Radiation and Human Health: Three Years After the Japan Disaster

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Fukushima Daitchi: March 11, 2011

Source: Digital Globe-Reuters-Time Magazine April 26, 2011

March 13, 2011

Radioactive Releases in Japan Could Last Months, Experts Say

By DAVID E. SANGER and MATTHEW L. WALD

WASHINGTON — As the scale of Japan's nuclear crisis begins to come to light, experts in Japan and the United States say the country is now facing a cascade of accumulating problems that suggest that radioactive releases of steam from the crippled plants could go on for weeks or even months.

The emergency flooding of two stricken reactors with seawater and the resulting steam releases are a desperate step intended to avoid a much bigger problem: a full meltdown of the nuclear cores in two reactors at the Fukushima Daiichi Nuclear Power Station. On Monday, an explosion blew the roof off the second reactor, not damaging the core, officials said, but presumably leaking more radiation.

So far, Japanese officials have said the melting of the nuclear cores in the two plants is assumed to be "partial," and the amount of radioactivity measured outside the plants, though twice the level Japan considers safe, has been relatively modest.

But Pentagon officials reported Sunday that helicopters flying 60 miles from the plant picked up small amounts of radioactive particulates — still being analyzed,

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RADIATION AND PUBLIC HEALTH

PHYSICIANS FOR SOCIAL RESPONSIBILITY PRESENTATION

ON THE MEDICAL CONSEQUENCES OF RADIATION

Ionizing Radiation Basics

Ionizing radiation is radiation with enough energy to remove electrons in the process of interacting with an atom, causing the atom to become charged or ionized. Ionizing radiation has enough energy to produce free radicals, break chemical bonds, produce new chemical bonds and cross-linkages between macromolecules, and damage molecules in human cells that regulate vital cell processes like DNA and RNA, which in turn may lead to cancer.[1] Cells are built to repair certain levels of damage at low doses, but higher doses can cause cell death.

There are three main types of ionizing radiation: alpha, beta, and gamma.

(α) **Alpha particles** are energetic, positively charged particles that rapidly lose energy when passing through matter.

(β) **Beta particles** are fast moving electrons emitted from the nucleus during radioactive decay.

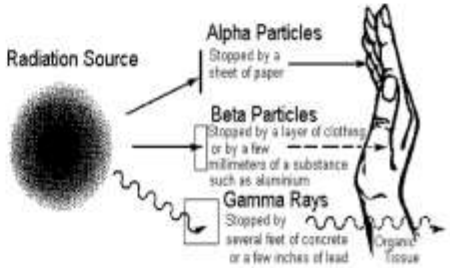

FIGURE 1: THE PENETRATING POWERS OF ALPHA, BETA, AND GAMMA RAYS, NORTH DAKOTA DEPARTMENT OF HEALTH

(γ) **Gamma particles** are highly energetic photons that penetrate deeply and are difficult to stop. Gamma rays and x-rays have essentially the same properties but are different in origin: x-rays originated from processes outside the nucleus, while gamma rays originate from within the nucleus of an atom.

Dose

To determine biological effects of radiation, one must know or estimate how much energy is deposited per unit mass of the part or whole of the body with which the radiation is interacting. The international (SI) unit of measure for absorbed dose is the gray (Gy), which is defined as 1 joule of energy deposited in 1 kilogram of mass. The old unit of measure for this is the rad, which stands for "radiation absorbed dose." - 1 Gy = 100 rad. Absorbed dose is not the best indicator of biological affect. The risk of stochastic or random effects can be measured better with equivalent dose. Equivalent dose is a quantity which takes into effect 'radiation quality', which relates to the degree to which type of ionizing radiation will produce biological damage.

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[1] American Cancer Society, "Radiation Exposure and Cancer" http://www.cancer.org/docroot/ped/content/ped_1_3x_radiation_exposure_and_cancer.asp (2010).

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Physicians for Social Responsibility Calls for A US Moratorium On New Nuclear Reactors, Citing Medical Risks

Warns Any Radiation Exposure Is Unsafe

Washington, DC - March 19, 2011 – Physicians for Social Responsibility (PSR) today called for a nationwide moratorium on new nuclear reactors in the United States and a suspension of operations at the nuclear reactors with a similar design as those involved in the disaster in Japan, as well as those on fault lines. PSR cited the medical risks associated with any level of radiation exposure regardless of how small. Lower doses result in less chance of harm than higher doses, but any dose level can put an individual at risk.

"There is no safe level of radiation exposure," said Jeff Patterson, MD, immediate past president of Physicians for Social Responsibility. "The direction of the wind and the amount of radioactivity released is going to determine the extent of the impact on human health. If the wind changes direction, a large release of radioactivity from the Fukushima reactors would have far-reaching medical consequences in Japan. Medical treatment for radiation is limited, at best."

"One of the basic tenets of medicine is that if you don't have a cure for something, you should prevent it from happening in the first place," said Alan H. Lockwood, MD, a member of the Board of Physicians for Social Responsibility. "The only way to avoid nuclear accidents is to not build nuclear reactors."

According to the National Academy of Sciences, any exposure to radiation increases a person's risk of developing cancer. In the case of the Japanese Fukushima reactors, the primary radionuclides of concern are:

- Iodine-131, which causes thyroid cancer when absorbed thru inhalation and ingestion.
- Cesium-137, which when ingested spreads throughout the body. Cesium-137 has the potential to get into the food supply. As a result of Chernobyl, Cesium-137 was taken up by lichen and plants, and animals which consumed those plants became radioactive.
- Strontium-90, which is deposited in bone and teeth where it remains for decades; it causes bone cancer, and leukemia.
- Plutonium-239, which causes lung cancer and remains a severe threat for thousands of years.

Medical treatment for radiation exposure is limited, at best. Iodine pills provide only limited protection against the absorption of Iodine-131, and this is only one of several of the radioactive isotopes that are released during an accident. It must be taken consistently and prior to exposure.

Temp Jobs at Fukushima

Source: David Guttenfelder (AP) *New York Times*, April 8, 2011

U.N. panel doubts radiation dose estimates among Fukushima workers

October 12, 2013 9

THE ASAHI SHIMBUN

The Japanese government may have underestimated by 20 percent the internal radiation doses in workers during the initial phases of the Fukushima No. 1 nuclear power plant disaster, a U.N. panel said.

The U.N. Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) raised doubts about the dose estimates of the Japanese government and Tokyo Electric Power Co., the plant operator, in a summary of a report submitted to the Fourth Committee of the U.N. General Assembly on Oct. 12.

UNSCEAR used data provided by the Japanese government, TEPCO and other entities to assess the amount of radioactive substances discharged during the nuclear crisis that began in March 2011. It also analyzed radiation doses in the 25,000 or so individuals who worked at the plant no later than October 2012.

The U.N. committee noted that workers were tested for thyroid gland doses from radioactive iodine only after a significant delay. It also said the dose assessment procedures totally ignored iodine-132 and iodine-133, which have short half-lives of 2 hours and 20 hours, respectively.

After assessing discharge volumes and their contribution to doses for each class of radioactive substance, UNSCEAR concluded that worker doses during the early stages of the nuclear crisis may have been underestimated by about 20 percent.

The government and TEPCO are providing free health checkups to Fukushima plant workers whose doses have reached certain levels.

Currently, about 1,100 individuals who received 50 millisieverts or more in whole-body doses can receive free tests for cancer of the thyroid gland, lungs, stomach and colon. About 2,000 people with whole-body doses below 50 millisieverts but thyroid gland doses of 100 millisieverts or more are qualified to be tested for thyroid gland cancer.

If UNSCEAR's assessment is accurate, more workers should be eligible for the health checkups. The panel plans to finish and release the report by year-end at the earliest.

INSUFFICIENT HEALTH RECORDS

But the possible underestimates are just one problem in a system that has proved inefficient in protecting workers' health.

Long-term observations are needed to fully understand the risk from radiation exposure among workers at the plant. But many companies involved have failed to conduct medical examinations or file reports to the government--even though they are required to do so under law.

A government database on workers' health conditions is still not running, making it impossible to check whether workers have suffered health problems.

The health ministry has required companies to submit medical examination results for 20,000 people who worked at the Fukushima No. 1 plant before December 2011, depending on the level of their radiation doses.

October 14, 2011

Radioactive Hot Spots in Tokyo Point to Wider Problems

By HIROKO TABUCHI

TOKYO — Takeo Hayashida signed on with a citizens' group to test for radiation near his son's baseball field in Tokyo after government officials told him they had no plans to check for fallout from the devastated Fukushima Daiichi nuclear plant. Like Japan's central government, local officials said there was nothing to fear in the capital, 160 miles from the disaster zone.

Then came the test result: the level of radioactive cesium in a patch of dirt just yards from where his 11-year-old son, Koshiro, played baseball was equal to those in some contaminated areas around Chernobyl.

The patch of ground was one of more than 20 spots in and around the nation's capital that the citizens' group, and the respected nuclear research center they worked with, found were contaminated with potentially harmful levels of radioactive cesium.

It has been clear since the early days of the nuclear accident, the world's second worst after Chernobyl, that that the vagaries of wind and rain had scattered worrisome amounts of radioactive materials in unexpected patterns far outside the evacuation zone 12 miles around the stricken plant. But reports that substantial amounts of cesium had accumulated as far away as Tokyo have raised new concerns about how far the contamination had spread, possibly settling in areas where the government has not even considered looking.

The government's failure to act quickly, a growing chorus of scientists say, may be exposing many more people than originally believed to potentially harmful radiation. It is also part of a pattern: Japan's leaders have continually insisted that the fallout from Fukushima will not spread far, or pose a health threat to residents, or contaminate the food chain. And officials have repeatedly been proved wrong by independent experts and citizens' groups that conduct testing on their own.

"Radioactive substances are entering people's bodies from the air, from the food. It's everywhere," said Kiyoshi Toda, a radiation expert at Nagasaki University's faculty of environmental studies and

January 21, 2012

Japanese Struggle to Protect Their Food Supply

By MARTIN FACKLER

ONAMI, Japan — In the fall, as this valley's rice paddies ripened into a carpet of gold, inspectors came to check for radioactive contamination.

Onami sits just 35 miles northwest of the wrecked Fukushima Daiichi nuclear plant, which spewed radioactive cesium over much of this rural region last March. However, the government inspectors declared Onami's rice safe for consumption after testing just two of its 154 rice farms.

Then, a few days later, a skeptical farmer in Onami, who wanted to be sure his rice was safe for a visiting grandson, had his crop tested, only to find it contained levels of cesium that exceeded the government's safety limit. In the weeks that followed, more than a dozen other farmers also found unsafe levels of cesium. An ensuing panic forced the Japanese government to intervene, with promises to test more than 25,000 rice farms in eastern Fukushima Prefecture, where the plant is located.

The uproar underscores how, almost a year after a huge earthquake and tsunami caused a triple meltdown at the Fukushima Daiichi plant, Japan is still struggling to protect its food supply from radioactive contamination. The discovery of tainted rice in Onami and a similar case in July involving contaminated beef have left officials scrambling to plug the exposed gaps in the government's food-screening measures, many of which were hastily introduced after the accident.

The repeated failures have done more than raise concerns that some Japanese may have been exposed to unsafe levels of radiation in their food, as regrettable as that is. They have also had a corrosive effect on public confidence in the food-monitoring efforts, with a growing segment of the public and even many experts coming to believe that officials have understated or even covered up the true extent of the public health risk in order to limit both the economic damage and the size of potential compensation payments.

Critics say farm and health officials have been too quick to allow food to go to market without

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FUKUSHIMA'S LESSONS

The Dangers of Nuclear Power

Robert M. Gould, MD

Since the multiple meltdowns at the Fukushima Daiichi site in March 2011, massive amounts of radioactive water have flushed into the seas bordering Japan, with unknown ramifications for sea life and the food chain.[1,2] Extensive contamination of land and food has been reported throughout Japan. Approximately 150,000 people have evacuated their homes and farmlands, with inadequate compensation for their losses.[2]

With growing opposition to nuclear power, all fifty-four nuclear plants are currently shut down in Japan,[3] which has halted plans to expand its domestic program. However, Japan has continued to push to reopen and/or extend the lifetime of currently sidelined plants[3] and to aggressively promote the export of Japanese nuclear technology to other nations in the region, such as Vietnam.[4]

reactors. A life-cycle analysis would include the profound environmental and public health impacts of worldwide uranium mining, fuel fabrication and waste storage, etc., on workers and communities and on land, air, and water quality. It would also include a full accounting of the risks of nuclear weapons proliferation and terrorism that have been historically connected with nuclear power programs.[8,9]

With more than 100 million Americans living within a fifty-mile radius of a nuclear power plant, our health system remains unprepared for a Fukushima-like nuclear disaster.[10,11,12]


~ From Hiroshima to Future Generations ~
Doctors Arguments against the Civil Use of Nuclear power
Andreas Nidecker and Martin Walter
IPPNW Switzerland
20th IPPNW Worldcongress
Hiroshima, Sunday August 26th 2012
IPPNW

Fig. 13 Removing Radioactivity in Farmland by Sunflowers

Ukraine

After
25years

Absorb as deep rooted

Contaminated 0~20cm in depth

Fukushima

Only
6 months

Not absorb as deep rooted

Contaminated 2~4cm
of the surface

20cm
Deep Plowing

Planted at Jisahara and Ota area in Minamisoma City (260 places)

Summary

- Contaminated area is limited
- High contaminated area locates across the main roads and rivers
- After deep plowing, decontamination by sunflower is effective
- Can expect physical half life and natural depuration effects in the future
- Essential to establish accurate understanding, supports, and cooperative activities

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伊達市
相馬市
福島市
飯舘村
計画的避難区域
川俣町
二本松市
南相馬市
浪江町
葛尾村
本宮市
双葉町
田村市
旧警戒区域
三春町
大熊町
富岡町
郡山市
川内村
小野町
楢葉町
20km
広野町
平田村
30km
いわき市
警戒区域
計画的避難区域
特定避難勧奨地点がある地域
60km


野菜・果物の
“チカラ”を
知っていますか?
国産野菜・果物を
食べましょう!
川内村産の
野菜は全て
放射能測定済みの
品物です。
川内


測定中


○診療科
○診療時間
ただし歯科
○休診日
双葉郡川内

After Fukushima: families on the edge of meltdown

Two years after the Fukushima nuclear disaster, a new phenomenon is on the rise: atomic divorce. Abigail Haworth reports on the unbearable pressures and prejudices being faced by those caught in the radiation zone

Abigail Haworth
The Observer, Saturday 23 February 2013

'Each anniversary we will be thinking, "Is this the year one of our daughters will get sick?"' Kenji and Aiko Nomura with Sakura, 3, and 15-month-old Koto. Photograph: Panos Pictures/Eric Rechsteiner

Perhaps one day Aiko and Kenji Nomura will laugh about the Birthday Cake Incident. It happened last autumn. Aiko, a care worker from the city of Koriyama in Japan's Fukushima prefecture, was celebrating her 35th birthday. Her husband Kenji decided to

Tests show 45% kids in Japan's nuke disaster area exposed to thyroid radiation

The city is located about 60 kilometers northwest of the crippled nuclear plant and is outside of the mandatory 20-km no-go zone or evacuation centers located closer to the troubled six-reactor nuclear complex.

One location had radioactive contamination levels as high as 931,000 becquerels per square meters and three locations tested had cesium levels at between 326,000 and 384,000 becquerels per square meter.

Experts note that children are far more vulnerable to the harmful effects of radiation disasters than the general population and are more likely to develop cancer in later life because their bodies absorb and metabolize substances differently, and because they are more likely to develop certain cancers, distinct from adults, from such an exposure.

In addition children also are closer to the ground, where radioactive fallout settles.

City officials in the prefecture, located 220 km northeast of Tokyo, have decided to distribute radiation meters to 34,000 children aged between four and 15 living in Fukushima city, to monitor their exposure levels, as concerns mount over the number and severity of the children already exposed to radiation from the leaking nuclear plant still central to the worst nuclear disaster since the 1986 Chernobyl cataclysm.

Underscoring the devastating affects of the Fukushima nuclear crisis, cesium-134 and 137 isotopes were detected in urine tests conducted on 10 children in Fukushima City, located in close proximity to the stricken No. 1 nuclear power plant.

The tests conducted in May by a Japanese civic group and Acro, a French organization specializing in measuring radiation levels, confirmed that all 10 children had been exposed to radiation internally, with 1.13 becquerels of cesium-134 per liter of urine found in one eight-year-old girl sampled and 1.30 becquerels found in the urine of a seven-year-old boy.

In light of the findings, in September tens of thousands of children living in Fukushima city, who already have their outdoor activities at school severely restricted due to ongoing fears of ground and airborne radiation, are to be given dosimeters to constantly measure their exposure to atmospheric radiation, city officials said.

Source: http://news.xinhuanet.com/english2010/world/2011-07/05/c_13967084_2.htm

甲状腺詳細調査始まる（2011年10月9日）

Flow Chart of Thyroid Ultrasound Examination

First Screening (Portable US machine)

No — **Nodule** — **Yes**

LOGIQ *e* Expert

Follow-up (2,5)

Secondary Screening
Precise US examination, Blood and Urine analysis

Follow-up — **Criteri a** — **FNAB**

Explanation Examination

Benign — **Malignant** — **Surgical Treatment**

HIVISION

Thyroid Disease

According to the proceedings of the 12th Prefectural Oversight Structure Committee Meeting for Fukushima, released on August 20, 2013, Thyroid ultrasound examinations conducted on 216,809 Fukushima children since October 2011 revealed 18 confirmed and 25 suspected thyroid cancer cases, with the youngest who was 6 at time of the accident.

The incidence of 22.3 per 100,000 overall, or 9.3 per 100,000 for confirmed cases exceeds even adult thyroid cancer rates.

In 2007 in Japan, normal incidence of thyroid cancer is 0.1 in 100,000 below age 15 and 0.9 in 100,000 in age 15-19.

According to the National Cancer Institute, pediatric thyroid cancer incidence in the US is 0.2 in 100,000 below age 15, and 1.76 per 100,000 in age 15-19 (12.2 in 100,000 adults).

IPPNW Press Conference: Japan Diet, Tokyo, August 29, 2012

International physicians' recommendations for protecting health after the Fukushima nuclear disaster

29 August 2012

FUKUSHIMA/TOKYO "Our most important obligation to the many harmed by the Fukushima disaster is to eradicate nuclear weapons and phase out nuclear power," says Associate Professor Tilman Ruff, Co-President of IPPNW – International Physicians for the Prevention of Nuclear War after a visit to Fukushima. Thirty physicians, medical students and scholars from the United States, Canada, United Kingdom, Germany, Finland, Israel, India, New Zealand and Australia visited Fukushima yesterday for an investigative tour.

The event was hosted by Physicians Against Nuclear War in Japan. The foreign experts have followed the Fukushima nuclear disaster with deep concern. In the past few days, they heard presentations by Japanese radiation, medical and nuclear engineering experts at the IPPNW 20th World Congress in Hiroshima and experts at a 27 August symposium in Tokyo.

The fundamental processes in nuclear reactors and nuclear weapons are the same. In 1998, IPPNW first took a clear position that on medical grounds nuclear power should be phased out. Nuclear power is unacceptably hazardous to health at all stages, risks catastrophic radiation releases, and is inextricably linked with the production of enriched uranium and plutonium which can be used for nuclear weapons, the greatest and most acute threat to global health.

The expert group made the following **key recommendations** for action to put the health and safety of people first in the continuing Fukushima nuclear disaster:

1. People living in contaminated regions should have access to full information on their likely radiation exposures and supported in all possible ways to minimize these. For those with anticipated annual exposure greater than 5 mSv, or more than 1mSv for children and women of child-bearing age, equitable and consistent access to health care, housing, employment and educational support and compensation should be provided if they choose to re-locate. The recent Nuclear Accident Child Victims Law is an important step in the right direction and should be effectively implemented as soon as feasible. All such measures should be based on actual radiation exposure levels and not distance. Every effort should be made to reduce exposures below 1 mSv per year as quickly as possible.
2. Early establishment of a comprehensive register of all likely to have been exposed to more than 1mSv of radiation from all sources as a result of the Fukushima disaster. This will include people in prefectures neighbouring Fukushima. This register should be linked with best estimates of radiation exposures since the disaster, and used as a basis for linkage with national data on mortality, cancer, congenital malformations and pregnancy outcome.
3. The group expressed concern for the health of the more than 20,000 workers who have worked at the Fukushima Daiichi plant since the earthquake, and the many more who will need to work there over the many decades it will take to decommission the damaged reactors and spent fuel ponds. They were disturbed by frequent reports of inadequate protection of workers and falsely low radiation exposure measurements. A lifetime radiation exposure register should quickly be established for all workers in the nuclear industry.
4. There has been regrettable misinformation disseminated, including by senior professionals and in school educational materials, downplaying the risks of radiation. The corrupting influence of the 'nuclear village' is widespread. Provision of accurate, independent, timely public information on radiation health is essential.

No effective treatment is possible for the catastrophic effects of a nuclear explosion or reactor disaster. When the imperative to prevent what cannot be controlled is so strong, it is clear that both nuclear weapons and nuclear power have no place in a safe, sustainable world.

Leaks Into Pacific Persist at Japan Nuclear Plant

Kyodo, via Reuters

Members of a Fukushima panel inspecting the construction of a barrier that is meant to stop contaminated water from leaking.

By MARTIN FACKLER
Published: August 6, 2013

TOKYO — Tons of contaminated groundwater from the stricken Fukushima nuclear plant have overwhelmed an underground barrier and are emptying daily into the Pacific, creating what a top regulator has called a crisis.

Errors Cast Doubt on Japan's Cleanup of Nuclear Accident Site

Tomas Munita for The New York Times

An abandoned train line in Namie, a town that was evacuated because of contamination from the Fukushima Daiichi nuclear plant.

By MARTIN FACKLER
Published: September 3, 2013 | Comment

NARAHA, Japan — In this small farming town in the evacuation zone surrounding the stricken Fukushima Daiichi nuclear power plant, small armies of workers in surgical masks and rubber gloves are busily scraping off radioactive topsoil in a desperate attempt to fulfill the central government's vow one day to allow most of Japan's 83,000 evacuees to return. Yet, every time it rains, more radioactive contamination cascades down the forested hillsides along the rugged coast.

Multimedia

Nearby, thousands of workers and a small fleet of cranes are preparing for one of the latest efforts to avoid a deepening environmental disaster that has China and other neighbors increasingly worried: removing spent fuel rods from the damaged No. 4 reactor

FUKUSHIMA DISASTER: IMPACTS AND CONTINUING THREATS

More than two years since the nuclear disaster began at the Fukushima Daiichi reactors, its impact is massive and widespread. It will be decades before the full scope of the impacts of this ongoing disaster is fully understood but significant health, economic, environmental and social consequences are already evident and quantifiable. Furthermore, independent expert analyses has documented extraordinary industry influence on government regulators, especially widespread collusion among the Japanese government, Tokyo Electric Power Company (TEPCO), the owner/operator of Fukushima, and the nuclear/utility industry. The Fukushima disaster leaves Japan with massive economic loss, radiation exposure to children and others, and a nation grappling with an uncertain nuclear future.

Public Health Effects & Radiation Exposure

- **Thyroid Disease** – According to the proceedings of the 12th Prefectural Oversight Structure Committee Meeting for Fukushima, released on August 20, 2013, Thyroid ultrasound examinations conducted on 216,809 Fukushima children since October 2011 revealed 18 confirmed and 25 suspected thyroid cancer cases, with the youngest who was 6 at time of the accident.[1] The incidence of 22.3 per 100,000 overall, or 9.3 per 100,000 for confirmed cases exceeds even adult thyroid cancer rates. In 2007 in Japan, normal incidence of thyroid cancer is 0.1 in 100,000 below age 15 and 0.9 in 100,000 in age 15-19.[2] According to the National Cancer Institute, pediatric thyroid cancer incidence in the US is 0.2 in 100,00 below age 15,[3] and 1.76 per 100,000 in age 15-19 (12.2 in 100,000 adults). While this may reflect screening bias, there has been an increasing rate of abnormalities including cysts and nodules in over 43% since the screening first began.

- **Radiation Release** - Initial estimates of radiation expelled into the air from Fukushima Daiichi indicate 900,000 terabecquerels compared to 5,200,000 terabecquerels released at Chernobyl.[4] Fortunately, most of the radioactivity fell in the Pacific Ocean away from population centers due to favorable winds—only 19 percent of the released radioactivity was deposited over land—keeping the exposed population relatively small compared to the predicted impact if winds had caused much of the airborne radioactivity to settle over Tokyo.[5]

- **Radioactive Cesium** – Which has a half-life of 30 years, has been found in all over Japan. TEPCO reports that total cesium leaked from Fukushima Daiichi is 360,000 terabecquerels, which is 4 times the cesium released from Chernobyl and equal to the cesium released by "168 Hiroshimas."[6] This is significant because cesium's soluble qualities allow it to enter animals and humans through inhalation or ingestion.

- **Strontium-90 'The Bone Seeker'** – another byproduct of nuclear accidents is Strontium-90. Strontium-90 is chemically similar to calcium, and tends to deposit in bone and blood- forming tissue (bone marrow). Internal exposure to Sr-90 is linked to bone cancer, cancer of the soft tissue near the bone, and leukemia.[7] High levels of Strontium 90 have been found in the groundwater near the Fukushima reactors, which have increased by more than 100 times between December 2012 and May 2013. The current readings show Strontium-90 levels more than 30 times the legal limit.[8]

- **Cesium bio-accumulates** in human tissue, especially in children, who receive a proportionately higher degree of damage from its effects. A primary isotope released by the reactor meltdowns, Cesium is accumulated at levels up to 10 times higher in heart and endocrine tissues, as opposed to skeletal muscle or surrounding tissues.

Radiation Release -- Initial estimates of radiation expelled into the air from Fukushima Daiichi indicate 900,000 terabecquerels compared to 5,200,000 terabecquerels released at Chernobyl.

Radioactive Cesium –- With a half-life of 30 years, has been found in all over Japan due to the initial explosion. The total atmospheric cesium-137 release from Fukushima Daiichi was about 100,000 TBq, similar to levels at Chernobyl and from 6,000 to 47,000 TBq of 137Cs discharged into the Pacific Ocean.

Strontium-90 -- Is chemically similar to calcium, and tends to deposit in bone and blood- forming tissue (bone marrow). Internal exposure to Sr-90 is linked to bone cancer, cancer of the soft tissue near the bone, and leukemia.7 High levels of Strontium 90 have been found in the groundwater near the Fukushima reactors, which have increased by more than 100 times between December 2012 and May 2013. The current readings show Strontium-90 levels more than 30 times the legal limit.

Growing levels of tritium have also been found in seawater near the Fukushima reactor.

Tritium is a highly radioactive isotope of hydrogen, with a specific activity of almost 10,000 curies per gram. In gaseous form, it poses far fewer risks than in other chemical forms.

Since tritium has the same chemical properties as hydrogen, it can combine with oxygen to form water. Since tritiated water is processed by plants, animals and humans like ordinary water, the tritium in it can become transformed into other chemicals, such as proteins, needed by the body. It can become part of the DNA and has been linked to problems with reproduction and abnormal development.

Why Fukushima Is A Greater Disaster Than Chernobyl

By Robert Alvarez

24 April, 2012

Institute for Policy Studies

The radioactive inventory of all the irradiated nuclear fuel stored in spent fuel pools at Fukushima is far greater and even more problematic than the molten cores.

In the aftermath of the world's worst nuclear power disaster, the news media is just beginning to grasp that the dangers to Japan and the rest of the world posed by the Fukushima-Dai-Ichi site are far from over. After repeated warnings by former senior Japanese officials, nuclear experts, and now a U.S. Senator, it is sinking in that the irradiated nuclear fuel stored in spent fuel pools amidst the reactor ruins may have far greater potential offsite consequences than the molten cores.Fukushima's devastation two weeks after the tsunami.

Fukushima Dai-Ichi site is storing 10,833 spent fuel assemblies (SNF) containing 327 million curies of long-lived radioactivity About 132 million curies is cesium-137 — or about 85 times the amount estimated to have been released at Chernobyl. With a half-life of 30 years, Cs-137 gives off potentially dangerous external penetrating radiation. It also mimics potassium as it accumulates in the food chain.

In 2012 Tokyo Electric Power Company (TEPCO) revealed plans to remove 2,274 spent fuel assemblies from the damaged reactors that will probably take at least a decade to accomplish.

The first priority will be removal of the contents in Pool No. 4, which is structurally damaged and contains about 10 times more cesium-137 than released at Chernobyl. Removal of SNF from the No. 4 reactor is optimistically expected to begin at the end of 2013.

Fuel Removal Underway At Crippled Plant in Japan

Tepco, via Agence France-Presse — Getty Images

This photo released by Tokyo Electric Power Company on Monday shows a cask of nuclear fuel being lifted and moved by Tepco workers as they began operations to remove fuel rods from a pool at the unit four reactor building at the Fukushima Daiichi power plant.

By HIROKO TABUCHI
Published: November 18, 2013

TOKYO — The operator of the crippled Fukushima Daiichi power plant on Monday began removing nuclear fuel assemblies from a storage pool atop one of the site's blown-out reactor buildings, a delicate yet critical operation that could help reduce risks at the plant.

Related

Removing Fuel Rods Poses New Risks at Crippled Nuclear Plant in Japan (November 11, 2013)

The Tokyo Electric Power Company released frequent updates about its progress on Monday, when it extracted four of the 1,533 fuel assemblies that lie in a pool of water at the plant's No. 4 reactor.

That reactor, along with three others, was heavily damaged by hydrogen explosions in the early days of the accident, set off by the

March 13, 2011

U.S. Nuclear Plants Have Same Risks, and Backups, as Japan Counterparts

By TOM ZELLER Jr.

With the Japanese authorities working to avert a catastrophic meltdown at the Fukushima Daiichi nuclear power plant and one other Japanese plant showing problems, the safety of America's nuclear plants — and the wisdom of any expansion — is beginning to come under a new round of scrutiny.

Although exactly what happened at Japan's nuclear power plants is still being sorted out, most of the nuclear plants in the United States share some or all of the risk factors that played a role at Fukushima Daiichi: locations on tsunami-prone coastlines or near earthquake faults, aging plants and backup electrical systems that rely on diesel generators and batteries that could fail in extreme

RECOMMENDATIONS FOR ENHANCING REACTOR SAFETY IN THE 21ST CENTURY

2011 NRC TASK FORCE RECOMMENDATIONS

- Upgrade design-based seismic and flooding protection of reactor structures and components
- Strengthen existing reactors abilities to deal with loss of power in the event of earthquake, tsunami, floods and other disasters
- Require that emergency plans address prolonged blackouts
- Require additional instrumentation and seismically protected systems to provide additional cooling water to spent fuel rods if necessary

The Christian Science Monitor - CSMonitor.com

Year after Fukushima, US plodding on nuclear plant fixes, watchdog says

The Union of Concerned Scientists lauds the NRC for its initial reaction to the Fukushima nuclear meltdown, but warns it is dragging its feet on safety recommendations for US nuclear plants.

Cooling towers for units 1 and 2 are seen through a car window during a tour before a visit by US Secretary of Energy Secretary Steven Chu to the Vogtle nuclear power plant in February, in Waynesboro, Ga.
(David Goldman/AP)

By Mark Clayton, Staff writer
posted March 6, 2012 at 3:51 pm EST

Federal regulators are not moving swiftly enough to safeguard the nation's nuclear power fleet from catastrophic accidents like the one at Fukushima Japan, according to a nuclear power industry watchdog that also slams the industry for seeking a quick cheap fix for safety.

The Nuclear Regulatory Commission deserves praise for its swift action to diagnose needed upgrades in US nuclear plants in the days and weeks after the March 11, 2011 meltdowns at Fukushima, says a major new report by the Union of Concerned Scientists (UCS).

But the study hammers the agency for plodding on implementing key recommendations the agency's own task force delivered last summer – and

Post-Fukushima, Arguments for Nuclear Safety Bog Down

Officials have recommended that nuclear plants like Nine Mile Point in New York install new safety equipment.

By ERIC LIPTON and MATTHEW L. WALD
Published: February 26, 2013 | 84 Comments

Alarms sounded and lights flashed as control panel dials at a nuclear power plant in upstate New York warned that the power for safety equipment was failing. The room went dark until the emergency lights kicked in. But there was no reason to worry on this frozen winter morning.

This was a simulation by Constellation Energy, the owner of the Nine Mile Point plant on Lake Ontario, for the benefit of two of the five members of the Nuclear Regulatory Commission. It was part of an intense lobbying campaign against a proposed rule that would require utilities to spend millions of dollars on safety equipment that could reduce the

Multimedia

Graphic

After Fukushima, Tasks Remain for the American Nuclear Industry

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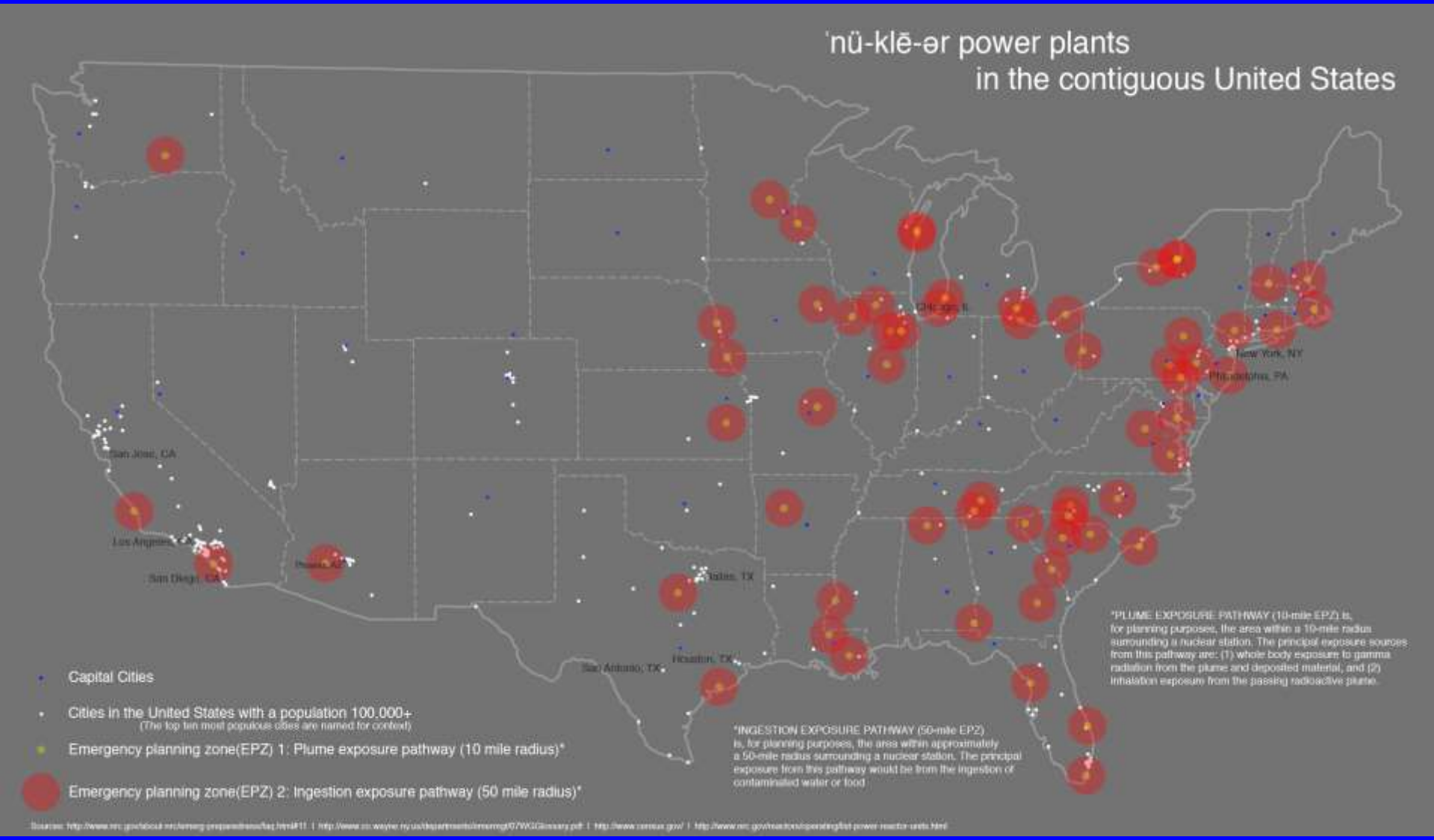
Nuclear Evacuation Zones



NATURE | FROM SCIENTIFIC AMERICAN

It's not just Fukushima: mass disaster evacuations challenge planners

The Fukushima evacuation zone raises the issue of what would happen during an evacuation in heavily populated US metropolises during a nuclear meltdown.

David Biello

05 March 2012

More than 180 million people live within 50 miles of a nuclear power plant in the US — the radius the US suggested be evacuated during the nuclear crisis at Fukushima Daiichi.

JEFF FUSCO/GETTY IMAGES

An article from *Scientific American*.

On March 11, 2011, Japan suffered a massive earthquake and subsequent tsunami that destroyed roads, bridges, and buildings; killed nearly 16,000 people; and critically disabled three reactors at the Fukushima Daiichi nuclear power plant. By March 12, the U.S. Nuclear Regulatory Commission (NRC) was already considering urging Americans within 50 miles of the stricken nuclear reactors to evacuate, given an explosion in Unit 1 that destroyed the reactor building and exposed

After Fukushima, fish tales

BY ALEX ROSLIN, SPECIAL TO THE GAZETTE JANUARY 13, 2012

An aerial view of debris floating in the Pacific Ocean off the coast of Honshu in March after a 9.0 magnitude earthquake and tsunami struck northern Japan: The garbage patch is estimated to be twice the size of Texas.

Photograph by: U.S. Navy

After the world's worst nuclear accident in 25 years, authorities in Canada said people living here were safe and faced no health risks from the fallout from Fukushima.

They said most of the radiation from the crippled Japanese nuclear power plant would fall into the ocean, where it would be diluted and not pose any danger.

Dr. Dale Dewar wasn't convinced. Dewar, a family physician in Wynyard, Sask., doesn't eat a lot of seafood herself, but when her grandchildren come to visit, she carefully checks seafood labels.

She wants to make sure she isn't serving them anything that might come from the western Pacific Ocean.

Dewar, the executive director of Physicians for Global Survival, a Canadian anti-nuclear group, says the Canadian government has downplayed the radiation risks from Fukushima and is doing little to monitor them.

Ocean Contamination – Levels of radioactive cesium off the Japanese Northeast coast peaked at more than 100,000 becquerels per cubic meter in early April, 2011— about 100 times higher than the peak levels detected in the Black Sea after the Chernobyl disaster in 1986. The central government hastily banned Fukushima's sales of 36 types of fish other than octopus and whelk.

Trace amounts of leaked cesium have been found in Bluefin tuna caught off the western coast of the United States. Since the Fukushima nuclear power plant disaster, the Fisheries Agency has measured the radiation levels of about 20,000 fish. The overall trend has been a decline of radioactive cesium, according to the news outlet, Asahi Shimbun.

However, in August 2012, two greenlings caught 20 kilometers north of the Fukushima plant were found to have cesium levels of 25,800 becquerels per kilogram, the **highest level ever measured in fish** since the nuclear accident. The Japanese government standard for food is 100 Becquerels per kilogram. High amounts of cesium have been found in freshwater fish as well in areas far removed from the Fukushima disaster.

CALIFORNIA MEDICAL ASSOCIATION
Resolution 121-12 (Adopted October 14, 2012)

MONITORING RADIATION FROM FUKUSHIMA IN SEAFOOD
Author: Robert M. Gould, MD

RESOLVED: That CMA call for the United States government to continue to monitor and fully report the radioactivity levels of edible Pacific Ocean species sold in the United States that could reasonably have been exposed to radiation from the ongoing 2011 Fukushima disaster, with information about any potential health implications of consuming such foods; and be it further

RESOLVED: That this matter be referred for national action.

Fish with very high levels of cesium found near Fukushima

January 11, 2014

THE ASAHI SHIMBUN

A fish contaminated with extremely high levels of radiation was found in waters near the crippled Fukushima No. 1 nuclear power plant, a government-affiliated research institute said.

The Fisheries Research Agency said Jan. 10 the black sea bream had 12,400 becquerels per kilogram of radioactive cesium, 124 times the safety standards for foodstuffs.

The fish was caught at the mouth of the Niidagawa river in Iwaki, Fukushima Prefecture, on Nov. 17. The site is 37 kilometers south of the stricken power plant.

It was one of 37 fish—all black sea bream--that researchers caught in waters in and off Iwaki in October and November to study the level of radiation to which they were exposed.

The research institute said it will study the fish further to try and determine when it became contaminated with such high levels of radioactive cesium.

Two other fish also exceeded the safety standards of 100 becquerels per kilogram, at 426 becquerels and 197 becquerels, respectively.

The readings of the remaining 34 fish were within the safety limits, according to the Fisheries Research Agency.

Officials said black sea bream in the region that was covered by the recent study have not been circulated as food in fish markets.

Black sea bream fishing in coastal waters off Fukushima and Miyagi prefectures is currently restricted.

They are also on the list of fish that local fishermen are asked to voluntarily refrain from catching in the northern municipalities of Ibaraki Prefecture, which is located just south of Fukushima Prefecture.

Berkeley Lab and Cal State Long Beach Researchers Launch 'Kelp Watch' to Determine Extent of Fukushima Contamination

Posted By jonweiner On January 13, 2014 @ 2:22 pm In Science Shorts | Comments Disabled

Researchers from California State University, Long Beach (CSULB) and the Lawrence Berkeley National Laboratory have launched "Kelp Watch 2014," a scientific campaign designed to determine the extent of radioactive contamination of the state's kelp forest from Japan's damaged Fukushima nuclear power plant following the March 11, 2011, earthquake and tsunami.

Initiated by CSULB Biology Professor Steven L. Manley and the Berkeley Lab's Head of Applied Nuclear Physics Kai Vetter, the project will rely on samples of Giant Kelp and Bull Kelp from along the California coast.

"The California kelp forest is a highly productive and complex ecosystem and a valuable state resource. It is imperative that we monitor this coastal forest for any radioactive contaminants that will be arriving this year in the ocean currents from Fukushima disaster," said Manley, an expert in marine algae and kelp.

"I receive calls and emails weekly from concerned visitors and Californians about the effect of the Fukushima disaster on our California marine life," he continued. "I tell them that the anticipated concentrations that will arrive are most likely very low but we have no data regarding its impact on our coastal ecosystem. Kelp Watch 2014 will provide an initial monitoring system at least in the short-term." [1]

The project includes the participation of 19 academic and government institutions and three other organizations/businesses. These participants will sample kelp from the entire California coastline as far north as Del Norte County and as far south as Baja California. The sampling will begin in mid-February and will end in late winter.

"What I have attempted to do is to organize marine scientists and educators from up and down the coastline to collect a large amount of kelp several times a year so that we can ascertain the amount of radioactive material entering our kelp forests," Manley explained. "The response has been overwhelming. Recently I was contacted by a scientist in Washington State, who wants to send samples. I said 'Sure.'"

Sampling will take place several times in 2014, and processed kelp samples will be sent to the Lawrence Berkeley National Lab's Low Background Facility for detailed radionuclide analysis. As data becomes available it will be posted for public access.

News Release

How Radioactive is Our Ocean?

Citizen science campaign aims to collect ocean samples and fund radiation analysis

FOR IMMEDIATE RELEASE

January 14, 2014 Media Relations Office

(508) 289-3340 media@whoi.edu

Woods Hole Oceanographic Institution (WHOI) marine chemist Ken Buesseler began sampling and analyzing seawater surrounding the Fukushima Dai-ichi nuclear power plant three months after the 2011 disaster. Today, he launched a crowd sourcing campaign and citizen science website to collect and analyze seawater along the West Coast of North America as the radioactive plume travels 5,000 miles across the Pacific Ocean.

"Whether you agree with predictions that levels of radiation along the Pacific Coast of North America will be too low to be of human health concern or to impact fisheries and marine life, we can all agree that radiation should be monitored, and we are asking for your help to make that happen," says Ken Buesseler, WHOI senior scientist and director of the Center for Marine and Environmental Radioactivity (CMER).

Through the website "How Radioactive is Our Ocean?" the public can support the monitoring of radiation in the ocean with tax-deductible donations to fund the analysis of existing samples or by proposing new locations and funding the samples and analysis of those sites.

"We already have dozens of seawater samples from the coast of Japan out to the middle of the Pacific, but now we need new samples—from up and down the West Coast of North America and across the Pacific. The trouble is, these samples are expensive to collect and analyze," Buesseler says.

To propose a new location for seawater sampling, individuals and communities will be asked to donate a minimum of $100 for seed funding. Not every proposed site can be accepted due to limits on sample throughput, but if selected, WHOI will setup a fundraising webpage to help a group reach their fundraising goal. The collection and analysis of a seawater sample costs between $550 and $600, depending upon location. Once the full amount is raised, the individual will receive a sampling kit to collect 20 liters (about five gallons) of seawater to be shipped back to the CMER lab for analysis.

The results from those analyses will be posted on an evolving map online, where you can see cesium concentrations and sponsors' names with links to information about radioactivity in the ocean and what the levels tell us.

WHOI senior scientist Ken Buesseler has collected and analyzed the seawater surrounding the Fukushima Dai-ichi nuclear power plant since the 2011 disaster. As the low-level radiation travels across the Pacific, Buesseler has launched a crowd sourcing campaign and website to monitor radiation levels along the West Coast of North America.
(Photo courtesy of Ken Buesseler, Woods Hole Oceanographic Institution)

The Center for Marine and Environmental Radiation at the Woods Hole Oceanographic Institution has launched a citizen science website, ourradioactiveocean.org, to involve the public in the sampling, funding, and analysis needed to monitor radiation levels in seawater along the Pacific coast. (Photo courtesy of Woods Hole Oceanographic Institution)

Since Japan's triple disaster

Nearly three years after the tsunami that resulted in the Fukushima Dai-ichi nuclear power plant accident, questions remain about how much radioactive material has been released and how widely and quickly it is dispersing in the Pacific Ocean. Marine chemist Ken Buesseler at the Woods Hole Oceanographic Institution (WHOI) has been gathering samples -- some from as close as half a mile from the damaged reactors -- and has been analyzing this seawater for Fukushima contaminants since 2011.

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Dirty, Dangerous and Expensive: The Truth about Nuclear Power

The nuclear industry seeks to revitalize itself by manipulating the public's concerns about global warming and energy insecurity to promote nuclear power as a clean and safe way to curb emissions of greenhouse gases and reduce dependence on foreign energy resources. Despite these claims by industry proponents, a thorough examination of the full life-cycle of nuclear power generation reveals nuclear power to be a dirty, dangerous and expensive form of energy that poses serious risks to human health, national security and U.S. taxpayers.

Nuclear Power is Dirty

Each year, enormous quantities of radioactive waste are created during the nuclear fuel process, including 2,000 metric tons of high-level radioactive waste[1] and 12 million cubic feet of low-level radioactive waste[2] in the U.S. alone. More than 58,000 metric tons of highly radioactive spent fuel already has accumulated at reactor sites around the U.S. for which there currently is no permanent repository. Even without new nuclear production, the inventory of commercial spent fuel in the U.S. already exceeds the 63,000 metric ton statutory capacity of the controversial Yucca Mountain repository, which has yet to receive a license to operate. Even if Yucca Mountain is licensed, the Department of Energy has stated that it would not open before 2017.

Uranium, which must be removed from the ground, is used to fuel nuclear reactors. Uranium mining, which creates serious health and environmental problems, has disproportionately impacted indigenous people because much of the world's uranium is located under indigenous land. Uranium miners experience higher rates of lung cancer, tuberculosis and other respiratory diseases. The production of 1,000 tons of uranium fuel generates approximately 100,000 tons of radioactive tailings and nearly one million gallons of liquid waste containing heavy metals and arsenic in addition to radioactivity.[3] These uranium tailings have contaminated rivers and lakes. A new method of uranium mining, known as in-situ leaching, does not produce tailings but it does threaten contamination of groundwater water supplies.

Serious Safety Concerns

Despite proponents' claims that it is safe, the history of nuclear energy is marked by a number of disasters and near disasters. The 1986 Chernobyl disaster in Ukraine is one of the most frightening examples of the potentially catastrophic consequences of a nuclear accident. An estimated 220,000 people were displaced from their homes, and the radioactive fallout from the accident made 4,440 square kilometers of agricultural land and 6,820 square kilometers of forests in Belarus and Ukraine unusable. It is extremely difficult to get accurate information about the health effects from Chernobyl. Government agencies in Ukraine, Russia, and Belarus estimate that about 25,000 of the 600,000 involved in fire-fighting and clean up operations

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