OCCASIONAL REPORT

NUCLEAR WARHEAD SAFETY

The occasional report in our previous issue included an assessment of nuclear warhead safety based on the Report of the Panel on Nuclear Weapons Safety of the Committee on Armed Services House of Representatives, December 1990 (the Drell Panel Report) and on a letter to Dante B. Fascell, chairman of the House Committee on Foreign Affairs by Ray Kidder. Since then, Kidder has published Report to the Congress: Assessment of the Safety of U.S. Nuclear Weapons and Related Nuclear Test Requirements *(Livermore, California: Lawrence Livermore National Laboratory, Report UCRL-LR-107454, 26 July 1991). We include here two excerpts from this report, one a grade-sheet on the safety of the US nuclear weapon stockpile and the second the summary of the report's conclusions relating to the need for further nuclear weapon testing.*

PRINCIPLE MEANS OF PROVIDING NUCLEAR WARHEAD SAFETY

The principle means of providing for nuclear warhead safety are the use of:

- **Enhanced Electrical Isolation** (EEI): Reduces the chance of the warhead's detonators being fired electrically in an accident to less than one in a million. It was first introduced in the B61-5 tactical bomb in 1977. [This safety feature is referred to in the Drell Panel Report and elsewhere as Enhanced Nuclear Detonation Safety (ENDS).]
- **Insensitive High Explosive** (IHE): A high explosive that is much less sensitive to being detonated by fire or impact than is the HE used in all nuclear warheads that entered the stockpile prior to 1978.
- **Fire-Resistant Pit** (FRP): The pit of a nuclear weapon is the part of the primary, or first stage of the weapon, that contains the plutonium. If the plutonium is encased within a ductile, high-melting-point metal shell that can withstand prolonged exposure to a jet fuel fire (~1000 °C) without melting or being eaten through by the corrosive action of molten plutonium, it then qualifies as an FRP. Although the plutonium itself may melt, it will remain contained within the encasing shell and not be dispersed into the environment.

- **Mechanical Safing** (MS): Can virtually eliminate the possibility that any significant nuclear yield will result from an accident in which the warhead's high explosive is detonated. (A nuclear yield is defined as significant if it exceeds that equivalent to exploding four pounds of HE.) Mechanical safing has been used successfully for more than 20 years.
- **Separable Components** (SC): A means of achieving many-point safety by *physically separating the plutonium in the warhead from the HE by a sufficient* distance and/or barrier before arming the weapon. Accidental detonation of the HE could not then result in either plutonium dispersal or nuclear yield. (No warhead in stockpile utilizes this concept.)
- **One-Point-Safe (OPS) Design**: Insures no significant nuclear yield will result if the warhead's HE is detonated at any one point.

The inclusion or noninclusion of these design features is used to provide the warhead safety ratings of tables 1 and 2.

Summary and Conclusions

A key element in improving the safety of the U.S. nuclear weapons stockpile is the timely retirement of most older warheads in the present stockpile. More than half the nuclear weapons in the stockpile today were designed at least 20 years ago and do not have some important electrical, nuclear and plutonium-dispersal safety features of modern weapons. This is not to say they are unsafe, but that their safety is clearly not up to modern standards. When those weapons now tentatively scheduled for retirement by the year 2000 are no longer in the stockpile, the remaining warheads will-with the exception of the Minuteman and Trident ballistic missile warheads and the short-range surface-to-surface tactical nuclear weapons deployed in Europe—all have the modern safety features of both IHE and EEI. In view of the reunification of Germany and the termination of the Warsaw Pact, it is anticipated the U.S. short-range surface-to-surface tactical nuclear weapons will be withdrawn from Europe and either safely stored or dismantled. Accelerating the existing

Table 1: Warhead safety ratings

Warhead	Weapon system	Stockpile entry date	Safety
W91	SRAM T†	–	A
W89	SRAM II†	–	A
B90	Nuclear depth-strike bomb	–	A
W61	Earth penetrator	–	B
B61-8	Tactical bomb	–	B
B61-9	Tactical bomb	–	B
B61-6	Tactical bomb	–	B
Stockpile			
(Entered stockpile after 1979)			
B61-10	Tactical bomb	1990	B
W88	Trident D5 SLBM	1990	C
B53-1	Strategic bomb	1988*	C–
W87	MX Peacekeeper ICBM	1986	A
B61-7	Strategic bomb	1986	B
W80-0	Cruise missile, SLCM	1984	B
B28-0, 1	Strategic bomb	1983*	C–
W84	Cruise missile, GLCM	1983*	A
B83	Strategic bomb	1983	A
W85	Pershing II IRBM	1983*	B
W80-1	Cruise missile. ALCM	1982	B
W70-3	Lance SSTM	1981	D
W79	Artillery shell, 8-inch	1980*	C+
B61-3	Tactical bomb	1980	B
B61-4	Tactical bomb	1980	B
W78	Minuteman III ICBM	1980	C
W76	Trident C4 SLBM	1979	C
(Entered stockpile before 1979)			
B61-5	Tactical bomb (⇒ B61-8)	1977*	C
B61-2	Tactical bomb (⇒ B61-8)	1976*	D
W71	Spartan ABM	1975*	D
W70-1, 2	Lance SSTM	1973*	D
W69	SRAM A (⇒ SRAM II)	1972*	D
W68	Poseidon SLBM	1970*	D
W62	Minuteman III ICBM	1970*	D
W56-4	Minuteman II ICBM	1968*	C+
B61-0	Tactical bomb (⇒ B61-6, 9)	1968*	D
B57-1, 2	Depth/strike bomb	1963*	D
W48	Artillery shell, 155-millimeter	1963*	D
W50	Pershing 1A IRBM	1963*	D
B43	Tactical bomb	1961*	D
W33	Artillery shell, 8-inch	1956*	NA

Table 1 notes

* An asterisk indicates warheads that have been retired or are being retired. The symbol ⇒ means "to be replaced by."

The grading system used in table 1 is as follows:

- A Has EEI, IHE, and FRP.
- B Has EEI, and IHE.
- C+ Has improved safety.
- C Has EEI.
- C– Does not have full EEI.
- D Has none of the above safety features.
- NA Not applicable. The W33 does not contain plutonium and is not a sealed pit design. It is a two-component, gun-assembled weapon that fully satisfies modern safety requirements when the two components are stored separately.

† *Editor's note: The SRAM II and SRAM T missiles have been cancelled. The fate of the warheads is uncertain.*

Table 2: Warhead safety ratings (with accelerated retirement schedule)

Warhead	Weapon system	Stockpile entry date	Safety
B61-10	Tactical bomb	1990	B
W88	Trident D5 SLBM	1990	C
W87	MX Peacekeeper ICBM	1986	A
B61-7	Strategic bomb	1986	B
W80-0	Cruise missile, SLCM	1984	B
B83	Strategic bomb	1983	A
W80-1	Cruise missile, ALCM	1982	B
B61-3	Tactical bomb	1980	B
B61-4	Tactical bomb	1980	B
W78	Minuteman III ICBM	1980	C
W76	Trident C4 SLBM	1979	C

schedule of warhead retirement would result in a significantly safer stockpile of nuclear weapons at an earlier date, possibly as early as 1995.

If a decision were made to replace the W78 Minuteman III, W76 C4, and W88 D5 ballistic missile warheads with new designs having the modern safety features of EEI, IHE, and FRP, past experience indicates that an average of six nuclear tests per weapon type, or a total of about 20 tests for the three types, would be needed to complete their development.

If the W78 ICBM and W88 SLBM warheads, or their nuclear explosive components, were replaced by existing, rather than newly designed, warheads having modern safety features and that are already in stockpile or well along in development, such as the W87 MX and W89 SRAM II warheads, only the W76 warheads would have to be replaced with a new design. In this case, the total number of tests needed would not be expected to exceed 10 tests, half the number needed for three all-new designs.

It follows, within the limits of a modest number (10–20) of nuclear tests, that the safety of the stockpile can be improved so that all warheads in stockpile not currently scheduled for retirement will have the benefits of both IHE and EEI.

The Drell Panel recommends a broad and in-depth examination of the safety of the Trident D5 missile system in view of the fact that its W88 warheads are not equipped with IHE and are mounted in a through-deck configuration in close proximity to the third-stage rocket motor that uses high energy, 1.1-class, detonatable propellant. We concur with the need for such an in-depth examination of the D5/W88, but we do not agree with the Drell Panel's apparent exemption of the Trident C4 missile system from similar examination. The C4/W76 missiles raise safety concerns that are essentially identical with those of the D5/W88 and are currently deployed in far greater numbers.

The Drell Panel recommends that "all nuclear bombs loaded onto aircraft—both bombs and cruise missiles—[be built] with both IHE and FRPs." As we have pointed out, a modest number of nuclear tests will suffice to provide a stockpile in which all warheads will have both EEI and IHE. If all nuclear bombs loaded onto aircraft are required to have FRPs as well, a large number of bombs and cruise missiles already in stockpile will have to be rebuilt. This would be a major undertaking, requiring that each be disassembled and reassembled with a redesigned, refabricated pit. The modification required to provide these bombs and missiles with FRPs represents a design change that is sufficiently significant to mandate at least one, and perhaps several, nuclear explosive tests for each of the five types of warheads being modified

Rather than rely on FRPs to reduce the risk of plutonium dispersal in a crash or fire involving an aircraft with nuclear warheads aboard, an alternative would be to virtually eliminate their need by prohibiting, in peacetime, air transport of these warheads or their deployment aboard aircraft that are in close proximity to operating runways, being refueled, or starting their engines. This latter alternative would eliminate the need for nuclear tests or rebuilding of the large number of stockpiled bombs and cruise missiles that have EEI and IHE but not FRPs.

The Drell Panel also recommends an aggressive study of all advanced design concepts for enhancing the safety of nuclear weapons and the development of truly innovative warhead designs that are as safe as practically achievable, consistent with reasonable military requirements. This goal has been actively pursued at the three nuclear weapons design laboratories for many years and has resulted in major and innovative improvements in nuclear weapon safety, including the introduction of EEI, IHE, and the FRP. The study of the separable-components concept as applied to sealed-pit warheads, the example of a truly innovative design referred to by the Drell Panel for purposes of illustration, has been under active study and limited development for at least 15 years without, as yet, a practical result.

While one cannot predict the future, the prospects of developing a practical separable component design do not appear promising. Nor is it clear that the limited safety improvement afforded by separable components beyond that of warheads already possessed of modern safety features would be worth the costs involved. The introduction of nuclear weapons of such complex design into the stockpile is likely to result in a less robust and reliable stockpile and would require both a major and extended nuclear test and missile test program.

We have estimated that a modest number (10–20) of nuclear tests would suffice to replace the W78 Minuteman III, W76 C4, and W88 D5 ballistic missile warheads with warheads having the modern safety features of EEI, IHE, and an FRP. The Drell Panel has recommended an immediate national policy review of the acceptability of retaining missile systems in the arsenal that do not use the safer nondetonatable class-1.3 propellant in rocket stages that are in close proximity to the warheads as well. A change in missile propellant would require missile tests but no nuclear tests, thus leaving our estimate of 10–20 nuclear tests unchanged.

A further note is that one-point safety tests can continue to be conducted within any reasonable limit on nuclear weapons test yields that might be negotiated. The improved capability to predict yields of one-point safety tests that results from the more extensive computer models available today, together with the extensive data base that has accumulated over the years, implies that adequate one-point safety tests could accommodate a yield threshold as low as one one-hundredth of a ton of HE or perhaps less.

In sum, we conclude that the safety of the U.S. stockpile of nuclear weapons can, within a few years, be brought up to a level that meets modern standards. At most, this upgrading will require a modest number of nuclear explosive tests, given an appropriate retirement schedule for older weapons in the stockpile and restrictions on the air transport of nuclear weapons and their deployment aboard aircraft in peacetime.