Damage Scenario Resulting from a Nuclear Attack: Brief Summary of a Study by the City of Hiroshima

In November 2007, upon adopting a civil protection plan, Hiroshima City deliberated a specific damage scenario resulting from a nuclear attack. Below is the brief summary of the study.

1. How Damage Results from the Use of Nuclear Weapons

Nuclear weapons employ the explosive energy released by the fission or fusion of atomic nuclei. The Hiroshima bomb generated 16 kilotons of destructive force; the Nagasaki bomb, 21 kilotons. The largest nuclear test to date was approximately 58 megatons. Approximately 50% of this energy is released as blast, 35% as heat, and 15% as radiation.

The damage wrought by radiation can be divided into acute radiation syndrome, which appears within months of exposure, and disorders that appear after a long period of latency. Acute radiation syndrome is due to cell death caused by damaged genes. The greater the dose, the worse the symptoms are. Also, the mutation of cells due to gene damage causes various health problems (aftereffects such as cancer) after certain periods of latency depending on the affected organ.

The high-temperature fireball formed by a nuclear reaction expands at supersonic speed, creating shockwaves at its extremity. Immediately after the explosion the shockwave grows with the fireball, and eventually separates from the surface of the fireball and propagates concentrically. It is a pressure wave that flattens anything at its point of arrival.

After the shockwave, the flow of air pushed out by the rapid expansion of the fireball turns into a blast wind, which rages through the air, destroying buildings and killing people. The blast blows away anything in its path, with the pressure arising from the movement of air. The effects of blast on the human body include direct effects, such as lung damage, eardrum rupture, and dislocation of internal organs or eyeballs. Indirect effects include collision with the ground or structures when blown by the blast, getting caught in the collapse of buildings, or being hit by flying debris.

The high-temperature fireball emits an extremely powerful light flash and thermal radiation. The thermal radiation rapidly raises the temperature near ground zero, causing the first to fourth degree burns to the human body and igniting combustible matter, triggering fires. In some cases numerous fires will join up to form a massive firestorm.

Furthermore, gamma rays and the atmosphere interact to emit electromagnetic pulse, which incapacitates a wide range of electronic appliances. Consequently, communications and control operations may suffer significant disturbance. Since the electromagnetic pulse would render electronic communication devices useless, a community that has suffered a nuclear attack is in a state where groundless rumors are most likely to occur.

In addition, a nuclear attack would cause psychological effects such as psychic aberration, suicide and post-traumatic stress disorder. Besides, a nuclear weapons attack would obviously destroy all economic and production infrastructure, but it would also destroy almost entirely the information required for public administration. The reconstruction of the affected community would confront unimaginable hardships. Moreover, the victims of a nuclear attack not only suffer the physical effects of radiation, blast and thermal radiation but also struggle with anxieties about genetic effects, exposure to social discrimination and prejudice. They consequently encounter severe difficulties in working and even leading everyday life. Thus, a nuclear weapons attack will inflict physical, psychological and social hardships that will cause suffering for many decades.

2. Estimate of Damage Caused by a Nuclear Attack

To make maximum use of Hiroshima's experience of August 6, 1945, the present study assumes that a bomb strikes the center of the city on a sunny weekday in summer (August). The following four cases were explored: 1) a 16-kiloton atomic bomb explodes 600 meters in the air (like the bombing 62 years ago); 2) a 1-megaton hydrogen bomb explodes 2,400 meters in the air; 3) a small atomic bomb (1 kiloton) explodes at 1 meter, and 4) a 16-kiloton atomic bomb explodes at 1 meter. (See Tables 1 and 2)

Given the strength of today's buildings, initial damage, exposure to massive initial radiation, and death due to collapsing buildings might be somewhat less than was the case 62 years ago. However, anyone near the hypocenter and anyone outdoors would be exposed to massive initial radiation before they even saw the flash. Those outdoors would then be assaulted by the heat and blast. Those lucky enough to be shielded from the effects of initial radiation and heat by a thick-walled building would still be far from safe. Fragments of shattered windows, internal/external walls and all loose items would become lethal projectiles. Elevators would stop, and many would be trampled or pushed to their deaths in the ensuing panic in crowded stairwells.
Those able to escape from buildings would find streets filled with the debris of toppled buildings and destroyed vehicles. Burning cars would undoubtedly become serious obstacles to escape. Those able to do so would be fleeing wildly to escape advancing flames. Meanwhile, they would be covered with and breathe in particles of radioactive dust and ash. Or, they might also be exposed to radioactive black rain, all of which would expose them to residual radiation.

Table 1 Estimated deaths and injuries from an airburst

Destructive Power			①16 kilotons	②1 megaton
Height of Explosion			600m	2,400m
Assumptions	Acute	deaths	66,000	372,000
		injuries	205,000	460,000
		casualty rate	46.4%	61.3%
	Aftereffects		Exposed to radiation: 155,000 Leukemia and cancer: 13,000	Exposed to radiation: 46,000 Leukemia and cancer: 1,000

Table 2 Estimated deaths and injuries from a surface burst (not including the effects of fallout)

Destructive Power			③1 kiloton	④16 kilotons
Assumptions	Acute	deaths	10,000 +	55,000 +
		injuries	50,000 +	146,000 +
		casualty rate	(34.4%)	(43.9%)

※ The "+" indicates that deaths and injuries will increase due to the effects of fallout.
Large numbers of aftereffects also anticipated.

3. Responses to Nuclear Weapon Attack Damage

To respond to damage caused by a nuclear attack, attempts may be made to 1) gather and communicate information, 2) determine appropriate responses, and 3) implement those responses, but all three of these response activities would be extremely difficult to perform. In summary, if a nuclear attack were to occur, it would be entirely impossible to avoid extensive damage which would be far beyond the response abilities of administrative agencies. Nuclear weapons are too destructive and the radioactive contamination caused by them too severe to enable adequate response operations. It should also be emphasized that the psychological and physical injuries inflicted on survivors of a nuclear weapon attack would never be healed, no matter how many years of effort and how much money was invested.

4. Conclusion

Based on this study, we have to conclude that protecting our citizens from nuclear attack, whether intentional or accidental, is impossible. The only way to protect our citizens from such an attack is prevention, and the only sure method of prevention is the total elimination of all nuclear weapons.

The results of this study demonstrate that the impact of a nuclear attack would be especially severe in cities. Accordingly, it is useful and necessary for cities to take the lead in arousing international public demand for the abolition of such weapons. In this regard, we look toward the proactive campaigns being conducted in Japan by the Council of Nuclear-Free Local Authorities and globally by Mayors for Peace.