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***Chapter 16***

# SUMMARY OF THE FUKUSHIMA DISASTER

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## DESTRUCTION WROUGHT BY THE EARTHQUAKE AND TSUNAMI

More than three and half years have passed since the magnitude 9.0 earthquake, the Great East Japan Earthquake (GEJE), occurred at 14:46 on March 11, 2011. More destructive than the earthquake itself were the accompanying tsunami waves, which devastated long coastal areas of eastern Japan. The disaster claimed 15,889 lives. According to the National Police Agency, 2,601 residents were still missing as of September 10, 2014. Disaster-associated deaths reached 3,089 as of March 31, 2014, according to the Reconstruction Agency. This number includes those who have died of physical and mental fatigue attributable to refuge life, those who died during transfer from homes to refuges, and those who died from lack of primary care because of impaired function of hospitals. More than half (55%) of those disaster-associated deaths were of Fukushima residents. Consequently, a total of more than 20,000 have died as a direct result of this disaster. Injured people were 6,152. Evacuees have decreased in number from 328,903 on November 17, 2011, to 263,392 as of February 13, 2014.

The number of houses that had been completely destroyed, half destroyed, and partially destroyed were 127,367, 273,335, and 744,539, respectively. Many houses were flooded above the floor level (3,352) and below the floor level (10,218). Non-residential houses or buildings destroyed were 57,880. Other damage includes destruction of roads (4,198 sites), bridges (116), embankments (45), and railways (29). Landslides have occurred at 45 sites. Additional damage includes destruction of port facilities and vessels including fishing boats. The Ministry of the Environment announced on March 31, 2014 that tsunami wreckage of 20 million tons and tsunami deposits of 10 million tons had been disposed of in 12 prefectures aside from Fukushima Prefecture, where 71% of wreckage and 46% of deposit had been treated. Of course radioactive contamination is responsible for the delay in the disposal. People who lived in tsunami-devastated areas were once in desperate conditions, but they

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have been able to find hope of restoration and vision for a better life in the near future. Now, the most disaffected are those who lived around the Fukushima Daiichi Nuclear Power Plant (FDNPP), which was damaged heavily by the tsunami and its aftermath.

## Survey of Refuge Life

For the first time since the earthquake, the Fukushima prefectural office conducted a questionnaire survey of 58,627 households during January and February, 2014. Of those questionnaire forms, 26,080 yielded responses. The results were publicized on April 28. The numbers of evacuees in and out of Fukushima Prefecture were 132,500. More than half of the families (14,429) of 26,080 live an evacuee lifestyle. Almost half of the families (48.9%) are separated to 2 (33.3%), 3 (12.1%), 4 (2.9%), or >5 (0.6%) places. Approximately half of the evacuees (44.7%) in Fukushima Prefecture want to return to their former places, while only a small fraction (17.5%) of those who live outside Fukushima Prefecture want to return to their homes. A quarter of those people (26.4%) chose to stay at the present refuge locations. Most importantly, 67% people expressed mental or physical disorders, indicating that life as an evacuee is extremely stressful.

Refuge life was forced upon people by government in response to radio-contamination. Refuge life with fear of radiation is so difficult that many people have been affected by suicide, divorce, separation of family members, migration and settlement to another places, mental illness, and so forth. The Cabinet Office reported that 129 (56 in Fukushima Prefecture) people had committed suicide until July, 2014, in association with GEJE—55 (10, ibid.) in 2011, 24 (13) in 2012, 37 (23) in 2013, and 13 (10) in 2014. Some numerals listed above demonstrate that GEJE caused tremendous material and human damage. Human damage includes not only physical but also mental damage. The major influence of the Fukushima tragedy derives from fear of radiation. Therefore, it is important to ascertain whether such fear is justified.

## Scrutiny of the LNT Model

Japan is the only nation in the world to have experienced the devastation of a nuclear attack, the distribution of energy from which was thermal radiation (including light, 35%), blast (pressure shock wave, 50%), and nuclear radiation (immediate and delayed, 15%) [1]. Thermal and blast energy, not radiation, were the major factors contributing to atomic bomb damage and death. Nevertheless, Japanese people may have some misunderstanding, at least in part, that a major part of the overall death toll was attributable to radiation. Such misunderstandings have helped formulate the current Japanese mental attitude of radiation phobia, which seems to constitute a background for their ready acceptance of the idea that radiation is limitlessly hazardous independent of the dose, as implied by the linear no-threshold (LNT) model.

In addition to the atomic bomb experience, fear of radiation is generated by the low radiation dose limit of 1 mSv/y for the general public set by the Japanese government and the recommendation to use the LNT model by the International Commission on Radiological

Protection (ICRP), which insists that the cancer risk is linearly proportional to the radiation dose, with no threshold [2]. When theories or models fail to explain data, they become invalid: so the LNT model is not valid. The LNT model torments Fukushima people and leaves them spell-bound. Not only residents but also farmers and fishery workers have been affected by harmful rumors that their products or catches are radio-contaminated. Consequently, they are rejected by markets.

The LNT model is based on analyses of cancers among atomic bomb survivors in Hiroshima and Nagasaki [3]. Solid cancers and tumors of the esophagus, stomach, colon, liver, lung, bladder, and breast increased as the radiation dose increases. No dose–effect relation was found in those of the pancreas, kidney, or prostate. No increase was detected in cancers or tumors of the rectum, gall bladder, or uterus. Cases of bile-duct cancers were, contrarily, reduced by irradiation. Combining all the cases, an upward-sloping line was obtained. The linear-quadratic model fit to the line best, but the linear model was not deviated significantly from the linear-quadratic line. Therefore, ICRP adopted the linear model. Cancer and tumor cases below 200 mSv were not significantly different from those of the comparative controls. This 200 mSv might therefore be set as the practical threshold. Standing on the side of safety, however, linearity was adopted, even though the originally compiled data could set the threshold at 40 mSv. Fundamentally, solid cancers and tumors are problematic. Radiation doses are not perfectly estimated. Identification of cancers or tumors is not always easy. Sensitivity of tissues or organs to radiation varies to a great degree. The onset of cancers and tumors requires varied lengths of periods of 10–40 years or more. Estimation of background levels of cancers and tumors as the basis for comparison is also extremely difficult because the levels differ depending on the age of exposure, sex, historical period, genetic background and so forth. Considering these factors, assumption of linearity as the LNT model based on solid cancers and tumors appears to be overly simplified and forced. In this regard, the cases of leukemia are much more reliable.

Leukemia is a tumor of blood cells. Its incidence reaches a peak several years after exposure to radiation. Atomic bomb-induced leukemia peaked a long time ago. The result was fixed, although analyses of solid cancers and tumors are still ongoing. The linear-quadratic model fits the incidence of leukemia [4] as for thyroid tumors [3]. In the linear-quadratic model, cancers and tumors increase linearly at first and then increase exponentially. As doses increase further, however, the cancer and tumor incidence reaches a peak and then decreases gradually because people exposed to higher doses die before cancers and tumors develop. Linearity of the LNT model must come into existence in a limited range of a linear-quadratic curve. The linear-quadratic model itself seems to come into existence in a limited, moderate dose range excluding lower and higher doses. Because many biological responses follow the sigmoidal curve, where responses do not appear at first, arise to some degree, gradually increase, and reach a peak. Then they fade out. For example, a bacterial growth curve and the dose–effect curve of a drug follow a sigmoidal curve. Radiation-induced cancers and tumors are likely to follow this curve closely as biological processes.

Irrespective of dose-response shape being the linear-quadratic curve or the sigmoidal curve, the effect of low-dose radiation below 200 mSv on cancer and tumor induction has not been demonstrated clearly. No statistically significant difference has been detected between the exposed and control groups in Hiroshima and Nagasaki. Therefore, the effect, if any, must be negligibly small. Moreover, radiation effect estimates from data in Hiroshima and Nagasaki are exaggerated because the radiation exposure occurred in a short period of time at a high dose-rate that induced 10–100 times higher biological effects than lower dose-rates [5]. In fact, ICRP acknowledges the dose-rate effect and adopts 2 as the dose and dose-rate effectiveness factor (DDREF), but this value is apparently too small and therefore exaggerates low-dose radiation effects.

## SOME DATA CONTRADICTORY TO THE LNT MODEL

Because several contributors in this book refer to data that are not explained by the LNT model, a few can be listed here. More than 2,500 nuclear bomb tests do not seem to have caused severe health hazards. People living in areas with high background radiation levels appear to be healthy. Japanese people are exposed to 4 mSv radiation on average for medical examinations or treatments. The LNT model predicted that 25,000 would die of cancers and tumors annually from 4 mSv annual dose. In fact, Japanese people have extremely high longevity among the world's people. These few examples support the idea that low-dose radiation is not hazardous to our health and that the LNT model is not relevant. The French Academy of Sciences – French National Academy of Medicine clearly discounts the LNT model [6]. It is of great interest to learn that the higher the radon levels in residences are, the lower the observed lung cancer mortalities. The dose-response relationship fits the linear-quadratic curve and deviates greatly from the LNT model [7]. Induced mutation frequencies in both somatic and germ cells were also found to follow the linear-quadratic curve [8]. These findings [7,8] not only negate the LNT model but also suggest the existence of special biological responses to low dose radiation. Indeed, several contributors to this book describe that low-dose radiation is not harmful, and that it is even beneficial. The idea of net benefit from radiation-stimulated beneficial changes is called hormesis. Some people prefer to call it an adaptive response. Hormesis, or adaptive response, is quite plausible when one examines the evolutional history of living organisms on the earth and the mechanisms of action of radiation on biological systems.

## EVOLUTIONAL VIEW OF RADIATION EFFECTS

When primitive life appeared on the earth around 3.8 billion years ago (Ba), the environment was anaerobic. Oxygen was toxic. When limited to K-40, the half life of which is 1.2 billion years, concentrations of K-40 on the earth were 2, 4, and 8 times higher, respectively, than those of the present day at 1.2, 2.4, and 3.6 Ba. Considering radiation from other sources, radiation would be much higher. Therefore, organisms without mechanisms to neutralize radiation effects would not have evolved. Photosynthetic organisms started to produce oxygen. The contents of oxygen in the atmosphere began to increase from around 2.5 Ba. Since then, aerobic organisms started to appear. Organisms without mechanisms to dispose of reactive oxygen species (ROS) were unlikely to have evolved. Considering the fact that radiation exerts toxic effects on organisms mostly by producing ROS, common mechanisms to address ROS produced by both radiation and aspiration are expected to have evolved. The Nrf2 system described in this book (chapter 7) is very likely to play a pivotal role in this process.

The essential task of organisms on the earth is to maintain homeostasis on their own. Our body temperature is maintained in a narrow range close to 37°C. Our blood pH is maintained at pH 7.4. Our heart beats, respiration rates, blood sugar levels, menstrual cycles, and many other biological indices are maintained at certain levels with marginal fluctuations by feedback control mechanisms. ROS levels are quite likely to be under the control of homeostasis. A television program reported that, when rats were captured in the Chernobyl Exclusion Zone and examined for hazardous effects, neither DNA damage nor elevation of DNA repair enzymes was detected. Only ROS scavenger levels were heightened. A recent report describes that when 16 species of birds were examined near Chernobyl, the glutathione, an ROS scavenger, level was found to be increased. The authors insist that hormesis is functioning under intense radiation levels [9]. Animals under strong radiation are expected to benefit by erasing ROS before DNA damage occurs.

## Quantitative Consideration of ROS Levels

Granted that quenching of ROS produced by respiration and radiation is under the control of homeostasis, what is the controllable range for the ROS-quenching mechanism? The following calculation is made mainly according to references [10, 11]. Numerous ROS ($10^9$/cell/day) are produced by respiration and cause $10^6$ base damage. Moreover, single strand breaks/cell/day are formed, but these are repaired efficiently to leave behind $10^2$ lesions/cell/day. The ROS produces 0.1 double strand breaks/cell/day that are less efficiently repaired to leave behind 0.01 lesions/cell/day. However, 0.005 base damage and single strand breaks/cell/day are formed by 1 mSv radiation and are repaired as efficiently as for those produced by respiration to leave behind 0.0000005 lesions/cell/day. Therefore, the ratio of lesions made by respiratory ROS to 1 mSv radiation is $2 \times 10^7$. Radiation produces more double strand breaks than respiratory ROS and forms 0.001 breaks/cell/day that are less efficiently repaired to leave behind 0.0001 lesions/cell/day. Consequently, the ratio of lesions produced by respiratory ROS to 1 mSv radiation is $1 \times 10^3$. Therefore, irrespective of base damage, single strand breaks, or double strand breaks, daily respiration produces at least $1 \times 10^3$ times more DNA damage than 1 mSv radiation does. In other words, 1,000 mSv is equivalent to daily respiration. Provided that homeostasis can control additional ROS equivalent to daily respiratory ROS, an acceptable or tolerable radiation dose would be 1,000 mSv or 1 Sv.

## Beyond the Spell of LNT

This book was compiled for all people who are concerned about radiation. Some major targets are the following: Those people working at nuclear power plants must feel relieved by reading this. Governmental authorities must assume heavy responsibility. The Ministry of Health, Labour, and Welfare (Japan) set a new standard on April 1, 2012, that radioactivity in food and water/milk be less than 100 and 50 Bq/kg, respectively, while the corresponding US standards are 1,000 and 1,200 Bq/kg. This strict standard only serves to stir up feelings that

**Table 1. Critical events in the Fukushima Daiichi disaster are chronologically tabulated**

| Date | Agent and/ or time[1] | Event |
|---|---|---|
| 1971.03.26 | FDNPP[2] | Unit 1 (0.46 MW) of FDNPP went into operation. |
| 1974.07.18 | | Unit 2 (0.784 MW) went into operation. |
| 1976.03.27 | | Unit 3 (0.784 MW) went into operation. |
| 1978.10.12 | | Unit 4 (0.784 MW) went into operation. |
| 1978.04.18 | | Unit 5 (0.784 MW) went into operation. |
| 1979.10.24 | | Unit 6 (1.1 MW) went into operation. |
| 2011.03.11 | 14:46 | The 2011 earthquake of a magnitude 9 occurred. |
| | 14:46 | Unit 1 automatically scrammed. |
| | 14:47 | The main turbine of the Unit 1 was automatically shut down. |
| | 14:47 | Unit 2 automatically scrammed, the main turbine was automatically shut down. The emergency diesel generator automatically started up. |
| | 14:47 | Unit 3 automatically scrammed. The main turbine was shut down manually. |
| | 14:47 | The emergency diesel generator of the Unit 5 automatically started up. |
| | 14:47 | The emergency diesel generator of the Unit 6 automatically started up. |
| | 14:48 | The emergency diesel generator of the Unit 3 automatically started up. |
| | 14:52 | The isolation condenser of the Unit 3 automatically started up. |
| | TOPCO[3] 15:06 | The Headquarters for emergency Disaster Control was set up. |
| | Jp. Gov.[4] 15:14 | The Headquarters for Extreme Disaster Management was set up in the Cabinet Office. |
| | 15:27 | The first wave hit the FDNPP; there were no hazards. |
| | 15:35 | The second wave hit the FDNPP; major buildings of Units 1 to 6 were flooded. |
| | 15:37 | Unit 1 lost all electric supply. |
| | 15:38 | Unit 3 lost all electric supply, but DC electricity was active. |
| | 15:38 | Unit 4 lost all electric supply. |
| 2011.03.11 | 15:40 | Unit 5 lost AC-electric supply, but DC electricity was active. |
| | 15:41 | Unit 2 lost all electric supply. |
| | 17:50 | High radioactivity was detected at near the double door of Unit 1. |
| | Fukushima P.[5], 20:50 | Fukushima P. ordered the inhabitants within a 2 km radius from FDNPP to evacuate. |
| | P.M.[6], 21:23 | P.M. ordered the inhabitants within a 3 km radius from FDNPP to evacuate. P.M. ordered the inhabitants within a 3-10 km radius from FDNPP to evacuate indoors. |
| | 21:51 | Entrance into Unit 1 was prohibited because of high radioactivity in it. |
| | 22:00～ | Meltdown seemed to start in Unit 1. |
| 2011.03.12 | 6:00 | M. Yoshida, General Manager of FDNPP, ordered to prepare for ventilation in Unit 1. |
| | 2:45 | Pressures of inside and outside of the reactor containment vessel of Unit 1 were equal. |
| | 2:55 | It was confirmed that the reactor core isolation cooling system (RCIC) of Unit 2 was working. |
| | 4:00～ | Fresh water was started to pour into the Unit 1 reactor. |
| | P.M., 5:44 | Prime minister ordered the inhabitants within a 10 km radius from FDNPP to evacuate. |
| | P.M., 7:11 | Prime Minister arrived at FDNPP. |
| | P.M., 8:04 | Prime Minister left FDNPP. |
| | 9:15 | An operator manually opened the ventilation valve of Unit 1. |
| | 11:36 | The reactor core isolation cooling system (RCIC) of Unit 3 stopped. |
| | 12:35 | The high pressure coolant injection (HPCI) of Unit 3 started automatically. |
| | 14:30 | The pressure in the drywell of Unit 1 reactor vessel was low; ventilation seemed successful. |
| | 15:36 | Explosion occurred in Unit 1. |

| Date | Agent and/ or time[1] | Event |
|---|---|---|
| | 17:30 | M. Yoshida ordered to prepare for ventilation in Unit 2 and 3. |
| | 18:25 | Prime minister ordered the inhabitants within a 20 km radius from FDNPP to evacuate. |
| | 19:04 | Sea water was started to pour into the Unit 1 reactor. |
| | 20:45 | Sea water containing borate was started to pour into the Unit 1 reactor. |
| 2011.03.13 | 2:42 | The high pressure coolant injection (HPCI, the first defense line) of Unit 3 was manually stopped. |
| | 9:20 | Ventilation was started in Unit 3. |
| | 9:25 | Fresh water containing borate was started to pour into the Unit 3 reactor. |
| | 10:00～ | Meltdown seemed to start in Unit 3. |
| | 10:15 | M. Yoshida ordered to start ventilation in Unit 2. |
| | 12:20 | Pouring of fresh water containing borate was finished in the Unit 3 reactor. |
| | 13:12 | Sea water was started to pour into the Unit 3 reactor. |
| | 14:45 | High radioactivity was detected at the double door of Unit 3. |
| 2011.03.14 | 3:20 | Sea water was started again to pour into the Unit 3 reactor. |
| | 4:08 | The temperature of the pool for spent nuclear fuel of Unit 4 was 84℃. |
| | 6:30 | The inner pressure of the containment building of Unit 3 became high. |
| | 11:01 | Explosion occurred in Unit 3. |
| | 13:25 | The high pressure coolant injection (HPCI) of Unit 2 stopped. |
| | 15:30～ | Sea water was started to pour into the Unit 3 reactor. |
| | 19:57 | Sea water was started to pour into the Unit 2 reactor. |
| 2011.03.14 | 22:00～ | Meltdown seemed to start in Unit 2. |
| 2011.03.15 | 5:35 | Jp. Gov. and Fukushima P. established a combined headquarters for emergency disaster control. |
| | 6:55 | Explosion occurred in Unit 4. |
| | 9:38 | A fire broke in Unit 4. |
| | P.M. 11:00 | Prime minister ordered the inhabitants within a 20-30 km radius from FDNPP to evacuate indoors. |
| | 11:00～ | The fire in Unit 4 died down automatically. |
| 2011.03.11-03.14 | | An east wind from March 11–14 carried large quantities of the radioactive substances over the Pacific. |
| 2011.03.15-03.16 | | A west wind on March 15 blew back the substances toward the Japanese archipelago. |
| 2011.03.15 — 03.16 | | Rain or snow from 5:00 p.m., March 15, to 4:00 a.m., March 16, was supposed to fix most contamination in Fukushima P. |
| 2011.03.17 | from 9:48 | Sea water was poured from choppers onto the pool for spent nuclear fuel of Unit 3 (totally 4 times). |
| | TOPCO | TOPCO published the Decontamination plan of Fukushima Daiichi Nuclear Power Plant. |
| 2011.03.18 | 13:30 | Three openings were made on the roof of the Unit 5 building. |
| | 17:00 | Three openings were made on the roof of the Unit 6 building. |
| 2011.03.20 | 14:30 | The Unit 5 reactor was in cold shutdown (its coolant system was below 100℃ at atmospheric pressure). |
| | 19:27 | The Unit 6 reactor was in cold shutdown. |
| 2011.03.22 | 10:35 | Units 3 and 4 were supplied with electricity from outside. |
| 2011.03.24 | | The feet of thee workers were soaked in contaminated water 15 cm in depth (no hazardous effects). |
| 2011.03.25 | 15:37 | Sea water was replaced with fresh water as a coolant in Unit 1. |
| | 18:02 | Sea water was replaced with fresh water as a coolant in Unit 3. |
| 2011.03.26 | 10:10 | Sea water was replaced with fresh water as a coolant in Unit 4. |
| 2011.03.28 | | Trenches outside the turbine facilities were found to be full of contaminated water. |
| 2011.06.24 | | Water treatment equipment was introduced to remove cesium-137 from contaminated water. |

**Table 1. (Continued)**

| Date | Agent and/ or time[1] | Event |
|---|---|---|
| 2011.07.02 | 18:00 | The recirculation cooling system using decontaminated water was adopted to the Units 1 and 2 reactors. |
| 2011.12.16 | 17:00 | Jp. Gov. and TOPCO declared that the 6 FDNPP reactors were in cold shutdown. |
| 2011.12.21 | | TOPCO published the "Mid-and-Long-Term Roadmap towards the Decommissioning of TEPCO's FDNPP." |
| 2012.02.10 | Cabinet Office | The Reconstruction Agency was set up (closing: 2021.03.31). |
| 2012.04.19 | | The FDNPP Units 2-4 were legally decommissioned. |
| 2012.04.20 | | The FDNPP Units 1 was legally decommissioned. |
| 2012.09.19 | Min. Environ[7] | The Nuclear Regulation Authorities was set up. |
| 2013.03.30 | TEPCO | Trial runs of the ALPS multi-nuclide removal equipment started at FDNPP. |
| 2013.07.08 | NRA[8] | Enforcement of the new regulatory requirements for commercial nuclear power plants. |
| 2013.09.03 | Jp. Gov. | Jp. Gov. declared the Basic Policy for the Contaminated Water Issue at the TEPCO's FDNPP. |
| 2013.09.15 | KEPCO[9] | KEPCO's Unit 4 at the Ohi nuclear power plant was shut down for regular inspections. This left Japan without any nuclear power for the third time in 40 years. |
| 2014.01.31 | TOPCO | The FDNPP Units 5 and 6 were legally decommissioned, leaving 48 reactors in Japan as of February 1, 2014. |
| 2014.03.31 | Min. Environ. | Debris ($2x10^7$ tones) and earth ($1x10^7$ tons) in Kanto and Tohoku districts excepting Fukushima were processed. |
| 2014.03.31 | Min. Environ. | Decontamination operation was over for a village and two towns out of 11 areas in Fukushima P. |
| 2014.04.01 | Jp. Gov. | Evacuation order was cancelled partially in Miyakoji district of Tamura City, Fukushima P. |
| 2014.04.02 | UNSCEAR[10] | UNSCEAR stated that cancer levels are likely to remain stable in the wake of the 2011 FDNPP accident. |
| 2014.06.02 | TEPCO | Construction of an ice wall 30 m deep and 1,500 m long started to stop inflow of underground water into FDNPP. |
| 2014.07.16 | NRA | The Sendai Nuclear Power Plant of KEPCO passed the review of the new regulatory requirements. |
| 2014.08.17 | Jp. Gov. | Evacuation order was cancelled from October 1, 2014, fully in Kawauchi Village, Fukushima P. |
| 2014.08.26 | Electric Co's | Nine electric companies had filed 20 applications (12 facilities) for a safety review to resume operations. |
| 2014.09.01 | Fukushima P. | The Governor of Fukushima accepted the construction of interim storage facility of contaminated soil (from 2015.01). |
| 2014.09.10 | NRA | NRA decided to issue a certificate to resume operations of KEPCO's two nuclear reactors. |
| 2014.09.11 | Cabinet Sec.[11] | The Accident Investigation Board of the TOPCO's FDNPP Accident publicized testimonies from 19 persons. |
| 2021 | | Removal of fuel debris will be started. |
| 2051 | | Full commissioning of nuclear reactors will be over. |

[1] Unless otherwise specified, events occurred at FDNPP.
[2] FDNPP: Fukushima Daiichi Nuclear Power Plant.
[3] TOPCO: Tokyo Electric Power Co., Ltd.
[4] Jp. Gov.: The Japanese Government.
[5] Fukushima P.: Fukushima Prefecture.
[6] P.M.: Prime Minister.
[7] Min. Environ.: The Ministry of Environment.
[8] NRA: The Nuclear Regulation Authorities.
[9] KEPCO: The Kansai Electric Power Co. Ltd.
[10] UNSCEAR: The United Nations Scientific Committee on the Effects of Atomic Radiation.
[11] Cabinet Sec.: Cabinet Secretariat.

low-dose radiation is dangerous. Most radiation-associated articles in magazines and newspapers take a pessimistic tone that low-dose radiation is dangerous. Journalists must be expected to learn the hormetic or adaptive response of radiation. Most activists who advocate that they protect the public from hazardous radiation usually emphasize the dangerous aspects of radiation, which tortures and torments the public by evoking undue fear and anxiety, which in turn might induce physical and mental disorders, familial separation, suicide, and so forth as described above. It is a brutal irony that the fear of radiation has been more dangerous than the radiation itself to the people in Fukushima. No one has been killed by radiation there, but more than 1,000 people have died as a direct result of fear and stress. The prime cause seems to reside in the traditional LNT model, on which new scientific light should be shed. Quantity changes quality. Strong instantaneous radiation (high dose rate) from atomic blasts is fatal just as drinking a large amount of alcohol in one gulp is fatal. Low-dose radiation over a prolonged period (low dose rate) is not only non-hazardous, but beneficial, as shown by hormesis or the adaptive response, just as a daily sip of alcohol might be helpful for longevity. The United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) reported on April 2, 2013 that radiation had not affected Fukushima people's health and predicted that cancer incidence would not increase in the future. Critical events in the Fukushima Daiichi disaster are chronologically tabulated in Table 1.

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