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TRIDENT WARHEAD HAZARDS:
CONSIDERATIONS AND CONSEQUENCES

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Nuclear weapons are, at their best, dangerous to have around. At their worst they are a near occasion of widespread death and illness. During the design of many nuclear weapons and delivery systems, the decision-makers chose performance over safety. Trident missiles, and Trident bombs, are among those cavalier choices. The three-member House Armed Services Committee Panel on Nuclear Weapons Safety, more commonly known as the Drell Panel, pointed out many problems which are discussed below. But the panel warned: The majority of the weapons in the current stockpile will have to be modified to meet [the specified and demanding safety criteria], unless they are retired. *Moreover, for some weapons we still lack necessary data to perform credible safety analyses.* (emphasis added)[1]

A . THE WARHEAD PRIMARY: HANDLE CAREFULLY AND KEEP COOL

It should not have surprised us, then, when the Departments of Energy and Defense (DOE and DOD) in 1990 revealed safety flaws in the Trident-2 warhead, known by the DOE designation W-88.These problems are in the so-called primary -- the fission trigger which provides the temperature and pressure to set off the thermonuclear fusion reaction of a hydrogen bomb. This primary, a fission atom bomb, is first set off by conventional explosives arranged in a hollow, spherical shell around the plutonium core, or "pit.” The conventional explosives implode to squeeze and heat the "pit" to a critical mass, thus causing an instantaneous nuclear fission reaction.

The Drell Panel announced in late 1990 that new computer models show "that unintended nuclear detonations present a greater risk than previously estimated (and believed) for some of the warheads in the stockpile."[2]

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[1]Drell Report, p. 31.

[2]Drell Report, p. 25.

1 . *One Point Safety.*

The conventional explosive arrangement in the warhead primary is such that detonation at any one point would certainly burst the case and scatter radioactive material, but it would not result in a nuclear explosion (yield). Thus a sharp blow at any one point will not cause a nuclear yield. To obtain a yield, the detonation of the conventional explosive would have to occur simultaneously at multiple points. One point safety (OPS), as it is called, is required in all US nuclear warheads, and all are said to have that feature.

With the development of three-dimensional computer modeling of nuclear explosions, however, Dr. Sidney Drell says, "we were wrong in the assumptions about the location of the most sensitive point in the weapon at which a one-point detonation of the high explosive could initiate a nuclear yield. We also know very little about the risk of multi-point insults -- i.e. incidence of fragments nearly simultaneously -- causing a nuclear detonation."[3]

2. Insensitive High Explosives.

Trident is not the first to have primary problems -- the original conventional-explosive triggers in Poseidon warheads were so touchy that a jolt of the missile could set them off. This *new* Trident problem is similar, and also concerns the chemical explosive trigger which then Energy Secretary James D. Watkins, a retired admiral and former Pentagon Chief of Naval Operations, says he would never have chosen. If heated by a fire it would at best detonate and scatter radioactive material, or at worst result in a nuclear explosion. When airplanes crashed with the old nuclear bombs, or released them -- as they did in Spain, Greenland and North Carolina -- the bombs broke open and spread radioactivity but there was no nuclear explosion. That was fortunate. But when a nuclear bomb is held in shape by a rugged reentry vehicle shell, and that bomb is heated to high temperature, it is more likely to trigger a nuclear blast.

Those warheads which present this danger are the ones using HMX-based explosives which are more sensitive to heat and impact. The insensitive high explosive (IHE) which is more resistant to temperature and shock is known as TATB. Although IHE was introduced into the stockpile in 1979, neither Trident warhead incorporated it.

The reason IHE was not used in Trident warheads is because IHE has only about two- thirds the explosive power as the same weight of HMX-based explosive. Had IHE been used in the W-88 bomb, for instance, the bomb would have had less yield. It is interesting to note that the W-87 bomb for MX is the same as Trident's W-88, except that the W-87 has a yield of 330 kilotons instead of 475. Air Force officials once said that MX's yield could be increased if necessary. The W-87 has IHE and the W-88 does not. The implication is obvious

Only about 400 of the Mark-5/W-88 warheads were manufactured (some sources say the number is 384). These are distributed among several submarines but not mixed with other warheads on the same missile. The bulk of the warheads carried on Trident-2 missiles are the same as those carried on Trident-1 -- the 100-kiloton W-76 warheads encased in Mark-4 reentry vehicles. These also have highly-detonatable rocket fuel in all three stages and the warheads do not use IHE. This hazard was highlighted by Dr. Ray Kidder of Lawrence Livermore National Laboratory (LLNL):

[3] Drell 1992 Testimony, p. 2.

"These safety concerns apply equally to both the W-88/D-5 missiles currently being deployed and the far larger number of W-76/C-4 missiles already deployed, a point largely overlooked by the Drell Panel."[4] Kidder goes on to explain that replacement of the W-76 warheads with warheads using IHE would probably require a new warhead to be designed and tested. In that light, production of the W-88 warhead was canceled largely because manufacturing facilities at Rocky Flats were closed, rather than for safety concerns.

3. Fire Resistant Pits.

Another breach of safety brought to public attention by the Drell panel is that the W-76 and W-88 bombs do not have fire-resistant pits (FRPs). In early 1992, only ten percent of the US stockpile had FRPs. That will only grow to 20 percent upon implementation of START-2.

FRPs are plutonium "pits" protected and contained by a ductile metal shell that can withstand a temperature of 1000^{0} C. (1832^{0} F.) and the corrosive action of molten plutonium for several hours. That is the heat expected from burning aircraft fuel. The plutonium may melt but it would be contained. Rocket fuel would produce heat of much higher temperature. FRPs would not protect against detonation of the conventional explosive so they would only be useful in conjunction with IHE. Also, FRPs would not be able to withstand the much higher temperatures of burning rocket fuel (about 2000^{0} C) so they are more applicable to gravity bombs and cruise missiles than missiles propelled by rockets. This implies that there is no such thing as fire resistant pits for warheads delivered by missiles.

4. Enhanced Nuclear Detonation Safety.

As IHE protects against physical hazards, enhanced nuclear detonation safety (ENDS) devices protect against electrical and electromagnetic phenomenon. ENDS were developed in 1972 and first introduced into the US stockpile in 1977, beginning with the B-61-5 bomb. In some reports ENDS is referred to as enhanced electrical isolation (EEI). As of the beginning of 1990, ENDS had been installed on only 52 percent of the US nuclear bombs. After implementing START-2, and after the planned retirement of other nuclear warheads, the US stockpile by the end of the century should be 100-percent ENDS equipped. Trident's Mark-5/W-88 warhead does have such a device, and so does the Mark-4/W-76. However, some weapons in the US stockpile are not so equipped so ENDS will be mentioned here.

For the chemical explosive shell to compress the nuclear pit to a supercritical state, the chemical explosive must detonate at many points simultaneously in order to apply pressure evenly all the way around. If this does not happen, a nuclear explosion (yield) will not take place. ENDS is designed to prevent simultaneous activation of all the detonation points by stray radio or radar waves.

ENDS physically isolates and shields the warhead electrical arming device from undesired outside sources of energy or abnormal environments. Electrical entry into this isolation area is by what is described as one weak link and two strong links. They are all in series so that all must be closed in order to arm the bomb. The strong links are both closed by electrical signals initiated by different phenomena. One is closed by a coded electric signal from the operator, and the other by some normal flight environment, such as when a prescribed deceleration force is sensed during reentry.

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[4]Kidder-1991/1, p. 5.

The weak link is always closed but will fail (open) like a circuit breaker in an abnormal environment, such as fire, shock, or crushing. The firing signal must go through all three. If either of the two strong ones are not closed, or if the weak one has failed, the conventional explosive is not supposed to detonate.

ENDS will not necessarily prevent the chemical explosive from detonating, or the spread of highly-radioactive material resulting from such a detonation. But the probability of such a detonation occurring, we are assured, is one in a million.

B. WARHEADS ON THE MISSILE: LOADED TO KILL, MAIM AND POLLUTE

The danger from not having IHE and fire-resistant pits is further amplified by two aspects in the design of Trident missiles, themselves. First is the rocket motor design. Trident-1 uses a rocket fuel which is so touchy the Air Force would not use it in MX, except for the smaller third stage motor which ignites way out in space. Trident-2 uses this more volatile propellant to increase its range a mere 100-150 nautical miles.

The other aspect is the manner in which the warheads are clustered around the third-stage motor. During the 1972 EXPO task force to configure an extended-range Poseidon missile -- now known as Trident-1 -- a third-stage motor was added. Warheads under the Poseidon nose fairing were arranged ten in an outer circle and four in the center, on the deck of the post-boost control system (PBCS, or “bus”). To find space for this new third-stage motor, the center reentry vehicles were removed. A third stage motor was then installed protruding up through the deck on which the warheads are mounted -- right in the middle of the circle of bombs. This arrangement then carried over into Trident-2. So now the responsible officials are belatedly worried that placing such touchy propellant in the middle of the warheads raises the ante for an accidental nuclear blast. Since the Drell Panel released its report, Trident missiles can no longer be handled with their warheads installed. The warheads are mated to the missile after the missile is installed in the submarine. Both the British and US Navies claim this was their procedure anyway.

When START-2 is ratified by Russia, only half the previously-planned number of Trident warheads will be deployed by 2003. One way of accomplishing that is to only load four on each missile, instead of eight. If that were the means chosen for reduction, Dr. Ray Kidder suggests using the space left to add blast deflectors and shielding that would protect the four remaining warheads from possible explosion of the third-stage motor.[5] If that were done, no missile could carry more than four warheads. And since Britain plans to obtain its missiles from a common pool, the British missiles would also be limited to four warheads each. A bad aspect of this idea is that the planned compliment of missiles will still be required and production could not be stopped.

C. THE SAFETY OF BRITAIN'S TRIDENT.

In response to public and parliamentary concern over how the Drell findings relate to the British Trident, the Secretary of State for Defence in mid-1991 commissioned MOD's Chief Scientific Adviser, Professor E.R. Oxburgh, to head up a Safety Review Group to "review, in the light of any relevant aspects of the report of the Drell Panel ... the safety of the present and

[5]See Kidder-1992, p. 13.

prospective UK nuclear armory."[6] The Safety Review Group's 12 February 1992 report (not published in sanitized version until the following July) pointed out that procedures for ensuring the safety of British nuclear weapons are many and complex, and that there is no single coordinating body. Although present arrangements are good for individual systems, "they are less good for viewing the safety of the *system as a whole."* (emphasis in original)[7]

The Safety Review Group pointed out that "in the case of Trident, the *whole system* comprises warhead, missile, submarine reactor, torpedoes, shore facilities, etc.," and added that an overview of the whole system is difficult but essential."[8] The Group then offered twenty detailed recommendations to provide that proper overview.[9]

Britain's 100-kiloton warhead for Trident has been shown to be the equivalent of the US W-76, if not identical. The MOD's Safety Review Group reported that Atomic Weapons Establishment personnel are reviewing the nuclear safety of their warhead's design with new computational methods. The Group points out that substituting computer studies of this kind for actual nuclear testing has only become feasible in recent years. But US government experts don't seem so confident that such studies are yet reliable. The US says computer-assisted modeling *if perfected could eventually* accomplish the same goal as actual nuclear test explosions in verifying safety improvements. (emphasis added)[10]

In addition, the Safety Review Group points out that the accuracy of such computer modeling can only be verified when another team of experts arrives at the same results independently, and by comparing these results with data from low-yield underground tests. In the first place, there is no second group of experts in Britain to independently verify the computer-assisted results. Regarding comparison with actual nuclear tests, the US Assistant Secretary of Energy at the time, Richard Claytor, said at least 25 test explosions would be needed to verify the effectiveness of proposed new safety enhancements to five US weapons systems, including the W-76 warhead.[11] It is unlikely that past tests would be transferable to new safety features.

Another recommendation of the Drell Panel was to *not* attach warheads before transporting the missile to and installing it in the submarine. Rather, the missile should first be installed into the submarine and then proceed with attaching the warheads. The Safety Review Group acknowledged that attaching warheads after missiles are in the submarine is to be British policy, but expressed concerns that when whole-system considerations are taken into account, "we feel that one practice may not be significantly preferable to the other."[12]

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[6]HC-337 of Session 1991-92, p. xv.

[7]*The Safety of UK Nuclear Weapons, p.* 1.

[8]*The Safety of UK Nuclear Weapons, p.* 1.

[9]*The Safety of UK Nuclear Weapons*, pp. 4-6.

[10]*The Sun,* 6 August 1992, pp. A 1 & A4.

[11]*The Sun,* 6 August 1992, p. A4.

[12]*The Safety of UK Nuclear Weapons*, p. 29.

Still another point of concern is in regard to the missiles, themselves. The Safety Review Group said: "The US have now accepted the Trident [missile] for service use but, particularly because some elements of the UK system are different, the UK authorities do not take the view that [the missiles] can therefore be assumed to be safe for UK use.... the UK must also assess safety thoroughly where there are differences from the US practices, e.g. different cranes, different jetties, different hulls, differently trained civilian and military personnel, etc."[13]

The Safety Review Group's conclusion stands as a stark signal of danger: "We conclude as we began by emphasizing that there is inevitably some degree of hazard associated with nuclear weapons." The Group's report ended with a warning that past successes in British nuclear weapons programs may be the nation's worst enemy: "The physics and engineering programmes remain enormously challenging, but they have been conducted so long without major untoward incident, that there is a danger that they may come to be regarded as straightforward and routine. Nothing could be further from the truth: the fatal Challenger accident in the US space programme is a chilling reminder of what can happen if a potentially dangerous technology is taken for granted.[14]

British-American Security Information Council’s report on the safety of Britain's nuclear stockpile is a concise and thorough documentation of Britain's nuclear weapons safety and potential problems.

The report on the safety of British nuclear weapons can hardly be classed as “generally a reassuring statement," as the Ministry of Defence described it to Parliament.[15] Rather, it seems to reveal a plethora of deficiencies in understanding and meeting the hazards of British nuclear weapons. A long and detailed list of recommendations was forthcoming. Techniques for determining safety were questioned and in some cases, at least by implication, decried. In many cases more detailed studies and better understanding were advised in order to perform realistic safety evaluations. Yes, the Ministry of Defence has gone through the motions of performing a safety investigation. But passing that investigation off as "generally a reassuring statement" is gross deception.

D. COMMAND AND CONTROL: LOOSE FINGERS ON THE BUTTON

Another worrisome matter for both the US and Britain is that so much destructive power is put under the control of so few men on a Trident submarine. In a 1984 letter, the late Congressman Ted Weiss said the Navy's Congressional Liaison Office admitted that a conspiracy of only four men on a Trident submarine could fire the missiles. A Trident submarine skipper with the cooperation of three other officers -- presumably the executive officer, the weapons officer, and the communications officer -- Could unleash the destructive power of as much as 6,500 Hiroshimas. They would also have a selection of target sets stored in the submarines computer, which could be fed into the missiles 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,

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[13]*The Safety of UK Nuclear Weapons*, pp. 29 & 30.

[14]*The Safety of UK Nuclear Weapons*, p. 35.

[15]HC-337 of Session 1991-92, pp. xv-xvi.

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."[16]

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.[17] No one on the submarine would know the combination to the safe until it is transmitted to them. How this will really work and how much safer this will be than previous methods is not known. But it will undoubtedly serve its 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.

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[16]Drell Report, p. 34.

[17]*The Day,* 4 January 1995, p. A11.

GLOSSARY

B-61-5	Model 5 of the B-61 nuclear gravity bomb.
bus	A name for the post boost control system (PBCS).
C-4	Trident-1 missile.
D-5	Trident-2 missile.
DOD	Department of Defense (US).
DOE	Department of Energy (US).
EEI	Enhanced Electrical Isolation. Also ENDS.
ENDS	Enhanced Nuclear Detonation Safety. Also EEI.
FRP	Fire Resistant Pits.
HMX	A conventional explosive which is not IHE.
IHE	Insensitive High Explosive.
Mark-4	Trident reentry body which holds the W-76 warhead.
Mark-5	Trident reentry body which holds the W-88 warhead.
MOD	Ministry of Defense (British).
MX	Missile-X -- a large US intercontinental ballistic missile. Also known as Peacekeeper.
OPS	One Point Safety.
PBCS	Post Boost Control System. The platform that dispenses the reentry vehicles from the missile.
pit	The plutonium core of a nuclear bomb.
START	STrategic Arms Reduction Talks.
TATB	A conventional explosive which is IHE.
W-76	A 100 kiloton yield Trident warhead.
W-87	A 330 kiloton yield MX missile warhead.
W-88	A 475 kiloton yield Trident warhead.
UK	United Kingdom.
US	United States.
yield	The explosive force of a nuclear bomb.