



Special Exhibition of Tokyo Tech Museum and Archives

Scientist Yasushi Nishiwaki in the Nuclear Age

Yasushi Nishiwaki (1917-2011), a professor emeritus at the Tokyo Institute of Technology, was a groundbreaker in the field of radiation biophysics in Japan. Throughout his life, he lived with problems of radiation exposure and atomic energy. At the dawn of the nuclear age, he was a member of the Japanese Army's atomic bomb development project. When a nuclear test was conducted by the United States at Bikini Atoll, he researched radioactive fallout and reported it to the world, which led to clarification of "dirty H-bomb." He was involved in nuclear energy policies at home and abroad. He passed away in the middle of media coverage of the nuclear power plant accident in Fukushima. This exhibition is focused on Nishiwaki as a scientist in the nuclear age: it covers his achievements, his convictions that he upheld in life, and his engagement with society.

Cosponsored by the Tokyo Institute of Technology's

- Tokyo Tech Museum and Archives
- Research Laboratory for Nuclear Reactors
- Graduate School of Decision Science and Technology

1. Yasushi Nishiwaki and the Nuclear Test at Bikini

Disaster-stricken *Fukuryu Maru*

At 6:45 a.m. on March 1, 1954, the United States conducted an H-bomb test at Bikini Atoll in the Marshall Islands. Code-named Bravo, it was the largest test ever conducted by the United States, a thousand times more powerful than the Hiroshima atomic bomb with an explosive force equal to 15 megatons of TNT.

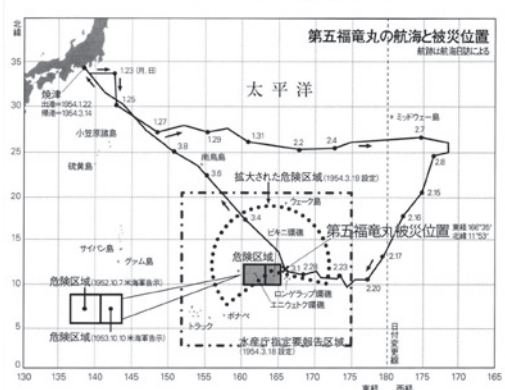


The mushroom cloud from the Bravo H-bomb blast on Bikini Atoll

At that moment, a tuna boat, the *Daigo Fukuryu Maru* (Lucky Dragon No. 5), was longline fishing near the danger zone of the H-bomb test. The boat's crew, on break after setting their longline, saw a bright light like a sun rising up in the western sky and heard a roaring sound a few minutes later. A few hours later, the "ashes of death" containing radioactive substances rained down on the *Fukuryu Maru*.

At night on March 14, the *Fukuryu Maru* returned to port in Yaizu, Shizuoka Prefecture. On the 16th, in its morning edition, the Yomiuri Shimbun first reported on the encounter of the boat's twenty-three crewmen with radioactive fallout, and news of it spread throughout Japan. Crewmembers had been exposed to two to three sieverts of radiation before returning to port and were diagnosed as "having acute radiation injury."

Tuna caught by the *Fukuryu Maru* that had been shipped around the country was disposed of in response to warnings from the port of Yaizu.



The chart is from "The *Fukuryu Maru* on a Voyage" edited by the Peace Society for the *Fukuryu Maru*, which shows the boat's fishing route and where it was exposed to radiation from the "ashes of death." The shaded rectangle that is divided into two parts and located at the bottom center of the chart shows the danger zones announced by the U.S. Atomic Energy Commission: The larger left part shows the zone announced on October 7, 1952; the smaller right part shows the zone announced on October 10, 1953. Bikini Atoll is located in the center of the smaller right part. The solid line shows the route taken by the *Fukuryu Maru* with labeled points marking its position on various dates during its voyage. It was exposed to radiation very close to the top right corner of the shaded rectangle. The dotted circle with a missing pie slice shows the expanded danger zone set on March 19, 1954. The broken-lined rectangle shows the area designated on March 18, 1954 by the Japanese Fisheries Agency that required any tuna destined for Japan that entered it to report to a designated port in Japan and be inspected for radioactivity.



An article from the Yomiuri Shimbun newspaper that reported on the encounter of the *Fukuryu Maru* with nuclear fallout

The *Fukuryu Maru* was not the only Japanese fishing boat exposed to radiation from the Bravo nuclear test: Many others were also. This was a little known fact for a long time, but is now shown in detail thanks to the "Seminar at Habata High School" in Kochi Prefecture, Japan.

Going to Yaizu Together with His Wife Jane

Yasushi Nishiwaki, who was working at Osaka City Medical College, now the Faculty of Medicine at Osaka City University, rushed to the Osaka central market on March 16 at the request of the Osaka City government. There, his Geiger counter started beeping violently when he pointed it at tuna. Shocked, he got on a train late that night to Yaizu together with his wife Jane.

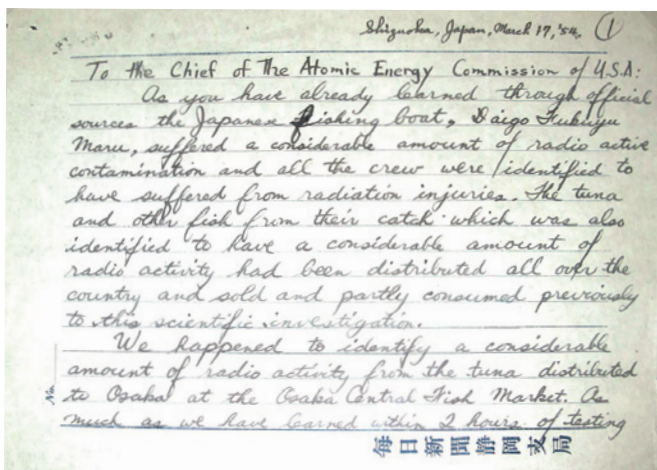
Nishiwaki arrived at Yaizu in the morning on the 17th. He measured the radiation levels of the *Fukuryu Maru* and realized how serious the crewmen's exposure was. (Nishiwaki is at the head in the picture on the right.) Before the day was out, he wrote a report about the disaster to the chairman of the United States Atomic Energy Commission on a notepad given by the Shizuoka branch of the Mainichi Shimbun newspaper. In his letter he asked the commission's chairman to inform him of the types of nuclides produced by the H-bomb blast so that the exposed crewmen could be treated, but there was no reply from the United States.

Nishiwaki and other Japanese scientists started independently analyzing the "ashes of death" (radioactive fallout) they collected. After March 16, groups of scientists from Shizuoka University, the University of Tokyo, and Kyoto University went to Yaizu to measure the radiation levels of the *Fukuryu Maru* and brought the "ashes of death" back to their laboratories. On the 18th, scientists from the University of Tokyo laboratory headed by Dr. Kenjiro Kimura, who had studied A-bombs dropped over Hiroshima and Nagasaki, started analyzing the "ashes of death" ahead of other teams and identified close to 30 different nuclides within a month. Among them was Uranium 237, which was later found to be decisive evidence for determining

the design of the Bikini bomb. (Please refer to page 7.) Nishiwaki analyzed the ashes in collaboration with a chemical analysis group from Osaka City University.



Nishiwaki checking the radiation levels of the *Fukuryu Maru*



The letter Nishiwaki wrote to the chairman of the United States Atomic Energy Commission. (This is on exhibit at the Nuclear Test Museum, Las Vegas.)
Photo by Kelly Michals

Behind Nishiwaki's quick response was an accumulation of knowledge from his past studies. He had learned experimental physics concerning nuclei at Osaka University. After the war, when the use of radioactive substances was banned in fields other than medicine, he obtained a position at Osaka City Medical College, where he specialized in radiation biophysics. The Bikini incident happened just as he was about to open up this new field after studying in the United States.

"Atomic Tuna" and Radioactive Rain

News of the *Fukuryu Maru*'s exposure to radiation quickly traveled around the country, and fear of radiation spread in Japan. Consumers were reluctant to buy tuna for fear that it might be radioactive and the price of tuna dropped, which hit the fishing industry hard. In addition, radioactive rain started to fall in Japan. In May, Kyoto had rain containing high levels of radioactivity, beyond eighty thousand counts per minute per liter. Levels this high do not occur naturally; it was positive proof that the radioactivity observed was generated by a nuclear test.

Inspection of Tuna and Its Termination

On March 30 the Ministry of Health and Welfare set an inspection standard for fish at harbors in response to issues of "atomic tuna," which mandated that fish be disposed of if it contained radioactive substances disintegrating at a rate greater than 100 counts per minute in total of β and γ rays when measured 10 cm away from its epidermis. By November, more than 450 tons of fish were dumped based on this standard. In addition, the Fisheries Agency formed a research group that embarked on a ship, the *Shunkotsu Maru*, from May through July to determine how much of the ocean was contaminated with radioactive fallout.

But, on December 28 the Ministry of Health and Welfare suddenly issued a notice that it would terminate the inspection of fish at harbors at the end of the year. Then, on January 4, 1955, both the Japanese and American Governments tried to put the disaster behind them through an agreement in which Japan would receive 2 million dollars (720 million yen) from the American Government. It was given in sympathy for the Japanese exposed to radiation from the H-bomb test.




Atomic tuna. From "The *Fukuryu Maru* on a Voyage"

On January 17 Nishiwaki and other scientists sent a written question to the Welfare Ministry about its abrupt decision to discontinue inspections.

(The picture on the bottom)
Written Question from Nishiwaki and Other Scientists to the Ministry of Health and Welfare
(Excerpt from April 1955 Issue of Science Journal *Shizen*)

"... December 31 of last year, the Government announced that it would terminate the inspection of fish for high levels of radioactivity, and shortly after that, it received 2 million dollars from the American Government for 'Bikini solatium.' ... Although, on November 7 (in the middle of the Japan-U.S. scientific conference on radiobiology) the Ministry of Health and Welfare announced that inspections would likely be eased, the current administrative action was altogether abrupt, and it is most regrettable that any academic standard behind it has not been made public. ..."

厚生省への質問状



西 脇 安 他

師走もし追った昨年の12月31日、政府はアメリカの“ビキニ補償金”200萬ドルで手を打ったのと前後して、突如として魚類の放射能検査打切りを發表した。

魚類の放射能検査廃止理由に関する質問書

今般厚生省に於きましては放射性物質で汚染された魚類の検査廃止を決定されましたが、私達は此の突然の検査廃止は、今なお汚染魚の入荷している現狀に於ては時期尚早であると考えますので、如何なる學問的理由で廢止に決定したかを詳細に御知らせ願えたら幸いと存じます。

昭和30年1月17日

Leading to a Movement against Nuclear Weapons

From Suginami, Tokyo

After the Bikini incident came to light, petition drives for bans on A- and H-bomb testing occurred spontaneously throughout the nation. In the forefront was a group consisting mainly of housewives from Suginami, Tokyo. The drive they organized was well known and became a good model for others to follow.



The petition campaign of Suginami, Tokyo
Courtesy Suginami Ward Local History Museum

In Osaka, Too

In Osaka, the Study Group on A- and H-bomb Diseases at Osaka University School of Medicine and the Teacher's Union of Osaka City took the lead in establishing "the Osaka Regional Liaison Office against the H-bomb," and they held lectures and signature-collecting campaigns. Nishiwaki's lecture about his findings from his study of the *Fukuryu Maru* was published in the first issue of the liaison office's bulletin.



The bulletin of the Osaka Regional Liaison Office in which an article about Nishiwaki's lecture was published

At the Tokyo Institute of Technology

At the Tokyo Institute of Technology, Prof. Atsushi Takamiya, a plant physiologist, took the initiative in a petition drive that collected signatures from 81% of the members of the university.



An article of "the Tokyo Institute of Technology Newspaper" reporting the campaign

The First World Conference against Atomic and Hydrogen Bombs Held

At the end of the year of the Bikini incident, the number of signatures petitioning for prohibition of A- and H-bombs totaled more than 20 million, and by August 1955 when the first World Conference against Atomic and Hydrogen Bombs was held in Hiroshima, it reached 30 million, which was more than one third of the Japanese population at that time.

This conference gave Japan the first opportunity to express, regardless of political views, its voice against nuclear weapons at home and abroad, which previously had not been allowed under American occupation.



2. Reporting the Bikini Disaster to Europe

For four months in 1954, from July to November, Nishiwaki visited Europe together with his American wife, Jane, and reported on the facts of the Bikini disaster in ten countries. He visited more than twenty places, which included churches, universities, research institutes, nuclear facilities, and others. In October, his speech at a BBC radio station was aired throughout the world. A great many MPs gathered to hear his report at the British parliament.



The places where Mr. and Mrs. Nishiwaki visited

Red circles mark the main institutes they visited.

- British Atomic Energy Research Institute
- Oxford University
- University of Liege, Belgium
- Max-Planck Institute, West Germany
- Heidelberg University
- Niels Bohr Institute, Denmark

The Dangers of Radio-active Dust

By YASUSHI NISHIWAKI

EARLIER this year there was world-wide concern over the case of twenty-three fishermen who were accidentally affected by atomic radiation following the experimental explosion of a hydrogen bomb in the Pacific. Recently one of the fishermen, Mr. Kuboyama, the first known victim of the hydrogen bomb, died. Just how does this radio-active dust affect a man like Mr. Kuboyama?

At the time of the explosion of an atomic or hydrogen bomb, strong radiation will come from the bomb itself. However, this is not what caused Mr. Kuboyama's death. Apart from the direct radiation, there is the radio-active dust from the bomb and the earth which go up into the air at the time of explosion, and this can be scattered very many miles. Dust giving out radiation is what caused the sickness of the twenty-three fishermen. They not only received strong radiation from outside their bodies but, with breathing and eating, the radio-active dust actually entered their bodies. This radiation given off from the dust we cannot hear, see, smell, taste or feel—and yet it injures the principal organs of the body. The most sensitive parts are the blood-forming and reproductive organs.

I vividly remember arriving at my laboratory after urgent calls from the public health authorities of Osaka City to go to the central market to examine fish brought back by the same boat on which the fishermen were injured. In examining the fish, I was greatly surprised by the high amount of radio-activity in their skin. So I decided to go to the port of Yaizu to examine the fishermen themselves and the radiation from the boat. From the measurements on the boat, it was apparent that some of the fishermen might have received sufficient radiation to cause their death. I had the opportunity of examining some of them. In my laboratory I found clear signs of radio-activity in their urine, blood, and so on. One of the striking points of radiation sickness is that it sometimes appears months or even years afterwards. Some of the fishermen who did not appear to be so sick in March had to be sent to hospital because their condition became worse in later weeks. All of these men are still in hospital and are receiving doctor's treatment and care in Tokyo.

I brought back some samples of dust from the boat to my laboratory.

I found that the very fine, greyish-white powder, which reminded me of chalk powder, was giving off strong radiation even though at this time more than two weeks had passed since the explosion. From more detailed testings I found many different radio-active substances in the dust. Some of those substances, if they enter a human body, are likely to affect such important organs as the bone, liver, kidney, and thyroid.

While I was testing fish and boats, I also made tests to measure the radio-active increase in the rain. Dust which fell with the rain was checked and found to be radio-active. It contained some of the same substances which I found in earlier tests of fish and boats. So we could see that it was definitely due to the hydrogen-bomb test at Bikini. In the middle of May, unusually high radio-active rainfall was observed all over Japan, and plants, vegetables, and milk became radio-active to a greater or lesser extent. The lungs and liver of cows also showed an increased amount of radio-activity. In the middle of September, unusually high radio-active rain fell all over Japan. Although you may have read that this was due to nuclear tests in Siberia, in my opinion there was not enough definite evidence to prove it, if direct information I have received from Japan within the past few days is correct.

You may well wonder if there is any possible protection against these serious dangers. Scientists hope to be able to develop a drug which will give at least some protection to everyone who has taken it before being exposed to radiation. But if an injury has been sustained, what then? There are two types of radiation injuries: those which appear in our lifetime and those in the future generations. For the first type of injury, there are many possible treatments, such as blood transfusions, but these cures do not overcome the hereditary injuries which may be transmitted to children or grandchildren. Nine years after the smaller type of atomic bomb used at Hiroshima and Nagasaki, illness, death, and abnormal children due to radiation injury are reported by our medical authorities. Although the great and terrible effects of atomic and hydrogen bombs are widely discussed in many countries of the world, we Japanese are the only people who have actually suffered twice in this way. Therefore, we feel it our right, our duty, and our responsibility to appeal strongly to the world, so that other peoples will not suffer in future.

—Home Service

An article about Nishiwaki's speech "The Dangers of Radio-active Dust" at a BBC radio station *The Listener*, Oct. 28 (1954): 700

The pictures on this page are newspaper articles covering Nishiwaki's lectures and reports. The left is a newspaper article in Dortmund, West Germany, the middle is in Hamburg, and the right is in Vienna, Austria.



~ A Newspaper Article in Dortmund ~
September 16, 1954 (Thursday)

Unstoppable bleeding

Professor Nishiwaki told us, in the unemotional and objective way of a scholar, about the 23 fishermen who were victims of the American bomb testing. He was himself directly involved in the medical examination of these people, and throughout his lecture, used authentic photographic material that showed the external radiation burns suffered by those affected. With the help of meticulously prepared tables, he explained the severe changes in their blood count, in particular, changes affecting their white blood cells (in terms of a pan-myelocytosis) and blood platelets (thrombocytes). The latter damage has the effect of causing a dangerous decrease in blood's ability to clot, which means even a minor injury can continue to bleed and become life threatening. Because immediate and extensive blood transfusions were carried out on the fishermen however, none of the victims has—as yet—died.*

Terrible consequences

Catastrophic alterations—about which, for obvious reasons, nothing has been published in Japan—have been observed in their reproductive organs. These alterations cause a decrease in sperm cell count, and may increase the risk of birth defects in their children too. In predicting these consequences, Professor Nishiwaki used the results of American research scientists, whose publications he referred

to and displayed throughout his lecture.

The speaker went on to discuss the radioactive rainfall in Japan in May this year, and presented evidence, based on meteorological data, that these events were not caused by Soviet atom bomb tests—as was reported in American newspapers—but were in fact the result of several American tests that had not been announced beforehand.

Calm, unemotional

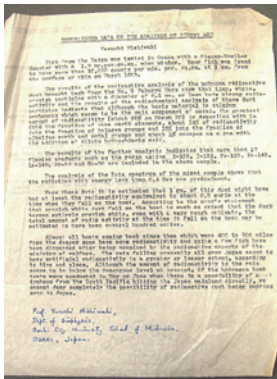
Professor Nishiwaki left a deep impression on his audience in two ways: firstly, through his calm, unemotional presentation of the terrifying consequences of testing and using hydrogen bombs, and secondly, through his forceful emphasis that these tragic events have not caused anti-American sentiments or hatred in Japan. Such animosity has not arisen because the Japanese people feel very strongly it would only exacerbate the situation. Everyone in the audience was content to believe these statements, spoken as they were by this earnest, humble man, who they saw with an American wife at his side.

It is unfortunate that, to date, the material used by Professor Nishiwaki has only been published in Japanese; however, an English language version written by him is anticipated. That will certainly make it easier to spread knowledge of these terrible events to the farthest corners of the globe, and rouse both the desire and driving forces to oppose this nuclear madness everywhere.

* One of the 23 crewmen of *Fukuryu Maru*, Aikichi Kuboyama, died on September 23 after this article was published.

Encounter with Joseph Rotblat

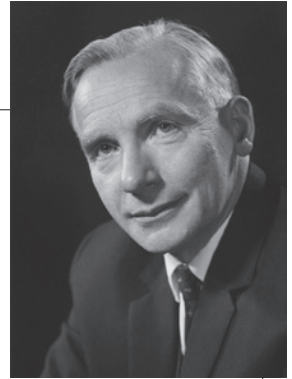
At the end of August in 1954, Nishiwaki participated in the first International Conference on Radiation Biology at the University of Liege, Belgium, where he met Joseph Rotblat (the photo on the right) from Britain. Nishiwaki handed Rotblat a memo, written in English (the picture below), which contained his estimates of the amount of radiation emitted from the radioactive dust that fell onto the *Fukuryu Maru*. Rotblat was astonished by its contents, which showed that an extraordinary amount of radioactive elements were produced from the hydrogen bomb on Bikini Atoll.



The memo Nishiwaki handed to Rotblat

It was discovered among the documents of the late Rotblat, which are stored in Churchill College, University of Cambridge.

Nishiwaki also told Rotblat that the “ashes of death” contained Uranium 237 in massive quantities. Rotblat thought deeply about this and realized that the hydrogen bomb tested on Bikini Atoll was composed not only of nuclear fissions caused by an A-bomb acting as a trigger (drawing B on the right) and the ensuing fusion reactions of hydrogen (drawing C on the right) but also of an additional nuclear fission reaction on a massive scale (drawings C and D on the right) as a result of high-speed neutrons generated by the nuclear fusion hitting the depleted uranium (Uranium 238) jacketing material. Many of the fission products and Uranium 237 were produced from the last stage. Rotblat named this bomb a fission-fusion-fission bomb, which is still known by this name. The H-bomb tested on Bikini Atoll was a “dirty bomb,” which enormously multiplied the detonation energy and amount of radioactivity released.

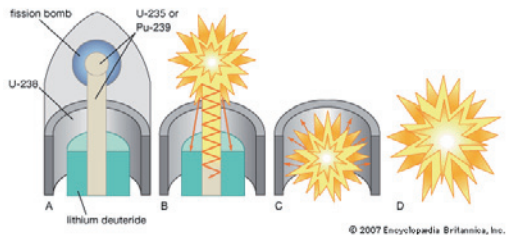


**Joseph Rotblat
(1908–2005)**

Rotblat was a physicist born in Poland. He studied under English physicist, James Chadwick, who discovered the neutron. During World War II he was engaged in A-bomb development in the United States at Los Alamos. He left the A-bomb project in December 1944 when he found out through Chadwick that Germany possessed no atomic bombs. After the war he became a British citizen and served as a professor of physics at St. Bartholomew's Hospital.

Photo: Courtesy National Portrait Gallery, London

How a thermonuclear weapon works



In a typical thermonuclear weapon (A), a fission reaction (B) is channeled by a uranium-235 (U-235) or plutonium-239 (Pu-239) “spark plug” to a mass of lithium deuteride to ignite a fusion reaction (C). Some weapons have a uranium-238 (U-238) mantle that undergoes fission (D) when bombarded by neutrons from the fusion reaction. (The depleted uranium jacketing an atomic bomb is omitted here.)

nuclear bomb: fission reaction, Art, from Britannica Online for kids accessed Aug. 6, 2014, <http://kids.britannica.com/comptons/art-124609>

Leading to the Russell-Einstein Manifesto

Rotblat told Bertrand Russell, an English philosopher, that the Bikini H-bomb was a “dirty bomb.” Russell was concerned that hydrogen bombs would plunge mankind into crisis and called Einstein, who was ill in bed, to draw up a statement against nuclear weapons, which became known as the “Russell-Einstein Manifesto.” Eleven prominent scientists signed the statement.



Russell announcing the manifesto at a press conference on July 9, 1955
Courtesy Pugwash Conferences on Science and World Affairs



Einstein (*left*) and Hideki Yukawa (*center*)

Hideki Yukawa, who became a friend of Einstein, signed the “Russell-Einstein Manifesto,” too. Einstein passed away on April 18 before the announcement of the declaration.

Photo by Wallace Litwin and Josef Kringold, courtesy AIP Emilio Segre Visual Archives, Wheeler Collection

Russell-Einstein Manifesto

In the tragic situation which confronts humanity, we feel that scientists should assemble in conference to appraise the perils that have arisen as a result of the development of weapons of mass destruction, and to discuss a resolution in the spirit of the appended draft.

We are speaking on this occasion, not as members of this or that nation, continent, or creed, but as human beings, members of the species Man, whose continued existence is in doubt. . . .

The general public, and even many men in positions of authority, have not realized what would be involved in a war with nuclear bombs. . . . No doubt in an H-bomb war great cities would be obliterated. . . . But we now know, especially since the Bikini test, that nuclear bombs can gradually spread destruction over a very much wider area than had been supposed.

. . . It is feared that if many H-bombs are used there will be universal death, . . .

Here, then, is the problem which we present to you, stark and dreadful and inescapable: Shall we put an end to the human race; or shall mankind renounce war? . . .

There lies before us, if we choose, continual progress in happiness, knowledge, and wisdom. Shall we, instead, choose death, because we cannot forget our quarrels? We appeal as human beings to human beings: Remember your humanity, and forget the rest. If you can do so, the way lies open to a new Paradise; . . .

Leading to the Pugwash Conference

Following the spirit of the “Russell-Einstein Manifesto,” Russell organized an international meeting of scientists to abolish nuclear weapons. It was called the “Pugwash Conference” since the first meeting (July 1957) was held in the isolated village of Pugwash, Canada. Shinichiro Tomonaga, Iwao Ogawa, and Yukawa attended from Japan (the photo on the bottom). In 1995 Rotblat and the Pugwash Conference were awarded the Nobel Peace Prize (the photo below)



Rotblat who was awarded the Nobel Peace Prize
Courtesy Bjoern Sigurdsoen / NTB Scanpix

2015 Pugwash Conference to Be Held in Nagasaki, Japan

The 61st Pugwash Conference will be held in Nagasaki in November. It will be the fifth time for Japan to host the conference following one in Kyoto (1975), one in Tokyo (1989), and two in Hiroshima (1995, 2005).



The members of the first Pugwash Conference
Courtesy Pugwash Conferences on Science and World Affairs

Beyond the Wall Dividing the West and East

In 1957 Nishiwaki visited Europe again and warned people of the danger of A- and H-bombs. In his speech in Moscow in June, he warned that radioactive contamination was increasing due to nuclear testing. He even sent Khrushchev, then leader of the Soviet Union, a letter asking him to release a statement that if the West stopped nuclear testing the Soviet Union would follow. Through the support of the Japanese Government and local organizations of scientists he visited Eastern Europe, where he made speeches at academic institutions and other places in Czechoslovakia, Hungary, Poland, and East Germany.

Nishiwaki was extremely active in the United States as well. In 1959, after he was invited by Linus Pauling (the photo on the right) to be a visiting research fellow at the California Institute of Technology, he gave more than forty speeches during a four month stay.

In addition to pursuing the prohibition of A- and H-bombs, Nishiwaki was also an advocate of realistic countermeasures against radioactive fallout based on scientific studies. In autumn 1958, the United States, Britain, and the Soviet Union voluntarily suspended nuclear tests with the goal of concluding a comprehensive nuclear test ban treaty. But in 1961, three years later, the Soviet Union resumed nuclear testing. In response, Nishiwaki called upon the Japanese Government to establish a task force against radiation and became an advisor to that group when it was established.

In spring 1962, the United States resumed nuclear testing in the atmosphere, which brought the world closer to a nuclear crisis. But after going to the brink of nuclear war over the Cuban missile crisis in October, the United States and the Soviet Union worked out a compromise nuclear test ban to ease tensions. In August 1963 the United States, Britain, and the Soviet Union agreed to prohibit all types of nuclear testing except underground (the Partial Test Ban Treaty), which helped rapidly decrease radioactive contamination of the atmosphere, a danger Nishiwaki had warned the world of.

Linus Pauling (1901–1994)

Pauling was an American chemist. He was awarded the Nobel Prize in Chemistry in 1954 for elucidating the principle of chemical bonds by applying quantum mechanics, and the Nobel Peace Prize in 1962 for his leadership role in the nuclear disarmament movement, including a campaign led by scientists petitioning for bans on nuclear testing despite many political obstacles posed by anti-communist sentiment.

The photo below is Pauling visiting Hiroshima.
Courtesy Special Collections, Oregon State University



Comprehensive Nuclear Test Ban Treaty (CTBT)

The United Nations General Assembly adopted the Comprehensive Nuclear Test Ban Treaty in 1996, shortly after the Cold War ended, to prohibit all types of nuclear testing including underground. Japan ratified the treaty in July 1997, but the United States and some other nuclear powers (including countries suspected of having nuclear weapons) still have not signed or ratified it.

3. Atomic Energy and Yasushi Nishiwaki

Over Nuclear Reactor at Tokai Power Plant

Nishiwaki was generous in his support for the peaceful uses of atomic energy. This was reflected in his remark about the nuclear reactor at Tokai Power Plant. (The reactor, which was graphite-moderated and made in Britain, started commercial operation in July 1966.) (The photo below) In his remark, made at a public hearing of the Atomic Energy Commission of Japan on July 31, 1959, he said that a nuclear accident would not have a serious effect on residents living near the plant based on accident data from Britain and estimates from the United States. In opposition, physicist Yoichi Fujimoto emphasized the danger of nuclear accidents by criticizing Nishiwaki for grossly underestimating the magnitude of radioactivity that would be produced by an accident.



Tokai Power Plant
Courtesy Japan Atomic Power Co., Inc.

argued as witnesses before the Diet that Japan should not allow a submarine that is possibly dangerous to visit a Japanese port since information necessary to determine if it is safe is classified as a military secret.

Nishiwaki, on the contrary, stated that the submarine was presumably built strong judging from even the limited information made public by the United States and there would be little danger since it produces a minute amount of radioactive substances during normal operations. His position sounded as if he had all but supported its visit to a Japanese port. Because of this statement Nishiwaki was criticized by Hideki Yukawa, Yoichi Fujimoto, and other scientists who were against it.

Nishiwaki continued to warn of the danger of nuclear weapons; while on the other hand, he supported the nuclear reactor at Tokai Power Plant and the US nuclear submarine's visit to a Japanese port, which gave many scientists the impression that he "had changed." As far as nuclear weapons were concerned, he shared opinions that were against even small amounts of radiation. However, he believed that such "qualitative absolutism," which was his term, should not be applied to the other uses of nuclear energy. He did not share the opinion that nuclear reactors should not be built because they could cause accidents, but instead thought that having a system in place for protecting the nation against radiation, in preparation for an accident, should be the most important thing if a reactor is constructed at all.

On the Issue of Nuclear Submarine Visiting a Port

In January 1963, a plan was revealed that would allow a US nuclear-powered submarine to visit a port in Japan. Fears were expressed about the possibility of radioactive contamination from or an accident accompanying the visit of a submarine to a fishing port in a densely populated area. Scientists from the Science Council of Japan



The nuclear submarine *Seadragon*
Courtesy National History & Heritage Command

Nishiwaki at the Tokyo Institute of Technology

Yasushi Nishiwaki and Health Physics

In 1960 Nishiwaki became a professor in the Research Facility for Nuclear Reactors, part of the Faculty of Science and Engineering, now the independent Research Laboratory for Nuclear Reactors, at the Tokyo Institute of Technology, where he taught health physics and radiation protection science.

He believed that development of health physics was indispensable for the peaceful uses of nuclear energy in order to protect people from radiation. His paper titled "Methods to Estimate the Land Surface Area and Population Covered by the Spread of Radioactive Clouds, and Its Collective Dose" (which estimated the amount of radiation which residents near a nuclear power plant would be exposed to when radioactive substances are emitted from the plant's reactor at the time of an accident or during normal operation; the figure below) was published on the opening page of the first issue of "Journal of the Atomic Energy Society of Japan." This shows that Nishiwaki's studies were highly regarded by atomic energy researchers.

While at the Tokyo Institute of Technology Nishiwaki published a variety of papers concerning health physics such as the effects of radiation on living things and ways of measuring radiation. According to his graduate students, he gave them attentive guidance until they decided their research theme, after which he encouraged them to work independently on their course of study. They also said that they were very inspired by the latest research information Nishiwaki brought back from his official trips abroad.

Nishiwaki also played a leading role in establishing the Health Physics Society of Japan and the International Radiation Protection Association (IRPA), which is an international organization of health physicists.

Civil Defense and Nuclear Armaments

During the Cold War the United States, the Soviet Union, and other nuclear powers took measures of civil defense such as constructing shelters in preparation for nuclear attacks. With many opportunities to exchange views with overseas experts on nuclear protection, Nishiwaki began to think that civil defense was necessary in Japan as well when he was a professor at the Tokyo Institute of Technology, and he joined in establishing the Civil Defense Association of Japan. However, in Japan, which had endured atomic bombings, it was generally believed that it would be impossible to protect against nuclear weapons and the idea of civil defense or nuclear shelters was not generally accepted. Nishiwaki admitted that he had been told he was crazy when he talked about civil defense against a nuclear attack.

Nishiwaki even believed that Japan should be armed with nuclear weapons. This was due to his realistic judgment that a nuclear deterrent would be necessary if the risk of nuclear attacks could not be ruled out although abolishing nuclear weapons would be ideal.



The diffusion of radioactive substances that Nishiwaki predicted based on his calculations
The vertical axis shows how wide it would be and the horizontal axis shows how far leeward it would be.

To the International Atomic Energy Agency (IAEA)

Nishiwaki was loaned to the International Atomic Energy Agency (IAEA) in Vienna in 1968 at the request of the Science and Technology Agency and was installed as Deputy Director of the Division of Health, Safety, and Waste Management, which was later changed to the Division of Nuclear Safety and Environmental Protection. Initially his tenure to the IAEA was supposed to expire in 1970, but he resigned from the Tokyo Institute of Technology in order to continue serving as secretary of science for a symposium titled “Atomic Power Plant and Environmental Issues” held at the United Nations Headquarters in the summer of 1970. He continued to be involved in all sorts of conferences as secretary of science since then, including the 1973 London Convention, which regulates dumping of nuclear waste in the ocean, where he worked hard on facilitating agreement on the draft recommendations. He ended up working for the IAEA until he retired in 1977 at the age of 60.



The headquarters of IAEA at the time when Nishiwaki was working there
Courtesy the IAEA



Nishiwaki (*left*) who is shaking hands with Secretary-General of the United Nations, U Thant, at a United Nations conference

Adopting Fuzzy Theory

After retiring from the IAEA, Nishiwaki continued working there part-time as an advisor while teaching nuclear safety and radiation protection at the University of Vienna. In 1979, a meltdown accident occurred at the nuclear power plant at Three Mile Island in the United States. A major issue in the accident was human factors. In order to deal with such factors, Nishiwaki changed direction and devoted himself to the study of fuzzy theory, which emphasizes the difference between probability and possibility: Even if the probability of a certain phenomenon occurring is negligibly small, the possibility of it occurring is not necessarily small. He did many studies that made use of fuzzy theory. The first was a joint research study with Michio Sugano and Takehisa Onisawa from the graduate course of Comprehensive Science and Technology, Tokyo Institute of Technology. In his paper with Onisawa, which analyzed the 1986 Chernobyl nuclear power plant accident in the former Soviet Union, he demonstrated that it is dangerous to believe that a small probability of error shows good reliability.

In the Middle of News on the Fukushima Nuclear Accident

Nishiwaki returned to Osaka, his hometown, remarried (late in 2008) and settled into a quiet life with his wife, Sakae. He was lying in the living room and watching intently TV news coverage of the accident at Tokyo Electric Power Company's Fukushima Daiichi Plant shortly after it occurred. When Sakae asked him about it, he shouted, "What do you expect me to do about it?" She said he quickly responded by saying, "50 km" to her question of how far the danger zone, which people should not enter, reached. "We are in Osaka. Don't worry," he added. He might have been frustrated by looking back on "his repeated warning that we should have radiation protection in preparation for a nuclear accident," she recalls. On March 27, 2011, about two weeks after the accident, Nishiwaki died of aspiration pneumonia at a hospital in Osaka City. He was 94 years old.



Fukushima nuclear accident
Courtesy Fukushima Central TV

Personal History of Yasushi Nishiwaki

Nishiwaki was born in 1917, the second son of Rika and Yasukichi Nishiwaki. Yasukichi was a professor of zymurgy (fermentation) at Osaka Technical School, which later became Osaka University of Engineering, and then the Faculty of Engineering, Osaka Imperial University. Rika graduated from Tokyo Women's Higher Normal School, now Ochanomizu University, and taught at Osaka Women's Normal School when Yasushi was little. She devoted her services to female education and became the first president of Tokiwa Gakuen Junior College. Yasushi's elder brother, Yasutoshi, graduated from Kyoto Imperial University and worked for the Osaka City Office where he was engaged in planning the expansion of Midosuji Avenue under then mayor Hajime Seki and presented the idea of planting ginkgo trees along the avenue. Unfortunately, he died when he was still young. Yasushi's younger brother, Yasuzo, was mobilized when he was a student at Kyoto Imperial University, and died as an Army Aviation pilot.

Yasushi studied physics under Tsunesaburo Asada in the Faculty of Science at Osaka Imperial University. After being a research fellow in the Aviation Laboratory at Tokyo Imperial University, he became an assistant professor in the Faculty of Science at Osaka Imperial University, where he conducted experiments on thermal diffusion for uranium enrichment as part of the Ni-go Project in which Asada was engaged. The Ni-go Project (based at the Institute of Physical and Chemical Research in Tokyo) was a nuclear development research project led by the Japanese Army.

From Physics to Biology

Under the American occupation after the war, experimental work on the atomic nucleus was prohibited in fields other than medical research. Because Nishiwaki was engaged in this type of work as a physicist and wanted to continue working with radioactive materials, he changed his field from physics to medical research, and became an associate professor at Osaka City Medical College, the predecessor of the present day Faculty of Medicine at Osaka City University. During this period, he went to the United States through the first cultural exchange program between Japan and America to learn the foundation of radiation biophysics at the University of Pennsylvania and Columbia University.

Chronological Record of Yasushi Nishiwaki's Career

February 20, 1917	Born in Abeno Ward, Osaka City
March 1939	Graduated from the Department of Physics in the Faculty of Science at Osaka Imperial University
April 1939	Became a research fellow in the Aviation Laboratory at Tokyo Imperial University
December 1939	Became a research assistant and then an assistant professor in the Physics Laboratory in the Faculty of Science at Osaka Imperial University
April 1945	Became an associate professor in the Mathematics and Physics Department at Osaka Science and Engineering University
June 1949	Became an associate professor of radiation biophysics at Osaka City Medical College
1950-1951	Studied in the United States at the University of Pennsylvania and Columbia University (through the first cultural exchange program between Japan and America)
March 1954	Received a Dr.Med.Sci. degree from Kyoto University
April 1955	Became an associate professor in the Faculty of Medicine at Osaka City University
1959	Became a visiting fellow at the California Institute of Technology
February 1960	Became a professor at the Tokyo Institute of Technology
April 1962	Received a D.Sc. from Kyoto University
April 1964	Became a professor in the Research Laboratory for Nuclear Reactors at the Tokyo Institute of Technology
March 1968	Became Deputy Director of the Division of Health, Safety, and Waste Management at the International Atomic Energy Agency
September 1970	Retired from the Tokyo Institute of Technology
August 1977	Retired from the International Atomic Energy Agency
March 1978	Became a Honorary professor at the University of Vienna
April 1991	Became a professor emeritus at the Tokyo Institute of Technology
November 1992	Received the Order of the Rising Sun, Gold Rays with Neck Ribbon
March 27, 2011	Passed away in Osaka City

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