THE FRENCH ATOMIC BOMB TESTS

by

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This article summarises the details of two French Atomic Tests. Both were carried out at Hamoudia in the vicinity of Reggane (Sahara), the first on 13th of February 1960 and the second on the 1st April 1960.

The nuclear explosive used in both cases was plutonium. In the first test the device was placed on the top of a tower of about 100 metres high whereas in the second test it was placed in a prefabricated shed. According to unofficial reports, the yields of the two tests were about 60 Kt and less than 20 Kt respectively.

Introduction

The second French atom bomb burst yielded less spectacular results than the first as its main purpose was to test certain specific features of the bomb, such as its transportability and effectiveness, both of which are very essential requisites in a device which is meant to be used in warheads.

The French experts seem to be confident after the burst of the second atom bomb that they can meet any military requirement regarding size, weight, etc. In the second atom bomb test the French were also able to release a previously specified quantum of energy.

The second bomb resembled the first one broadly but differed in constructional details. The installations etc. was made in a prefabricated shed in the case of the second atomic bomb. As a result, a crater was formed and secondly there was only local fallout, in the immediate proximity of Ground Zero.

The test explosion of the first French atom bomb required an effort of great magnitude. The preparation of the nuclear explosive, in this case, plutonium, necessitated the building up of a great industrial group at Marcule. The calculation of the supercritical mass involved the use of computing machines and had to be done accurately as anything less than the supercritical amount does not lead to an explosion and an excess value leads to undesirable effects, endangering the proper functioning of the device. In order to achieve maximum efficiency in the release of energy from the bomb, the chain reaction in the fissile material must prolong itself for the longest period possible. The efficiency of the bomb can be increased by enclosing the bomb in a highly resistant casing and also by shaping the supercritical mass in such a way as to allow maximum chain reaction. Besides the length of the chain reaction, its nature and speed are also important; other factors external to the fissile materials, such as the mode of initiation of the reaction by injection of a stream of neutrons and the nature of the reflectors which prevent the particles from flying away also have an effect on the amount of energy released.

Fabrication

The actual fabrication of the bomb raised many practical issues. The formation of the supercritical mass can be achieved in either of two ways; by a sudden merging of two or more subcritical masses or by giving a overcritical geometry to a previously subcritical mass. For this purpose it is essential to have a thorough knowledge regarding the explosives that can be used. The second problem was regarding the handling of the fissile material, plutonium, on account of its extreme toxicity and difficult metallurgy and to guard against the possibility of accidentally achieving a supercritical mass. For these reasons the French physicists manipulated plutonium only in small quantities. Production of sufficient quantities of plutonium itself was a problem and this could not have been achieved but for the construction of the reactor at Marcule.

The explosion

The fission of each nucleus of plutonium under the action of neutron bombardment is accompanied by the release of a certain quantity of energy. Some of the neutrons which do not happen to strike the plutonium nuclei with the nuclei of the material constituting the bomb and those of the surrounding gases. In the first case it causes the formation of radioactive substances with a fairly long half period. In the second case under certain conditions of impact they can excite the atoms struck and cause emission of secondary gamma rays.

Thermal effects

Immediately following a nuclear explosion a fire ball is formed whose temperature is of the order of several million degrees. It is estimated that the thermal energy constitutes about 35 per cent. of the total energy released of the bomb. The fire ball continues to emit thermal radiation for a few seconds. The rays are propagated better in clear air and high irradiation can occur if the visibility is satisfactory.

Effect of blast

The sudden rise in temperature causes a rapid increase of pressure which results in the formation of a shock wave. The shock wave which initially travels with the fire ball gets itself detached at the end of a few thousandths of a second. In the case of an explosion occurring at some height above the ground a part of the shock wave gets reflected. The direct and the reflected waves by interference would then give rise to the formation of a "Mach front" which moves parallel to the ground followed by a wind exerting a "dynamic pressure". The sequence of events is as follows. The high pressure shock wave is followed by a depression which is in turn followed by the dynamic pressure of the wind. 50% of the total explosion energy developed is dissipated thus.

Nuclear radiations

The nuclear radiations emitted at the time of the explosions, which consist of neutrons and gamma rays form about 5% of the total energy of the bomb.

The turbulent cloud which goes up in the form of a mush-room after an atom bomb burst attains a height of about 10,000 metres in the case of a bomb of medium power. This mush-room cloud constains—

(*a*) The radioactive fission products with half-lives more than one minute. These are the sources of residual radioactivity (10% of the total energy of the bomb).

(*b*) In certain cases the dusts sucked from the ground which are carriers of "induced radioactivity".

(*c*) Water vapour subjected to a strong bombardment of neutron and gamma rays.

The material descends to the ground at different distances and after different time intervals depending on the meteorological conditions and constitutes what is known as "fallout". The substances in fallout which are most dangerous to man are Strontium-90 and Caesium-137 with half-lives of about 28 years each.

Besides these, there are other long-term hazards also. The neutrons emitted can transmute nitrogen into carbon-14 which combining with oxygen can enter into the human system through respiration. Carbon-14 has a very long half-life—5,600 years—and can cause genetic damage.

Experimentation

In order to learn the mechanism of explosion and what follows after it, a variety of instruments had to be established near the site of the explosion. Equipment for detecting electromagnetic radiations and seismic waves (ultra-seismographs) propagating through geological structures to various distances was also installed. Besides these the effects of the bomb burst on various materials at various distances were also studied.

The latest series of tests carried out by the Health-Services aimed at measuring the biological effects of radioactivity. Special equipment was designed for use in these studies. It is hoped that such of the valuable information which is not of defence interest will be made available to the public. That will enable us to see whether the conclusions arrived at in these tests confirm those of the Americans and whether it would be necessary at all to conduct any more tests of this type.

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