THE CASE AGAINST NUCLEAR POWER

Radiation and harm to human health

A PUBLICATION OF BEYOND NUCLEAR

Introduction

As any activist engaged in anti-nuclear advocacy knows, nuclear power is a complex topic. It can be challenging to describe all the various dangers and detriments in simple, concise language.

To address this, we have created a series of booklets that, taken together, comprise The Case Against Nuclear Power: Facts and Arguments from A-Z.

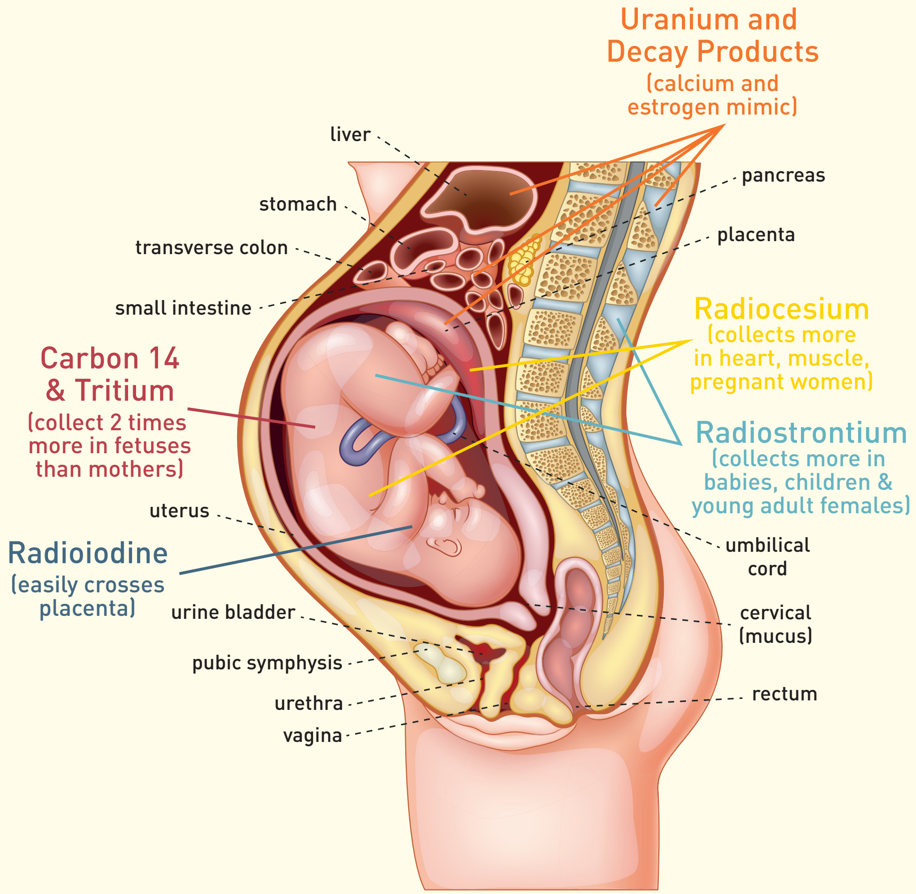
Each booklet presents simplified, boiled down explanations of the topic at hand. We also rebut the false pro-nuclear propaganda in circulation. And we endeavor to help everyone — whether a long time campaigner or an ingenue — feel confident about their ability to articulate the facts, and to do so in compelling and non-technical language.

Each booklet will be posted to the Beyond Nuclear International website when completed and will also be available as a standalone piece in print. Once all the booklets are completed, the entire work may be downloaded as a single handbook. The content of each booklet is documented through references and footnotes.

In assembling such a wealth of information, omissions will be inevitable. The status of nuclear power is also constantly changing and some of these facts and figures may quickly go out of date. We encourage you to find the updates on line.

By necessity, some sections focus mainly on the US. However, many if not most of the facts and arguments are universally true. We encourage you to use and share these booklets widely. They are also freely available to download and reprint without permission.

Selected radionuclides and where they collect in the pregnant woman



*Radioactivity appears to interfere with estrogenic pathways. Proper estrogen function is essential for healthy pregnancy.

Radiation and human health

Humans cannot see, feel, taste, smell or hear ionizing radiation, yet it can damage our health. This type of radiation comes from natural sources such as cosmic rays, rocks and soil. It also comes from artificial sources like industrial and medical processes. Human exposure to natural radiation is responsible for a certain number of disease-causing mutations and cancers. Since there is no safe dose, any additional exposure above natural background radiation will increase the risk of otherwise preventable illness. Women, children and pregnancy are particularly at risk.

What are radiation and radioactivity?

In order to understand radiation and radioactivity, it is first necessary to explain what a radionuclide is. A radionuclide (also called a radioactive isotope, radioisotope, or radioactive nuclide) is a chemical element with an unstable nucleus. When this disintegrates to a more stable form, it gives off energy in the form of **radiation**. The whole process is called **radioactivity**.

This is a spontaneous natural process where gamma rays, alpha particles, beta particles, X-rays and neutrons can be emitted. This process is also called radioactive decay. During these decays, radionuclides change from one chemical element to another until their nuclei become stable – a process that can take a second or less to millions of years in some cases.

What is radiation exposure?

External radiation exposure

Radiation from outside the body can cause harm as it travels through our DNA, cells, tissues, and organs. It tears apart DNA molecules, rips away electrons from atoms inside your cells, and disrupts cell structures such that proper repair is difficult. Faulty cellular repair leads to disease. However, once you shield or remove yourself from the external source, you stop the exposure.

Internal radiation exposure

If someone eats food contaminated with radioactivity, or breathes in radioactively-contaminated air, radionuclides enter their body. This is a serious matter, because the human body mistakes these radionuclides for natural elements. For example, radioactive strontium-90 and cesium-137 from nuclear accidents such as at Fukushima and Chernobyl can enter the body. When this happens, the strontium-90 replaces the body's stable calcium, and the cesium-137 replaces its stable potassium. These radionuclides thus lodge in bones and muscles respectively and irradiate people from within for long periods of time.

This is called internal radiation. It is more serious than external radiation because of the long exposures involved. In addition, some radionuclides that cause limited harm outside the body have nothing stopping their full damaging energy once they are inside the body.

How quickly a radionuclide is absorbed into, or released from, the body depends on both its physical and chemical forms. For example, is it a gas, liquid or a solid? If a solid, is it soluble or insoluble? Or in air, is it volatile or not?

Once a radionuclide is taken into the body, where it settles tells you which organs will be damaged. For example, radioactive iodine is preferentially concentrated in our thyroid glands and lymphatic systems. If someone continues to breathe contaminated air and/or eat contaminated food, radionuclide concentrations increase up to a certain level where the amounts taken in are balanced by the amounts being excreted.

Radionuclide concentrations usually increase the higher up the food chain one goes, for example, in water environments concentrations will travel: microbe —algae—plankton—tiny fish—larger fish—top predator fish. This is called bioaccumulation.

Because some radionuclides, like radon-222 and potassium-40, exist in our environment naturally, they can be present in our bodies —mostly at very low levels. The resulting radiation is a major part of what we call background radiation. The result is that radiation is everywhere in our world. We cannot avoid exposure to some radiation.

No safe dose

The U.S. National Academy of Sciences (NAS) has investigated the dangers of low-energy, low-dose ionizing radiation and has concluded, "that it is unlikely that a threshold exists for the induction of cancers…"[1] Therefore, saying that there can be a "safe" level of radiation exposure is simply wrong. There is no guarantee that even the smallest doses of radiation will not cause some level of harm. Human health data also point to women and children being more susceptible to damage from radiation exposure than adult males, with pregnancy being particularly vulnerable.

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"Natural" versus "man-made" radiation

Natural radiation is all around us. It is why we get radon levels measured before we buy a house. Then there are "man-made" radioactive isotopes that do not occur in nature, but have now become part of our "background" dose. More than 1,000 radionuclides are known. Only about 50 of these are found in nature. But before we learn where these radionuclides come from and their different effects, we should explore what we know about the electromagnetic waves and particles they give off.

Particles and Waves: Radioactivity from A to X

Radionuclides give off two different kinds of radiation. The first kind is as particles (alphas, betas, and neutrons). The second kind is in the form of electromagnetic waves (gamma and X-rays). X-rays are generated primarily by machines in hospitals and dental surgeries.

Alpha particles

Alpha particles are high energy, large, heavy, cannot travel very far and can be stopped by a piece of paper or skin. However, once taken inside the body, they have the power to tear through cells in organs or blood, releasing their tremendous energy to surrounding tissue and leaving extensive damage in their wake. Alphas primarily come from naturally occurring nuclides or from heavy transuranics produced in nuclear fuel. Uranium, thorium, and radon are some natural isotopes that give off alphas. Transuranics are nuclides that are heavier than uranium and include plutonium and neptunium.

Beta particles

Beta particles are electrons. They are a tiny fraction of the size of alpha particles, but they can travel farther and are more penetrating. Therefore, a stronger protective barrier is needed such as a half-inch of Plexiglass or water shielding. Although beta particles can leave a skin burn from external exposure, inhaling or ingesting beta-emitting radionuclides poses the greatest risk. Betas mostly come from nuclides produced by the fission process in nuclear power reactors. Radioactive hydrogen (known as tritium) and strontium-90 (which mimics calcium in the body) are two common beta emitters that are hazardous to health.

Gamma rays

Gamma rays are the most penetrating type of radiation and can be stopped only by thick lead or concrete. They pose a hazard both inside and outside the body and arise naturally (for example from radium-226) and through man-made fission products (for example from cesium-134). Barium-137m is a decay product of cesium-137 and gives off gamma rays. However, because barium-137m decays in under three minutes, cesium-137 is commonly labeled a gamma emitter.

Neutrons

Neutrons occur naturally in space but are also generated through the fission process of nuclear reactors. Neutrons are emitted at reactor sites and from nuclear waste casks and can travel great distances in air, making them the source of "[t]he primary dose to the public near a nuclear facility…"[2]

Shielding neutrons is very challenging and not always successful, requiring multiple layers of different materials set up in a maze-like network. Neutrons are most effectively shielded by water, or hydrocarbons like paraffin wax and concrete.

Unlike other radioactive emissions, neutron radiation can make most substances inherently radioactive (to varying degrees) including air, water, soil, and body tissues. Dubbed neutron activation, this phenomenon was first recognized during the Operation Crossroads atomic bomb tests in 1946. Neutrons are more damaging than most other forms of radioactivity, particularly to soft body tissues, yet little research has focused exclusively on the health effects of neutrons.

X-rays

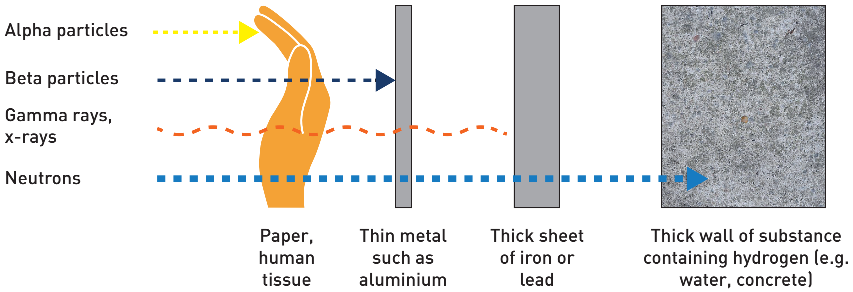
X-rays resemble gamma rays but are most often generated electrically by a machine (rather than from radionuclides), usually for medical diagnostic procedures. X-rays also require lead shielding. When generated by medical equipment, their production does not create nuclear waste, unlike other types of nuclear processes that produce radioactive elements.

Where does radioactivity come from?

Radioactivity is released all along the uranium fuel chain and poses harm to human and environmental health at every stage, whether from nuclear power or nuclear weapons.

You may hear that some radioactivity is "naturally occurring" and therefore somehow unavoidable and relatively harmless. However, this is misleading.

Penetration ability of various forms of radiation



"Naturally occurring" radiation vs. "background" radiation

Radiation does occur naturally, including from cosmic rays, radon, the earth (terrestrial radiation), and trace amounts of radioactive elements in food such as potassium-40. Some naturally occurring radiation can be avoided, lowering the health risks from exposure.

Additionally, there is **man-enhanced** radiation that has been added through atomic bomb test explosions, and various industrial processes that release radioactivity, such as uranium mining, milling, fission and handling of nuclear waste. These types of radioactivity are NOT naturally occurring but they are NOW part of background radiation and have added to our health risks, increasing over time, because there is no safe dose of radioactivity. For instance, cesium-137 does not exist in nature, but has been released from atomic bomb explosions, nuclear power routine releases and catastrophes, and is now "impossible to avoid."[3]

The misleading banana comparison

Pro-nuclear enthusiasts try to claim that ingesting bananas, which contain naturally occurring potassium-40, is more dangerous than living near a nuclear reactor. This is incorrect. Ordinary potassium contains 0.0118% potassium-40. Since the levels of potassium in our body are under strict homeostatic control, the body quickly gets rid of any excess potassium in the banana – including its potassium-40. In other words, the levels of potassium-40 do not increase for long after eating a banana, and the net dose from eating a banana is very small. The tiny radiation increase lasts only for a few hours[4] after ingestion, namely the time it takes for the extra potassium to be passed out of the body.

Cosmic radiation

Cosmic radiation is used by nuclear power proponents in an effort to convince people that flying in an airplane, for example, is the same as radiation exposure from the radioactive releases at nuclear reactors, living in a

During uranium mining, milling and processing heavy metals are also released. From a health perspective, these can be of equal and sometimes greater concern than radiation.

permanently radioactively contaminated environment, or being forced to eat radioactively contaminated food. This comparison is unfair and misleading. Flying is a voluntary and occasional activity exposing people only while they fly. Living near a nuclear reactor or in contaminated areas, or eating contaminated food, is not always voluntary and results in a more continual and *internal* exposure, which is very different.

Radioactive releases from uranium mining and milling

The radioactive isotopes of uranium (uranium-238 and its decay products) found in uranium ores do occur naturally, but usually they are deep underground where they pose a relatively low threat to human health. However when these ores are mined, brought to the surface, milled and processed, they release airborne and waterborne nuclides that can be inhaled or ingested. The tailings from uranium mines retain up to 85%[5] of the ore's original radioactivity, which is now more easily accessed by plants and animals, and is dissolved and scattered by rain and wind. Tailings sludges can seep into water supplies, affecting human health as well.

Radioactive releases from nuclear reactors

In a nuclear reactor, once the fission process is started and a chain reaction is sustained, radionuclides are produced that do not occur, or occur only rarely, in nature. These radionuclides are routinely released into the air and water during operation of nuclear power reactors and pose dangers that can differ from uranium and its decay products.

It is not just about radiation

Radioactivity is not the only hazard released along the nuclear fuel chain. During uranium mining, milling and processing heavy metals are also released. From a health perspective, these can be of equal and sometimes greater concern than radiation. For example, when in situ leach mining is used, the acidic mine water will likely also contain heavy metals such as lead, aluminum, vanadium, as well as metalloids such as arsenic, which are dangerous as small amounts can be lethal.

Terms and measurements for radioactivity

When people talk about measurements of radioactivity, they may use a variety of terms. Even more confusingly, different terms are used for similar measurements depending on the country where you live.

Becquerels and Curies

Becquerels and curies are the units used to describe how radioactive a substance is. One "becquerel" (Bq) means one atomic disintegration per second. The unit was named after Henri Becquerel, a French physicist and Nobel laureate, who was the first person to discover evidence of radioactivity. One "curie" (Ci), means 37 billion disintegrations per second. It was named after Marie Curie, also a Nobel laureate and discoverer of polonium and radium. The curie is gradually being replaced by the becquerel, which has become the standard unit in most countries outside the US and Russia.

Grays and Rads

A **gray** (Gy) is a unit of radiation exposure. A gray means one joule of energy deposited in a kilogram of tissue. More precisely, it means the absorbed energy from a radiation source which has been homogeneously distributed in a kilogram mass. It does not represent biological *damage*, only an amount of exposure. Furthermore, a joule only represents energy from photons. It does not account for the impacts of particles like alphas and betas released from radionuclides.

The radiation-absorbed dose or **rad**, was the older expression of deposited energy, (100 rad equals one Gy) although its use has fallen out of favor except in the US. Like the gray, the rad represents the energy absorbed from radiation.

Sievert and Rem

The **sievert** (Sv), based on the gray, attempts to take the energy absorbed or deposited in tissue and evaluate the damage it causes. The sievert, therefore, should try to account for a number of differences in both the types of radioactivity and the target of damage. However, many important effects remain unaccounted for, particularly the disproportionate impacts suffered by women, children and pregnancy, and cumulative damage over time.

The **rem**, or roentgen equivalent man, was the older expression of damage, (100 rem equals 1 Sv) although its use has fallen out of favor except in the US and Russia.

Defining doses as high or low can be misleading

Differentiating between high and low doses is very tricky, depending on whether the doses are delivered to a whole body, an individual organ, or a few cells. The distribution of radiation exposures is important for understanding damage; but precise distributions of many radionuclides within the body eludes experts.

For instance, a single track from an alpha particle delivered to the body from outside could be considered a "low" dose to the entire body, even though, as Pierre Curie discovered, alpha exposures produced nasty skin burns. In this scenario, alphas would not be a threat to internal organs, however.

For internal radiation, this matter is even more important. If an alpha-emitting isotope is inhaled or ingested, a single alpha track can impart a huge dose to the cell(s) it travels through. This dose isn't divided among the entire body for two reasons. First, because the chemical the radionuclide mimics can collect in specific organs rather than distributing evenly in the body; second, even within that organ, the radionuclide could be irradiating a much smaller grouping of cells rather than the entire organ.

Therefore, representing radiation doses through a "low" or "high" dose model is not applicable to internally deposited radionuclides, particularly since damage to even a single cell can trigger a disease. A much better model would equate the amount of *measured* radioactivity contained within an organ to resulting damage.

But this is not done at present. Also deceptive is that doses termed "low" that are well within the range of background can cause childhood disease. "Low" often is taken to mean "safe" but this is incorrect, as there is no dose that is absolutely safe.

High doses

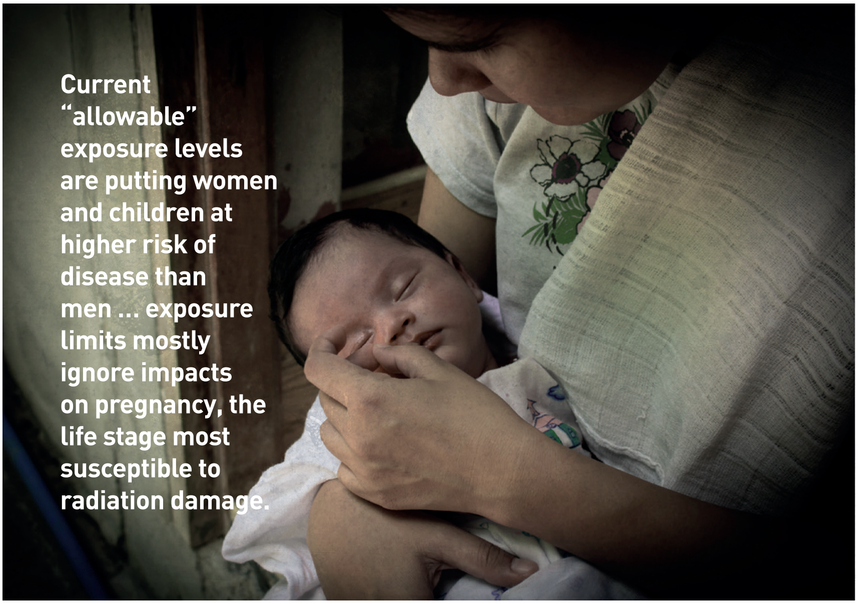
The term "high dose" is often used in the context of radiation exposure imparted over a short span of time such as the result of uncontrolled or unexpected releases from a nuclear catastrophe like Three Mile Island, Chernobyl or Fukushima. Many of the cleanup workers (liquidators) who were asked to come in right after the Chernobyl explosion experienced the symptoms of high radiation doses.

Large doses of ionizing radiation can cause death, radiation sickness, hair loss, sterility, radiation burns, cataracts, and many other harmful effects that are apparent within hours, days, weeks or a few months after exposure. Extremely high doses can be fatal within a few hours. These are called "prompt effects." They can be prevented by lowering the exposure through limiting how much time is spent being exposed, moving farther from the source of exposure, or blocking the source using materials which shield the body (water, lead, glass, etc.) depending on the type of radiation causing the exposure.

Low doses

The term "low dose" is often used to refer to exposures from background environmental contamination, like the kind still blanketing parts of Europe ever since the 1986 Chernobyl nuclear disaster, or routine releases from nuclear power reactors.

Low doses of radiation can cause solid cancers and blood cancers (leukemias), and non-cancer impacts such as cardio-vascular diseases, genetic



damage to the DNA of reproductive cells, impaired neural development, and a variety of other ailments that will often not become apparent for years or even decades after exposure. These are called "delayed effects" of radiation. Closing reactors and moving away from nuclear facilities can lower one's radiation dose, as can avoiding the consumption of food grown in contaminated areas. However, the sad truth is that many people carry man-made radioactivity in their bodies as a legacy of nuclear technology, particularly releases from atomic bomb testing and nuclear power catastrophes.

While nuclear proponents will claim that these radiation doses are too low to cause any "proven" harm, research demonstrates that, especially for children and pregnant women, leukemia and impaired neural development are associated with doses well within what the industry claims are "background" levels.

What is "Reference Man" and why is it bad?

Radiation damage assessments and federal "allowable" exposure limits are based on "Reference Man," a healthy, white male in the prime of life. "Allowable" exposure limits do not mean "safe" exposure levels since there is no safe level of exposure, even within current background levels. However, according to the National Academy of Sciences, women are 37- 50% more vulnerable than men to the harmful effects of ionizing radiation.[6] Data on women and children are "averaged" with reference man data. This means that current "allowable" exposure levels are putting women and children at higher risk of disease than men.

Additionally, "allowable" exposure limits mostly ignore impacts on pregnancy, the life stage most susceptible to radiation damage. Instead, pregnancy, rather than reference man[7], should form the basis for any exposure standards.

Why we can't trust post-nuclear accident health figures

After a serious nuclear power accident, it can be difficult to assess how many people were exposed and to what levels of radiation they were exposed. Such data-keeping is made more complicated by the evacuation and dispersal of affected communities and even by the political regime in place. For example, there are widely differing views as to the numbers of deaths due to the Chernobyl nuclear accident and it is virtually impossible to know both the fatality numbers as well as those who were sickened and survived, with any degree of certainty. The only certainty is that many thousands — and likely at least tens if not hundreds of thousands of people — died as a result of Chernobyl who would otherwise not have died from that cause. Estimates will be similarly difficult for the Fukushima nuclear disaster.

Why we can't trust the World Health Organization's statements on nuclear accident health impacts

A widely-cited source for health impact figures after a nuclear accident is the World Health Organization. But the WHO is bound by a 1959 agreement[8] with the International Atomic Energy Agency, which can veto any actions by the WHO that relate to nuclear power. Since the IAEA's mandate is to promote nuclear energy, any WHO estimates of current or future health effects from nuclear accidents have to pass muster with a nuclear promoter, the IAEA. Most WHO statements on nuclear accident health impacts should therefore be treated with considerable skepticism.[9]

How do we know radioactive releases are harmful?

There are countless scientific and medical studies from around the world that demonstrate the harm to health caused by radiation. Here we list some key findings. You will find a document link in the endnote[10] that contains this full section, referenced.

Studies of background radiation (natural and man-made)

- All childhood cancers start to increase at exposures not much more than natural annual doses.
- Among childhood cancers, leukemia and central nervous system cancer risks predominate.
- There appears to be a strong impact of radioactive contamination on individual fitness in current and future generations, with potentially significant population-level consequences, even beyond the area

contaminated with radioactive material.

- Radioactivity is also associated with negative, subclinical health impacts such as impaired neural development and lower I.Q.
- Radiation can increase resistance of bacteria to antibiotics.
- Radiation appears to act along the estrogen pathway, hinting that, in addition to a carcinogen, radioactivity may be an endocrine disruptor. Estrogen plays key roles in healthy pregnancy and puberty and is greater in women than men.

Uranium studies

- Uranium in drinking water – at levels allowed by the Environmental Protection Agency – disrupts the estrogen pathway.
- Birth defects and abnormal pregnancy development, including low birth weight, are associated with ingestion of uranium.
- The incidence of reproductive or gonadal cancer in New Mexico Native American children and teenagers is eight-fold greater than that in non-Native Americans of the same ages. New Mexico has been home to hundreds of uranium mines, all of which are now abandoned (although threats of new mines remain). These mines have left behind tailings and other radioactive wastes that have contaminated soil, air and water and which continue to harm health.

Operating reactor/fuel facility studies

- The National Academy of Sciences says childhood leukemia is a sentinel indicator for radiation exposure in a community.
- When data around normally operating nuclear facilities are examined worldwide, we find increases in childhood leukemia. Over 60 studies indicate this.

Catastrophe studies

- Children in Chernobyl-contaminated areas have suffered reduced respiratory capacity as recently as 2010. The more radioactive cesium in their body, the greater the effect.
- Exposure to radioactivity is associated with chronic fatigue immune dysfunction syndrome (CFIDS).
- Cardiovascular defects are still surfacing from radioactivity due to the ongoing Chernobyl catastrophe.
- Birth defects (blastopathies) and other health disturbances are found among not only those who were adults at the time of the Chernobyl disaster, but their children who were in utero at the time and, most disturbingly, their later offspring.

- Thyroid cancers in the Three Mile Island area appear to bear a radiation-specific biological marker, occur earlier and seem more aggressive. Thyroid cancers continued increasing years after Chernobyl began. Thyroid cancers have been observed in children since the Fukushima nuclear disaster in Japan, but studies at Fukushima suffer from poor methodology and lack of transparency, putting in serious jeopardy any independent analysis.
- Research indicates that forest matter in the contaminated areas around Chernobyl is taking years or even decades longer to decay than it should.
- Monkeys in Fukushima-contaminated areas are born with fewer blood components, including white blood cells, now that their environment is radioactively contaminated from the reactor explosions of 2011. Having a diminished number of white blood cells, which fight disease, can lead to a compromised immune system.
- Negative impacts on animals such as smaller brains and lower sperm counts, to name just two, are also occurring at Chernobyl and Fukushima.

Radiation damage is written in our blood

There are a number of tags that radiation exposure leaves in our bodies. These tags, called "bioindicators," can include chromosome defects, cellular malformations, certain proteins and other effects.

Some tags are uniquely sensitive measures of radiation exposure and can be used reliably to assess dose while others are not only associated with exposure to radioactivity, but also with increased disease risk.

Such malformations resulting from radiation exposure have been used in health studies to assess exposure levels and should be used in any case of unplanned or planned exposures (such as nuclear power refueling outages). Unfortunately, this measure of potential damage is largely ignored in favor of techniques such as mathematical dose estimates, which can obscure true health impacts.

Women, children, fetuses and embryos are the most radiosensitive

Early human life stages (pregnancy and childhood) and females are especially susceptible to damage from radiation. While the impact of radiation on human health has been studied, there has been little investigation into why women are more susceptible to its damage than men. Experts theorize that rapid cell division during childhood and pregnancy seem to be the reasons for the vulnerability of embryos and fetuses, and unique developments certainly occur during pregnancy. There are also studies that indicate a negative impact of radiation on estrogen and its functions; therefore radiation might be an endocrine disruptor and this would affect women in particular. Other reasons are that women have much larger reproductive organs and far more hormonal systems than men.

Paying special attention to the impact on reproductive health is important for two reasons:

1. the vulnerability of pregnancy and childhood can not only lead to health impacts during these stages, but exposures during these stages can cause diseases years later when the person is an adult; and
2. this lifetime risk from early developmental exposure is all but ignored[11] in radiation exposure standards in the US.

Normalizing Radiation

Science shows women and children pay the highest price for exposure to radioactivity. Despite this, they are often accused[12] of harboring irrational fears of radiation, sometimes labeled as "radiophobia." There is no scientific evidence to support such an allegation. In fact, a recent study reveals that communicating the danger of exposure does not increase false perception of greater health impacts.[13]

However, "radiophobia" is used by some governments as an excuse to "normalize" radiation and even raise the "acceptable" exposure levels to dangerous rates as has happened in Japan since Fukushima.

After Chernobyl, efforts were made to attribute radiation-induced illnesses to "hysteria" and "psychological" fears, often dubbed "Chernobyl syndrome". In reality, many of the effects are genuine medical diseases. But even if some are the result of a psychological response, psychiatric illnesses are still illnesses, and are consequences of trauma that should not be dismissed.

In Japan, "radiophobia" is being used as a label with which to ostracize and socially isolate people. It is even equated with a lack of "patriotism." After the Fukushima nuclear disaster, Japanese authorities raised the "acceptable" level of exposure to radiation as high as 20 millisieverts a year for the contaminated areas that cannot be cleaned up. People were expected to move back into communities and suffer exposures without complaint. Yet this dose is equivalent to the annual "allowable" dose for a European nuclear power plant worker and is an exposure level that should never be allowed for women, children and especially pregnant women.

The canceled US cancer study

While many studies in Europe have observed increased rates of leukemia among children living around nuclear power reactors, no such studies have been conducted in the US. In 2010, the National Academy of Sciences (NAS) was commissioned by the US Nuclear Regulatory Commission (NRC) to examine cancer incidences around nuclear facilities.

The NAS completed the first phase of the study in 2012 and had selected two epidemiological methods with which to conduct a pilot study around seven nuclear facilities (six power reactors and one fuel fabrication facility). One study design would examine all members of the population; the second, and more important, study would examine the impact on just children within 30 miles of the facilities. Upon completion of the pilot study, projected to take three years and $8 million, the NAS was to perform Phase II, a nationwide study around nuclear facilities.

However, the NRC cancelled the study in 2015 claiming that it would cost too much money. This argument was scarcely plausible given the agency had squandered[14] $350 million of taxpayer money on a new building at its Maryland headquarters that remains nearly empty.

However, the NAS was planning not only to incorporate independently collected data along with those generated by the nuclear industry, it was also proposing to alter some of the health models currently used and investigate the impact of some ignored radionuclides. The NAS was also making the data on nuclear power pollution easily accessible to researchers and the public. The NAS research was positioned to be in-depth, carefully constructed, paradigm-shifting, and publicly available. This may have stoked NRC fears that a cancer connection would be found, especially in light of a groundbreaking hypothesis in 2014, offering a plausible explanation for childhood cancer increases in children living near nuclear reactors.[15]

The Precautionary Principle

When the Precautionary Principle was first established at the January 1998 Wingspread conference, it concluded that precaution should prevail when an activity raises threats of harm to human health or the environment, even if some cause and effect relationships are not fully established scientifically. The members of the conference also concluded that current environmental policies do not do enough to prevent environmental disasters and instead tend to try to control damage after an incident.

Clearly, the activities all along the uranium fuel chain offend against the Precautionary Principle. Given the potential for harm, these activities should be avoided. And yet, they continue. The absence of deployment of the Precautionary Principle in so many areas of life, and especially given the destructive capacity of nuclear power and nuclear weapons, has worsened the outlook for the survival and well-being of all life forms including, but by no means limited to, humans.

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[6] Atomic Radiation Is More Harmful to Women. https://www.genderandradiation.org/wp-content/uploads/2017/05/corrected-radiationwomenfinal.pdf

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[10] For full RESEARCH STUDY citation list, please see Studies of radiation damage. http://www.beyondnuclear.org/storage/radiation-and-health/study%20references%20handbook%20health%20chapter.pdf

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