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use would most probably be directed at cities, and the bombs delivered by aircraft or relatively short-range rocket. It might be air-burst or ground-burst, with bombs in the ten- to one-hundred kiloton range.

Accidental or unauthorized launch of an intercontinental missile or a submarine-launched missile from one of the big nuclear arsenals might destroy a city with a bomb in the range of 100 kilotons to one megaton.

A terrorist attack is perhaps the most likely risk. It is possible that a 'hydrogen bomb' might be acquired from one of the military arsenals, and delivered by ship to the harbour of a port. More likely is a bomb in the ten-kiloton range exploded at ground level in a city, or in a ship.

An accident to a nuclear weapon, such as dropping it down a silo or from an aircraft, would not cause a full-scale nuclear explosion, but could scatter kilograms of plutonium by detonation of the high-explosive charge. To cause a nuclear explosion, the charge has to be detonated absolutely simultaneously all round the nuclear core, which is done by special electric circuits. Accidental detonation by a shock would not do this, but one wonders whether an electrical fault or a lightning stroke could ever do it.

FINAL COMMENTS

The above description was set in the context of a North American city. As proliferation of nuclear weapons continues, there is a greater risk that a tropical city may be attacked.

In such circumstances, the deaths and injuries from firestorms and flash burns would be higher than in the North American context, because many of the dwellings would be of light construction, and a higher proportion of the population would be likely to be in the open at the time of the explosion.

The distances quoted from ground zero are derived from a number of secondary sources, which do not all agree. Basically the numbers are derived from United States government measurements made during the years before 1963, when test nuclear explosions were permitted in the atmosphere.

It does not really matter if some of these distances are not accurate. Similarly, even if the estimates of deaths and injuries are considerably over-stated, the consequences of exploding a nuclear bomb and giving rise to a disaster even approaching this magnitude — anywhere on earth — remain completely unacceptable.

The only way to abolish this risk is to get rid of all the nuclear bombs in the world.

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SUGGESTED FURTHER READING

Glasstone & Dolan. 1977. **The Effects of Nuclear Weapons**. U.S. Dept. Defense & U.S. Dept. Energy.

Dennis, Jack ed. 1982. **Nuclear Almanac**. Addison Wesley.

W.H.O. 1987. 2nd ed. **Effects of Nuclear War on Health and Health Services**. Geneva.

Hiroshima International Council for Medical Care of the Radiation-Exposed, ed. Brian Harrison, transl. 1993. **A-Bomb Radiation Effects Digest**. Harwood Academic.

Liebow, Averill. 1970, 1985. **Encounter with Disaster: A Medical Diary of Hiroshima, 1945**. Norton, Penguin (Canada).

Hersey, John [journalist for "The New Yorker"]. 1946, 1982. **Hiroshima**. Penguin.

Books on ideas and current work in hand towards elimination of nuclear weapons:

Schell, Jonathan. 1998. **The Gift of Time**. Owl Books.

Green, Robert. 2000. **The Naked Nuclear Emperor–Debunking Nuclear Deterrence**. Christchurch NZ: The Disarmament & Security Centre.

Rotblat, Joseph, J. Steinberger, B. Udgaonkar ed. Pugwash Monograph. 1993. **A Nuclear Weapon-free World Desireable? Feasible?**. USA: Westview Press.

Roche, Douglas. 1997. **The Ultimate Evil**. Toronto: Lorimer.

Security and Survival–the Case for a Nuclear Weapons Convention. 1999. IPPNW, IALANA and INESAP. Cambridge, Mass.

Personal recollections:

Akizuki, Dr. Tatsuichiro. 1981. **Nagasaki 1945**. Quartet Books.

Townsend, Peter. 1985 (1st ed. 1984-Collins). **The Postman of Nagasaki**. Penguin.

A novel, based on real diaries and recollections:

Ibuse, Masuji, trans. John Bester. 1985. **Black Rain**. Bantam (Kodansha International 1969).

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THE EFFECTS OF A NUCLEAR BOMB EXPLOSION ON THE INHABITANTS OF A CITY

by Alan F. Phillips, M.D., D.M.R.T.

THE DETONATION OF A SINGLE NUCLEAR BOMB OR "WARHEAD" WOULD CAUSE A LOCAL DISASTER ON A SCALE THAT FEW PEOPLE IN THE WORLD have seen and survived. However, it should not be confused with the effects of a nuclear war, in which many nuclear bombs would be exploded. That would cause the end of civilization in the countries concerned, and perhaps over the whole world, as well as radioactive contamination of whole continents, and terrible damage to the environment and ecology.

The effect of a single bomb would depend on its power, and where it exploded – high in the air or at ground level – and whether in a densely populated and built-up area like a city or in open country like an attack on a missile silo.

The nuclear bombs available to the great military powers of the world (China, France, Israel, Russia, United Kingdom, United States) range in power from several megatons down to a few kilotons (and some even smaller).

A "megaton" is the explosive power of one million tons of TNT [1]. A "kiloton" is the power of one thousand tons of TNT. Bombs likely to be available to terrorist organizations or governments other than the great military powers would be in the 10- to 100-kiloton range. Bombs made by amateurs might not explode with the full power they were designed for.

The two bombs that have been exploded over cities, Hiroshima and Nagasaki in Japan in August 1945, were in the 10- to 20-kiloton range.

A ONE-MEGATON BOMB DETONATED IN THE AIR

First, we will look at the result of a single bomb of one megaton detonated at an altitude of 2,500 metres above a city, to cause maximum blast effects. This is believed to have been a main part of the targeting strategy of the Soviet Union and the United States during the "Cold War". The Russian and U.S. governments have stated that missiles would not remain targeted on cities. However, thousands of missiles and warheads are still deployed. They could be targeted on any city in the world in a matter of minutes, and re-targeted to their original targets in seconds.

Flash and Fireball

The first effect of a nuclear explosion in the air is an intense flash of light, as quick as a lightning flash but a thousand times as bright. It is accompanied by a powerful pulse of heat radiation, sufficient to set fire to light combustible material out to a distance of fourteen km., and to paint or wood at half that distance. There is also an intense pulse of X-rays, sufficient to be lethal at a distance of three km.; in fact that would be a rather small factor, since people that close would all or nearly all be killed by the blast that follows.

Immediately after the flash, a "fireball" forms in the air and rises for several seconds, blindingly bright and radiating much heat. On a clear day or night, people up to eighty km. away who happened to be facing that way, or who turned their eyes to look where the flash came from, would be temporarily or permanently blinded.

Within ten km. of "ground zero" (which is the point directly under the explosion) all parts of the body exposed to the flash would be burned deeply into the flesh. Superficial burns would be caused at greater distances, out to fifteen km. at least. Clothing that caught fire would cause many more burns.

[1] TNT stands for tri-nitro-toluene, a high explosive commonly used in shells and bombs throughout the Second World War. Weight for weight, its explosive power is roughly equal to that of dynamite.

The weather conditions prevailing, and the time of day the bomb exploded, would both influence the degree of damage. For example, the distances for skin burns and blindness would depend on the weather. Rain or fog reduces the range of the heat and light rays, and would reduce the severity of burns and eye damage; on the other hand, darkness dilates the pupils of the eyes and would increase the severity of eye damage from the flash.

Blast

Starting at the same instant, but travelling more slowly (like the sound of thunder following a lightning flash) is an enormously powerful blast wave. It would destroy even reinforced concrete buildings for a radius of two km., and ordinary brick or timber frame houses out to eight km. Major damage to houses would extend out to fourteen km., and windows would be broken at twenty or thirty km. People at a distance, if they realized what had happened when they saw the flash, would have a few seconds to lie down, or even to dive into a ditch or hollow, before the blast hit.

Within three km., almost everyone would be killed, either directly by the blast or by collapsing or flying masonry. At eight km., it is estimated that about fifty per cent of people would be killed by the effects of the blast.

Immediately following the blast wave would be hurricane force winds, first outwards from the explosion, and many seconds later inwards to replace the air that went out. Within four km., the wind would be of tornado force, six hundred km./hr., sufficient to drive straws into wooden utility poles or glass splinters into people, but of course over a much wider area than a tornado. People in the open would be picked up and hurled into any object strong enough to be still standing.

Firestorm

Many fires would have been started by the first flash. Burst fuel tanks, gas mains, and collapsed buildings would provide more fuel, and it is likely that confluent fires would cause a "firestorm". This is when coalescent fires cause sufficient updraft to form their own wind, blowing inwards from all sides and thereby increasing the intensity of the fire. The temperature even in basements and bomb shelters rises above lethal levels, and all available oxygen is used by the fire.

The wind blowing inwards is of gale force, so that even strong uninjured people would have difficulty walking or trying to run outwards away from the fire.

Delayed Radiation ("fallout")

A nuclear explosion, as well as giving off a great pulse of radiation at the time, leaves everything in the vicinity radioactive. In the case of an "air-burst" as just described, most of the radioactive products would be gaseous, or completely vaporized, and would rise with the fireball and come down slowly, if at all. There might be a rainstorm containing radioactivity, as there was at Hiroshima; and the rubble within a kilometre or two of the ground zero would be radioactive. This might hamper later rescue efforts, and affect the very few survivors from that central area, but would not be a major factor.

In any nuclear bomb explosion, a large fraction (a minimum of one-third) of the original fissile material (plutonium or U-235) does not get destroyed. This would result in widespread contamination, increasing the late risk of cancer for those who survived ten to twenty years. (These amounts of plutonium and uranium would have no immediate toxic effects.)

Rescue Problems

If the bomb exploded squarely over the centre of a city, no rescue services within the area of major structural damage would be able to function. All down-town hospitals would be destroyed, and there would be no electricity, water, or telephone communication in the area served by city utilities.

Rescue services from outside would be hampered by impassable roads and the central area of severe damage would be inaccessible. The number of injured in the peripheral area would be so great that emergency services of surrounding cities would be completely overloaded, as would be any surviving suburban hospitals and all the hospitals of neighbouring cities. Even to be seen by a doctor and given analgesics, the injured from one city would need to be distributed among all the hospitals of North America.

The destroyed city would be radioactive. Decisions to attempt rescue work would depend first on a survey of the area by a specialist team with appropriate protection, and then on a policy decision as to how much radiation the rescue teams should be permitted. Willingness of the team members and their unions to accept the risk would be a final factor.

Medical Problems

The estimates for a city of one million or two million struck by a single one-megaton bomb are that around one third of the inhabitants would be killed instantly or fatally injured, one third seriously injured, and the rest uninjured or only slightly injured. That number of injured, if they could be distributed throughout the hospitals of North America, would occupy something like a third of the total number of beds; and of course no hospital can deal adequately with such an influx of urgent cases within a few days.

There might be fifty times as many cases of severe burns as there are burn beds in the whole of North America. A whole year's supply of blood for transfusion would be needed immediately, and of course is not available in storage nor could it be collected from volunteers in a few days.

The injured who reached hospitals would have to be assayed for radioactivity, for the safety of the staff, which would cause a serious bottle-neck and delay in most hospitals.

The result of this huge overload of cases is that most of the injured would die, even though prompt treatment might have saved them. Relatively few would even get reached by rescue teams before they were moribund or dead; the majority would probably die in hours or days without any analgesic, and without food, water, or any assistance.

A ONE-MEGATON BOMB DETONATED AT GROUND LEVEL

If the bomb exploded at ground level instead of high above the city, the main difference would be an enormous crater four hundred metres across and seventy metres deep. All the dirt, rock, or masonry excavated would be made into radioactive dust and small debris. The larger particles would quickly descend in the immediate vicinity, and the finer particles and dust would descend in minutes or hours, mainly downwind from the site of the explosion.

The radiation dose to people exposed to this fallout would depend upon many factors, and would be enough to be lethal to anyone in the open or in a frame house for several hundred kilometres downwind. A simple basement "fallout shelter" would afford good protection. It would be necessary to spend a week or more in a fall-out shelter, and it would be impossible to judge when it would be safe to leave without a radiation survey meter or advice from public health authorities.

The area of blast damage would be smaller by perhaps a half, compared with an air-burst, though an earthquake effect would add to structural damage to buildings. The number of immediate deaths might be about half of those from an air-burst, but unless survivors could find protection from fall-out there would be many deaths from radiation sickness days or weeks after the bomb.

Photo: U.S. Dept. of Energy

A TEN-KILOTON BOMB DETONATED AT GROUND LEVEL

If a bomb in the 10- to 20-kiloton range (the likeliest terrorist bomb) were to be exploded near ground level or in a ship in the harbour, the areas of blast, heat, and burn damage would be much smaller, perhaps reaching out to only one-tenth of the distances estimated for the one-megaton air-burst. The numbers of immediately killed and severely injured people would be counted in thousands, not hundreds of thousands.

Exploded on land, the bomb would vaporize all people and buildings in the immediate vicinity, and make a crater that might be as much as one hundred metres in diameter. If in the harbour, there would be a crater in the harbour floor and a tidal wave. The outstanding feature would be a radioactive downpour because much of the water in the harbour would be made radioactive and thrown high into the air as fine and coarse spray.

The explosion at ground level of this type of bomb would probably not cause a firestorm, so rescue operations for the injured might have some degree of success.

In either case, radioactive fallout would be serious, and might make the city, and an area of countryside stretching tens of kilometres downwind, uninhabitable for weeks or years. There would be a number of deaths from radiation sickness, for which there is really no effective medical treatment. The total amount of radioactivity might be comparable with the Chernobyl disaster, more or less depending on many circumstances.

THE ENHANCED RADIATION WEAPON OR "NEUTRON BOMB"

This is a small 'hydrogen bomb' in the 1- to 10-kiloton range without the outer casing of depleted uranium, which in an ordinary hydrogen bomb stops the neutrons that are formed and converts them into additional explosive power. The result is a spray of neutrons that is lethal for a distance of a few hundred metres. These neutrons, unlike the X-rays from the explosion, penetrate a considerable thickness of concrete or steel protection, like defence posts or the sides of a tank. They are designed for 'battle-field' use, not for use against cities. It is commonly said that neutron bombs spare buildings, but we believe this is a misconception. The blast effect would be reduced by half, and would still be enormous.

HOW COULD THIS SORT OF "ONE-BOMB" SCENARIO DEVELOP?

It is worth considering what circumstances might result in one or just a few nuclear bombs exploding, as opposed to a major nuclear war.

We hope, but we cannot be sure, that a nuclear attack by one of the original five "nuclear weapon states" (USA, Russia, Britain, France, China) against a smaller country (which has been threatened several times since 1945) would never be carried out for any reason whatever.

There have been serious risks of war involving the other three countries with nuclear weapons: Israel, India and Pakistan. Particularly against a non-nuclear opponent, this might result in one "demonstration" nuclear bomb, or just a small number. Clear or veiled threats of nuclear attack have been made by all these countries, and by some countries who are not known to have nuclear weapons but may be trying to acquire them. Such