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THE NEUTRON BOMB AND THE OTHER NEW LIMITED NUCLEAR WAR WEAPONS

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The neutron bomb, or Enhanced Radiation Weapon (ERW), is the first tactical nuclear weapon specifically designed for fighting a nuclear war and not simply for deterrence. The ERW is only the first of a new generation of nuclear weapon designed for a limited nuclear war. Specialised weapons such as the RRR bomb (tested in 1979 in the USA) and the EMP bomb (currently under development) may soon be added to the neutron bomb to replace the A-bombs of the 50s and 60s which are presently deployed. This possible replacement initiates an evolution towards the introduction of directed energy or high energy beam weapons. This third generation will complete, from 1990, the nuclear arsenals of the first and second generations with weapons having specialised effects (mechanical, thermal, electromagnetic, radiological) focusing energy in the form of rays on the target from a distance, rather than in all directions from the centre of an explosion.

1. *The effects of chemical and nuclear explosions*

Until 1945 only chemical reactions could be used by man to create explosions sufficiently strong to provoke militarily significant destruction. This type of explosion produces mechanical effects and radiations. The mechanical effects result from the shock-wave produced by the explosion. Its blast can knock over obstacles and carry along debris (shell fragments) hitting targets not directly aimed at. The radiations emitted are principally thermal (heat) but also comprise frequencies in the visible range (light-flash) and even feeble radio signals and X-rays.

In nuclear explosions there are mechanical effects and radiations as well, of much greater magnitude. The mechanical effects are similar, though enormously increased, but the radiations emitted comprise not only electromagnetic radiations (thermal, visible, radio frequencies, X-rays) but also nuclear radiations (gamma rays, neutrons, . . .). In addition, all nuclear explosions produce radioactive fallout, which is much more dangerous waste than the chemical waste produced by conventional chemical explosions.

To summarise, if one analyses the effects produced by nuclear explosions, one finds five major categories, of which the first two are common to conventional explosions:

1. *Mechanical effects*: Shock-wave, projection of debris.
2. *Thermal effects*: Heat, fire, burns, fire storms.
3. *Electromagnetic effects*: Damage to electronic devices of command, control and communication. Disturbing the atmospheric propagation of radio-waves.
4. *Radiological effects*: Effects of neutrons, X-rays and gamma rays on material and living things.
5. *Radioactive fallout*: Similar to radiological effects but extended in time and space depending on meteorological conditions.

All nuclear explosions produce these five types of effects without exception, but in varying degrees, depending on the type of bomb used.

2. *First generation nuclear weapons: A, H and U-bombs*

First generation nuclear weapons are those

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of which the principal function is strategic, in that their use is envisaged only as a last resort, and that the threat of their certain and suicidal use has to guarantee the credibility of a doctrine called 'deterrence'.

The nuclear bomb using the phenomenon of *fission*, generally called the atomic bomb or A-bomb, was perfected in 1945 and used on the cities of Hiroshima and Nagasaki. The yield of this bomb is only limited in practice by its cost, to about 100 kilotonnes. Most of these bombs have yields between 10 and 20 kilotonnes, which is comparable to those used on Hiroshima and Nagasaki. They make up almost half of the total number of nuclear weapons available to the armies, i.e. the 20,000 to 30,000 tactical nuclear weapons.

The thermonuclear bomb, or H-bomb, utilises the phenomenon of *fusion*. This nuclear reaction can only be started with the aid of an A-bomb, which therefore serves as a trigger for the H-bomb proper. This type of bomb permits, at a more or less constant price, an explosion of theoretically unlimited yield. Most H-bombs have a yield of 100 to 10,000 kilotonnes (0.1 to 10 megatonnes) and are installed on intercontinental ballistic missiles or long-range strategic bombers. These H-bombs make up approximately the other half of the 50,000 nuclear weapons manufactured up to now.

The *A-bombs* are designed principally for *tactical* use. Most of these weapons date from the 50s and 60s. Like all A-bombs, they have the disadvantage of producing not only mechanical and thermal effects but also substantial fallout.

On the other hand, an *H-bomb* which explodes at a sufficient height above the ground behaves principally like a huge *incendiary bomb* capable of instantly igniting a city of several million inhabitants. Under these conditions, the explosion of the H-bomb guarantees the scattering of the fallout over a sufficiently large area to be 'tolerable' for its user if the meteorological conditions are favourable. If, however, the H-bomb explodes *too low*, the fallout will preclude occupation of the land. Alternatively, if it explodes *too high* it will produce huge *electromagnetic effects* which (because of the so-called 'electromagnetic pulse' or EMP effect) could destroy electronic equipment and communications, friend or foe, on the scale of a continent!

Finally, if an H-bomb is surrounded with a thick blanket of uranium, one has a bomb which combines successively the effects of fission, fusion and fission again, which is why one calls it the FFF or U-bomb. This arrangement is the cheapest way of making the most powerful bombs with yields in the range of 100000 kilotonnes (100 megatonnes) or more, which would, however, produce unacceptable radioactive fallout.

3. *Second generation nuclear weapons: ERW, RRR and EMP bombs*

The major disadvantage of first generation nuclear weapons is that when exploded they produce effects whose combination is never optimal from the military perspective. For this reason, they lend themselves well to strategic deterrence of the 'mutually assured destruction' kind but badly to limited nuclear war fighting. This is why important research has been undertaken in civilian and military laboratories to understand better the physics of fission and fusion which are essential to the further development of nuclear weapons. Such research led to the testing, as early as 1963, of the neutron bomb, or enhanced radiation warhead (ERW). This development was followed in 1979 by the successful trial of an RRR bomb (reduced residual radioactivity warhead) by scientists of the same Lawrence Livermore Laboratory near San Francisco in the USA. To these two types of weapons one must add the EMP bomb, of which the purpose will be, on exploding, to produce an exceptionally powerful electromagnetic pulse.

It is interesting to observe that the analysis of the physics of these bombs suggests that their development and improvement will happen simultaneously and in parallel with the better understanding of thermonuclear fusion. Likewise, the miniaturisation and the manufacturing processes of these new weapons are similar. The actual production of neutron bombs, therefore, presages a possible rapid deployment of the RRR and EMP bombs.

Briefly, the new bombs have the following properties:

ERW Bomb (*Enhanced Radiation Warhead*): Compared with an A-bomb of the same yield, the ERW produces about 10 times more neutrons. An ERW explosion of 1 kilotonne distributes a radiation dose greater than 10,000 rem up to a distance of 900 metres from the centre of the explosion. This dose is instantly fatal to any unprotected person, but can be reduced by a factor of 10 or more if the person is sheltered inside a modern armoured tank; this is the result of modern tank technology where, instead of steel, light-weight composite materials are extensively used for shielding, together with internal designs which maximise the protection of the tank crew from nuclear radiation effects. This suggests that the neutron bomb does not find its most effective use as an antitank weapon, but rather as an anti-personnel weapon.

RRR Bomb (*Reduced Residual Radioactivity Warhead*): This weapon, in contrast to the ERW, minimises radiations. Equally, it minimises fallout, so the residual radiation after the explosion is reduced to a minimum, which makes it easier to advance in the case of a military offensive. Exploding at ground level, it produces a shock-wave twice as strong as that of a weapon exploding at the optimum height and produces only half the thermal effect. So it is a weapon exploiting to the maximum the mechanical effect, which is decisive on the battlefield.

EMP Bomb (*Enhanced Electro-magnetic Pulse Wardead*): Fewer details are known of this bomb. However, it is known that it enhances the electromagnetic effects so that it damages all unprotected electronic equipment (radios, computers, sensor, . . .) within a given area. We also know that in addition it could create well-defined regions in which all radio communication (internal as well as external) would be impossible.

It is interesting to consider that the combination of these three types of weapons, ERW, RRR and EMP (anti-personnel, anti-material, anti-electronic) will permit envisaging all sorts of new tactics and strategies of nuclear war fighting. Therefore, it is important to view the neutron bomb not only as a new tactical warhead but also as a key element in the modernisation of the tactical weapons of the nuclear battlefield. The three thus constitute a considerable advance in that each of them minimises to thermal and fallout effects relative to the particular effect that they enhance. Nonetheless all three still have the disadvantage of being bombs projecting their effects simultaneously in all directions rather than concentrating them on a specific target. Research is pointing in this direction already, notably in the case of the neutron bomb which, with the help of a reflector, directs its neutrons down, rather than towards the sky. However, this ability to direct the effects will only be fully achieved in the nuclear weapons of the third generation. . .

4. *Third generation nuclear weapons: directed energy weapons*

Directed energy weapons, or high energy beam weapons, produce rays of energetic particles (photons, electrons, protons, atoms, . .) and project them directly onto the target. The development of these arms is the object of considerable research in the laboratories of all first and second strength military powers today. The possible introduction of these weapons is part of a continuing evolution by which nuclear arsenals are more and more reinforced with specialised weapons, always more amenable to nuclear war fighting at all possible levels. In order to illustrate this continuity, but without developing the subject in detail, we will be content merely to give the main anticipated properties of three categories of directed energy weapons envisaged at this time.

Laser beams: A laser beam is a ray of coherent light, continuous or pulsed, which produces mechanical and thermal effects on the target from a distance. In the atmosphere, the military use of lasers is envisaged to defend warships against cruise missiles, tanks against precision guided missiles, etc. In anti-aircraft defence the precision of the laser would allow direct aiming at the pilot, which is the most effective way of destroying simultaneously the aircraft and its pilot. In outer space, the laser is foreseen as defending or attacking satellites, intercontinental ballistic missiles (ICBM), long-range bombers flying above the clouds, etc. . .

Micro-wave beams: A directed energy micro-wave beam is essentially the same as an extremely powerful pulsed radar beam which can be directed at a target containing complex electronic equipment. It is in fact a weapon derived from existing electronic warfare systems already capable of saturating momentarily the electronic apparatus of an enemy aircraft. The micro-wave beams envisaged for the future would have sufficient power to cause permanent damage by overloading the electronic systems. American specialists think that their Soviet counterparts are developing this type of weapon to defend their installations against cruise missiles.

Particle beams: Particle beams consist of bundles of elementary particles (electrons, protons, atoms, . . .) accelerated to high energy by extremely powerful accelerators. Instead of merely being able to interact at the surface of the target as with laser beams, the accelerated particles can penetrate and cause in-depth damage. Moreover, accelerated particles generate all sorts of secondary radiations along their path through the air and inside the target, as well as electro-magnetic effects similar to the EMP bomb. Militarily speaking, particle beams are potentially the most interesting. Nevertheless, their development depends in particular on the success of laser and microwave beam weapons. Their possible applications overlap those of the laser and micro-wave beams with, in addition, for example, anti-missile defence of ICBM silos, antitank defence, anti-personnel machine-gunning. Particle beams also permit envisaging certain types of meteorological manipulation, the disturbance of communications in limited regions, etc.

Finally, compared to second generation weapons, directed energy weapons include the supplementary advantages of not producing radioactive fallout and allowing an almost complete separation of the desired mechanical, thermal, electro-magnetic or radiological effects. The introduction of these weapons could already take place between 1985-1995 depending on the type and on international tension. They will imply considerable changes in military strategy and tactics and it is possible that a growing de-stabilisation of the world military situation will result.

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