Adequate Shelters and Quick Reaction to Warning: A Key to Civil Defense

Abstract. *Case histories collected by investigators in Japan during 1945 illustrate both the effectiveness of shelters and the dangers inherent in apathy of the population, which suffered needless casualties by ignoring air raid warnings. Adequate shelters and immediate response to warnings are essential to survival in nuclear attack.*

This discussion is concerned with underground or semisurface shelters in Hiroshima and Nagasaki, considered to be the most desirable from the standpoint of protection, and is based primarily on certain reports, now in custody of the Armed Forces Institute of Pathology, collected by the Joint Commission for the Investigation of the Effects of the Atomic Bomb in Japan (*1*). These reports serve to point up what the lack of an effective warning system and a limited response to it can mean in the event of an attack, regardless of the availability of shelter areas, for although shelters and warning were available in both Hiroshima and Nagasaki, the population paid little heed to the warning. People who happened to be in shelters received at most, relatively minor injuries, while people outside were killed. Long-range problems of survival are not discussed, nor are types of shelters considered in this report (*2*).

Hiroshima. The city of Hiroshima had provided sufficient shelters to accommodate approximately one-third of the population along the river banks and at the military headquarters nearby. The shelters were built of reinforced concrete or consisted of excavations supported by beams and roofed with wood and earth. These withstood the blast even at 300 yards (275 m) (Fig. 1). Many of the unsupported, excavated shelters within the first 1000 yards (900 m) collapsed, however.

The Governor of Hiroshima Prefecture (*1*) reported that on 6 August 1945 at 7:09 A.M., an "air raid alert" was sounded, followed at 7:30 by the "all clear." There was no further warning, but at about 8:16 A.M., 46 minutes after the alert had been lifted, the bomb was dropped.

An example of one of the better types of shelter in Hiroshima was the Communications Building at Chugoku Army Headquarters. This structure was located about 750 yards (685 m) east from ground zero. (At this distance most of the people outdoors were killed.) It was a concrete structure largely below ground level (Fig. 2); the side of the building facing the explosion received additional protection from the stone facing of a moat. The strong construction of this shelter is apparent from an inspection of Figs. 3–5.

Twenty-six Hijiyama School girls were working in the building as switchboard operators and in other capacities on the morning of 6 August 1945. Of these, 19 were subsequently examined by members of the Atomic Bomb Commission, 16 on 5 November and three on 14 November 1945. The examinations revealed that eight of the girls were unhurt and 11 sustained minor contusions or lacerations caused by flying debris. One of the 11 girls injured had questionable radiation sickness. Another of the injured girls probably had a mild cerebral concussion due to blast (being unconscious for several minutes after the explosion but having no mechanical head injury). Of the seven girls not examined in the survey, two were drowned in the castle moat while trying to escape from the area after the bombing. The other five were known to be living and to have suffered no serious ill effects after the bombing.

On the basis of the group studied, therefore, it appears that the Communications Building furnished complete protection against burns and probably against radiation sickness, despite its proximity to the explosion. The doors and windows (Figs. 3 and 4) on the west face of the building were open at the time of the explosion and the blast was clearly perceived by those present.

Nagasaki. The responsibility for the planning, construction, and location of shelters in Nagasaki was vested in the engineering department of the city government. In October 1943, a directive was received from the Ministry of Home Affairs that ordered each family to construct a shelter and the city to construct covered-trench and tunnel-type shelters. The topography of Nagasaki lent itself readily to the construction of the latter type of shelter. City officials stated that by 1944 each family had built a shelter but that most of them offered only temporary protection, and that, in 1944, the city began a program to construct tunnel shelters to provide protection for about 75,000 persons. Shelters were constructed and available for family and public use in Nagasaki by 9 August 1945, and they could have protected a large percentage of the population if full advantage had been taken of them.

Fig. 1. "Hiroshima. Typical, part below ground, earth-covered, timber framed shelter 300 yds. from the centre of damage, which is to the right. In common with similar but fully sunk shelters, none appeared to have been structurally damaged by the blast. Exposed woodwork was liable to 'flashburn'. Internal blast probably threw the occupants about, and gamma rays may have caused casualties." (Reprinted by permission from Report of the British Mission to Japan (*3*) and the Imperial War Museum, London.)

The following information, abstracted from a report (*1*) concerning certain types of shelters in Nagasaki, describes various cave or tunnel-type shelters—their construction, capacity, and availability.

The hills on which the greater part of Nagasaki was built, being composed largely of clay and limestone, offered excellent opportunity for the construction of tunnel-type shelters. During 1944 and 1945, the city built about 6¾ miles (10⅞ km) of tunnel shelters, and block associations constructed nearly 8⅝ miles (13⅞ km). Approximately 50 percent of these shelters were rein-

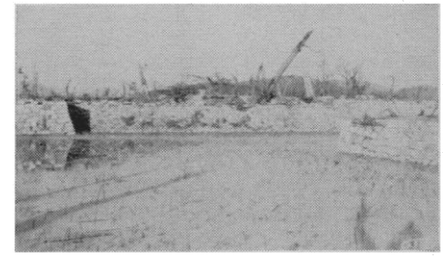

Fig. 2. Chugoku Army Headquarters (750 m from ground zero). View of the underground communications trench from across the moat, looking away from the center of the explosion, with which the optical axis of the camera is in line. The ventilator of the communications trench is just visible near the center, above the stone facing of the moat. (AFIP Neg. HB 209.)

Fig. 3 (left). Chugoku Army Headquarters (750 m from ground zero). Underground communications trench. Entrance at left. (AFIP Neg. HB 321.) Fig. 4 (right). Chugoku Army Headquarters (750 m from ground zero). Underground communications trench. Open metal port. This is a view looking away from the center of the explosion, with which the optical axis of the camera is in line. (Reprinted by permission from A. W. Oughterson and S. Warren, *Medical Effects of the Atomic Bomb in Japan* (McGraw-Hill, New York, 1956), p. 61.) (AFIP Neg. HB 320.)

forced with heavy timbers, and most of them had the entrances well protected by baffle walls. Two such tunnel shelters constructed by the city were of reinforced concrete, with walls about 1½ ft (½ m) thick. The tunnels were divided into about ten rooms each, had a roof covering of 30 to 50 ft (9 to 15 m) of earth, and were equipped with electricity, seating arrangements, sanitary facilities, and two concrete updraft ventilators. The capacity of each tunnel was about 600 persons. Shelters of this type had three well-protected entrances and an additional emergency exit. The city had planned to construct a number of them, but the shortage of steel and cement compelled the use of timber for reinforcement.

The control center of Nagasaki was located in a shelter constructed according to the specifications described in the preceding paragraph. Cement and steel were not available to the public after 1943, but in many cases the military services and industries engaged in war production were able to secure these materials to build shelters that would afford very good protection for their personnel.

The home type of shelter was usually a hole about 3 ft (1 m) deep, dug beneath the house, sufficiently large to accommodate the family. Some had sidewalls braced with timber, but most often there was no shoring. Under raid conditions, these shelters often became death traps, since both entrances were inside the house. Sometimes the family shelter was constructed in the yard or other open space, in which case it was usually a semi-surface type, reinforced and braced with timber, and covered with 2 to 3 ft (⅔ to 1 m) of small stones and dirt (Fig. 6).

The city and block associations also built 1160 covered trench-type shelters that were timber-reinforced; information as to the capacity and depth of covering is not known, however. Open trenches were also dug, and by 1945 many of them had been covered with wooden boards and about 2 ft (⅔ m) of earth.

Investigation revealed that tunnel shelters of all types stood up very well from the blast and concussion of the atomic bomb.

On the day the bomb was dropped on Nagasaki (9 August, 1945) an "air raid alert" was sounded at 7:50 A.M. It was cancelled at 8:30, and the city remained in a state of "warning alert." As a result, most of the school children remained at home instead of going to their labor assignments. A majority of the school children were incorporated in the labor force, some working in shops established in the schools, and others working in factories and municipal offices throughout the city. The fact that the school children remained at home was in accordance with the normal routine for warning alerts in Nagasaki.

At about 11:00 o'clock another "air raid alert" was given, followed in about 2 minutes by the atomic bomb explosion. Many of the people enroute to shelter stopped to watch the two B-29 aircraft. Some hesitated to take cover, since only two heavy bombers were visible. Consequently, many people were in the open looking toward the sky when the explosion occurred. Others, unimpressed by the air raid warnings, continued their habitual occupations at home and at work.

Accurate figures are not available as to the number that took cover in the city's tunnel shelter system. The Governor of Nagasaki stated that not more than 400 had taken cover in the tunnels, which could have offered shelter to 75,000 (*1*). Interviews with survivors who were located in the caves indicated that most of these people were engaged in repair work or other type of work detail. A few persons who quite accidentally happened to be in the caves also survived.

Available shelters in Nagasaki could have protected more people had they been properly utilized. This opinion is illustrated by tunnel diagrams (Figs. 7 and 8) and the observations, reactions, and effects on persons in them at the time of the bombing.

Subject A and a number of other persons were working in a shelter located in the north side of an elevation about 20 to 25 ft (6 to 8 m) high, with the entrance approximately 200 yards (180 m) from the estimated cen-

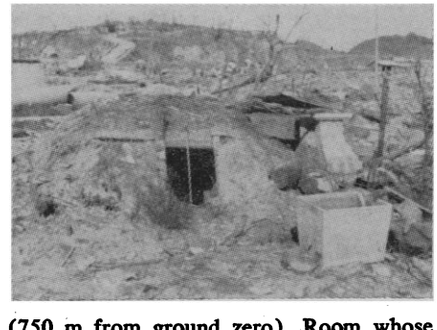

Fig. 5 (left). Chugoku Army Headquarters (750 m from ground zero). Room whose ports are seen from the outside in Figs. 3 and 4. (Reprinted by permission from A. W. Oughterson and S. Warren, *Medical Effects of the Atomic Bomb in Japan* (McGraw-Hill, New York, 1956), p. 61.) (AFIP Neg. HB 322.) Fig. 6 (right). "Nagasaki. Typical small earth-covered backyard shelter with crude wooden frame, less than 100 yds. from the centre of damage, which is to the right. There was a large number of such shelters, but whereas nearly all those as close as this one had their roofs forced in, only half were damaged at 300 yds. and practically none at half a mile from the centre of damage." (Reprinted by permission from Report of the British Mission to Japan (*3*) and the Imperial War Museum, London.)

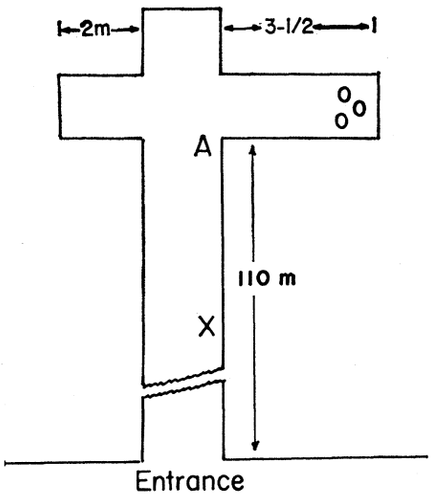

Fig. 7. Diagram of a tunnel in Nagasaki. *A*, subject interviewed; *X*, casualty; *O*, uninjured persons.

ter of the bomb impact (Fig. 7). The shelter did not have a baffle wall protecting the entrance although material had been acquired for that purpose. Subject A was standing with her back toward the entrance when the explosion occurred. She was knocked over by the blast and was burned on the back of the legs and on the upper part of the right arm. The scars remaining from the burns had the appearance of dark brown blotches such as might result from burns inflicted by hot sparks. Subject A had been wearing cotton slacks of a dark green color, which she had rolled up above her knees, and a sleeveless shirt. No burns were inflicted on any part of her body that was covered by clothing. She stated that she suffered no ill effects other than the burns. Persons working in the 12-ft (3⅔-m) T-section of the tunnel suffered no injuries. A woman working at spot *X* (Fig. 7) was facing the entrance and was burned on the face, arms, and upper part of the chest, but she recovered and suffered no aftereffects. All of the persons outside of the shelter died as a result of severe burns.

Subjects B, C, and D, with about 20 other persons, were working on another shelter, located in a steep earth bank 50 to 60 ft (15 to 18 m) high, about 600 yd (550 m) directly west of the center of the bomb impact. They were working in shifts of eight persons inside the shelter, with the rest outside at the time of the explosion. The layout of the shelter and the location of the persons in it at the time of the explosion are indicated in Fig. 8. Subject B, who was in charge of the group, was thrown backward against the wall of the tunnel and stunned for a brief time, but suffered no burns or other injuries. As soon as he was able, he went to investigate the condition of the people outside and found all of them badly burned. Some of them had been able to walk or crawl into one of the shelter entrances. Realizing that he could do nothing for them, he went back into the shelter to do what he could for those inside. (All the persons outside the shelter either died instantly or within a 2-day period.) Subjects C and D were both knocked over by the blast and stunned for a short time. The only possible manifestation of radiation effect suffered by subject C was gingivitis (bleeding of the gums). Subject D was reported as having suffered no ill effects. The persons whose locations are indicated by *X* (Fig. 8) were burned on the back, and some swelling was noted, but both of them have recovered with no apparent ill effects. The persons whose location is indicated by *O* suffered no injuries. All of the subjects saw a flash and indicated that the blast was very hot. When they attempted to go out of the shelter, the whole area was enveloped in a black or gray smoke through which they could see flames shooting high into the air.

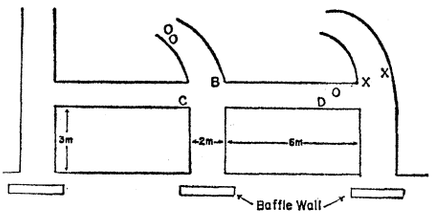

Fig. 8. Diagram of another tunnel in Nagasaki. *B*, *C*, *D*, subjects interviewed; *X*, casualties; *O*, uninjured persons.

It was the opinion of the subjects interviewed and of civilian defense officials questioned that if the people had taken the proper position in these two tunnel shelters—not in the entrance—most of them would have suffered little or no injury.

This report has been presented to emphasize the need for immediate reaction to adequate warning systems and proper safety measures in case of nuclear attack. The injuries, the effects of fallout or residual radiation—in fact, all the tragic aftereffects—have been well described in numerous studies and releases published since 1945. Perhaps the mounting volume of such information has developed in the public a sense of inadequacy and a fatalistic attitude regarding the need for civil defense. Still, thousands of people did survive in Japan, and many more would have lived if proper warnings had been given and acted upon.

I believe in the necessity of achieving the most reliable and accurate warning system that can be devised, and in generating the complete confidence, cooperation, and response of the populace to this system. Irrespective of the protective measures devised, the shelters prepared and identified, and the instructions issued, the immediate and unquestioning compliance of the individual with safety procedures will be the greatest factor in survival. The achievement of this end must be one of the most important concerns of our age.

FRANCIS X. LYNCH
Atomic Bomb Unit,
Armed Forces Institute of Pathology,
Washington, D.C. 20305

References

1. A. W. Oughterson, G. V. LeRoy, A. A. Liebow, E. C. Hammond, H. L. Barnett, J. D. Rosenbaum, B. A. Schneider, *Medical Report of the Joint Commission for the Investigation of the Effects of the Atomic Bomb in Japan*, unpublished portions, vols. 1–6.
2. This information is available in the 1962 edition of the Atomic Energy Commission's report, *The Effects of Nuclear Weapons* (AEC, Washington, D.C., 1962).
3. Report of the British Mission to Japan, *The Effects of the Atomic Bombs at Hiroshima and Nagasaki* (His Majesty's Stationery Office, London, 1946).

15 August 1963

Eocene Epiphyllous Fungi

Abstract. *Fossil fungi belonging to the Meliolaceae and Microthyriaceae were found in Eocene deposits in Tennessee. Germinated spores for each form of fungus were identified. One of the two forms of the genus* Meliola, *(Meliolaceae) appears to have parasitized the leaf upon which it grew. The vegetative, sexual, and asexual reproductive structures are preserved in a member of the genus* Asterina *(Microthyriaceae). The discovery of these fungi indicates that Western Tennessee was warm and humid during the Eocene.*

Fossil leaves from lower Eocene clay deposits in Tennessee contain epiphyllous fungi, including members of the families Meliolaceae and Microthyriaceae. This is the first record of these families from fossil deposits in the Western Hemisphere. Both have previously been found in Eocene deposits in Germany (*1*) and Scotland (*2*) and in Oligocene-Miocene deposits