*, a Congressional Budget Office report, 20 March 1995.

Hamilton, Robert A.; "Missile Submarines Certified For 42 Years," *The Day* (New London, CT), 21 March 1998, pp. C1 & C3.

Hart, Amelia; "Navy Plans To Remove Two Kings Bay Tridents," *Tribune & Georgian* (Camden County, GA), 26 February 1999.

HASC No. 102-8 -- *Department of Defense Authorization for Appropriations for Fiscal Years 1992 and 1993*, transcript of hearings before the House Armed services Committee (1991).

Horn, Richard; "'Trident Cuts Could Boost Shipyard,'" *Bremerton, WA Sun*, 14 May 1999, pp. A1 & A4.

IIT Study -- *Trident C-4 Missile Life Extension Study*, report of study performed for the Pentagon's Weapon Support Improvement Group by the Reliability Analysis Center of IIT Research Institute, 30 September 1992.

Kidder, Ray E., "How Much Nuclear Testing Do We Need?," *Arms Control Today*, September 1992.

Lamphere, Sean: "USS Kentucky Scheduled To Arrive At Bangor May 1," *Central Kitsap Recorder*, 1 March 2002.

*Mercury News* (San Jose, CA), various issues.

Milner, Aaron; *The Environmental Effects of the Trident-2 Upgrade at Naval Submarine Base Bangor*, unpublished paper, May 1999. (To obtain a copy, send self-addressed stamped envelope -- 55 cents -- to Aaron Milner, 3227 NE 198<sup>th</sup> Place, Seattle, WA 98155)

Myers, Steven Lee; "Pentagon Proposes Reductions in Nuclear Arsenal," *New York Times*, posted at <http://www.mercurycenter.com/premium/codes/N/docs/N900.htm> at 10:30 p.m. PST, 22 November 1998.

Nelson, Robert W.; "Low-Yield Earth-Penetrating Nuclear Weapons," *FAS Public Interest Report: The Journal Of The Federation Of American Scientists*, January/February 2001.

*New Horizons*, Lockheed Martin Space Systems Company, various issues.

Newman, Richard J.; "Shooting From The Ship," *U.S. News*, 3 July 2000.

*New York Times*, (New York, NY), various issues.

Norton-Taylor, Richard; "Itch Fingers On The Trigger," *The Guardian* (London), 12 March 2002.

Offley, Ed; "Bangor Expansion Planned: Bigger Missiles, More Subs," *Post Intelligencer* (Seattle, WA), 9 September 1988, pp. A1 & A9.

Offley, Ed; "Arms Pact Will Bring Change To Submarine Base," *Post Intelligencer* (Seattle, WA), 15 April 1996, P. A1.

Offley, Ed; "Changes Ahead , But Navy Tridents To Stick Around," *Post Intelligencer* (Seattle, WA), 17 April 1997, P. A12.

Offley, Ed; "\$5 Billion Trident Sub Project For Bremerton," *Post Intelligencer* (Seattle, WA), 19 January 1999.

Offley, Ed; "Large Share For State Military Projects," *Post Intelligencer* (Seattle, WA), 2 February 1999.

Offley, Ed; "4 Trident Subs May Get New Mission: Cruise Missiles Would Replace Nuclear Arms," *Post Intelligencer* (Seattle, WA), 2 August 1999.

Performance Measures for FY 2003, in the Weapons Activities/Directed Stockpile Workload/Stockpile R&D section of the fiscal year 2003 DOE budget.

Pincus, Walter; "Does the US Need So Many Subs?" *The Washington Post*, published in *The Seattle Times*, 4 January 1999.

Pincus, Walter; "US Studies Developing New Nuclear Bomb," *The Washington Post*, 15 April 2001, p. A02.

Pritchett, Lloyd; "3 Subs To Be Moved To Bangor, 4 To Be Stripped Of Missiles," *Sun* (Bremerton, WA), 17 April 1997, pp. A1 & A8.

Pritchett, Lloyd; "Bangor, Sub Fleet Looking At \$4.2 Billion Facelift," *Sun* (Bremerton, WA), circa 1998, pp. A1 & A6.

*Program Acquisition Cost By Weapons System*, Department of Defense Budget for Fiscal Years 2000/2001, February 1999.

Rai, Milan; *Tactical Trident: The Riftkind Doctrine and the Third World* (London, Drava Papers, 1994).

"Report on Options for Trident-2 (D-5) Missile Acquisition and Industrial Base Sustainment," prepared by the Direct Reporting Program Manager (Strategic Systems programs), Office of the Assistant Secretary of the Navy (Research, Development, and Acquisition), May 1995.

Richter, Paul (*Los Angeles Times* writer); "List Of U.S. Nuclear Targets Disclosed," *Mercury News*, 9 March 2002, pp. 1A & 18A.

SAND2002-0253 -- Sandia National Laboratory report dated February 2002.

*San Francisco Chronicle* (San Francisco, CA), various issues.

SAR-011231 -- Department of Defense Selected Acquisition Reports, 31 December 2001.

SASC-92 -- *Department of Defense Authorization for Appropriations for Fiscal Years 1992 and 1993*, transcript of hearings before the Senate Armed Services Committee, Part 2, May and June 1991.

*Seattle Post Intelligencer* (Seattle, WA), various issues.

Shulman, Seth; *The Threat at Home: Confronting the Toxic Legacy of the US Military* (Boston, Beacon Press, 1992).

Space Daily, <http://www.spacedaily.com/news>.

*Star*, *The* (Lockheed Martin Space Systems Company, Missiles & Space Division), various issues.

Stober, Dan; "U.S. Weapons Labs Plan New Generation Of Smaller Warheads," *Mercury News*, 14 March 2002, p. 1A

*Submarine Roles in the 1990s and Beyond*, published by the Assistant Chief of Naval Operations for Undersea Warfare, Department of the Navy, Washington, D.C. 20350-2000, 18 January 1992.

*Sun, The*, (Bremerton, WA), various issues.

Thompson, T., "Performance of the SATRACK/Global Positioning System Trident-1 Missile Tracking System," IEEE Paper #CH1597-4/80/0000-0445, 1980.

*Times Union, The* (Jacksonville, FL), various issues.

Weiner, Tim; "Senate Passes Defense Appropriations Package," *New York Times*; posted on San Jose, CA *Mercury News* web site on 9 June 1999.

White House Press Conference, President George W. Bush, 13 March 2002.

## **GLOSSARY.**

AF&F	Arming, Fuzing & Firing system (for a hydrogen bomb).
C-4	US Navy designation for the Trident-1 missile.
CAIG	Cost Analysis Improvement Group of the Office of the Secretary of Defense.
CEP	Circular Error Probability -- the radius of the circle, centered on the target, within which the warhead has a 50 percent chance of hitting.
CND	Campaign for Nuclear Disarmament (Britain).
D-5	US Navy designation for the Trident-2 missile.
D5-LE	D-5 Life Extension program.
DASO	Demonstration And Shakedown Operations where firing missiles is part of the preparing the submarine for operational status.
DOD	Department Of Defense (US).
DOE	Department Of Energy (US).
EAR	Environmental Assessment Report.
EIS	Environmental Impact Statement.
ELF	Extreme Low frequency.
EOH	Engineered Overhaul.
ERO	Engineered refueling Overhaul.
ERP	Extended refit Period.
ESGN	Electrostatically Supported Gyro Navigator.
FBM	Fleet Ballistic Missile.
FY	Fiscal Year .
GPS	Global Positioning System
ICBM	Inter-Continental Ballistic Missile -- silo-based strategic missiles.
knot	One nautical mile per hour.
kt	Kiloton -- the explosive energy equivalent to 1000 tons of conventional explosives.
MILCON	MILitary CONstruction.
MIRV	Multiple Independently-targeted Reentry Vehicle.
NAVSTAR	NAVigation System Targeting And Ranging.
NPR	Nuclear Posture Review.
SAR	Selected Acquisition Reports.
SATRACK	SATellite TRACKing -- a system used with certain Trident missile test flights.
SIG	Stellar Inertial Guidance system.
SCOOP	SSBN Continuity Of Operation Program.
SINS	Ship Inertial Navigation System
SLBM	Submarine-Launched Ballistic Missile.
SORT	Strategic Offensive Reductions Treaty.

SRAM Short Range Attack Missile -- launched from strategic bombers.

SSBN Nuclear-powered ballistic missile submarine. In this designation the "SS" indicates a submarine, the "B" tells that it carries ballistic missiles, and the "N" means it is nuclear powered.

SSGN Nuclear-powered guided missile submarine. In this designation the "SS" indicates a submarine, the "G" tells that it carries guided missiles, and the "N" means it is nuclear powered.

SSN Nuclear-powered attack submarine.

SSP Strategic Systems Programs -- the US Navy Trident headquarters.

START Strategic Arms Reduction Talks.

SWFPAC Strategic Weapons Facility PACific.

UK United Kingdom (of Great Britain and Northern Ireland).

ULMS Underwater Long-range Missile System.

US United States.

yield The explosive energy of a nuclear bomb, usually expressed equivalent to thousands of tons (kilotons) or millions of tons (megatons) of conventional explosives.

**APPENDIX-A  
US TRIDENT SUBMARINES**

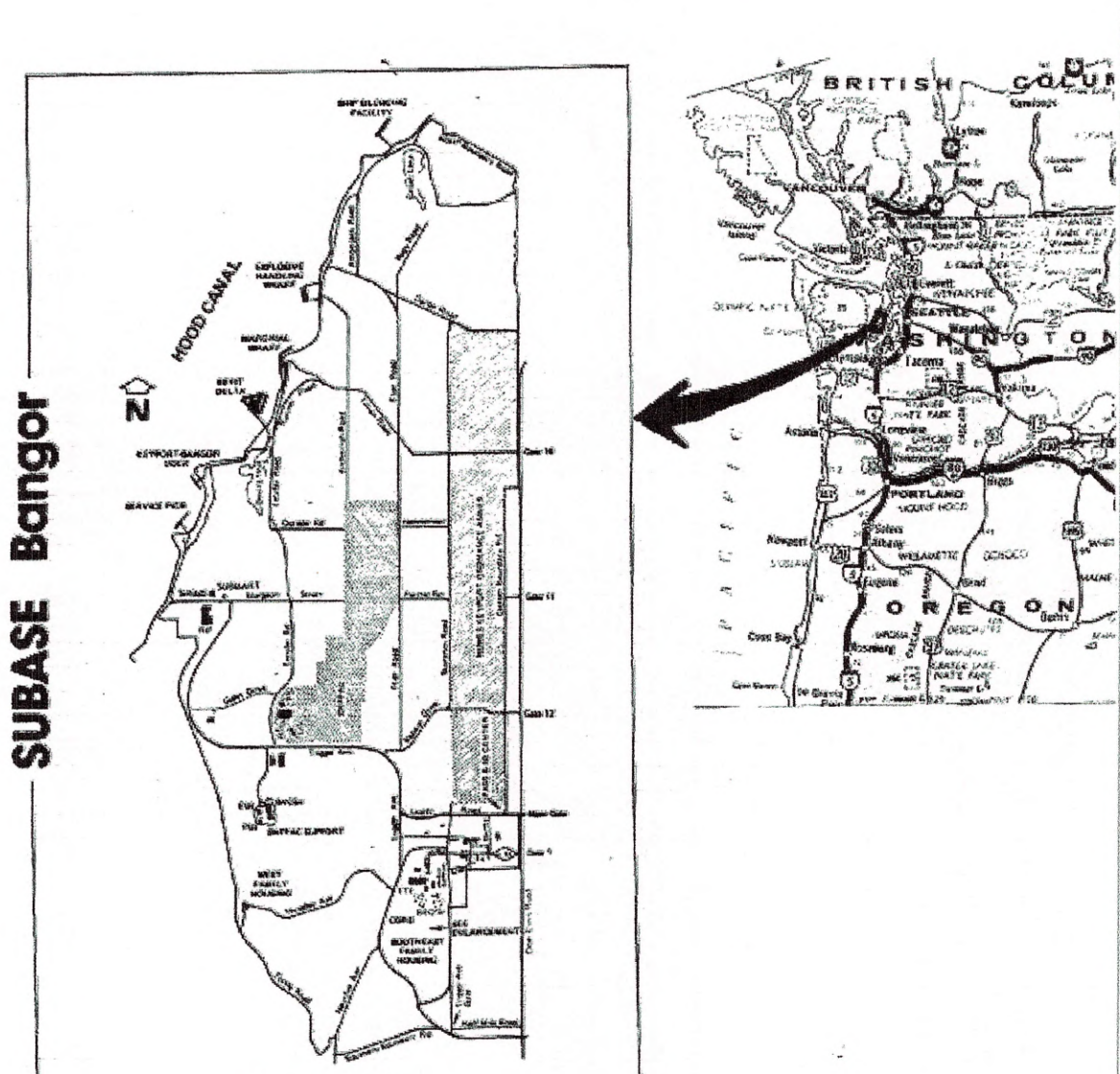
<u>SSBN</u>	<u>USS</u>	<u>COMMISSION DATE</u>	<u>HOME PORT</u>	<u>MISSILE</u>
726	<i>Ohio</i>	11 Nov 81	Bangor	C-4 (To be SSGN)
727	<i>Michigan</i>	11 Sep 82	Bangor	C-4 (To be SSGN)
728	<i>Florida</i>	18 Jun 83	Bangor	C-4 (To be SSGN)
729	<i>Georgia</i>	11 Feb 84	Bangor	C-4 (To be SSGN)
730	<i>Henry M. Jackson</i>	6 Oct 84	Bangor	C-4 (To be D-5 backfitted)
731	<i>Alabama</i>	25 May 85	Bangor	C-4 (To be D-5 backfitted)
732	<i>Alaska</i>	25 Jan 86	Bangor	D-5 (Originally C-4)
733	<i>Nevada</i>	16 Aug 86	Bangor	C-4 (In backfit to D-5)
734	<i>Tennessee</i>	17 Dec 88	Kings Bay	D-5
735	<i>Pennsylvania</i>	9 Sep 89	Bangor	D-5 (Originally Kings Bay)
736	<i>West Virginia</i>	20 Oct 90	Kings Bay	D-5
737	<i>Kentucky</i>	13 Jul 91	Bangor	D-5 (Originally Kings Bay)
738	<i>Maryland</i>	13 Jun 92	Kings Bay	D-5
739	<i>Nebraska</i>	10 Jul 93	Kings Bay	D-5
740	<i>Rhode Island</i>	9 Jul 94	Kings Bay	D-5
741	<i>Maine</i>	29 Jul 95	Kings Bay	D-5
742	<i>Wyoming</i>	13 Jul 96	Kings Bay	D-5
743	<i>Louisiana</i>	6 Sep 97	Kings Bay	D-5

**APPENDIX-B**  
**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) NAVSTAR GPS satellite receiver
Crew	157 with Trident-1 missiles (15 officers/142 enlisted) 165 with Trident-2 missiles (15 officers/150 enlisted)
Armaments	4 torpedo tubes 24 Trident SLBMs carrying either 192 Mark-4/W76 or Mark-5/W88 MIRVs

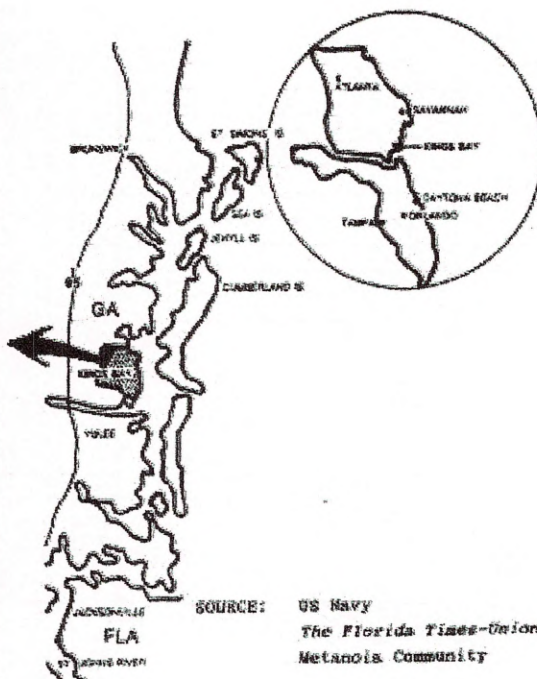
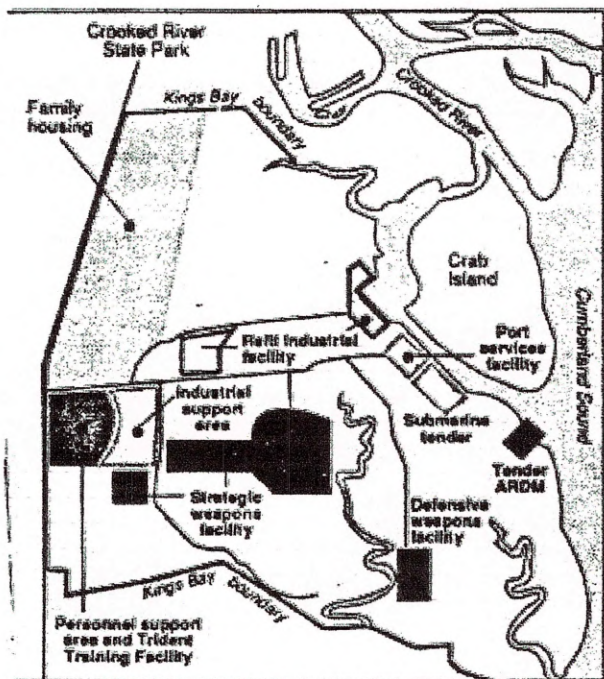


APPENDIX-C  
 MAP OF US WEST-COAST SUB-BASE BANGOR



Source: US Navy  
 Ground Zero Center for Nonviolent Action

**APPENDIX-D  
MAP OF US EAST-COAST SUB-BASE KINGS BAY**



SOURCE: US Navy  
The Florida Times-Union  
Metanoia Community

**APPENDIX-E**  
**TRIDENT-1 (C-4) 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 warheads. 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.
START-1 warhead loading limit	6 Mark-4/W76, 100 kt MIRVs.

**APPENDIX-F**  
**TRIDENT-2 (D-5) 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 warheads. 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 submarine before launch.
Accuracy	400-500 feet CEP.
Max. warhead loading	8 Mark-5/W88, 475 kt. MIRVs, or 8 Mark-4/W76, 100 kt. MIRVs.

**APPENDIX-G  
TRIDENT-2 (D-5) MISSILE PROCUREMENT**

Fiscal Year	US Missiles Ordered	British Missiles Ordered
-----	-----	-----
1987	21	
1988	66	
1989	66	
1990	41	3
1991	52	
1992	28	23
1993	21	18
1994	24	
1995	18	
1996	6	
1997	7	7
1998	5	7
1999	5	
2000	12	
2001	12	
2002	12	
2003-2013	172 planned	
-----	-----	-----
Total	568	58

- ! Missiles are usually delivered two years after they are ordered.
- ! Trident-2 missile production was to stop at the end of FY-2005 when Trident submarines had a service life of 30 years. However, Trident submarine service life has been extended to 42 years -- two 20-year service stints separated by a two-year refueling overhaul.
- ! *Space Daily* reported 29 January 2002 on its web site that the US Navy has purchased 396 Trident-2 missiles since initial production began in 1987. That agrees with this chart for procurement through 2002. SAR-011231 reports that the total production run (to end in fiscal year 2013) will be 568 missiles. The 568 total is further verified by the "SAR Program Acquisition Cost Summary" dated 30 September 2002. That leaves 172 missiles yet to be ordered from 2003 through 2013.