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**Description of contents**

- (1) Box no. 242
- (2) Folder title/number: (20)  
Translation Requested of Allied Translator and Interpreter Section
- (3) Date: Nov. 1946
- (4) Subject:
 

| Classification | Type of record |
|----------------|----------------|
| 752, 850       | g              |
- (5) Item description and comment:  
Translation Requested by ESS
- (6) Reproduction:  Yes  No
- (7) Film no. \_\_\_\_\_ Sheet no. \_\_\_\_\_

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30 Nov. 1946

Records of the Special Committee Report  
on Investigation and Research in the Atomic Bomb Destruction

Scientific Research Council

Contents

1. Society for the Study of Physics, Chemistry, and Physical Geography: Physics Section - Committee Member NISHINA, Yoshio (仁科若雄) (1).
2. Society for the Study of Physics, Chemistry, and Physical Geography: Chemistry Section - Committee Member NOGUCHI, Kimio (野口喜三雄) (6).
3. Society for the Study of Physics, Chemistry, and Physical Geography: Physical Geography Section - Committee Member WATANABE, Takeo (渡辺武男) (10).
4. Society for the Study of Biology - Committee Member MAEKAWA, Fumio (前川文夫) (17).
5. Society for the Study of Mechanics and Metals - Committee Member TSUTSUI, Toshimasa (筒井俊正) (24).
6. Society for the Study of Civil Engineering and Construction - Committee Member TANAKA, Yutaka (田中豊) (28).
7. Society for the Study of Medical Science - Committee Member TSUZUKI, Masao (都築正男) (33).
8. Society for the Study of Agriculture and Fisheries - Committee Member ASAMI, Yoshichi (浅見英七) (39).
9. Salutation - Chief of the Scientific Education Bureau, Ministry of Education; YAMAZAKI, Kyosuke (山崎匡輔) (42).

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Doc No 26823

Society for the Study of Physics, Chemistry, and Physical Geography;  
Physics Section - NISHINA, Yoshio.

Committee Chairman HAYASHI (林):

It is time to open the meeting. This is the first meeting for reports of the Special Committee's investigation of the atomic bomb destruction. We shall hear brief reports on the work which has been completed to date.

We did not send out programs because sufficient preparations were not made beforehand. I intend to call on the representatives in the order printed here. Physics, Chemistry, and Physical Geography comes first. Mr. NISHIKAWA (西川) the representative of the Physics Section, is ill so I shall call on Committee Member Mr NISHINA of the Physical and Chemical Research Institute (RIKEN).

Committee Member NISHINA, Yoshio:

I shall confine myself to that with which I am familiar.

The first research carried out on the part of Physics was concerned with radioactivity. HIROSHIMA and NAGASAKI were handled separately. Two or three men from the Physical and Chemical Research Institute accompanied the people from the Army Medical School to HIROSHIMA. The first of the several things we did was to measure the radioactivity of bones and of the sulphur inside electric insulators. This matter was made radioactive by the neutrons released at the time of the atomic bomb explosion.

Committee Member SASAHARA, (笹原), of KYUSHU Imperial University, is doing the same sort of investigation at NAGASAKI. There is strong radioactivity in particular areas. Besides the zero point of the explosion, there are places where radioactive particles of the atomic nucleus, scattered in the air by the explosion, fell with rain. At HIROSHIMA such particles landed at a place called TAKASU, (高須) about two miles west of the zero point of the explosion. At NAGASAKI these particles fell near NISHIYAMA (西山), about a mile and a quarter to the east. We are measuring the radioactivity of these areas. That is to say, we are measuring the radioactivity of the zero point of the explosions and of places a short distance away from there.

We are working with the Chemical Section to discover the cause of this radioactivity. According to chemical analysis, which will give us the answer, elements such as barium, strontium, and the "rare earths" are present. This fact makes it certain that the radioactivity at TAKASU and NISHIYAMA was caused by the fission of the atomic nucleus. We can calculate by the strength of the radioactivity in the zero point and surrounding areas the number of neutrons.

The so-called "atomic bomb illness" is generally understood to be caused by gamma rays, for this reason. We know that there are heavy

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Doc. No 26823

neutrons present, which are absorbed by the atmosphere. This process releases gamma rays, whose approximate strength has been estimated. The strength of these rays generally corresponds to the amount of injury discovered by the Medical Science Section. With regard to radioactivity, we know the areas where it is found, its approximate distribution in the zero point and the places where fragments have dropped. This sums up, in general, the research in radioactivity. We also discovered that the explosion caused an extremely strong glare and great heat, which charred the objects in its way. In the charred area, an object, like a pole, throwing a shadow, would block off the glare and heat. Since the bomb exploded above the ground, this shadow would describe the incidence of the light and heat from the point of explosion. The center of the explosion and its height above the ground were calculated in this way. It was discovered that the zero point at HIROSHIMA was in the general area of the SHIMA Hospital, about 220 yards south and 33 yards east of the TOMII (gate) at the GOKOKU Shrine. At NAGASAKI the zero point was calculated to be at the tennis court at MATSUYAMA Mechi, 170 Banchi.

The height of the explosion at HIROSHIMA was about 625 yards. At NAGASAKI it was about 540 yards. This covers, in general, the work of the Physics Section. There are other matters that have come up in discussions among persons both in and outside the section, such as the glare or flash, the amount of energy, the force of the blast, and so forth; but we have as yet no definite figures for them. For instance, since there are no definite data for the duration of the blast and of the flash and heat, we cannot calculate definite figures for them. However, the original energy of the atomic explosion can be calculated because (as mentioned before) we know the number of heavy neutrons released to be approximately  $10^{25}$ . Calculating from this figure, the energy released is found to be approximately  $10^{13}$  calories. The question arises as to what form the energy took at its release. That is, how much of it went into the blast, and how much into the flash. In our rough estimate, not all of the energy went into the blast. We think that the greater part of the energy went into the explosion, but the remainder became the energy of the flash. There will probably be reports from other sources about the energy converted into light and heat. There was also an amount of energy not manifested as light and heat. This is a fact which I omitted before, at the time of the explosion the light formed a ball of fire. Its size is figured from the shadow mentioned before in this way. It can be seen that there is a penumbra at the edge of this shadow, where the burn is slight. From this, the approximate size of the ball can be calculated. The diameter of this ball, which I failed to mention before, was 165 yards at HIROSHIMA, and 155 yards at NAGASAKI. With the size of this ball of fire, using the value of the afore-mentioned energy manifested as heat and light, it is possible to calculate the temperature of the fire-ball, which is approximately  $9000^{\circ}$  Centigrade. This is the energy manifested as light and heat. However, since there were also ultra-violet rays and X-rays, all of them taken together would amount to about twice as much. That is to say, the same amount of energy was manifested as ultraviolet rays and X-rays as by heat and light. These

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# SECRET

Doc No 26923

are our approximations. We hope to make a more detailed report in the future.

I understand that considerably different results are obtained by different people for such values as the duration of the blast, the duration of the explosion, the resulting energy of the blast, the duration of the heat and light, and their energy. I would like to propose at this time that you appoint a committee, sub-committee, or some such groups to discuss these matters in detail. It seems to me that it would be very worth-while for such a group to meet and decide on some definite values.

I understand that the gentlemen from the Allied Nations who are here today would like to have such figures submitted. Yesterday I met a gentleman from ENGLAND who would like to have some definite values. Since such requests are being made, we also would like to have such discussions and submit definite values. I hope this plan will be put into effect.

That about covers everything I have to say.

Society for the Study of Physics, Chemistry,  
and Physical Geography; Chemistry Section.

Committee Chairman HAYASHI:

Mr. NOGUCHI, of the research staff, representing Committee Member KIMURA of the Chemistry Section.

Researcher NOGUCHI, Kinzo:

Committee Member KIMURA had another engagement today, so I will make a brief report.

One of the studies of the Chemistry Section, in co-operation with the Physics Section, was to discover which elements caused radioactivity in the soil, in bones, and in the dust resulting from the explosion. As committee member NISHINA said a while ago, appropriate methods of chemical analysis of materials taken from both HIROSHIMA and NAGASAKI showed which elements were radioactive. The special characteristics of the radioactivity were compiled by Committee Member NISHINA and Committee Member SAGANE (山崎 栄根) of TOKYO Imperial University. Another one of our tasks was to discover the effect of the atomic bomb explosion on water underground.

First, as a result of our investigations concerning which elements were radioactive, we discovered, by chemical analysis of human and animal bones at HIROSHIMA, that calcium was not radioactive, while phosphorus was. We also discovered that, in the western section of HIROSHIMA,

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# SECRET

Doc No 26823

there was great radioactivity in such elements as strontium, barium, and the rare earths, but not in anything else. That is to say, the phosphorus in the soil had no radioactivity, whereas the barium, strontium, and rare earths were strongly radioactive. Comparing the amounts of phosphorus in these compounds we find that compounds rich in phosphorus are not necessarily strongly radioactive. There is, therefore, no relationship between the amount of phosphorus in a compound and the strength of its radioactivity. There is a soil made of an ash-like material which fell on the NISHIYAMA area of NAGASAKI. By chemical analysis, extracting with acid, we discovered that the radioactivity of the part which did not dissolve was from 70% to 67%. The part which dissolved in the acid was precipitated with hydrogen sulphide and had a radioactivity of 14%.

When we precipitated the dissolved part with ammonia water, we got iron aluminum SHISAN\* with a radioactivity of 53%. Precipitating the remainder (after the precipitation of iron aluminum) with manganese carbonate, we got a radioactivity of 6%. The magnesium part was 1.75% and that of the alkali metals was 2.5%, so that there was a great deal of radioactivity in the part insoluble in acid and the part which precipitated in ammonia. These figures are calculated on the basis of 100% for the radioactivity of the first substance.

The materials from NAGASAKI are being analyzed at present. The alkali metals in them have very weak radio-activity. All of these radioactive elements which are being analyzed are in very small amounts. For this reason, we precipitate them and add other chemicals, making certain that the added chemicals are not radioactive. In our investigation of well water, we took samples from many places, beginning at the zero point and working away from it, but we discovered no regular gradation. Occasionally we found water near the zero point with an acidity of about pH 5.7 - 5.8, but, since we also found acid water far away from the zero point, it is not clear whether or not the acidity was a result of the explosion.

Moreover, right in the zero point there was a yard-square tub of water for anti-aircraft defense which had an alkalinity of pH 9.4. We imagine that this water, probably containing coal, reached a high temperature from the heat of the explosion and thus became alkaline. This water had a chlorine content of only about 15.2 milli.

The Chemical Education Section also did some work in measuring radioactivity, particularly alpha rays. They found none in the soil at the zero point and some radioactivity near TAKASU. Radioactivity was found everywhere, except for a few spots, in the soil at NISHIYAMA. The reason for these spots of no radioactivity in between radioactive areas is thought to be the way the ash-like substance fell. In some

(TN \*Indicates exact ROMAJI transliteration of the original KANA.)

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**SECRET**

Doc No 26823

places none fell at all and in other places only a small amount fell. These spots are limited in size and number, but there are places of no radioactivity, nevertheless. I might add that there is something a little strange about the metal fragments gathered at HIROSHIMA.

Committee Chairman HAYASHI:

Now we shall call on Committee Member WATANABE of the Physical Geography Section.

Society for the Study of Physics, Chemistry,  
and Physical Geography; Physical Geography Section.

Committee Member WATANABE, Takeo:

I went with the gentlemen of the Physical Geography Section, accompanying the gentlemen of the Physics and Chemistry Sections, to the affected areas. At first, since I did not know to what extent my field would be concerned with these events, I merely went with the idea of seeing the affected areas and was ill-prepared. Since I did not have the necessary instruments, my investigation was extremely inadequate. However, I shall report the general result.

Upon arriving at the affected areas, I conducted an investigation as it is ordinarily done. My plan was to make a thorough investigation of the situation to discover what changes had been made by the atomic bomb, and to make an accurate drawing of the area.

In our work, the thing that caught our attention more than anything else was the building stone. Our observations were principally concerned with the mineralogical changes in rock and stone, in minerals composed of rock and stone, and in ceramic products (such things as roof tile, concrete, and other artificial building stone). I shall report briefly the appearance of these changes:

In the first place, the foundation of the HIROSHIMA region is granite, but because HIROSHIMA itself is a place where many rivers come together, it is like an alluvial plain. The type of granite in the ground is not apparent. For the most part, it is composed of sand from the granite.

Because of subsequent storms, rain, and other influences of the weather, there were no places left where the direct results of the change were clearly seen. However, since there is much granite rock around HIROSHIMA, very many buildings, gravestones, and the like are made of granite. The changes in these structures could be easily observed. It is an odd fact that, in some places, other kinds of stone are used, such as limestone and andesite. We observed these materials as well.

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Doc No 26823

The most representative article of the ceramic products was roof tile, because it was distributed throughout almost all the city. Moreover, roof tile manufacturers of any area are limited in their raw materials, and most of the tile in HIROSHIMA came from SHIKOKU; consequently, most of the roof tiles are substantially of the same quality. By means of inquiries at the building stone dealers in the neighborhood, I was able to find out in general the origin of the building stone mentioned previously.

A study of all these facts would make it possible to show on the drawing, to some extent, the changed condition at the zero point and the extent of the effect of the explosion. Since my research on the stone of that area is as yet incomplete, I cannot give a detailed account. However, I will report the most outstanding results of my investigation of the affected areas.

First of all, with regard to the roof tiles, their surface was more or less melted by heat or other forms of energy. Walking within the limits of the affected area at HIROSHIMA, I discovered that the area in which the roof tiles were melted had a radius of roughly 660 yards, from the zero point. This melting of the tiles was conspicuous at the zero point, but it was very difficult to determine the limits of the area where this phenomenon occurred. However, near the zero point, on roofs where there were rounded ridge tiles, the parts of the tiles which were perpendicular to the direction of the rays were most strongly affected, and the effect lessened gradually as the angle with the rays changed from the perpendicular to the tangent. Since the boundary between the least affected parts and the parts where there was no effect at all could be distinguished to some extent with the naked eye, the melting effect shown in this boundary was taken as the standard to determine the limits of the area in which the melting phenomenon occurred. However, at the limits of this area the melting of the roof tiles was not uniform because only the tiles which were perpendicular to the rays were affected. For this reason, we took as our standard for the boundary area places where we could find perhaps one or two tiles among the ruins which had been affected by the rays.

Another definite observation which we were able to make was the fact that the surface of granite had blistered and peeled. This phenomenon might have occurred at the melting point of quartz, 573° centigrade, or it could have been caused by a diversity of coefficients of expansion. The limits of the area in which this phenomenon occurred are farther out than the limits in which roof tiles were melted by about 440 yards. In other words, this blistering of the granite occurred in an area with a radius of about 1100 yards from the zero point. Among the colored minerals of which granite is composed, the blackish ones, such as biotite, were melted near the zero point. None of the other minerals, such as quartz and feldspar seemed to have been melted. We are still investigating what changes occurred in other kinds of rocks. We discovered that various specimens of the same kind of rock may show

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Doc No 26823

different effects, depending on their mineral composition. Along with our careful investigation of the changes in these minerals in the affected areas, if we use the data of mineralogy on experiments to discover the effect of temperature changes on minerals, we can make a rather worthwhile study of the mineralogical changes at HIROSHIMA.

We have attempted to make similar observations at NAGASAKI, preparing a drawing for that area as well, and we have tried to compare the various phenomena. The NAGASAKI area is composed substantially of andesite. Andesite lava and dikes, on the surface and in substratal layers, and tuff are found everywhere. Because I lacked time, I could not make a detailed geological chart, but I was able to study the general distribution. There is also a wide distribution of sand formed by the pulverization of these rocks. Because of the nature of the earth's surface in this area, andesite is used for building such structures as gravestones and gate posts. NAGASAKI differs from HIROSHIMA in that there is very little granite.

Since granite is not used in NAGASAKI, except for an occasional gravestone or shrine gate (TORII), it was almost impossible to compare the effects with Hiroshima, where there is much granite. However, we could make somewhat of a comparison with the few pieces of granite that are found in NAGASAKI. The roof tiles in NAGASAKI also differ from those in HIROSHIMA because most of them are CHIKUGO tiles. This made it difficult to make an accurate comparison of the effect on the roof tiles of the two cities. However, in plotting the effects on a map we disregarded the difference in tiles. Our diagram then showed that the area in which the roof tiles were melted was wider than in HIROSHIMA since its radius was about 1100 yards. The size of this area is not quite clear, but it falls between 990 and 1100 yards. We also discovered that the area in which granite had a pock-marked and bald appearance was much wider than the area in which roof tiles were affected. It extended about 550 yards beyond the melted roof tiles.

Another difference between HIROSHIMA and NAGASAKI was that, at NAGASAKI there were andesite quarries and like places here and there where stone was exposed, and the effect of melting could be seen.

In addition to these findings, we were able to calculate the height of and direction toward the center of the explosion by means of the shadows and angles made by various objects. Our figures agree completely with those briefly explained by the Physics Section. We had three geographers with us who spent most of their time making routine investigations in their special fields, gathering statistics on the harm done to animals and humans, which they tried to show in rather easily understandable graphs. Not all of this material is sufficiently arranged to report in detail here, but I have given you a very elementary and general outline.

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Doc No 26823

## Society for the Study of Biology

Committee Chairman HAYASHI:

Mr OKADA, President of the Society for the Study of Biology will not be present, so I shall call on Mr MAEKAWA of the research committee.

Researcher MAEKAWA:

Since Professor OKADA had to be at a faculty meeting, I shall make the report in his stead.

The zoology section concentrated on an investigation of the effect on creatures in the ground and insects which move about very little, and the effect on vertebrates and on their fertility. The conditions were very bad because the investigation was made after storms from KYUSHU and SANIN had done considerable damage to the area. The investigators followed the general practice of digging a hole one meter square and 30 centimeters deep, at points 500, 1000, and 1500 meters from the zero point finding every form of life in each hole. They found, according to the data that we have now, that the creatures in the ground were still living, even at the zero point. For instance, in different places at least 10 kinds of ants, besides black ants (*TN lasinus fuliginosus*) were uncovered. Other creatures, such as earthworms, were also found alive. Therefore, although everything above the ground was destroyed, we decided that perhaps the creatures from 10 to 30 centimeters underground were left alive. As for the vertebrates, no doubt all that were near the vicinity of the zero point at the time were destroyed almost instantly. A few living things may be seen there above the surface at the present time, but various considerations lead us to believe that they have come there since the explosion.

We can see that it is possible for these creatures (who have come into this area since the explosion) to exist there at the present time. To determine the effect on fertility, we are breeding some of the creatures that have been collected and must wait for the results of these experiments, which have been delegated to various persons. Another notable occurrence is what seems to be a sudden outbreak of the "EBIGARA Sparrow" (*TN Presumably the Russet Sparrow*). The investigation of the botany section was somewhat restricted by the fact that, at HIROSHIMA, the bomb fell within the city, where there is no natural vegetation. At NAGASAKI, however, the bomb dropped to the north of the city, where the surrounding hills still have what approaches a fairly natural grove.

This grove naturally became the object of most of the investigation. Just as was the case with the zoology section, the investigation was handicapped in being made so long after the occurrence of the blast. In two or three cases it was difficult to decide whether the effects

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# SECRET

Doc No 26823

had been caused by the atomic bomb or by something which had happened since the explosion.

In mid-October, the time of the investigation, there was a luxuriant growth of vegetation at the zero point, which was pointed out by the Physics Section. This vegetation was mostly a year's growth of grass. The KAYATSURI grass was covered with seeds. It was apparent, therefore, that, although everything had been destroyed instantly by the explosion, there was no hindrance to new growth.

At NAGASAKI, the prefecture's experimental farm was very close to the zero point. There, at a place 220 yards from the zero point, numerous vegetable seeds, of varieties of ISOBA, Chinese cabbage, and the like, had been planted. These plants were growing. The seeds had begun to sprout, and no particular effect was apparent. At the time of the explosion, within a radius of five-eighths of a mile, some things that were shielded by houses or steep hillsides remained alive. However, at least within an area about five-eighths of a mile in diameter, everything else was completely destroyed. In this area, every bit of the trees above the ground were withered. Although most of the trees were left standing, in the severely affected areas they had been broken down. A grass plain of several years' growth had been blasted above the ground, but except for the area near the zero point, the stalks below the ground remained. At the time of the investigation, some shoots were visible. These facts show that even plants which were just a little way underground escaped the effect of the bombing. Scarcely any trees remained within 550 yards of the explosion. Irregular shoots appeared at the base of the trees which did remain. The new leaves were considerably changed in shape. It is thought that perhaps there was a change in the regenerative power of the trees. Outside the 550 yard radius, stronger trees gradually became apparent. These were such trees as the chestnut, China tree, Phoenix tree, fig tree, plum, cycad, ginkgo, spindle tree, *Fatsia japonica* (YATSUDE), *Torreya nucifera* (KAYA), and apricot.

Since the bomb fell in the city, most of the trees affected were trees that might be cultivated in gardens. These trees, along with varieties of bamboo, although their parts above the ground had been withered, were sprouting new shoots near their roots. Among the plants with strong roots and stalks underground, some that had begun to show new growth were the sweet potato, taro, *lycoris radiata*, canna, purple wood-sorrel, *polygastum kaynautria* (ITAPOR) and *lincope graminifolia* (YABURAN). Among these plants, the *cyperus rotundus* (HAMASUGE) seems to be perhaps the strongest. About 110 yards away it was growing luxuriantly, the heads lengthening, and fruit already appearing. Another thing, the seedlings seemed to be appropriate to the seeds from which they had sprouted. However, careful consideration is needed to decide whether those seeds were in, or above the ground in this area at the time, and escaped the effect of the bombing, or whether they had been scattered there since that time by the wind and other causes.

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**SECRET**

Doc No 26823

Continued investigations are being made of such things as the abundant growth of chestnut seedlings and cassia tonka (EBISUKUSA). There probably were seeds of such plants as the morning-glory and wild chrysanthemum, which had been kept over from the previous winter, and it is thought that these dormant seeds began to sprout after receiving some stimulus. One of the gentlemen mentioned the water for fire fighting some time ago, which was here and there in the area. An investigation was made of the fresh-water plants found in this water. These plants showed some growth, a point which seems to indicate that the effect of the bomb was not felt in the water.

Among the broad-leaved evergreens in this area there are such trees as the pasania (TN a kind of oak), and chestnuts like the ones on AKAMON Dori. These trees, which flourish in mountains and fields, had had an abundant growth here, their leaves reaching a maximum size. Near the zero point, they had withered, of course, and most of their leaves had fallen. In places more than 1100 yards away, there were spots here and there on the leaves. These spots, which are thought to be burns of some kind, appear in a very wide area. At NAGASAKI, for instance, this phenomenon is very noticeable at the top of a mountain to the northwest called "IWAYAMA", which is about two miles away from the zero point. In the opposite direction this phenomenon could be seen in places up to three miles away. Other of the various kinds of spots all over the leaves in this area were black stripes and cloud-shaped spots, and white, star-shaped marks. These phenomena resemble the experiments of the botany section's Professor SASAOCHI (保速) at the Physical Science Research Institute (RIKEN, or RIGAKUKENKYUSHO), and they, too, probably are caused by neutrons. They were very noticeable in certain restricted areas. The leaves which had come out since the time of the explosion were also very strange. Their edges seemed to be cut into shreds or irregularly indented in a wavy pattern. This also is thought to be the effect of radioactivity. The area affected in this way, within which not all the leaves were withered, extended about a mile and a quarter from the zero point. Beyond that, the withering of the leaves was hardly noticeable. Certain plants, such as the lycoris radiata, have bulbous roots, which were about four inches below the ground at the time of the bombing. The stems had not yet sprouted out of the bulbs.

These are thought to have been slightly affected by the bombing. For example, near MICHIO, about two and a half miles north of NAGASAKI, those plants had already bloomed. However, near the zero point, they were from four to eight inches long, just barely above the surface of the ground. The plants that were about to bloom were about one third the usual size. Putting all those facts together, it was observed that the plants were larger in proportion to the distance from the zero point, and the smallness of the plants near the center is thought to be the effect of the explosion. In order to discover whether or not this effect

**SECRET**



**SECRET**

Doc No 26823

will remain in the plant, we have gathered specimens in various places and are waiting for next year's data.

To find the height of the explosion (which was mentioned before), we used the phenomenon of the burns on the broad-leaved evergreens on top of IWAYAMA Hill. Accurately projecting the direction of the rays from the ridge of the hill, which can be determined by the location of the burns, it was found that the explosion occurred below the height of the hill. Since this was not an accurate calculation, being done with the eye alone, we intend to make better measurements at a later date. The rough calculation is that the explosion occurred at a height of 220 to 330 yards.

I have one more thing which I will just mention because we know nothing definite about it. The HIROSHIMA area is noted for its *Aremellaria edodes* (TN Japanese MATSUTAKE, a large type mushroom). The harvest of these mushrooms dropped off at the time of the bombing. Perhaps this was another effect of the explosion.

Committee Chairman HAYASHI:

I should like to call on Researcher TSUTSUI of the Society for the Study of Mechanics and Metals.

Society for the Study of Mechanics and Metals

Researcher TSUTSUI (筒居):

Professor MAJIMA (真島), who was to have made this report today, was incapacitated suddenly, so I will report as much as I know.

We of the applied physics section of the Society for the Study of Mechanics and Metals went to the bombed areas to discover the point of the explosion, the pressure of the blast, and, if possible, to measure the energy and temperature. The first of these objectives, discovering the point of the explosion, was accomplished in the manner already described: by calculations based on the shadows left on the granite, which was roughened and greatly marred by the radiation.

The point of explosion at HIROSHIMA was found to be substantially in the same place as calculated by the Physics and Physical Geography Sections: about 220 yards east of GENAN BASHI. This is a little farther east than the point calculated by the Physics Section. The height at HIROSHIMA was about 635 yards; at NAGASAKI, about 600 yards. The zero point at NAGASAKI was between the TENSUDO at URAKAMI and the SHIROYAMA National School, right over an airfield. I think it was really a little to the side of that, but at least it was in that vicinity.

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Doc No 26823

As mentioned before, granite is very scarce in NAGASAKI. At HIROSHIMA, there were many granite gravestones on which we relied for our calculations, but at NAGASAKI most of the gravestones were made of andesite, which was unsuitable for our purposes. For our calculations there, we relied on a few bridges, schools, and other buildings which were similar to granite.

Next, the temperature. Wherever we walked we noticed that the granite gravestones and the roof tiles had melted. Investigating the extent and distribution of this phenomenon, we discovered that at HIROSHIMA it was in an area reaching about 770 yards from the zero point, and at NAGASAKI it was from 1100 to 1320 yards. These are much the same as the figures given by the Physical Geography Section. We conclude, then, that within the radius of 770 yards from the zero point at HIROSHIMA and 1100 yards at NAGASAKI, the roof tiles must have reached a temperature of 1200 - 1300 degrees centigrade.

Then there is the pressure - the pressure of the blast. Investigation of the destruction to buildings and like subjects were entrusted to specialists in those fields. We were concerned with small objects, such as gravestones. At NAGASAKI there were many similar gravestones about 1100 yards from the zero point. Among these gravestones, some had fallen down; some were standing just as before; and some were leaning over. Estimating the size and mass of the gravestones, we calculated that at NAGASAKI the pressure about 1100 yards from the zero point at 130 130 grams per square centimeter. At HIROSHIMA, it was impossible to make an accurate calculation of the pressure, because there was nothing suitable upon which it could be based.

The energy released from the bomb, which is next in order, cannot possibly be calculated by our simple means. However, let us suppose that at NAGASAKI the pressure of 1300 (TN Sic) grams per square centimeter, calculated at 1100 yards from the zero point, was the original pressure at the center, reaching out with a radius of 1100 yards. This would make the mechanical energy equal about  $10^{13}$  calories, substantially the same result obtained from calculation with the number of neutrons. Possibly the mechanical energy is a little larger figure than the other, but with rough calculations they come out the same.

According to the Physics Section, when the bomb exploded, a ball of fire was formed, a hundred and several score yards in diameter. In connection with this, we came across something at NAGASAKI which was very interesting and difficult to explain. A shrine gate (TN TORII) which we found there was greatly damaged where it faced the zero point, and only slightly damaged in back. The strange part was that the damaged part of the gate posts went part way around to the back, away from the explosion. The energy required to do this was considerable, and the size of the ball of fire was very large: about 1100 yards, according to calculations based on the position of the shadow behind

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Doc No 26823

the shrine gate. We have said that the surface of granite was damaged. Although this is true of many gravestones, there were some that were completely undamaged; their surface showed nothing at all. At first we thought this very strange. Later we found that there had been trees in the vicinity. They were not there when we made our investigation, but we could see evidence of their having been there. We decided that the radiation must have been obstructed by the leaves of these trees, completely shielding the gravestones from its effects. At NAGASAKI, the shadows of dandelions were clearly imprinted on the stepping-stones at the TENSHUDO in URAKAMI. We concluded from these and similar observations that the damage to the surface of granite was caused by radiation. For this reason, the zero point, calculated from the positions of these shadows, is believed to be correct.

Committee Chairman HAYASHI:

I call on Committee Member TANAKA, Yutaka (田中豊), of the Society for the Study of Civil Engineering and Construction.

Society for the Study of Civil Engineering  
and Construction

Committee Member TANAKA, Yutaka:

As you know, civil engineering is concerned with transportation facilities, such as railroads and railroad bridges, harbors, rivers, and waterworks. Construction includes that of individual homes as well as larger buildings. The efforts of the various committee members have been apparent in the reports to which we have been listening. To them I shall add my rough outline.

In general, there was no damage to the railroads. At HIROSHIMA, the railroads ran on dirt embankments, one of which we shall take as a valuable example. This embankment west of the station, is said to have opened to a width of one yard on the side facing the zero point. Nothing else happened to it. Of the 47 cars of a freight train running in the vicinity, 22 were derailed and overturned; they ignited and burned. Fortunately, however, not one car in HIROSHIMA itself was overturned - a very important fact.

The roads can be said to be practically undamaged. The road along the river bank was completely undamaged, although the bank itself had been caved in at few places; a fact which I think deserves further study.

There is some rather interesting data on the bridges. The GENANBASHI Bridge was mentioned before as being about 220 yards from the HIROSHIMA explosion. Oddly enough, only the tops of the lamps on this bridge were blown off. The lamps themselves leaned away from the center of explosion. The handrail on the AIOIBASHI Bridge was torn off.

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Doc No 26823

Representative of the interesting observations at NAGASAKI was the small concrete bridge spanning the river behind a steel foundry. This bridge was suspended between two bridge girders which remained in place while only the center part fell, probably as a result of the blast. Observations such as these indicate that there must have been a strong pressure from the explosion.

Next is the very interesting subject of rivers and harbors. We would very much like to know whether or not an explosion with such great pressure would cause much disturbance on the surface of the water. Only the people there at the time know what happened on the water. Some who were near the shore at the time say that the water was not especially disturbed and that nothing out of the ordinary happened to the boats on it. We have no clear record of what happened near the zero point.

A detailed investigation was made of the water-supply system. The damage to its structures was very slight, probably because they are laid underground. There was some damage to the distributing pipes, but it was apparent that they had collapsed from other bombings.

An interesting subject of investigation was the fact that, near the explosion, the girders in large, reinforced concrete buildings had been broken by the explosion. At the National School in NAGASAKI the lateral pressure on the walls made the girders double upwards. At the same time, a wooden air raid shelter (about six feet wide) at HIROSHIMA showed no effects of the explosion, probably for the same reason that the embankment mentioned before was comparatively undamaged.

The effect of the energy and duration, both extremely interesting subjects, on various kinds of structures cannot be related in brief. We intend to ask Professor Muto (武藤) to make several investigations. In general, reinforced concrete buildings about five-eighths of a mile away came through the explosion very well. Professor MUTO has calculated that the explosion had the effect of about 15,000 tons of gunpowder, which would be much the same as the thermal energy of  $10^{13}$  calories which was mentioned before. It is difficult to judge the effect on public works without various calculations. These calculations make it seem very likely that the pressure of the explosion was stronger at NAGASAKI. Using the collapse of the gravestones at NAGASAKI as a basis, we calculate the energy to have been  $10^{17}$  ergs or  $10^{12}$  calories. This differs by one power, or ten times, with the other calculation, but that cannot be helped. The report of the Mechanics Section, which I saw for the first time today, gives essentially the same figures for the energy. The thermal energy does not differ from the energy of the explosion by more than ten times, if at all. A mistake of only one power shows rather good calculation. Interestingly enough, the Mechanics Section's calculation of 130 grams per square centimeter at 1100 yards is much the same as ours.

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Doc No 26823

It is interesting to observe that although the moving train was upset, as mentioned before, the many railroad cars in the yards at the station were not overturned. It has been said that a train running in open country would overturn in a wind with a force of 250 grams per square centimeter. It is strange, therefore, that the pressure in this instance should have overturned some cars and left others upright. This is an example of the disadvantages of elasticity. Another is that, according to reports from ENGLAND, tall objects receive comparatively more severe damage. A train on springs sways at intervals of from one to three seconds. If it sways at less than one-second intervals and is going rather fast, a pressure of considerable strength will not upset it. These are very interesting subjects which we are at present discussing with Professor MUTO concerning materials for research. We know very little, so far, about the height of the explosion and the speed of the blast. Perhaps they may be calculated by the distance from the zero point, but we must discuss the matter further.

Committee Chairman HAYASHI:

Committee Member SETO, Shoji (瀬藤象二), of the Society for the Study of Electric Power and Communications.

Committee Member SETO, Shoji:

The report of the Electric Power is not yet complete and will be given at the next meeting.

Society For The Study of Medical Science

Committee Chairman HAYASHI:

We shall now hear from Committee member TSUZUKI, Masao (都築正男), the Society For The Study of Medical Science.

Committee member TSUZUKI, Masao:

At this time, I would like to make a general report on the Society For The Study of Medical Science. The truth is that prior to the establishment of the Atomic Bomb Research Committee, the authorities in their respective fields had been engaged in various research and practical works. Therefore, when the Atomic Bomb Research Committee was created, since we did not have the opportunity to discuss the matter at length, our work was confused, being inconsistent with the theories of the Research Committee. I would like to have your understanding on this point.

Besides my report today, there are many other materials gathered from various sources. Moreover, many Investigation and Research Committee members have arrived recently from AMERICA, and we have cooperated

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Doc No 26823

with them in doing various research work. At the present time, we are in the midst of organizing these data. I would like to make this report simple in the time allotted me.

In general, the period of investigation has been from 6 August to the end of November in HIROSHIMA and from 9 August in NAGASAKI. However, the investigations are still being continued today, and it is difficult to say just how many years the research must be carried on. The primary research organs are the medical educational organs throughout the nation, medical colleges of the Army and Navy, hospitals of the Army and Navy attached thereto, research centers of the Welfare Ministry, contagious disease research centers, and numerous other establishments. The facilities and attached personnel of HIROSHIMA and NAGASAKI Prefectures also serve as research organs.

Our accomplishments have been the dispatching of relief sections, treatment sections, and subsequently, the Investigation and Research Committee to each area affected in accordance with its conditions. At the same time that research was carried on in the areas affected, the wounded from the bombing were taken into clinical centers and given treatment. The measures taken by our society differ slightly from that of the Atomic Bomb Research Committee, and besides the conducting of investigations, we have placed great emphasis on the giving of treatment. As a result, various data have been gathered, and although we are not fully cognizant of all the details, as far as I know, our investigations have been carried out with considerable thoroughness.

Although our activities have covered a wide range, our primary interest has centered on the compilation of what may be called the statistics of the destruction, such as the number of dead and the number of wounded. For instance, the question of the population of HIROSHIMA on 6 August was scrutinized by various authorities, but the authentic figures cannot be ascertained. My personal estimation is that there have been approximately 120,000 killed and about 100,000 wounded in the city of HIROSHIMA, and about 80,000 killed and 80,000 wounded in NAGASAKI up until today. Although the matter of the effect of the atomic bomb on living creature was brought up a little while ago, it may be conceived that there are four types of effects which may be classified as follows:

1. Burns from the heat of thermic and ultra-violet rays.
2. Mechanical obstructions caused by the blast.
3. Effects of the radioactivity of X rays, gamma rays, and neutrons.
4. Effects caused by various toxic gases which were formed at the time of the explosion.

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**SECRET**

Doc No 26823

First of all, the burns caused by heat were generally inflicted in areas within a radius of two and one-half miles from the zero point. In areas within a radius of one and one-fourth miles from the zero point, many people were burned and many died after developing peculiar symptoms. In areas within a radius of one and one-fourth and two and one-half miles from the explosion, many people were burned; their burns were comparatively light. These burns were entirely different in nature from those we experienced as a result of incendiary bombs and others. There have been various reports made on these so-called peculiar burns.

As a result of the blast, houses were destroyed and people were blown into the air. However, many people were injured in areas within a radius of two and one-half miles from the zero point. In distant areas, many people were injured by flying fragments of glass. In areas near the zero point, people were crushed to death when houses collapsed. Many people were burned, some fatally, as a result of the burning houses.

The damage caused by radioactivity were also a phenomenon which we have not experienced to a great extent. However, of approximately 80 percent of those who escaped instantaneous death due to collapsing homes or burns received in areas within a radius of five-eighths of a mile from the zero point, a great many have died from internal hemorrhage and diarrhea, spitting blood, moving bloody excrements and becoming extremely weak within several days to two weeks. Furthermore, approximately half of the people who had been in areas within a radius of one and one-fourth miles from the center of the blast developed such ailments as pyrexia, hemorrhage, and alopecia within three to six weeks, causing the deaths of a great many of them. As a result of clinical and post-mortem research, we have come to the conclusion that the causes for death may be attributed to internal injuries, especially damages to the viscera as a result of radioactivity.

There had been some discussion on the problem of whether or not living creatures could exist in areas hit by the bomb. However, when considering this matter by compiling the results of various research works, there has been considerable amount of toxic matter left in the areas near the zero point, especially in areas within a radius of 500 meters from the zero point for several days after the bombing. There are various opinions in regard to the substance of these toxic matters. As a specific example, there is a concrete building left standing near the center of the explosion in HIROSHIMA, and fortunately, a portion of this concrete building escaped fire. Although few in number, a portion of the people who came from other areas to help out after the bombing and who were engaged in work while living in this building for several days, have lost some of their white corpuscles, and we have come to believe that they may have been affected by radioactivity. All these cases were minor in nature, and they have all regained their health once again. However, there are rumors that a person who touched

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Doc No 26823

the bones of a corpse died, spitting blood, or died as the result of alopecia. We have done our utmost in the investigation of these rumors, but up until today we have not been able to discover a single incidence which corroborates these rumors.

Consequently, as far as we are concerned, we believe that there were no toxic substance left in the human body which may be specially attributed to the atomic bomb after one week or more had passed after the bombing. The people of HIROSHIMA had never experienced any air raids up until the dropping of the atomic bomb and did not realize just how bad conditions could get from a hygienic standpoint in such an event. In spite of everything, it may be conceived that all that occurred in HIROSHIMA are speculated in various ways and attributed simply to the atomic bomb. Therefore, these points should be considered carefully from a scientific point. However, judging from these points, I believe that hereafter we may regard toxic substance especially attributable to the atomic bomb as non-existent.

In connection with the talk given by Mr MAEKAWA of the Society for the Study of Biology a little while ago, I would like to say that the Society for the Study of Medical Science has obtained results in investigations it has conducted in regard to the effect of the bomb on the propagation of mankind in the future, including effects on male sperms, menstruation of women, pregnancy, and birth. At the present time, injuries of this nature have been positively recognized to some extent. However, some of the people affected are already on the road to recovery. At this time, it is difficult to say for certain how these afflicted persons will recover. My personal opinion is that, these people will, in all probability, regain their former health.

Although this may be off the subject, I would like to say that 1,200 members of the Society for the Study of Medical Science have been engaged in investigation and research work for the past three months. Unfortunately, during this period, 12 members of the Medical Section of the KYOTO Imperial University were killed in line of duty when a typhoon struck the Army hospital at ONO, HIROSHIMA. Furthermore, another person from the TOKYO Imperial University, who had been in NAGASAKI, was killed in line of duty. Regrettable though it may be, I would like to take this opportunity to report these incidents.

As I have stated before, since the various affiliated research organs are in possession of their respective special data, I am contemplating the idea of submitting a detailed report immediately after reorganizing this data in some form or other.

Committee Chairman HAYASHI:

We will now hear from Mr ASAMI of the Society for the Study of Agriculture and Fisheries.

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Doc No 26823

## Society for the Study of Agriculture and Fisheries

Committee member ASAMI:

Although the Society for the Study of Agriculture and Fisheries has sent many members to HIROSHIMA and NAGASAKI, the reports received up till now are very few in number. Consequently, the general situation is not yet known. I would now like to make a brief report based upon the few reports we have received.

In regard to the effects of the bomb on agricultural products, we had no basis for believing that these effects were of a lingering nature at the time investigations were carried out two months after the dropping of the bomb. We are of the opinion that there is absolutely no fear as to the effects of the bomb on the future potentialities of agricultural products. As I see it, the primary interests of the members of our society lie in the abnormal phenomenon presented by the agricultural products. For example, when there have been such abnormal phenomenon as FUKIRI (TN Meaning not clear), the changing of the shapes of leaves, or the enlarging of stems, the members have collected the seeds of these abnormal products for the purpose of experimenting, to determine whether or not this phenomenon has had any effect on the reproductive cells of the plants and whether or not it is a hereditary phenomenon. We are making experimental preparations to discover whether or not the new plants, which will grow from these seeds to be sown in the future, will present the same abnormal phenomenon. I believe that the results of this experiment will be of great interest to all.

According to the report of entomologists in HIROSHIMA, the insects living near the surface of the ground in areas within 500 to 600 meters from the zero point were extremely weakened and some of those entering the ground from the surface were observed to be in an extremely weak condition. Since the reports did not specify as to how far underground the investigations were conducted to determine the effects of the bomb on animals living underground. I cannot make any definite statements on this subject, but I believe the investigations covered only the considerably shallow depths. Underground animals living in areas within 500 to 600 meters of the zero point were noticeably weakened. Insects living above ground in areas within five-eighths of a mile of the zero point were weakened to some extent and no changes have been observed in animals living underground. The report further states that no especially peculiar points can be observed in insects living both above and under the ground in areas within five-eighths of a mile of the zero point.

According to the investigation report of agrologists in NAGASAKI, soil has been collected from areas five-sixteenths of a mile, three-fourths of a mile, and two and one-tenths miles from the zero point at depths of within 1 centimeter, 1 to 5 centimeters, and 5 to 10 centimeters. The seeds of such plants as rice-plant, wheat, beans, or radishes were

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Doc No 26823

then sown on this soil, and the growing conditions of these plants were experimented upon, but there were no signs of any peculiar phenomenon.

There was a phenomenon which was believed to be peculiar in the growth of the seeds in soil taken from the shallowest and nearest area from the zero point. However, whether this soil was affected by the bomb or not is uncertain. There have been hardly any noticeable changes in the growth of these seeds besides the peculiarity already mentioned although the actuality of the phenomenon is not clear; this point has presented quite a problem. Furthermore, the amount of nitrogen extractable from this soil is now being estimated. This measure is still under experimentation.

Two or three members of the Fisheries Section were sent to both HIROSHIMA and NAGASAKI, but no noticeable peculiarities have been noted in the reports of these members until now. According to what I have heard about the damages inflicted at the time of the bombing, damages were greater among marine life existing near the surface of the water and the higher type of marine life in waters within five-eighths of a mile from the zero points. However, this effect was not so devastating as to hamper the propagation of marine life. There have been reports to the effect that no peculiar phenomenon could be observed until today in the composition of water, in planktons, and in fish. Although my report has been brief and concise, this concludes it.

Salutation

YAMAZAKI, Chief of the Scientific Education Bureau:

I am YAMAZAKI, Chief of the Scientific Education Bureau. As the sponsor of this discussion, I would like to take this opportunity to make a few remarks.

When the investigation of the atomic bomb destruction was decided upon through requests to the authorities in various fields, we received the wholehearted approval of the Atomic Bomb Research Committee on the matter. Originally, I had intended to request a small-scale research, but through your ardent enthusiasm, it was possible to establish the complete research body which we have today, and we appreciate it from the bottom of our hearts.

Furthermore, we are very grateful to all of you who have come here from far-off places in spite of the typhoon, railroad accidents, and other things, and who have never experienced such hardships in their ordinary lives - this must be said to be an act of God. In spite of everything, you have accomplished your work with great enthusiasm, and as the representatives of the scientific world, we are very proud of you.

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Doc No 26823

We have dispatched officials and other personnel to give you as many conveniences as possible in regard to your living quarters and food. We have done everything we can to help you, but I believe there were some things amiss on our part for which I wish to apologize. Although I wanted to inspect your work and wanted to visit the actual localities, since I had just taken over my post at the Education Ministry which had various plans for doing new things, I was kept occupied day after day, time became precious to me, and it was impossible for me to make plans for a trip which required staying overnight. Please excuse me. I sent Chemist KINOSHITA on my behalf to have him extend my appreciation to the government officials and others who have cooperated with all of you and also to give you my regards. Please understand this point.

Today we have some members of the Occupation Forces here with us, and I wish to say that the aim of our research absolutely does not lie in the scheming of warped ambitions in regard to the employment of the atomic bomb. But our aim is to analyze the results of the atomic bomb as much as possible with the scientific knowledge of our country and contribute our efforts to the civilization of mankind to some extent by submitting the results of our research. I wish that the members of the Occupation Forces would also understand this point. For this reason, I wish that you would complete your pending reports in the shortest possible time and submit them to us.

As I forgot to mention, a considerable number of members from this research committee were killed in line of duty, and I regret this from the bottom of my heart. Although I sent letters of condolence at the time these calamities occurred, I wish to take this opportunity to further express my deepest sympathy. I wish to thank you all again for your earnest cooperation.

Committee member NISHINA, Yoshio:

I would like to suggest that the problems previously mentioned such as determining the location of the zero point, size of the ball of fire, force of the blast, and estimating the heat energy, duration of the heat, the blast energy, duration of the blast, blast speed, the shape of the blast, and the periodical progression of the bomb be determined by discussion. I would also like to suggest that we establish a sub-committee with such members as Professors TANAKA and MAJIMA who are interested in physics, and metals and mechanics, and reach some conclusion after the matter has been discussed thoroughly. I would like to have the consent of all of you in regard to this matter.

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