PEOPLE TO PEOPLE

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6 Dec 96

Dear Friends,

TRIDENTS RESISTER'S HANDBOOK - UPDATES

Enclosed is the latest printing of the Updates. We are collating the sheets at the same time as we are reading the news in the national press of the "Generals' Statement", in which, among others, General Lee Butler states that the only possible way forward is for a global ban on nuclear weapons to be set in place. "*The end of the Cold War makes it possible; terrorism and a new nuclear arms race render it necessary*".

Those of us working for nuclear disarmament have always known this to be true. But we must continue to press the case, particularly on Trident. We need to work with our US friends in continuing to expose the dangers and the cost. This is where the Handbook and Bob Aldridge's meticulous work is invaluable.

We really seem to be seeing the chance of a nuclear free future and a safer world. Let us continue the struggle for the complete elimination of the Trident nuclear armed submarine.

Please could you be kind enough to send us £3.50* as a contribution towards printing and postage.

We would like to wish you all a Very Happy Nuclear Free New Year

In Peace.

Rae Street and Pat Sanchez

*Just for interest, look in your Handbook at the statements endorsed by General Lee Butler when he convened the Reed Panel in 1991, when "nuclear targetting" was endorsed

Rae Street and Pat Sánchez

* cheques payable to People-to-People

MARCH 1996 REVISION

INSTRUCTIONS FOR UPDATING YOUR *TRIDENT RESISTER'S HANDBOOK*

REMOVE old pages CS2-1/CS2-2, CS3-1/CS3-2, CS5-1/CS5-2, CS6-1/CS6-2, CS7-1/CS7-2, CSS-1/CSS-2, LF-1/LF-2.
ADD new pages CS2-1/CS2-2, CS3-1/CS3-2, CS5-1/CS5-2, CS6-1/CS6-2, CS7-1/CS7-2, CSS-1/CSS-2, LF-1/LF-2.
Changed to agree with chapter revisions.

REMOVE old pages 2.1-5, 2.1-6 and 2.1-9 through 2.1-12.
ADD new pages 2.1-5, 2.1-6 and 2.1-9 through 2.1-12.
Updates status of British Trident submarines in text.
Updates Figure 2.1-6.
Corrects "tons" to "tonnes" in Figure 2.1-8.

REMOVE old pp. 2.2-1 thru 2.2-4, 2.2-7 & 2.2-8, 2.2-11 & 2.2-12.
ADD new pp. 2.2-1 thru 2.2-4, 2.2-7 & 2.2-8, 2.2-11 thru 2.2-14.
Corrects Figure 2.2-1 on p. 2.2-1.
Updates British missile purchases on p. 2.2-4.
Added new references on p. 2.2-7.
Added DASO #13 and FCET #9 & #10 flights on p. 2.2-11.
Added Figure 2.2-8 on p. 2.2-12.
Added Figure 2.2-9 on p. 2.2-13

REMOVE old Chapter 3.2 (pp. 3.2-1 through 3.2-4).
ADD new Chapter 3.2 (pp. 3.2-1 through 3.2-4).
Added full name of acronyms.
Updated NAVSTAR information.
Moved References to end of chapter.

REMOVE old pages 5.1-7 and 5.1-8.
ADD new pages 5.1-7 through 5.1-10.
Added shore control scheme for US Trident subs.
Added Section E on criticality problem.
Added references to end of chapter.

REMOVE old pages 5.2-3 through 5.2-12.
ADD new pages 5.2-3 through 5.2-14.
Generally updated this chapter.

REMOVE old Chapter 6.3 (pp. 6.3-1 through 6.3-6).
ADD new Chapter 6.3 (pp. 6.3-1 through 6.3-6).
Updated savings for stopping Trident.

REMOVE old Chapter 7.2 (pp. 7.2-1 through 7.2-4).
ADD new Chapter 7.2 (pp. 7.2-1 through 7.2-4).
Generally updated this chapter.

REMOVE old Appendix-C (pp. AC-1 & AC-2)
ADD new Appendix-C (pp. AC-1 & AC-2)
Revised sources for complete references.

REMOVE old Appendix-D (pp. AD-1 & AD-2)
ADD new Appendix-D (pp. AD-1 & AD-2)
Corrected "million" to "billion" in first paragraph.
Revised sources for complete references.

REMOVE old Appendix-F (pp. AF-1 & AF-2)
ADD new Appendix-F (pp. AF-1 & AF-2)
Added Nuclear Free Local Authorities *Bulletin*.
Removed *Trident Information Network Newsletter*.

REMOVE old Appendix-G (pp. AG-1 through AG-6)
ADD new Appendix-G (pp. AG-1 through AG-6)
Updated START-1 and START-2 status.
Added References at end.

FILE this page in appropriate order in Section R -- "Record of Revisions."

On the back of this sheet is a current list of PLRC papers available. You may want to order a more recent revision of the papers which interest you.

-- ***UPDATE YOUR HANDBOOK IMMEDIATELY -- KEEP IT CURRENT*** --

PACIFIC LIFE RESEARCH CENTER

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March 26, 1996

The following papers are available from Pacific Life Research Center. Single copies are free. Send a self-addressed, stamped business envelope (#10), unless another size is indicated. The amount of US postage to be on envelope is specified in brackets after each listing.

PLRC-960301 -- *Land-Attack Tomahawks: A Background Paper on Sea-Launched Long-Range Cruise Missiles*, 1 March 1996 (11 pages) [55 cents postage in US]

PLRC-950726C -- *Lockheed Martin Missiles & Space: A Background Paper on the World's Top Missile Peddler*, Revised 8 February 1996 (11 pages) [55 cents postage in US]

PLRC-950223B -- *From Star Wars to Scud Buster: A Background Paper on Ballistic Missile Defense*, Rev. 29 Sept 1995 (34 pages) [$1.01 postage in US, on a 9"x12" envelope]

PLRC-941207A -- *Hegemony in Europe: Part-2 -- The Intracacies of Economic Competition*, Rev. 8 March 1995 (21 pages) [55 cents postage in US] {FINAL REVISION}

PLRC-941107 -- *Hegemony in Europe: Part-1 -- The Subtleties of Political Competition*, 7 November 1994 (20 pages) [55 cents postage in US]

PLRC-941005 -- *Background Paper on the Extreme Low Frequency (ELF) Submarine Communication System*, Rev. 5 October 1994 (14 pages) [55 cents postage in US] {FINAL REVISION}

PLRC-940829 -- *What After Bosnia? A Background Paper on the Potential for a Major War in the Balkans*, 29 August 1994 (20 pages) [55 cents postage in US]

PLRC-940814B -- *Korea and Nuclear Weapons: A Background Paper on Easing Tensions on the Korean Peninsula*, Rev. 27 March 1995 (6 pages) [32 cents postage in US]

PLRC-940106B -- *The Dark Side of Free Trade: NAFTA, GATT and APEC*, Rev. 23 February 1995 (19 pages) [55 cents postage in US] {FINAL REVISION}

CHECK THE REVISION LETTER AFTER THE PLRC NUMBER (OR THE REVISION DATE) TO MAKE CERTAIN YOU HAVE THE LATEST UPDATE.

CONTENTS OF SECTION 2 -- THE TRIDENT SUBMARINE AND MISSILE SYSTEM

CONTENTS OF SECTION 3 -- SUPPORTING SYSTEMS

CONTENTS OF SECTION 5 -- THE HAZARDS OF TRIDENT

CONTENTS OF SECTION 6 -- TRIDENT ECONOMICS

CONTENTS OF SECTION 7 -- NUCLEAR WEAPONS INVENTORIES

CONTENTS OF SUPPLEMENTAL SECTIONS

LIST OF FIGURES

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 26 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]

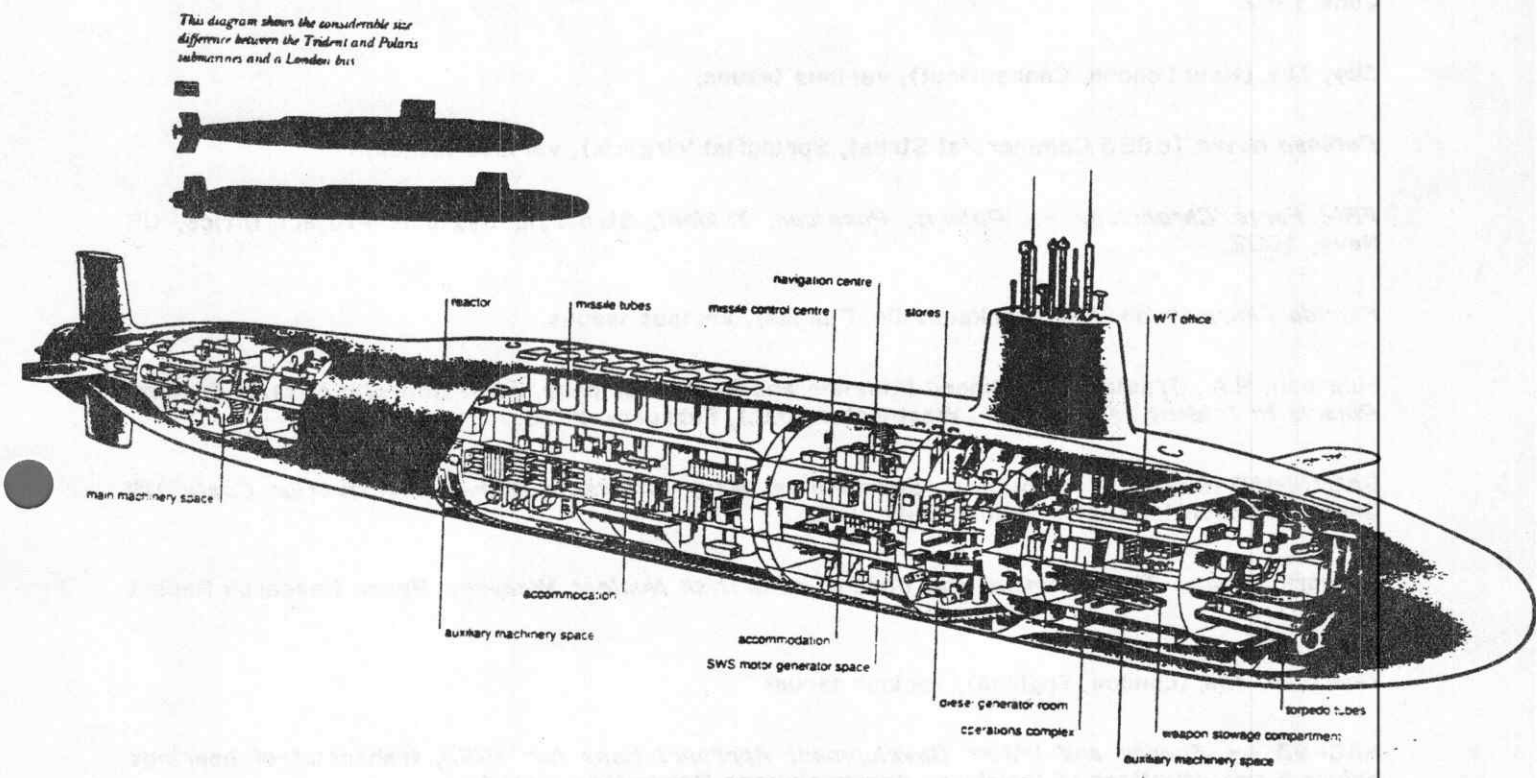

FIGURE 2.1-4
BRITISH TRIDENT SUBMARINE LAYOUT
Source: British Ministry of Defence

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 2.1-6
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

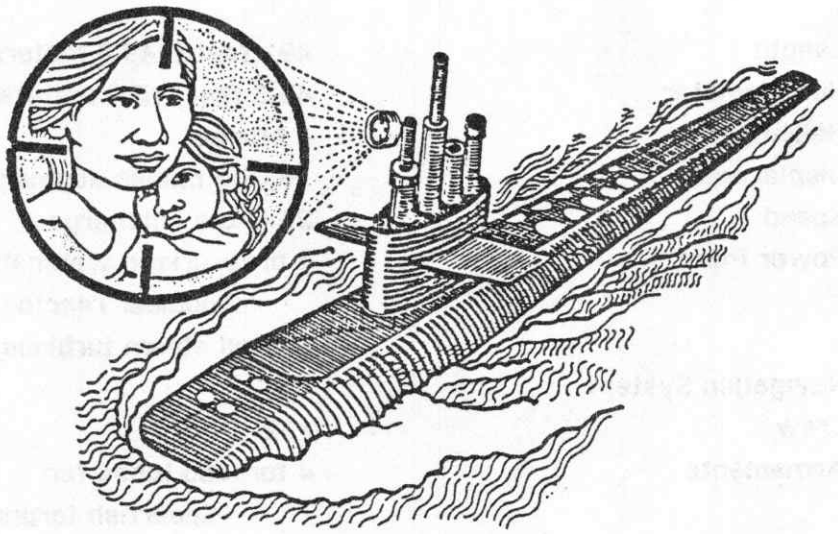
FIGURE 2.1-7
US TRIDENT SUBMARINE SPECIFICATIONS

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 2.1-6
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

TRIDENT RESISTER'S HANDBOOK

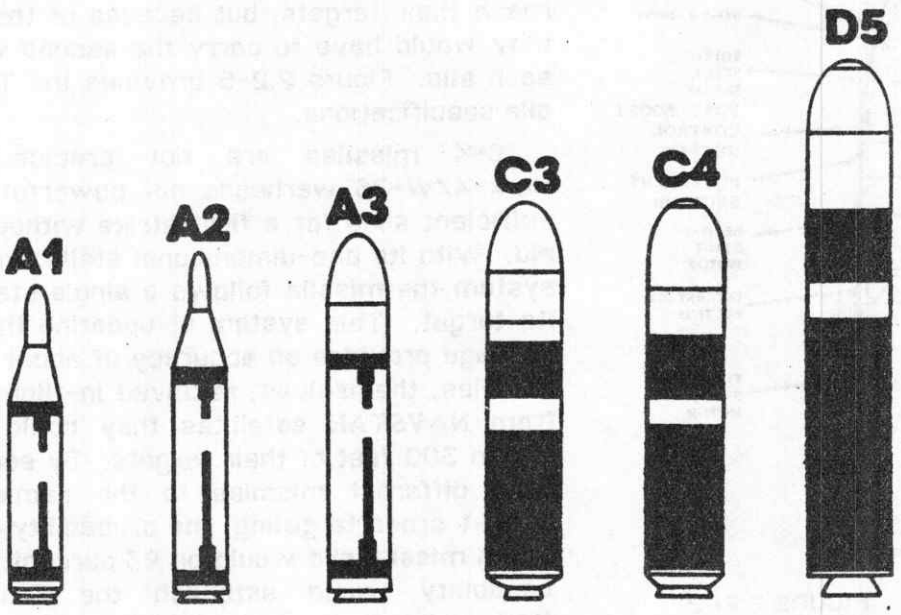


2.1-12

September 1995 revision

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.

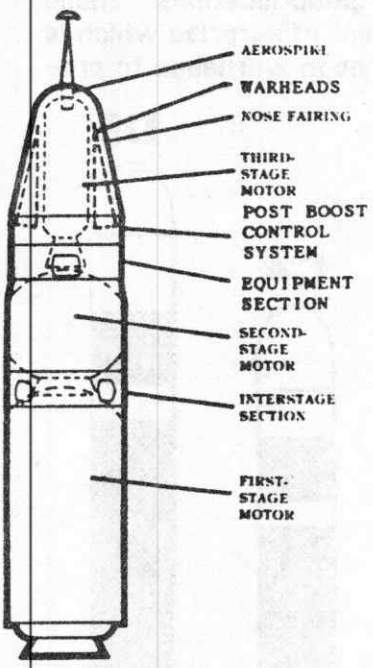


FIGURE 2.2-2
TRIDENT-1 (C-4) MISSILE
Source: US Navy

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.

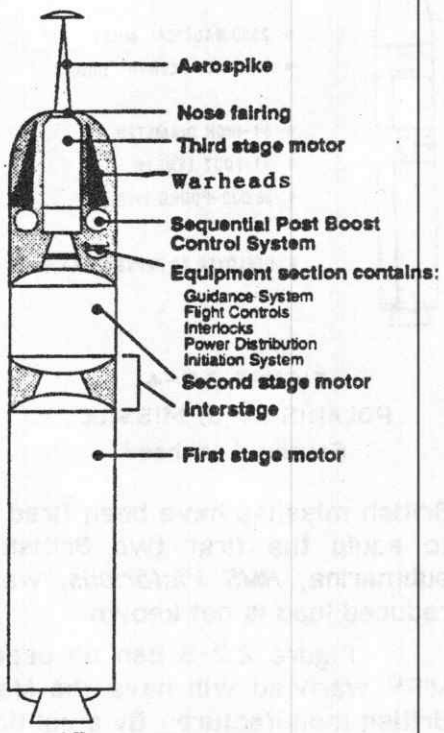


FIGURE 2.2-3
TRIDENT-2 (D-5) MISSILE
Source: US Navy

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.

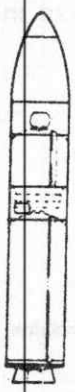


FIGURE 2.2-4
POLARIS (A-3) MISSILE
Source: Lockheed

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

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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 stream-lined 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.

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.

3.2 NAVIGATION: STRAIGHT AND TRUE

Submarines, like missiles, have an inertial navigation system comprised of instruments which sense every movement of the vessel as well as tides and currents. By keeping track of all this relative motion the navigation system provides a pretty fair location of the submarine over a given period of time. But the margin of error increases with time and the sub needs a navigation *fix* to update its exact location. Then the corrected inertial system continues for another increment of time. Prior to the 1990s, submarines relied on land-based Omega and Loran-C signals, and Transit navigation satellites for these periodic positional fixes. Now the NAVSTAR global positioning system is taking over.

A. OMEGA, LORAN-C, AND TRANSIT

Omega is a very-low-frequency (VLF) system with eight transmitting stations spread throughout the world to provide global coverage. Every ten seconds each of these stations emit a unique beep, but they are not emitted simultaneously or haphazardly. Through the use of very accurate and precisely synchronized atomic clocks, these beeps are emitted in a prearranged sequence at a specific time. A submarine can raise an antenna to within 30-40 feet of the surface to receive at least three of these stations at any time. By knowing when the beep is emitted and recording, by means of an on-board atomic clock, the time it is received, the submarine's navigator can calculate how far the boat is from each station. Then it is merely a matter of trigonometry to determine the sub's position. Of course this is all done automatically by computer. Omega is accurate to within 3,000 feet. An improvement called Differential Omega can improve the accuracy to several hundred feet. In this system a nearby land station of known location determines the error accumulated during the travel of the radio signal, and then broadcasts local correction factors. But such stations are limited and even Differential Omega is not accurate enough for destroying hard targets.

Loran-C uses land-based transmitters to send out signals in the low-frequency (LF) band. Most areas of the world are covered but to receive these fixes a submarine has to put an antenna within 9-12 feet of the ocean's surface. Loran-C fixes are accurate to within 250-500 feet -- still not good enough for hard-target missiles.

Finally, there are Transit navigation satellites which can also transmit in the LF band but are only in view of a specific submarine's location every hour or so. Then a submarine must leave its antenna within 9-12 feet of the surface for three to four minutes in order to get a fix from different positions of the single satellite in view. Transit accuracy is anywhere from 150 to 600 feet, which is still not good enough.

It was because of this lack of precision in navigation aids that submarine-launched missiles never had the accuracy of land-based ICBMs. A faster and more accurate sys-

tem was needed to make Trident a first strike weapon. The answer was the NAVSTAR Global Positioning System (GPS).

NAVSTAR GPS

In *First Strike* (Aldridge, 1983), the history and function of the Navigation System Timing And Ranging (NAVSTAR) is outlined. NAVSTAR is now available at any time, in any weather, and at any place on or above the earth. A 30-second fix gives the receiver's position within 10 meters (33 feet) in all three dimensions, and velocity (speed and direction) within a fraction of a mile per hour. Navstar also provides precise time within a millionth of a second to synchronize the submarine's atomic clock.

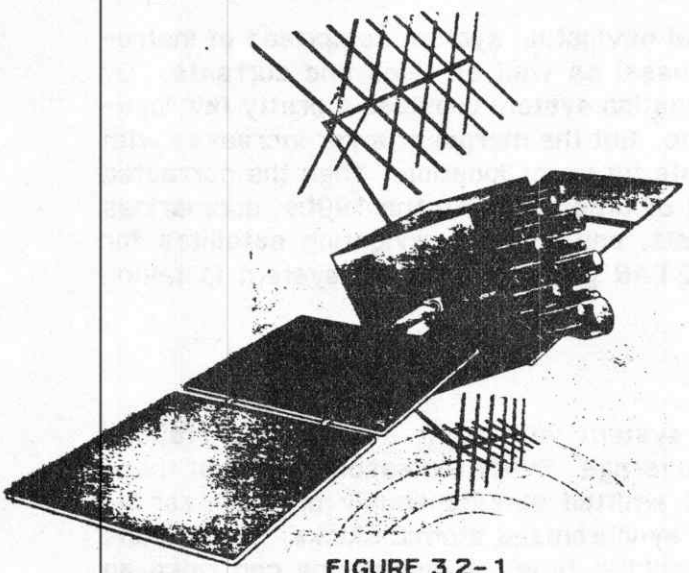

FIGURE 3.2-1
NAVSTAR SATELLITE
Source: San Jose *Mercury News*

A more accurate application of NAVSTAR is available at certain critical locations. Called Differential NAVSTAR, it provides 3-dimensional accuracy within 2 meters (6.6 feet). To accomplish this a receiver of precisely known location receives the NAVSTAR signals, calculates the error, and then broadcasts a correction factor for that locality. For civilian use, however, the Pentagon will only provide navigation fixes with an accuracy of 100 meters (330 feet) in all three dimensions.

The full NAVSTAR constellation consists of 24 operational satellites. They are divided equally in six polar orbital planes inclined 55 degrees to the equator. The orbits are approximately half-geosynchronous (10,898 nautical miles above the earth), which means each satellite completes about two trips per day around the globe. With this full constellation there will always be five satellites in view. The satellites have about a 7-year service life. NAVSTAR satellites are now being put into orbit by Delta-2 rockets launched from Cape Canaveral. Falcon Air Force Base in Colorado is the master control station for NAVSTAR, which was used extensively during the war with Iraq. The first Block-2 operational satellite was launched into orbit on 14 February 1989. All Block-2 and Block-2A satellites, built by Rockwell Space Systems Division (Downey, California), have now been launched into orbit.

In 1989 the US Air Force awarded a contract for 21 replacement satellites designated Block-2R. Lockheed Martin Missiles & Space Company (LMMS -- Sunnyvale, California) will deliver the first of these in 1996. They are also expected to last about 7 years in space.

LMMS is preparing a proposal for a third generation NAVSTAR called Block-2F. They will have more auxilliary payload space and last about 10 years. Originally the Air Force wanted 51 of the Block-2Fs but in mid-1995 that was scaled back to 33. Besides LMMS, Rockwell Space Systems Division and Hughes Space & Communications Company (Los Angeles, California) are competing for the contract.

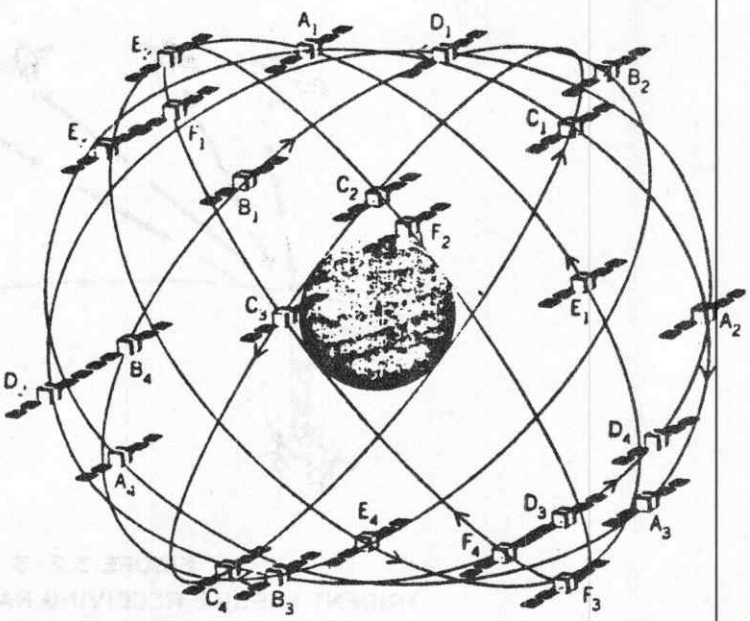

FIGURE 3.2-2
FULL NAVSTAR CONSTELLATION
Source: Unknown

Obtaining the navigation fixes from NAVSTAR is, again, a sophisticated exercise in triangulation. Extremely precise atomic clocks time the intervals between transmission and receiving of radio signals from each of the satellites in view. A computer then solves four or five simultaneous equations to obtain the receiver's position. Subsequent readings provide speed and direction.

NAVSTAR, by giving the exact position of launch, is the answer to submarine-launched missile accuracy. NAVSTAR receivers could also be in the missiles, themselves, to provide in-flight missile guidance updates for even greater precision. Both Trident-1 and Trident-2 missiles have received NAVSTAR signals during test flights, purportedly to calibrate the on-board navigation system. But millions of dollars have been spent to integrate NAVSTAR fixes with inertial navigation packages and it would be no great effort to do that for Trident. NAVSTAR has already been incorporated on cruise missiles (21 inches in diameter) and receivers have been designed for use in 155-millimeter artillery shells (six inches diameter. Some NAVSTAR receivers are as small as cigarette packages, so space and weight are not problems. NAVSTAR updates would only be necessary for Trident-2 missiles carrying the smaller and lighter 100-kiloton warheads, so weight is definitely not a problem. Regarding space, the receiver is so small it could be installed almost anywhere on the reentry vehicle deployment platform (bus) to aim each warhead directly at its target.

* * * * *

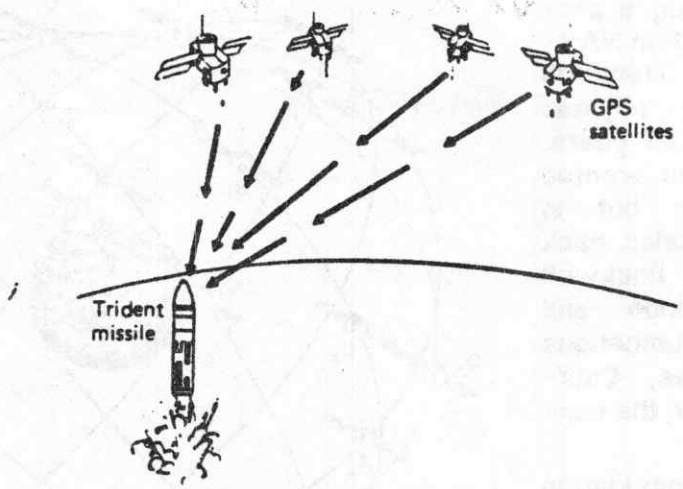

FIGURE 3.2-3
TRIDENT MISSILE RECEIVING NAVSTAR SIGNALS
Source: Thompson

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before launch. That is scary. Given 70 days of confined environment in an atmosphere of paranoia and secrecy, it is not hard to construct scenarios where reality can be distorted.

The Drell Panel expressed satisfaction with the technical measures and serious consideration regarding control of the use of US Air Force nuclear weapons. But it points out that "the Navy's fleet ballistic missile system differs in that, whereas launch authority comes from outside the submarine, there is no requirement for external information to be provided in order physically to enable a launch. It is also important to evaluate the suitability of continuing this procedure in the future." [Drell Report, p. 34]

In response to the report's criticism, the US Navy "reluctantly agreed" to install electronic devices in Trident submarines that can only be unlocked by shore-based authorities. [*The Day*, 4 January 1995, p. A1] How much safer this will be than previous methods is not known. But it will undoubtedly serve a public-relations purpose.

Command and control of missiles on a British submarine must be similar, and hardly any more stringent. The danger is certainly no less.

E. A CRITICALITY PROBLEM

By Katherine Jane Harine, PhD, a nuclear weapons consultant who warned of this Trident-2 missile safety hazard while working for Lockheed.

The W-88 warhead, due to its high yield, has a criticality problem that was not known to the Drell panel, although it was listed as an "exception" in the final weapon development report by the designing laboratory, the Los Alamos National Laboratory. Subcriticality cannot be assured if water penetrates the warhead. There is a sufficient quantity of enriched uranium in a small volume so that when water floods the internal U^{235}-rich components, moderating the neutrons, a critical geometry is established. The result is a boiling water reactor.

A boiling water reactor is one whose criticality depends on the presence of water. As the power level of the reactor increases and the heat turns the water into steam, fewer water molecules are present in the reactor; hence, the moderation decreases and the nuclear reactions are fewer. Then, as the power level decreases, the reactor cools causing the water to condense. Thus more water molecules return to the reactor and the nuclear reactions increase again. The result is a reactor which is self-limiting. It will not explode. It will continue working.

In the case of the W-88 an explosion would be small and the reaction would cease. By continuing, the W-88's nuclear reactions will produce radiation and radioactive debris, fission fragments. The radiation will only have a local effect. However, the radioactive fission fragments will disperse throughout the environment emitting radiation wherever they go. These radioactive products are deadly when ingested or inhaled by animals or humans.

The [Mark-5] reentry body and the [W-88] warhead inside it have seals to prevent the ingress of water at moderate pressures. Initially it might appear that only the loss of a submarine in the deep waters of the ocean would produce pressures high enough to

rupture the seals. However, several other scenarios of accidents which could result in the breach of the seals exist. One would start with the weakening of the seals due to heat from a fire. Another would begin with damage to the seals from a shock wave or projectiles from an explosion or dropping accident. If one of these scenarios preceded the falling of the reentry body into a shallow depth, water infusion could easily occur. The nuclear reactions would begin and continue until enough of the enriched uranium was expended so that the mass is no longer critical. Although the direct radiation from the warhead would be dangerous to animals or humans nearby, the real danger is from the fission products that would escape and propagate throughout the environment.

Iodine 131, cesium 137, and strontium 90 are typical radioactive products that will enter the body and then radiate as they decay. Iodine is absorbed by the thyroid gland, cesium is similar chemically to sodium and potassium, and strontium is similar chemically to calcium. As might be expected, strontium 90 shows up in milk and then bones after it is released throughout the environment. The fact that these radioactive isotopes enter tissues so easily and then radiate inside the tissue makes their effects so hideous.

The design criteria that forced the warhead to have this critical geometry are the range and yield that have been stipulated. If a shorter range of a lower yield were allowed, a warhead could be designed without this criticality problem. Of course, the high yield and long range are needed to attack hard targets -- i.e. super hard missile silos. Since these silos contain the SS-18 missiles, which would be the first missiles launched [if Russian struck first] due to their high number of multiple reentry vehicles, the Trident-2 with the W-88 would [by targeting these silos] be a first strike weapon. If the former Soviet Union had launched first, these silos would be empty.

There are only 400 of the W-88 warheads instead of a planned 4,000 or so because the Rocky Flats facility, which manufactured the W-88 pits, was closed down due to safety and security problems. The 400 W-88s are still a significant number, however. The 400 could be loaded on two Trident-2 submarines or spread out over all the Trident-2 submarines, which are based in the Atlantic Ocean. Since the United States does *not* need a first-strike capability, it would seem prudent to replace the 400 W-88 high yield warheads with lower yield W-76 warheads which do not have the criticality problem.

* * * * *

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Sometimes the train would take alternate routes in an attempt to evade the people waiting along the tracks to express concern about this load of destruction passing through their communities. But the white train stood out like a sore thumb and aerial patrols -- usually media helicopters -- could pick it up quickly. This led to repainting the train -- each car a different color. Later some of the bomb-carrying cars had an additional superstructure added to accommodate the larger Trident-2 warheads.

Nuclear train cars are designated TSSX -- TSS meaning Transportation Safeguards [at DOE] Sandia, and the X meaning the cars are not owned by the railroad, or that they are under long-term lease from the railroad. The bomb-carrying cars range from TSSX 519 to 570. The turret or guard cars are designated TSSX G32 through G35.

The Department of Energy threatened to make it a crime to publish information about movements of the nuclear train. Violations would be punishable by a $100,000 fine or 20 years in prison. Nevertheless, the Agape Community grew, and continued to vigil along the tracks as the train passed.

The nuclear train disappeared in 1986, except for a trial run of a car converted to carry Trident-2 warheads in 1988. (See Figure 5.2-1) So much attention being drawn to nuclear warhead movement must have embarrassed the US government, so shipments by train were discontinued. It is presumed that warheads are now being transported by other means. DOE transportation by air is currently only of weapons equipped with IHE. The Pentagon, with a need to ship overseas as well as in the US, has restrictions that are not so rigid. The Drell Panel recommended: "In the interest of safety against plutonium dispersal there should be a consistent policy governing the very large number of weapons movements whose numbers have typically, in recent years, added up to more than 1,000 vehicle trips and one-million miles per year." [Drell Report, p. 30]

In early February 1992, Assistant Defense Secretary Stephen J. Hadley suggested to the Senate Armed Services Committee that the nuclear train be loaned to Russia to haul its warheads in from the field for deactivation. On February 17th Russia accepted the offer of using the 25 special boxcars along with 250 special warhead containers and smaller containers for components -- even bullet-proof blankets with which to cover the warheads. However, the nuclear train still sits at Pantex, Texas and could be used again. As for now, nuclear warheads continue to be hauled by truck [see below]. Observers at Pantex are seeing a lot of nuclear truck activity movi ng in and out of the plant.

B. MISSILE-MOTOR BOXCARS

When a special freight train destined for Sub-Base Bangor derailed near Puget Sound in April 1986, Navy officials promptly disclaimed the presence of explosive material. Documents later obtained through the Freedom Of Information Act revealed that over 50 tons of Class-A explosives in the form of Trident-1 (C-4) rocket motors were on board. Class-A tops the danger list.

Conditions became acute in Alabama in November 1988 when an afternoon freight train enroute to Cape Canaveral edged east from Birmingham. It derailed a mile outside of Talladega at about 4:00 PM. Steel box car number DODX 29504 left the tracks with a pair of Trident-2 (D-5) missile motors inside. Flashing warning lights and a placard reading "EXPLOSIVES A" prompted sheriff deputies to immediately evacuate people living within a

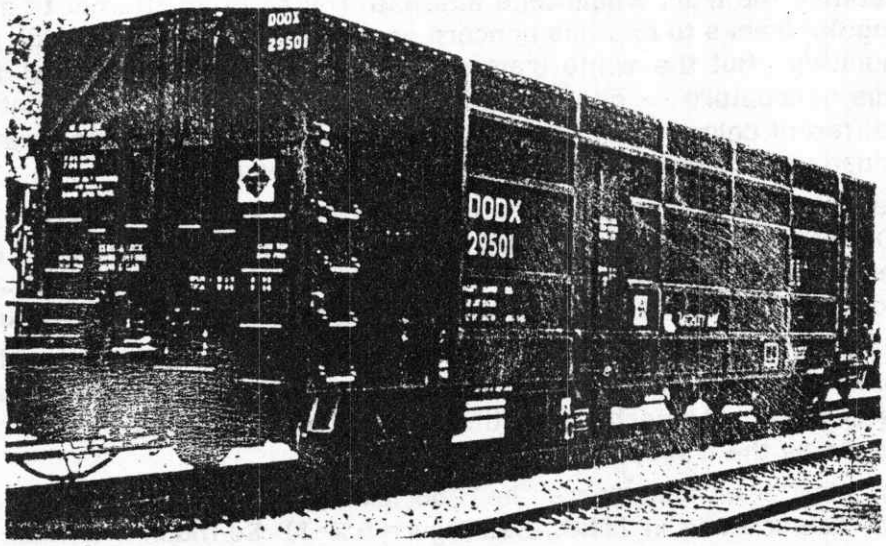


FIGURE 5.2-3
MISSILE-MOTOR BOXCAR -- DODX-29501
Photo Courtesy of Agape Community

mile radius.

These close encounters with disaster epitomize the danger that rides the rails of America. Luckily, no one was hurt in either incident. But had a fire started this story could have had a different ending. Had it caught fire in a city, the outcome would have been catastrophic.

The Department of Defense owns nine specially designed and constructed boxcars designated DODX 29500 through 29508. DOD, of course meaning that the cars belong to the Department of Defense, and the X signifies they are not owned by the railroad. These boxcars have an environmental control system (air conditioning) which maintain the temperature between -20^{0}F and 120^{0}F. If the environmental control system should fail and the weather outside is not in that range, the cars cannot maintain the desired temperature for twelve hours. A warning light on an upper corner goes on if such a failure occurs.

For that reason, when the train's route will encounter an outside temperature more extreme than the desired shipping range, security escort personnel go along in case the environmental control system fails. To accommodate these people, the DOD has exclusively leased four comfortably-equipped cabooses which are also designated DODX.

Trident-2 motors contain almost 56 tons of extremely high explosive propellant. It is general practice for over 50 tons of rocket propellant to be shipped in one boxcar. Two such box cars have been observed adjacent to each other in one train -- it is possible there could be more. The propellant composition is secret but it is a real bomb which can be ignited by fire or a sharp blow. The resulting explosion is so powerful that Trident-2 test launches at Cape Canaveral took place according to stringent weather criteria because under certain atmospheric conditions a motor explosion would damage the nearby

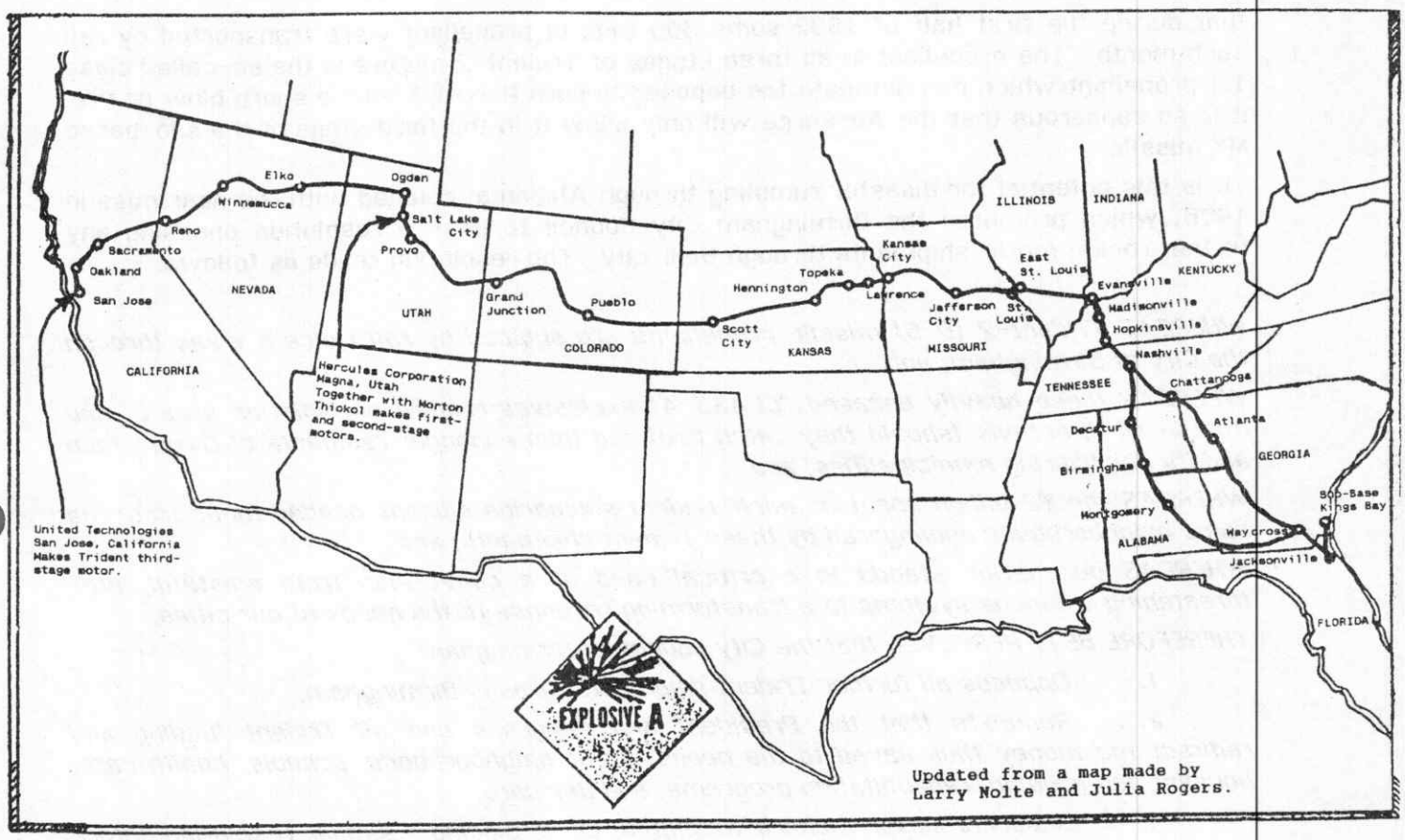


FIGURE 5.2-4
RAILROAD MAP OF MISSILE MOTOR SHIPMENTS

town.

The Navy requires wide buffer areas around all locations where Trident motors are handled and assembled. Personnel are also kept to a minimum. But no such safety considerations exists along railroad tracks and roads during transit because, according to the Navy, commercial carriers are subject only to Department of Transportation regulations. There are, however, special instructions warning that if a fire reaches the cargo compartment everyone, fire fighters and the public alike, must withdraw to at least one mile from the scene. Under such lax transportation procedures, these multi-ton bombs pass through our communities unannounced. Even the Alabama sheriffs didn't know what was in that fractious boxcar in November 1988.

Glen Milner of Seattle (see Appendix E) has for years studied government bills of lading obtained through the Freedom Of Information Act. From this data he has determined that during the first half of 1992 some 300 tons of propellant were transported by rail

that during the first half of 1992 some 300 tons of propellant were transported by rail each month. The propellant in all three stages of Trident-2 motors is the so-called class 1.1 propellant which can detonate (as opposed to burn fiercely) from a sharp blow or fire. It is so dangerous that the Air Force will only allow it in the third stage of the silo-based MX missile.

It is this potential for disaster rumbling through Alabama, coupled with the near miss in 1988, which prompted the Birmingham City Council to pass a resolution opposing any further rocket motor shipments through their city. The resolution reads as follows:

WHEREAS Trident-2 (D-5) missile propellants are shipped by rail twice a week through the City of Birmingham; and

WHEREAS these heavily encased "CLASS A" explosives require an isolation area of one mile in all directions (should they catch fire) and thus endanger residents of Birmingham and its neighboring municipalities; and

WHEREAS the $2 billion spent on each Trident submarine siphons needed funds from the same neighborhoods endangered by these Trident shipments; and

WHEREAS our nation stands in a critical need of a conversion from wasteful, life-threatening weapons systems to a transforming response to the needs of our cities;

THEREFORE BE IT RESOLVED that the City council of Birmingham

1. Opposes all further Trident shipments through Birmingham;

2. Requests that the President and Congress end all Trident funding and redirect the money thus saved to the needs of our neighborhoods: schools, health care, housing, job training, rehabilitation programs, and day care;

3. Supports Mayor Richard Arrington, Jr. in placing a similar resolution before the Black Mayors' Conference in Kansas City, Missouri opposing Trident shipments passing through and endangering any of the cities there represented and seeking the conversion of all Trident funding to human resources for our cities.

Trident-2's third-stage motors are made at the United Technologies' Chemical Systems Division plant near San Jose, California. The completed motors are trucked from San Jose to Oakland in a special RGTZ trailer which is painted white and marked "Rio Grande The Action Railroad." Each trailer can hold four

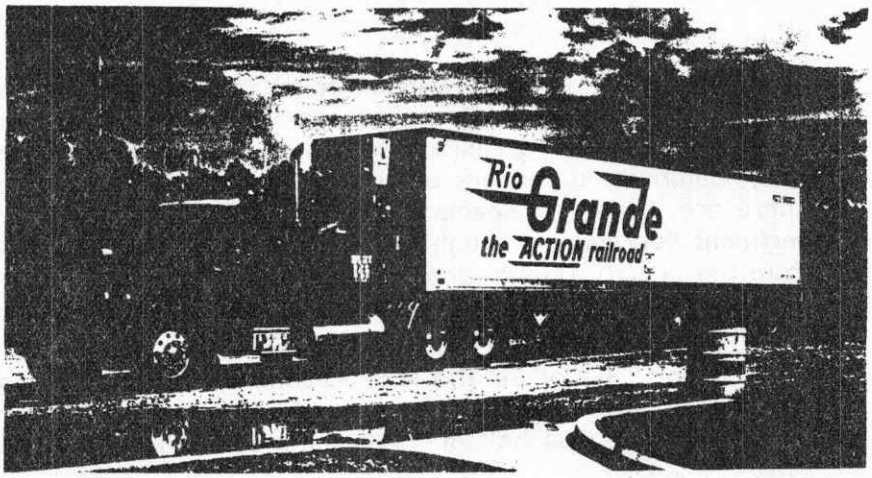
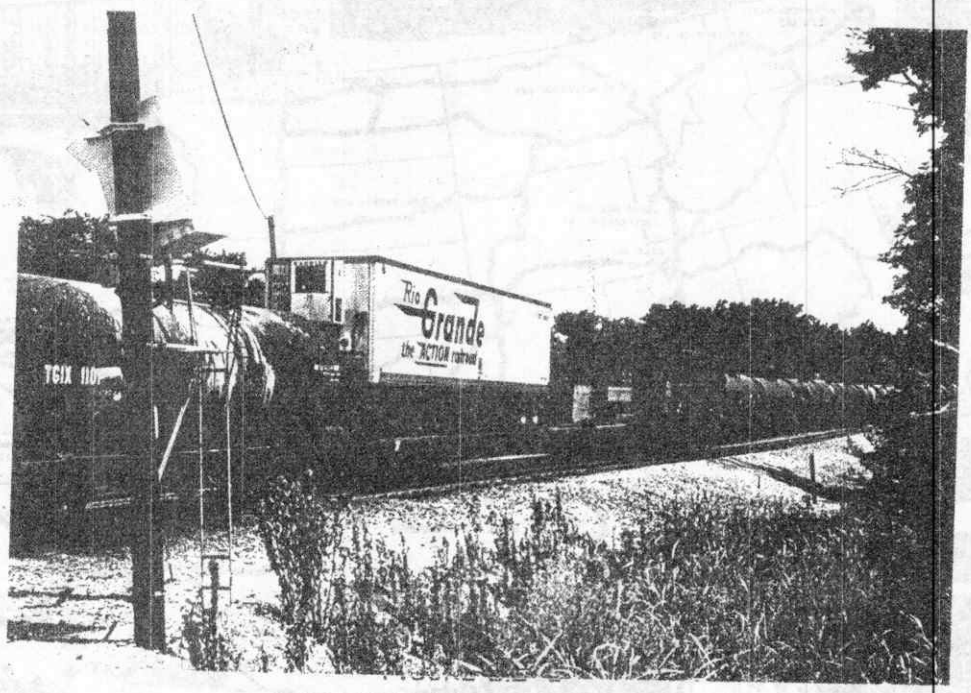


FIGURE 5.2-5
RGTZ TRAILER WITH TRI-STATE TRACTOR
Photo courtesy of Agape Community

third-stage motors and has an air-conditioning system in front. Two warning lights are on the right-upper-front corner -- one to warn if the temperature is out of the desired range, and the other to indicate a power loss. A yellow diamond sign denotes a cargo rated "Explosives A" Tri-State tractors have been used to pull the RGTZ trailers, but it appears that Diablo Transportation may be doing the trucking between San Jose and Oakland.



RGTZ TRAILER ON A FLAT CAR
Photo by Ann Sorenson, Evansville, Indiana, 1991

At the Oakland freight yard the trailer is loaded onto a flat car for shipment to Sub-Base Kings Bay in Georgia. Sometimes this flat car may end up in the same train with DODX boxcars.

C. ARMORED NUCLEAR TRUCKS

Every day a fleet of unmarked, armored, and heavily armed articulated trucks (tractor and trailer) owned by the Department of Energy travel the nation's highways. They log over 3.5 million miles per year and are accompanied by one or more escort vehicles. Nukewatch USA has mapped the routes travelled by these trucks. It has also advertised the truck's appearance and characteristics, as well as that of escort vehicles. Periodic "Truck Watches," sponsored by Nukewatch, keeps this information current.

On 18 July 1991, Metanoia Community observed for the first time a convoy of three 18-wheeler trucks escorted by five security vehicles enter Sub Base Kings Bay in Georgia. It is presumed they were carrying thirty-six Mark-5/W-88 warheads.

The DOE tractors which transport nuclear warheads and components are made by Marmon Motor Company of Dallas, Texas, but have no special markings and carry no warning signs of explosive or radioactive cargo. The heavily-armed personnel wear no distinctive uniforms or badges. The trucks do bear government license plates beginning with "E", and usually have stripes painted on the cab. There is a horizontal radio antenna

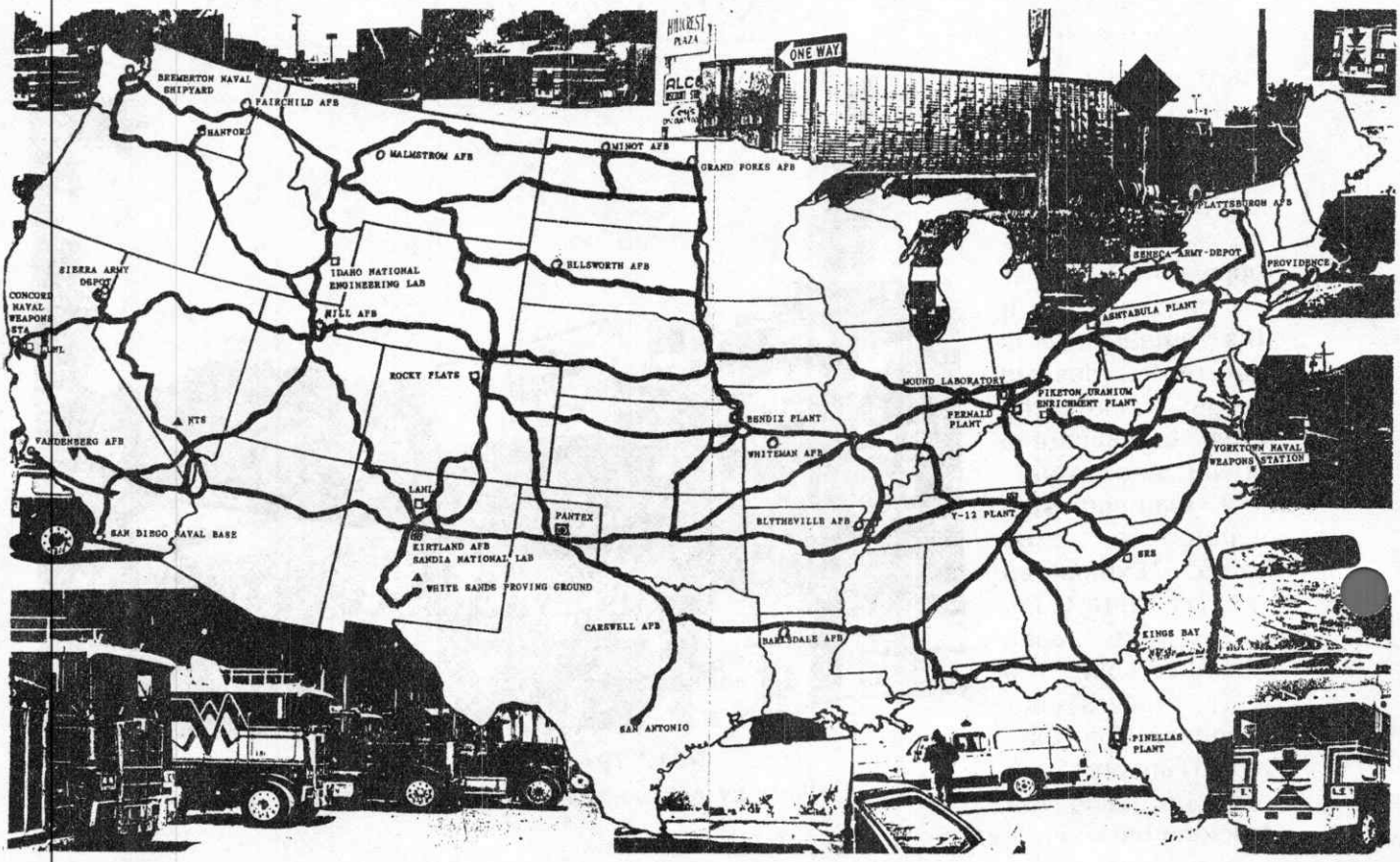


FIGURE 5.2-7
MAP OF NUCLEAR TRUCK ROUTES
Courtesy of Nukewatch USA

across the top of the cab. Newer tractors are long-snouted rather than cab-over-engine design.

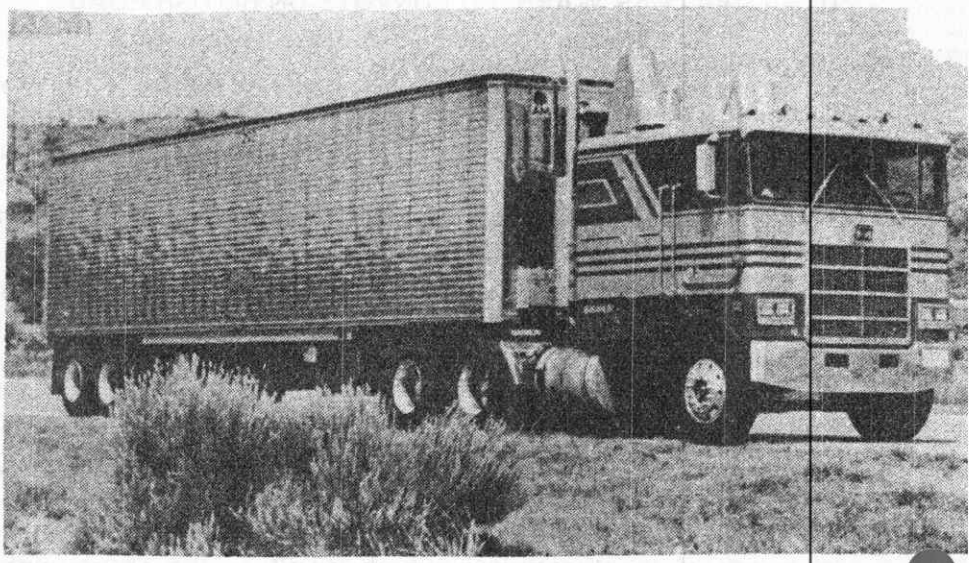
The "safe-secure trailers" have unpainted steel sides. The letters "AM" are painted on the right front. A metal box protrudes below the trailer floor. Diagonal black and white stripes on the rear go about a third the way up the back of the trailer, which contains intricate alarms and security devices to prevent unauthorized entry.

Two or more courier vehicles escort the trucks. They are also plain and are usually Chevrolet Suburbans. A radio antenna is on the left rear of the vehicle and a white box is at the base of the antenna. Both truck and courier personnel are heavily armed and have shoot-to-kill authorization.

Nukewatch-USA has not tracked nuclear bomb trucks since 1992 because they lack funds and volunteers. Peace Camp at Pantex, Texas reports there is a lot of activity hauling H-bombs and materials in and out of the Pantex plant. Anyone wishing to become involved with tracking nuclear bombs and warning local people and authorities should contact Nukewatch-USA, P.O. Box 2658, Madison, Wisconsin 63701-2658; Phone 608-256-4145.

NUKEWATCH PHOTO by Camy Condon

Rear view of safe secure trailer: Diagonal black and white "pin stripes" go about one-third the way up the back of the trailer.



NUKEWATCH photo by Nat Batchelder

Courier car: One or more of these escort each convoy, traveling sometimes close by and sometimes at a distance. Usually Chevrolet suburbans or similar. They are fitted with a radio antenna at left rear of vehicle; white box near the base of the antenna.

FIGURE 5.2-8

DOE TRUCKS AND ESCORT VEHICLES

Department of Energy "safe secure trailers" have no identifying markings and no warning signs of the nuclear and explosive cargo. The convoy crews are heavily armed but wear no uniforms or insignia. Features typical of these trucks are (a)unmarked and unpainted steel trailer sides, (b) horizontal radio antenna on top of cab, (c) perhaps the "Marmon" manufacturing emblem on front and sides of cab, (d) most trucks painted with stripes as shown, (e) US government license plates starting with the letter "E", (f) the letters "AM" on right front of trailer, and (g) metal box protruding below trailer floor. Cab-over-engine tractor at upper right has been in service since the 1970s. The long-snouted tractor at bottom right --also made by Marmon Motor Company of Dallas, Texas -- has been in use since the late 1980s. Tractor photos obtained from the DOE through a Freedom-of-Information request by Glen Milner of Seattle, Washington.

D. NUCLEAR WARHEAD CONVOYS ON BRITISH ROADS

By Nigel Chamberlain (Nukewatch-UK)

Most nuclear warheads are transported in Britain by road although the Ministry of Defence has investigated the possibility of a return to sea transportation. Trident warheads are moved from AWE Burghfield near Reading in the south of England to RNAD Coulport on the Clyde near Glasgow in Scotland. The warheads are stored in underground bunkers until required for the operational patrols of *Vanguard, Victorious, Vigilant* and *Vengeance* from their Faslane submarine base.

Chevaline warheads from the decomissioned Polaris submarines are returned by road to AWE Burghfield from RNAD Coulport for dismantling. Britain's other nuclear bombs, the WE-177, are being removed from Royal Navy surface ships and Royal Air Force Tornado bombers. It is believed that the fissile material from these warheads is refurbished for Trident warheads.

Unmarked warhead convoys frequently use the very busy British roads and drive past, or through, major conabations (Oxford, London, Peterborough, Leeds, Newcastle, Carlisle, Edinburgh, Glasgow) without informing the Local Authorities. Nukewatch-UK is a network of local activists which monitors the movements of these convoys and campaigns against secrecy and for public safety.

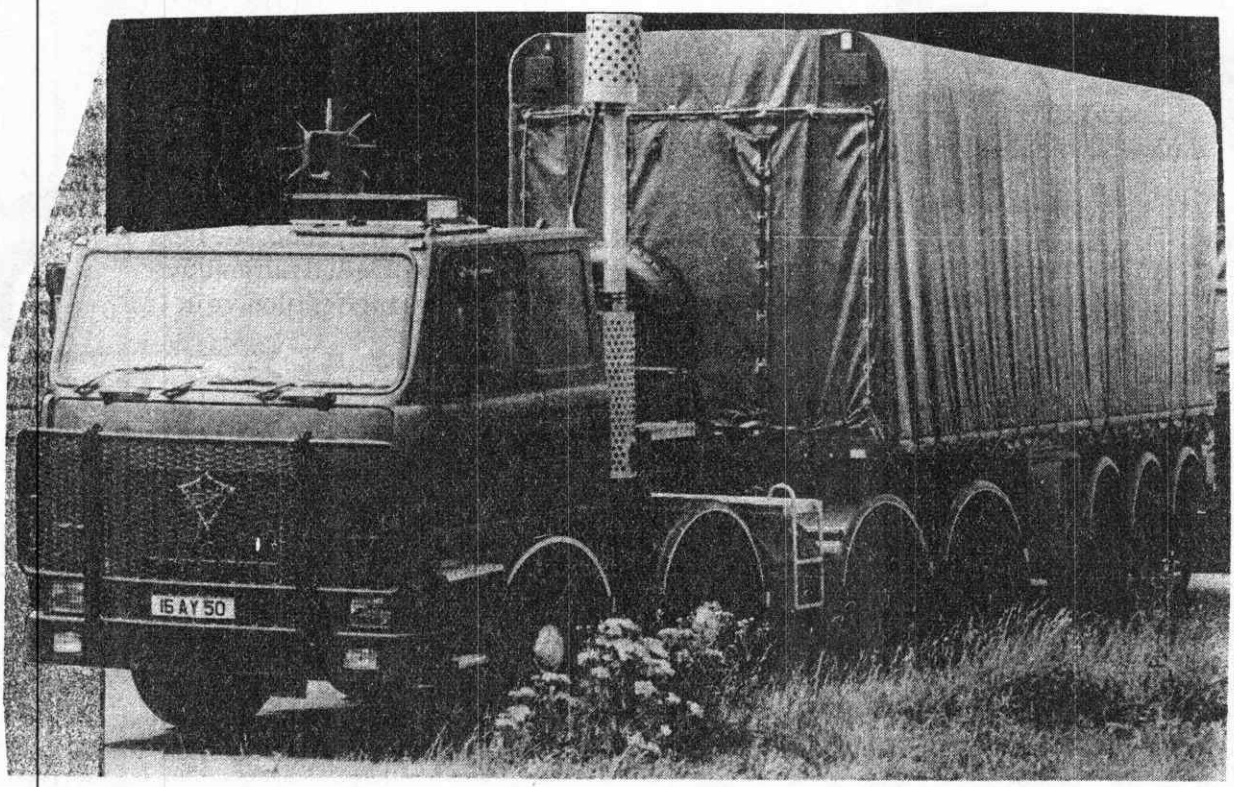


FIGURE 5.2-9
FODEN TRACTOR WITH TRUCK CARGO HEAVY DUTY MARK-II NUCLEAR WARHEAD CARRIER
Photo courtesy of Nukewatch-UK and CND

The aging Mammoth Major carriers were replaced by "Truck Cargo Heavy Duty Mark-II" carriers in 1992, which are manufactured by Brown and Root Vickers. The carriers are built over three axles and are articulated. They are dark green and covered with a green tarpaulin. The tractor units are made by Foden and have a distinctive vertical exhaust pipe and an air conditioning system on the cab with a spiked cooling unit on the driver's side. There are military number plates on the front of the tractor unit and on the back of the carrier. Apart from two "long vehicle" signs, there are no other warning signs on the carriers.

FIGURE 5.2-10
CHRIS AND NIGEL CHAMBERLAIN WITH ONE OF THEIR SONS MARKING A NUCLEAR CONVOY ROUTE
Photo courtesy of Nukewatch-UK and CND

As many as five warhead carriers are escorted in convoy by three RAF and MOD motorcycle outriders, two light green transits with officers and technicians, four or five grey transit vehicles with armed Royal Marines, a spare tractor unit for breakdowns, a fire engine, a tow truck, and a convoy support vehicle which carries radiation detection and decontamination equipment and is fitted with sophisticated communications.

There have been a disturbingly large number of "incidents" involving nuclear warhead convoys through the 1980s and 1990s, ranging from frequent breakdowns, occasional accidents, and one civilian fatality. Most serious of these were the overturning of one carrier on icy roads in Wiltshire on 10 January 1987, a crash which killed a motorists in Somerset on 17 September 1988, and a crash in Northumberland on 11 August 1993 when

FIGURE 5.2-11
RAF TRANSIT VAN
Photo courtesy of Faslane Peace Camp

a large civilian lorry went out of control and seriously injured an RAF motorcyclist at the head of the convoy.

On 1 December 1991, the very busy M25 motorway around London was closed for several hours while a warhead was removed from one vehicle by crane and transferred to another carrier. Typically, the military attempt to deal with these potentially hazardous "incidents" with their own resources and keep local authority emergency services in the dark.

Nukewatchers inform the local authorities of the movements of nuclear warhead convoys and work closely with journalists to inform an unassuming public. We lobby local and national politicians and prepare briefings for interested organisations and political parties. Some Nukewatchers are also involved with direct action against the convoys which impedes their progress, draws attention to the secrecy which surrounds them, and builds opposition to the development of the nuclear state.

* * * * *

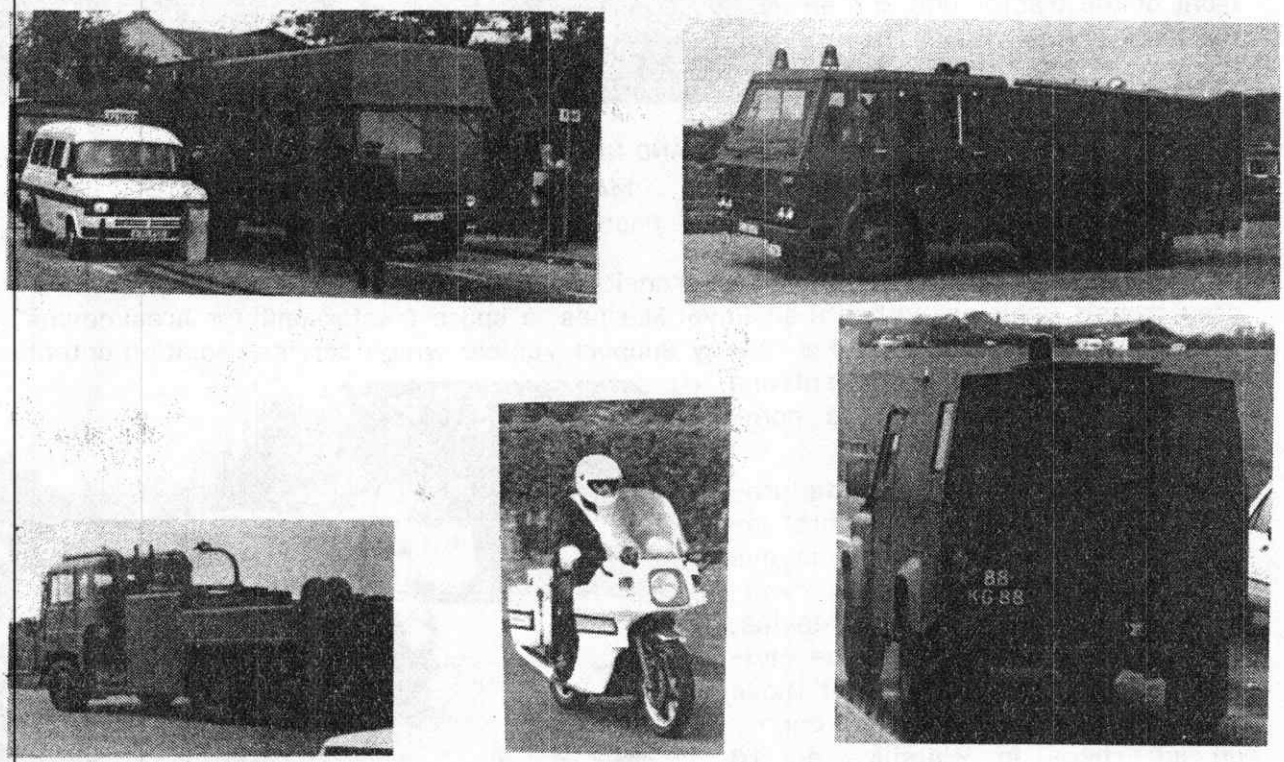


FIGURE 5.2-12
OTHER BRITISH CONVOY VEHICLES
Left to right above: Support Vehicle, Fire Engine. Left to right below: Tow Truck, RAF Police Motorcycle, Unidentified Convoy Vehicle. Photos courtesy of Faslane Peace Camp.

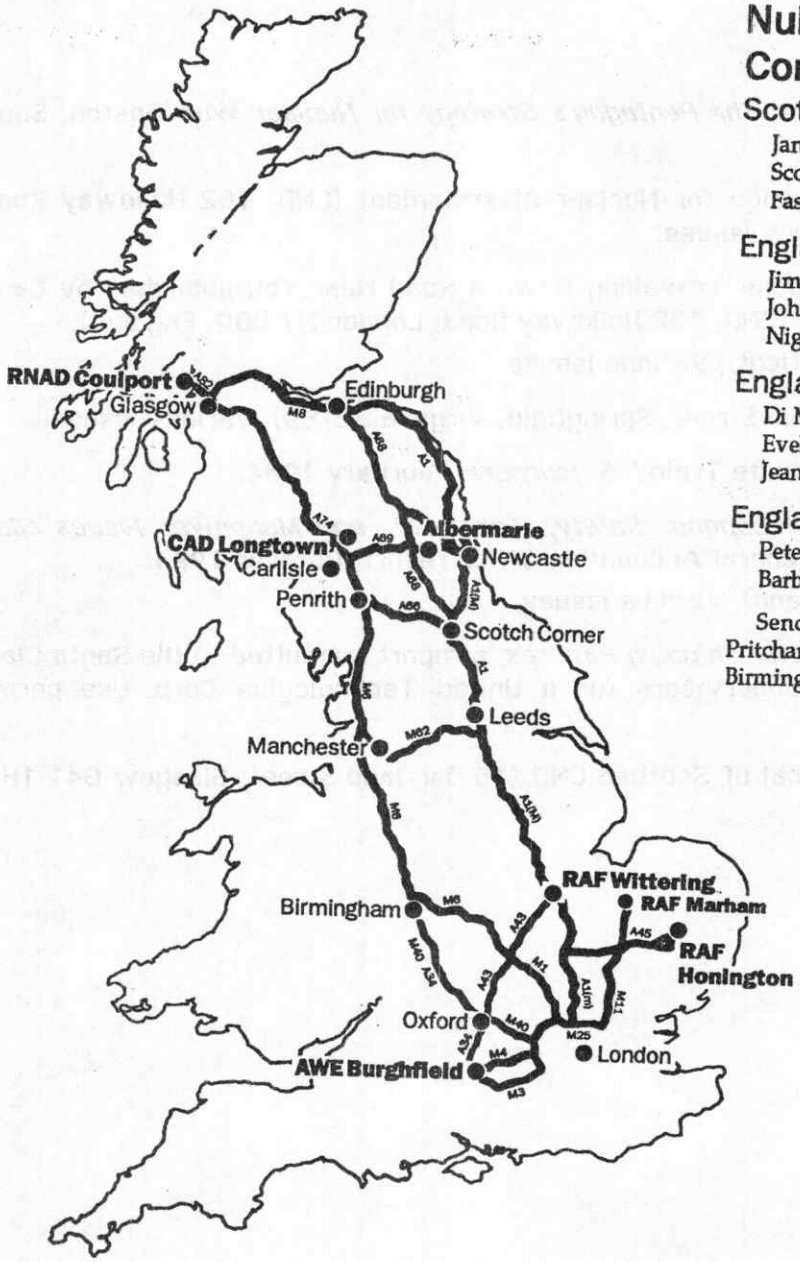


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FIGURE 5.2-13

BRITISH ROADS THE CONVOYS TRAVEL

The convoys travel all types of roads in all weather conditions. They frequently vary their routes. This map shows the main roads but many other roads throughout Britain are used.

Courtesy of Nukewatch-UK and CND

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6.3 SAVINGS FROM HALTING THE US TRIDENT

This is the fourth edition of this chapter since it was first written in 1993. Each year the potential savings goes down because the Trident program is nearing its end. But very important -- and not to be overlooked -- is that there have been savings along the way. A good share of this can be indirectly attributed to the global movement for peace and justice bringing the cold war to an end. Even more of this can be directly attributed to the Anti-Trident Network's persistent drive to keep Trident in the forefront of citizen and legislative debate -- something that does not easily happen with a system hidden in the vastness of the oceans and far removed from general consciousness. Headway toward stopping Trident has been made! We must not forget that.

Pentagon officials have recognized the anti-Trident trend and now present the appearance of voluntarily curtailing the program. In September 1994 the Defense Department's Nuclear Posture Review recommended that Trident subs be cut from 18 to 14. These recommendations were accepted by the Clinton administration, although the four oldest subs will not be retired until the START-2 Treaty becomes fully effective in 2003. But Navy plans to retire the four oldest submarines do not provide the savings that first seems apparent. The plan also provides that the remaining four Trident-1 submarines be converted to carry Trident-2 missiles. That requires modification of those subs, conversion of Sub-Base Bangor to handle Trident-2 missiles, and manufacture of more Trident-2 missiles.

In the short term, presumably to soothe public opinion, the Navy has also cut back on production of Trident-2 missiles. In February 1993, the proposed FY-1994 buy of 39 Trident missiles was reduced to 24. A year later the FY-1995 Trident budget was reduced from a previously-planned 24 missiles to 18 -- with plans for 12 thereafter. But that was further reduced in the FY-1996 budget request -- six for that year with seven planned for FYs-1997 through 1999. Of course the British plan to order seven for each one of those last three years also, making a total of 14 yearly.

Even this apparent cutback in US missile orders is deceptive. The Navy has come up with a concept of "Incremental Procurement," ostensibly to quantity-buy critical components and rocket motor sets from subcontractors for a cheaper price. Critical components include missile nose fairings, nose caps (presumably for the reentry vehicles), major components for the post-boost control system which dispenses the multiple warheads to their targets, and the missile equipment section. Motor sets include rocket motor assemblies for all three stages. Everything else comes under the heading of non-critical components. In 1996 dollars, a missile set of non-critical components costs $4.67 million each, a set of critical components $9.5 million each, and $6.67 million for a set of motors. Besides what is necessary for the six missiles ordered in FY-1966, the Navy also ordered an additional 9 sets of critical components and 18 extra sets of motors. Over the next six years, in addition to the 72 complete missiles scheduled to be purchased in FYs-1996 through 2001, an additional 29 sets of critical components and 45 extra motor sets will be ordered. The short-term cutback is not cut back as far as the Navy would like us to believe.

Actual missile orders will pick up again after the turn of the century. In FY-2000 the US orders will jump to 12 annually through FY-2004, and then 10 for FY-2005. From FY-1997 on, that adds up to 112 more missiles to be bought for both the US and Britain, but most of the major parts for those missiles will be procured in the short term. FY-2005 will be the last of the Trident-2 missile program unless the submarine service life is extended to 40 years -- another gentle way of slipping it to the public that the Navy and Lockheed Martin plan extensive missile production.

So there is still plenty of resistance to offer and a lot of savings to be realized. The anti-Trident pressure must not relax. If the four older subs remaining, if the Navy actually cuts back to 14, were not converted to carry Trident-2 missiles there would be a savings in not retrofitting as well as an automatic end to the need for more missiles. Better yet, if nine submarines were retired instead of four, the US could still "stay up" to START-2 allowances, save retrofit costs, and have a surplus of Trident missiles -- even the British wouldn't have to order more.

Last year this chapter examined only the difference between what the Navy's 14-sub plan would cost over the lifetime of the Trident fleet, and an alternative plan that would accommodate the same number of warheads. That was when it was implied that the four older subs would be taken out of service immediately and kept in mothballs until 2003. Now it appears that no submarines will be taken out of service until START-2 is fully implemented in 2003. Therefore, the analysis this year will look at the savings between the full 18-sub plan and other alternatives. Trident resisters should keep in mind, however, that bringing the Trident inventory down to the alternatives shown below are only an immediate first step toward eliminating Trident completely.

START-2 requires that sea-based strategic warheads be reduced to 1,750 maximum. [See Appendix G for an explanation of the START treaties] The US at first settled on 1728 which is half its original plan. That would mean four warheads per missile instead of eight. If and when the 14-sub program is implemented the total warheads will number 1680 (5 warheads per missile). Reductions are to be completed by 2003.

Common sense tells us that with only half the deployed warheads the Navy needs only half the number of submarines and half the number of missiles. The missiles would still be loaded to their full capacity of eight warheads. The official argument against doing this is that START-2 has already been negotiated for four warheads per missile, and it would require renegotiation of the treaty. That is deception because the treaty sets up a commission to handle such changes. This deception became apparent with the 14-submarine plan in which each missile would carry five warheads. That change would also have to be submitted to the commission. It would be just as easy -- even easier because verification would be simpler -- to stay with eight warheads per missile and simply cut the submarines back to nine. So much for START-2 considerations. Now let us look into saving some money.

A. SAVINGS FROM NOT BACKFITTING FOUR TRIDENT-1 SUBS

In a 9-sub fleet were planned, all Trident-1 carrying submarines would be removed from service. It would not be necessary to backfit Trident-2 missiles into any of them.

For an 18- or 14-sub fleet, however, the US Navy has long argued that Trident-1 missiles remaining in service beyond 2004 would have to be equipped with new motors. Navy officials say it would be cheaper in the long run to replace them with Trident-2 mis-

siles. However, a Pentagon-commissioned study by the New York based Reliability Analysis Center of the IIT Research Institute arrived at a different conclusion. Its 8 November 1992 report entitled "Trident C-4 Missile Life Extension Study" said the currently-deployed Trident-1 missiles could safely and effectively be used until 2016, when the last Trident-1 equipped submarine reaches the end of its service life. The report recommended against re-motoring the existing missiles or replacing them with Trident-2 missiles.

Cancelling backfit of four Trident-1 subs in a 14-sub fleet would save $1.1 billion, in 1996 dollars, in submarine work alone. [*Inside The Pentagon*, 4 February 1993, adjusted for four submarines and updated to 1996 dollars]

B. SAVINGS FROM REDUCING THE NUMBER OF SUBMARINES FROM 18 TO 9

The number of deployed SLBM warheads planned for the US under START-2 would only require nine submarines. The eight Trident-1 submarines and one of the Trident-2 submarines could be retired, say, by the end of FY-1996, (which is 30 September 1996). Assuming a 30-year service life [SASC-92], some 165 submarine-years of operation would be cancelled, as shown:

USS Ohio	15 years
USS Michigan	16 years
USS Florida	17 years
USS Georgia	18 years
USS Jackson	18 years
USS Alabama	19 years
USS Alaska	20 years
USS Nevada	20 years
USS Tennessee	22 years
Total:	165 years

At $77 million per submarine-year for operation, maintenance and support, **the savings would be $12.7 billion in 1996 dollars.** (The operating, maintenance and support costs for one Trident submarine over its 30-year service life is $2.3 billion, the annual cost is then $77 million.)

In the shorter six-year term, FY-1997 through FY-2002, the savings is $4.2 billion in 1996 dollars. (9 submarines x 6 years x $77 million = $4.2 billion.)

C. SAVINGS FROM REDUCING SUBMARINE BASES TO ONE.

With only a 9-sub fleet, all the submarines could operate from one base. With the range of Trident missiles, there would be no problem reaching any perceived target. That means Sub-Base Bangor would not have to be converted to accommodate Trident-2 missiles. The savings would be $253 million according to a 1989 Pentagon budget proposal.

[*Seattle Post-Intelligencer*, 22 September 1994, p. A12] **That would amount to $309 million savings in 1996 dollars.**

D. SAVINGS FROM CANCELLING TRIDENT-2 (D-5) MISSILE PRODUCTION

By the end of FY-1996 there will be 343 Trident-2 missiles bought or ordered for the US. According to the US Navy, there have been 80 Trident-2 missiles flown as of 19 January 1995. Assuming another 4 were used during the past year, that would mean 84 of the 343 were expended -- leaving 259 on submarines or in storage. That number (259) is enough to carry the 1,728 SLBM warheads planned under START-2 with 43 left over for testing and spares.

Current Navy plans are to procure an additional 91 US missiles from FY-1997 on. The six missiles ordered in FY-1996 will cost $55.3 million each. [Hall, Raymond J., *Selected Weapons Costs from the Administration's 1996 Program*, modified per a telephone conversation with Raymond J. Hall of the Congressional Budget Office.] Assuming that the unit cost will remain somewhat the same, **the savings from not producing the 91 missiles planned after FY-1996 would be $5.03 billion** (91 missiles x $55.3 million per missile = $5032.3 million).

To figure savings for the shorter 6-year term, FY-1997 through FY-2002, it will be assumed that the "Incremental Procurement" (pre-buying rocket motor sets and critical components) will be complete by 2000. From FY-1997 through FY-2000 the Congressional Budget Office total spending figures will be used. For FY-2001 and FY-2002 the number of missiles planned times the $55.3 million unit cost will be used. **The six-year savings from cancelling Trident-2 missile production at the end of FY-1996 is $3.1 billion in 1996 dollars.** It is broken down as follows:

	FY1997	FY1998	FY1999	FY2000	FY2001	FY200	Total
Missiles cancelled	7	7	7	12	12	12	57
Savings (millions)	$359	$362	$407	$628	$664	$664	$3084

E. COUNTERING THE JOBS LOST

The only production jobs lost under the 9-sub plan would be in missile construction. Not more than 4,000 Lockheed Martin Missiles and Space Company (LMMS) employees are producing Trident-2 (D-5) missiles -- most of them at the main Sunnyvale, California plant. That number of jobs being terminated sounds threatening, but when seen in perspective it is not as serious as one might assume. The 4,000 Trident-2 jobs is less than 0.032% of California's 12.45 million jobs.

The transition away from military spending is inevitable. A Congressional Budget Office study illustrates how a few austere years are unavoidable in weaning our economy from its military dependency. But in the long run, if the savings are properly spent, the economy will be stronger and the gross national product higher than if military spending had been continued. [See *The Economic Effects of Reduced Military Spending*.] Further-

more, government-sponsored programs, funded by part of the savings, can make the transition to a civilian-based economy less stressful for the more critical regions. [See OTA-ITE-525]

California, where Trident missile work is concentrated, is one of the most critical regions. That state once received about a quarter of America's military contracting dollars. Consequently, it was hardest hit by defense layoffs. Between 1990 and 1993 California lost 700,000 jobs. Its unemployment rate soared to 10% in 1993 while the US average was 7.1%.

But the austere years are behind us. While California's current 7.7% unemployment is still significantly above the national average of 5.6%, it has improved considerably. Now the California Department of Finance, known for its conservative estimates, predicts that by the end of 1996 the state will have recovered its 1990 pre-recession peak of 12.7 million jobs. The economy can stand the demise of Trident employment.

F. CONCLUSION

Over the life of the Trident fleet, the savings of the 9-sub plan over the 18-sub plan is $19.1 billion in 1996 dollars, broken down as shown:

-- Not backfitting four Trident-1 subs:	$ 1.1 billion
-- Reducing number of submarines from 18 to 9:	12.7 billion
-- Reducing submarine bases to one:	0.3 billion
-- Cancelling Trident-2 missile production:	5.0 billion
Savings over life of Trident fleet:	$19.1 billion

In the shorter term, over the next six-years, FY-1997 through FY-2002, the savings would be $7.3 billion in 1996 dollars, broken down as shown:

-- Reducing number of submarines from 18 to 9:	$ 4.2 billion
-- Cancelling Trident-2 missile production:	3.1 billion
Savings FY-1997 through FY-2002:	$ 7.3 billion

These are remarkable savings for stopping something which will immediately become surplus under START-2 -- and which is already obsolete, even from a military viewpoint, in the post-cold war era.

A few thousand lost jobs will be an immediate hardship but jobs-lost compared to savings-gained is a very favorable ratio. Cancelling Trident-2 missile production yields a savings of $3.1 billion over the next six years. Yet the jobs cancelled would only raise California's unemployment figure by 0.032%. That is assuming that all the 4,000 jobs lost would result in unemployment, which would certainly not be the case. It can be expected that at least half would be from attrition. And the other half could certainly be compensated by jobs created in other areas.

Imagined threats which keep the weapons business flourishing must be examined with a cynical eye. The real reason Trident continues is because arms manufacturers have a powerful lobby in Washington. It is time for American citizens to make their desires felt. It is time to make democracy work. And it is time to spend for justice instead of killing. In the meantime we will come closer to balancing the federal budget.

* * * * *

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7.2 NUCLEAR WEAPONS OF BRITAIN

Britain, like the US, possesses both tactical and strategic nuclear weapons. Only Britain does not have near as many. The following is a summary of that country's nuclear capability.

A. BRITISH STRATEGIC NUCLEAR WEAPONS

Unlike the US, Britain does not have a strategic triad. Its strategic weapons are all based in submarines at sea. Britain's strategic nuclear role commenced with the 1962 Nassau Agreement between President John Kennedy and Prime Minister Harold Macmillan, when the US agreed to sell Polaris A-3 missiles to Britain. Britain built four *Resolution* class submarines to carry the missiles (*HMS Resolution, HMS Repulse, HMS Renown,* and *HMS Revenge*). The lead ship, *HMS Resolution,* entered service in October 1967 and the others followed at about one-year intervals. At first these subs probably carried warheads similar to the 200-kiloton Mark-2/W-58 warheads used on US Polaris A-3s. There were three of these on each missile and they all went to the same target -- exploding in a triangular pattern to create more widespread destruction. In the 1980s the British Polaris fleet was refitted with maneuvering Chevaline warheads. But even with these each missile could only attack one target.

1. Britain's Shrinking Polaris Fleet.

Today Britain has two Polaris submarines still operational -- *HMS Resolution* and *HMS Repulse.* These submarines hold 16 Polaris A-3 missiles each. It is believed that each Polaris SLBM carries two Chevaline warheads which are probably in the 75-100 kiloton range.

Targets would have to be within a range of 2,500 nautical miles because that is the reach of Polaris A-3 missiles. And because of the A-3's poor accuracy, the targets would have to be soft -- such as cities, which are sprawling and vulnerable.

2. Britain's Growing Trident Fleet.

During the 1990s, Britain plans to replace its Polaris fleet with four new *Vanguard* class Trident submarines. *HMS Vanguard* became operational on 13 December 1994, *HMS Victorious* on 7 January 1996. The last two ships, *HMS Vigilant* and *HMS Vengeance,* are expected to become operational in early 1998 and 2000 respectively. British Tridents carry 16 missiles each (not 24 as do US Trident ships) so the number of SLBMs deployed will remain at 64 -- the same as for four Polaris boats. But the comparison stops there.

The new submarines will carry US Trident-2 (D-5) missiles, each loaded with up to eight 100-kiloton warheads. These warheads will be MIRVs, which means they can be sent to separate targets. Thus, rather than each submarine being able to attack 16 targets, as was the case with Polaris, each of the new Trident boats will be able to attack up to 128.

The types of targets will also be different. The accuracy of Trident-2 SLBMs makes them "hard target killers." Hard targets are heavily fortified with concrete and steel and usually buried underground. The ability to threaten another country's command bunkers will significantly destabilize international relations.

More and harder targets is not the end of Trident's capability over Polaris. Trident will threaten such targets over a larger geographic area. Trident-2 missiles are designed to travel slightly over 4,000 nautical miles with eight 475-kiloton bombs. That in itself is a longer reach than Polaris. But the British Trident, carrying smaller and lighter 100-kiloton bombs, should have a range close to 6,000 nautical miles. From its home port on the Clyde, one of these submarines can threaten almost half the globe. Its missiles will reach all of Africa north of the equator except Kenya, Somalia, and part of Ethiopia. The missiles would also reach all of the Mid-East including Afghanistan and Pakistan, and all of the former Soviet Union except the very easternmost part. They would even reach Washington, D.C. and Sub-Base Kings Bay.

B. BRITISH TACTICAL NUCLEAR WEAPONS

In recent years Britain has had a Lance missile and nuclear artillery role. Nuclear warheads for these delivery vehicles were under US control during normal times. But in a crisis or combat the entire nuclear system would have to be under British control. The Lance and nuclear artillery role has now been given up and the units handling such weapons have been disbanded.

The other tactical nuclear weapon in the British arsenal is the WE-177 bomb.

1. Britain's WE-177 Bombs.

From 1966 until mid-1992 Britain had some 200 WE-177 free-fall (gravity) bombs and depth bombs in the Royal Air Force and Royal Navy. The WE-177 is believed to be a copy of the US B-57 gravity/depth bomb which was deployed two years earlier, in 1964. The WE-177 has three models. WE-177A and WE-177B are RAF free-fall bombs with yields of 400 and 200 kilotons respectively. The WE-177C is a Royal Navy free-fall/depth bomb with a yield of 10 kilotons.

On 15 June 1992, British Secretary of Defense Malcolm Rifkind announced that the WE-177 inventory would be approximately halved and they would no longer be deployed at sea under ordinary circumstances. He said WE-177s would be removed, by the end of 1992, from all RN ships, from all of the carrier-based Sea Harrier aircraft, and from RAF maritime patrol planes. That leaves up to 100 WE-177 free-fall bombs for RAF Tornado aircraft based in England and Germany. Plans are to progressively retire the W-177 after the year 2000.

2. Britain's Tactical Trident.

To replace the WE-177 bombs, Britain originally planned for a new nuclear air-launched standoff missile called the Tactical Air-to-Surface Missile (TASM). Those plans have now been abandoned in favor of a Tactical Trident.

When *HMS Victorious* left Faslane on 7 January 1996 for its first patrol, it was carrying the first Tactical Trident missiles. Presumably these missiles are loaded with a single warhead which can be used against any country which threatens to use weapons of mass destruction. That includes chamical and biological weapons as well as nuclear. In November 1993, then British Defence Secretary Malcolm Rifkind said the Tactical Trident would be used to give "an unmistalkeable message of our willingness to defend our vital interests to the utmost." [Cited in *Heddwch*] That is far from a "No First Use" pledge. Those vital interests that the Tactical Trident is to protect were spelled out in Britain's 1995 Defence White Paper: "We have global interests and responsibilities ... As a nation we live by trade and investment ... Our manufacturing industry is dependent on raw materials from overseas. Our global investments are estimated to be worth around $300 million." [Cited in *Heddwch*]

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APPENDIX C

ESTIMATED TOTAL COST OF US 18-SUB TRIDENT SYSTEM
THROUGH THE YEAR 2032
(In then-year US dollars)

Following is a cost breakdown for the complete US Trident program -- from inception to 2032. It includes backfitting Trident-1 missiles into Poseidon submarines along with estimated support and operation costs for those submarines (not for the missiles). Although the total cost seems astronomical, it is the best compilation possible from public sources. Even so, it may be conservative. The support and operation costs for Trident-1 missiles associated with Poseidon submarines is not included. In some cases, DOE expenses and government-furnished equipment are known to be excluded, and in others it is not known whether such expenses and equipment are excluded or not. So even this huge total may be too low.

Cost of backfitting 12 Poseidon submarines with Trident-1 missiles. [a]	+$ 3.6 billion
Operating and support cost for 12 backfitted Poseidon submarines, 1979-1999. Operation and support cost for missiles is not included. [b]	+$ 7.7 billion
Cost of first 8 Trident submarines, associated Trident-1 missiles, and the base at Bangor, Washington. [a] [c]	+$ 16.9 billion
Strategic Weapons System (SWS) research and development (R&D). 28 development Trident-2 missiles. 815 production Trident-2 missiles for 19-submarine fleet. Operation and support costs for SWS subsystems. Convert 8 Trident-1 submarines to Trident-2 capability. Construct Strategic Weapons Facility at Kings Bay, Georgia. Trident-2 portion of Strategic Weapons Facility at Bangor, Washington. [d]	+$ 99.3 billion
Less cost of missiles plus spares and qualification/training launches for 19th sub. 28 missiles at $26.8 million each, plus $1.0 billion operation & support costs for 28 missiles. [e]	-$ 1.8 billion
Cost of delaying until 2003 the backfit of Trident-2 missiles into the first 8 Trident submarines. [My estimate]	+$ 1.0 billion
R&D to incorporate Trident-2 capability in Trident submarines. [d]	+$ 0.1 billion

[MORE]

Cost to build 10 Trident-2 submarines. Nos. 9 through 18 [f]	+$ 11.6 billion
Military construction of non-SWS facilities and related construction activities at Kings Bay: Trident Training Facility, Trident Refit Facility, Submarine Base. [d]	+$ 1.0 billion
Submarine-related and other non-SWS equipment required for the Trident Training Facility, the Trident Refit Facility, and the Submarine Base at Kings Bay. [d]	+$ 0.8 billion
Estimated operating and support costs for 19 Trident submarines. Includes cost of submarine personnel, operations, and maintenance through the year 2032. [d]	+$ 31.0 billion
Less estimated operating and support cost of the 19th submarine. [My estimate]	-$ 1.0 billion
	==========
TOTAL TRIDENT COST THROUGH THE YEAR 2032	$170.2 billion

SOURCES:

a. CRS-IB73001, *Trident Program*, Congressional Research Service Issue Brief by Jonathan E. Medalia, Foreign Affairs and National Defense Division, updated 22 March 1991, p. 11.

b. My estimate based on GAO/NSIAD-89-40, *Navy Strategic Forces: Trident-2 Proceding Toward Deployment*, US General Accounting Office report, November 1988, p. 31.

c. Does not include DOE costs for nuclear warheads and reactor fuel. Cost of reactor fuel appears to be approximately $51 million per submarine in 1992 dollars (comparing submarine costs on pp. 11 & 12 of CRS-IB73001).

d. GAO/NSIAD-89-40, op. cit., p. 31.

e. Based on CRS-IB73001, op. cit., p. 15 for missile costs, and extrapolating from GAO/NSIAD-89-40, op. cit., p. 31 for operation and support costs. Cost of nuclear warheads furnished by DOE are not included.

f. Calculated from figures given in GAO/NSIAD-89-40, op. cit., p. 31; CRS-IB73001, op. cit., p. 12; and *Department of Defense Authorization for Appropriations for Fiscal Years 1992 and 1993*, transcript of hearings before the Senate Armed Services Committee, Part 2, 1991, p. 164.

APPENDIX D

ESTIMATED TOTAL COST OF BRITISH 4-SUB TRIDENT SYSTEM THROUGH THE YEAR 2032
(Billions of British pounds at 1991-1992 prices)

Following is the estimated complete cost of the British four-submarine Trident system over its 30-year lifetime. It includes the official British government estimate which adds up to 10.518 billion pounds, along with the Greenpeace UK addendum which shows the true price at 33.085 billion pounds.

GOVERNMENT ESTIMATE:	
Submarines (less SWS equipment). [a]	3.810
SWS Equipment. [a]	1.168
SWS Missiles. [a]	0.988
Tactical Weapons System. [a]	0.890
Shore Construction. [a]	1.188
Rosyth Works and Functional Machinery. [a]	0.137
Warhead, Miscellaneous and Unallocated Contingency. [a]	2.337
TOTAL GOVERNMENT COST ESTIMATE (10.676 billion at 1993 prices)	10.518 billion
GREENPEACE UK ADDENDUM:	
Development of PWR-2 submarine nuclear propulsion plant. [b]	0.535
30-year running costs for 4 boats. [b]	11.415
12 refits of the 4-boat fleet at 158 million pounds each. [b]	1.896
Decommissioning costs. [b]	0.077
VLF communications improvements. [b]	0.033
Construction at Faslane Works. [b]	0.397
Clyde Submarine Base externals (roads and services). [b]	0.003
Construction at Coulport Works. [b]	0.001
Construction at Rosyth Works. [b]	0.285
Construction at Works elsewhere. [b]	0.002
Aldermaston Works (warheads, etc.). [b]	1.431
Trident's share of AWE running cost over 30-year life. [b]	6.492
TOTAL GREENPEACE UK ADDENDUM	22.567 billion
TOTAL COST OF TRIDENT PROGRAM	33.085 billion

Sources:

a. HC-337 of Session 1991-92, *Progress of the Trident Programme, The*, Fifth Report of the Defense Committee, House of Commons, 11 March 1992, p. 25.

b. *The Rising Cost of Trident*, Nuclear Free Seas Campaign Report from Greenpeace UK, April 1992, p. 2; and *The True Cost of Trident*, Report from Greenpeace UK, April 1992, p. 5.

APPENDIX F

PUBLICATIONS TO HELP THE NETWORK
FOR RESISTING TRIDENT

BASIC Reports
British American Security Information Council
Carrara House
20 Embankment Place
London WC2N 6NN ENGLAND
(071) 925-0862 (Voice)
(071) 925-0861 (FAX)
or
1900 "L" Street, NW; Suite 401-2
Washington, D.C. 20036, USA
(202) 785-1266 (Voice)
(202) 387-6298 (FAX)

Campaign
Campaign for Nuclear Disarmament
162 Holloway Road
London N7 8DQ ENGLAND
(071) 700-2393

Damocles in Brief (English language)
Center for Documentation and Research on Peace and Conflicts
B.P. 1027
69201 Lyon Cedex 01, France
(33) 78 36 93 03 (Voice)
(33) 78 36 36 83 (FAX)

From Trident To Life Newsletter
c/o CALC
340 Mead Road
Decatur, Georgia 30030 USA

Heddwch Action News
CND Cymru (Wales)
c/o Peace Shop
56 Mackintosh Place, Roath
Cardiff, CF2 4RQ WALES
(0222) 489260

Nuclear Free Local Authorities Bulletin
National Steering Committee
The Planning & Environmental Health Department
Town Hall
Manchester M60 2LA, ENGLAND

Nuclear Free Scotland
Scottish CND
15 Barrland Street
Glasgow, G41 1QH, SCOTLAND
(041) 423-1222 (Voice)
(041) 423-1231 (FAX)

Nukewatch Pathfinder
P.O. Box 2658
Madison, Wisconsin 53701-2658 USA
(608) 767-3023

Nukewatch Newsletter
c/o Nigel Chamberlain
Glover's Cottage, Laxonby
Penrith CA10 1AJ, England

Peace Work
A New England Peace and Social Justice Newsletter
American Friends Service Committee
2161 Massachusetts Avenue
Cambridge, MA 02104 USA
(617) 661-2832

Positive Alternatives
The Center for Economic Conversion
222 View Street, Suite C
Mountain View, California 94041 USA
(415) 968-8798

Space and Security News
5115 South A1A Highway
Melbourne Beach, Florida 32951 USA
(407) 952-0600

APPENDIX G

THE START TREATIES

Two landmark events took place during 1992 which set the stage for significant reductions in strategic nuclear weapons -- i.e. cuts in intercontinental ballistic missiles (ICBMs), submarine-launched ballistic missiles (SLBMs), and long-range bombers. A joint understanding between the US and Russia regarding a START-2 Treaty (the so-called Bush-Yeltsin Agreement) was signed on 17 June 1992, and the START-1 Treaty was ratified by the US Senate on 1 October 1992. Although the terms and status of these two treaties are vaguely understood, a working knowledge by the general public seems to be lacking.

A. START-1

The first Strategic Arms Reduction Talks (START-1, or sometimes simply START) Treaty was signed by US President George Bush and Soviet President Mikhail Gorbachev on 31 July 1991. But on 25 December 1991 the Soviet Union ceased to exist. Soviet strategic nuclear weapons were then located in four of the successor states -- Russia, Ukraine, Kazakhstan, and Belarus.

On 23 May 1992 these four states, now members of the Commonwealth of Independent States (CIS), signed an agreement with the US in which all five become parties to the SALT-1 Treaty. That protocol provides that:

-- the four new CIS states will decide among themselves how to implement their responsibilities under START-1.

-- Ukraine, Kazakhstan, and Belarus committed themselves to joining the Nuclear Nonproliferation Treaty (NPT) as non-nuclear states. This means they will give up their nuclear weapons.

-- Russia remains a nuclear state party to the NPT.

1. Terms of the START-1 Treaty.

After the legislatures of all five parties ratify START-1 and instruments of ratification are exchanged, the treaty will go into effect. Reductions must then be completed in three phases over a period of seven years. The treaty is of 15 years duration unless abrogated earlier, and may be renewed in five year increments.

In general, START-1 covers "deployed" strategic nuclear delivery vehicles (SNDVs) and warheads. It does not mandate destruction. SNDVs and warheads can be removed from deployment by removing the launchers. The basic START-1 limits are:

1600 SNDVs which carry no more than

6000 "accountable" nuclear warheads, of which only 4900 can be on ballistic missiles.

1540 maximum on heavy ICBMs (SS-18s).

1100 maximum on mobile ICBMs.

A major obstacle during negotiations was how to count nuclear sea-launched cruise missiles (SLCMs), which the US insists are tactical weapons, not long-range strategic weapons. This was solved by a political statement (a gentlemen's agreement) that

neither country will build more than 880. The US only planned on 750 anyway. But this agreement is separate from START and does not count against the SNDV and warhead ceilings.

Another stumbling block was how to count warheads on bombers. This led to a formula for "accountable" nuclear warheads. Each bomber carrying only gravity bombs or short-range attack missiles (SRAMs) will be counted as one SNDV with only one warhead, regardless of the number of bombs and SRAMs it can carry. For bombers carrying air-launched cruise missiles (ALCMs), the first 150 of such US bombers are counted as carrying only ten warheads each, although they can carry twenty. The first 210 of such Soviet bombers are counted as having eight warheads each, although they can carry up to twelve. Above these numbers (150 and 210) the actual number of warheads on each bomber are counted. So, although there are only 6000 "accountable" warheads allowed under START, the actual number of strategic warheads could be as follows:

	US	USSR
On SLBMs	3456	1872
On ICBMs	1444	3028
Bombs/SRAMs	2720	960
ALCMs	1860	1300
Total W/Hs on 1600 SNDVs	9480	7160
Total W/Hs with 880 SLCMs	10360	8040

2. Status of the START-1 Treaty.

By a vote of 93-6 the US Senate on 1 October 1992 ratified the START-1 Treaty. Kazakhstan had already ratified START-1 and Russia followed suit on 4 November 1992. Belarus ratified on 2 February 1993. Although Ukraine started removing its missiles and warheads earlier, it completed the ratification process for START-1 in December 1994. START-1 is now in effect and dismantling to comply with its limits must be completed by the end of 2001.

B. START-2

During the 17 June 1992 Washington Summit, Presidents Bush and Yeltsin signed a Memorandum of Joint Understanding, commonly called the Bush-Yeltsin Agreement. The Joint Understanding agreed to cut strategic warheads considerably below START-1 ceilings -- to between 3,000 and 3,500 on each side by 2003. (Russia plans 3,000 and the US 3,500). Deployed Trident warheads allowed will be halved from the possible 3,456 to 1,728.

The START-2 Treaty was signed by Presidents Bush and Yeltsin on 3 January 1993. It codified the Joint Understanding and may not enter into force before START-1, but shall remain in force as long as START-1. All of the START-1 provisions apply except as specifically modified by START-2. Like START-1, START-2 limits only deployment of SNDVs and warheads -- it does not restrict the stockpile -- except for the SS-18 heavy ICBM.

1. Terms of the START-2 Treaty.

The concept of "accountable" warheads has been removed by START-2. SLCMs, however, are still not covered. START-2 is to be implemented in two phases.

a. Phase-1 Reductions. The first phase is completion of START-1 reductions seven years after that treaty enters into force. Only the US and Russia are parties to START-2 because Ukraine, Kazakhstan, and Belarus will have disposed of their strategic weapons by the end of this phase. The START-1 reductions for this phase have been further modified by START-2:

1600 SNDVs (same as START-1)

3800-4250 "actual" warheads (rather than 6000 "accountable"); with sub-ceilings of:

2160 maximum SLBM warheads (new limit).

1200 maximum MIRVed ICBMs (new limit).

650 maximum on heavy ICBMs (rather than 1540).

1100 maximum on mobile ICBMs (same as START-1).

b. Phase-2 Reductions. Phase 2 is the completion of START-2 reductions by 2003 -- or by the end of the year 2000 if the US can help Russia finance elimination of its strategic weapons. The final limits are:

1600 SNDVs (same as Phase-1/START-1)

3000-3500 "actual" warheads; with sub-ceilings of:

1700-1750 maximum SLBM warheads (may be MIRVed).

1100 maximum mobile ICBM warheads (same as Phase-1/START-1).

Zero MIRVed ICBM warheads (only one warhead allowed on each ICBM).

Zero heavy ICBM warheads (SS-18s entirely eliminated).

c. Warhead Downloading Rules. The number of warheads that can be taken off of a missile to meet treaty requirements is limited. Only two types of missiles for both countries, in addition to the US Minuteman-3 ICBM and the Russian SS-N-18 SLBM, may be downloaded by up to four warheads each. There is no limit on the aggregate number of warheads downloaded as long as no more than four come from each missile.

An exception to this rule was made so that Russia would not have to build new missiles. Since each SS-19 carries six warheads, five would have to be downloaded to make it a single-warhead (non-MIRVed) missile. Therefore, a maximum of 105 SS-19s can substituted for one of the two missile types specified for downloading. Each ICBM may only be deployed in its existing silo.

Under these downloading rules, all US Minuteman-3 ICBMs (now three MIRVs each), all Russian SS-17 ICBMs (now four MIRVs each), and 105 Russian SS-19 ICBMs may be downloaded to single-warhead missiles. The new Russian SS-25 is already a single-warhead ICBM.

If the SS-18 weren't eliminated as a heavy ICBM, nine of its ten MIRVs would have to be downloaded to become a single-warhead missile. That exceeds the downloading rule so it would have been eliminated anyway. By that same token, the US MX ICBM and

the Russian SS-24 ICBM (each loaded with ten MIRVs) will have to be removed from deployment. Likewise for all SS-19 ICBMs in excess of the 105 allowed.

d. Launcher and SNDV Destruction. Missiles are removed from accountability by destroying their launchers or by converting those launchers to only accommodate an approved type of missile. Launchers are the silos for fixed ICBMs, mobile launchers for mobile ICBMs, and the submarine missile section for SLBMs.

One restriction is that only 90 of the SS-18 silos may be converted to accommodate another type of missile. The remainder must be destroyed. Russia says it will use these 90 silos for its SS-25 missiles. Conversion of these silos involves pouring five meters of concrete in the bottom and attaching a metal ring of smaller diameter than an SS-18 to the top.

Another deviation from the general requirements of START-2 is that all SS-18 missiles and their canisters must be destroyed. Destroying or converting the silos is not enough to remove these heavy ICBMs from accountability.

e. Bomber Accountability. Each bomber will be counted for the actual number of nuclear gravity bombs, SRAMs, or ALCMs it is equipped to carry. This number will be declared in the treaty Memorandum of Attribution and verified by one-time exhibition and by routine START on-site inspections.

Up to 100 heavy bombers that have never been converted to carry ALCMs can be reoriented to a conventional role. They must be based separately with no nuclear weapons at their location. They must be used only for non-nuclear roles and have observable differences from nuclear bombers of the same type. With a three-month notice these bombers can be returned to a nuclear role but can never again be reoriented toward conventional use.

f. Verification. In addition to the comprehensive START-1 verification procedures, START-2 will include some new verification measures.

-- Observation of SS-18 missile and canister destruction.

-- Observation of conversion of 90 SS-18 silos.

-- Exhibition and inspection of all heavy bombers to confirm weapons loading. This includes the US B-2 stealth bomber although its more sensitive parts will be covered.

-- Exhibition of all heavy bombers reoriented to a conventional role to confirm their observable differences.

-- Inspection of SS-19 warheads to verify the downloading rule.

g. Third Country Issues. START bans the transfer of strategic nuclear arms to third countries. It also prohibits permanent overseas bases for strategic nuclear arms. "However, our long-standing pattern of cooperation with the United Kingdom is specifically permitted by the Treaty." [ACIS 93, p. 12] Neither do START Treaties prevent port calls for ballistic missile submarines nor the temporary stationing of heavy bombers abroad.

2. The Final START-2 Inventories.

The strategic warhead inventory for the US and Russia after START-2 reductions are complete is expected to be approximately as follows:

	US	Russia
Land-based warheads	500	504
Sea-launched warheads	1728	1744
Air-launched warheads	1272	752
TOTAL WARHEADS	3500	3000

3. Status of the START-2 Treaty.

After much stalling the US Senate ratified START-2 on 26 January 1996 by an overwhelming majority of 87 to 4. Had the Senators not been playing political football with the Treaty, it could have been ratified years earlier. The delay has made ratification by the Russian Parliament more difficult because the hardliners have gained strength.

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Defense News (6883 Commercial St., Springfield, Virginia 22159), various issues.

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