

Hiroshima

By John Hersey

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Contents

Hiroshima

A Noiseless Flash.	1
The Fire	9
Details Are Being Investigated	22
Panic Grass and Feverfew.	35

An Eyewitness Account

By Father John A. Siemes.	49
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The Atomic Bombings Of Hiroshima And Nagasaki

Introduction	60
The Manhattan Project Atomic Bomb Investigating Group	60
Propaganda	61
Summary Of Damages And Injuries	62
Main Conclusions.	63
The Selection Of The Target.	64
Description Of The Cities Before The Bombings.	66
The Attacks	67
General Comparison Of Hiroshima And Nagasaki	69
Description Of Damage Caused By The Atomic Explosions.	70
Total Casualties	76
The Nature Of An Atomic Explosion	78
Characteristics Of The Damage Caused By The Bombs	80
Calculations Of The Peak Pressure Of The Blast Wave.	81
Long Range Blast Damage	82
Ground Shock	82
Shielding, Or Screening From Blast	83
Flash Burn.	84
Characteristics Of The Injuries To Persons	86
Burns	86
Mechanical Injuries.	87
Blast Injuries	87
Radiation Injuries	88
Shielding From Radiation	91
The Effects On The Inhabitants Of The Bombed Cities	91

Worldwide Effects Of Nuclear War

Introduction	93
The Mechanics Of Nuclear Explosions	95
Radioactive Fallout	95
Alterations Of The Global Environment.	98
Some Conclusions	101
Notes	102

Quotations

A Few Selected Quotes Of John Hersey	105
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Chapter One

A Noiseless Flash

At exactly fifteen minutes past eight in the morning, on August 6, 1945, Japanese time, at the moment when the atomic bomb flashed above Hiroshima, Miss Toshiko Sasaki, a clerk in the personnel department of the East Asia Tin Works, had just sat down at her place in the plant office and was turning her head to speak to the girl at the next desk. At that same moment, Dr. Masakazu Fujii was settling down cross-legged to read the Osaka Asahi on the porch of his private hospital, overhanging one of the seven deltaic rivers which divide Hiroshima; Mrs. Hatsuyo Nakamura, a tailor's widow, stood by the window of her kitchen, watching a neighbor tearing down his house because it lay in the path of an air-raid-defense fire lane; Father Wilhelm Kleinsorge, a German priest of the Society of Jesus, reclined in his underwear on a cot on the top floor of his order's three-story mission house, reading a Jesuit magazine, *Stimmen der Zeit*; Dr. Terufumi Sasaki, a young member of the surgical staff of the city's large, modern Red Cross Hospital, walked along one of the hospital corridors with a blood specimen for a Wassermann test in his hand; and the Reverend Mr. Kiyoshi Tanimoto, pastor of the Hiroshima Methodist Church, paused at the door of a rich man's house in Koi, the city's western suburb, and prepared to unload a handcart full of things he had evacuated from town in fear of the massive B-29 raid which everyone expected Hiroshima to suffer. A hundred thousand people were killed by the atomic bomb, and these six were among the survivors. They still wonder why they lived when so many others died, Each of them counts many small items of chance or volition—a step taken in time, a decision to go in-doors, catching one streetcar instead of the next— that spared him. And now each knows that in the act of survival he lived a dozen lives and saw more death than he ever thought he would see. At the time, none of them knew anything.

The Reverend Mr. Tanimoto got up at five o'clock that morning. He was alone in the parsonage, because for some time his wife had been commuting with their year-old baby to spend nights with a friend in Ushida, a suburb to the north. Of all the important cities of Japan, only two, Kyoto and Hiroshima, had not been visited in strength by B-san, or Mr. B, as the Japanese, with a mixture of respect and unhappy familiarity, called the B-29; and Mr. Tanimoto, like all his neighbors and friends, was almost sick with anxiety. He had heard uncomfortably detailed accounts of mass raids on Kure, Iwakuni, Tokuyama, and other nearby towns; he was sure Hiroshima's turn would come soon. He had slept badly the night before, because there had been several air-raid warnings. Hiroshima had been getting such warnings almost every night for weeks, for at that time the B-29s were using Lake Biwa, northeast of Hiroshima, as a rendezvous point, and no matter what city the Americans planned to hit, the Superfortresses streamed in over the coast near Hiroshima. The frequency

of the warnings and the continued abstinence of Mr. B with respect to Hiroshima had made its citizens jittery; a rumor was going around that the Americans were saving something special for the city.

Mr. Tanimoto is a small man, quick to talk, laugh, and cry. He wears his black hair parted in the middle and rather long; the prominence of the frontal bones just above his eyebrows and the smallness of his mustache, mouth, and chin give him a strange, old-young look, boyish and yet wise, weak and yet fiery. He moves nervously and fast, but with a restraint which suggests that he is a cautious, thoughtful man. He showed, indeed, just those qualities in the uneasy days before the bomb fell. Besides having his wife spend the nights in Ushida, Mr. Tanimoto had been carrying all the portable things from his church, in the close-packed residential district called Nagaragawa, to a house that belonged to a rayon manufacturer in Koi, two miles from the center of town. The rayon man, a Mr. Matsui, had opened his then unoccupied estate to a large number of his friends and acquaintances, so that they might evacuate whatever they wished to a safe distance from the probable target area, Mr. Tanimoto had had no difficulty in moving chairs, hymnals, Bibles, altar gear, and church records by pushcart himself, but the organ console and an upright piano required some aid. A friend of his named Matsuo had, the day before, helped him get the piano out to Koi; in return, he had promised this day to assist Mr. Matsuo in hauling out a daughter's belongings. That is why he had risen so early.

Mr. Tanimoto cooked his own breakfast. He felt awfully tired. The effort of moving the piano the day before, a sleepless night, weeks of worry and unbalanced diet, the cares of his parish—all combined to make him feel hardly adequate to the new day's work. There was another thing, too: Mr. Tanimoto had studied theology at Emory College, in Atlanta, Georgia; he had graduated in 1940; he spoke excellent English; he dressed in American clothes; he had corresponded with many American friends right up to die time the war began; and among a people obsessed with a fear of being spied upon—perhaps almost obsessed himself—he found himself growing increasingly uneasy. The police had questioned him several times, and just a few days before, he had heard that an influential acquaintance, a Mr. Tanaka, a retired officer of the Toyo Kisen Kaisha steamship line, an anti-Christian, a man famous in Hiroshima for his showy philanthropies and notorious for his personal tyrannies, had been telling people that Tanimoto should not be trusted. In compensation, to show himself publicly a good Japanese, Mr. Tanimoto had taken on the chairmanship of his local *tonarigumi*, or Neighborhood Association, and to his other duties and concerns this position had added the business of organizing air-raid defense for about twenty families,

Before six o'clock that morning, Mr. Tanimoto started for Mr. Matsuo's house. There he found that their burden was to be a *tansu*, a large Japanese cabinet, full of clothing and household goods. The two men set out, The morning was perfectly clear and so warm that the day promised to be uncomfortable. A few minutes after they started, the air-raid siren went off—a minute-long blast that warned of approaching planes but indicated to the people of Hiroshima only a slight degree of danger, since it sounded every morning at this time, when an American weather plane came over. The two men pulled and pushed the handcart through the city streets. Hiroshima was a fan-shaped city, lying mostly on the six islands

formed by the seven estuarial rivers that branch out from the Ota River] its main commercial and residential districts, covering about four square miles in the center of the city, contained three-quarters of its population, which had been reduced by several evacuation programs from a wartime peak of 380,000 to about 245,000. Factories and other residential districts, or suburbs, lay compactly around the edges of the city. To the south were the docks, an airport, and the island-studded Inland Sea. A rim of mountains runs around the other three sides of the delta, Mr. Tanimoto and Mr. Matsuo took their way through the shopping center, already full of people, and across two of the rivers to the sloping streets of Koi, and up them to the outskirts and foothills. As they started up a valley away from the tight-ranked houses, the all-clear sounded, (The Japanese radar operators, detecting only three planes, supposed that they comprised a reconnaissance.) Pushing the handcart up to the rayon man's house was tiring, and the men, after they had maneuvered their load into the driveway and to the front steps, paused to rest awhile. They stood with a wing of the house between them and the city. Like most homes in this part of Japan, the house consisted of a wooden frame and wooden walls supporting a heavy tile roof. Its front hall, packed with rolls of bedding and clothing, looked like a cool cave full of fat cushions. Opposite the house, to the right of the front door, there was a large, finicky rock garden. There was no sound of planes. The morning was still; the place was cool and pleasant.

Then a tremendous flash of light cut across the sky. Mr. Tanimoto has a distinct recollection that it travelled from east to west, from the city toward the hills. It seemed a sheet of sun. Both he and Mr. Matsuo reacted in terror—and both had time to react (for they were 3,500 yards, or two miles, from the center of the explosion). Mr. Matsuo dashed up the front steps into the house and dived among the bedrolls and buried himself there. Mr. Tanimoto took four or five steps and threw himself between two big rocks in the garden. He bellied up very hard against one of them. As his face was against the stone, he did not see what happened. He felt a sudden pressure, and then splinters and pieces of board and fragments of tile fell on him. He heard no roar. (Almost no one in Hiroshima recalls hearing any noise of the bomb. But a fisherman in his sampan on the Inland Sea near Tsuzu, the man with whom Mr. Tanimoto's mother-in-law and sister-in-law were living, saw the flash and heard a tremendous explosion; he was nearly twenty miles from Hiroshima, but the thunder was greater than when the B-29s hit Iwakuni, only five miles away.)

When he dared, Mr. Tanimoto raised his head and saw that the rayon man's house had collapsed. He thought a bomb had fallen directly on it. Such clouds of dust had risen that there was a sort of twilight around. In panic, not thinking for the moment of Mr. Matsuo under the ruins, he dashed out into the street. He noticed as he ran that the concrete wall of the estate had fallen over—toward the house rather than away from it. In the street, the first thing he saw was a squad of soldiers who had been burrowing into the hillside opposite, making one of the thousands of dugouts in which the Japanese apparently intended to resist invasion, hill by hill, life for life; the soldiers were coming out of the hole, where they should have been safe, and blood was running from their heads, chests, and backs. They were silent and dazed.

Under what seemed to be a local dust cloud, the day grew darker and

darker.

At nearly midnight, the night before the bomb was dropped, an announcer on the city's radio station said that about two hundred B-29s were approaching southern Honshu and advised the population of Hiroshima to evacuate to their designated "safe areas," Mrs. Hatsuyo Nakamura, the tailor's widow, who lived in the section called Nobori-cho and who had long had a habit of doing as she was told, got her three children—a ten-year-old boy, Toshio, an eight-year-old girl, Yaeko, and a five-year-old girl, Myeko—out of bed and dressed them and walked with them to the military area known as the East Parade Ground, on the northeast edge of the city. There she unrolled some mats and the children lay down on them. They slept until about two, when they were awakened by the roar of the planes going over Hiroshima.

As soon as the planes had passed, Mrs. Nakamura started back with her children. They reached home a little after two-thirty and she immediately turned on the radio, which, to her distress, was just then broadcasting a fresh warning. When she looked at the children and saw how tired they were, and when she thought of the number of trips they had made in past weeks, all to no purpose, to the East Parade Ground, she decided that in spite of the instructions on the radio, she simply could not face starting out all over again. She put the children in their bedrolls on the floor, lay down herself at three o'clock, and fell asleep at once, so soundly that when the planes passed over later, she did not waken to their sound,

The siren jarred her awake at about seven. She arose, dressed quickly, and hurried to the house of Mr. Nakamoto, the head of her Neighborhood Association, and asked him what she should do. He said that she should remain at home unless an urgent warning—a series of intermittent blasts of the siren —was sounded. She returned home, lit the stove in the kitchen, set some rice to cook, and sat down to read that morning's Hiroshima Chugoku. To her relief, the all-clear sounded at eight o'clock. She heard the children stirring, so she went and gave each of them a handful of peanuts and told them to stay on their bedrolls, because they were tired from the night's walk. She had hoped that they would go back to sleep, but the man in the house directly to the south began to make a terrible hullabaloo of hammering, wedging, ripping, and splitting. The prefectural government, convinced, as everyone in Hiroshima was, that the city would be attacked soon, had begun to press with threats and warnings for the completion of wide fire lanes, which, it was hoped, might act in conjunction with the rivers to localize any fires started by an incendiary raid; and the neighbor was reluctantly sacrificing his home to the city's safety. Just the day before, the prefecture had ordered all able-bodied girls from the secondary schools to spend a few days helping to clear these lanes, and they started work soon after the all-clear sounded

Mrs. Nakamura went back to the kitchen, looked at the rice, and began watching the man next door. At first, she was annoyed with him for making so much noise, but then she was moved almost to tears by pity. Her emotion was specifically directed toward her neighbor, tearing down his home, board by board, at a time when there was so much unavoidable destruction, but undoubtedly she also felt a generalized, community pity, to say nothing of self-pity. She had not had an easy time. Her husband, Isawa, had gone into the Army just after Myeko was born, and she had heard nothing from or of him for a long time, until, on March 5, 1942,

she received a seven-word telegram: "Isawa died an honorable death at Singapore," She learned later that he had died on February 15th, the day Singapore fell, and that he had been a corporal. Isawa had been a not particularly prosperous tailor, and his only capital was a Sankoku sewing machine. After his death, when his allotments stopped coming, Mrs. Nakamura got out the machine and began to take in piecework herself, and since then had supported the children, but poorly, by sewing,

As Mrs. Nakamura stood watching her neighbor, everything flashed whiter than any white she had ever seen. She did not notice what happened to the man next door; the reflex of a mother set her in motion toward her children. She had taken a single step (the house was 1,350 yards, or three-quarters of a mile, from the center of the explosion) when something picked her up and she seemed to fly into the next room over the raised sleeping platform, pursued by parts of her house.

Timbers fell around her as she landed, and a shower of tiles pommelled her; everything became dark, for she was buried. The debris did not cover her deeply. She rose up and freed herself. She heard a child cry, "Mother, help me!" and saw her youngest—Myeko, the five-year-old—buried up to her breast and unable to move. As Mrs. Nakamura started frantically to claw her way toward the baby, she could see or hear nothing of her other children,

In the days right before the bombing, Dr. Masakazu Fujii, being prosperous, hedonistic, and at the time not too busy, had been allowing himself the luxury of sleeping until nine or nine-thirty, but fortunately he had to get up early the morning the bomb was dropped to see a house guest off on a train. He rose at six, and half an hour later walked with his friend to the station, not far away, across two of the rivers. He was back home by seven, just as the siren sounded its sustained warning. He ate breakfast and then, because the morning was already hot, undressed down to his underwear and went out on the porch to read the paper. This porch—in fact, the whole building—was curiously constructed, Dr. Fujii was the proprietor of a peculiarly Japanese institution: a private, single-doctor hospital. This building, perched beside and over the water of the Kyo River, and next to the bridge of the same name, contained thirty rooms for thirty patients and their kinfolk—for, according to Japanese custom, when a person falls sick and goes to a hospital, one or more members of his family go and live there with him, to cook for him, bathe, massage, and read to him, and to offer incessant familial sympathy, without which a Japanese patient would be miserable indeed, Dr. Fujii had no beds—only straw mats—for his patients. He did, however, have all sorts of modern equipment: an X-ray machine, diathermy apparatus, and a fine tiled laboratory. The structure rested two-thirds on the land, one-third on piles over the tidal waters of the Kyo. This overhang, the part of the building where Dr. Fujii lived, was queer-looking, but it was cool in summer and from the porch, which faced away from the center of the city, the prospect of the river, with pleasure boats drifting up and down it, was always refreshing. Dr. Fujii had occasionally had anxious moments when the Ota and its mouth branches rose to flood, but the piling was apparently firm enough and the house had always held.

Dr. Fujii had been relatively idle for about a month because in July, as the number of untouched cities in Japan dwindled and as Hiroshima seemed more and more inevitably a target, he began turning patients away, on the

ground that in case of a fire raid he would not be able to evacuate them, Now he had only two patients left—a woman from Yano, injured in die shoulder, and a young man of twenty-five recovering from burns he had suffered when the steel factory near Hiroshima in which he worked had been bit. Dr. Fujii had six nurses to tend his patients. His wife and children were safe; his wife and one son were living outside Osaka, and an-other son and two daughters were in the country on Kyushu. A niece was living with him, and a maid and a manservant. He had little to do and did not mind, for he had saved some money. At fifty, he was healthy, convivial, and calm, and he was pleased to pass the evenings drinking whiskey with friends, always sensibly and for the sake of conversation, Before the war, he had affected brands imported from Scotland and America; now he was perfectly satisfied with the best Japanese brand, *Suntory*.

Dr. Fujii sat down cross-legged in his underwear on the spotless matting of the porch, put on his glasses, and started reading the Osaka *Asahi*. He liked to read the Osaka news because his wife was there. He saw the flash. To him—faced away from the center and looking at his paper—it seemed a brilliant yellow. Startled, he began to rise to his feet. In that moment (he was 1,550 yards from the center), the hospital leaned behind his rising and, with a terrible ripping noise, toppled into the river. The Doctor, still in the act of getting to his feet, was thrown forward and around and over; he was buffeted and gripped; he lost track of everything, be-cause things were so speeded up; he felt the water.

Dr. Fujii hardly had time to think that he was dying before he realized that he was alive, squeezed tightly by two long timbers in a V across his chest, like a morsel suspended between two huge chop-sticks—held upright, so that he could not move, with his head miraculously above water and his torso and legs in it The remains of his hospital were all around him in a mad assortment of splintered lumber and materials for the relief of pain. His left shoulder hurt terribly, His glasses were gone.

Father Wilhelm Kleinsorge, of the Society of Jesus, was, on the morning of the explosion, in rather frail condition, The Japanese wartime diet had not sustained him, and he felt the strain of being a foreigner in an increasingly xenophobic Japan; even a German, since the defeat of the Fatherland, was unpopular. Father Kleinsorge had, at thirty-eight, the look of a boy growing too fast—thin in the face, with a prominent Adam's apple, a hollow chest, dangling hands, big feet. He walked clumsily, leaning forward a little. He was tired all the time, To make matters worse, he had suffered for two days, along with Father Cieslik, a fellow-priest, from a rather painful and urgent diarrhea, which they blamed on the beans and black ration bread they were obliged to eat. Two other priests then living in the mission compound, which was in the Nobori-cho section—Father Superior LaSalle and Father Schiffer—had happily escaped this affliction.

Father Kleinsorge woke up about six the morning the bomb was dropped, and half an hour later-he was a bit tardy because of his sickness-he began to read Mass in the mission chapel, a small Japanese-style wooden building which was without pews, since its worshippers knelt on the usual Japanese matted floor, facing an altar graced with splendid silks, brass, silver, and heavy embroideries. This morning, a Monday, the only worshippers were Mr. Takemoto, a theological student living in the mission house; Mr. Fukai, the secretary of the diocese; Mrs. Murata, the mission's devoutly Christian housekeeper; and his fellow-priests. After Mass, while

Father Kleinsorge was reading the Prayers of Thanksgiving, the siren sounded. He stopped the service and the missionaries retired across the compound to the bigger building. There, in his room on the ground floor, to the right of the front door, Father Kleinsorge changed into a military uniform which he had acquired when he was teaching at the Rokko Middle School in Kobe and which he wore during air-raid alerts.

After an alarm, Father Kleinsorge always went out and scanned the sky, and in this instance, when he stepped outside, he was glad to see only the single weather plane that flew over Hiroshima each day about this time. Satisfied that nothing would happen, he went in and breakfasted with the other Fathers on substitute coffee and ration bread, which, under the circumstances, was especially repugnant to him. The Fathers sat and talked awhile, until, at eight, they heard the all-clear. They went then to various parts of the building. Father Schiffer retired to his room to do some writing. Father Cieslik sat in his room in a straight chair with a pillow over his stomach to ease his pain, and read. Father Superior LaSalle stood at the window of his room, thinking. Father Kleinsorge went up to a room on the third floor, took off all his clothes except his underwear, and stretched out on his right side on a cot and began reading his *Stimmen der Zeit*.

After the terrible flash—which, Father Kleinsorge later realized, reminded him of something he had read as a boy about a large meteor colliding with the earth—he had time (since he was 1,400 yards from the center) for one thought: A bomb has fallen directly on us. Then, for a few seconds or minutes, he went out of his mind.

Father Kleinsorge never knew how he got out of the house. The next things he was conscious of were that he was wandering around in the mission's vegetable garden in his underwear, bleeding slightly from small cuts along his left flank; that all the buildings round about had fallen down except the Jesuits' mission house, which had long before been braced and double-braced by a priest named Gropper, who was terrified of earthquakes; that the day had turned dark; and that Murata-san, the housekeeper, was nearby, crying over and over, "*Shu Jesusu, awaremi tama!* Our Lord Jesus, have pity on us!"

On the train on the way into Hiroshima from the country, where he lived with his mother, Dr. Terafumi Sasaki, the Red Cross Hospital surgeon, thought over an unpleasant nightmare he had had the night before. His mother's home was in Mukaihara, thirty miles from the city, and it took him two hours by train and tram to reach the hospital. He had slept uneasily all night and had wakened an hour earlier than usual, and, feeling sluggish and slightly feverish, had debated whether to go to the hospital at all; his sense of duty finally forced him to go, and he had started out on an earlier train than he took most mornings. The dream had particularly frightened him because it was so closely associated, on the surface at least, with a disturbing actuality. He was only twenty-five years old and had just completed his training at the Eastern Medical University, in Tsingtao, China. He was something of an idealist and was much distressed by the inadequacy of medical facilities in the country town where his mother lived. Quite on his own, and without a permit, he had begun visiting a few sick people out there in the evenings, after his eight hours at the hospital and four hours' commuting. He had recently learned that the penalty for practicing without a permit was severe; a fellow-doctor whom he had asked about it had given him a serious scolding. Nevertheless, he

had continued to practice. In his dream, he had been at the bedside of a country patient when the police and the doctor he had consulted burst into the room, seized him, dragged him outside, and beat him up cruelly. On the train, he just about decided to give up the work in Mukaihara, since he felt it would be impossible to get a permit, because the authorities would hold that it would conflict with his duties at the Red Cross Hospital.

At the terminus, he caught a streetcar at once. (He later calculated that if he had taken his customary train that morning, and if he had had to wait a few minutes for the streetcar, as often happened, he would have been close to the center at the time of the explosion and would surely have perished.) He arrived at the hospital at seven-forty and reported to the chief surgeon. A few minutes later, he went to a room on the first floor and drew blood from the arm of a man in order to perform a Wassermann test* The laboratory containing the incubators for the test was on the third floor,, With the blood specimen in his left hand, walking in a kind of distraction he had felt all morning, probably because of the dream and his restless night, he started along the main corridor on his way toward the stairs. He was one step beyond an open window when the light of the bomb was reflected, like a gigantic photographic flash, in the corridor. He ducked down on one knee and said to himself, as only a Japanese would, "Sasaki, *gambare!* Be brave!" Just then (the building was 1,650 yards from the center), the blast ripped through the hospital. The glasses he was wearing flew off his face; the bottle of blood crashed against one wall; his Japanese slippers zipped out from under his feet—but otherwise, thanks to where he stood, he was untouched, Dr. Sasaki shouted the name of the chief surgeon and rushed around to the man's office and found him terribly cut by glass. The hospital was in horrible confusion: heavy partitions and ceilings had fallen on patients, beds had overturned, windows had blown in and cut people, blood was spattered on the walls and floors, instruments were everywhere, many of the patients were running about screaming, many more lay dead. (A colleague working in the laboratory to which Dr. Sasaki had been walking was dead; Dr. Sasaki's patient, whom he had just left and who a few moments before had been dreadfully afraid of syphilis, was also dead,) Dr. Sasaki found himself the only doctor in the hospital who was unhurt,

Dr. Sasaki, who believed that the enemy had hit only the building he was in, got bandages and began to bind the wounds of those inside the hospital; while outside, all over Hiroshima, maimed and dying citizens turned their unsteady steps toward the Red Cross Hospital to begin an invasion that was to make Dr. Sasaki forget his private nightmare for a long, long time.

Miss Toshiko Sasaki, the East Asia Tin Works clerk, who is not related to Dr. Sasaki, got up at three o'clock in the morning on the day the bomb fell. There was extra housework to do. Her eleven-month-old brother, Akio, had come down the day before with a serious stomach upset; her mother had taken him to the Tamura Pediatric Hospital and was staying there with him. Miss Sasaki, who was about twenty, had to cook breakfast for her father, a brother, a sister, and herself, and—since the hospital, because of the war, was unable to provide food—to prepare a whole day's meals for her mother and the baby, in time for her father, who worked in a factory making rubber earplugs for artillery crews, to take the food by on his way to the plant. When she had finished and had cleaned and put

away the cooking things, it was nearly seven. The family lived in Koi, and she had a forty-five-minute trip to the tin works, in the section of town called Kannonmachi. She was in charge of the personnel records in the factory. She left Koi at seven, and as soon as she reached the plant, she went with some of the other girls from the personnel department to die factory auditorium, A prominent local Navy man, a former employee, had committed suicide the day before by throwing himself under a train—a death considered honorable enough to warrant a memorial service, which was to be held at the tin works at ten o'clock that morning- In the large hall, Miss Sasaki and the others made suitable preparations for the meeting. This work took about twenty minutes.

Miss Sasaki went back to her office and sat down at her desk. She was quite far from the windows, which were off to her left, and behind her were a couple of tall bookcases containing all the books of the factory library, which the personnel department had organized. She settled herself at her desk, put some things in a drawer, and shifted papers. She thought that before she began to make entries in her lists of new employees, discharges, and departures for the Army, she would chat for a moment with the girl at her right. Just as she turned her head away from the windows, the room was filled with a blinding light. She was paralyzed by fear, fixed still in her chair for a long moment (the plant was 1,600 yards from the center).

Everything fell, and Miss Sasaki lost consciousness. The ceiling dropped suddenly and the wooden floor above collapsed in splinters and the people up there came down and the roof above them gave way; but principally and first of all, the bookcases right behind her swooped forward and the contents threw her down, with her left leg horribly twisted and breaking underneath her. There, in the tin factory, in the first moment of the atomic age, a human being was crushed by books.

Chapter Two

The Fire

Immediately after die explosion, the Reverend Mr. Kiyoshi Tanimoto, having run wildly out of the Matsui estate and having looked in wonderment at the bloody soldiers at the mouth of the dugout they had been digging, attached himself sympathetically to an old lady who was walking along in a daze, holding her head with her left hand, supporting a small boy of three or four on her back with her right, and crying, "I'm hurt! I'm hurt! I'm hurt!" Mr. Tanimoto transferred the child to his own back and led the woman by the hand down the street, which was darkened by what seemed to be a local column of dust. He took the woman to a grammar school not far away that had previously been designated for use as a temporary hospital in case of emergency. By this solicitous behavior, Mr. Tanimoto at once got rid of his terror. At the school, he was much surprised to see glass all over the floor and fifty or sixty injured people already waiting to be treated. He reflected that, although the all-clear had sounded and he had heard no planes, several bombs must have been dropped. He thought of a hillock in the rayon man's garden from which he could get a view of the whole of Koi—of the whole of Hiroshima, for that matter—and he ran back up to the estate.

From the mound, Mr. Tanimoto saw an astonishing panorama. Not just a patch of Koi, as he had expected, but as much of Hiroshima as he could see through the clouded air was giving off a thick, dreadful miasma. Clumps of smoke, near and far, had begun to push up through the general dust, He wondered how such extensive damage could have been dealt out of a silent sky; even a few planes, far up, would have been audible. Houses nearby were burning, and when huge drops of water the size of marbles began to fall, he half thought that they must be coming from the hoses of firemen fighting the blazes, (They were actually drops of condensed moisture falling from the turbulent tower of dust, heat, and fission fragments that had already risen miles into the sky above Hiroshima.)

Mr. Tanimoto turned away from the sight when he heard Mr. Matsuo call out to ask whether he was all right Mr. Matsuo had been safely cushioned within the falling house by the bedding stored in the front hall and had worked his way out. Mr. Tanimoto scarcely answered,, He had thought of his wife and baby, his church, his home, his parishioners, all of them down in that awful murk. Once more he began to run in fear—toward the city.

Mrs. Hatsuyo Nakamura, the tailor's widow, having straggled up from under the ruins of her house after the explosion, and seeing Myeko, the youngest of her three children, buried breast-deep and unable to move, crawled across the debris, hauled at timbers, and flung tiles aside, in a hurried effort to free the child. Then, from what seemed to be caverns far below, she heard two small voices dying, "*Tasukete! Tasukete!* Help! Help!"

She called the names of her ten-year-old son and eight-year-old daughters "Toshio! Yaeko!"

The voices from below answered.

Mrs. Nakamura abandoned Myeko, who at least could breathe, and in a frenzy made the wreckage fly above the crying voices. The children had been sleeping nearly ten feet apart, but now their voices seemed to come from the same place. Toshio, the boy, apparently had some freedom to move, because she could feel him undermining the pile of wood and tiles as she worked from above. At last she saw his head, and she hastily pulled him out by it A mosquito net was wound intricately, as if it had been carefully wrapped, around his feet. He said he had been blown right across the room and had been on top of his sister Yaeko under the wreckage. She now said, from underneath, that she could not move, because there was something on her legs. With a bit more digging, Mrs. Nakamura cleared a hole above the child and began to pull her arm. "*Itai!* It hurts!" Yaeko cried. Mrs. Nakamura shouted, "There's no time now to say whether it hurts or not," and yanked her whimpering daughter up. Then she freed Myeko. The children were filthy and bruised, but none of them had a single cut or scratch.

Mrs. Nakamura took the children out into the street. They had nothing on but underpants, and although the day was very hot, she worried rather confusedly about their being cold, so she went back into the wreckage and burrowed underneath and found a bundle of clothes she had packed for an emergency, and she dressed them in pants, blouses, shoes, padded-cotton air-raid helmets called *bokuzuki*, and even, irrationally, overcoats. The children were silent, except for the five-year-old, Myeko, who kept asking

questions: "Why is it night already? Why did our house fall down? What happened?" Mrs. Nakamura, who did not know what had happened (had not the all-clear sounded?), looked around and saw through the darkness that all the houses in her neighborhood had collapsed, The house next door, which its owner had been tearing down to make way for a fire lane, was now very thoroughly, if crudely, torn down; its owner, who had been sacrificing his home for the community's safety, lay dead, Mrs. Nakamoto, wife of the head of the local air-raid-defense Neighborhood Association, came across the street with her head all bloody, and said that her baby was badly cut; did Mrs. Nakamura have any bandage? Mrs. Nakamura did not, but she crawled into the remains of her house again and pulled out some white cloth that she had been using in her work as a seamstress, ripped it into strips, and gave it to Mrs. Nakamoto.

While fetching the cloth, she noticed her sewing machine; she went back in for it and dragged it out. Obviously, she could not carry it with her, so she unthinkingly plunged her symbol of livelihood into the receptacle which for weeks had been her symbol of safety—the cement tank of water in front of her house, of the type every household had been ordered to construct against a possible fire raid.

A nervous neighbor, Mrs. Hataya, called to Mrs. Nakamura to run away with her to the woods in Asano Park—an estate, by the Kyo River not far off, belonging to the wealthy Asano family, who once owned the Toyo Kisen Kaisha steamship line. The park had been designated as an evacuation area for their neighborhood. Seeing fire breaking out in a nearby ruin (except at the very center, where the bomb itself ignited some fires, most of Hiroshima's citywide conflagration was caused by inflammable wreckage falling on cook stoves and live wires), Mrs. Nakamura suggested going over to fight it, Mrs. Hataya said, "Don't be foolish. What if planes come and drop more bombs?" So Mrs. Nakamura started out for Asano Park with her children and Mrs. Hataya, and she carried her rucksack of emergency clothing, a blanket, an umbrella, and a suit-case of things she had cached in her air-raid shelter. Under many ruins, as they hurried along, they heard muffled screams for help. The only building they saw standing on their way to Asano Park was the Jesuit mission house, alongside the Catholic kindergarten to which Mrs. Nakamura had sent Myeko for a time. As they passed it, she saw Father Kleinsorge, in bloody underwear, running out of the house with a small suitcase in his hand.

Right after the explosion, while Father Wilhelm Kleinsorge, S. J., was wandering around in his under-wear in the vegetable garden, Father Superior LaSalle came around the corner of the building in the darkness. His body, especially his back, was bloody; the flash had made him twist away from his window, and tiny pieces of glass had flown at him. Father Kleinsorge, still bewildered, managed to ask, "Where are the rest?" Just then, the two other priests living in the mission house appeared—Father Cieslik, unhurt, supporting Father Schiffer, who was covered with blood that spurted from a cut above his left ear and who was very pale. Father Cieslik was rather pleased with himself, for after the flash he had dived into a doorway, which he had previously reckoned to be the safest place inside the building, and when the blast came, he was not injured., Father LaSalle told Father Cieslik to take Father Schiffer to a doctor before he bled to death, and suggested either Dr. Kanda, who lived on the next corner, or Dr. Fujii, about six blocks away, The two men went out of the compound

and up the street.

The daughter of Mr. Hoshijima, the mission catechist, ran up to Father Kleinsorge and said that her mother and sister were buried under the ruins of their house, which was at the back of the Jesuit compound, and at the same time the priests noticed that the house of the Catholic kindergarten teacher at the front of the compound had collapsed on her. While Father LaSalle and Mrs. Murata, the mission housekeeper, dug the teacher out, Father Kleinsorge went to the catechist's fallen house and began lifting things off the top of the pile. There was not a sound underneath; he was sure the Hoshijima women had been killed. At last, under what had been a corner of the kitchen, he saw Mrs. Hoshijima's head. Believing her dead, he began to haul her out by the hair, but suddenly she screamed, "*Itai! Itai!* It hurts! It hurts!" He dug some more and lifted her out. He managed, too, to find her daughter in the rubble and free her. Neither was badly hurt.

A public bath next door to the mission house had caught fire, but since there the wind was southerly, the priests thought their house would be spared. Nevertheless, as a precaution, Father Kleinsorge went inside to fetch some things he wanted to save. He found his room in a state of wierd and illogical confusion. A first-aid kit was hanging undisturbed on a hook on the wall, but his clothes, which had been on other hooks nearby, were nowhere to be seen. His desk was in splinters all over the room, but a mere papier-mache suitcase, which he had hidden under the desk, stood handle-side up, with-out a scratch on it, in the doorway of the room, where he could not miss it. Father Kleinsorge later came to regard this as a bit of Providential interference, inasmuch as the suitcase contained his breviary, the account books for the whole diocese, and a considerable amount of paper money belonging to the mission, for which he was responsible. He ran out of the house and deposited the suitcase in the mission air-raid shelter.

At about this time, Father Cieslik and Father Schiffer, who was still spurting blood, came back and said that Dr. Kanda's house was ruined and that fire blocked them from getting out of what they supposed to be the local circle of destruction to Dr. Fujii's private hospital, on the bank of the Kyo River.

Dr. Masakazu Fujii's hospital was no longer on the bank of the Kyo River; it was in the river. After the overturn, Dr. Fujii was so stupefied and so tightly squeezed by the beams gripping his chest that he was unable to move at first, and he hung there about twenty minutes in the darkened morning. Then a thought which came to him—that soon the tide would be running in through the estuaries and his head would be submerged—inspired him to fearful activity; he wriggled and turned and exerted what strength he could (though his left arm, because of the pain in his shoulder, was useless), and before long he had freed himself from the vise. After a few moments' rest, he climbed onto the pile of timbers and, finding a long one that slanted up to the river-bank, he painfully shinnied up it.

Dr. Fujii, who was in his underwear, was now soaking and dirty. His undershirt was torn, and blood ran down it from bad cuts on his chin and back. In this disarray, he walked out onto Kyo Bridge, beside which his hospital had stood. The bridge had not collapsed. He could see only fuzzily without his glasses, but he could see enough to be amazed at the number of houses that were down all around. On the bridge, he encountered a

friend, a doctor named Machii, and asked in bewilderment, "What do you think it was?"

Dr. Machii said, "It must have been a *Molotoffano hanakago*"—a Molotov flower basket, the delicate Japanese name for the "bread basket," or self-scattering cluster of bombs.

At first, Dr. Fujii could see only two fires, one across the river from his hospital site and one quite far to the south. But at the same time, he and his friend observed something that puzzled them, and which, as doctors, they discussed: although there were as yet very few fires, wounded people were hurrying across the bridge in an endless parade of misery, and many of them exhibited terrible burns on their faces and arms. "Why do you suppose it is?" Dr. Fujii asked. Even a theory was comforting that day, and Dr. Machii stuck to his. "Perhaps be-cause it was a Molotov flower basket," he said.

There had been no breeze earlier in the morning when Dr. Fujii had walked to the railway station to see his friend off, but now brisk winds were blowing every which way; here on the bridge the wind was easterly. New fires were leaping up, and they spread quickly, and in a very short time terrible blasts of hot air and showers of cinders made it impossible to stand on the bridge any more. Dr. Machii ran to the far side of the river and along a still unkindled street. Dr. Fujii went down into the water under the bridge, where a score of people had already taken refuge, among them his servants, who had extricated themselves from the wreckage. From there, Dr. Fujii saw a nurse hanging in die timbers of his hospital by her legs, and then another painfully pinned across the breast. He enlisted the help of some of the others under the bridge and freed both of them. He thought he heard the voice of his niece for a moment, but he could not find her; he never saw her again. Four of his nurses and the two patients in the hospital died, too. Dr. Fujii went back into the water of the river and waited for the fire to subside.

The lot of Drs. Fujii, Kanda, and Machii right after the explosion—and, as these three were typical, that of the majority of the physicians and surgeons of Hiroshima—with their offices and hospitals destroyed, their equipment scattered, their own bodies incapacitated in varying degrees, explained why so many citizens who were hurt went untended and why so many who might have lived died. Of a hundred and fifty doctors in the city, sixty-five were already dead and most of the rest were wounded. Of 1,780 nurses, 1,654 were dead or too badly hurt to work. In the biggest hospital, that of the Red Cross, only six doctors out of thirty were able to function, and only ten nurses out of more than two hundred. The sole uninjured doctor on the Red Cross Hospital staff was Dr. Sasaki. After the explosion, he hurried to a storeroom to fetch bandages. This room, like everything he had seem as he ran through the hospital, was chaotic—bottles of medicines thrown off shelves and broken, salves spattered on the walls, instruments strewn every-where. He grabbed up some bandages and an unbroken bottle of mercurochrome, hurried back to the chief surgeon, and bandaged his cuts. Then he went out into the corridor and began patching up the wounded patients and the doctors and nurses there. He blundered so without his glasses that he took a pair off the face of a wounded nurse, and although they only approximately compensated for the errors of his vision, they were better than nothing. (He was to depend on them for more than a month.)

Dr. Sasaki worked without method, taking those who were nearest him first, and he noticed soon that the corridor seemed to be getting more and more crowded. Mixed in with the abrasions and lacerations which most people in the hospital had suffered, he began to find dreadful burns. He realized then that casualties were pouring in from outdoors. There were so many that he began to pass up the lightly wounded; he decided that all he could hope to do was to stop people from bleeding to death. Before long, patients lay and crouched on the floors of the wards and the laboratories and all the other rooms, and in the corridors, and on the stairs, and in the front hall, and under the *porte-cochère*, and on the stone front steps, and in the driveway and courtyard, and for blocks each way in the streets outside. Wounded people supported maimed people; disfigured families leaned together, many people were vomiting. A tremendous number of schoolgirls—some of those who had been taken from their classrooms to work outdoors, clearing fire lanes—crept into the hospital. In a city of two hundred and forty-five thousand, nearly a hundred thousand people had been killed or doomed at one blow; a hundred thousand more were hurt. At least ten thousand of the wounded made their way to the best hospital in town, which was altogether unequal to such a trampling, since it had only six hundred beds, and they had all been occupied. The people in the suffocating crowd inside the hospital wept and cried, for Dr. Sasaki to hear, "Sensei! Doctor!" and the less seriously wounded came and pulled at his sleeve and begged him to go to the aid of the worse wounded. Tugged here and there in his stockinged feet, bewildered by the numbers, staggered by so much raw flesh, Dr. Sasaki lost all sense of profession and stopped working as a skillful surgeon and a sympathetic man; he became an automaton, mechanically wiping, daubing, winding, wiping, daubing, winding.

Some of the wounded in Hiroshima were unable to enjoy the questionable luxury of hospitalization. In what had been the personnel office of the East Asia Tin Works, Miss Sasaki lay doubled over, unconscious, under the tremendous pile of books and plaster and wood and corrugated iron. She was wholly unconscious (she later estimated) for about three hours. Her first sensation was of dreadful pain in her left leg. It was so black under the books and debris that the borderline between awareness and unconsciousness was fine; she apparently crossed it several times, for the pain seemed to come and go. At the moments when it was sharpest, she felt that her leg had been cut off somewhere below the knee. Later, she heard someone walking on top of the wreckage above her, and anguished voices spoke up, evidently from within the mess around her "Please help! Get us out!"

Father Kleinsorge stemmed Father Schiffer's spurting cut as well as he could with some bandage that Dr. Fujii had given the priests a few days before. When he finished, he ran into the mission house again and found the jacket of his military uniform and an old pair of gray trousers. He put them on and went outside. A woman from next door ran up to him and shouted that her husband was buried under her house and the house was on fire; Father Kleinsorge must come and save him.

Father Kleinsorge, already growing apathetic and dazed in the presence of the cumulative distress, said, "We haven't much time." Houses all around were burning, and the wind was now blowing hard. "Do you know exactly which part of the house he is under?" he asked.

"Yes, yes," she said. "Come quickly."

They went around to the house, the remains of which blazed violently, but when they got there, it turned out that the woman had no idea where her husband was. Father Kleinsorge shouted several times, "Is anyone there?" There was no answer. Father Kleinsorge said to the woman, "We must get away or we will all die." He went back to the Catholic compound and told the Father Superior that the fire was coming closer on the wind, which had swung around and was now from the north; it was time for everybody to go.

Just then, the kindergarten teacher pointed out to the priests Mr. Fukai, the secretary of the diocese, who was standing in his window on the second floor of the mission house, facing in the direction of the explosion, weeping. Father Cieslik, because he thought the stairs unusable, ran around to the back of the mission house to look for a ladder. There he heard people crying for help under a nearby fallen roof. He called to passers-by running away in the street to help him lift it, but nobody paid any attention, and he had to leave the buried ones to die. Father Kleinsorge ran inside the mission house and scrambled up the stairs, which were awry and piled with plaster and lathing, and called to Mr. Fukai from the doorway of his room.

Mr. Fukai, a very short man of about fifty, turned around slowly, with a queer look, and said, "Leave me here."

Father Kleinsorge went into the room and took Mr. Fukai by the collar of his coat and said, "Come with me or you'll die."

Mr. Fukai said, "Leave me here to die."

Father Kleinsorge began to shove and haul Mr. Fukai out of the room. Then the theological student came up and grabbed Mr. Fukai's feet, and

Father Kleinsorge took his shoulders, and together they carried him downstairs and outdoors. "I can't walk!" Mr. Fukai cried "Leave me here!" Father Kleinsorge got his paper suitcase with the money in it and took Mr. Fukai up pickaback, and the party started for the East Parade Ground, their district's "safe area." As they went out of the gate, Mr. Fukai, quite childlike now, beat on Father Kleinsorge's shoulders and said, "I won't leave. I won't leave." Irrelevantly, Father Kleinsorge turned to Father LaSalle and said, "We have lost all our possessions but not our sense of humor."

The street was cluttered with parts of houses that had slid into it, and with fallen telephone poles and wires. From every second or third house came the voices of people buried and abandoned, who invariably screamed, with formal politeness, "*Tasukete kure!* Help, if you please!" The priests recognized several ruins from which these cries came as the homes of friends, but because of the fire it was too late to help. All the way, Mr. Fukai whimpered, "Let me stay." The party turned right when they came to a block of fallen houses that was one flame. At Sakai Bridge, which would take them across to the East Parade Ground, they saw that the whole community on the opposite side of the river was a sheet of fire; they dared not cross and decided to take refuge in Asano Park, off to their left. Father Kleinsorge, who had been weakened for a couple of days by his bad case of diarrhea, began to stagger under his protesting burden, and as he tried to climb up over the wreckage of several houses that blocked their way to the park, he stumbled, dropped Mr. Fukai, and plunged down,

head over heels, to the edge of the river. When he picked himself up, he saw Mr. Fukai running away. Father Kleinsorge shouted to a dozen soldiers, who were standing by the bridge, to stop him. As Father Kleinsorge started back to get Mr. Fukai, Father LaSalle called out, "Hurry! Don't waste time!" So Father Kleinsorge just requested the soldiers to take care of Mr. Fukai, They said they would, but the little, broken man got away from them, and the last the priests could see of him, he was running back toward the fire.

Mr. Tanimoto, fearful for his family and church, at first ran toward them by the shortest route, along Koi Highway. He was the only person making his way into the city; he met hundreds and hundreds who were fleeing, and every one of them seemed to be hurt in some way. The eyebrows of some were burned off and skin hung from their faces and hands. , Others, because of pain, held their arms up as if carrying something in both hands. Some were vomiting as they walked. Many were naked or in shreds of clothing. On some undressed bodies, the burns had made patterns—of undershirt straps and suspenders and, on the skin of some women (since white repelled the heat from the bomb and dark clothes absorbed it and conducted it to the skin), the shapes of flowers they had had on their kimonos. Many, although injured themselves, supported relatives who were worse off. Almost all had their heads bowed, looked straight ahead, were silent, and showed no expression whatever.

After crossing Koi Bridge and Kannon Bridge, having run the whole way, Mr. Tanimoto saw, as he approached the center, that all the houses had been crushed and many* were afire. Here the trees were bare and their trunks were charred. He tried at several points to penetrate the ruins, but the flames always stopped him. Under many houses, people screamed for help, but no one helped; in general, survivors that day assisted only their relatives or immediate neighbors, for they could not comprehend or tolerate a wider circle of misery. The wounded limped past the screams, and Mr. Tanimoto ran past them. As a Christian he was filled with compassion for those who were trapped, and as a Japanese he was overwhelmed by the shame of being unhurt, and he prayed as he ran, "God help them and take them out of the fire."

He thought he would skirt the fire, to the left. He ran back to Kannon Bridge and followed for a distance one of the rivers. He tried several cross streets, but all were blocked, so he turned far left and ran out to Yokogawa, a station on a railroad line that detoured the city in a wide semicircle, and he followed the rails until he came to a burning train. So impressed was he by this time by the extent of the damage that he ran north two miles to Gion, a suburb in the foothills. All the way, he overtook dreadfully burned and lacerated people, and in his guilt he turned to right and left as he hurried and said to some of them, "Excuse me for having no burden like yours." Near Gion, he began to meet country people going toward the city to help, and when they saw him, several exclaimed, "Look! There is one who is not wounded." At Gion, he bore toward the right bank of the main river, the Ota, and ran down it until he reached fire again. There was no fire on the other side of the river, so he threw off his shirt and shoes and plunged into it. In midstream, where the current was fairly strong, exhaustion and fear finally caught up with him—he had run nearly seven miles—and he became limp and drifted in the water. He prayed, "Please, God, help me to cross. It would be nonsense for me to be drowned when I am the only uninjured one." He managed a few more

strokes and fetched up on a spit downstream.

Mr. Tanimoto climbed up the bank and ran along it until, near a large Shinto shrine, he came to more fire, and as he turned left to get around it, he met, by incredible luck, his wife. She was carrying their infant son. Mr. Tanimoto was how so emotionally worn out that nothing could surprise him. He did not embrace his wife; he simply said, "Oh, you are safe." She told him that she had got home from her night in Ushida just in time for the explosion; she had been buried under the parsonage with the baby in her arms. She told how the wreckage had pressed down on her, how the baby had cried. She saw a chink of light, and by reaching up with a hand, she worked the hole bigger, bit by bit. After about half an hour, she heard the crackling noise of wood burning. At last the opening was big enough for her to push the baby out, and afterward she crawled out herself. She said she was now going out to Ushida again, Mr. Tanimoto said he wanted to see his church and take care of the people of his Neighborhood Association. They parted as casually—as bewildered—as they had met.

Mr. Tanimoto's way around the fire took him across the East Parade Ground, which, being an evacuation area, was now the scene of a gruesome review: rank on rank of the burned and bleeding. Those who were burned moaned, "*Mizu! mizu!* Water, water!" Mr. Tanimoto found a basin in a nearby street and located a water tap that still worked in the crushed shell of a house, and he began carrying water to the suffering strangers. When he had given drink to about thirty of them, he realized he was taking too much time. "Excuse me," he said loudly to those nearby who were reaching out their hands to him and crying their thirst. "I have many people to take care of." Then he ran away. He went to the river again, the basin in his hand, and jumped down onto a sandspit. There he saw hundreds of people so badly wounded that they could not get up to go farther from the burning city. When they saw a man erect and unhurt, the chant began again: "*Mizu, mizu, mizu!*" Mr. Tanimoto could not resist them; he carried them water from the river—a mistake, since it was tidal and brackish. Two or three small boats were ferrying hurt people across the river from Asano Park, and when one touched the spit, Mr. Tanimoto again made his loud, apologetic speech and jumped into the boat. It took him across to the park. There, in the underbrush, he found some of his charges of the Neighborhood Association, who had come there by his previous instructions, and saw many acquaintances, among them Father Kleinsorge and the other Catholics. But he missed Fukai, who had been a close friend. "Where is Fukai-san?" he asked.

"He didn't want to come with us," Father Kleinsorge said, "He ran back."

When Miss Sasaki heard the voices of the people caught along with her in the dilapidation at the tin factory, she began speaking to them. Her nearest neighbor, she discovered, was a high-school girl who had been drafted for factory work, and who said her back was broken. Miss Sasaki replied, "I am lying here and I can't move. My left leg is cut off,"

Some time later, she again heard somebody walk overhead and then move off to one side, and whoever it was began burrowing. The digger released several people, and when he had uncovered the high-school girl, she found that her back was not broken, after all, and she crawled out. Miss Sasaki spoke to the rescuer, and he worked toward her. He pulled away a great number of books, until he had made a tunnel to her. She could see his perspiring face as he said, "Come out, Miss." She tried. "I

can't move," she said. The man excavated some more and told her to try with all her strength to get out. But books were heavy on her hips, and the man finally saw that a bookcase was leaning on the books and that a heavy beam pressed down on the bookcase. "Wait," he said "I'll get a crowbar."

The man was gone a long time, and when he came back, he was ill-tempered, as if her plight were all her fault, "We have no men to help you!" he shouted in through the tunnel "You'll have to get out by yourself."

"That's impossible," she said. "My left leg . . ." The man went away.

Much later, several men came and dragged Miss Sasaki out. Her left leg was not severed, but it was badly broken and cut and it hung askew below the knee. They took her out into a courtyard. It was raining. She sat on the ground in the rain. When the downpour increased, someone directed all the wounded people to take cover in the factory's air-raid shelters. "Come along," a torn-up woman said to her. "You can hop." But Miss Sasaki could not move, and she just waited in the rain. Then a man propped up a large sheet of corrugated iron as a kind of lean-to, and took her in his arms and carried her to it. She was grateful until he brought two horribly wounded people—a woman with a whole breast sheared off and a man whose face was all raw from a burn—to share the simple shed with her. No one came back. The rain cleared and the cloudy afternoon was hot; before nightfall the three grotesques under the slanting piece of twisted iron began to smell quite bad.

The former head of the Nobori-cho Neighbor-hood Association to which the Catholic priests belonged was an energetic man named Yoshida. He had boasted, when he was in charge of the district air-raid defenses, that fire might eat away all of Hiroshima but it would never come to Nobori-cho. The bomb blew down his house, and a joist pinned him by the legs, in full view of the Jesuit mission house across the way and of the people hurrying along the street. In their confusion as they hurried past, Mrs. Nakamura, with her children, and Father Kleinsorge, with Mr. Fukai on his back, hardly saw him; he was just part of the general blur of misery through which they moved. His cries for help brought no response from them; there were so many people shouting for help that they could not hear him separately. They and all the others went along. Nobori-cho became absolutely deserted, and the fire swept through it, Mr. Yoshida saw the wooden mission house—the only erect building in the area—go up in a lick of flame, and the heat was terrific on his face. Then flames came along his side of the street and entered his house. In a paroxysm of terrified strength, he freed himself and ran down the alleys of Nobori-cho, hemmed in by the fire he had said would never come. He began at once to behave like an old man; two months later his hair was white,,

As Dr. Fujii stood in the river up to his neck to avoid the heat of the fire, the wind blew stronger and stronger, and soon, even though the expanse of water was small, the waves grew so high that the people under the bridge could no longer keep their footing. Dr. Fujii went close to the shore, crouched down, and embraced a large stone with his usable arm. Later it became possible to wade along the very-edge of the river, and Dr. Fujii and his two surviving nurses moved about two hundred yards upstream, to a sandspit near Asano Park. Many wounded were lying on the sand. Dr. Machii was there with his family; his daughter, who had been outdoors when the bomb burst, was badly burned on her hands and legs

but fortunately not on her face. Although Dr. Fujii's shoulder was by now terribly painful, he examined the girl's burns curiously. Then he lay down, In spite of the misery all around, he was ashamed of his appearance, and he remarked to Dr. Machii that he looked like a beggar, dressed as he was in nothing but torn and bloody underwear. Later in the afternoon, when the fire began to subside, he decided to go to his parental house, in the suburb of Nagatsuka. He asked Dr. Machii to join him, but the Doctor answered that he and his family were going to spend the night on the spit, because of his daughter's injuries. Dr. Fujii, together with his nurses, walked first to Ushida, where, in the partially damaged house of some relatives, he found first-aid materials he had stored there. The two nurses bandaged him and he them. They went on. Now not many people walked in the streets, but a great number sat and lay on the pavement, vomited, waited for death, and died. The number of corpses on the way to Nagatsuka was more and more puzzling. The Doctor wondered: Could a Molotov flower basket have done all this?

Dr. Fujii reached his family's house in the evening, It was five miles from the center of town, but its roof had fallen in and the windows were all broken.

All day, people poured into Asano Park This private estate was far enough away from the explosion so that its bamboos, pines, laurel, and maples were still alive, and the green place invited refugees —partly because they believed that if the Americans came back, they would bomb only buildings; partly because the foliage seemed a center of coolness and life, and the estate's exquisitely precise rock gardens, with their quiet pools and arching bridges, were very Japanese, normal, secure; and also partly (according to some who were there) because of an irresistible, atavistic urge to hide under leaves. Mrs. Nakamura and her children were among the first to arrive, and they settled in the bamboo grove near the river. They all felt terribly thirsty, and they drank from the river. At once they were nauseated and began vomiting, and they retched the whole day. Others were also nauseated; they all thought (probably because of the strong odor of ionization, an "electric smell" given off by the bomb's fission) that they were sick from a gas the Americans had dropped. When Father Kleinsorge and the other priests came into the park, nodding to their friends as they passed, the Nakamuras were all sick and prostrate. A woman named Iwasaki, who lived in the neighborhood of the mission and who was sitting near the Nakamuras, got up and asked the priests if she should stay where she was or go with them.

Father Kleinsorge said, "I hardly know where the safest place is," She stayed there, and later in the day, though she had no visible wounds or burns, she died. The priests went farther along the river and settled down in some underbrush. Father LaSalle lay down and went right to sleep. The theological student, who was wearing slippers, had carried with him a bundle of clothes, in which he had packed two pairs of leather shoes. When he sat down with the others, he found that the bundle had broken open and a couple of shoes had fallen out and now he had only two lefts. He retraced his steps and found one right. When he rejoined the priests, he said, "It's funny, but things don't matter any more. Yesterday, my shoes were my most important possessions. To-day, I don't care. One pair is enough."

Father Cieslik said, "I know. I started to bring my books along, and then

I thought, "This is no time for books."

When Mr. Tanimoto, with his basin still in his hand, reached the park, it was very crowded, and to distinguish the living from the dead was not easy, for most of the people lay still, with their eyes open. To Father Kleinsorge, an Occidental, the silence in the grove by the river, where hundreds of gruesomely wounded suffered together, was one of the most dreadful and awesome phenomena of his whole experience. The hurt ones were quiet; no one wept, much less screamed in pain; no one complained; none of the many who died did so noisily; not even the children cried; very few people even spoke. And when Father Kleinsorge gave water to some whose faces had been almost blotted out by flash burns, they took their share and then raised themselves a little and bowed to him, in thanks,

Mr. Tanimoto greeted the priests and then looked around for other friends. He saw Mrs. Matsumoto, wife of the director of the Methodist School, and asked her if she was thirsty. She was, so he went to one of the pools in the Asano's rock gardens and got water for her in his basin. Then he decided to try to get back to his church. He went into Nobori-cho by the way the priests had taken as they escaped, but he did not get far; the fire along the streets was so fierce that he had to turn back. He walked to the river bank and began to look for a boat in which he might carry some of the most severely injured across the river from Asano Park and away from the spreading fire. Soon he found a good-sized pleasure punt drawn up on the bank, but in and around it was an awful tableau—five dead men, nearly naked, badly burned, who must have expired more or less all at once, for they were in attitudes which suggested that they had been working together to push the boat down into the river. Mr. Tanimoto lifted them away from the boat, and as he did so, he experienced such horror at disturbing the dead—preventing them, he momentarily felt, from launching their craft and going on their ghostly way—that he said out loud, "Please forgive me for taking this boat. I must use it for others, who are alive," The punt was heavy, but he man-aged to slide it into the water. There were no oars, and all he could find for propulsion was a thick bamboo pole. He worked the boat upstream to the most crowded part of the park and began to ferry the wounded. He could pack ten or twelve into the boat for each crossing, but as the river was too deep in the center to pole his way across, he had to paddle with the bamboo, and consequently each trip took a very long time. He worked several hours that way,

Early in the afternoon, the fire swept into the woods of Asano Park, The first Mr. Tanimoto knew of it was when, returning in his boat, he saw that a great number of people had moved toward the riverside. On touching die bank, he went up to investigate, and when he saw the fire, he shouted, "All the young men who are not badly hurt come with me!" Father Kleinsorge moved Father Schiffer and Father LaSalle close to the edge of the river and asked people there to get them across if the fire came too near, and then joined Tanimoto's volunteers. Mr. Tanimoto sent some to look for buckets and basins and told others to beat the burning underbrush with their clothes; when utensils were at hand, he formed a bucket chain from one of the pools in the rock gardens. The team fought the fire for more than two hours, and gradually defeated the flames. As Mr. Tanimoto's men worked, the frightened people in the park pressed closer and closer to the river, and finally the mob began to force, some of the unfortunates who were on the very bank into the water. Among those driven into the

river and drowned were Mrs. Matsumoto, of the Methodist School, and her daughter,

When Father Kleinsorge got back after fighting the fire, he found Father Schiffer still bleeding and terribly pale. Some Japanese stood around and stared at him, and Father Schiffer whispered, with a weak smile, "It is as if I were already dead." "Not yet," Father Kleinsorge said. He had brought Dr. Fujii's first-aid kit with him, and he had noticed Dr. Kanda in the crowd, so he sought him out and asked him if he would dress Father Schiffer's bad cuts. Dr. Kanda had seen his wife and daughter dead in the ruins of his hospital; he sat now with his head in his hands. "I can't do anything," he said. Father Kleinsorge bound more bandage around Father Schiffer's head, moved him to a steep place, and settled him so that his head was high, and soon the bleeding diminished

The roar of approaching planes was heard about this time. Someone in the crowd near the Nakamura family shouted, "It's some Grummans coming to strafe us!" A baker named Nakashima stood up and commanded, "Everyone who is wearing anything white, take it off." Mrs. Nakamura took the blouses off her children, and opened her umbrella and made them get under it. A great number of people, even badly burned ones, crawled into bushes and stayed there until the hum, evidently of a reconnaissance or weather run, died away.

It began to rain. Mrs. Nakamura kept her children under the umbrella. The drops grew abnormally large, and someone shouted, "The Americans are dropping gasoline. They're going to set fire to us!" (This alarm stemmed from one of the theories being passed through the park as to why so much of Hiroshima had burned: it was that a single plane had sprayed gasoline on the city and then somehow set fire to it in one flashing moment.) But the drops were palpably water, and as they fell, the wind grew stronger and stronger, and suddenly—probably because of the tremendous convection set up by the blazing city—a whirlwind ripped through the park. Huge trees crashed down; small ones were uprooted and flew into the air. Higher, a wild array of flat things revolved in the twisting funnel—pieces of iron roofing, papers, doors, strips of matting. Father Kleinsorge put a piece of cloth over Father Schiffer's eyes, so that the feeble man would not think he was going crazy. The gale blew Mrs. Murata, the mission housekeeper, who was sitting close by the river, down the embankment at a shallow, rocky place, and she came out with her bare feet bloody. The vortex moved out onto the river, where it sucked up a waterspout and eventually spent itself.

After the storm, Mr. Tanimoto began ferrying people again, and Father Kleinsorge asked the theological student to go across and make his way out to the Jesuit Novitiate at Nagatsuka, about three miles from the center of town, and to request the priests there to come with help for Fathers Schiffer and LaSalle. The student got into Mr. Tanimoto's boat and went off with him. Father Kleinsorge asked Mrs. Nakamura if she would like to go out to Nagatsuka with the priests when they came. She said she had some luggage and her children were sick—they were still vomiting from time to time, and so, for that matter, was she—and therefore she feared she could not. He said he thought the fathers from the Novitiate could come back the next day with a pushcart to get her.

Late in the afternoon, when he went ashore for a while, Mr. Tanimoto, upon whose energy and initiative many had come to depend, heard people

begging for food. He consulted Father Kleinsorge, and they decided to go back into town to get some rice from Mr. Tanimoto's Neighborhood Association shelter and from the mission shelter. Father Cieslik and two or three others went with them. At first, when they got among the rows of prostrate houses, they did not know where they were; the change was too sudden, from a busy city of two hundred and forty-five thousand that morning to a mere pattern of residue in the afternoon. The asphalt of the streets was still so soft and hot from the fires that walking was uncomfortable. They encountered only one person, a woman, who said to them as they passed, "My husband is in those ashes." At the mission, where Mr. Tanimoto left the party, Father Kleinsorge was dismayed to see the building razed. In the garden, on the way to the shelter, he noticed a pumpkin roasted on the vine. He and Father Cieslik tasted it and it was good. They were surprised at their hunger, and they ate quite a bit. They got out several bags of rice and gathered up several other cooked pumpkins and dug up some potatoes that were nicely baked under the ground, and started back. Mr. Tanimoto rejoined them on the way. One of the people with him had some cooking utensils. In the park, Mr. Tanimoto organized the lightly wounded women of his neighborhood to cook. Father Kleinsorge offered the Nakamura family some pumpkin, and they tried it, but they could not keep it on their stomachs. Altogether, the rice was enough to feed nearly a hundred people.

Just before dark, Mr. Tanimoto came across a twenty-year-old girl, Mrs. Kamai, the Tanimotos' next-door neighbor. She was crouching on the ground with the body of her infant daughter in her arms. The baby had evidently been dead all day. Mrs. Kamai jumped up when she saw Mr. Tanimoto and said, "Would you please try to locate my husband?"

Mr. Tanimoto knew that her husband had been inducted into the Army just the day before; he and Mrs. Tanimoto had entertained Mrs. Kamai in the afternoon, to make her forget, Kamai had reported to the Chugoku Regional Army Headquarters—near the ancient castle in the middle of town—where some four thousand troops were stationed. Judging by the many maimed soldiers Mr. Tanimoto had seen during the day, he surmised that the barracks had been badly damaged by whatever it was that had hit Hiroshima. He knew he hadn't a chance of finding Mrs. Kamai's husband, even if he searched, but he wanted to humor her. "I'll try," he said.

"You've got to find him," she said. "He loved our baby so much. I want him to see her once more."

Chapter Three

Details Are Being Investigated

Early in the evening of the day the bomb exploded, a Japanese naval launch moved slowly up and down the seven rivers of Hiroshima, It stopped here and there to make an announcement —alongside the crowded sandspits, on which hundreds of wounded lay; at the bridges, on which others were crowded; and eventually, as twilight fell, opposite Asano Park A young officer stood up in the launch and shouted through a megaphone, "Be patient! A naval hospital ship is coming to take care of you!" The sight of the shipshape launch against the background of the havoc across the river; the unruffled young man in his neat uniform;

above all, the promise of medical help—the first word of possible succor anyone had heard in nearly twelve awful hours—cheered the people in the park tremendously. Mrs. Nakamura settled her family for the night with the assurance that a doctor would come and stop their retching. Mr. Tanimoto resumed ferrying the wounded across the river. Father Kleinsorge lay down and said the Lord's Prayer and a Hail Mary to himself, and fell right asleep; but no sooner had he dropped off than Mrs. Murata, the conscientious mission housekeeper, shook him and said, "Father Kleinsorge! Did you remember to repeat your evening prayers?" He answered rather grumpily, "Of course," and he tried to go back to sleep but could not. This, apparently, was just what Mrs. Murata wanted. She began to chat with the exhausted priest. One of the questions she raised was when he thought the priests from the Novitiate, for whom he had sent a messenger in mid-afternoon, would arrive to evacuate Father Superior LaSalle and Father Schiffer.

The Messenger Father Kleinsorge had sent—the theological student who had been living at the mission house—had arrived at the Novitiate, in the hills about three miles out, at half past four. The sixteen priests there had been doing rescue work in the out-skirts; they had worried about their colleagues in the city but had not known how or where to look for them. Now they hastily made two litters out of poles and boards, and the student led half a dozen of them back into the devastated area. They worked their way along the Ota above the city; twice the heat of the fire forced them into the river. At Misasa Bridge, they encountered a long line of soldiers making a bizarre forced march away from the Chugoku Regional Army Headquarters in the center of the town. All were grotesquely burned, and they supported themselves with staves or leaned on one another. Sick, burned horses, hanging their heads, stood on the bridge. When the rescue party reached the park, it was after dark, and progress was made extremely difficult by the tangle of fallen trees of all sizes that had been knocked down by the whirl-wind that afternoon. At last—not long after Mrs. Murata asked her question—they reached their friends, and gave them wine and strong tea.

The priests discussed how to get Father Schiffer and Father LaSalle out to the Novitiate. They were afraid that blundering through the park with them would jar them too much on the wooden litters, and that the wounded men would lose too much blood. Father Kleinsorge thought of Mr. Tanimoto and his boat, and called out to him on the river. When Mr. Tanimoto reached the bank, he said he would be glad to take the injured priests and their bearers upstream to where they could find a clear roadway. The rescuers put Father Schiffer onto one of the stretchers and lowered it into the boat, and two of them went aboard with it. Mr. Tanimoto, who still had no oars, poled the punt upstream.

About half an hour later, Mr. Tanimoto came back and excitedly asked the remaining priests to help him rescue two children he had seen standing up to their shoulders in the river. A group went out and picked them up—two young girls who had lost their family and were both badly burned. The priests stretched them on the ground next to Father Kleinsorge and then embarked Father LaSalle. Father Cieslik thought he could make it out to the Novitiate on foot, so he went aboard with the others. Father Kleinsorge was too feeble; he decided to wait in the park until the next day. He asked the men to come back with a handcart, so that they could take Mrs.

Nakamura and her sick children to the Novitiate,

Mr. Tanimoto shoved off again. As the boatload of priests moved slowly upstream, they heard weak cries for help. A woman's voice stood out especially: "There are people here about to be drowned! Help us! The water is rising!" The sounds came from one of the sandspits, and those in the punt could see, in the reflected light of the still-burning fires, a number of wounded people lying at the edge of the river, already partly covered by the flooding tide. Mr. Tanimoto wanted to help them, but the priests were afraid that Father Schiffer would die if they didn't hurry, and they urged their ferryman along. He dropped them where he had put Father Schiffer down and then started back alone toward the sand-spit.

The night was hot, and it seemed even hotter because of the fires against the sky, but the younger of the two girls Mr. Tanimoto and the priests had rescued complained to Father Kleinsorge that she was cold. He covered her with his jacket. She and her older sister had been in the salt water of the river for a couple of hours before being rescued. The younger one had huge, raw flesh burns on her body; the salt water must have been excruciatingly painful to her. She began to shiver heavily, and again said it was cold. Father Kleinsorge borrowed a blanket from someone nearby and wrapped her up, but she shook more and more, and said again, "I am so cold," and then she suddenly stopped shivering and was dead.

Mr. Tanimoto found about twenty men and women on the sandspit. He drove the boat onto the bank and urged them to get aboard. They did not move and he realized that they were too weak to lift themselves. He reached down and took a woman by the hands, but her skin slipped off in huge, glove-like pieces. He was so sickened by this that he had to sit down for a moment. Then he got out into the water and, though a small man, lifted several of the men and women, who were naked, into his boat. Their backs and breasts were clammy, and he remembered uneasily what the great burns he had seen during the day had been like: yellow at first, then red and swollen, with the skin sloughed off, and finally, in the evening, suppurated and smelly. With the tide risen, his bamboo pole was now too short and he had to paddle most of the way across with it. On the other side, at a higher spit, he lifted the slimy living bodies out and carried them up the slope away from the tide. He had to keep consciously repeating to himself, "These are human beings." It took him three trips to get them all across the river. When he had finished, he decided he had to have a rest, and he went back to the park.

As Mr. Tanimoto stepped up the dirt bank, he tripped over someone, and someone else said angrily, "Look out! That's my hand." Mr. Tanimoto, ashamed of hurting wounded people, embarrassed at being able to walk upright, suddenly thought of the naval hospital ship, which had not come (it never did), and he had for a moment a feeling of blind, murderous rage at the crew of the ship, and then at all doctors. Why didn't they come to help these people?

Dr. Fujii lay in dreadful pain throughout the night on the floor of his family's roofless house on the edge of the city. By the light of a lantern, he had examined himself and found: left clavicle fractured; multiple abrasions and lacerations of face and body, including deep cuts on the chin, back, and legs; extensive contusions on chest and trunk; a couple of ribs possibly fractured. Had he not been so badly hurt, he might have been at Asano Park, assisting the wounded.

By nightfall, ten thousand victims of the explosion had invaded the Red Cross Hospital, and Dr. Sasaki, worn out, was moving aimlessly and dully up and down the stinking corridors with wads of bandage and bottles of mercurochrome, still wearing the glasses he had taken from the wounded nurse, binding up the worst cuts as he came to them. Other doctors were putting compresses of saline solution on the worst burns. That was all they could do. After dark, they worked by the light of the city's fires and by candles the ten remaining nurses held for them. Dr. Sasaki had not looked outside the hospital all day; the scene inside was so terrible and so compelling that it had not occurred to him to ask any questions about what had happened beyond the windows and doors. Ceilings and partitions had fallen; plaster, dust, blood, and vomit were every-where. Patients were dying by the hundreds, but there was nobody to carry away the corpses. Some of the hospital staff distributed biscuits and rice balls, but the charnel-house smell was so strong that few were hungry. By three o'clock the next morning, after nineteen straight hours of his gruesome work, Dr. Sasaki was incapable of dressing another wound. He and some other survivors of the hospital staff got straw mats and went outdoors—thousands of patients and hundreds of dead were in the yard and on the driveway—and hurried around behind the hospital and lay down in hiding to snatch some sleep. But within an hour wounded people had found them; a complaining circle formed around them: "Doctors! Help us! How can you sleep?" Dr. Sasaki got up again and went back to work. Early in the day, he thought for the first time of his mother, at their country home in Mukaiharu, thirty miles from town. He usually went home every night. He was afraid she would think he was dead.

Near the spot upriver to which Mr. Tanimoto had transported the priests, there sat a large case of rice cakes which a rescue party had evidently brought for the wounded lying thereabouts but hadn't distributed. Before evacuating the wounded priests, the others passed the cakes around and helped themselves. A few minutes later, a band of soldiers came up, and an officer, hearing the priests speaking a foreign language, drew his sword and hysterically-asked who they were. One of the priests calmed him down and explained that they were Germans—allies. The officer apologized and said that there were reports going around that American parachutists had landed.

The priests decided that they should take Father Schiffer first. As they prepared to leave, Father Superior LaSalle said he felt awfully cold. One of the Jesuits gave up his coat, another his shirt; they were glad to wear less in the muggy night. The stretcher bearers started out. The theological student led the way and tried to warn the others of obstacles, but one of the priests got a foot tangled in some telephone wire and tripped and dropped his corner of the litter. Father Schiffer rolled off, lost consciousness, came to, and then vomited. The bearers picked him up and went on with him to the edge of the city, where they had arranged to meet a relay of other priests, left him with them, and turned back and got the Father Superior.

The wooden litter must have been terribly painful for Father LaSalle, in whose back scores of tiny particles of window glass were embedded. Near the edge of town, the group had to walk around an automobile burned and squatting on the narrow road, and the bearers on one side, unable to see their way in the darkness, fell into a deep ditch. Father LaSalle was thrown

onto the ground and the litter broke in two. One priest went ahead to get a hand-cart from the Novitiate, but he soon found one beside an empty house and wheeled it back. The priests lifted Father LaSalle into the cart and pushed him over the bumpy road the rest of the way. The rector of the Novitiate, who had been a doctor before he entered the religious order, cleaned the wounds of the two priests and put them to bed between clean sheets, and they thanked God for the care they had received.

Thousands of people had nobody to help them. Miss Sasaki was one of them. Abandoned and help-less, under the crude lean-to in the courtyard of the tin factory, beside the woman who had lost a breast and the man whose burned face was scarcely a face any more, she suffered awfully that night from the pain in her broken leg. She did not sleep at all; neither did she converse with her sleepless companions.

In the park, Mrs. Murata kept Father Kleinsorge awake all night by talking to him. None of the Nakamura family were able to sleep, either; the children, in spite of being very sick, were interested in everything that happened. They were delighted when one of the city's gas-storage tanks went up in a tremendous burst of flame. Toshio, the boy, shouted to the others to look at the reflection in the river. Mr. Tanimoto, after his long run and his many hours of rescue work, dozed uneasily. When he awoke, in the first light of dawn, he looked across the river and saw that he had not carried the festered, limp bodies high enough on the sandspit the night before. The tide had risen above where he had put them; they had not the strength to move; they must have drowned. He saw a number of bodies floating in the river.

Early that day, August 7th, the Japanese radio broadcast for the first time a succinct announcement that very few, if any, of the people most concerned with its content, the survivors in Hiroshima, happened to hear: "Hiroshima suffered considerable damage as the result of an attack by a few B-29s. It is believed that a new type of bomb was used. The details are being investigated," Nor is it probable that any of the survivors happened to be tuned in on a short-wave rebroadcast of an extraordinary announcement by the President of the United States, which identified the new bomb as atomic: "That bomb had more power than twenty thousand tons of TNT. It had more than two thousand times the blast power of the British Grand Slam, which is the largest bomb ever yet used in the history of warfare." Those victims who were able to worry at all about what had happened thought of it and discussed it in more primitive, childish terms—gasoline sprinkled from an airplane, maybe, or some combustible gas, or a big cluster of incendiaries, or the work of parachutists; but, even if they had known the truth, most of them were too busy or too weary or too badly hurt to care that they were the objects of the first great experiment in the use of atomic power, which (as the voices on the short wave shouted) no country except the United States, with its industrial know-how, its willingness to throw two billion gold dollars into an important wartime gamble, could possibly have developed.

Mr. Tanimoto was still angry at doctors. He decided that he would personally bring one to Asano Park—by the scruff of the neck, if necessary. He crossed the river, went past the Shinto shrine where he had met his wife for a brief moment the day before, and walked to the East Parade Ground. Since this had long before been designated as an evacuation area, he thought he would find an aid station there. He did find one, operated

by an Army medical unit, but he also saw that its doctors were hopelessly overburdened, with thousands of patients sprawled among corpses across the field in front of it. Nevertheless, he went up to one of the Army doctors and said, as reproachfully as he could, "Why have you not come to Asano Park? You are badly needed there."

Without even looking up from his work, the doctor said in a tired voice, "This is my station."

"But there are many dying on the riverbank over there,"

"The first duty," the doctor said, "is to take care of the slightly wounded."

"Why—when there are many who are heavily wounded on the riverbank?"

The doctor moved to another patient. "In an emergency like this," he said, as if he were reciting from a manual, "the first task is to help as many as possible—to save as many lives as possible. There is no hope for the heavily wounded. They will die. We can't bother with them."

"That may be right from a medical standpoint—" Mr. Tanimoto began, but then he looked out across the field, where the many dead lay close and intimate with those who were still living, and he turned away without finishing his sentence, angry now with himself. He didn't know what to do; he had promised some of the dying people in the park that he would bring them medical aid. They might die feeling cheated. He saw a ration stand at one side of the field, and he went to it and begged some rice cakes and biscuits, and he took them back, in lieu of doctors, to the people in the park.

The morning again, was hot. Father Kleinsorge went to fetch water for the wounded in a bottle and a teapot he had borrowed. He had heard that it was possible to get fresh tap water outside Asano Park. Going through the rock gardens, he had to climb over and crawl under the trunks of fallen pine trees; he found he was weak. There were many dead in the gardens. At a beautiful moon bridge, he passed a naked, living woman who seemed to have been burned from head to toe and was red all over. Near the entrance to the park, an Army doctor was working, but the only medicine he had was iodine, which he painted over cuts, bruises, slimy burns, every-thing—and by now everything that he painted had pus on it. Outside the gate of the park, Father Kleinsorge found a faucet that still worked—part of the plumbing of a vanished house—and he filled his vessels and returned. When he had given the wounded the water, he made a second trip. This time, the woman by the bridge was dead* On his way back with the water, he got lost on a detour around a fallen tree, and as he looked for his way through the woods, he heard a voice ask from the underbrush, "Have you anything to drink?" He saw a uniform* Thinking there was just one soldier, he approached with the water. When he had penetrated the bushes, he saw there were about twenty men, and they were all in exactly the same nightmarish state: their faces were wholly burned, their eyesockets were hollow, the fluid from their melted eyes had run down their cheeks. (They must have had their faces upturned when the bomb went off; perhaps they were anti-aircraft personnel) Their mouths were mere swollen, pus-covered wounds, which they could not bear to stretch enough to admit the spout of the teapot. So Father Kleinsorge got a large piece of grass and drew out the stem so as to make a straw, and gave them all water to drink that way. One of them said, "I can't see anything."

Father Kleinsorge answered, as cheerfully as he could, "There's a doctor at the entrance to the part He's busy now, but he'll come soon and fix your eyes, I hope."

Since that day, Father Kleinsorge has thought back to how queasy he had once been at the sight of pain, how someone else's cut finger used to make him turn faint. Yet there in the park he was so be-numbed that immediately after leaving this horrible sight he stopped on a path by one of the pools and discussed with a lightly wounded man whether it would be safe to eat the fat, two-foot carp that floated dead on the surface of the water. They decided, after some consideration, that it would be unwise,

Father Kleinsorge filled the containers a third time and went back to the riverbank. There, amid the dead and dying, he saw a young woman with a needle and thread mending her kimono, which had been slightly torn. Father Kleinsorge joshed her, "My, but you're a dandy!" he said She laughed,

He felt tired and lay down. He began to talk with two engaging children whose acquaintance he had made the afternoon before. He learned that their name was Kataoka; the girl was thirteen, the boy five. The girl had been just about to set out for a barbershop when the bomb fell As the family started for Asano Park, their mother decided to turn back for some food and extra clothing; they became separated from her in the crowd of fleeing people, and they had not seen her since. Occasionally they stopped suddenly in their perfectly cheerful playing and began to cry for their mother.

It was difficult for all the children in the park to sustain the sense of tragedy. Toshio Nakamura got quite excited when he saw his friend Seichi Sato riding up the river in a boat with his family, and he ran to the bank and waved and shouted, "Sato! Sato!"

The boy turned his head and shouted, "Who's that?"

"Nakamura."

"Hello, Toshio!"

"Are you all safe?"

"Yes,, What about you?"

"Yes, we're all right. My sisters are vomiting, but I'm fine."

Father Kleinsorge began to be thirsty in the dreadful heat, and he did not feel strong enough to go for water again. A little before noon, he saw a Japanese woman handing something out, Soon she came to him and said in a kindly voice, "These are tea leaves. Chew them, young man, and you won't feel thirsty." The woman's gentleness made Father Kleinsorge suddenly want to cry. For weeks, he had been feeling oppressed by the hatred of foreigners that the Japanese seemed increasingly to show, and he had been uneasy even with his Japanese friends. This stranger's gesture made him a little hysterical.

Around noon, the priests arrived from the Novitiate with the handcart They had been to the site of the mission house in the city and had retrieved some suitcases that had been stored in the air-raid shelter and had also picked up the remains of melted holy vessels in the ashes of the chapel They now packed Father Kleinsorge's *papier-maché* suitcase and the things belonging to Mrs. Murata and the Nakamuras into the cart, put

the two Nakamura girls aboard, and prepared to start out. Then one of the Jesuits who had a practical turn of mind remembered that they had been notified some time before that if they suffered property damage at the hands of the enemy, they could enter a claim for compensation with the prefectural police. The holy men discussed this matter there in the park, with the wounded as silent as the dead around them, and decided that Father Kleinsorge, as a former resident of the destroyed mission, was the one to enter the claim. So, as the others went off with the handcart, Father Kleinsorge said goodbye to the Kataoka children and trudged to a police station. Fresh, clean-uniformed policemen from another town were in charge, and a crowd of dirty and disarrayed citizens crowded around them, mostly asking after lost relatives. Father Kleinsorge filled out a claim form and started walking through the center of the town on his way to Nagatsuka. It was then that he first realized the extent of the damage; he passed block after block of ruins, and even after all he had seen in the park, his breath was taken away. By the time he reached the Novitiate, he was sick with exhaustion. The last thing he did as he fell into bed was request that someone go back for the motherless Kataoka children,

Altogether, Miss Sasaki was left two days and two nights under the piece of propped-up roofing with her crushed leg and her two unpleasant comrades. Her only diversion was when men came to the factory air-raid shelters, which she could see from under one corner of her shelter, and hauled corpses up out of them with ropes. Her leg became discolored, swollen, and putrid. All that time, she went without food and water. On the third day, August 8th, some friends who supposed she was dead came to look for her body and found her. They told her that her mother, father, and baby brother, who at the time of the explosion were in the Tamura Pediatric Hospital, where the baby was a patient, had all been given up as certainly dead, since the hospital was totally destroyed. Her friends then left her to think that piece of news over. Later, some men picked her up by the arms and legs and carried her quite a distance to a truck. For about an hour, the truck moved over a bumpy road, and Miss Sasaki, who had become convinced that she was dulled to pain, discovered that she was not. The men lifted her out at a relief station in the section of Inokuchi, where two Army doctors looked at her. The moment one of them touched her wound, she fainted. She came to in time to hear them discuss whether or not to cut off her leg; one said there was gas gangrene in the lips of the wound and predicted she would die unless they amputated, and the other said that was too bad, because they had no equipment with which to do the job. She fainted again. When she recovered consciousness, she was being carried somewhere on a stretcher. She was put aboard a launch, which went to the nearby island of Ninoshima, and she was taken to a military hospital there. Another doctor examined her and said that she did not have gas gangrene, though she did have a fairly ugly compound fracture. He said quite coldly that he was sorry, but this was a hospital for operative surgical cases only, and because she had no gangrene, she would have to return to Hiroshima that night. But then the doctor took her temperature, and what he saw on the thermometer made him decide to let her stay.

That day, August 8th, Father Cieslik went into the city to look for Mr. Fukai, the Japanese secretary of the diocese, who had ridden unwillingly out of the flaming city on Father Kleinsorge's back and then had run back crazily into it. Father Cieslik started hunting in the neighborhood of Sakai

Bridge, where the Jesuits had last seen Mr. Fukai; he went to the East Parade Ground, the evacuation area to which the secretary might have gone, and looked for him among the wounded and dead there; he went to the prefectural police and made inquiries. He could not find any trace of the man. Back at the Novitiate that evening, the theological student, who had been rooming with Mr. Fukai at the mission house, told the priests that the secretary had re-marked to him, during an air-raid alarm one day not long before the bombing, "Japan is dying. If there is a real air raid here in Hiroshima, I want to die with our country." The priests concluded that Mr. Fukai had run back to immolate himself in the flames. They never saw him again.

At the Red Cross Hospital, Dr. Sasaki worked for three straight days with only one hour's sleep. On the second day, he began to sew up the worst cuts, and right through the following night and all the next day he stitched. Many of the wounds were festered. Fortunately, someone had found intact a supply of narucoapon, a Japanese sedative, and he gave it to many who were in pain. Word went around among the staff that there must have been something peculiar about the great bomb, because on the second day the vice-chief of the hospital went down in the basement to the vault where the X-ray plates were stored and found the whole stock exposed as they lay. That day, a fresh doctor and ten nurses came in from the city of Yamaguchi with extra bandages and antiseptics, and the third day another physician and a dozen more nurses arrived from Matsue—yet there were still only eight doctors for ten thousand patients. In the afternoon of the third day, exhausted from his foul tailoring, Dr. Sasaki became obsessed with the idea that his mother thought he was dead. He got permission to go to Mukaijima. He walked out to the first suburbs, beyond which the electric train service was still functioning, and reached home late in the evening. His mother said she had known he was all right all along; a wounded nurse had stopped by to tell her. He went to bed and slept for seventeen hours.

Before dawn on August 8th, someone entered the room at the Novitiate where Father Kleinsorge was in bed, reached up to the hanging light bulb, and switched it on. The sudden flood of light, pouring in on Father Kleinsorge's half sleep, brought him leaping out of bed, braced for a new concussion. When he realized what had happened, he laughed confusedly and went back to bed. He stayed there all day.

On August 9th, Father Kleinsorge was still tired, The rector looked at his cuts and said they were not even worth dressing, and if Father Kleinsorge kept them clean, they would heal in three or four days. Father Kleinsorge felt uneasy; he could not yet comprehend what he had been through; as if he were guilty of something awful, he felt he had to go back to the scene of the violence he had experienced, He got up out of bed and walked into the city. He scratched for a while in the ruins of the mission house, but he found nothing. He went to the sites of a couple of schools and asked after people he knew. He looked for some of the city's Japanese Catholics, but he found only fallen houses. He walked back to the Novitiate, stupefied and without any new understanding.

At two minutes after eleven o'clock on the morning of August 9th, the second atomic bomb was dropped, on Nagasaki. It was several days before the survivors of Hiroshima knew they had company, because the Japanese radio and newspapers were being extremely cautious on the subject of the

strange weapon.

On August 9th, Mr. Tanimoto was still working in the park. He went to the suburb of Ushida, where his wife was staying with friends, and got a tent which he had stored there before the bombing. He now took it to the park and set it up as a shelter for some of the wounded who could not move or be moved. Whatever he did in the park, he felt he was being watched by the twenty-year-old girl, Mrs. Kamai, his former neighbor, whom he had seen on the day the bomb exploded, with her dead baby daughter in her arms. She kept the small corpse in her arms for four days, even though it began smelling bad on the second day. Once, Mr. Tanimoto sat with her for a while, and she told him that the bomb had buried her under their house with the baby strapped to her back, and that when she had dug herself free, she had discovered that the baby was choking, its mouth full of dirt. With her little finger, she had carefully cleaned out the infant's mouth, and for a time the child had breathed normally and seemed all right; then suddenly it had died. Mrs. Kamai also talked about what a fine man her husband was, and again urged Mr. Tanimoto to search for him. Since Mr. Tanimoto had been all through the city the first day and had seen terribly burned soldiers from Kamai's post, the Chugoku Regional Army Headquarters, everywhere, he knew it would be impossible to find Kamai, even if he were living, but of course he didn't tell her that. Every time she saw Mr. Tanimoto, she asked whether he had found her husband. Once, he tried to suggest that perhaps it was time to cremate the baby, but Mrs. Kamai only held it tighter. He began to keep away from her, but whenever he looked at her, she was staring at him and her eyes asked the same question. He tried to escape her glance by keeping his back turned to her as much as possible.

The Jesuits took about fifty refugees into the exquisite chapel of the Novitiate. The rector gave them what medical care he could—mostly just the cleaning away of pus. Each of the Nakamuras was provided with a blanket and a mosquito net, Mrs. Nakamura and her younger daughter had no appetite and ate nothing; her son and other daughter ate, and lost, each meal they were offered. On August 10th, a friend, Mrs. Osaki, came to see them and told them that her son Hideo had been burned alive in the factory where he worked. This Hideo had been a kind of hero to Toshio, who had often gone to the plant to watch him run his machine. That night, Toshio woke up screaming. He had dreamed that he had seen Mrs. Osaki coming out of an opening in the ground with her family, and then he saw Hideo at his machine, a big one with a revolving belt, and he himself was standing beside Hideo, and for some reason this was terrifying.

ON August 10th, Father Kleinsorge, having heard from someone that Dr. Fujii had been injured and that he had eventually gone to the summer house of a friend of his named Okuma, in the village of Fukawa, asked Father Cieslik if he would go and see how Dr. Fujii was. Father Cieslik went to Misasa station, outside Hiroshima, rode for twenty minutes on an electric train, and then walked for an hour and a half in a terribly hot sun to Mr. Okuma's house, which was beside the Ota River at the foot of a mountain. He found Dr. Fujii sitting in a chair in a kimono, applying compresses to his broken collarbone. The Doctor told Father Cieslik about having lost his glasses and said that his eyes bothered him. He showed the priest huge blue and green stripes where beams had bruised him. He offered the Jesuit first a cigarette and then whiskey, though it was only

eleven in the morning. Father Cieslik thought it would please Dr. Fujii if he took a little, so he said yes. A servant brought some *Suntory* whiskey, and the Jesuit, the Doctor, and the host had a very pleasant chat. Mr. Okuma had lived in Hawaii, and he told some things about Americans. Dr. Fujii talked a bit about the disaster. He said that Mr. Okuma and a nurse had gone into the ruins of his hospital and brought back a small safe which he had moved into his air-raid shelter. This contained some surgical instruments, and Dr. Fujii gave Father Cieslik a few pairs of scissors and tweezers for the rector at the Novitiate. Father Cieslik was bursting with some inside dope he had, but he waited until the conversation turned naturally to the mystery of the bomb. Then he said he knew what kind of bomb it was; he had the secret on the best authority—that of a Japanese newspaperman who had dropped in at the Novitiate. The bomb was not a bomb at all; it was a kind of fine magnesium powder sprayed over the whole city by a single plane, and it exploded when it came into contact with the live wires of the city power system. "That means," said Dr. Fujii, perfectly satisfied, since after all the information came from a newspaperman, "that it can only be dropped on big cities and only in the daytime, when the tram lines and so forth are in operation."

After five days of ministering to the wounded in the park, Mr. Tanimoto returned, on August 11th, to his parsonage and dug around in the ruins. He retrieved some diaries and church records that had been kept in books and were only charred around the edges, as well as some cooking utensils and pottery. While he was at work, a Miss Tanaka came and said that her father had been asking for him, Mr. Tanimoto had reason to hate her father, the re-tired shipping-company official who, though he made a great show of his charity, was notoriously selfish and cruel, and who, just a few days before the bombing, had said openly to several people that Mr. Tanimoto was a spy for the Americans. Several times he had derided Christianity and called it un-Japanese. At the moment of the bombing, Mr. Tanaka had been walking in the street in front of the city's radio station. He received serious flash burns, but he was able to walk home. He took refuge in his Neighborhood Association shelter and from there tried hard to get medical aid. He expected all the doctors of Hiroshima to come to him, because he was so rich and so famous for giving his money away. When none of them came, he angrily set out to look for them; leaning on his daughter's arm, he walked from private hospital to private hospital, but all were in ruins, and he went back and lay down in the shelter again. Now he was very weak and knew he was going to die. He was willing to be comforted by any religion.

Mr. Tanimoto went to help him. He descended into the tomblike shelter and, when his eyes were adjusted to the darkness, saw Mr. Tanaka, his face and arms puffed up and covered with pus and blood, and his eyes swollen shut. The old man smelled very bad, and he moaned constantly. He seemed to recognize Mr. Tanimoto's voice. Standing at the shelter stairway to get light, Mr. Tanimoto read loudly from a Japanese-language pocket Bible: "For a thousand years in Thy sight are but as yesterday when it is past, and as a watch in the night. Thou earnest the children of men away as with a flood; they are as a sleep; in the morning they are like grass which groweth up. In the morning it flourisheth and groweth up; in the evening it is cut down, and withereth. For we are consumed by Thine anger and by Thy wrath are we troubled. Thou hast set our iniquities before Thee, our secret sins in the light of Thy countenance. For all our

days are passed away in Thy wrath: we spend our years as a tale that is told....”

Mr. Tanaka died as Mr. Tanimoto read the psalm.

On August 11th, word came to the Ninoshima Military Hospital that a large number of military casualties from the Chugoku Regional Army Head-quarters were to arrive on the island that day, and it was deemed necessary to evacuate all civilian patients. Miss Sasaki, still running an alarmingly high fever, was put on a large ship. She lay out on deck, with a pillow under her leg. There were awnings over the deck, but the vessel's course put her in the sunlight. She felt as if she were under a magnifying glass in the sun. Pus oozed out of her wound, and soon the whole pillow was covered with it. She was taken ashore at Hatsukaichi, a town several miles to the southwest of Hiroshima, and put in the Goddess of Mercy Primary School, which had been turned into a hospital. She lay there for several days before a specialist on fractures came from Kobe. By then her leg was red and swollen up to her hip. The doctor decided he could not set the breaks. He made an incision and put in a rubber pipe to drain off the putrescence.

At the Novitiate, the motherless Kataoka children were inconsolable,, Father Cieslik worked hard to keep them distracted. He put riddles to them. He asked, * What is the cleverest animal in the world?,” and after the thirteen-year-old girl had guessed the ape, the elephant, the horse, he said, “No, it must be the hippopotamus,” because in Japanese that animal is *kaba* the reverse of *baka*, stupid. He told Bible stories, beginning, in the order of things, with the Creation. He showed them a scrapbook of snapshots taken in Europe. Nevertheless, they cried most of the time for their mother.

Several days later, Father Cieslik started hunting for the children's family. First, he learned through the police that an uncle had been to the authorities in Kure, a city not far away, to inquire for the children. After that, he heard that an older brother had been trying to trace them through the post office in Ujina, a suburb of Hiroshima, Still later, he heard that the mother was alive and was on Goto Island, off Nagasaki And at last, by keeping a check on the Ujina post office, he got in touch with the brother and returned the children to their mother.

About a week after the bomb dropped, a vague, in-comprehensible rumor reached Hiroshima—that the city had been destroyed by the energy released when atoms were somehow split in two. The weapon was referred to in this word-of-mouth report as *genshi bakudan*—the root characters of which can be translated as “original child bomb.” No one understood the idea or put any more credence in it than in the powdered magnesium and such things. Newspapers were being brought in from other cities, but they were still confining themselves to extremely general statements, such as Domei's assertion on August 12th: “There is nothing to do but admit the tremendous power of this inhuman bomb.” Already, Japanese physicists had entered the city with Lauritsen electroscopes and Neher electrometers; they understood the idea all too well.

On August 12th, the Nakamuras, all of them still rather sick, went to the nearby town of Kabe and moved in with Mrs. Nakamura's sister-in-law. The next day, Mrs. Nakamura, although she was too ill to walk much, returned to Hiroshima alone, by electric car to the outskirts, by foot from there. All

week, at the Novitiate, she had worried about her mother, brother, and older sister, who had lived in the part of town called Fukuro, and besides, she felt drawn by some fascination, just as Father Kleinsorge had been. She discovered that her family were all dead, She went back to Kabe so amazed and depressed by what she had seen and learned in the city that she could not speak that evening,

A comparative orderliness, at least, began to be established at the Red Cross Hospital. Dr. Sasaki, back from his rest, undertook to classify his patients (who were still scattered everywhere, even on the stairways). The staff gradually swept up the debris. Best of all, the nurses and attendants started to remove the corpses. Disposal of the dead, by decent cremation and enshrinement, is a greater moral responsibility to the Japanese than adequate care of the living,, Relatives identified most of the first day's dead in and around the hospital. Beginning on the second day, whenever a patient appeared to be moribund, a piece of paper with his name on it was fastened to his clothing. The corpse detail carried the bodies to a clearing outside, placed them on pyres of wood from ruined houses, burned them, put some of the ashes in envelopes intended for exposed X-ray plates, marked the envelopes with the names of the de-ceased, and piled them, neatly and respectfully, in stacks in the main office. In a few days, the envelopes filled one whole side of the impromptu shrine.

In Kabe, on the morning of August 15th, ten-year-old Toshio Nakamura heard an airplane overhead.

He ran outdoors and identified it with a professional eye as a B-29. "There goes Mr. B!" he shouted.

One of his relatives called out to him, "Haven't you had enough of Mr. B?"

The question had a kind of symbolism. At almost that very moment, the dull, dispirited voice of Hirohito, the Emperor Tenno, was speaking for the first time in history over the radios "After pondering deeply the general trends of the world and the actual conditions obtaining in Our Empire today, We have decided to effect a settlement of the present situation by resorting to an extraordinary measure... "

Mrs. Nakamura had gone to the city again, to dig up some rice she had buried in her Neighborhood Association air-raid shelter. She got it and started back for Kabe. On the electric car, quite by chance, she ran into her younger sister, who had not been in Hiroshima the day of the bombing. "Have you heard the news?" her sister asked.

'What news?"

"The war is over."

'Don't say such a foolish thing, sister."

"But I heard it over the radio myself." And then, in a whisper, "It was the Emperor's voice."

"Oh," Mrs. Nakamura said (she needed nothing more to make her give up thinking, in spite of the atomic bomb, that Japan still had a chance to win the war), "in that case..."

Some time later, in a letter to an American, Mr. Tanimoto described the events of that morning. "At the time of the Post-War, the marvelous thing in our history happened Our Emperor broadcasted his own voice through radio directly to us, common people of Japan, August 15th we were told

that some news of great importance could be heard & all of us should hear it. So I went to Hiroshima railway station. There set a loud-speaker in the ruins of the station,, Many civilians, all of them were in bound-age, some being helped by shoulder of their daughters, some sustaining their injured feet by sticks, they listened to the broadcast and when they came to realize the fact that it was the Emperor, they cried with full tears in their eyes. "What a wonderful blessing it is that Tenno himself call on us and we can hear his own voice in person. We are thoroughly satisfied in such a great sacrifice.' When they came to know the war was ended—that is, Japan was defeated, they, of course, were deeply disappointed, but followed after their Emperor's commandment in calm spirit, making whole-hearted sacrifice for the everlasting peace of the world—and Japan started her new way,"

Chapter Four

Panic Grass and Feverfew

On August 18th, twelve days after the bomb burst, Father Kleinsorge set out on foot for Hiroshima from the Novitiate with his papier-mache suitcase in his hand. He had begun to think that this bag, in which he kept his valuables, had a talismanic quality, because of the way he had found it after the explosion, standing handle-side up in the doorway of his room, while the desk under which he had previously hidden it was in splinters all over the floor. Now he was using it to carry the yen belonging to the Society of Jesus to the Hiroshima branch of the Yokohama Specie Bank, already reopened in its half-ruined building, On the whole, he felt quite well that morning. It is true that the minor cuts he had received had not healed in three or four days, as the rector of the Novitiate, who had examined them, had positively promised they would, but Father Kleinsorge had rested well for a week and considered that he was again ready for hard work. By now he was accustomed to the terrible scene through which he walked on his way into the city; the large rice field near the Novitiate, streaked with brown; the houses on the outskirts of the city, standing but decrepit, with broken windows and dishevelled tiles; and then, quite suddenly, the beginning of the four square miles of reddish-brown scar, where nearly everything had been buffeted down and burned; range on range of collapsed city blocks, with here and there a crude sign erected on a pile of ashes and tiles ("Sister, where are you?" or "All safe and we live at Toyosaka"); naked trees and canted telephone poles; the few standing, gutted buildings only accentuating the horizontality of everything else (the Museum of Science and Industry, with its dome stripped to its steel frame, as if for an autopsy; the modern Chamber of Commerce Building, its tower as cold, rigid, and unassailable after the blow as before; the huge, low-lying, camouflaged city hall; the row of dowdy banks, caricaturing a shaken economic system); and in the streets a macabre traffic—hundreds of crumpled bicycles, shells of streetcars and automobiles, all halted in mid-motion, The whole way, Father Kleinsorge was oppressed by the thought that all the damage he saw had been done in one instant by one bomb. By the time he reached the center of town, the day had become very hot He walked to the Yokohama Bank, which was doing business in a temporary wooden stall on the ground floor of its building, deposited the money, went by the mission compound just to have another look

at the wreckage, and then started back to the Novitiate. About halfway there, he began to have peculiar sensations. The more or less magical suitcase, now empty, suddenly seemed terribly heavy. His knees grew weak. He felt excruciatingly tired. With a considerable expenditure of spirit, he managed to reach the Novitiate. He did not think his weakness was worth mentioning to the other Jesuits. But a couple of days later, while at-tempting to say Mass, he had an onset of faintness and even after three attempts was unable to go through with the service, and the next morning the rector, who had examined Father Kleinsorge's apparently negligible but unhealed cuts daily, asked in surprise, "What have you done to your wounds?" They had suddenly opened wider and were swollen and inflamed.

As she dressed on the morning of August 20th, in the home of her sister-in-law in Kabe, not far from Nagatsuka, Mrs. Nakamura, who had suffered no cuts or burns at all, though she had been rather nauseated all through the week she and her children had spent as guests of Father Kleinsorge and the other Catholics at the Novitiate, began fixing her hair and noticed, after one stroke, that her comb carried with it a whole handful of hair; the second time, the same thing happened, so she stopped combing at once. But in the next three or four days, her hair kept falling out of its own accord, until she was quite bald. She began living indoors, practically in hiding. On August 26th, both she and her younger daughter, Myeko, woke up feeling extremely weak and tired, and they stayed on their bedrolls. Her son and other daughter, who had shared every experience with her during and after the bombing, felt fine.

At about the same time—he lost track of the days, so hard was he working to set up a temporary place of worship in a private house he had rented in the outskirts—Mr. Tanimoto fell suddenly ill with a general malaise, weariness, and feverishness, and he, too, took to his bedroll on the floor of the half-wrecked house of a friend in the suburb of Ushida. These four did not realize it, but they were coming down with the strange, capricious disease which came later to be known as radiation sickness.

Miss Sasaki lay in steady pain in the Goddess of Mercy Primary School, at Hatsukaichi, the fourth station to the southwest of Hiroshima on the electric train. An internal infection still prevented the proper setting of the compound fracture of her lower left leg. A young man who was in the same hospital and who seemed to have grown fond of her in spite of her unremitting preoccupation with her suffering, or else just pitied her because of it, lent her a Japanese translation of de Maupassant, and she tried to read the stories, but she could concentrate for only four or five minutes at a time,

The hospitals and aid stations around Hiroshima were so crowded in the first weeks after the bombing, and their staffs were so variable, depending on their health and on the unpredictable arrival of out-side help, that patients had to be constantly shifted from place to place. Miss Sasaki, who had already been moved three times, twice by ship, was taken at the end of August to an engineering school, also at Hatsukaichi. Because her leg did not improve but swelled more and more, the doctors at the school bound it with crude splints and took her by car, on September 9th, to the Red Cross Hospital in Hiroshima. This was the first chance she had had to look at the ruins of Hiroshima; the last time she had been carried through the city's streets, she had been hovering on the edge of unconsciousness.

Even though the wreckage had been described to her, and though she was still in pain, the sight horrified and amazed her, and there was something she noticed about it that particularly gave her the creeps. Over everything—up through the wreckage of the city, in gutters, along the riverbanks, tangled among tiles and tin roofing, climbing on charred tree trunks—was a blanket of fresh, vivid, lush, optimistic green; the verdancy rose even from the foundations of ruined houses. Weeds already hid the ashes, and wild flowers were in bloom among the city's bones. The bomb had not only left the underground organs of plants intact; it had stimulated them. Everywhere were bluets and Spanish bayonets, goosefoot, morning glories and day lilies, the hairy-fruited bean, purslane and clotbur and sesame and panic grass and feverfew. Especially in a circle at the center, sickle senna grew in extraordinary regeneration, not only standing among the charred remnants of the same plant but pushing up in new places, among bricks and through cracks in the asphalt. It actually seemed as if a load of sickle-senna seed had been dropped along with the bomb.

At the Red Cross Hospital, Miss Sasaki was put under the care of Dr. Sasaki Now, a month after the explosion, something like order had been reestablished in the hospital; which is to say that the patients who still lay in the corridors at least had mats to sleep on and that the supply of medicines, which had given out in the first few days, had been replaced, though inadequately, by contributions from other cities. Dr. Sasaki, who had had one seventeen-hour sleep at his home on the third night, had ever since then rested only about six hours a night, on a mat at the hospital; he had lost twenty pounds from his very small body; he still wore the borrowed glasses.

Since Miss Sasaki was a woman and was so sick (and perhaps, he afterward admitted, just a little bit because she was named Sasaki), Dr. Sasaki put her on a mat in a semi-private room, which at that time had only eight people in it. He questioned her and put down on her record card, in the correct, scrunched-up German in which he wrote all his records: "*Mittelgrosse Patientin in gutem Ernährungszustand. Fraktur am linken Unterschenkelknochen mit Wunde; Anschwellung in der linken Unterschenkelgegend. Haut und sichtbare Schleimhaut mässig durchblutet und kein Oedema,*" noting that she was a medium-sized female patient in good general health; that she had a compound fracture of the left tibia, with swelling of the left lower leg; that her skin and visible mucous membranes were heavily spotted with *petechiae*, which are hemorrhages about the size of grains of rice, or even as big as soybeans; and, in addition, that her head, eyes, throat, lungs, and heart were apparently normal; and that she had a fever. He wanted to set her fracture and put her leg in a cast, but he had run out of plaster of Paris long since, so he just stretched her out on a mat and prescribed aspirin for her fever, and glucose intravenously and diastase orally for her under-nourishment (which he had not entered on her record because everyone suffered from it). She exhibited only one of the queer symptoms so many of his patients were just then beginning to show— the spot hemorrhages.

Dr. Fujii was still pursued by bad luck, which still was connected with rivers. Now he was living in the summer house of Mr. Okuma, in Fukawa. This house clung to the steep banks of the Ota River. Here his injuries seemed to make good progress, and he even began to treat refugees who came to him from the neighborhood, using medical supplies he had

retrieved from a cache in the suburbs. He noticed in some of his patients a curious syndrome of symptoms that cropped out in the third and fourth weeks, but he was not able to do much more than swathe cuts and burns. Early in September, it began to rain, steadily and heavily. The river rose. On September 17th, there came a cloudburst and then a typhoon, and the water crept higher and higher up the bank Mr. Okuma and Dr. Fujii be-came alarmed and scrambled up the mountain to a peasant's house. (Down in Hiroshima, the flood took up where the bomb had left off—swept away bridges that had survived the blast, washed out streets, undermined foundations of buildings that still stood —and ten miles to the west, the Ono Army Hospital, where a team of experts from Kyoto Imperial University was studying the delayed affliction of the patients, suddenly slid down a beautiful, pine-dark mountainside into the Inland Sea and drowned most of the investigators and their mysteriously diseased patients alike.) After the storm, Dr. Fujii and Mr. Okuma went down to the river and found that the Okuma house had been washed altogether away.

Because so many people were suddenly feeling sick nearly a month after the atomic bomb was dropped, an unpleasant rumor began to move around, and eventually it made its way to the house in Kabe where Mrs. Nakamura lay bald and ill. It was that the atomic bomb had deposited some sort of poison on Hiroshima which would give off deadly emanations for seven years; nobody could go there all that time. This especially upset Mrs. Nakamura, who remembered that in a moment of confusion on the morning of the explosion she had literally sunk her entire means of livelihood, her Sankoku sewing machine, in the small cement water tank in front of what was left of her house; now no one would be able to go and fish it out. Up to this time, Mrs. Nakamura and her relatives had been quite resigned and passive about the moral issue of the atomic bomb, but this rumor suddenly aroused them to more hatred and resentment of America than they had felt all through the war.

Japanese physicists, who knew a great deal about atomic fission (one of them owned a cyclotron), worried about lingering radiation at Hiroshima, and in mid-August, not many days after President Truman's disclosure of the type of bomb that had been dropped, they entered the city to make investigations. The first thing they did was roughly to determine a center by observing the side on which telephone poles all around the heart of the town were scorched; they settled on the torii gateway of the Gokoku Shrine, right next to the parade ground of the Chugoku Regional Army Headquarters. From there, they worked north and south with Lauritsen electroscopes, which are sensitive to both beta particles and gamma rays. These indicated that the highest intensity of radioactivity, near the torii, was 4.2 times the average natural "leak" of ultra-short waves for the earth of that area. The scientists noticed that the flash of the bomb had discolored concrete to a light reddish tint, had scaled off the surface of granite, and had scorched certain other types of building material, and that consequently the bomb had, in some places, left prints of the shadows that had been cast by its light. The experts found, for instance, a permanent shadow thrown on the roof of the Chamber of Commerce Building (220 yards from the rough center) by the structure's rectangular tower; several others in the look-out post on top of the Hypothec Bank (2,050 yards); another in the tower of the Chugoku Electric Supply Building (800 yards); another projected by the handle of a gas pump (2,630 yards); and sev-eral on granite tombstones in the Gokoku Shrine

(385 yards). By triangulating these and other such shadows with the objects that formed them, the scientists determined that the exact center was a spot a hundred and fifty yards south of the torii and a few yards southeast of the pile of ruins that had once been the Shima Hospital (A few vague human silhouettes were found, and these gave rise to stories that eventually included fancy and precise details, One story told how a painter on a ladder was monumentalized in a kind of bas-relief on the stone facade of a bank building on which he was at work, in the act of dipping his brush into his paint can; another, how a man and his cart on the bridge near the Museum of Science and Industry, almost under the center of the explosion, were cast down in an em-bossed shadow which made it clear that the man was about to whip his horse.) Starting east and west from the actual center, the scientists, in early September, made new measurements, and the highest radiation they found this time was 3.9 times the natural "leak," Since radiation of at least a thousand times the natural "leak" would be required to cause serious effects on the human body, the scientists announced that people could enter Hiroshima without any peril at all.

As soon as this reassurance reached the household in which Mrs. Nakamura was concealing herself— or, at any rate, within a short time, after her hair had started growing back again—her whole family relaxed their extreme hatred of America, and Mrs. Nakamura sent her brother-in-law to look for the sewing machine. It was still submerged in the water tank, and when he brought it home, she saw, to her dismay, that it was all rusted and useless.

By the end of the first week in September, Father Kleinsorge was in bed at the Novitiate with a fever of 102.2, and since he seemed to be getting worse, his colleagues decided to send him to the Catholic International Hospital in Tokyo. Father Cieslik and the rector took him as far as Kobe and a Jesuit from that city took him the rest of the way, with a message from a Kobe doctor to the Mother Superior of the International Hospital: "Think twice before you give this man blood transfusions, because with atomic-bomb patients we aren't at all sure that if you stick needles in them, they'll stop bleeding."

When Father Kleinsorge arrived at the hospital, he was terribly pale and very shaky. He complained that the bomb had upset his digestion and given him abdominal pains. His white blood count was three thousand (five to seven thousand is normal), he was seriously anemic, and his temperature was 104. A doctor who did not know much about these strange manifestations—Father Kleinsorge was one of a handful of atomic patients who had reached Tokyo —came to see him, and to the patient's face he was most encouraging. "You'll be out of here in two weeks," he said. But when the doctor got out in the corridor, he said to the Mother Superior, "He'll die. All these bomb people die—you'll see. They go along for a couple of weeks and then they die.

The doctor prescribed suralimentation for Father Kleinsorge. Every three hours, they forced some eggs or beef juice into him, and they fed him all the sugar he could stand. They gave him vitamins, and iron pills and arsenic (in Fowler's solution) for his anemia. He confounded both the doctor's predictions; he neither died nor got up in a fortnight, Despite the fact that the message from the Kobe doctor deprived him of transfusions, which would have been the most useful therapy of all, his fever and his digestive trouble cleared up fairly quickly, His white count went up for a

while, but early in October it dropped again, to 3,600; then, in ten days, it suddenly climbed above normal, to 8,800; and it finally settled at 5,800. His ridiculous scratches puzzled everyone. For a few days, they would mend, and then, when he moved around, they would open up again. As soon as he began to feel well, he enjoyed himself tremendously. In Hiroshima he had been one of thousands of sufferers; in Tokyo he was a curiosity. American Army doctors came by the dozen to observe him. Japanese experts questioned him. A newspaper interviewed him. And once, the confused doctor came and shook his head and said, "Baffling cases, these atomic-bomb people."

Mrs. Nakamura lay indoors with Myeko. They both continued sick, and though Mrs. Nakamura vaguely sensed that their trouble was caused by the bomb, she was too poor to see a doctor and so never knew exactly what the matter was. Without any treatment at all, but merely resting, they began gradually to feel better. Some of Myeko's hair fell out, and she had a tiny burn on her arm which took months to heal. The boy, Toshio, and the older girl, Yaeko, seemed well enough, though they, too, lost some hair and occasionally had bad headaches, Toshio was still having nightmares, always about the nineteen-year-old mechanic, Hideo Osaki, his hero, who had been killed by the bomb.

On his back with a fever of 104, Mr. Tanimoto worried about all the funerals he ought to be conducting for the deceased of his church. He thought he was just overtired from the hard work he had done since the bombing, but after the fever had persisted for a few days, he sent for a doctor. The doctor was too busy to visit him in Ushida, but he dispatched a nurse, who recognized his symptoms as those of mild radiation disease and came back from time to time to give him injections of Vitamin B₁. A Buddhist priest with whom Mr. Tanimoto was acquainted called on him and suggested that moxibustion might give him relief; the priest showed the pastor how to give himself the ancient Japanese treatment, by setting fire to a twist of the stimulant herb moxa placed on the wrist pulse. Mr. Tanimoto found that each moxa treatment temporarily reduced his fever one degree. The nurse had told him to eat as much as possible, and every few days his mother-in-law brought him vegetables and fish from Tsuzu, twenty miles away, where she lived. He spent a month in bed, and then went ten hours by train to his father's home in Shikoku. There he rested another month.

DR. Sasaki and his colleagues at the Red Cross Hospital watched the unprecedented disease unfold and at last evolved a theory about its nature,, It had, they decided, three stages. The first stage had been all over before the doctors even knew they were dealing with a new sickness; it was the direct reaction to the bombardment of the body, at the moment when the bomb went off, by neutrons, beta particles, and gamma rays. The apparently uninjured people who had died so mysteriously in the first few hours or days had succumbed in this first stage. It killed ninety-five per cent of the people within a half mile of the center, and many thousands who were farther away. The doctors realized in retrospect that even though most of these dead had also suffered from burns and blast effects, they had absorbed enough radiation to kill them. The rays simply destroyed body cells—caused their nuclei to degenerate and broke their walls. Many people who did not die right away came down with nausea, headache, diarrhea, malaise, and fever, which lasted several days. Doctors

could not be certain whether some of these symptoms were the result of radiation or nervous shock. The second stage set in ten or fifteen days after the bombing. Its first symptom was falling hair. Diarrhea and fever, which in some cases went as high as 106, came next. Twenty-five to thirty days after the explosion, blood disorders appeared: gums bled, the white-blood-cell count dropped sharply, and *petechiae* appeared on the skin and mucous membranes. The drop in the number of white blood corpuscles reduced the patient's capacity to resist infection, so open wounds were unusually slow in healing and many of the sick developed sore throats and mouths. The two key symptoms, on which the doctors came to base their prognosis, were fever and the lowered white-corpuscle count. If fever remained steady and high, the patient's chances for survival were poor. The white count almost always dropped below four thousand; a patient whose count fell below one thousand had little hope of living. Toward the end of the second stage, if the patient survived, anemia, or a drop in the red blood count, also set in. The third stage was the reaction that came when the body struggled to compensate for its ills—when, for instance, the white count not only returned to normal but increased to much higher than normal levels. In this stage, many patients died of complications, such as infections in the chest cavity. Most burns healed with deep layers of pink, rubbery scar tissue, known as keloid tumors. The duration of the disease varied, depending on the patient's constitution and the amount of radiation he had received. Some victims recovered in a week; with others the disease dragged on for months.

As the symptoms revealed themselves, it became clear that many of them resembled the effects of overdoses of X-ray, and the doctors based their therapy on that likeness. They gave victims liver extract, blood transfusions, and vitamins, especially B₁. The shortage of supplies and instruments hampered them. Allied doctors who came in after the surrender found plasma and penicillin very effective. Since the blood disorders were, in the long run, the predominant factor in the disease, some of the Japanese doctors evolved a theory as to the seat of the delayed sickness. They thought that perhaps gamma rays, entering the body at the time of the explosion, made the phosphorus in the victims' bones radioactive, and that they in turn emitted beta particles, which, though they could not penetrate far through flesh, could enter the bone marrow, where blood is manufactured, and gradually tear it down. Whatever its source, the disease had some baffling quirks. Not all the patients exhibited all the main symptoms. People who suffered flash burns were protected, to a considerable extent, from radiation sickness. Those who had lain quietly for days or even hours after the bombing were much less liable to get sick than those who had been active. Gray hair seldom fell out. And, as if nature were protecting man against his own ingenuity, the reproductive processes were affected for a time; men became sterile, women had miscarriages, menstruation stopped.

For ten days after the flood, Dr. Fujii lived in the peasant's house on the mountain above the Ota. Then he heard about a vacant private clinic in Kaitaichi, a suburb to the east of Hiroshima. He bought it at once, moved there, and hung out a sign inscribed in English, in honor of the conquerors;

M. MUJII, M.D.

Medical & Veneral

Quite recovered from his wounds, he soon built up a strong practice, and

he was delighted, in the evenings, to receive members of the occupying forces, on whom he lavished whiskey and practiced English.

Giving Miss Sasaki a local anaesthetic of procaine, Dr. Sasaki made an incision in her leg on October 23rd, to drain the infection, which still lingered on eleven weeks after the injury. In the following days, so much pus formed that he had to dress the opening each morning and evening. A week later, she complained of great pain, so he made another incision; he cut still a third, on November 9th, and enlarged it on the twenty-sixth. All this time, Miss Sasaki grew weaker and weaker, and her spirits fell low. One day, the young man who had lent her his translation of de Maupassant at Hatsukaichi came to visit her; he told her that he was going to Kyushu but that when he came back, he would like to see her again. She didn't care. Her leg had been so swollen and painful all along that the doctor had not even tried to set the fractures, and though an X-ray taken in November showed that the bones were mending, she could see under the sheet that her left leg was nearly three inches shorter than her right and that her left foot was turning inward. She thought often of the man to whom she had been engaged. Someone told her he was back from overseas. She wondered what he had heard about her injuries that made him stay away.

Father Kleinsorge was discharged from the hospital in Tokyo on December 19th and took a train home. On the way, two days later, at Yokogawa, a stop just before Hiroshima, Dr. Fujii boarded the train. It was the first time the two men had met since before the bombing. They sat together, Dr. Fujii said he was going to the annual gathering of his family, on the anniversary of his father's death. When they started talking about their experiences, the Doctor was quite entertaining as he told how his places of residence kept falling into rivers. Then he asked Father Kleinsorge how he was, and the Jesuit talked about his stay in the hospital. "The doctors told me to be cautious," he said. "They ordered me to have a two-hour nap every afternoon."

Dr. Fujii said, "It's hard to be cautious in Hiroshima these days. Everyone seems to be so busy,"

A new municipal government, set up under Allied Military Government direction, had gone to work at last in the city hall. Citizens who had recovered from various degrees of radiation sickness were coming back by the thousand—by November 1st, the population, mostly crowded into the outskirts, was already 137,000, more than a third of the war-time peak—and the government set in motion all kinds of projects to put them to work rebuilding the city. It hired men to clear the streets, and others to gather scrap iron, which they sorted and piled in mountains opposite the city hall. Some returning residents were putting up their own shanties and huts, and planting small squares of winter wheat beside them, but the city also authorized and built four hundred one-family "barracks." Utilities were re-paired—electric lights shone again, trams started running, and employees of the waterworks fixed seventy thousand leaks in mains and plumbing. A Planning Conference, with an enthusiastic young Military Government officer, Lieutenant John D. Montgomery, of Kalamazoo, as its adviser, began to consider what sort of city the new Hiroshima should be. The ruined city had flourished—and had been an inviting target—mainly because it had been one of the most important military-command and communications centers in Japan, and would have become the Imperial headquarters had the islands been invaded and Tokyo been captured. Now

there would be no huge military establishments to help revive the city. The Planning Conference, at a loss as to just what importance Hiroshima could have, fell back on rather vague cultural and paving projects. It drew maps with avenues a hundred yards wide and thought seriously of erecting a group of buildings as a monument to the disaster, and naming them the Institute of International Amity. Statistical workers gathered what figures they could on the effects of the bomb. They reported that 78,150 people had been killed, 13,983 were missing, and 37,425 had been injured. No one in the city government pre-tended that these figures were accurate—though the Americans accepted them as official—and as the months went by and more and more hundreds of corpses were dug up from the ruins, and as the number of unclaimed urns of ashes at the Zempoji Temple in Koi rose into the thousands, the statisticians began to say that at least a hundred thousand people had lost their lives in the bombing. Since many people died of a combination of causes, it was impossible to figure exactly how many were killed by each cause, but the statisticians calculated that about twenty-five per cent had died of direct burns from the bomb, about fifty per cent from other in-juries, and about twenty per cent as a result of radiation effects. The statisticians' figures on property damage were more reliable: sixty-two thousand out of ninety thousand buildings destroyed, and six thousand more damaged beyond repair. In the heart of the city, they found only five modern buildings that could be used again without major repairs. This small number was by no means the fault of flimsy Japanese construction. In fact, since the 1923 earthquake, Japanese building regulations had required that the roof of each large building be able to bear a minimum load of seventy pounds per square foot, whereas American regulations do not normally specify more than forty pounds per square foot.

Scientists swarmed into the city. Some of them measured the force that had been necessary to shift marble gravestones in the cemeteries, to knock over twenty-two of the forty-seven railroad cars in the yards at Hiroshima station, to lift and move the concrete roadway on one of the bridges, and to perform other noteworthy acts of strength, and concluded that the pressure exerted by the explosion varied from 5.3 to 8.0 tons per square yard. Others found that mica, of which the melting point is 9000° C, had fused on granite gravestones three hundred and eighty yards from the center; that telephone poles of *Cryptomeria japonica*, whose carbonization temperature is 240° C, had been charred at forty-four hundred yards from the center; and that the surface of gray clay tiles of the type used in Hiroshima, whose melting point is 1,300° C, had dissolved at six hundred yards; and, after examining other significant ashes and melted bits, they concluded that the bomb's heat on the ground at the center must have been 6,000° C. And from further measurements of radiation, which involved, among other things, the scraping up of fission fragments from roof troughs and drainpipes as far away as the suburb of Takasu, thirty-three hundred yards from the center, they learned some far more important facts about the nature of the bomb. General MacArthur's headquarters systematically censored all mention of the bomb in Japanese scientific publications, but soon the fruit of the scientists' calculations became common knowledge among Japanese physicists, doctors, chemists, journalists, professors, and, no doubt, those statesmen and military men who were still in circulation. Long before the American public had been told, most of the scientists and lots of

non-scientists in Japan knew—from the calculations of Japanese nuclear physicists—that a uranium bomb had exploded at Hiroshima and a more powerful one, of plutonium, at Nagasaki. They also knew that theoretically one ten times as powerful—or twenty—could be developed. The Japanese scientists thought they knew the exact height at which the bomb at Hiroshima was exploded and the approximate weight of the uranium used. They estimated that, even with the primitive bomb used at Hiroshima, it would require a shelter of concrete fifty inches thick to protect a human being entirely from radiation sickness. The scientists had these and other details which remained subject to security in the United States printed and mimeographed and bound into little books. The Americans knew of the existence of these, but tracing them and seeing that they did not fall into the wrong hands would have obliged the occupying authorities to set up, for this one purpose alone, an enormous police system in Japan. Altogether, the Japanese scientists were somewhat amused at the efforts of their conquerors to keep security on atomic fission.

Late in February, 1946, a friend of Miss Sasaki's called on Father Kleinsorge and asked him to visit her in the hospital. She had been growing more and more depressed and morbid; she seemed little interested in living. Father Kleinsorge went to see her several times. On his first visit, he kept the conversation general, formal, and yet vaguely sympathetic, and did not mention religion. Miss Sasaki herself brought it up the second time he dropped in on her. Evidently she had had some talks with a Catholic. She asked bluntly, "If your God is so good and kind, how can he let people suffer like this?" She made a gesture which took in her shrunken leg, the other patients in her room, and Hiroshima as a whole.

"My child," Father Kleinsorge said, "man is not now in the condition God intended. He has fallen from grace through sin." And he went on to explain all the reasons for everything.

It came to Mrs. Nakamura's attention that a carpenter from Kabe was building a number of wooden shanties in Hiroshima which he rented for fifty yen a month—\$3.33, at the fixed rate of exchange. Mrs. Nakamura had lost the certificates for her bonds and other war-time savings, but fortunately she had copied off all the numbers just a few days before the bombing and had taken the list to Kabe, and so, when her hair had grown in enough for her to be presentable, she went to her bank in Hiroshima, and a clerk there told her that after checking her numbers against the records the bank would give her her money. As soon as she got it, she rented one of the carpenter's shacks. It was in Nobori-cho, near the site of her former house, and though its floor was dirt and it was dark inside, it was at least a home in Hiroshima, and she was no longer dependent on the charity of her in-laws. During the spring, she cleared away some nearby wreckage and planted a vegetable garden. She cooked with utensils and ate off plates she scavenged from the debris. She sent Myeko to the kindergarten which the Jesuits re-opened, and the two older children attended Nobori-cho Primary School, which, for want of buildings, held classes out of doors. Toshio wanted to study to be a mechanic, like his hero, Hideo Osaki. Prices were high; by midsummer Mrs. Nakamura's savings were gone. She sold some of her clothes to get food. She had once had several expensive kimonos, but during the war one had been stolen, she had given one to a sister who had been bombed out in Tokuyama, she

had lost a couple in the Hiroshima bombing, and now she sold her last one. It brought only a hundred yen, which did not last long. In June, she went to Father Kleinsorge for advice about how to get along, and in early August, she was still considering the two alternatives he suggested—taking work as a domestic for some of the Allied occupation forces, or borrowing from her relatives enough money, about five hundred yen, or a bit more than thirty dollars, to repair her rusty sewing machine and resume the work of a seamstress.

When Mr. Tanimoto returned from Shikoku, he draped a tent he owned over the roof of the badly damaged house he had rented in Ushida. The roof still leaked, but he conducted services in the damp living room. He began thinking about raising money to restore his church in the city. He became quite friendly with Father Kleinsorge and saw the Jesuits often. He envied them their Church's wealth; they seemed to be able to do anything they wanted. He had nothing to work with except his own energy, and that was not what it had been.

The Society of Jesus had been the first institution to build a relatively permanent shanty in the ruins of Hiroshima. That had been while Father Kleinsorge was in the hospital. As soon as he got back, he began living in the shack, and he and another priest, Father Laderman, who had joined him in the mission, arranged for the purchase of three of the standardized "barracks," which the city was selling at seven thousand yen apiece. They put two together, end to end, and made a pretty chapel of them; they ate in the third. When materials were available, they commissioned a contractor to build a three-story mission house exactly like the one that had been destroyed in the fire. In the compound, carpenters cut timbers, gouged mortises, shaped tenons, whittled scores of wooden pegs and bored holes for them, until all the parts for the house were in a neat pile; then, in three days, they put the whole thing together, like an Oriental puzzle, without any nails at all. Father Kleinsorge was finding it hard, as Dr. Fujii had suggested he would, to be cautious and to take his naps. He went out every day on foot to call on Japanese Catholics and prospective converts. As the months went by, he grew more and more tired. In June, he read an article in the Hiroshima Chugoku warning survivors against working too hard—but what could he do? By July, he was worn out, and early in August, almost exactly on the anniversary of the bombing, he went back to the Catholic International Hospital, in Tokyo, for a month's rest.

Whether or not Father Kleinsorge's answers to Miss Sasaki's questions about life were final and absolute truths, she seemed quickly to draw physical strength from them. Dr. Sasaki noticed it and congratulated Father Kleinsorge. By April 15th, her temperature and white count were normal and the infection in the wound was beginning to clear up. On the twentieth, there was almost no pus, and for the first time she jerked along a corridor on crutches. Five days later, the wound had begun to heal, and on the last day of the month she was discharged,

During the early summer, she prepared herself for conversion to Catholicism. In that period she had ups and downs. Her depressions were deep. She knew she would always be a cripple. Her fiancé never came to see her. There was nothing for her to do except read and look out, from her house on a hillside in Koi, across the ruins of the city where her parents and brother died. She was nervous, and any sudden noise made

her put her hands quickly to her throat. Her leg still hurt; she rubbed it often and patted it, as if to console it.

It took six months for the Red Cross Hospital, and even longer for Dr. Sasaki, to get back to normal. Until the city restored electric power, the hospital had to limp along with the aid of a Japanese Army generator in its back yard. Operating tables, X-ray machines, dentist chairs, everything complicated and essential came in a trickle of charity from other cities. In Japan, face is important even to institutions, and long before the Red Cross Hospital was back to par on basic medical equipment, its directors put up a new yellow brick veneer facade, so the hospital became the handsomest building in Hiroshima—from the street. For the first four months, Dr. Sasaki was the only surgeon on the staff and he almost never left the building; then, gradually, he began to take an interest in his own life again. He got married in March. He gained back some of the weight he lost, but his appetite remained only fair; before the bombing, he used to eat four rice balls at every meal, but a year after it he could manage only two. He felt tired all the time. "But I have to realize," he said, "that the whole community is tired.

A year after the bomb was dropped, Miss Sasaki was a cripple; Mrs. Nakamura was destitute; Father Kleinsorge was back in the hospital; Dr. Sasaki was not capable of the work he once could do; Dr. Fujii had lost the thirty-room hospital it took him many years to acquire, and had no prospects of rebuilding it; Mr. Tanimoto's church had been ruined and he no longer had his exceptional vitality. The lives of these six people, who were among the luckiest in Hiroshima, would never be the same. What they thought of their experiences and of the use of the atomic bomb was, of course, not unanimous. One feeling they did seem to share, however, was a curious kind of elated community spirit, something like that of the Londoners after their blitz—a pride in the way they and their fellow-survivors had stood up to a dreadful ordeal. Just before the anniversary, Mr. Tanimoto wrote in a letter to an American some words which expressed this feeling: "What a heart-breaking scene this was the first night! About mid-night I landed on the riverbank. So many injured people lied on the ground that I made my way by striding over them. Repeating 'Excuse me,' I forwarded and carried a tub of water with me and gave a cup of water to each one of them. They raised their upper bodies slowly and accepted a cup of water with a bow and drank quietly and, spilling any remnant, gave back a cup with hearty expression of their thankfulness, and said, "I couldn't help my sister, who was buried under the house, because I had to take care of my mother who got a deep wound on her eye and our house soon set fire and we hardly escaped. Look, I lost my home, my family, and at last myself bitterly injured. But now I have gotted my mind to dedicate what I have and to complete the war for our country's sake." Thus they pledged to me, even women and children did the same. Being entirely tired I lied down on the ground among them, but couldn't sleep at all. Next morning I found many men and women dead, whom I gave water last night. But, to my great surprise, I never heard any one cried in disorder, even though they suffered in great agony. They died in silence, with no grudge, setting their teeth to bear it. All for the country!

"Dr. Y. Hiraiwa, professor of Hiroshima University of Literature and Science, and one of my church members, was buried by the bomb under the two storied house with his son, a student of Tokyo University, Both of

them could not move an inch under tremendously heavy pressure. And the house already caught fire. His son said, "Father, we can do nothing except make our mind up to consecrate our lives for the country. Let us give *Banzai* to our Emperor.' Then the father followed after his son, '*Tenno Heika, Banzai, Banzai, Banzai!*' In the result, Or, Hiraiwa said, 'Strange to say, I felt calm and bright and peaceful spirit in my heart, when I chanted *Banzai* to Tenno.' Afterward his son got out and dugged down and pulled out his father and thus they were saved. In thinking of their experience of that time Dr. Hiraiwa repeated, What a fortunate that we are Japanese! It was my first time I ever tasted such a beautiful spirit when I decided to die for our Emperor.'

"Miss Kayoko Nobutoki, a student of girls' high school, Hiroshima Jazabuin, and a daughter of my church member, was taking rest with her friends beside the heavy fence of the Buddhist Temple. At the moment the atomic bomb was dropped, the fence fell upon them. They could not move a bit under such a heavy fence and then smoke entered into even a crack and choked their breath. One of the girls begun to sing *Kimi Ga Yo*, national anthem, and others followed in chorus and died. Meanwhile one of them found a crack and struggled hard to get onto. When she was taken in the Red Cross Hospital she told how her friends died, tracing back in her memory to singing in chorus our national an-then. They were just 13 years old.

"Yes, people of Hiroshima died manly in the atomic bombing, believing that it was for Emperor's sake."

A surprising number of the people of Hiroshima remained more or less indifferent about the ethics of using the bomb. Possibly they were too terrified by it to want to think about it at all. Not many of them even bothered to find out much about what it was like. Mrs. Nakamura's conception of it—and awe of it—was typical. "The atom bomb," she would say when asked about it, "is the size of a matchbox. The heat of it is six thousand times that of the sun. It exploded in the air. There is some radium in it. I don't know just how it works, but when the radium is put together, it explodes." As for the use of the bomb, she would say, "It was war and we had to expect it," And then she would add, "*Shikata ga nai*," a Japanese expression as common as, and corresponding to, the Russian word "*nichevo*": "It can't be helped. Oh, well. Too bad." Dr. Fujii said approximately the same thing about the use of the bomb to Father Kleinsorge one evening, in German: "*Da ist nichts zu machen*. There's nothing to be done about it."

Many citizens of Hiroshima, however, continued to feel a hatred for Americans which nothing could possibly erase. "I see," Dr. Sasaki once said, "that they are holding a trial for war criminals in Tokyo just now. I think they ought to try the men who decided to use the bomb and they should hang them all."

Father Kleinsorge and the other German Jesuit priests, who, as foreigners, could be expected to take a relatively detached view, often discussed the ethics of using the bomb. One of them, Father Siemes, who was out at Nagatsuka at the time of the attack, wrote in a report to the Holy See in Rome: "Some of us consider the bomb in the same category as poison gas and were against its use on a civilian population. Others were of the opinion that in total war, as carried on in Japan, there was no difference between civilians and soldiers, and that the bomb itself was an

effective force tending to end the bloodshed, warning Japan to surrender and thus to avoid total destruction. It seems logical that he who supports total war in principle cannot complain of a war against civilians. The crux of the matter is whether total war in its present form is justifiable, even when it serves a just purpose. Does it not have material and spiritual evil as its consequences which far exceed whatever good might result? When will our moralists give us a clear answer to this question?"

It would be impossible to say what horrors were embedded in the minds of the children who lived through the day of the bombing in Hiroshima. On the surface, their recollections, months after the disaster, were of an exhilarating adventure. Toshio Nakamura, who was ten at the time of the bombing, was soon able to talk freely, even gaily, about the experience, and a few weeks before the anniversary he wrote the following matter-of-fact essay for his teacher at Nobori-cho Primary School: "The day before the bomb, I went for a swim. In the morning, I was eating peanuts. I saw a light. I was knocked to little sister's sleeping place. When we were saved, I could only see as far as the tram. My mother and I started to pack our things. The neighbors were walking around burned and bleeding, Hataya-san told me to run away with her. I said I wanted to wait for my mother. We went to the park, A whirlwind came. At night a gas tank burned and I saw the reflection in the river. We stayed in the park one night. Next day I went to Taiko Bridge and met my girl friends Kikuki and Murakami. They were looking for their mothers. But Kikuki's mother was wounded and Murakami's mother, alas, was dead."

An Eyewitness Account

By Father John A. Siemes

Professor of modern philosophy at Tokyo's Catholic University Hiroshima
August 6th, 1945

Up to August 6th, occasional bombs, which did no great damage, had fallen on Hiroshima. Many cities roundabout, one after the other, were destroyed, but Hiroshima itself remained protected. There were almost daily observation planes over the city but none of them dropped a bomb. The citizens wondered why they alone had remained undisturbed for so long a time. There were fantastic rumors that the enemy had something special in mind for this city, but no one dreamed that the end would come in such a fashion as on the morning of August 6th.

August 6th began in a bright, clear, summer morning. About seven o'clock, there was an air raid alarm which we had heard almost every day and a few planes appeared over the city. No one paid any attention and at about eight o'clock, the all-clear was sounded. I am sitting in my room at the Novitiate of the Society of Jesus in Nagatsuke; during the past half year, the philosophical and theological section of our Mission had been evacuated to this place from Tokyo. The Novitiate is situated approximately two kilometers from Hiroshima, half-way up the sides of a broad valley which stretches from the town at sea level into this mountainous hinterland, and through which courses a river. From my window, I have a wonderful view down the valley to the edge of the city.

Suddenly—the time is approximately 8:14—the whole valley is filled by a garish light which resembles the magnesium light used in photography, and I am conscious of a wave of heat. I jump to the window to find out the cause of this remarkable phenomenon, but I see nothing more than that brilliant yellow light. As I make for the door, it doesn't occur to me that the light might have something to do with enemy planes. On the way from the window, I hear a moderately loud explosion which seems to come from a distance and, at the same time, the windows are broken in with a loud crash. There has been an interval of perhaps ten seconds since the flash of light. I am sprayed by fragments of glass. The entire window frame has been forced into the room. I realize now that a bomb has burst and I am under the impression that it exploded directly over our house or in the immediate vicinity.

I am bleeding from cuts about the hands and head. I attempt to get out of the door. It has been forced outwards by the air pressure and has become jammed. I force an opening in the door by means of repeated blows with my hands and feet and come to a broad hallway from which open the various rooms. Everything is in a state of confusion. All windows are broken and all the doors are forced inwards. The bookshelves in the hallway have tumbled down. I do not note a second explosion and the fliers seem to have gone on. Most of my colleagues have been injured by fragments of glass. A few are bleeding but none has been seriously injured. All of us have been fortunate since it is now apparent that the wall of my room opposite the window has been lacerated by long fragments of glass.

We proceed to the front of the house to see where the bomb has landed. There is no evidence, however, of a bomb crater; but the southeast section of the house is very severely damaged. Not a door nor a window remains. The blast of air had penetrated the entire house from the southeast, but the house still stands. It is constructed in a Japanese style with a wooden framework, but has been greatly strengthened by the labor of our Brother Gropper as is frequently done in Japanese homes. Only along the front of the chapel which adjoins the house, three supports have given way (it has been made in the manner of Japanese temple, entirely out of wood.)

Down in the valley, perhaps one kilometer toward the city from us, several peasant homes are on fire and the woods on the opposite side of the valley are aflame. A few of us go over to help control the flames. While we are attempting to put things in order, a storm comes up and it begins to rain. Over the city, clouds of smoke are rising and I hear a few slight explosions. I come to the conclusion that an incendiary bomb with an especially strong explosive action has gone off down in the valley. A few of us saw three planes at great altitude over the city at the time of the explosion. I, myself, saw no aircraft whatsoever.

Perhaps a half-hour after the explosion, a procession of people begins to stream up the valley from the city. The crowd thickens continuously. A few come up the road to our house. We give them first aid and bring them into the chapel, which we have in the meantime cleaned and cleared of wreckage, and put them to rest on the straw mats which constitute the floor of Japanese houses. A few display horrible wounds of the extremities and back. The small quantity of fat which we possessed during this time of war was soon used up in the care of the burns. Father Rektor who, before taking holy orders, had studied medicine, ministers to the injured, but our bandages and drugs are soon gone. We must be content with cleansing the wounds.

More and more of the injured come to us. The least injured drag the more seriously wounded. There are wounded soldiers, and mothers carrying burned children in their arms. From the houses of the farmers in the valley comes word: "Our houses are full of wounded and dying. Can you help, at least by taking the worst cases?" The wounded come from the sections at the edge of the city. They saw the bright light, their houses collapsed and buried the inmates in their rooms. Those that were in the open suffered instantaneous burns, particularly on the lightly clothed or unclothed parts of the body. Numerous fires sprang up which soon consumed the entire district. We now conclude that the epicenter of the explosion was at the edge of the city near the Jokogawa Station, three kilometers away from us. We are concerned about Father Kopp who that same morning, went to hold Mass at the Sisters of the Poor, who have a home for children at the edge of the city. He had not returned as yet.

Toward noon, our large chapel and library are filled with the seriously injured. The procession of refugees from the city continues. Finally, about one o'clock, Father Kopp returns, together with the Sisters. Their house and the entire district where they live has burned to the ground. Father Kopp is bleeding about the head and neck, and he has a large burn on the right palm. He was standing in front of the nunnery ready to go home. All of a sudden, he became aware of the light, felt the wave of heat and a large blister formed on his hand. The windows were torn out by the blast. He thought that the bomb had fallen in his immediate vicinity. The

nunnery, also a wooden structure made by our Brother Gropper, still remained but soon it is noted that the house is as good as lost because the fire, which had begun at many points in the neighborhood, sweeps closer and closer, and water is not available. There is still time to rescue certain things from the house and to bury them in an open spot. Then the house is swept by flame, and they fight their way back to us along the shore of the river and through the burning streets.

Soon comes news that the entire city has been destroyed by the explosion and that it is on fire. What became of Father Superior and the three other Fathers who were at the center of the city at the Central Mission and Parish House? We had up to this time not given them a thought because we did not believe that the effects of the bomb encompassed the entire city. Also, we did not want to go into town except under pressure of dire necessity, because we thought that the population was greatly perturbed and that it might take revenge on any foreigners which they might consider spiteful onlookers of their misfortune, or even spies.

Father Stolte and Father Erlinghagen go down to the road which is still full of refugees and bring in the seriously injured who have sunken by the wayside, to the temporary aid station at the village school. There iodine is applied to the wounds but they are left uncleansed. Neither ointments nor other therapeutic agents are available. Those that have been brought in are laid on the floor and no one can give them any further care. What could one do when all means are lacking? Under those circumstances, it is almost useless to bring them in. Among the passersby, there are many who are uninjured. In a purposeless, insensate manner, distraught by the magnitude of the disaster most of them rush by and none conceives the thought of organizing help on his own initiative. They are concerned only with the welfare of their own families. It became clear to us during these days that the Japanese displayed little initiative, preparedness, and organizational skill in preparation for catastrophes. They failed to carry out any rescue work when something could have been saved by a cooperative effort, and fatalistically let the catastrophe take its course. When we urged them to take part in the rescue work, they did everything willingly, but on their own initiative they did very little.

At about four o'clock in the afternoon, a theology student and two kindergarten children, who lived at the Parish House and adjoining buildings which had burned down, came in and said that Father Superior LaSalle and Father Schiffer had been seriously injured and that they had taken refuge in Asano Park on the river bank. It is obvious that we must bring them in since they are too weak to come here on foot.

Hurriedly, we get together two stretchers and seven of us rush toward the city. Father Rektor comes along with food and medicine. The closer we get to the city, the greater is the evidence of destruction and the more difficult it is to make our way. The houses at the edge of the city are all severely damaged. Many have collapsed or burned down. Further in, almost all of the dwellings have been damaged by fire. Where the city stood, there is a gigantic burned-out scar. We make our way along the street on the river bank among the burning and smoking ruins. Twice we are forced into the river itself by the heat and smoke at the level of the street.

Frightfully burned people beckon to us. Along the way, there are many

dead and dying. On the Misasi Bridge, which leads into the inner city we are met by a long procession of soldiers who have suffered burns. They drag themselves along with the help of staves or are carried by their less severely injured comrades...an endless procession of the unfortunate.

Abandoned on the bridge, there stand with sunken heads a number of horses with large burns on their flanks. On the far side, the cement structure of the local hospital is the only building that remains standing. Its interior, however, has been burned out. It acts as a landmark to guide us on our way.

Finally we reach the entrance of the park. A large proportion of the populace has taken refuge there, but even the trees of the park are on fire in several places. Paths and bridges are blocked by the trunks of fallen trees and are almost impassable. We are told that a high wind, which may well have resulted from the heat of the burning city, has uprooted the large trees. It is now quite dark. Only the fires, which are still raging in some places at a distance, give out a little light.

At the far corner of the park, on the river bank itself, we at last come upon our colleagues. Father Schiffer is on the ground pale as a ghost. He has a deep incised wound behind the ear and has lost so much blood that we are concerned about his chances for survival. The Father Superior has suffered a deep wound of the lower leg. Father Cieslik and Father Kleinsorge have minor injuries but are completely exhausted.

While they are eating the food that we have brought along, they tell us of their experiences. They were in their rooms at the Parish House—it was a quarter after eight, exactly the time when we had heard the explosion in Nagatsuke—when came the intense light and immediately thereafter the sound of breaking windows, walls and furniture. They were showered with glass splinters and fragments of wreckage. Father Schiffer was buried beneath a portion of a wall and suffered a severe head injury. The Father Superior received most of the splinters in his back and lower extremity from which he bled copiously. Everything was thrown about in the rooms themselves, but the wooden framework of the house remained intact. The solidity of the structure which was the work of Brother Gropper again shone forth.

They had the same impression that we had in Nagatsuke: that the bomb had burst in their immediate vicinity. The Church, school, and all buildings in the immediate vicinity collapsed at once. Beneath the ruins of the school, the children cried for help. They were freed with great effort. Several others were also rescued from the ruins of nearby dwellings. Even the Father Superior and Father Schiffer despite their wounds, rendered aid to others and lost a great deal of blood in the process.

In the meantime, fires which had begun some distance away are raging even closer, so that it becomes obvious that everything would soon burn down. Several objects are rescued from the Parish House and were buried in a clearing in front of the Church, but certain valuables and necessities which had been kept ready in case of fire could not be found on account of the confusion which had been wrought. It is high time to flee, since the oncoming flames leave almost no way open. Fukai, the secretary of the Mission, is completely out of his mind. He does not want to leave the house and explains that he does not want to survive the destruction of his fatherland. He is completely uninjured. Father Kleinsorge drags him out of

the house on his back and he is forcefully carried away.

Beneath the wreckage of the houses along the way, many have been trapped and they scream to be rescued from the oncoming flames. They must be left to their fate. The way to the place in the city to which one desires to flee is no longer open and one must make for Asano Park. Fukai does not want to go further and remains behind. He has not been heard from since. In the park, we take refuge on the bank of the river. A very violent whirlwind now begins to uproot large trees, and lifts them high into the air. As it reaches the water, a waterspout forms which is approximately 100 meters high. The violence of the storm luckily passes us by. Some distance away, however, where numerous refugees have taken shelter, many are blown into the river. Almost all who are in the vicinity have been injured and have lost relatives who have been pinned under the wreckage or who have been lost sight of during the flight. There is no help for the wounded and some die. No one pays any attention to a dead man lying nearby.

The transportation of our own wounded is difficult. It is not possible to dress their wounds properly in the darkness, and they bleed again upon slight motion. As we carry them on the shaky litters in the dark over fallen trees of the park, they suffer unbearable pain as the result of the movement, and lose dangerously large quantities of blood. Our rescuing angel in this difficult situation is a Japanese Protestant pastor. He has brought up a boat and offers to take our wounded up stream to a place where progress is easier. First, we lower the litter containing Father Schiffer into the boat and two of us accompany him. We plan to bring the boat back for the Father Superior. The boat returns about one-half hour later and the pastor requests that several of us help in the rescue of two children whom he had seen in the river. We rescue them. They have severe burns. Soon they suffer chills and die in the park.

The Father Superior is conveyed in the boat in the same manner as Father Schiffer. The theology student and myself accompany him. Father Cieslik considers himself strong enough to make his way on foot to Nagatsuke with the rest of us, but Father Kleinsorge cannot walk so far and we leave him behind and promise to come for him and the housekeeper tomorrow. From the other side of the stream comes the whinny of horses who are threatened by the fire. We land on a sand spit which juts out from the shore. It is full of wounded who have taken refuge there. They scream for aid for they are afraid of drowning as the river may rise with the sea, and cover the sand spit. They themselves are too weak to move. However, we must press on and finally we reach the spot where the group containing Father Schiffer is waiting.

Here a rescue party had brought a large case of fresh rice cakes but there is no one to distribute them to the numerous wounded that lie all about. We distribute them to those that are nearby and also help ourselves. The wounded call for water and we come to the aid of a few. Cries for help are heard from a distance, but we cannot approach the ruins from which they come. A group of soldiers comes along the road and their officer notices that we speak a strange language. He at once draws his sword, screamingly demands who we are and threatens to cut us down. Father Laures, Jr., seizes his arm and explains that we are German. We finally quiet him down. He thought that we might well be Americans who had parachuted down. Rumors of parachutists were being bandied about

the city. The Father Superior who was clothed only in a shirt and trousers, complains of feeling freezing cold, despite the warm summer night and the heat of the burning city. The one man among us who possesses a coat gives it to him and, in addition, I give him my own shirt. To me, it seems more comfortable to be without a shirt in the heat.

In the meantime, it has become midnight. Since there are not enough of us to man both litters with four strong bearers, we determine to remove Father Schiffer first to the outskirts of the city. From there, another group of bearers is to take over to Nagatsuke; the others are to turn back in order to rescue the Father Superior. I am one of the bearers. The theology student goes in front to warn us of the numerous wires, beams and fragments of ruins which block the way and which are impossible to see in the dark. Despite all precautions, our progress is stumbling and our feet get tangled in the wire. Father Kruer falls and carries the litter with him. Father Schiffer becomes half unconscious from the fall and vomits. We pass an injured man who sits all alone among the hot ruins and whom I had seen previously on the way down.

On the Misasa Bridge, we meet Father Tappe and Father Luhmer, who have come to meet us from Nagatsuke. They had dug a family out of the ruins of their collapsed house some fifty meters off the road. The father of the family was already dead. They had dragged out two girls and placed them by the side of the road. Their mother was still trapped under some beams. They had planned to complete the rescue and then to press on to meet us. At the outskirts of the city, we put down the litter and leave two men to wait until those who are to come from Nagatsuke appear. The rest of us turn back to fetch the Father Superior.

Most of the ruins have now burned down. The darkness kindly hides the many forms that lie on the ground. Only occasionally in our quick progress do we hear calls for help. One of us remarks that the remarkable burned smell reminds him of incinerated corpses. The upright, squatting form which we had passed by previously is still there.

Transportation on the litter, which has been constructed out of boards, must be very painful to the Father Superior, whose entire back is full of fragments of glass. In a narrow passage at the edge of town, a car forces us to the edge of the road. The litter bearers on the left side fall into a two meter deep ditch which they could not see in the darkness. Father Superior hides his pain with a dry joke, but the litter which is now no longer in one piece cannot be carried further. We decide to wait until Kinjo can bring a hand cart from Nagatsuke. He soon comes back with one that he has requisitioned from a collapsed house. We place Father Superior on the cart and wheel him the rest of the way, avoiding as much as possible the deeper pits in the road.

About half past four in the morning, we finally arrive at the Novitiate. Our rescue expedition had taken almost twelve hours. Normally, one could go back and forth to the city in two hours. Our two wounded were now, for the first time, properly dressed. I get two hours sleep on the floor; someone else has taken my own bed. Then I read a Mass in *gratiarum actionem*, it is the 7th of August, the anniversary of the foundation of our society. Then we bestir ourselves to bring Father Kleinsorge and other acquaintances out of the city.

We take off again with the hand cart. The bright day now reveals the

frightful picture which last night's darkness had partly concealed. Where the city stood everything, as far as the eye could reach, is a waste of ashes and ruin. Only several skeletons of buildings completely burned out in the interior remain. The banks of the river are covered with dead and wounded, and the rising waters have here and there covered some of the corpses. On the broad street in the Hakushima district, naked burned cadavers are particularly numerous. Among them are the wounded who are still alive. A few have crawled under the burnt-out autos and trams. Frightfully injured forms beckon to us and then collapse. An old woman and a girl whom she is pulling along with her fall down at our feet. We place them on our cart and wheel them to the hospital at whose entrance a dressing station has been set up. Here the wounded lie on the hard floor, row on row. Only the largest wounds are dressed. We convey another soldier and an old woman to the place but we cannot move everybody who lies exposed in the sun. It would be endless and it is questionable whether those whom we can drag to the dressing station can come out alive, because even here nothing really effective can be done. Later, we ascertain that the wounded lay for days in the burnt-out hallways of the hospital and there they died.

We must proceed to our goal in the park and are forced to leave the wounded to their fate. We make our way to the place where our church stood to dig up those few belongings that we had buried yesterday. We find them intact. Everything else has been completely burned. In the ruins, we find a few molten remnants of holy vessels. At the park, we load the housekeeper and a mother with her two children on the cart. Father Kleinsorge feels strong enough, with the aid of Brother Nobuhara, to make his way home on foot. The way back takes us once again past the dead and wounded in Hakushima. Again no rescue parties are in evidence. At the Misasa Bridge, there still lies the family which the Fathers Tappe and Luhmer had yesterday rescued from the ruins. A piece of tin had been placed over them to shield them from the sun. We cannot take them along for our cart is full. We give them and those nearby water to drink and decide to rescue them later. At three o'clock in the afternoon, we are back in Nagatsuka.

After we have had a few swallows and a little food, Fathers Stolte, Luhmer, Erlinghagen and myself, take off once again to bring in the family. Father Kleinsorge requests that we also rescue two children who had lost their mother and who had lain near him in the park. On the way, we were greeted by strangers who had noted that we were on a mission of mercy and who praised our efforts. We now met groups of individuals who were carrying the wounded about on litters. As we arrived at the Misasa Bridge, the family that had been there was gone. They might well have been borne away in the meantime. There was a group of soldiers at work taking away those that had been sacrificed yesterday.

More than thirty hours had gone by until the first official rescue party had appeared on the scene. We find both children and take them out of the park: a six-year old boy who was uninjured, and a twelve-year old girl who had been burned about the head, hands and legs, and who had lain for thirty hours without care in the park. The left side of her face and the left eye were completely covered with blood and pus, so that we thought that she had lost the eye. When the wound was later washed, we noted that the eye was intact and that the lids had just become stuck together. On

the way home, we took another group of three refugees with us. They first wanted to know, however, of what nationality we were. They, too, feared that we might be Americans who had parachuted in. When we arrived in Nagatsuka, it had just become dark.

We took under our care fifty refugees who had lost everything. The majority of them were wounded and not a few had dangerous burns. Father Rektor treated the wounds as well as he could with the few medicaments that we could, with effort, gather up. He had to confine himself in general to cleansing the wounds of purulent material. Even those with the smaller burns are very weak and all suffered from diarrhea. In the farm houses in the vicinity, almost everywhere, there are also wounded. Father Rektor made daily rounds and acted in the capacity of a painstaking physician and was a great Samaritan. Our work was, in the eyes of the people, a greater boost for Christianity than all our work during the preceding long years.

Three of the severely burned in our house died within the next few days. Suddenly the pulse and respirations ceased. It is certainly a sign of our good care that so few died. In the official aid stations and hospitals, a good third or half of those that had been brought in died. They lay about there almost without care, and a very high percentage succumbed. Everything was lacking: doctors, assistants, dressings, drugs, etc. In an aid station at a school at a nearby village, a group of soldiers for several days did nothing except to bring in and cremate the dead behind the school.

During the next few days, funeral processions passed our house from morning to night, bringing the deceased to a small valley nearby. There, in six places, the dead were burned. People brought their own wood and themselves did the cremation. Father Luhmer and Father Laures found a dead man in a nearby house who had already become bloated and who emitted a frightful odor. They brought him to this valley and incinerated him themselves. Even late at night, the little valley was lit up by the funeral pyres.

We made systematic efforts to trace our acquaintances and the families of the refugees whom we had sheltered. Frequently, after the passage of several weeks, some one was found in a distant village or hospital but of many there was no news, and these were apparently dead. We were lucky to discover the mother of the two children whom we had found in the park and who had been given up for dead. After three weeks, she saw her children once again. In the great joy of the reunion were mingled the tears for those whom we shall not see again.

The magnitude of the disaster that befell Hiroshima on August 6th was only slowly pieced together in my mind. I lived through the catastrophe and saw it only in flashes, which only gradually were merged to give me a total picture. What actually happened simultaneously in the city as a whole is as follows: As a result of the explosion of the bomb at 8:15, almost the entire city was destroyed at a single blow. Only small outlying districts in the southern and eastern parts of the town escaped complete destruction. The bomb exploded over the center of the city. As a result of the blast, the small Japanese houses in a diameter of five kilometers, which compressed 99% of the city, collapsed or were blown up. Those who were in the houses were buried in the ruins. Those who were in the open sustained burns resulting from contact with the substance or rays emitted by the bomb. Where the substance struck in quantity, fires sprang up. These

spread rapidly.

The heat which rose from the center created a whirlwind which was effective in spreading fire throughout the whole city. Those who had been caught beneath the ruins and who could not be freed rapidly, and those who had been caught by the flames, became casualties. As much as six kilometers from the center of the explosion, all houses were damaged and many collapsed and caught fire. Even fifteen kilometers away, windows were broken. It was rumored that the enemy fliers had spread an explosive and incendiary material over the city and then had created the explosion and ignition. A few maintained that they saw the planes drop a parachute which had carried something that exploded at a height of 1,000 meters. The newspapers called the bomb an "atomic bomb" and noted that the force of the blast had resulted from the explosion of uranium atoms, and that gamma rays had been sent out as a result of this, but no one knew anything for certain concerning the nature of the bomb.

How many people were a sacrifice to this bomb? Those who had lived through the catastrophe placed the number of dead at at least 100,000. Hiroshima had a population of 400,000. Official statistics place the number who had died at 70,000 up to September 1st, not counting the missing ... and 130,000 wounded, among them 43,500 severely wounded. Estimates made by ourselves on the basis of groups known to us show that the number of 100,000 dead is not too high. Near us there are two barracks, in each of which forty Korean workers lived. On the day of the explosion, they were laboring on the streets of Hiroshima. Four returned alive to one barracks and sixteen to the other. 600 students of the Protestant girls' school worked in a factory, from which only thirty to forty returned. Most of the peasant families in the neighborhood lost one or more of their members who had worked at factories in the city. Our next door neighbor, Tamura, lost two children and himself suffered a large wound since, as it happened, he had been in the city on that day. The family of our reader suffered two dead, father and son; thus a family of five members suffered at least two losses, counting only the dead and severely wounded. There died the Mayor, the President of the central Japan district, the Commander of the city, a Korean prince who had been stationed in Hiroshima in the capacity of an officer, and many other high ranking officers. Of the professors of the University, thirty-two were killed or severely injured. Especially hard hit were the soldiers. The Pioneer Regiment was almost entirely wiped out. The barracks were near the center of the explosion.

Thousands of wounded who died later could doubtless have been rescued had they received proper treatment and care, but rescue work in a catastrophe of this magnitude had not been envisioned; since the whole city had been knocked out at a blow, everything which had been prepared for emergency work was lost, and no preparation had been made for rescue work in the outlying districts. Many of the wounded also died because they had been weakened by under-nourishment and consequently lacked in strength to recover. Those who had their normal strength and who received good care slowly healed the burns which had been occasioned by the bomb. There were also cases, however, whose prognosis seemed good who died suddenly. There were also some who had only small external wounds who died within a week or later, after an inflammation of the pharynx and oral cavity had taken place. We thought at first that this was the result of inhalation of the substance of the bomb.

Later, a commission established the thesis that gamma rays had been given out at the time of the explosion, following which the internal organs had been injured in a manner resembling that consequent upon Roentgen irradiation. This produces a diminution in the numbers of the white corpuscles.

Only several cases are known to me personally where individuals who did not have external burns later died. Father Kleinsorge and Father Cieslik, who were near the center of the explosion, but who did not suffer burns became quite weak some fourteen days after the explosion. Up to this time small incised wounds had healed normally, but thereafter the wounds which were still unhealed became worse and are to date (in September) still incompletely healed. The attending physician diagnosed it as leucopenia. There thus seems to be some truth in the statement that the radiation had some effect on the blood. I am of the opinion, however, that their generally undernourished and weakened condition was partly responsible for these findings. It was noised about that the ruins of the city emitted deadly rays and that workers who went there to aid in the clearing died, and that the central district would be uninhabitable for some time to come. I have my doubts as to whether such talk is true and myself and others who worked in the ruined area for some hours shortly after the explosion suffered no such ill effects.

None of us in those days heard a single outburst against the Americans on the part of the Japanese, nor was there any evidence of a vengeful spirit. The Japanese suffered this terrible blow as part of the fortunes of war ... something to be borne without complaint. During this, war, I have noted relatively little hatred toward the allies on the part of the people themselves, although the press has taken occasion to stir up such feelings. After the victories at the beginning of the war, the enemy was rather looked down upon, but when allied offensive gathered momentum and especially after the advent of the majestic B-29's, the technical skill of America became an object of wonder and admiration.

The following anecdote indicates the spirit of the Japanese: A few days after the atomic bombing, the secretary of the University came to us asserting that the Japanese were ready to destroy San Francisco by means of an equally effective bomb. It is dubious that he himself believed what he told us. He merely wanted to impress upon us foreigners that the Japanese were capable of similar discoveries. In his nationalistic pride, he talked himself into believing this. The Japanese also intimated that the principle of the new bomb was a Japanese discovery. It was only lack of raw materials, they said, which prevented its construction. In the meantime, the Germans were said to have carried the discovery to a further stage and were about to initiate such bombing. The Americans were reputed to have learned the secret from the Germans, and they had then brought the bomb to a stage of industrial completion.

We have discussed among ourselves the ethics of the use of the bomb. Some consider it in the same category as poison gas and were against its use on a civil population. Others were of the view that in total war, as carried on in Japan, there was no difference between civilians and soldiers, and that the bomb itself was an effective force tending to end the bloodshed, warning Japan to surrender and thus to avoid total destruction. It seems logical to me that he who supports total war in principle cannot complain of war against civilians. The crux of the matter is whether total

war in its present form is justifiable, even when it serves a just purpose. Does it not have material and spiritual evil as its consequences which far exceed whatever good that might result? When will our moralists give us a clear answer to this question?

The Atomic Bombings Of Hiroshima And Nagasaki

By The Manhattan Engineer District, June 29, 1946.

Introduction

Statement by the President of the United States: "Sixteen hours ago an American airplane dropped one bomb on Hiroshima, Japan, and destroyed its usefulness to the enemy. That bomb had more power than 20,000 tons of T.N.T. It had more than two thousand times the blast power of the British Grand Slam, which is the largest bomb ever yet used in the history of warfare".

These fateful words of the President on August 6th, 1945, marked the first public announcement of the greatest scientific achievement in history. The atomic bomb, first tested in New Mexico on July 16, 1945, had just been used against a military target.

On August 6th, 1945, at 8:15 A.M., Japanese time, a B-29 heavy bomber flying at high altitude dropped the first atomic bomb on Hiroshima. More than 4 square miles of the city were instantly and completely devastated. 66,000 people were killed, and 69,000 injured.

On August 9th, three days later, at 11:02 A.M., another B-29 dropped the second bomb on the industrial section of the city of Nagasaki, totally destroying 1 1/2 square miles of the city, killing 39,000 persons, and injuring 25,000 more.

On August 10, the day after the atomic bombing of Nagasaki, the Japanese government requested that it be permitted to surrender under the terms of the Potsdam declaration of July 26th which it had previously ignored.

The Manhattan Project Atomic Bomb Investigating Group

On August 11th, 1945, two days after the bombing of Nagasaki, a message was dispatched from Major General Leslie R. Groves to Brigadier General Thomas F. Farrell, who was his deputy in atomic bomb work and was representing him in operations in the Pacific, directing him to organize a special Manhattan Project Atomic Bomb Investigating Group.

This Group was to secure scientific, technical and medical intelligence in the atomic bomb field from within Japan as soon as possible after the cessation of hostilities. The mission was to consist of three groups:

1. Group for Hiroshima.
2. Group for Nagasaki.
3. Group to secure information concerning general Japanese activities in the field of atomic bombs.

The first two groups were organized to accompany the first American troops into Hiroshima and Nagasaki.

The primary purposes of the mission were as follows, in order of

importance:

1. To make certain that no unusual hazards were present in the bombed cities.
2. To secure all possible information concerning the effects of the bombs, both usual and unusual, and particularly with regard to radioactive effects, if any, on the targets or elsewhere.

General Groves further stated that all available specialist personnel and instruments would be sent from the United States, and that the Supreme Allied Commander in the Pacific would be informed about the organization of the mission.

On the same day, 11 August, the special personnel who formed the part of the investigating group to be sent from the United States were selected and ordered to California with instructions to proceed overseas at once to accomplish the purposes set forth in the message to General Farrell. The main party departed from Hamilton Field, California on the morning of 13 August and arrived in the Marianas on 15 August.

On 12 August the Chief of Staff sent the Theater Commander the following message:

"FOR MACARTHUR, SIGNED MARSHALL:

"GROVES HAS ORDERED FARRELL AT TINIAN TO ORGANIZE A SCIENTIFIC GROUP OF THREE SECTIONS FOR POTENTIAL USE IN JAPAN IF SUCH USE SHOULD BE DESIRED. THE FIRST GROUP IS FOR HIROSHIMA, THE SECOND FOR NAGASAKI, AND THE THIRD FOR THE PURPOSE OF SECURING INFORMATION CONCERNING GENERAL JAPANESE ACTIVITIES IN THE FIELD OF ATOMIC WEAPONS. THE GROUPS FOR HIROSHIMA AND NAGASAKI SHOULD ENTER THOSE CITIES WITH THE FIRST AMERICAN TROOPS IN ORDER THAT THESE TROOPS SHALL NOT BE SUBJECTED TO ANY POSSIBLE TOXIC EFFECTS ALTHOUGH WE HAVE NO REASON TO BELIEVE THAT ANY SUCH EFFECTS ACTUALLY EXIST. FARRELL AND HIS ORGANIZATION HAVE ALL AVAILABLE INFORMATION ON THIS SUBJECT."

General Farrell arrived in Yokohama on 30 August, with the Commanding General of the 8th Army; Colonel Warren, who was Chief of the Radiological Division of the District, arrived on 7 September. The main body of the investigating group followed later. Preliminary inspections of Hiroshima and Nagasaki were made on 8-9 and 13-14 September, respectively. Members of the press had been enabled to precede General Farrell to Hiroshima.

The special groups spent 16 days in Nagasaki and 4 days in Hiroshima, during which time they collected as much information as was possible under their directives which called for a prompt report. After General Farrell returned to the U.S. to make his preliminary report, the groups were headed by Brigadier General J. B. Newman, Jr. More extensive surveys have been made since that time by other agencies who had more time and personnel available for the purpose, and much of their additional data has thrown further light on the effects of the bombings. This data has been duly considered in the making of this report.

Propaganda

On the day after the Hiroshima strike, General Farrell received instructions from the War Department to engage in a propaganda

campaign against the Japanese Empire in connection with the new weapon and its use against Hiroshima. The campaign was to include leaflets and any other propaganda considered appropriate. With the fullest cooperation from CINCPAC of the Navy and the United States Strategic Air Forces, he initiated promptly a campaign which included the preparation and distribution of leaflets, broadcasting via short wave every 15 minutes over radio Saipan and the printing at Saipan and distribution over the Empire of a Japanese language newspaper which included the description and photographs of the Hiroshima strike.

The campaign proposed:

1. Dropping 16,000,000 leaflets in a period of 9 days on 47 Japanese cities with population of over 100,000. These cities represented more than 40% of the total population.
2. Broadcast of propaganda at regular intervals over radio Saipan.
3. Distribution of 500,000 Japanese language newspapers containing stories and pictures of the atomic bomb attacks.

The campaign continued until the Japanese began their surrender negotiations. At that time some 6,000,000 leaflets and a large number of newspapers had been dropped. The radio broadcasts in Japanese had been carried out at regular 15 minute intervals.

Summary Of Damages And Injuries

Both the Hiroshima and the Nagasaki atomic bombs exhibited similar effects.

The damages to man-made structures and other inanimate objects was the result in both cities of the following effects of the explosions:

- A. Blast, or pressure wave, similar to that of normal explosions.
- B. Primary fires, i.e., those fires started instantaneously by the heat radiated from the atomic explosion.
- C. Secondary fires, i.e., those fires resulting from the collapse of buildings, damage to electrical systems, overturning of stoves, and other primary effects of the blast.
- D. Spread of the original fires (B and C) to other structures.

The casualties sustained by the inhabitants of both cities were due to:

- A. "Flash" burns, caused directly by the almost instantaneous radiation of heat and light at the moment of the explosion.
- B. Burns resulting from the fires caused by the explosion.
- C. Mechanical injuries caused by collapse of buildings, flying debris, and forceable hurling—about of persons struck by the blast pressure waves.
- D. Radiation injuries caused by the instantaneous penetrating radiation (in many respects similar to excessive X-ray exposure) from the nuclear explosion; all of these effective radiations occurred during the first minute after initiation of the explosion, and nearly all occurred during the first second of the explosion.

No casualties were suffered as a result of any persistent radioactivity of fission products of the bomb, or any induced radioactivity of objects near the explosion. The gamma radiations emitted by the nuclear explosion did

not, of course, inflict any damage on structures.

The number of casualties which resulted from the pure blast effect alone (i.e., because of simple pressure) was probably negligible in comparison to that caused by other effects.

The central portions of the cities underneath the explosions suffered almost complete destruction. The only surviving objects were the frames of a small number of strong reinforced concrete buildings which were not collapsed by the blast; most of these buildings suffered extensive damage from interior fires, had their windows, doors, and partitions knocked out, and all other fixtures which were not integral parts of the reinforced concrete frames burned or blown away; the casualties in such buildings near the center of explosion were almost 100%. In Hiroshima fires sprang up simultaneously all over the wide flat central area of the city; these fires soon combined in an immense "fire storm" (high winds blowing inwards toward the center of a large conflagration) similar to those caused by ordinary mass incendiary raids; the resulting terrific conflagration burned out almost everything which had not already been destroyed by the blast in a roughly circular area of 4.4 square miles around the point directly under the explosion (this point will hereafter in this report be referred to as X). Similar fires broke out in Nagasaki, but no devastating fire storm resulted as in Hiroshima because of the irregular shape of the city.

In both cities the blast totally destroyed everything within a radius of 1 mile from the center of explosion, except for certain reinforced concrete frames as noted above. The atomic explosion almost completely destroyed Hiroshima's identity as a city. Over a fourth of the population was killed in one stroke and an additional fourth seriously injured, so that even if there had been no damage to structures and installations the normal city life would still have been completely shattered. Nearly everything was heavily damaged up to a radius of 3 miles from the blast, and beyond this distance damage, although comparatively light, extended for several more miles. Glass was broken up to 12 miles.

In Nagasaki, a smaller area of the city was actually destroyed than in Hiroshima, because the hills which enclosed the target area restricted the spread of the great blast; but careful examination of the effects of the explosion gave evidence of even greater blast effects than in Hiroshima. Total destruction spread over an area of about 3 square miles. Over a third of the 50,000 buildings in the target area of Nagasaki were destroyed or seriously damaged. The complete destruction of the huge steel works and the torpedo plant was especially impressive. The steel frames of all buildings within a mile of the explosion were pushed away, as by a giant hand, from the point of detonation. The badly burned area extended for 3 miles in length. The hillsides up to a radius of 8,000 feet were scorched, giving them an autumnal appearance.

Main Conclusions

The following are the main conclusions which were reached after thorough examination of the effects of the bombs dropped on Hiroshima and Nagasaki:

1. No harmful amounts of persistent radioactivity were present after the explosions as determined by:

- A. Measurements of the intensity of radioactivity at the time of the

investigation; and

B. Failure to find any clinical evidence of persons harmed by persistent radioactivity.

The effects of the atomic bombs on human beings were of three main types:

A. Burns, remarkable for (1) the great ground area over which they were inflicted and (2) the prevalence of "flash" burns caused by the instantaneous heat radiation.

B. Mechanical injuries, also remarkable for the wide area in which suffered.

C. Effects resulting from penetrating gamma radiation. The effects from radiation were due to instantaneous discharge of radiation at the moment of explosion and not to persistent radioactivity (of either fission products or other substances whose radioactivity might have been induced by proximity to the explosions).

The effects of the atomic bombs on structures and installations were of two types:

A. Destruction caused by the great pressure from the blast; and

B. Destruction caused by the fires, either started directly by the great heat radiation, or indirectly through the collapse of buildings, wiring, etc.

4. The actual tonnage of T.N.T. which would have caused the same blast damage was approximately of the order of 20,000 tons.

5. In respect to their height of burst, the bombs performed exactly according to design.

6. The bombs were placed in such positions that they could not have done more damage from any alternative bursting point in either city.

7. The heights of burst were correctly chosen having regard to the type of destruction it was desired to cause.

8. The information collected would enable a reasonably accurate prediction to be made of the blast damage likely to be caused in any city where an atomic explosion could be effected.

The Selection Of The Target

Some of the most frequent queries concerning the atomic bombs are those dealing with the selection of the targets and the decision as to when the bombs would be used.

The approximate date for the first use of the bomb was set in the fall of 1942 after the Army had taken over the direction of and responsibility for the atomic bomb project. At that time, under the scientific assumptions which turned out to be correct, the summer of 1945 was named as the most likely date when sufficient production would have been achieved to make it possible actually to construct and utilize an atomic bomb. It was essential before this time to develop the technique of constructing and detonating the bomb and to make an almost infinite number of scientific and engineering developments and tests. Between the fall of 1942 and June 1945, the estimated probabilities of success had risen from about 60% to above 90%; however, not until July 16, 1945, when the first full-scale test took place in New Mexico, was it conclusively proven that the

theories, calculations, and engineering were correct and that the bomb would be successful.

The test in New Mexico was held 6 days after sufficient material had become available for the first bomb. The Hiroshima bomb was ready awaiting suitable weather on July 31st, and the Nagasaki bomb was used as soon after the Hiroshima bomb as it was practicable to operate the second mission.

The work on the actual selection of targets for the atomic bomb was begun in the spring of 1945. This was done in close cooperation with the Commanding General, Army Air Forces, and his Headquarters. A number of experts in various fields assisted in the study. These included mathematicians, theoretical physicists, experts on the blast effects of bombs, weather consultants, and various other specialists. Some of the important considerations were:

- A. The range of the aircraft which would carry the bomb.
- B. The desirability of visual bombing in order to insure the most effective use of the bomb.
- C. Probable weather conditions in the target areas.
- D. Importance of having one primary and two secondary targets for each mission, so that if weather conditions prohibited bombing the target there would be at least two alternates.
- E. Selection of targets to produce the greatest military effect on the Japanese people and thereby most effectively shorten the war.
- F. The morale effect upon the enemy.

These led in turn to the following:

- A. Since the atomic bomb was expected to produce its greatest amount of damage by primary blast effect, and next greatest by fires, the targets should contain a large percentage of closely-built frame buildings and other construction that would be most susceptible to damage by blast and fire.
- B. The maximum blast effect of the bomb was calculated to extend over an area of approximately 1 mile in radius; therefore the selected targets should contain a densely built-up area of at least this size.
- C. The selected targets should have a high military strategic value.
- D. The first target should be relatively untouched by previous bombing, in order that the effect of a single atomic bomb could be determined.

The weather records showed that for five years there had never been two successive good visual bombing days over Tokyo, indicating what might be expected over other targets in the home islands. The worst month of the year for visual bombing was believed to be June, after which the weather should improve slightly during July and August and then become worse again during September. Since good bombing conditions would occur rarely, the most intense plans and preparations were necessary in order to secure accurate weather forecasts and to arrange for full utilization of whatever good weather might occur. It was also very desirable to start the raids before September.

Description Of The Cities Before The Bombings

Hiroshima

The city of Hiroshima is located on the broad, flat delta of the Ota River, which has 7 channel outlets dividing the city into six islands which project into Hiroshima Bay. The city is almost entirely flat and only slightly above sea level; to the northwest and northeast of the city some hills rise to 700 feet. A single hill in the eastern part of the city proper about 1/2 mile long and 221 feet in height interrupted to some extent the spreading of the blast damage; otherwise the city was fully exposed to the bomb. Of a city area of over 26 square miles, only 7 square miles were completely built-up. There was no marked separation of commercial, industrial, and residential zones. 75% of the population was concentrated in the densely built-up area in the center of the city.

Hiroshima was a city of considerable military importance. It contained the 2nd Army Headquarters, which commanded the defense of all of southern Japan. The city was a communications center, a storage point, and an assembly area for troops. To quote a Japanese report, "Probably more than a thousand times since the beginning of the war did the Hiroshima citizens see off with cries of 'Banzai' the troops leaving from the harbor."

The center of the city contained a number of reinforced concrete buildings as well as lighter structures. Outside the center, the area was congested by a dense collection of small wooden workshops set among Japanese houses; a few larger industrial plants lay near the outskirts of the city. The houses were of wooden construction with tile roofs. Many of the industrial buildings also were of wood frame construction. The city as a whole was highly susceptible to fire damage.

Some of the reinforced concrete buildings were of a far stronger construction than is required by normal standards in America, because of the earthquake danger in Japan. This exceptionally strong construction undoubtedly accounted for the fact that the framework of some of the buildings which were fairly close to the center of damage in the city did not collapse.

The population of Hiroshima had reached a peak of over 380,000 earlier in the war but prior to the atomic bombing the population had steadily decreased because of a systematic evacuation ordered by the Japanese government. At the time of the attack the population was approximately 255,000. This figure is based on the registered population, used by the Japanese in computing ration quantities, and the estimates of additional workers and troops who were brought into the city may not be highly accurate. Hiroshima thus had approximately the same number of people as the city of Providence, R.I., or Dallas, Tex.

Nagasaki

Nagasaki lies at the head of a long bay which forms the best natural harbor on the southern Japanese home island of Kyushu. The main commercial and residential area of the city lies on a small plain near the end of the bay. Two rivers divided by a mountain spur form the two main valleys in which the city lies. This mountain spur and the irregular lay-out of the city tremendously reduced the area of destruction, so that at first glance Nagasaki appeared to have been less devastated than Hiroshima.

The heavily build-up area of the city is confined by the terrain to less than 4 square miles out of a total of about 35 square miles in the city as a whole.

The city of Nagasaki had been one of the largest sea ports in southern Japan and was of great war-time importance because of its many and varied industries, including the production of ordnance, ships, military equipment, and other war materials. The narrow long strip attacked was of particular importance because of its industries.

In contrast to many modern aspects of Nagasaki, the residences almost without exception were of flimsy, typical Japanese construction, consisting of wood or wood-frame buildings, with wood walls with or without plaster, and tile roofs. Many of the smaller industries and business establishments were also housed in wooden buildings or flimsily built masonry buildings. Nagasaki had been permitted to grow for many years without conforming to any definite city zoning plan and therefore residences were constructed adjacent to factory buildings and to each other almost as close as it was possible to build them throughout the entire industrial valley.

The Attacks

Hiroshima

Hiroshima was the primary target of the first atomic bomb mission. The mission went smoothly in every respect. The weather was good, and the crew and equipment functioned perfectly. In every detail, the attack was carried out exactly as planned, and the bomb performed exactly as expected.

The bomb exploded over Hiroshima at 8:15 on the morning of August 6, 1945. About an hour previously, the Japanese early warning radar net had detected the approach of some American aircraft headed for the southern part of Japan. The alert had been given and radio broadcasting stopped in many cities, among them Hiroshima. The planes approached the coast at a very high altitude. At nearly 8:00 A.M., the radar operator in Hiroshima determined that the number of planes coming in was very small—probably not more than three—and the air raid alert was lifted. The normal radio broadcast warning was given to the people that it might be advisable to go to shelter if B-29's were actually sighted, but no raid was expected beyond some sort of reconnaissance. At 8:15 A.M., the bomb exploded with a blinding flash in the sky, and a great rush of air and a loud rumble of noise extended for many miles around the city; the first blast was soon followed by the sounds of falling buildings and of growing fires, and a great cloud of dust and smoke began to cast a pall of darkness over the city.

At 8:16 A.M., the Tokyo control operator of the Japanese Broadcasting Corporation noticed that the Hiroshima station had gone off the air. He tried to use another telephone line to reestablish his program, but it too had failed. About twenty minutes later the Tokyo railroad telegraph center realized that the main line telegraph had stopped working just north of Hiroshima. From some small railway stops within ten miles of the city there came unofficial and confused reports of a terrible explosion in Hiroshima. All these reports were transmitted to the Headquarters of the Japanese General Staff.

Military headquarters repeatedly tried to call the Army Control Station in Hiroshima. The complete silence from that city puzzled the men at

Headquarters; they knew that no large enemy raid could have occurred, and they knew that no sizeable store of explosives was in Hiroshima at that time. A young officer of the Japanese General Staff was instructed to fly immediately to Hiroshima, to land, survey the damage, and return to Tokyo with reliable information for the staff. It was generally felt at Headquarters that nothing serious had taken place, that it was all a terrible rumor starting from a few sparks of truth.

The staff officer went to the airport and took off for the southwest.

After flying for about three hours, while still nearly 100 miles from Hiroshima, he and his pilot saw a great cloud of smoke from the bomb.

In the bright afternoon, the remains of Hiroshima were burning.

Their plane soon reached the city, around which they circled in disbelief. A great scar on the land, still burning, and covered by a heavy cloud of smoke, was all that was left of a great city. They landed south of the city, and the staff officer immediately began to organize relief measures, after reporting to Tokyo.

Tokyo's first knowledge of what had really caused the disaster came from the White House public announcement in Washington sixteen hours after Hiroshima had been hit by the atomic bomb.

Nagasaki

Nagasaki had never been subjected to large scale bombing prior to the explosion of the atomic bomb there. On August 1st, 1945, however, a number of high explosive bombs were dropped on the city. A few of these bombs hit in the shipyards and dock areas in the southwest portion of the city. Several of the bombs hit the Mitsubishi Steel and Arms Works and six bombs landed at the Nagasaki Medical School and Hospital, with three direct hits on buildings there. While the damage from these few bombs were relatively small, it created considerable concern in Nagasaki and a number of people, principally school children, were evacuated to rural areas for safety, thus reducing the population in the city at the time of the atomic attack.

On the morning of August 9th, 1945, at about 7:50 A.M., Japanese time, an air raid alert was sounded in Nagasaki, but the "All clear" signal was given at 8:30. When only two B-29 superfortresses were sighted at 10:53 the Japanese apparently assumed that the planes were only on reconnaissance and no further alarm was given. A few moments later, at 11:00 o'clock, the observation B-29 dropped instruments attached to three parachutes and at 11:02 the other plane released the atomic bomb.

The bomb exploded high over the industrial valley of Nagasaki, almost midway between the Mitsubishi Steel and Arms Works, in the south, and the Mitsubishi-Urakami Ordnance Works (Torpedo Works), in the north, the two principal targets of the city.

Despite its extreme importance, the first bombing mission on Hiroshima had been almost routine. The second mission was not so uneventful. Again the crew was specially trained and selected; but bad weather introduced some momentous complications. These complications are best described in the brief account of the mission's weaponeer, Comdr., now Capt., F. L. Ashworth, U.S.N., who was in technical command of the bomb and was charged with the responsibility of insuring that the bomb was successfully dropped at the proper time and on the designated target. His narrative

runs as follows:

"The night of our take-off was one of tropical rain squalls, and flashes of lightning stabbed into the darkness with disconcerting regularity. The weather forecast told us of storms all the way from the Marianas to the Empire. Our rendezvous was to be off the southeast coast of Kyushu, some 1500 miles away. There we were to join with our two companion observation B-29's that took off a few minutes behind us. Skillful piloting and expert navigation brought us to the rendezvous without incident.

"About five minutes after our arrival, we were joined by the first of our B-29's. The second, however, failed to arrive, having apparently been thrown off its course by storms during the night. We waited 30 minutes and then proceeded without the second plane toward the target area.

"During the approach to the target the special instruments installed in the plane told us that the bomb was ready to function. We were prepared to drop the second atomic bomb on Japan. But fate was against us, for the target was completely obscured by smoke and haze. Three times we attempted bombing runs, but without success. Then with anti-aircraft fire bursting around us and with a number of enemy fighters coming up after us, we headed for our secondary target, Nagasaki.

"The bomb burst with a blinding flash and a huge column of black smoke swirled up toward us. Out of this column of smoke there boiled a great swirling mushroom of gray smoke, luminous with red, flashing flame, that reached to 40,000 feet in less than 8 minutes. Below through the clouds we could see the pall of black smoke ringed with fire that covered what had been the industrial area of Nagasaki.

"By this time our fuel supply was dangerously low, so after one quick circle of Nagasaki, we headed direct for Okinawa for an emergency landing and refueling".

General Comparison Of Hiroshima And Nagasaki

It was not at first apparent to even trained observers visiting the two Japanese cities which of the two bombs had been the most effective.

In some respects, Hiroshima looked worse than Nagasaki. The fire damage in Hiroshima was much more complete; the center of the city was hit and everything but the reinforced concrete buildings had virtually disappeared. A desert of clear-swept, charred remains, with only a few strong building frames left standing was a terrifying sight.

At Nagasaki there were no buildings just underneath the center of explosion. The damage to the Mitsubishi Arms Works and the Torpedo Works was spectacular, but not overwhelming. There was something left to see, and the main contours of some of the buildings were still normal.

An observer could stand in the center of Hiroshima and get a view of the most of the city; the hills prevented a similar overall view in Nagasaki. Hiroshima impressed itself on one's mind as a vast expanse of desolation; but nothing as vivid was left in one's memory of Nagasaki.

When the observers began to note details, however, striking differences appeared. Trees were down in both cities, but the large trees which fell in Hiroshima were uprooted, while those in Nagasaki were actually snapped off. A few reinforced concrete buildings were smashed at the center in

Hiroshima, but in Nagasaki equally heavy damage could be found 2,300 feet from X. In the study of objects which gave definite clues to the blast pressure, such as squashed tin cans, dished metal plates, bent or snapped poles and like, it was soon evident that the Nagasaki bomb had been much more effective than the Hiroshima bomb. In the description of damage which follows, it will be noted that the radius for the amount of damage was greater in Nagasaki than Hiroshima.

Description Of Damage Caused By The Atomic Explosions

In considering the devastation in the two cities, it should be remembered that the cities' differences in shape and topography resulted in great differences in the damages. Hiroshima was all on low, flat ground, and was roughly circular in shape; Nagasaki was much cut up by hills and mountain spurs, with no regularity to its shape.

In Hiroshima almost everything up to about one mile from X was completely destroyed, except for a small number (about 50) of heavily reinforced concrete buildings, most of which were specially designed to withstand earthquake shock, which were not collapsed by the blast; most of these buildings had their interiors completely gutted, and all windows, doors, sashes, and frames ripped out. In Nagasaki, nearly everything within 1/2 mile of the explosion was destroyed, including heavy structures. All Japanese homes were destroyed within 1 1/2 miles from X.

Underground air raid shelters with earth cover roofs immediately below the explosion had their roofs caved in; but beyond 1/2 mile from X they suffered no damage.

In Nagasaki, 1500 feet from X high quality steel frame buildings were not completely collapsed, but the entire buildings suffered mass distortion and all panels and roofs were blown in.

In Nagasaki, 2,000 feet from X, reinforced concrete buildings with 10" walls and 6" floors were collapsed; reinforced concrete buildings with 4" walls and roofs were standing but were badly damaged. At 2,000 feet some 9" concrete walls were completely destroyed.

In Nagasaki, 3,500 feet from X, church buildings with 18" brick walls were completely destroyed. 12" brick walls were severely cracked as far as 5,000 feet.

In Hiroshima, 4,400 feet from X, multi-story brick buildings were completely demolished. In Nagasaki, similar buildings were destroyed to 5,300 feet.

In Hiroshima, roof tiles were bubbled (melted) by the flash heat out to 4,000 feet from X; in Nagasaki, the same effect was observed to 6,500 feet.

In Hiroshima, steel frame buildings were destroyed 4,200 feet from X, and to 4,800 feet in Nagasaki.

In both cities, the mass distortion of large steel buildings was observed out to 4,500 feet from X.

In Nagasaki, reinforced concrete smoke stacks with 8" walls, specially designed to withstand earthquake shocks, were overturned up to 4,000 feet from X.

In Hiroshima, steel frame buildings suffered severe structural damage up to 5,700 feet from X, and in Nagasaki the same damage was sustained as far as 6,000 feet.

In Nagasaki, 9" brick walls were heavily cracked to 5,000 feet, were moderately cracked to 6,000 feet, and slightly cracked to 8,000 feet. In both cities, light concrete buildings collapsed out to 4,700 feet.

In Hiroshima, multi-story brick buildings suffered structural damage up to 6,600 feet, and in Nagasaki up to 6,500 feet from X.

In both cities overhead electric installations were destroyed up to 5,500 feet; and trolley cars were destroyed up to 5,500 feet, and damaged to 10,500 feet.

Flash ignition of dry, combustible material was observed as far as 6,400 feet from X in Hiroshima, and in Nagasaki as far as 10,000 feet from X.

Severe damage to gas holders occurred out to 6,500 feet in both cities.

All Japanese homes were seriously damaged up to 6,500 feet in Hiroshima, and to 8,000 feet in Nagasaki. Most Japanese homes were damaged up to 8,000 feet in Hiroshima and 10,500 feet in Nagasaki.

The hillsides in Nagasaki were scorched by the flash radiation of heat as far as 8,000 feet from X; this scorching gave the hillsides the appearance of premature autumn.

In Nagasaki, very heavy plaster damage was observed in many buildings up to 9,000 feet; moderate damage was sustained as far as 12,000 feet, and light damage up to 15,000 feet.

The flash charring of wooden telegraph poles was observed up to 9,500 feet from X in Hiroshima, and to 11,000 feet in Nagasaki; some reports indicate flash burns as far as 13,000 feet from X in both places.

Severe displacement of roof tiles was observed up to 8,000 feet in Hiroshima, and to 10,000 feet in Nagasaki.

In Nagasaki, very heavy damage to window frames and doors was observed up to 8,000 feet, and light damage up to 12,000 feet.

Roofs and wall coverings on steel frame buildings were destroyed out to 11,000 feet.

Although the sources of many fires were difficult to trace accurately, it is believed that fires were started by primary heat radiation as far as 15,000 feet from X.

Roof damage extended as far as 16,000 feet from X in Hiroshima and in Nagasaki.

The actual collapse of buildings was observed at the extreme range of 23,000 feet from X in Nagasaki.

Although complete window damage was observed only up to 12,000 feet from X, some window damage occurred in Nagasaki up to 40,000 feet, and actual breakage of glass occurred up to 60,000 feet.

Heavy fire damage was sustained in a circular area in Hiroshima with a mean radius of about 6,000 feet and a maximum radius of about 11,000 feet; similar heavy damage occurred in Nagasaki south of X up to 10,000 feet, where it was stopped on a river course.

In Hiroshima over 60,000 of 90,000 buildings were destroyed or severely

damaged by the atomic bomb; this figure represents over 67% of the city's structures.

In Nagasaki 14,000 or 27% of 52,000 residences were completely destroyed and 5,400, or 10% were half destroyed. Only 12% remained undamaged. This destruction was limited by the layout of the city. The following is a summary of the damage to buildings in Nagasaki as determined from a ground survey made by the Japanese:

Destruction of Buildings and Houses	Number	Percentage
(Compiled by Nagasaki Municipality)		
Total in Nagasaki (before atomic explosion)	50,000	100.0
Blasted (not burned)	2,652	5.3
Blasted and burned	11,494	23.0
Blasted and/or burned	14,146	28.3
Partially burned or blasted	5,441	10.9
Total buildings and houses destroyed	19,587	39.2
Undamaged	30,413	60.8

In Hiroshima, all utilities and transportation services were disrupted for varying lengths of time. In general however services were restored about as rapidly as they could be used by the depleted population. Through railroad service was in order in Hiroshima on 8 August, and electric power was available in most of the surviving parts on 7 August, the day after the bombing. The reservoir of the city was not damaged, being nearly 2 miles from X. However, 70,000 breaks in water pipes in buildings and dwellings were caused by the blast and fire effects. Rolling transportation suffered extensive damage. The damage to railroad tracks, and roads was comparatively small, however. The electric power transmission and distribution systems were badly wrecked. The telephone system was approximately 80% damaged, and no service was restored until 15 August.

Despite the customary Japanese lack of attention to sanitation measures, no major epidemic broke out in the bombed cities. Although the conditions following the bombings makes this fact seem surprising, the experience of other bombed cities in both Germany and Japan show Hiroshima and Nagasaki not to be isolated cases.

The atomic explosion over Nagasaki affected an over-all area of approximately 42.9 square miles of which about 8.5 square miles were water and only about 9.8 square miles were built up, the remainder being partially settled. Approximately 36% of the built up areas were seriously damaged. The area most severely damaged had an average radius of about 1 mile, and covered about 2.9 square miles of which 2.4 were built up.

In Nagasaki, buildings with structural steel frames, principally the Mitsubishi Plant as far as 6,000 feet from X were severely damaged; these buildings were typical of wartime mill construction in America and Great Britain, except that some of the frames were somewhat less substantial. The damage consisted of windows broken out (100%), steel sashes ripped out or bent, corrugated metal or corrugated asbestos roofs and sidings ripped off, roofs bent or destroyed, roof trusses collapsed, columns bent and cracked and concrete foundations for columns rotated. Damage to

buildings with structural steel frames was more severe where the buildings received the effect of the blast on their sides than where the blast hit the ends of buildings, because the buildings had more stiffness (resistance to negative moment at the top of columns) in a longitudinal direction. Many of the lightly constructed steel frame buildings collapsed completely while some of the heavily constructed (to carry the weight of heavy cranes and loads) were stripped of roof and siding, but the frames were only partially injured.

The next most seriously damaged area in Nagasaki lies outside the 2.9 square miles just described, and embraces approximately 4.2 square miles of which 29% was built up. The damage from blast and fire was moderate here, but in some sections (portions of main business districts) many secondary fires started and spread rapidly, resulting in about as much over-all destruction as in areas much closer to X.

An area of partial damage by blast and fire lies just outside the one just described and comprises approximately 35.8 square miles. Of this area, roughly 1/6th was built up and 1/4th was water. The extent of damage varied from serious (severe damage to roofs and windows in the main business section of Nagasaki, 2.5 miles from X), to minor (broken or occasionally broken windows at a distance of 7 miles southeast of X).

As intended, the bomb was exploded at an almost ideal location over Nagasaki to do the maximum damage to industry, including the Mitsubishi Steel and Arms Works, the Mitsubishi-Urakami Ordnance Works (Torpedo Works), and numerous factories, factory training schools, and other industrial establishments, with a minimum destruction of dwellings and consequently, a minimum amount of casualties. Had the bomb been dropped farther south, the Mitsubishi-Urakami Ordnance Works would not have been so severely damaged, but the main business and residential districts of Nagasaki would have sustained much greater damage casualties.

Calculations show that the structural steel and reinforced concrete frames which survived the blast fairly close to X could not have withstood the estimated peak pressures developed against the total areas presented by the sides and roof of the buildings. The survival of these frames is explained by the fact that they were not actually required to withstand the peak pressure because the windows were quickly knocked out and roof and siding stripped off thereby reducing total area and relieving the pressure. While this saved the building frame, it permitted severe damage to building interior and contents, and injuries to the building occupants. Buildings without large panel openings through which the pressure could dissipate were completely crushed, even when their frames were as strong as those which survived.

The damage sustained by reinforced concrete buildings depended both on the proximity to X and the type and strength of the reinforced concrete construction. Some of the buildings with reinforced concrete frames also had reinforced concrete walls, ceilings, and partitions, while others had brick or concrete tile walls covered either with plaster or ornamental stone, with partitions of metal, glass, and plaster. With the exception of the Nagasaki Medical School and Hospital group, which was designed to withstand earthquakes and was therefore of heavier construction than most American structures, most of the reinforced concrete structures could be classified only as fair, with concrete of low strength and density, with

many of the columns, beams, and slabs underdesigned and improperly reinforced. These facts account for some of the structural failures which occurred.

In general, the atomic bomb explosion damaged all windows and ripped out, bent, or twisted most of the steel window or door sashes, ripped doors from hinges, damaged all suspended wood, metal, and plaster ceilings. The blast concussion also caused great damage to equipment by tumbling and battering. Fires generally of secondary origin consumed practically all combustible material, caused plaster to crack off, burned all wooden trim, stair covering, wooden frames of wooden suspended ceilings, beds, mattresses, and mats, and fused glass, ruined all equipment not already destroyed by the blast, ruined all electrical wiring, plumbing, and caused spalling of concrete columns and beams in many of the rooms.

Almost without exception masonry buildings of either brick or stone within the effective limits of the blast were severely damaged so that most of them were flattened or reduced to rubble. The wreckage of a church, approximately 1,800 feet east of X in Nagasaki, was one of the few masonry buildings still recognizable and only portions of the walls of this structure were left standing. These walls were extremely thick (about 2 feet). The two domes of the church had reinforced concrete frames and although they were toppled, they held together as units.

Practically every wooden building or building with timber frame within 2.0 miles of X was either completely destroyed or very seriously damaged, and significant damage in Nagasaki resulted as far as 3 miles from X. Nearly all such buildings collapsed and a very large number were consumed by fire.

A reference to the various photographs depicting damage shows that although most of the buildings within the effective limits of the blast were totally destroyed or severely damaged, a large number of chimneys even close to X were left standing, apparently uninjured by the concussion. One explanation is that concrete chimneys are approximately cylindrical in shape and consequently offer much less wind resistance than flat surfaces such as buildings. Another explanation is that since the cities were subject to typhoons the more modern chimneys were probably designed to withstand winds of high velocity. It is also probable that most of the recently constructed chimneys as well as the more modern buildings were constructed to withstand the acceleration of rather severe earthquakes. Since the bombs were exploded high in the air, chimneys relatively close to X were subjected to more of a downward than a lateral pressure, and consequently the overturning moment was much less than might have been anticipated.

Although the blast damaged many bridges to some extent, bridge damage was on the whole slight in comparison to that suffered by buildings. The damage varied from only damaged railings to complete destruction of the superstructure. Some of the bridges were wrecked and the spans were shoved off their piers and into the river bed below by the force of the blast. Others, particularly steel plate girder bridges, were badly buckled by the blast pressure. None of the failures observed could be attributed to inadequate design or structural weaknesses.

The roads, and railroad and street railway trackage sustained practically no primary damage as a result of the explosion. Most of the damage to railroads occurred from secondary causes, such as fires and damage to

bridges or other structures. Rolling stock, as well as automobiles, trolleys, and buses were destroyed and burned up to a considerable distance from X. Streets were impassable for awhile because of the debris, but they were not damaged. The height of the bomb explosion probably explains the absence of direct damage to railroads and roads.

A large part of the electric supply was interrupted by the bomb blast chiefly through damage to electric substations and overhead transmission systems. Both gas works in Nagasaki were severely damaged by the bomb. These works would have required 6-7 months to get into operation. In addition to the damage sustained by the electrical and gas systems, severe damage to the water supply system was reported by the Japanese government; the chief damage was a number of breaks in the large water mains and in almost all of the distributing pipes in the areas which were affected by the blast. Nagasaki was still suffering from a water shortage inside the city six weeks after the atomic attack.

The Nagasaki Prefectural report describes vividly the effects of the bomb on the city and its inhabitants:

"Within a radius of 1 kilometer from X, men and animals died almost instantaneously and outside a radius of 1 kilometer and within a radius of 2 kilometers from X, some men and animals died instantly from the great blast and heat but the great majority were seriously or superficially injured. Houses and other structures were completely destroyed while fires broke out everywhere. Trees were uprooted and withered by the heat.

"Outside a radius of 2 kilometers and within a radius of 4 kilometers from X, men and animals suffered various degrees of injury from window glass and other fragments scattered about by the blast and many were burned by the intense heat. Dwellings and other structures were half damaged by blast.

"Outside a radius of 4 kilometers and within a radius of 8 kilometers living creatures were injured by materials blown about by the blast; the majority were only superficially wounded. Houses were only half or partially damaged."

The British Mission to Japan interpreted their observations of the destruction of buildings to apply to similar construction of their own as follows:

A similar bomb exploding in a similar fashion would produce the following effects on normal British houses:

Up to 1,000 yards from X it would cause complete collapse.

Up to 1 mile from X it would damage the houses beyond repair.

Up to 1.5 miles from X it would render them uninhabitable without extensive repair, particularly to roof timbers.

Up to 2.5 miles from X it would render them uninhabitable until first-aid repairs had been carried out.

The fire damage in both cities was tremendous, but was more complete in Hiroshima than in Nagasaki. The effect of the fires was to change profoundly the appearance of the city and to leave the central part bare, except for some reinforced concrete and steel frames and objects such as safes, chimney stacks, and pieces of twisted sheet metal. The fire damage resulted more from the properties of the cities themselves than from those

of the bombs.

The conflagration in Hiroshima caused high winds to spring up as air was drawn in toward the center of the burning area, creating a "fire storm". The wind velocity in the city had been less than 5 miles per hour before the bombing, but the fire-wind attained a velocity of 30-40 miles per hour. These great winds restricted the perimeter of the fire but greatly added to the damage of the conflagration within the perimeter and caused the deaths of many persons who might otherwise have escaped. In Nagasaki, very severe damage was caused by fires, but no extensive "fire storm" engulfed the city. In both cities, some of the fires close to X were no doubt started by the ignition of highly combustible material such as paper, straw, and dry cloth, upon the instantaneous radiation of heat from the nuclear explosion. The presence of large amounts of unburnt combustible materials near X, however, indicated that even though the heat of the blast was very intense, its duration was insufficient to raise the temperature of many materials to the kindling point except in cases where conditions were ideal. The majority of the fires were of secondary origin starting from the usual electrical short-circuits, broken gas lines, overturned stoves, open fires, charcoal braziers, lamps, etc., following collapse or serious damage from the direct blast.

Fire fighting and rescue units were stripped of men and equipment. Almost 30 hours elapsed before any rescue parties were observable. In Hiroshima only a handful of fire engines were available for fighting the ensuing fires, and none of these were of first class type. In any case, however, it is not likely that any fire fighting equipment or personnel or organization could have effected any significant reduction in the amount of damage caused by the tremendous conflagration.

A study of numerous aerial photographs made prior to the atomic bombings indicates that between 10 June and 9 August 1945 the Japanese constructed fire breaks in certain areas of the cities in order to control large scale fires. In general these fire breaks were not effective because fires were started at so many locations simultaneously. They appear, however, to have helped prevent fires from spreading farther east into the main business and residential section of Nagasaki.

Total Casualties

There has been great difficulty in estimating the total casualties in the Japanese cities as a result of the atomic bombing. The extensive destruction of civil installations (hospitals, fire and police department, and government agencies) the state of utter confusion immediately following the explosion, as well as the uncertainty regarding the actual population before the bombing, contribute to the difficulty of making estimates of casualties. The Japanese periodic censuses are not complete. Finally, the great fires that raged in each city totally consumed many bodies.

The number of total casualties has been estimated at various times since the bombings with wide discrepancies. The Manhattan Engineer District's best available figures are:

TABLE A

Estimates of Casualties

Hiroshima Nagasaki

Pre-raid population 255,000 195,000
 Dead 66,000 39,000
 Injured 69,000 25,000
 Total Casualties 135,000 64,000

The relation of total casualties to distance from X, the center of damage and point directly under the air-burst explosion of the bomb, is of great importance in evaluating the casualty-producing effect of the bombs. This relationship for the total population of Nagasaki is shown in the table below, based on the first-obtained casualty figures of the District:

TABLE B

Relation of Total Casualties to Distance from X

Distance square mile	Total Killed	per from X, feet	Killed	Injured	Missing	Casualties
0 - 1,640	7,505	960	1,127	9,592	24,700	1,640 - 3,300 3,688
1,478 - 1,799	6,965	4,040	3,300	4,900	8,678	17,137 3,597 29,412 5,710
4,900 - 6,550	221	11,958	28	12,207	125	6,550 - 9,850 112 9,460 17 9,589 20

No figure for total pre-raid population at these different distances were available. Such figures would be necessary in order to compute per cent mortality. A calculation made by the British Mission to Japan and based on a preliminary analysis of the study of the Joint Medical-Atomic Bomb Investigating Commission gives the following calculated values for per cent mortality at increasing distances from X:

TABLE C

Per-Cent Mortality at Various Distances

Distance from X, Per-cent Mortality

in feet

0 - 1000 93.0%
 1000 - 2000 92.0
 2000 - 3000 86.0
 3000 - 4000 69.0
 4000 - 5000 49.0
 5000 - 6000 31.5
 6000 - 7000 12.5
 7000 - 8000 1.3
 8000 - 9000 0.5
 9000 - 10,000 0.0

It seems almost certain from the various reports that the greatest total number of deaths were those occurring immediately after the bombing. The causes of many of the deaths can only be surmised, and of course many persons near the center of explosion suffered fatal injuries from more than one of the bomb effects. The proper order of importance for possible causes of death is: burns, mechanical injury, and gamma radiation. Early estimates by the Japanese are shown in D below:

TABLE D

Cause of Immediate Deaths

City Cause of Death Per-cent of Total

Hiroshima Burns 60%

Falling debris 30

Other 10

Nagasaki Burns 95%

Falling debris 9

Flying glass 7

Other 7

The Nature Of An Atomic Explosion

The most striking difference between the explosion of an atomic bomb and that of an ordinary T.N.T. bomb is of course in magnitude; as the President announced after the Hiroshima attack, the explosive energy of each of the atomic bombs was equivalent to about 20,000 tons of T.N.T.

But in addition to its vastly greater power, an atomic explosion has several other very special characteristics. Ordinary explosion is a chemical reaction in which energy is released by the rearrangement of the atoms of the explosive material. In an atomic explosion the identity of the atoms, not simply their arrangement, is changed. A considerable fraction of the mass of the explosive charge, which may be uranium 235 or plutonium, is transformed into energy. Einstein's equation, $E = mc^2$, shows that matter that is transformed into energy may yield a total energy equivalent to the mass multiplied by the square of the velocity of light. The significance of the equation is easily seen when one recalls that the velocity of light is 186,000 miles per second. The energy released when a pound of T.N.T. explodes would, if converted entirely into heat, raise the temperature of 36 lbs. of water from freezing temperature (32 deg F) to boiling temperature (212 deg F). The nuclear fission of a pound of uranium would produce an equal temperature rise in over 200 million pounds of water.

The explosive effect of an ordinary material such as T.N.T. is derived from the rapid conversion of solid T.N.T. to gas, which occupies initially the same volume as the solid; it exerts intense pressures on the surrounding air and expands rapidly to a volume many times larger than the initial volume. A wave of high pressure thus rapidly moves outward from the center of the explosion and is the major cause of damage from ordinary high explosives. An atomic bomb also generates a wave of high pressure which is in fact of, much higher pressure than that from ordinary explosions; and this wave is again the major cause of damage to buildings and other structures. It differs from the pressure wave of a block buster in the size of the area over which high pressures are generated. It also differs in the duration of the pressure pulse at any given point: the pressure from a blockbuster lasts for a few milliseconds (a millisecond is one thousandth of a second) only, that from the atomic bomb for nearly a second, and was felt by observers both in Japan and in New Mexico as a very strong wind going by.

The next greatest difference between the atomic bomb and the T.N.T. explosion is the fact that the atomic bomb gives off greater amounts of radiation. Most of this radiation is "light" of some wave-length ranging from the so-called heat radiations of very long wave length to the so-called gamma rays which have wave-lengths even shorter than the

X-rays used in medicine. All of these radiations travel at the same speed; this, the speed of light, is 186,000 miles per second. The radiations are intense enough to kill people within an appreciable distance from the explosion, and are in fact the major cause of deaths and injuries apart from mechanical injuries. The greatest number of radiation injuries was probably due to the ultra-violet rays which have a wave length slightly shorter than visible light and which caused flash burn comparable to severe sunburn. After these, the gamma rays of ultra short wave length are most important; these cause injuries similar to those from over-doses of X-rays.

The origin of the gamma rays is different from that of the bulk of the radiation: the latter is caused by the extremely high temperatures in the bomb, in the same way as light is emitted from the hot surface of the sun or from the wires in an incandescent lamp. The gamma rays on the other hand are emitted by the atomic nuclei themselves when they are transformed in the fission process. The gamma rays are therefore specific to the atomic bomb and are completely absent in T.N.T. explosions. The light of longer wave length (visible and ultra-violet) is also emitted by a T.N.T. explosion, but with much smaller intensity than by an atomic bomb, which makes it insignificant as far as damage is concerned.

A large fraction of the gamma rays is emitted in the first few microseconds (millionths of a second) of the atomic explosion, together with neutrons which are also produced in the nuclear fission. The neutrons have much less damage effect than the gamma rays because they have a smaller intensity and also because they are strongly absorbed in air and therefore can penetrate only to relatively small distances from the explosion: at a thousand yards the neutron intensity is negligible. After the nuclear emission, strong gamma radiation continues to come from the exploded bomb. This generates from the fission products and continues for about one minute until all of the explosion products have risen to such a height that the intensity received on the ground is negligible. A large number of beta rays are also emitted during this time, but they are unimportant because their range is not very great, only a few feet. The range of alpha particles from the unused active material and fissionable material of the bomb is even smaller.

Apart from the gamma radiation ordinary light is emitted, some of which is visible and some of which is the ultra violet rays mainly responsible for flash burns. The emission of light starts a few milliseconds after the nuclear explosion when the energy from the explosion reaches the air surrounding the bomb. The observer sees then a ball of fire which rapidly grows in size. During most of the early time, the ball of fire extends as far as the wave of high pressure. As the ball of fire grows its temperature and brightness decrease. Several milliseconds after the initiation of the explosion, the brightness of the ball of fire goes through a minimum, then it gets somewhat brighter and remains at the order of a few times the brightness of the sun for a period of 10 to 15 seconds for an observer at six miles distance. Most of the radiation is given off after this point of maximum brightness. Also after this maximum, the pressure waves run ahead of the ball of fire.

The ball of fire rapidly expands from the size of the bomb to a radius of several hundred feet at one second after the explosion. After this the most striking feature is the rise of the ball of fire at the rate of about 30

yards per second. Meanwhile it also continues to expand by mixing with the cooler air surrounding it. At the end of the first minute the ball has expanded to a radius of several hundred yards and risen to a height of about one mile. The shock wave has by now reached a radius of 15 miles and its pressure dropped to less than 1/10 of a pound per square inch. The ball now loses its brilliance and appears as a great cloud of smoke: the pulverized material of the bomb. This cloud continues to rise vertically and finally mushrooms out at an altitude of about 25,000 feet depending upon meteorological conditions. The cloud reaches a maximum height of between 50,000 and 70,000 feet in a time of over 30 minutes.

It is of interest to note that Dr. Hans Bethe, then a member of the Manhattan Engineer District on loan from Cornell University, predicted the existence and characteristics of this ball of fire months before the first test was carried out.

To summarize, radiation comes in two bursts—an extremely intense one lasting only about 3 milliseconds and a less intense one of much longer duration lasting several seconds. The second burst contains by far the larger fraction of the total light energy, more than 90%. But the first flash is especially large in ultra-violet radiation which is biologically more effective. Moreover, because the heat in this flash comes in such a short time, there is no time for any cooling to take place, and the temperature of a person's skin can be raised 50 degrees centigrade by the flash of visible and ultra-violet rays in the first millisecond at a distance of 4,000 yards. People may be injured by flash burns at even larger distances. Gamma radiation danger does not extend nearly so far and neutron radiation danger is still more limited.

The high skin temperatures result from the first flash of high intensity radiation and are probably as significant for injuries as the total dosages which come mainly from the second more sustained burst of radiation. The combination of skin temperature increase plus large ultra-violet flux inside 4,000 yards is injurious in all cases to exposed personnel. Beyond this point there may be cases of injury, depending upon the individual sensitivity. The infra-red dosage is probably less important because of its smaller intensity.

Characteristics Of The Damage Caused By The Bombs

The damage to man-made structures caused by the bombs was due to two distinct causes: first the blast, or pressure wave, emanating from the center of the explosion, and, second, the fires which were caused either by the heat of the explosion itself or by the collapse of buildings containing stoves, electrical fixtures, or any other equipment which might produce what is known as a secondary fire, and subsequent spread of these fires.

The blast produced by the atomic bomb has already been stated to be approximately equivalent to that of 20,000 tons of T.N.T. Given this figure, one may calculate the expected peak pressures in the air, at various distances from the center of the explosion, which occurred following detonation of the bomb. The peak pressures which were calculated before the bombs were dropped agreed very closely with those which were actually experienced in the cities during the attack as computed by Allied experts in a number of ingenious ways after the occupation of Japan.

The blast of pressure from the atomic bombs differed from that of

ordinary high explosive bombs in three main ways:

A. Downward thrust. Because the explosions were well up in the air, much of the damage resulted from a downward pressure. This pressure of course most largely effected flat roofs. Some telegraph and other poles immediately below the explosion remained upright while those at greater distances from the center of damage, being more largely exposed to a horizontal thrust from the blast pressure waves, were overturned or tilted. Trees underneath the explosion remained upright but had their branches broken downward.

B. Mass distortion of buildings. An ordinary bomb can damage only a part of a large building, which may then collapse further under the action of gravity. But the blast wave from an atomic bomb is so large that it can engulf whole buildings, no matter how great their size, pushing them over as though a giant hand had given them a shove.

C. Long duration of the positive pressure pulse and consequent small effect of the negative pressure, or suction, phase. In any explosion, the positive pressure exerted by the blast lasts for a definite period of time (usually a small fraction of a second) and is then followed by a somewhat longer period of negative pressure, or suction. The negative pressure is always much weaker than the positive, but in ordinary explosions the short duration of the positive pulse results in many structures not having time to fail in that phase, while they are able to fail under the more extended, though weaker, negative pressure. But the duration of the positive pulse is approximately proportional to the $1/3$ power of the size of the explosive charge. Thus, if the relation held true throughout the range in question, a 10-ton T.N.T. explosion would have a positive pulse only about $1/14$ th as long as that of a 20,000-ton explosion. Consequently, the atomic explosions had positive pulses so much longer than those of ordinary explosives that nearly all failures probably occurred during this phase, and very little damage could be attributed to the suction which followed.

One other interesting feature was the combination of flash ignition and comparative slow pressure wave. Some objects, such as thin, dry wooden slats, were ignited by the radiated flash heat, and then their fires were blown out some time later (depending on their distance from X) by the pressure blast which followed the flash radiation.

Calculations Of The Peak Pressure Of The Blast Wave

Several ingenious methods were used by the various investigators to determine, upon visiting the wrecked cities, what had actually been the peak pressures exerted by the atomic blasts. These pressures were computed for various distances from X, and curves were then plotted which were checked against the theoretical predictions of what the pressures would be. A further check was afforded from the readings obtained by the measuring instruments which were dropped by parachute at each atomic attack. The peak pressure figures gave a direct clue to the equivalent T.N.T. tonnage of the atomic bombs, since the pressures developed by any given amount of T.N.T. can be calculated easily.

One of the simplest methods of estimating the peak pressure is from crushing of oil drums, gasoline cans, or any other empty thin metal vessel with a small opening. The assumption made is that the blast wave pressure comes on instantaneously, the resulting pressure on the can is

more than the case can withstand, and the walls collapse inward. The air inside is compressed adiabatically to such a point that the pressure inside is less by a certain amount than the pressure outside, this amount being the pressure difference outside and in that the walls can stand in their crumpled condition. The uncertainties involved are, first, that some air rushes in through any opening that the can may have, and thus helps to build up the pressure inside; and, second, that as the pressure outside falls, the air inside cannot escape sufficiently fast to avoid the walls of the can being blown out again to some extent. These uncertainties are such that estimates of pressure based on this method are on the low side, i.e., they are underestimated.

Another method of calculating the peak-pressure is through the bending of steel flagpoles, or lightning conductors, away from the explosion. It is possible to calculate the drag on a pole or rod in an airstream of a certain density and velocity; by connecting this drag with the strength of the pole in question, a determination of the pressure wave may be obtained.

Still another method of estimating the peak pressure is through the overturning of memorial stones, of which there are a great quantity in Japan. The dimensions of the stones can be used along with known data on the pressure exerted by wind against flat surfaces, to calculate the desired figure.

Long Range Blast Damage

There was no consistency in the long range blast damage. Observers often thought that they had found the limit, and then 2,000 feet farther away would find further evidence of damage.

The most impressive long range damage was the collapse of some of the barracks sheds at Kamigo, 23,000 feet south of X in Nagasaki. It was remarkable to see some of the buildings intact to the last details, including the roof and even the windows, and yet next to them a similar building collapsed to ground level.

The limiting radius for severe displacement of roof tiles in Nagasaki was about 10,000 feet although isolated cases were found up to 16,000 feet. In Hiroshima the general limiting radius was about 8,000 feet; however, even at a distance of 26,000 feet from X in Hiroshima, some tiles were displaced.

At Mogi, 7 miles from X in Nagasaki, over steep hills over 600 feet high, about 10% of the glass came out. In nearer, sequestered localities only 4 miles from X, no damage of any kind was caused. An interesting effect was noted at Mogi; eyewitnesses said that they thought a raid was being made on the place; one big flash was seen, then a loud roar, followed at several second intervals by half a dozen other loud reports, from all directions. These successive reports were obviously reflections from the hills surrounding Mogi.

Ground Shock

The ground shock in most cities was very light. Water pipes still carried water and where leaks were visible they were mainly above ground. Virtually all of the damage to underground utilities was caused by the collapse of buildings rather than by any direct exertion of the blast

pressure. This fact of course resulted from the bombs' having been exploded high in the air.

Shielding, Or Screening From Blast

In any explosion, a certain amount of protection from blast may be gained by having any large and substantial object between the protected object and the center of the explosion. This shielding effect was noticeable in the atomic explosions, just as in ordinary cases, although the magnitude of the explosions and the fact that they occurred at a considerable height in the air caused marked differences from the shielding which would have characterized ordinary bomb explosions.

The outstanding example of shielding was that afforded by the hills in the city of Nagasaki; it was the shielding of these hills which resulted in the smaller area of devastation in Nagasaki despite the fact that the bomb used there was not less powerful. The hills gave effective shielding only at such distances from the center of explosion that the blast pressure was becoming critical—that is, was only barely sufficient to cause collapse—for the structure. Houses built in ravines in Nagasaki pointing well away from the center of the explosion survived without damage, but others at similar distances in ravines pointing toward the center of explosion were greatly damaged. In the north of Nagasaki there was a small hamlet about 8,000 feet from the center of explosion; one could see a distinctive variation in the intensity of damage across the hamlet, corresponding with the shadows thrown by a sharp hill.

The best example of shielding by a hill was southeast of the center of explosion in Nagasaki. The damage at 8,000 feet from X consisted of light plaster damage and destruction of about half the windows. These buildings were of European type and were on the reverse side of a steep hill. At the same distance to the south-southeast the damage was considerably greater, i.e., all windows and frames, doors, were damaged and heavy plaster damage and cracks in the brick work also appeared. The contrast may be illustrated also by the fact that at the Nagasaki Prefectural office at 10,800 feet the damage was bad enough for the building to be evacuated, while at the Nagasaki Normal School to which the Prefectural office had been moved, at the same distance, the damage was comparatively light.

Because of the height of the bursts no evidence was expected of the shielding of one building by another, at least up to a considerable radius. It was in fact difficult to find any evidence at any distance of such shielding. There appeared to have been a little shielding of the building behind the Administration Building of the Torpedo Works in Nagasaki, but the benefits were very slight. There was also some evidence that the group of buildings comprising the Medical School in Nagasaki did afford each other mutual protection. On the whole, however, shielding of one building by another was not noticeable.

There was one other peculiar type of shielding, best exhibited by the workers' houses to the north of the torpedo plant in Nagasaki. These were 6,000 to 7,000 feet north of X. The damage to these houses was not nearly as bad as those over a thousand feet farther away from the center of explosion. It seemed as though the great destruction caused in the torpedo plant had weakened the blast a little, and the full power was not restored for another 1,000 feet or more.

Flash Burn

As already stated, a characteristic feature of the atomic bomb, which is quite foreign to ordinary explosives, is that a very appreciable fraction of the energy liberated goes into radiant heat and light. For a sufficiently large explosion, the flash burn produced by this radiated energy will become the dominant cause of damage, since the area of burn damage will increase in proportion to the energy released, whereas the area of blast damage increases only with the two-thirds power of the energy. Although such a reversal of the mechanism of damage was not achieved in the Hiroshima and Nagasaki bombs, the effects of the flash were, however, very evident, and many casualties resulted from flash burns. A discussion of the casualties caused by flash burns will be given later; in this section will be described the other flash effects which were observed in the two cities.

The duration of the heat radiation from the bomb is so short, just a few thousandths of a second, that there is no time for the energy falling on a surface to be dissipated by thermal defusion; the flash burn is typically a surface effect. In other words the surface of either a person or an object exposed to the flash is raised to a very high temperature while immediately beneath the surface very little rise in temperature occurs.

The flash burning of the surface of objects, particularly wooden objects, occurred in Hiroshima up to a radius of 9,500 feet from X; at Nagasaki burns were visible up to 11,000 feet from X. The charring and blackening of all telephone poles, trees and wooden posts in the areas not destroyed by the general fire occurred only on the side facing the center of explosion and did not go around the corners of buildings or hills. The exact position of the explosion was in fact accurately determined by taking a number of sights from various objects which had been flash burned on one side only.

To illustrate the effects of the flash burn, the following describes a number of examples found by an observer moving northward from the center of explosion in Nagasaki. First occurred a row of fence posts at the north edge of the prison hill, at 0.3 miles from X. The top and upper part of these posts were heavily charred. The charring on the front of the posts was sharply limited by the shadow of a wall. This wall had however been completely demolished by the blast, which of course arrived some time after the flash. At the north edge of the Torpedo works, 1.05 miles from X, telephone poles were charred to a depth of about 0.5 millimeters. A light piece of wood similar to the flat side of an orange crate, was found leaning against one of the telephone poles. Its front surface was charred the same way as the pole, but it was evident that it had actually been ignited. The wood was blackened through a couple of cracks and nail holes, and around the edges onto the back surface. It seemed likely that this piece of wood had flamed up under the surface for a few seconds before the flame was blown out by the wind of the blast. Farther out, between 1.05 and 1.5 miles from the explosion, were many trees and poles showing a blackening. Some of the poles had platforms near the top. The shadows cast by the platforms were clearly visible and showed that the bomb had detonated at a considerable height. The row of poles turned north and crossed the mountain ridge; the flash burn was plainly visible all the way to the top of the ridge, the farthest burn observed being at 2.0 miles from X.

Another striking effect of the flash burn was the autumnal appearance of the bowl formed by the hills on three sides of the explosion point. The ridges are about 1.5 miles from X. Throughout this bowl the foliage turned yellow, although on the far side of the ridges the countryside was quite green. This autumnal appearance of the trees extended to about 8,000 feet from X.

However, shrubs and small plants quite near the center of explosion in Hiroshima, although stripped of leaves, had obviously not been killed.

Many were throwing out new buds when observers visited the city.

There are two other remarkable effects of the heat radiated from the bomb explosion. The first of these is the manner in which heat roughened the surface of polished granite, which retained its polish only where it was shielded from the radiated heat travelling in straight lines from the explosion. This roughening by radiated heat caused by the unequal expansion of the constituent crystals of the stone; for granite crystals the melting temperature is about 600 deg centigrade. Therefore the depth of roughening and ultimate flaking of the granite surface indicated the depth to which this temperature occurred and helped to determine the average ground temperatures in the instant following the explosion. This effect was noted for distances about 1 1/2 times as great in Nagasaki as in Hiroshima.

The second remarkable effect was the bubbling of roof tile. The size of the bubbles and their extent was proportional to their nearness to the center of explosion and also depended on how squarely the tile itself was faced toward the explosion. The distance ratio of this effect between Nagasaki and Hiroshima was about the same as for the flaking of polished granite.

Various other effects of the radiated heat were noted, including the lightening of asphalt road surfaces in spots which had not been protected from the radiated heat by any object such as that of a person walking along the road. Various other surfaces were discolored in different ways by the radiated heat.

As has already been mentioned the fact that radiant heat traveled only in straight lines from the center of explosion enabled observers to determine the direction toward the center of explosion from a number of different points, by observing the "shadows" which were cast by intervening objects where they shielded the otherwise exposed surface of some object. Thus the center of explosion was located with considerable accuracy. In a number of cases these "shadows" also gave an indication of the height of burst of the bomb and occasionally a distinct penumbra was found which enabled observers to calculate the diameter of the ball of fire at the instant it was exerting the maximum charring or burning effect.

One more interesting feature connected with heat radiation was the charring of fabric to different degrees depending upon the color of the fabric. A number of instances were recorded in which persons wearing clothing of various colors received burns greatly varying in degree, the degree of burn depending upon the color of the fabric over the skin in question. For example a shirt of alternate light and dark gray stripes, each about 1/8 of an inch wide, had the dark stripes completely burned out but the light stripes were undamaged; and a piece of Japanese paper exposed nearly 1 1/2 miles from X had the characters which were written in black

ink neatly burned out.

Characteristics Of The Injuries To Persons

Injuries to persons resulting from the atomic explosions were of the following types:

A. Burns, from

1. Flash radiation of heat
2. Fires started by the explosions.

B. Mechanical injuries from collapse of buildings, flying debris, etc.

C. Direct effects of the high blast pressure, i.e., straight compression.

D. Radiation injuries, from the instantaneous emission of gamma rays and neutrons.

It is impossible to assign exact percentages of casualties to each of the types of injury, because so many victims were injured by more than one effect of the explosions. However, it is certain that the greater part of the casualties resulted from burns and mechanical injuries. Col. Warren, one of America's foremost radiologists, stated it is probable that 7 per cent or less of the deaths resulted primarily from radiation disease.

The greatest single factor influencing the occurrence of casualties was the distance of the person concerned from the center of explosion.

Estimates based on the study of a selected group of 900 patients indicated that total casualties occurred as far out as 14,000 feet at Nagasaki and 12,000 feet at Hiroshima.

Burns were suffered at a considerable greater distance from X than any other type of injury, and mechanical injuries farther out than radiation effects.

Medical findings show that no person was injured by radioactivity who was not exposed to the actual explosion of the bombs. No injuries resulted from persistent radioactivity of any sort.

Burns

Two types of burns were observed. These are generally differentiated as flame or fire burn and so-called flash burn.

The early appearance of the flame burn as reported by the Japanese, and the later appearance as observed, was not unusual.

The flash burn presented several distinctive features. Marked redness of the affected skin areas appeared almost immediately, according to the Japanese, with progressive changes in the skin taking place over a period of a few hours. When seen after 50 days, the most distinctive feature of these burns was their sharp limitation to exposed skin areas facing the center of the explosion. For instance, a patient who had been walking in a direction at right angles to a line drawn between him and the explosion, and whose arms were swinging, might have burns only on the outside of the arm nearest the center and on the inside of the other arm.

Generally, any type of shielding protected the skin against flash burns, although burns through one, and very occasionally more, layers of clothing did occur in patients near the center. In such cases, it was not unusual

to find burns through black but not through white clothing, on the same patient. Flash burns also tended to involve areas where the clothes were tightly drawn over the skin, such as at the elbows and shoulders.

The Japanese report the incidence of burns in patients surviving more than a few hours after the explosion, and seeking medical attention, as high as 95%. The total mortalities due to burns alone cannot be estimated with any degree of accuracy. As mentioned already, it is believed that the majority of all the deaths occurred immediately. Of these, the Japanese estimate that 75%, and most of the reports estimate that over 50%, of the deaths were due to burns.

In general, the incidence of burns was in direct proportion to the distance from X. However, certain irregularities in this relationship result in the medical studies because of variations in the amount of shielding from flash burn, and because of the lack of complete data on persons killed outright close to X.

The maximum distance from X at which flash burns were observed is of paramount interest. It has been estimated that patients with burns at Hiroshima were all less than 7,500 feet from the center of the explosion at the time of the bombing. At Nagasaki, patients with burns were observed out to the remarkable distance of 13,800 feet.

Mechanical Injuries

The mechanical injuries included fractures, lacerations, contusions, abrasions, and other effects to be expected from falling roofs, crumbling walls, flying debris and glass, and other indirect blast effects. The appearance of these various types of mechanical injuries was not remarkable to the medical authorities who studied them.

It was estimated that patients with lacerations at Hiroshima were less than 10,600 feet from X, whereas at Nagasaki they extended as far as 12,200 feet.

The tremendous drag of wind, even as far as 1 mile from X, must have resulted in many injuries and deaths. Some large pieces of a prison wall, for example, were flung 80 feet, and many have gone 30 feet high before falling. The same fate must have befallen many persons, and the chances of a human being surviving such treatment are probably small.

Blast Injuries

No estimate of the number of deaths or early symptoms due to blast pressure can be made. The pressures developed on the ground under the explosions were not sufficient to kill more than those people very near the center of damage (within a few hundred feet at most). Very few cases of ruptured ear drums were noted, and it is the general feeling of the medical authorities that the direct blast effects were not great. Many of the Japanese reports, which are believed to be false, describe immediate effects such as ruptured abdomens with protruding intestines and protruding eyes, but no such results were actually traced to the effect of air pressure alone.

Radiation Injuries

As pointed out in another section of this report the radiations from the nuclear explosions which caused injuries to persons were primarily those experienced within the first second after the explosion; a few may have occurred later, but all occurred in the first minute. The other two general types of radiation, viz., radiation from scattered fission products and induced radioactivity from objects near the center of explosion, were definitely proved not to have caused any casualties.

The proper designation of radiation injuries is somewhat difficult. Probably the two most direct designations are radiation injury and gamma ray injury. The former term is not entirely suitable in that it does not define the type of radiation as ionizing and allows possible confusion with other types of radiation (e.g., infra-red). The objection to the latter term is that it limits the ionizing radiation to gamma rays, which were undoubtedly the most important; but the possible contribution of neutron and even beta rays to the biological effects cannot be entirely ignored. Radiation injury has the advantage of custom, since it is generally understood in medicine to refer to X-ray effect as distinguished from the effects of actinic radiation. Accordingly, radiation injury is used in this report to mean injury due only to ionizing radiation.

According to Japanese observations, the early symptoms in patients suffering from radiation injury closely resembled the symptoms observed in patients receiving intensive roentgen therapy, as well as those observed in experimental animals receiving large doses of X-rays. The important symptoms reported by the Japanese and observed by American authorities were epilation (lose of hair), petechiae (bleeding into the skin), and other hemorrhagic manifestations, oropharyngeal lesions (inflammation of the mouth and throat), vomiting, diarrhea, and fever.

Epilation was one of the most spectacular and obvious findings. The appearance of the epilated patient was typical. The crown was involved more than the sides, and in many instances the resemblance to a monk's tonsure was striking. In extreme cases the hair was totally lost. In some cases, re-growth of hair had begun by the time patients were seen 50 days after the bombing. Curiously, epilation of hair other than that of the scalp was extremely unusual.

Petechiae and other hemorrhagic manifestations were striking findings. Bleeding began usually from the gums and in the more seriously affected was soon evident from every possible source. Petechiae appeared on the limbs and on pressure points. Large ecchymoses (hemorrhages under the skin) developed about needle punctures, and wounds partially healed broke down and bled freely. Retinal hemorrhages occurred in many of the patients. The bleeding time and the coagulation time were prolonged. The platelets (coagulation of the blood) were characteristically reduced in numbers.

Nausea and vomiting appearing within a few hours after the explosion was reported frequently by the Japanese. This usually had subsided by the following morning, although occasionally it continued for two or three days. Vomiting was not infrequently reported and observed during the course of the later symptoms, although at these times it generally appeared to be related to other manifestation of systemic reactions associated with infection.

Diarrhea of varying degrees of severity was reported and observed. In the more severe cases, it was frequently bloody. For reasons which are not yet clear, the diarrhea in some cases was very persistent.

Lesions of the gums, and the oral mucous membrane, and the throat were observed. The affected areas became deep red, then violaceous in color; and in many instances ulcerations and necrosis (breakdown of tissue) followed. Blood counts done and recorded by the Japanese, as well as counts done by the Manhattan Engineer District Group, on such patients regularly showed leucopenia (low-white blood cell count). In extreme cases the white blood cell count was below 1,000 (normal count is around 7,000). In association with the leucopenia and the oropharyngeal lesions, a variety of other infective processes were seen. Wounds and burns which were healing adequately suppurated and serious necrosis occurred. At the same time, similar ulcerations were observed in the larynx, bowels, and in females, the genitalia. Fever usually accompanied these lesions.

Eye injuries produced by the atomic bombings in both cities were the subject of special investigations. The usual types of mechanical injuries were seen. In addition, lesions consisting of retinal hemorrhage and exudation were observed and 75% of the patients showing them had other signs of radiation injury.

The progress of radiation disease of various degrees of severity is shown in the following table:

Summary of Radiation Injury

Clinical Symptoms and Findings

Day

after

Explo-

sion Most Severe Moderately Severe Mild

- | | | |
|-----|------------------------|-------------------------|
| 1. | 1. Nausea and vomiting | 1. Nausea and vomiting |
| 2. | after 1-2 hours. | after 1-2 hours. |
| 3. | NO DEFINITE SYMPTOMS | |
| 4. | | |
| 5. | 2. Diarrhea | |
| 6. | 3. Vomiting | NO DEFINITE SYMPTOMS |
| 7. | 4. Inflammation of the | |
| | mouth and throat | |
| 8. | 5. Fever | |
| 9. | 6. Rapid emaciation | |
| 10. | Death | NO DEFINITE SYMPTOMS |
| 11. | (Mortality probably | 2. Beginning epilation. |
| 12. | 100%) | |
| 13. | | |
| 14. | | |
| 15. | | |
| 16. | | |

- 17.
18. 3. Loss of appetite
19. and general malaise. 1. Epilation
20. 4. Fever. 2. Loss of appetite
21. 5. Severe inflammation and malaise.
22. of the mouth and throat 3. Sore throat.
23. 4. Pallor.
24. 5. Petechiae
25. 6. Diarrhea
26. 7. Moderate emacia-
27. 6. Pallor. tion.
28. 7. Petechiae, diarrhea
29. and nose bleeds (Recovery unless com-
30. plicated by previous
31. 8. Rapid emaciation poor health or
Death super-imposed in-
(Mortality probably 50%) juries or infec-
tion).

It was concluded that persons exposed to the bombs at the time of detonation did show effects from ionizing radiation and that some of these patients, otherwise uninjured, died. Deaths from radiation began about a week after exposure and reached a peak in 3 to 4 weeks. They practically ceased to occur after 7 to 8 weeks.

Treatment of the burns and other physical injuries was carried out by the Japanese by orthodox methods. Treatment of radiation effects by them included general supportive measures such as rest and high vitamin and caloric diets. Liver and calcium preparations were administered by injection and blood transfusions were used to combat hemorrhage. Special vitamin preparations and other special drugs used in the treatment of similar medical conditions were used by American Army Medical Corps officers after their arrival. Although the general measures instituted were of some benefit no definite effect of any of the specific measures on the course of the disease could be demonstrated. The use of sulfonamide drugs by the Japanese and particularly of penicillin by the American physicians after their arrival undoubtedly helped control the infections and they appear to be the single important type of treatment which may have effectively altered the earlier course of these patients.

One of the most important tasks assigned to the mission which investigated the effects of the bombing was that of determining if the radiation effects were all due to the instantaneous discharges at the time of the explosion, or if people were being harmed in addition from persistent radioactivity. This question was investigated from two points of view. Direct measurements of persistent radioactivity were made at the time of the investigation. From these measurements, calculations were made of the graded radiation dosages, i.e., the total amount of radiation which could have been absorbed by any person. These calculations showed that the highest dosage which would have been received from

persistent radioactivity at Hiroshima was between 6 and 25 roentgens of gamma radiation; the highest in the Nagasaki Area was between 30 and 110 roentgens of gamma radiation. The latter figure does not refer to the city itself, but to a localized area in the Nishiyama District. In interpreting these findings it must be understood that to get these dosages, one would have had to remain at the point of highest radioactivity for 6 weeks continuously, from the first hour after the bombing. It is apparent therefore that insofar as could be determined at Hiroshima and Nagasaki, the residual radiation alone could not have been detrimental to the health of persons entering and living in the bombed areas after the explosion.

The second approach to this question was to determine if any persons not in the city at the time of the explosion, but coming in immediately afterwards exhibited any symptoms or findings which might have been due to persistence induced radioactivity. By the time of the arrival of the Manhattan Engineer District group, several Japanese studies had been done on such persons. None of the persons examined in any of these studies showed any symptoms which could be attributed to radiation, and their actual blood cell counts were consistently within the normal range. Throughout the period of the Manhattan Engineer District investigation, Japanese doctors and patients were repeatedly requested to bring to them any patients who they thought might be examples of persons harmed from persistent radioactivity. No such subjects were found.

It was concluded therefore as a result of these findings and lack of findings, that although a measurable quantity of induced radioactivity was found, it had not been sufficient to cause any harm to persons living in the two cities after the bombings.

Shielding From Radiation

Exact figures on the thicknesses of various substances to provide complete or partial protection from the effects of radiation in relation to the distance from the center of explosion, cannot be released at this time. Studies of collected data are still under way. It can be stated, however, that at a reasonable distance, say about 1/2 mile from the center of explosion, protection to persons from radiation injury can be afforded by a layer of concrete or other material whose thickness does not preclude reasonable construction.

Radiation ultimately caused the death of the few persons not killed by other effects and who were fully exposed to the bombs up to a distance of about 1/2 mile from X. The British Mission has estimated that people in the open had a 50% chance of surviving the effects of radiation at 3/4 of a mile from X.

The Effects On The Inhabitants Of The Bombed Cities

In both Hiroshima and Nagasaki the tremendous scale of the disaster largely destroyed the cities as entities. Even the worst of all other previous bombing attacks on Germany and Japan, such as the incendiary raids on Hamburg in 1943 and on Tokyo in 1945, were not comparable to the paralyzing effect of the atomic bombs. In addition to the huge number of persons who were killed or injured so that their services in rehabilitation were not available, a panic flight of the population took place from both cities immediately following the atomic explosions. No significant

reconstruction or repair work was accomplished because of the slow return of the population; at the end of November 1945 each of the cities had only about 140,000 people. Although the ending of the war almost immediately after the atomic bombings removed much of the incentive of the Japanese people toward immediate reconstruction of their losses, their paralysis was still remarkable. Even the clearance of wreckage and the burning of the many bodies trapped in it were not well organized some weeks after the bombings. As the British Mission has stated, "the impression which both cities make is of having sunk, in an instant and without a struggle, to the most primitive level."

Aside from physical injury and damage, the most significant effect of the atomic bombs was the sheer terror which it struck into the peoples of the bombed cities. This terror, resulting in immediate hysterical activity and flight from the cities, had one especially pronounced effect: persons who had become accustomed to mass air raids had grown to pay little heed to single planes or small groups of planes, but after the atomic bombings the appearance of a single plane caused more terror and disruption of normal life than the appearance of many hundreds of planes had ever been able to cause before. The effect of this terrible fear of the potential danger from even a single enemy plane on the lives of the peoples of the world in the event of any future war can easily be conjectured.

The atomic bomb did not alone win the war against Japan, but it most certainly ended it, saving the thousands of Allied lives that would have been lost in any combat invasion of Japan.

Worldwide Effects Of Nuclear War

By U.S. Arms Control and Disarmament Agency, 1975

Introduction

It has now been two decades since the introduction of thermonuclear fusion weapons into the military inventories of the great powers, and more than a decade since the United States, Great Britain, and the Soviet Union ceased to test nuclear weapons in the atmosphere. Today our understanding of the technology of thermonuclear weapons seems highly advanced, but our knowledge of the physical and biological consequences of nuclear war is continuously evolving.

Only recently, new light was shed on the subject in a study which the Arms Control and Disarmament Agency had asked the National Academy of Sciences to undertake. Previous studies had tended to focus very largely on radioactive fallout from a nuclear war; an important aspect of this new study was its inquiry into all possible consequences, including the effects of large-scale nuclear detonations on the ozone layer which helps protect life on earth from the sun's ultraviolet radiations. Assuming a total detonation of 10,000 megatons--a large-scale but less than total nuclear "exchange," as one would say in the dehumanizing jargon of the strategists--it was concluded that as much as 30-70 percent of the ozone might be eliminated from the northern hemisphere (where a nuclear war would presumably take place) and as much as 20-40 percent from the southern hemisphere. Recovery would probably take about 3-10 years, but the Academy's study notes that long term global changes cannot be completely ruled out.

The reduced ozone concentrations would have a number of consequences outside the areas in which the detonations occurred. The Academy study notes, for example, that the resultant increase in ultraviolet would cause "prompt incapacitating cases of sunburn in the temperate zones and snow blindness in northern countries . . ."

Strange though it might seem, the increased ultraviolet radiation could also be accompanied by a drop in the average temperature. The size of the change is open to question, but the largest changes would probably occur at the higher latitudes, where crop production and ecological balances are sensitively dependent on the number of frost-free days and other factors related to average temperature. The Academy's study concluded that ozone changes due to nuclear war might decrease global surface temperatures by only negligible amounts or by as much as a few degrees. To calibrate the significance of this, the study mentioned that a cooling of even 1 degree centigrade would eliminate commercial wheat growing in Canada.

Thus, the possibility of a serious increase in ultraviolet radiation has been added to widespread radioactive fallout as a fearsome consequence of the large-scale use of nuclear weapons. And it is likely that we must reckon with still other complex and subtle processes, global in scope, which could seriously threaten the health of distant populations in the event of an all-out nuclear war.

Up to now, many of the important discoveries about nuclear weapon effects have been made not through deliberate scientific inquiry but by accident. And as the following historical examples show, there has been a series of surprises.

“Castle/Bravo” was the largest nuclear weapon ever detonated by the United States. Before it was set off at Bikini on February 28, 1954, it was expected to explode with an energy equivalent of about 8 million tons of TNT. Actually, it produced almost twice that explosive power--equivalent to 15 million tons of TNT.

If the power of the bomb was unexpected, so were the after-effects. About 6 hours after the explosion, a fine, sandy ash began to sprinkle the Japanese fishing vessel Lucky Dragon, some 90 miles downwind of the burst point, and Rongelap Atoll, 100 miles downwind. Though 40 to 50 miles away from the proscribed test area, the vessel's crew and the islanders received heavy doses of radiation from the weapon's “fallout”--the coral rock, soil, and other debris sucked up in the fireball and made intensively radioactive by the nuclear reaction. One radioactive isotope in the fallout, iodine-131, rapidly built up to serious concentration in the thyroid glands of the victims, particularly young Rongelapese children.

More than any other event in the decade of testing large nuclear weapons in the atmosphere, Castle/Bravo's unexpected contamination of 7,000 square miles of the Pacific Ocean dramatically illustrated how large-scale nuclear war could produce casualties on a colossal scale, far beyond the local effects of blast and fire alone.

A number of other surprises were encountered during 30 years of nuclear weapons development. For example, what was probably man's most extensive modification of the global environment to date occurred in September 1962, when a nuclear device was detonated 250 miles above Johnson Island. The 1.4-megaton burst produced an artificial belt of charged particles trapped in the earth's magnetic field. Though 98 percent of these particles were removed by natural processes after the first year, traces could be detected 6 or 7 years later. A number of satellites in low earth orbit at the time of the burst suffered severe electronic damage resulting in malfunctions and early failure. It became obvious that man now had the power to make long term changes in his near-space environment.

Another unexpected effect of high-altitude bursts was the blackout of high-frequency radio communications. Disruption of the ionosphere (which reflects radio signals back to the earth) by nuclear bursts over the Pacific has wiped out long-distance radio communications for hours at distances of up to 600 miles from the burst point.

Yet another surprise was the discovery that electromagnetic pulses can play havoc with electrical equipment itself, including some in command systems that control the nuclear arms themselves.

Much of our knowledge was thus gained by chance--a fact which should imbue us with humility as we contemplate the remaining uncertainties (as well as the certainties) about nuclear warfare. What we have learned enables us, nonetheless, to see more clearly. We know, for instance, that some of the earlier speculations about the after-effects of a global nuclear war were as far-fetched as they were horrifying--such as the idea that the worldwide accumulation of radioactive fallout would eliminate all life on the

planet, or that it might produce a train of monstrous genetic mutations in all living things, making future life unrecognizable. And this accumulation of knowledge which enables us to rule out the more fanciful possibilities also allows us to reexamine, with some scientific rigor, other phenomena which could seriously affect the global environment and the populations of participant and nonparticipant countries alike.

This paper is an attempt to set in perspective some of the longer term effects of nuclear war on the global environment, with emphasis on areas and peoples distant from the actual targets of the weapons.

The Mechanics Of Nuclear Explosions

In nuclear explosions, about 90 percent of the energy is released in less than one millionth of a second. Most of this is in the form of the heat and shock waves which produce the damage. It is this immediate and direct explosive power which could devastate the urban centers in a major nuclear war.

Compared with the immediate colossal destruction suffered in target areas, the more subtle, longer term effects of the remaining 10 percent of the energy released by nuclear weapons might seem a matter of secondary concern. But the dimensions of the initial catastrophe should not overshadow the after-effects of a nuclear war. They would be global, affecting nations remote from the fighting for many years after the holocaust, because of the way nuclear explosions behave in the atmosphere and the radioactive products released by nuclear bursts.

When a weapon is detonated at the surface of the earth or at low altitudes, the heat pulse vaporizes the bomb material, target, nearby structures, and underlying soil and rock, all of which become entrained in an expanding, fast-rising fireball. As the fireball rises, it expands and cools, producing the distinctive mushroom cloud, signature of nuclear explosions.

The altitude reached by the cloud depends on the force of the explosion. When yields are in the low-kiloton range, the cloud will remain in the lower atmosphere and its effects will be entirely local. But as yields exceed 30 kilotons, part of the cloud will punch into the stratosphere, which begins about 7 miles up. With yields of 2-5 megatons or more, virtually all of the cloud of radioactive debris and fine dust will climb into the stratosphere. The heavier materials reaching the lower edge of the stratosphere will soon settle out, as did the Castle/Bravo fallout at Rongelap. But the lighter particles will penetrate high into the stratosphere, to altitudes of 12 miles and more, and remain there for months and even years. Stratospheric circulation and diffusion will spread this material around the world.

Radioactive Fallout

Both the local and worldwide fallout hazards of nuclear explosions depend on a variety of interacting factors: weapon design, explosive force, altitude and latitude of detonation, time of year, and local weather conditions.

All present nuclear weapon designs require the splitting of heavy elements like uranium and plutonium. The energy released in this fission process is many millions of times greater, pound for pound, than the

most energetic chemical reactions. The smaller nuclear weapon, in the low-kiloton range, may rely solely on the energy released by the fission process, as did the first bombs which devastated Hiroshima and Nagasaki in 1945. The larger yield nuclear weapons derive a substantial part of their explosive force from the fusion of heavy forms of hydrogen--deuterium and tritium. Since there is virtually no limitation on the volume of fusion materials in a weapon, and the materials are less costly than fissionable materials, the fusion, "thermonuclear," or "hydrogen" bomb brought a radical increase in the explosive power of weapons. However, the fission process is still necessary to achieve the high temperatures and pressures needed to trigger the hydrogen fusion reactions. Thus, all nuclear detonations produce radioactive fragments of heavy elements fission, with the larger bursts producing an additional radiation component from the fusion process.

The nuclear fragments of heavy-element fission which are of greatest concern are those radioactive atoms (also called radionuclides) which decay by emitting energetic electrons or gamma particles. (See "Radioactivity" note.) An important characteristic here is the rate of decay. This is measured in terms of "half-life"--the time required for one-half of the original substance to decay--which ranges from days to thousands of years for the bomb-produced radionuclides of principal interest. (See "Nuclear Half-Life" note.) Another factor which is critical in determining the hazard of radionuclides is the chemistry of the atoms. This determines whether they will be taken up by the body through respiration or the food cycle and incorporated into tissue. If this occurs, the risk of biological damage from the destructive ionizing radiation (see "Radioactivity" note) is multiplied.

Probably the most serious threat is cesium-137, a gamma emitter with a half-life of 30 years. It is a major source of radiation in nuclear fallout, and since it parallels potassium chemistry, it is readily taken into the blood of animals and men and may be incorporated into tissue.

Other hazards are strontium-90, an electron emitter with a half-life of 28 years, and iodine-131 with a half-life of only 8 days. Strontium-90 follows calcium chemistry, so that it is readily incorporated into the bones and teeth, particularly of young children who have received milk from cows consuming contaminated forage. Iodine-131 is a similar threat to infants and children because of its concentration in the thyroid gland. In addition, there is plutonium-239, frequently used in nuclear explosives. A bone-seeker like strontium-90, it may also become lodged in the lungs, where its intense local radiation can cause cancer or other damage. Plutonium-239 decays through emission of an alpha particle (helium nucleus) and has a half-life of 24,000 years.

To the extent that hydrogen fusion contributes to the explosive force of a weapon, two other radionuclides will be released: tritium (hydrogen-3), an electron emitter with a half-life of 12 years, and carbon-14, an electron emitter with a half-life of 5,730 years. Both are taken up through the food cycle and readily incorporated in organic matter.

Three types of radiation damage may occur: bodily damage (mainly leukemia and cancers of the thyroid, lung, breast, bone, and gastrointestinal tract); genetic damage (birth defects and constitutional and degenerative diseases due to gonadal damage suffered by parents); and developmental and growth damage (primarily growth and mental

retardation of unborn infants and young children). Since heavy radiation doses of about 20 roentgen or more (see "Radioactivity" note) are necessary to produce developmental defects, these effects would probably be confined to areas of heavy local fallout in the nuclear combatant nations and would not become a global problem.

A. Local Fallout

Most of the radiation hazard from nuclear bursts comes from short-lived radionuclides external to the body; these are generally confined to the locality downwind of the weapon burst point. This radiation hazard comes from radioactive fission fragments with half-lives of seconds to a few months, and from soil and other materials in the vicinity of the burst made radioactive by the intense neutron flux of the fission and fusion reactions.

It has been estimated that a weapon with a fission yield of 1 million tons TNT equivalent power (1 megaton) exploded at ground level in a 15 miles-per-hour wind would produce fallout in an ellipse extending hundreds of miles downwind from the burst point. At a distance of 20-25 miles downwind, a lethal radiation dose (600 rads) would be accumulated by a person who did not find shelter within 25 minutes after the time the fallout began. At a distance of 40-45 miles, a person would have at most 3 hours after the fallout began to find shelter. Considerably smaller radiation doses will make people seriously ill. Thus, the survival prospects of persons immediately downwind of the burst point would be slim unless they could be sheltered or evacuated.

It has been estimated that an attack on U.S. population centers by 100 weapons of one-megaton fission yield would kill up to 20 percent of the population immediately through blast, heat, ground shock and instant radiation effects (neutrons and gamma rays); an attack with 1,000 such weapons would destroy immediately almost half the U.S. population. These figures do not include additional deaths from fires, lack of medical attention, starvation, or the lethal fallout showering to the ground downwind of the burst points of the weapons.

Most of the bomb-produced radionuclides decay rapidly. Even so, beyond the blast radius of the exploding weapons there would be areas ("hot spots") the survivors could not enter because of radioactive contamination from long-lived radioactive isotopes like strontium-90 or cesium-137, which can be concentrated through the food chain and incorporated into the body. The damage caused would be internal, with the injurious effects appearing over many years. For the survivors of a nuclear war, this lingering radiation hazard could represent a grave threat for as long as 1 to 5 years after the attack.

B. Worldwide Effects of Fallout

Much of our knowledge of the production and distribution of radionuclides has been derived from the period of intensive nuclear testing in the atmosphere during the 1950's and early 1960's. It is estimated that more than 500 megatons of nuclear yield were detonated in the atmosphere between 1945 and 1971, about half of this yield being produced by a fission reaction. The peak occurred in 1961-62, when a total of 340 megatons were detonated in the atmosphere by the United States and Soviet Union. The limited nuclear test ban treaty of 1963 ended atmospheric testing for the United States, Britain, and the Soviet Union, but two major non-signatories, France and China, continued nuclear

testing at the rate of about 5 megatons annually. (France now conducts its nuclear tests underground.)

A U.N. scientific committee has estimated that the cumulative per capita dose to the world's population up to the year 2000 as a result of atmospheric testing through 1970 (cutoff date of the study) will be the equivalent of 2 years' exposure to natural background radiation on the earth's surface. For the bulk of the world's population, internal and external radiation doses of natural origin amount to less than one-tenth rad annually. Thus nuclear testing to date does not appear to pose a severe radiation threat in global terms. But a nuclear war releasing 10 or 100 times the total yield of all previous weapons tests could pose a far greater worldwide threat.

The biological effects of all forms of ionizing radiation have been calculated within broad ranges by the National Academy of Sciences. Based on these calculations, fallout from the 500-plus megatons of nuclear testing through 1970 will produce between 2 and 25 cases of genetic disease per million live births in the next generation. This means that between 3 and 50 persons per billion births in the post-testing generation will have genetic damage for each megaton of nuclear yield exploded. With similar uncertainty, it is possible to estimate that the induction of cancers would range from 75 to 300 cases per megaton for each billion people in the post-test generation.

If we apply these very rough yardsticks to a large-scale nuclear war in which 10,000 megatons of nuclear force are detonated, the effects on a world population of 5 billion appear enormous. Allowing for uncertainties about the dynamics of a possible nuclear war, radiation-induced cancers and genetic damage together over 30 years are estimated to range from 1.5 to 30 million for the world population as a whole. This would mean one additional case for every 100 to 3,000 people or about 1/2 percent to 15 percent of the estimated peacetime cancer death rate in developed countries. As will be seen, moreover, there could be other, less well understood effects which would drastically increase suffering and death.

Alterations Of The Global Environment

A nuclear war would involve such prodigious and concentrated short term release of high temperature energy that it is necessary to consider a variety of potential environmental effects.

It is true that the energy of nuclear weapons is dwarfed by many natural phenomena. A large hurricane may have the power of a million hydrogen bombs. But the energy release of even the most severe weather is diffuse; it occurs over wide areas, and the difference in temperature between the storm system and the surrounding atmosphere is relatively small. Nuclear detonations are just the opposite--highly concentrated with reaction temperatures up to tens of millions of degrees Fahrenheit. Because they are so different from natural processes, it is necessary to examine their potential for altering the environment in several contexts.

A. High Altitude Dust

It has been estimated that a 10,000-megaton war with half the weapons exploding at ground level would tear up some 25 billion cubic meters of rock and soil, injecting a substantial amount of fine dust and particles into the stratosphere. This is roughly twice the volume of material blasted

loose by the Indonesian volcano, Krakatoa, whose explosion in 1883 was the most powerful terrestrial event ever recorded. Sunsets around the world were noticeably reddened for several years after the Krakatoa eruption, indicating that large amounts of volcanic dust had entered the stratosphere.

Subsequent studies of large volcanic explosions, such as Mt. Agung on Bali in 1963, have raised the possibility that large-scale injection of dust into the stratosphere would reduce sunlight intensities and temperatures at the surface, while increasing the absorption of heat in the upper atmosphere.

The resultant minor changes in temperature and sunlight could affect crop production. However, no catastrophic worldwide changes have resulted from volcanic explosions, so it is doubtful that the gross injection of particulates into the stratosphere by a 10,000-megaton conflict would, by itself, lead to major global climate changes.

B. Ozone

More worrisome is the possible effect of nuclear explosions on ozone in the stratosphere. Not until the 20th century was the unique and paradoxical role of ozone fully recognized. On the other hand, in concentrations greater than 1 part per million in the air we breathe, ozone is toxic; one major American city, Los Angeles, has established a procedure for ozone alerts and warnings. On the other hand, ozone is a critically important feature of the stratosphere from the standpoint of maintaining life on the earth.

The reason is that while oxygen and nitrogen in the upper reaches of the atmosphere can block out solar ultraviolet photons with wavelengths shorter than 2,420 angstroms (A), ozone is the only effective shield in the atmosphere against solar ultraviolet radiation between 2,500 and 3,000 A in wavelength. (See note 5.) Although ozone is extremely efficient at filtering out solar ultraviolet in the 2,500-3,000 A region of the spectrum, some does get through at the higher end of the spectrum. Ultraviolet rays in the range of 2,800 to 3,200 A which cause sunburn, prematurely age human skin and produce skin cancers. As early as 1840, arctic snow blindness was attributed to solar ultraviolet; and we have since found that intense ultraviolet radiation can inhibit photosynthesis in plants, stunt plant growth, damage bacteria, fungi, higher plants, insects and animals, and produce genetic alterations.

Despite the important role ozone plays in assuring a liveable environment at the earth's surface, the total quantity of ozone in the atmosphere is quite small, only about 3 parts per million. Furthermore, ozone is not a durable or static constituent of the atmosphere. It is constantly created, destroyed, and recreated by natural processes, so that the amount of ozone present at any given time is a function of the equilibrium reached between the creative and destructive chemical reactions and the solar radiation reaching the upper stratosphere.

The mechanism for the production of ozone is the absorption by oxygen molecules (O₂) of relatively short-wavelength ultraviolet light. The oxygen molecule separates into two atoms of free oxygen, which immediately unite with other oxygen molecules on the surfaces of particles in the upper atmosphere. It is this union which forms ozone, or O₃. The heat released by the ozone-forming process is the reason for the curious increase with

altitude of the temperature of the stratosphere (the base of which is about 36,000 feet above the earth's surface).

While the natural chemical reaction produces about 4,500 tons of ozone per second in the stratosphere, this is offset by other natural chemical reactions which break down the ozone. By far the most significant involves nitric oxide (NO) which breaks ozone (O₃) into molecules. This effect was discovered only in the last few years in studies of the environmental problems which might be encountered if large fleets of supersonic transport aircraft operate routinely in the lower stratosphere. According to a report by Dr. Harold S. Johnston, University of California at Berkeley--prepared for the Department of Transportation's Climatic Impact Assessment Program--it now appears that the NO reaction is normally responsible for 50 to 70 percent of the destruction of ozone.

In the natural environment, there is a variety of means for the production of NO and its transport into the stratosphere. Soil bacteria produce nitrous oxide (N₂O) which enters the lower atmosphere and slowly diffuses into the stratosphere, where it reacts with free oxygen (O) to form two NO molecules. Another mechanism for NO production in the lower atmosphere may be lightning discharges, and while NO is quickly washed out of the lower atmosphere by rain, some of it may reach the stratosphere. Additional amounts of NO are produced directly in the stratosphere by cosmic rays from the sun and interstellar sources.

It is because of this catalytic role which nitric oxide plays in the destruction of ozone that it is important to consider the effects of high-yield nuclear explosions on the ozone layer. The nuclear fireball and the air entrained within it are subjected to great heat, followed by relatively rapid cooling. These conditions are ideal for the production of tremendous amounts of NO from the air. It has been estimated that as much as 5,000 tons of nitric oxide is produced for each megaton of nuclear explosive power.

What would be the effects of nitric oxides driven into the stratosphere by an all-out nuclear war, involving the detonation of 10,000 megatons of explosive force in the northern hemisphere? According to the recent National Academy of Sciences study, the nitric oxide produced by the weapons could reduce the ozone levels in the northern hemisphere by as much as 30 to 70 percent.

To begin with, a depleted ozone layer would reflect back to the earth's surface less heat than would normally be the case, thus causing a drop in temperature--perhaps enough to produce serious effects on agriculture. Other changes, such as increased amounts of dust or different vegetation, might subsequently reverse this drop in temperature--but on the other hand, it might increase it.

Probably more important, life on earth has largely evolved within the protective ozone shield and is presently adapted rather precisely to the amount of solar ultraviolet which does get through. To defend themselves against this low level of ultraviolet, evolved external shielding (feathers, fur, cuticular waxes on fruit), internal shielding (melanin pigment in human skin, flavonoids in plant tissue), avoidance strategies (plankton migration to greater depths in the daytime, shade-seeking by desert iguanas) and, in almost all organisms but placental mammals, elaborate mechanisms to repair photochemical damage.

It is possible, however, that a major increase in solar ultraviolet might overwhelm the defenses of some and perhaps many terrestrial life forms. Both direct and indirect damage would then occur among the bacteria, insects, plants, and other links in the ecosystems on which human well-being depends. This disruption, particularly if it occurred in the aftermath of a major war involving many other dislocations, could pose a serious additional threat to the recovery of postwar society. The National Academy of Sciences report concludes that in 20 years the ecological systems would have essentially recovered from the increase in ultraviolet radiation-- though not necessarily from radioactivity or other damage in areas close to the war zone. However, a delayed effect of the increase in ultraviolet radiation would be an estimated 3 to 30 percent increase in skin cancer for 40 years in the Northern Hemisphere's mid-latitudes.

Some Conclusions

We have considered the problems of large-scale nuclear war from the standpoint of the countries not under direct attack, and the difficulties they might encounter in postwar recovery. It is true that most of the horror and tragedy of nuclear war would be visited on the populations subject to direct attack, who would doubtless have to cope with extreme and perhaps insuperable obstacles in seeking to reestablish their own societies. It is no less apparent, however, that other nations, including those remote from the combat, could suffer heavily because of damage to the global environment.

Finally, at least brief mention should be made of the global effects resulting from disruption of economic activities and communications. Since 1970, an increasing fraction of the human race has been losing the battle for self-sufficiency in food, and must rely on heavy imports. A major disruption of agriculture and transportation in the grain-exporting and manufacturing countries could thus prove disastrous to countries importing food, farm machinery, and fertilizers--especially those which are already struggling with the threat of widespread starvation. Moreover, virtually every economic area, from food and medicines to fuel and growth engendering industries, the less-developed countries would find they could not rely on the "undamaged" remainder of the developed world for trade essentials: in the wake of a nuclear war the industrial powers directly involved would themselves have to compete for resources with those countries that today are described as "less-developed."

Similarly, the disruption of international communications--satellites, cables, and even high frequency radio links--could be a major obstacle to international recovery efforts.

In attempting to project the after-effects of a major nuclear war, we have considered separately the various kinds of damage that could occur. It is also quite possible, however, that interactions might take place among these effects, so that one type of damage would couple with another to produce new and unexpected hazards. For example, we can assess individually the consequences of heavy worldwide radiation fallout and increased solar ultraviolet, but we do not know whether the two acting together might significantly increase human, animal, or plant susceptibility to disease. We can conclude that massive dust injection into the stratosphere, even greater in scale than Krakatoa, is unlikely by itself to produce significant climatic and environmental change, but we cannot rule

out interactions with other phenomena, such as ozone depletion, which might produce utterly unexpected results.

We have come to realize that nuclear weapons can be as unpredictable as they are deadly in their effects. Despite some 30 years of development and study, there is still much that we do not know. This is particularly true when we consider the global effects of a large-scale nuclear war.

Notes

Note 1: Nuclear Weapons Yield

The most widely used standard for measuring the power of nuclear weapons is "yield," expressed as the quantity of chemical explosive (TNT) that would produce the same energy release. The first atomic weapon which leveled Hiroshima in 1945, had a yield of 13 kilotons; that is, the explosive power of 13,000 tons of TNT. (The largest conventional bomb dropped in World War II contained about 10 tons of TNT.)

Since Hiroshima, the yields or explosive power of nuclear weapons have vastly increased. The world's largest nuclear detonation, set off in 1962 by the Soviet Union, had a yield of 58 megatons--equivalent to 58 million tons of TNT. A modern ballistic missile may carry warhead yields up to 20 or more megatons.

Even the most violent wars of recent history have been relatively limited in terms of the total destructive power of the non-nuclear weapons used. A single aircraft or ballistic missile today can carry a nuclear explosive force surpassing that of all the non-nuclear bombs used in recent wars. The number of nuclear bombs and missiles the superpowers now possess runs into the thousands.

Note 2: Nuclear Weapons Design

Nuclear weapons depend on two fundamentally different types of nuclear reactions, each of which releases energy:

Fission, which involves the splitting of heavy elements (e.g. uranium); and fusion, which involves the combining of light elements (e.g. hydrogen).

Fission requires that a minimum amount of material or "critical mass" be brought together in contact for the nuclear explosion to take place. The more efficient fission weapons tend to fall in the yield range of tens of kilotons. Higher explosive yields become increasingly complex and impractical.

Nuclear fusion permits the design of weapons of virtually limitless power. In fusion, according to nuclear theory, when the nuclei of light atoms like hydrogen are joined, the mass of the fused nucleus is lighter than the two original nuclei; the loss is expressed as energy. By the 1930's, physicists had concluded that this was the process which powered the sun and stars; but the nuclear fusion process remained only of theoretical interest until it was discovered that an atomic fission bomb might be used as a "trigger" to produce, within one- or two-millionths of a second, the intense pressure and temperature necessary to set off the fusion reaction.

Fusion permits the design of weapons of almost limitless power, using materials that are far less costly.

Note 3: Radioactivity

Most familiar natural elements like hydrogen, oxygen, gold, and lead are stable, and enduring unless acted upon by outside forces. But almost all elements can exist in unstable forms. The nuclei of these unstable "isotopes," as they are called, are "uncomfortable" with the particular mixture of nuclear particles comprising them, and they decrease this internal stress through the process of radioactive decay.

The three basic modes of radioactive decay are the emission of alpha, beta and gamma radiation:

Alpha--Unstable nuclei frequently emit alpha particles, actually helium nuclei consisting of two protons and two neutrons. By far the most massive of the decay particles, it is also the slowest, rarely exceeding one-tenth the velocity of light. As a result, its penetrating power is weak, and it can usually be stopped by a piece of paper. But if alpha emitters like plutonium are incorporated in the body, they pose a serious cancer threat.

Beta--Another form of radioactive decay is the emission of a beta particle, or electron. The beta particle has only about one seven-thousandth the mass of the alpha particle, but its velocity is very much greater, as much as eight-tenths the velocity of light. As a result, beta particles can penetrate far more deeply into bodily tissue and external doses of beta radiation represent a significantly greater threat than the slower, heavier alpha particles. Beta-emitting isotopes are as harmful as alpha emitters if taken up by the body.

Gamma--In some decay processes, the emission is a photon having no mass at all and traveling at the speed of light. Radio waves, visible light, radiant heat, and X-rays are all photons, differing only in the energy level each carries. The gamma ray is similar to the X-ray photon, but far more penetrating (it can traverse several inches of concrete). It is capable of doing great damage in the body.

Common to all three types of nuclear decay radiation is their ability to ionize (i.e., unbalance electrically) the neutral atoms through which they pass, that is, give them a net electrical charge. The alpha particle, carrying a positive electrical charge, pulls electrons from the atoms through which it passes, while negatively charged beta particles can push electrons out of neutral atoms. If energetic betas pass sufficiently close to atomic nuclei, they can produce X-rays which themselves can ionize additional neutral atoms. Massless but energetic gamma rays can knock electrons out of neutral atoms in the same fashion as X-rays, leaving them ionized. A single particle of radiation can ionize hundreds of neutral atoms in the tissue in multiple collisions before all its energy is absorbed. This disrupts the chemical bonds for critically important cell structures like the cytoplasm, which carries the cell's genetic blueprints, and also produces chemical constituents which can cause as much damage as the original ionizing radiation.

For convenience, a unit of radiation dose called the "rad" has been adopted. It measures the amount of ionization produced per unit volume by the particles from radioactive decay.

Note 4: Nuclear Half-Life

The concept of "half-life" is basic to an understanding of radioactive decay of unstable nuclei.

Unlike physical "systems"--bacteria, animals, men and stars--unstable

isotopes do not individually have a predictable life span. There is no way of forecasting when a single unstable nucleus will decay.

Nevertheless, it is possible to get around the random behavior of an individual nucleus by dealing statistically with large numbers of nuclei of a particular radioactive isotope. In the case of thorium-232, for example, radioactive decay proceeds so slowly that 14 billion years must elapse before one-half of an initial quantity decayed to a more stable configuration. Thus the half-life of this isotope is 14 billion years. After the elapse of second half-life (another 14 billion years), only one-fourth of the original quantity of thorium-232 would remain, one eighth after the third half-life, and so on.

Most manmade radioactive isotopes have much shorter half-lives, ranging from seconds or days up to thousands of years. Plutonium-239 (a manmade isotope) has a half-life of 24,000 years.

For the most common uranium isotope, U-238, the half-life is 4.5 billion years, about the age of the solar system. The much scarcer, fissionable isotope of uranium, U-235, has a half-life of 700 million years, indicating that its present abundance is only about 1 percent of the amount present when the solar system was born.

Note 5: Oxygen, Ozone and Ultraviolet Radiation

Oxygen, vital to breathing creatures, constitutes about one-fifth of the earth's atmosphere. It occasionally occurs as a single atom in the atmosphere at high temperature, but it usually combines with a second oxygen atom to form molecular oxygen (O₂). The oxygen in the air we breathe consists primarily of this stable form.

Oxygen has also a third chemical form in which three oxygen atoms are bound together in a single molecule (O₃), called ozone. Though less stable and far more rare than O₂, and principally confined to upper levels of the stratosphere, both molecular oxygen and ozone play a vital role in shielding the earth from harmful components of solar radiation.

Most harmful radiation is in the "ultraviolet" region of the solar spectrum, invisible to the eye at short wavelengths (under 3,000 Å). (An angstrom unit--Å--is an exceedingly short unit of length--10 billionths of a centimeter, or about 4 billionths of an inch.) Unlike X-rays, ultraviolet photons are not "hard" enough to ionize atoms, but pack enough energy to break down the chemical bonds of molecules in living cells and produce a variety of biological and genetic abnormalities, including tumors and cancers.

Fortunately, because of the earth's atmosphere, only a trace of this dangerous ultraviolet radiation actually reaches the earth. By the time sunlight reaches the top of the stratosphere, at about 30 miles altitude, almost all the radiation shorter than 1,900 Å has been absorbed by molecules of nitrogen and oxygen. Within the stratosphere itself, molecular oxygen (O₂) absorbs the longer wavelengths of ultraviolet, up to 2,420 Å; and ozone (O₃) is formed as a result of this absorption process. It is this ozone then which absorbs almost all of the remaining ultraviolet wavelengths up to about 3,000 Å, so that almost all of the dangerous solar radiation is cut off before it reaches the earth's surface.

Quotations

A Few Selected Quotes Of John Hersey

All morning they watched for the plane which they thought would be looking for them. They cursed war in general and PTs in particular. At about ten o'clock the hulk heaved a moist sigh and turned turtle.

And, as if nature were protecting man against his own ingenuity, the reproductive processes were affected for a time; men became sterile, women had miscarriages, menstruation stopped.

Do not work primarily for money; do your duty to patients first and let the money follow; our life is short, we don't live twice; the whirlwind will pick up the leaves and spin them, but then it will drop them and they will form a pile.

It's a failure of national vision when you regard children as weapons, and talents as materials you can mine, assay, and fabricate for profit and defense.

Journalism allows its readers to witness history; fiction gives its readers an opportunity to live it.

Learning starts with failure; the first failure is the beginning of education.

Many people who did not die right away came down with nausea, headache, diarrhea, malaise, and fever, which lasted several days. Doctors could not be certain whether some of these symptoms were the result of radiation or nervous shock.

Not a particular country, not a particular city, and not a particular people.

The crux of the matter is whether total war in its present form is justifiable, even when it serves a just purpose. Does it not have material and spiritual evil as its consequences which far exceed whatever good might result? When will our moralists give us an answer to this question?

The doctors realized in retrospect that even though most of these dead had also suffered from burns and blast effects, they had absorbed enough radiation to kill them. The rays simply destroyed body cells - caused their nuclei to degenerate and broke their walls.

The first stage had been all over before the doctors even knew they were dealing with a new sickness; it was the direct reaction to the bombardment of the body, at the moment when the bomb went off, by neutrons, beta particles, and gamma rays.

The second stage set in ten or fifteen days after the bombing. Its first symptom was falling hair. Diarrhea and fever, which in some cases went as high as 106, came next.

The third stage was the reaction that came when the body struggled

to compensate for its ills - when, for instance, the white count not only returned to normal but increased to much higher than normal levels.

There, in the tin factory, in the first moment of the atomic age, a human being was crushed by books.

What has kept the world safe from the bomb since 1945 has not been deterrence, in the sense of fear of specific weapons, so much as it's been memory. The memory of what happened at Hiroshima.

Yes, people of Hiroshima died manly in the atomic bombing, believing that it was for Emperor's sake.