

A photograph of a nuclear power plant at night. Two large cooling towers are visible, emitting thick plumes of white steam that rise into the dark sky. The plant's structures are illuminated with warm orange and yellow lights, which are reflected in the calm water in the foreground. The overall scene is dark, with the primary light sources being the plant's own lighting and the ambient light from the steam.

The Case Against Nuclear Power in Utah

Utah Physicians for a Healthy
Environment

The Case Against Nuclear Power in Utah

“The unleashed power of the atom has changed everything save our modes of thinking and we thus drift toward unparalleled catastrophe.”

--- Albert Einstein

“Now, when we go back to nuclear power, we are creating something (radiation) which nature tried to make life impossible... the most important thing we could do is... outlaw nuclear reactors too”.

**--Admiral Hyman G. Rickover
father of the nuclear navy,
warned Congress in 1982**



<https://cosmoscience.in/fukushima-nuclear-disaster/>

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Chernobyl liquidators

1. Executive Summary

News reports indicate that Utah state government leaders have recently been lured by the AI data industry into incentivizing the development of nuclear power plants in Utah. This has manifest itself in vague plans to develop new nuclear power plants, a research center, and/or allow tech companies to build their own small nuclear power plants to supply electricity to their centers.

Just as state leaders are dismissing the empirical reality of an accelerating climate crisis in the face of overwhelming scientific evidence, and facilitating expanded fossil fuel extraction, they are also dismissing multiple lines of evidence that mitigate against expanding nuclear power. In encouraging and offering financial incentives for nuclear power in Utah, state leaders are ignoring relevant, past and present secrecy and deception by the nuclear industry. They are ignoring, or are unaware of, the peril of the financial foundation of the AI data industry and population trends that combine to question the assumptions behind Gov. Cox's urgent, "all of the above" campaign to increase the state's energy capacity.

Every phase of the nuclear fuel cycle, from the mining of uranium to the routine operation of the power plants, to the decommissioning of those plants, exposes the general public to more radiation. External radiation is not the same, and does not represent the same risk, as internal radiation, the most common cause of cancer. Yet industry proponents are forever dismissing, or are unaware of, the increased risk of internal radiation that is emitted during normal nuclear plant operations, and that contaminates local landscapes, water, soil, and the food supply.

Nations with either nuclear weapons or nuclear power plants, international agencies, and companies within the nuclear industry, known collectively as the "nuclear village," have a collective self interest in discounting the health hazards of radiation exposure, whether it's from nuclear weapons testing, the atomic bombing of Japan, or the present-day radiation releases of the nuclear power industry.

But the science is well established, there is no safe level of radiation exposure, internal or external. The biologic and physiologic damage and disease potential is cumulative, increasing with each added exposure. Those in the earliest stages of life, i.e. fetuses, infants, and children, and females of all ages are the most vulnerable, and largely dismissed in regulatory standards and research. Those standards completely ignore such issues as what kind of radioactive particles can cross the placenta, where significant damage to humans can be done, yet not become manifest until decades later. For all humans, radiation exposure at any stage of life jeopardizes health in all future stages, and is almost certainly transgenerational.

Numerous studies consistently demonstrate that people who live within a few miles of nuclear power plants have an increased risk of multiple types of cancer. But radiation is even more strongly associated with cardiovascular disease, and is strongly connected to brain and nervous system damage, reproductive disorders, infertility, and genotoxicity.

There is still no solution to the problem of needing safe, long-term storage of high-level nuclear waste. That this waste must be isolated for hundreds of thousands of years, places an existential burden on countless future generations for which they will receive no benefit.

The cost of nuclear power has been and still is prohibitive, and far more than renewables and even fossil fuels. That almost certainly will not be any different with Small Modular Reactors (SMRs). Any potential SMR industry will also depend on public subsidies, just as the previous iteration of nuclear plants did. The Dept. of Energy has provided billions in development funds for various SMR designs that have essentially no customers.²⁴¹

Furthermore, nuclear power has always required a long-time frame to complete plant construction, and every project in recent decades has been characterized by long delays and large cost overruns. That same scenario is almost certainly likely to plague SMRs.

SMRs add significantly to the problem of storing high level nuclear waste by generating more of that waste per unit of electricity created. Because essentially every SMR site will also have to be a long-term high level radioactive waste storage site, numerous SMRs will only make the waste storage problem even worse--more hazardous, more complicated, and more expensive, especially if these SMRs are created to be mobile.

A major nuclear accident in any one of the hundreds of nuclear power plants throughout the world has the potential to contaminate half the globe for hundreds of years, as we have seen with three power plant accidents. There is no other power source that can come close to that kind of potential for catastrophic damage.

Official government and industry claims of minimal morbidity and mortality secondary to the high-profile nuclear accidents like Three Mile Island, Chernobyl, and Fukushima are in sharp contrast to estimates from independent scientists that are far greater in each case.

Many of the world's most qualified and highly respected scientists have warned against nuclear power plants since the 1960s and 70s. Their observations and critiques are just as valid now as they were decades ago.

2. The Deception Behind the Nuclear Industry

A. Utah's politicians have a long history of allowing scientific evidence to be subordinated to ideology in state decisions

Utah state officials have a long and embarrassing track record of failing to integrate science, common sense, due diligence, and appropriate caution into public policy. Politics, promises of "too good to be true" economic benefits, anti-science ideology, and dismissal of public health and environmental protections have played a prominent role in many poor state government decisions, especially regarding energy.

Utah has also been labeled both the Ponzi Scheme capital of the US, and the fraud capital of the US. Sordid and expensive examples are many and varied. A few examples are: the “cold fusion” energy miracle of 1989, the 1991 Syncrete scam, Rep. Aaron Tilton’s supposed nuclear power plant company, Blue Castle Holdings, the COVID TestUtah debacle, \$800,000 spent on hydroxychloroquine, the fantasy island on Utah Lake project, the Utah Inland Port Authority (UIPA) signing a no-bid contract with logistics company QuayChain, the 40 year lease obligation by UIPA for a transloading facility whose viability evaporated before the ink was dry, and the recently cancelled nuclear reactor pipe dream by Utah Associated Municipal Power Systems (UAMPS) and NuScale Power Corporation.

These patterns continue with state officials’ eager embrace of the nuclear industry’s present-day lobbyists. Now that it is paired with the nuclear industry’s own long history of downplaying, ignoring and even falsifying the health and environmental consequences of nuclear processes, that combination could lead to more poor decisions effecting multiple generations of Utah residents. If there is any state that should be wary of anything that would expose its population to more radioactivity it would be Utah’s.

If there is any state that should be wary of anything that would expose its population to more radioactivity it would be Utah.

In 2006 the Pentagon announced it was going to test a 700 ton “bunker busting super bomb” at an inactive Nevada nuclear testing site. It said, "The U.S. military must be able to defeat hard and deeply buried targets in order to deny an adversary the ability to use these facilities against us."²⁴⁰ It was simulated to create a 5,000 ft. mushroom cloud. Worry that the test would launch another round of radioactive dust into the air provoked strong local and state opposition in both Nevada and Utah. The Pentagon claimed it would not release radioactive dust, but the environmental assessment they offered did not consider small inhalable dust. Thankfully the Pentagon agreed to cancel the test after pressure from Utah Governor, Jon Huntsman. That aversion to anymore radioactive exposure seems to have disappeared among Utah’s current political leaders.



One of the first atomic bomb tests in the Nevada Proving Grounds. Note the close proximity of thousands of American soldiers.

Courtesy of Nevada State Museum,
<https://www.reviewjournal.com/news/scientists-conducted-first-atomic-bomb-test-in-1951-last-in-92/>

Holtec International, whose primary business is decommissioning retired nuclear plants, has been embroiled in numerous scandals for 15 years, beginning with a scandal involving bribery, overbilling Tennessee Valley Authority, and a temporary ban from federal work. Holtec is a defendant in a whistleblower lawsuit filed by their former chief financial officer (CFO) accusing the company of false and misleading statements to investors. Holtec in turn is suing the whistleblower. They have paid a \$5 million fine and were censured by the state of New Jersey in a plea arrangement to avoid prosecution on a scheme to avoid state taxes. Another former CFO claimed “Holtec sought to conceal \$150 million in projected losses for its proposed nuclear waste facility in New Mexico. He also claims Holtec ‘grossly overstated’ the amount of money it spends annually on research and development, lied about long-term company debt, and inflated the value of its manufacturing facilities.”

Holtec has been accused of inappropriately delaying decommissioning work and leaving a litany of broken promises on handling of highly radioactive waste. Holtec sought to dump a million gallons of radioactive water in Cape Cod’s bay, and when stopped by regulators, it secretly just evaporated much of the waste water which is just as dangerous to the public.

^{242,243,244,245,246} That water was contaminated with a million times more radioactive tritium, and 200 million times more Cesium-137 than background levels.²⁷⁸ When stopped by regulators, Holtec secretly evaporated much of the radioactive water which is just as dangerous.

Welcoming Holtec to Utah is not just an indictment of the judgement of Utah’s leaders, it is an indictment of the Nuclear Regulatory Commission’s (NRC) function as an industry watch dog.

Ten years ago salesmen for the nuclear industry convinced six Western state Governors to formally endorse a plan to test small modular reactors (SMR) under a new US Energy Department program. The endorsement was also billed as part of a "Western Initiative for Nuclear," advertised as "providing an important pathway to test the technical and economic viability of a clean and promising nuclear technology." UPHE joined the 30,000 member international organization, Physicians for Social Responsibility (PSR), in opposing the rehabilitation of nuclear power at that time. Ten years later, we don’t see evidence that the reasons for opposing it have changed or diminished.

In falling for sales pitches from the latest nuclear companies--Valar Atomic, High Tech Solutions, and Holtec International--Gov. Cox continues a Utah tradition of poor due diligence, devaluing expertise, spending taxpayer money after inadequate vetting, making agreements with unethical companies, and willfully ignoring much of the relevant science.

Forbes magazine said, “The failure of the U.S. nuclear power program ranks as the largest managerial disaster in business history, a disaster on a monumental scale.”²⁴¹ This failed history of nuclear power is the product of financial miscalculation, technological and scientific hubris, political opportunism, and corporate lobbying. All these factors are still in play today.

In 2026, rather than the United States basking in a “nuclear renaissance,” this latest trend would be more appropriately viewed as the resurrection of the “nuclear

fantasy.” And it will almost certainly go belly up, as all previous attempted nuclear revivals have done.

B. Forecast Energy Demands Likely Exaggerated

1. Business Case for AI data centers is faulty

A major driver for the state’s enthusiasm for nuclear power is the electricity demand of AI data centers. While not the subject of this report, data centers, especially AI data centers, are controversial for many reasons and they are rapidly losing support among citizens nationwide. There is still serious question about the value of AI in business applications and grave concerns about its social impact. AI data centers have a well-recognized environmental footprint, including, but not limited to, water consumption, PFAS

The founder of Valar Atomics, Isaiah Taylor, is a high-school dropout who is essentially a salesman. He has connections to a controversial Christian nationalist church and has received assistance from a Russian-American power broker²⁸¹ with ties to both a pro-Putin Russian youth movement and convicted pedophile Jeffrey Epstein.

His business background prior to his pursuit of accomplishing what no one in the world has succeeded in accomplishing—making nuclear power profitable—came from running an auto repair shop. And he has virtually no experience with nuclear energy.²⁶⁴ Taylor’s lack of nuclear expertise was startlingly revealed by an April 2025 post on his company’s website where he stated Valar’s spent fuel was so safe that holding it in one’s bare hands for five minutes would result in a dose equivalent only to that of a CT scan.²⁶⁵ This claim is preposterous and evidence enough to establish that Taylor has no business being in charge of building a nuclear power plant.

The president of High Tech Solutions, Chris Hayter, claims nuclear power is safe because he’s worked in “nearly every area of a reactor”²⁷⁹ and he’s “in good health today”²⁷⁹ so, there’s nothing to worry about. Before co-founding Hi-Tech Solutions in 2009, he was a “Reactor Services Technician.” Before that he was an “account manager for Gold’s Gym.”²⁸⁰ He lists his education as “Tacoma Community College” and “University of Washington Tacoma, Business Administration and Management, General.”²⁸⁰ Not exactly a resume dripping with expertise in nuclear physics, engineering, or radiation health hazards.

chemical contamination, abuse of land use, and electricity demand. Through-out the country there is growing local push back and activism being organized by communities unwilling to accept AI data centers forced upon them by local, county, and state officials. This antipathy is likely to grow and cloud Utah state officials’ claim that massive amounts of new electricity will be needed.

There is also concern in the business community that the demand for AI data centers represents an industry bubble, and the underlying financial math simply won’t pan out, making profitability nearly impossible. This is because data center components, like chips, age rapidly, either made obsolete through rapid advances in technology, or are broken down over years of constant, high-powered usage. The life span of an AI data center may be as short as three years, but not likely more than ten, and the revenue taken in by them over that time will not approach the cost of the construction. In short, the industry is

spending \$30 billion a month and only taking in \$1 billion in revenue.²²⁷ Furthermore, there are numerous reports of AI use already declining at large companies as they are not seeing much of a return on investment.²²⁸

2. Population growth is slowing

The perennial obsession by state leaders with perpetual growth is seemingly disconnected from population trends. Birthrates in the United States have been falling steadily for 15 years. While Utah has slightly lagged that trend, even in Utah the birth rate has fallen to 1.8 per reproductive age female, i.e. below replacement levels of 2.1.²²⁹ This trend has been underway for several years, and for multiple reasons it is likely to continue. With the Trump Administration's immigration policies, immigration to the United States has essentially ceased. That means unless there is significant interstate migration, the population, and therefore the electricity demands within the state are likely to stall, especially if public push back against AI data centers grows.

C. Federal government developed nuclear processes behind a mushroom cloud of deception

The Documentary "Bombshell" illustrated how America's initial perceptions of the danger of nuclear weapons was deliberately shaped by tight censorship of information and journalists by the military. The military used a prominent NYTimes journalist, William L. Laurence, as their mouthpiece. He remained on the pay roll of the New York Times but functioned as a cheerleader for government spin and propaganda by issuing what amounted to unchallenged press releases for the military, passing them off as vetted news.

Right from the beginning of the Manhattan Project and the development of America's nuclear weapons program, the United States government has been committed to a shroud of secrecy and deception about the risks of nuclear processes. Within a few years after the bombing of Hiroshima and Nagasaki, the Eisenhower Administration launched the "Atoms for Peace" campaign, which included an electricity nuclear power plant initiative, and deception was part of the strategy. In 1954, Lewis L. Strauss, chairman of the Atomic Energy Commission (AEC) famously told the National Association of Science Writers that nuclear power plants would generate electricity "too cheap to meter." Glenn Seaborg, chairman of the AEC in 1971, proclaimed that nuclear reactors would generate nearly all the world's electricity by 2000.¹

The US military, the federal government and its agencies, the AEC and now the Nuclear Regulatory Commission (NRC) have continued that deceptive narrative ever since, protecting the nuclear industry, and proving they cannot be trusted to adopt the appropriate amount of caution, or deal truthfully with the public on nuclear radiation's health hazards.

Military leaders did not want our nuclear weapons to be viewed with the same public revulsion as the horrific chemical weapons of WWI, but that's exactly how the radiation of the bombs should have been viewed. To that end, American troops confiscated nearly all the photographs of the hideous human consequences of the bombs dropped on Japan. The Army spokesperson

called stories of hideous deaths from the radioactivity of atomic bombs “pure propaganda.” The army required all journalists to submit their stories about the bombings and radioactive deaths and disease to army censorship.

Over and over health and radiation experts who have disputed official narratives of radiation emissions and their health consequences have been the victims of ad hominem attacks from industry and government officials. Many were fired and/or had their research funds pulled.

In 1957, government scientists working for the AEC, led by controversial nuclear physicist, Edward Teller, were enamored with the power and scientific marvel of nuclear explosions and were unrestrained by concern for public health. They proposed large scale excavation projects known as “Project Plowshares.” Those projects included the digging of canals, harbors, and reservoirs, as well as petroleum and natural gas recovery using nuclear “fracking” and the subsurface liquification of tar sands. Between December 1961 and May 1973, the United States detonated 35 nuclear devices as part of 27 separate Plowshare projects, at a cost of \$700 million.^{2,3}



Project Plowshare's underground nuclear tests were conducted in the Nevada Test Site north of Las Vegas. One 100-kiloton device was detonated 635 ft underground where it displaced 12 million tons of earth.

Photo courtesy of U.S. Dept. of Energy

None of the projects accomplished the intended results, and most released radiation into the atmosphere and the general environment. Those conducted to extract natural gas contaminated the released gas with radioactive tritium and strontium 90, an easily anticipated outcome. The poor judgement to use nuclear explosions as gigantic construction tools showed that some of the nation's most brilliant scientists were still capable of appalling judgement.

Heavily hyped, new nuclear power technologies have been promised to be the next big thing for the last forty years. But in spite of massive public subsidies, each new miracle application of nuclear fission technology has failed to deliver the intended result.

D. Nuclear Industry Scandals

Throughout the seven decades of the nuclear power industry, scandal has plagued the industry primarily because it has no chance of financially standing on its own feet. And that is all the

more true in an era where renewable energy has become the cheapest source of energy. Below is a small sample of some of the most recent scandals.

Two businessmen were indicted in 2023 in Kansas City, Kansas, for an alleged scheme to fraudulently steer and award subcontracts by a major engineering firm for work on nuclear weapons manufacturing projects for the National Nuclear Security Administration's Kansas City National Security Campus.²⁶⁶

It was called "likely the largest bribery money-laundering scheme ever perpetrated against the people of the state of Ohio." FirstEnergy bribed key Ohio state politicians with \$61 million and their allies to pass favorable legislation. The bill guaranteed a \$1.3 billion bailout to FirstEnergy in order to keep open its two failing Ohio nuclear power plants running, as well as struggling coal plants. House Speaker, Larry Householder, was sentenced to 20 years, with several others getting lesser sentences for 27 total felonies.²⁶⁷

At almost the exact same time as the Ohio scandal, Commonwealth Edison Co. agreed pay a \$200 million fine to settle federal charges for bribing the speaker of the Illinois House to pass legislation that would obligate that state's rate payers to bailout two of their nuclear plants.²⁶⁸

Four business executives were convicted on various charges for lying about the cost overruns and lack of progress in building two South Carolina nuclear reactors in 2017. It led to the collapse of South Carolina's public utility, SCANA, the bankruptcy of Westinghouse, and the defrauding of rate payers of billions of dollars.²⁶⁹

In Nov. 2025, the government of Ukraine announced that a criminal group was operating at nuclear utility Energoatom, and its members took kickbacks from contractors in the amount of 10-15% of the value of contracts. Eight people were charged with bribery, abuse of office, and illicit enrichment.²⁷⁰

A former Hanford nuclear site subcontractor and its owner will pay over \$1.1 million to resolve accusations they defrauded the federal government through a COVID pandemic loan program. In a lawsuit filed Nov. 2024, energy company, Avangrid, accused NextEra Energy, owners of the Seabrook nuclear power plant, of sabotaging the development of a transmission line meant to bring Canadian hydropower onto the New England grid.²⁷¹

In Sept. 2020, Bechtel Corporation, AECOM Energy & Construction, , and their subsidiary Waste Treatment Completion Company, agreed to pay \$58 million to the U.S. Department of Justice to resolve claims that Bechtel and AECOM fraudulently overcharged the U.S. Department of Energy (DOE) in connection with its operation of the Hanford Waste Treatment Plant project.²⁷²

Employees at Constellation Energy Group, owner of more nuclear plants in the country, were recently caught lying to the NRC about an accident at its Quad Cities plant that involved leaking 1,200 gallons of radioactive water.²⁷³ From 2007 to 2017 there were 35 reported leaks of radioactive water from the nuclear plants in Illinois.

Even after the Fukushima disaster in Japan, the operator of a nuclear plant in central Japan admitted its employees used “cherry-picked data” (read false) in simulated tests that were required to demonstrate whether it would be safe to restart the reactor in case of an earthquake.²⁷⁴

E. Current Nuclear Hype, Myths, and SMRs



Nuclear proponents claim nuclear is needed for base load electricity because the wind doesn't blow and the sun doesn't shine all the time. However, nuclear itself needs back up because power demand never exactly matches output, and nuclear power cannot be ramped up nearly as quickly as natural gas, hydropower, or batteries. Furthermore, if the nuclear reactor has to shut down, it still needs back up power to provide cooling, and diesel generators may not last long enough to

provide that, or they may be disabled by the cause of the accident itself as happened with the Fukushima disaster.

“SMRs,” (small modular reactors) are still nuclear reactors, and there are multiple new designs of SMRs. But they are nonetheless, still essentially conventional nuclear power plants, using, by and large, the same technology, wrapped up in a shiny new, smaller package, or “fun size.” The term “modular” in the context of SMRs refers to fabrication of major components of the nuclear steam component system in a factory and shipped to the point of use, in theory lowering the cost through economy of scale.

SMRs reactors could theoretically produce anywhere from 20 to 300 megawatts, compared to conventional reactors that produce 1,000 MW or more and are custom built. The variety of sizes could be used for applications beyond just adding to the grid, such as powering energy for AI data centers and cryptocurrency mining (both of which are of questionable, if not outright negative social value). They are even billed as being “mobile.”

SMRs cannot be assumed to be capable of providing reliable off-the-grid power for facilities such as data centers, bitcoin mining, hydrogen or petrochemical production. It is almost certain that any SMR design would need to be connected to the grid for reliable access to electricity to power all important vital safety systems like coolant pumps. Just like large nuclear plants, SMRs will be at risk from earthquakes (although perhaps less than larger reactors) and extreme weather events, either of which can trigger a loss of offsite power forcing them to shut down.

SMRs do not use fuel more efficiently than large reactors. Some SMR designs use a type of uranium called “high-assay low enriched uranium (HALEU),” which contains higher concentrations of uranium-235 than conventional light-water reactor fuel. This reduces the total mass of fuel within the reactor, but that doesn't mean it requires less original uranium to

produce, and does not mean there is less waste in the “front-end” of production, i.e. mining and milling activities. In fact, the opposite is more likely. SMRs could produce anywhere from 2 to 30 times more post reactor, high-level waste that needs to be isolated for hundreds of thousands of years, due to the use of neutron reflectors and/or of chemically reactive fuels and coolants in SMR designs.²³⁰ The authors said, “These findings stand in sharp contrast to the cost and waste reduction benefits that advocates have claimed for advanced nuclear technologies.”

A nuclear reactor produces energy when a neutron splits a uranium atom in the reactor core, generating additional neutrons that go on to split other uranium atoms, creating a chain reaction. But neutrons also escape from the core, called neutron leakage, and strike surrounding structural materials, like steel or concrete, which in turn become radioactive. Due merely to their smaller size, SMRs will experience more neutron leakage than conventional reactors per unit of electricity generated. This increased leakage affects the amount and composition of their waste streams.

SMRs are less efficient in use of nuclear fuel, and create more waste per unit of electricity generated. They complicate the problem of high levels waste even more than conventional reactors.

If these units are designed to be mobile, how will high level waste be handled? Every time a unit is moved will the high-level waste be moved as well, or will high level waste be left as a perpetual risk and hazard at sites that are abandoned?

There are many reasons to oppose nuclear power, or at best be skeptical of current claims. SMRs do not change the overall cost vs. benefit equation of nuclear power. The Director of Nuclear Power Safety for the Union of Concerned Scientists, Ed Lyman, lists five reasons⁴ to be skeptical of salesmen for all things nuclear. We address those five reasons and others.

3. Health Consequences of Radiation

A. Lies, Distortions, Cover-Ups, Political Spin, and Conflicts of Interest

The nuclear industry has left environmental and public health carnage wherever it has operated. Lies about radiation and its dangers started almost immediately after the bombings of Hiroshima and Nagasaki in 1945. Over 200,000 people died from the Hiroshima blast or the radiation. The US army’s official history states that based on their visits to Nagasaki less than 30 days after that city was destroyed by a plutonium nuclear bomb, "In all the areas examined, ground contamination with radioactive materials was found to be below the hazardous limits."⁵

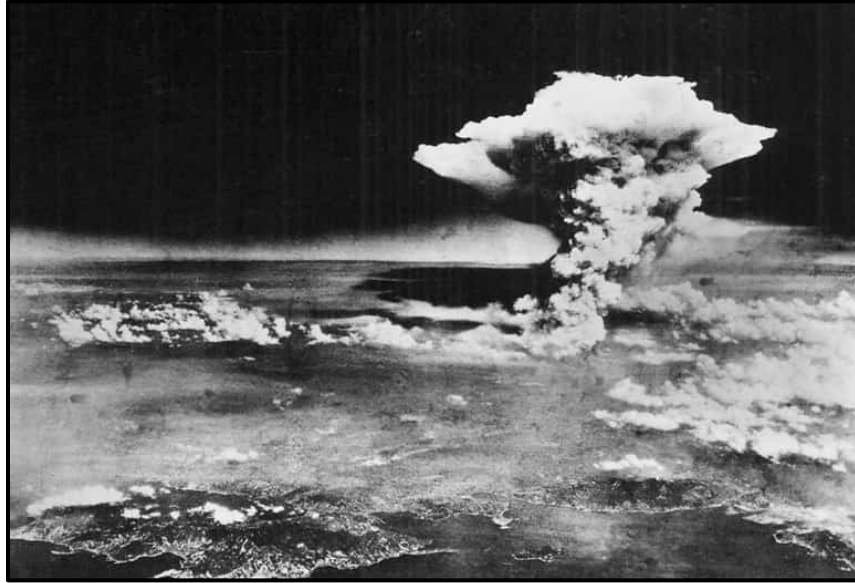


Photo of Hiroshima
Explosion Rare Historical Photos. "Hiroshima Before the After
Atomic Day." [https://rarehistoricalphotos.com/hiroshima-before-
after-atomic-day/](https://rarehistoricalphotos.com/hiroshima-before-after-atomic-day/)

Within two weeks after its inspection team began surveying the two Japanese cities, the War Department announced that scientists had determined that the residual radiation in Nagasaki did not merit concern. But within just a few weeks, some of approximately 1,000 marines who were deployed to Nagasaki started breaking out in the same kind of skin sores they had observed in the survivors. Years later they developed high rates of various chronic illnesses including cancers at unusually early ages.⁶

Maj. Gen. Leslie Groves, in charge of public communication for the military's nuclear weapons project, publicly claimed that Japanese reports of deaths from the radioactive effects of the atomic bombs were pure propaganda. Called to testify before Congress months later he acknowledged radiation was killing people, but said it was "a pleasant way to die."⁷

No one knows better than downwinder victims in Utah how US government agencies downplayed, often to the point of outright falsifying information about the risks of human caused radiation and about radiation releases by nuclear plants and weapons testing. For example, in 1957 the AEC issued this public announcement.

"You people who live near Nevada Test Site are in a very real sense active participants in the Nation's atomic test program. You have been close observers of tests which have contributed greatly to building the defenses of our country and of the free world. . . Every test detonation in Nevada is carefully evaluated as to your safety before it is included in a schedule. Every phase of the operation is likewise studied from the safety viewpoint. Nevada test fallout has not caused illness or injured the health of anyone living near the test site."⁸ This was 12 years after Nagasaki. They had known it wasn't true for years. Neither did they share the results of 1950 research which showed cows would eat grass on which highly radioactive I_{131} would have fallen, which would concentrate in the milk. Children who drank the milk would get large doses of

radiation going directly to their thyroids increasing the risk of cancer, poor brain development (especially if the exposure occurred prenatally), and other diseases.²⁶³

When 4,390 grazing Utah sheep died a few weeks after being downwind of a nuclear bomb test in Nevada in 1953 (including 1,420 lambing ewes and 2,970 stillborn or aborted lambs) many of them suffered otherwise inexplicable facial, ear, and mouth burns and most of the new lambs were born dead or with birth defects.⁹

Horses in the area showed up with white burns in their hides, the same burns that the original Manhattan project scientists had documented in nearby animals after the first “Trinity test.” AEC tests four years earlier had confirmed the damage to livestock and other animals from radiation.



Photograph of horses with beta burns resulting from the 1953 Upshot-Knothole nuclear test series.
| Utah Division of Archives and Record Service, series 11571
<https://www.pbssocal.org/shows/artbound/downwind-upshot-knothole>

Flock owners sold highly radioactive sheep carcasses for meat and wool to unsuspecting customers to recoup some of their losses. But the AEC never told the ranchers what had caused the hideous deaths and that their sheep, including the meat and wool, were radioactive.¹⁰ Nonetheless the government’s position was announced nine months later in this press release:

“On the basis of information now available, it is evident that radioactivity from atomic tests was not responsible for deaths and illness among sheep in areas adjacent to the Nevada Proving Grounds . The AEC findings, reached as the result of extensive research, was concurred by the U.S. Public Health Service and the Bureau of Animal Industry, U.S. Department of Agriculture. Prior to issuance by the AEC, the report was reviewed by the Department of Health, State of Utah.”

This statement defied the obvious and the evidence. Autopsies showed dramatically increased levels of radioactive I_{131} in the thyroids and bone marrow of the sheep. The AEC claimed that malnutrition and owner negligence had caused the mass die-offs.¹¹

When farm animals and wildlife in communities surrounding many of the nation's nuclear power plants showed unusually high rates of various radiation caused disorders, the AEC made similar unsubstantiated, far-fetched, and self-serving comments.¹²

St. George area infants and children who consumed fresh milk within days of a single 1953 atmospheric, "safe" atomic test received doses of Iodine₁₃₁ that were later determined to be as high as 150 to 750 times what was deemed annually permissible at the time. Dr. Joseph Lyon co-director of the Utah Cancer Registry estimated that Utah children suffered a 40% increase in the risk of leukemia from the Nevada tests, and that 15-20 Utah children died from leukemia caused by the atmospheric tests.¹³

In 1977, Dr. Ernest Sternglass charged that strontium 90 emissions from a nuclear plant in Connecticut were extraordinarily high, and would lead to an increase in local cancers. Soon after, the NRC eliminated the requirement for nuclear plants to collect strontium data, citing budget concerns.¹⁴

A recent study concluded that atmospheric testing occurring just from 1951 to 1958 in Nevada likely contributed to 186,500 overall deaths and 63,500 cancer deaths by 1971, and many more after that.¹⁵ An earlier study by Dr. Sternglass found indirect evidence that 375,000 infants had died due to nuclear fallout.¹⁶ As of 2024, 41,000 claimants had received compensation from the RECA Act,¹⁷ although that is obviously not necessarily the same as the number of cases that can be attributed to the radiation exposure.

Nuclear industry operatives in different countries have a mutual self interest in downplaying the health consequences of nuclear accidents and routinely released radiation as do the government of all countries that use nuclear power plants, a consortium often referred to as the "nuclear village." **In all three cases of the most notorious, high profile nuclear accidents in history, Three Mile Island, Chernobyl, and Fukushima, there is a consistent pattern of vast discrepancies between the number of deaths, cancers, and public health consequences acknowledged by respective government agencies and the nuclear industry, and what has been estimated by independent scientists.** These nuclear accidents are dealt with separately later in this report. In fact, the differences are so stark that it almost demands the conclusion that the "nuclear village" is engaged in an ongoing attempt to sanitize the consequences of radiation exposure from all sources; weapons, power plants, accidents, waste storage, and even medical use.

The World Health Organization (WHO), in many respects a highly credible organization, has been accused of subordinating itself to the International Atomic Energy Agency (IAEA) whose statutory purpose is to promote nuclear energy. To that end, in 1959, the WHO signed an agreement with the IAEA, giving the latter veto power over anything that the WHO issues regarding public pronouncements on human health and ionizing radiation, essentially neutering their ability and willingness to challenge the narrative of the "nuclear village."¹⁸

The United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) portrays itself as body of scientific experts, but as their acronym implies, they have a strong bias

of protecting the nuclear industry from “scary” criticism. They dismissed concern over the Chernobyl disaster by pronouncing that it only “added 2% to natural background radiation.”¹⁹

That statement is highly disingenuous, discounting five critical points.

1. Radiation and therefore the health impact was obviously not evenly distributed throughout the globe.
2. Nonetheless, even a small increase in global background radiation will have massive global health consequences. A small increase in risk for billions of people will create millions of victims.
3. Radioactive particles can biomagnify up the food chain just like mercury and other heavy metals, such that the food supply can pose orders of magnitude greater risk than radioactivity in the atmosphere. They can further bioaccumulate within individual organisms, concentrating in critical organs, leading to organ failure or cancer.
4. Background radiation, minus human caused radioactivity, does not normally contain the most dangerous type of radiation, internal radiation from alpha particles and beta particles, which were certainly present in high concentrations from Chernobyl.
5. With nuclear explosions we can establish the exact time and date they occurred, but you can never say when the consequences will end, if ever, given that transgenerational harm is well known.

B. Limitations of Current Research

Research on the hazards of radioactivity falls into a no man’s land. Non-nuclear entities believe the nuclear industry should fund health risk research, yet the nuclear industry doesn't want to fund research when they assume accidents are too rare to worry about, and they would be risking their own future with adverse findings. Better that we all remain ignorant.²⁰

The most widely cited study on the health effects of nuclear radiation is the longitudinal *Life Span Study* of the survivors of the Hiroshima and Nagasaki atomic bombings.²¹

But there are serious limitations in extrapolating from this study to other circumstances, like nuclear power plants.

1. Study didn’t begin until five years after the bombings and didn’t involve any of the fatalities that occurred in that population before 1950, i.e. five years later.
2. By virtue of that, it self-selected a population that was more resistant to radiation for whatever reason.
3. It only intended to assess the harm of external radiation, not internal radiation.

4. Impacts to pregnancies in 1945 or to subsequent generations were not studied.
5. The basic premise that radiation exposure is a consistent, universal, interchangeable, indiscriminate event is seriously flawed.

Many studies and claims that minimize the public health consequences of radiation, fail to consider the population most susceptible to radiation damage, i.e. those at the earliest stages of human development, i.e. embryos, fetuses, newborns, and infants. The increased risk is secondary to increased doses relative to small body weight, immature immune system, under-developed liver, and rapidly dividing cells being more vulnerable to damage.²² The clinical manifestations include spontaneous abortion, premature birth, low birth weight, stillbirth, infant death, congenital malformation, underactive thyroid gland function in newborns, and brain damage—all within weeks or months after the event given that the exposure can often happen through food and water ingestion weeks or months afterwards.

Most of the studies on the health impact of ionizing radiation have focused only on cancer risk. But that tunnel vision was never warranted and is not now. The integrity of genes and the expression of genes, play a central role in maintaining physiological homeostasis, overall human health and defense against virtually every disease. Anything that impairs genetic function will have wide spread health consequences. Radiation can cause chromosomal “instability,” not sufficient to cause the mutations that lead to cancer, but to other poor health outcomes.²³

The “nuclear village” would like the public to believe that physics alone explains the risks of radiation, that exposure to all types of radiation is equivalent and the health risks are based solely on the amount of excess radiation energy that human body is subjected to. But physics is only half of the equation. In “health physics” the mathematical modeling treats the human body as a single bag of water, which is inappropriately simplistic. Health Physics as a discipline was created essentially by physicists, not physicians.

Cancer usually starts in a single cell whose function has been disrupted, whose DNA has been damaged (usually a double strand break), and unrepaired or inadequately repaired. It is at the level of the cell where radiation effects become significant, not over large masses of tissue.

Physics alone does not explain or quantify human disease. A physics explanation of radiotoxicity focuses on the amount of energy transfer of radioisotopes. But the disease potential of ionizing radiation cannot be accurately modeled by simply dividing the quantity of energy by the mass into which it is deposited. In fact, energy transfer can be totally useless as a measure of biological harm. For example, a dose of 400 rads to the entire body in terms of “thermal energy”



is about the same as a hot cup of coffee, only enough to raise a person's temperature about 0.001 degree C. But delivered acutely that is enough radiation to kill 50% of people.^{259,260}

What is being ignored by focusing only on physics is biology, and with biology there are far more unknowns, and it is a discipline much less amenable to being quantified by mathematical equations.

There are vast differences in the defense capability and disease vulnerability of the human body depending on what kind of tissues and organs are being exposed to radiation, the route of exposure, and where the radiation is concentrating. Established radiation limits address what an entire body may be subjected to, but that's not the most important consideration. The most important consideration is; are there clusters of cells in certain critical organs where that radiation is being concentrated?

Cancer usually starts in a single cell whose function has been disrupted, whose DNA has been damaged (usually a double strand break), and unrepaired or inadequately repaired. It is at the level of the cell where radiation effects become significant, not over large masses of tissue. Put another way, the amount of radiation distributed evenly over the entire body does not have the same health implication as the same amount of radiation concentrated in the thyroid gland.

Carcinogenic changes in cells usually do not occur immediately after irradiation. Instead, surviving cells likely have acquired an instability of their DNA which causes an increased rate of mutations in future generations of the cell's multiplication.

The adult male model or "reference man" used for research and regulations is grossly inadequate to assess radiation risks to the broader population.²⁴ "Reference man" is defined as being between 20–30 years of age, weighing 70 kg, is 170 cm in height, and lives in a climate with an average temperature of from 10°C to 20°C. "Reference man" is defined as caucasian and is a Western European or North American in habitat and custom. Obviously using reference man as a basis for evaluating radiation harm will lead to serious flaws in protecting anyone who is much different, either through age, biological sex, body habitus, and even race.

The most extreme flaws in this model are its dismissal of the critical relevance of the biological lifecycles of humans when radiation exposure occurs. Exposure at any stage of life has the potential to harm all subsequent stages, so exposure at the earliest stages of life deserve special consideration and protection. However, early life stage exposure is still ignored in regulation and most research in favor of focusing on "reference man."

Exposure at any stage of life has the potential to harm all subsequent stages, so exposure at the earliest stages of life deserve special consideration and protection. However, early life stage exposure is still ignored in regulation and most research

Children are much more sensitive to radiation for multiple reasons beyond body size. Children are less well protected from external radiation. All their cells are dividing more quickly, therefore more susceptible to DNA damage. Their immune systems and DNA repair mechanisms are less mature. Their skulls are thinner and their brains smaller, decreasing protection and impacting a larger percentage of their brains when exposed to external radiation. Internal radiation can also damage a larger portion of an infant's smaller organs. Children have a longer remaining life span than adults, allowing for more time for diseases like cancer to develop.^{25,26}

Like many other toxic agents, it is not the amount of radiation distributed throughout the environment that is so serious, it is the timing of exposure, the selective concentration in the food chain and ultimately in specific organs of the developing embryo that accounts for the most damage to society from its toxicity. To the same extent radiation harms the development of the human embryo, it harms all of mankind, now and in the future. All nuclear plants are potential global disasters that threaten the future of mankind and every living thing.

The toxicity from these heavy radioactive elements is both chemical and radioactive.²⁷ For example, uranium is a heavy metal, and irrespective of its radioactivity it is toxic like mercury or lead. Chemical toxicity occurs on a more acute time frame than radiotoxicity. The permissible levels of soluble uranium compounds are based on its chemical toxicity, and for insoluble uranium compounds on its radiotoxicity. Its primary chemical toxicity is related to damage of the kidneys, lungs, and central nervous system, which may not be reversible.²⁷⁶

C. No safe level of radiation—focus on cancer

“Each added amount of radiation causes damage to the health of human beings all over the world and causes damage to the pool of human germ plasm such as to lead to an increase in the number of seriously defective children that will be born in future generations...The entire nuclear power program was based on a fraud--namely that there was a 'safe' amount of radiation, a permissible dose that wouldn't hurt anybody.” --- Dr. John Gofman, one of the original Manhattan Project scientists and one of the nation's top health researchers

Ionizing radiation is defined as radiation that has enough energy to displace electrons from molecules. Free electrons, in turn, can damage virtually all types of human and animal cells. Radiation-induced mutations would be expected to occur with exposure to the reproductive cells of the human body (sperm and eggs), resulting in heritable disease.²⁸

The Federal Radiation Council published a 1962 report²⁹ that concluded “any radiation is potentially harmful...it is virtually certain that genetic effects can be produced by even the lowest doses.” It can take years for radiation damage to manifest pathology. That there is no safe level of radiation exposure was established again by the National Academy of Sciences. (BEIR

Report VII, National Academy of Sciences).³⁰ That implies that man-made exposures that are not consented to are *de facto* unethical.

Radiation damage is cumulative and each successive dose builds upon the cellular damage and disease potential of previous exposures. Any exposure to radiation increases the risk of damage to key biologic infrastructure--tissues, cells, DNA and other subcellular structures, with the capability of causing genetic mutations, cancers, leukemias, birth defects, and reproductive, cardiovascular, endocrine, and immune system disorders. Across all age groups the most rapidly dividing cells are those most at risk for damage.

A meta-analysis of over 46 scientific studies examining plants, animals and humans for effects on immunology, physiology, DNA mutations and disease occurrence, demonstrated that even the smallest measurable amounts of background radiation have statistically proven adverse health consequences.³¹

Furthermore, various analytical and statistical techniques seeking to minimize the risk by averaging effects over large areas and populations obscure the effects that exposures can have on susceptible individuals, and concentrations of radioactive isotopes in certain environments, in the food web, and within specific organs of humans and animals.

Study of the survivors of the Nagasaki and Hiroshima nuclear bombs are still the basis for most traditional conclusions about radiation dose and health outcomes, but have been and still are, grossly inadequate to do that and for multiple reasons. *Science* magazine wrote "Some of the most important data on the effects of nuclear radiation on humans may be wrong." The amount of neutron radiation delivered by the bombs had been grossly overestimated, perhaps by a factor of ten. Thus the people of Hiroshima and Nagasaki may have suffered cancer and other radiation side effects from doses far smaller than previously believed.³²

Epidemiological studies show increased risk of various cancers for people living near nuclear plants. Workers at the plants are also at increased risk for cancer. Studying 175 nuclear plants in 17 countries, researchers found residents living near nuclear plants have a higher risk of all types of cancer, especially for children under 5 years old.^{33,34} This is supported by numerous other studies.^{35,36,37,38,39,40,41,42,43,44,45,46}

For example, in Massachusetts there is an increased risk of cancer inversely proportional to the distance of a residence from a nuclear power plant. At a distance of 2 km from such a plant, the increased risk varied from 52% to 253% depending on the sex and age of the residents.⁴⁷

Routine operation of nuclear power plants release radiation into the local and broader environment. It is no surprise the numerous studies have documented increased rates of cancer in communities within a few miles of nuclear plants.

In a report to Congress the National Cancer Institute reported that perhaps 10,000 to 75,000 thyroid cancers could have resulted, particularly among children drinking contaminated milk in

the Mountain states closest to the Nevada nuclear testing site. But the NCI study only considered radioactive Iodine and not the other fission byproducts like strontium and cesium, nor did they consider the nuclear tests outside the US.⁴⁸

D. Obscuring the increased danger of internal radiation

"The best way of deceiving all of you about the effects of radiation is to talk about the effects of one kind of radiation when you're measuring the other."⁴⁹

Dr. Edward Martell,
fall out specialist for the Air Force and AEC,
scientist at the National Center for Atmospheric Research
(referring to a concerted effort to obscure
the extra danger of internal radiation)

1. Difference between Internal and External Radiation

Consider this thought process. If ten bullets are fired into a crowd of 50,000 people, does it make sense to predict the outcome based on the amount of energy carried by those bullets averaged over all 50,000 people? With that methodology you would conclude there was no harmful consequence. Obviously, the appropriate methodology is to examine the ten people who were hit, and what body parts were penetrated. Equating the consequences of internal radiation (bullets) on the basis of energy transfer without considering the size of the target, or the role that a particular target organ plays in overall health, can yield very misleading conclusions.

At high doses the difference between external and internal radiation become blurred. But at low doses, internal radiation and external radiation exposures are vastly different entities, and research on external radiation cannot be accurately used to predict the effects of internal radiation. Low-level, internal radiation from the ingestion of man-made fission products, like alpha and beta particles, was essentially non-existent prior to 1945. Internal radiation may have genetic impacts that external radiation does not, and internal radiation can be two orders of magnitude more biologically damaging than external radiation.⁵⁰

All sources of radiation create an external radiation field. External radiation refers to situations where the body is exposed to a penetrating radiation field that may pass through the entire body or parts of the body. Examples are gamma rays and x-rays. Exposure ends when the source ends.

Internal radiation refers to exposure to radioactive material (gases, liquids, or solids) that can enter the body and can stay for variable lengths of time. The material can be incorporated into the body itself, causing on going radiation of cells, tissues, and organs, ending only when the body excretes it. Usually, radioactive substances are distributed within the body based on the chemical properties of the isotope.

For example, radioactive Iodine (I_{131}) will concentrate in the thyroid gland, radioactive cesium (C_{137}) will mimic potassium and concentrate in soft tissues like muscle and all bodily fluids, and strontium (S_{90}) will concentrate in bones and teeth because it mimics calcium. Through bioconcentration (direct exposure to an environmental contaminant such as through air or water, can be expressed as a ratio of the concentration in an organism compared to the environment), or biomagnification (concentration of a contaminant in an organism via dietary exposure to that contaminant as it moves up the food chain), the internal exposure from these radioactive particles is increased in critical areas and can be prolonged for decades. Most radiation induced cancers are caused by internal radiation that reaches the organs that where the different radioactive isotopes concentrate. For example, radon most commonly causes lung cancer because it enters the body throughout inhalation. Radioactive iodine causes thyroid cancer, strontium will more likely cause bone cancer or leukemia because of its damage to bone

Large unstable atoms become more stable over time by emitting radiation to get rid of excess atomic energy (radioactivity). This radiation can be emitted in the form of positively charged alpha particles, negatively charged beta particles, gamma rays, or x-rays. Through this process — called radioactive decay — radioisotopes lose their radioactivity over time. This gradual loss of radioactivity is measured in half-lives. A half-life of a radioactive material is the time it takes one-half of the atoms of a radioisotope to decay by emitting radiation.

All types of radioisotopes can be harmful if inhaled or ingested.

There are two types of internal radiation, beta particles (high speed electrons or positrons emitted by radioactive decay), and alpha particles (two neutrons and two protons bound tightly together). Important characteristics of both are:

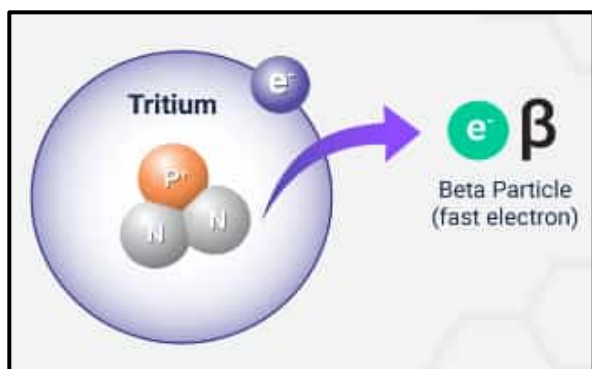
Alpha particles are much larger and heavier than beta particles, and cannot penetrate thin layers of skin or a piece of paper. But they can penetrate more sensitive tissues like the cornea, nasal mucosa, lining of the respiratory or GI tract where they are far more dangerous. Think of them as bowling balls. Common alpha particle emitters are uranium, plutonium, thorium, radium, and radon.

Beta particles have a small mass, (about $1/2,000^{\text{th}}$ of a proton) but are released with high speed. They can penetrate paper and skin, but are stopped by thicker tissues and common material like wood. But they can penetrate more sensitive tissues easily. Although they are not as damaging as alpha particles, they can still cause cancer.

Think of them as bullets. Common beta emitters are strontium, cesium, and tritium.

Neutrons are high-speed nuclear particles that have an exceptional ability to penetrate other materials. Neutrons are the only particles that can make target objects, such as the containment structure of a nuclear power plant, radioactive. Think of them as cannon balls.

Generally, the shorter the half-life of a radioactive substance the more radioactive it is, meaning the more disintegrations over a specified time.



marrow, and cesium₁₃₇ is more likely to cause soft tissue cancers and pancreatic cancer, and contribute to diabetes, and pancreatitis,⁵¹

2. Beta particles and the special problem of tritium

Tritium is the most prevalent radioactive isotope routinely emitted from nuclear plants. Tritium is

often incorrectly dismissed as “weakly radioactive” despite being a potent beta emitter. Its half-life is 12.3 years, long enough to cause internal damage, and short enough to be highly radioactive. It is about 150,000 times more radioactive (disintegrations per unit time) than plutonium 239. One gram (the weight of about one-fifth of a teaspoon of water) of tritium as tritiated water (HTO) will contaminate almost 500 billion liters of water up to the U.S. drinking water limit of 20,000 picocuries per liter. Remediation of tritium contaminated water is essentially impossible.

The amount of damage to the human population can be vastly different if the radio isotope can cross the placenta or not, something that has not been part of any regulatory consideration. Harm to the fetus is where ultimately the greatest impact on public health is found with virtually all environmental contaminants, including radioactive metals, and this is particularly true of Tritium. No environmental toxin that crosses the placenta can be considered “weak” because of the ability to irreversibly interfere with fetal organ formation with life-long consequences.

Units of Radioactivity		
Topic	Becquerel (Bq) International or SI unit	Curie (Ci) U.S. unit
How the unit is derived	Radioactivity represents the rate of <u>radioactive decay</u> . One becquerel (Bq) is equal to one radioactive decay per second.	One curie (Ci) is the approximate number of radioactive decays in one gram of radium per second - approximately 3.7×10^{10} decays per second.
Conversions	1 becquerel (Bq) = 2.703×10^{-11} curie (Ci)	1 curie (Ci) = 3.7×10^{10} becquerel (Bq)
Common Metric Prefixes	1 gigabecquerel (GBq) = 1,000,000,000 Bq 1 megabecquerel (MBq) = 1,000,000 Bq 1 kilobecquerel (kBq) = 1,000 Bq	1 millicurie (mCi) = 0.001 Ci 1 microcurie (μ ci) = 0.000 001 Ci 1 picocurie (pCi) = 0.000 000 000 001 Ci

Because it mimics water, tritium spreads and dissipates as easily as water, and easily passes through the placenta and concentrates in the fetus. The ratio of tritium in the fetus compared to the mother is 1.6. Tritium can also be integrated into organic molecules and hence into body tissues such as during fetal development. Tritium is particularly damaging to mitochondrial DNA, critical to cell energy production.

If the fetus is female then her eggs are also developing in utero proving that up to three generations can be harmed by

one exposure. Radionuclides with longer half-lives can similarly impact the fetus with pre-conception exposure of the mother. Radionuclides can also harm unexposed generations so via being incorporated in sperm and spermatocytes.

The nervous system is especially vulnerable to tritium and beta particles during fetal development.⁵²

Beta particles have an average energy of 5,700 electron-volts. A typical chemical bond in a biological molecule is bound by only few electron-volts. A single beta particle could cause about 1,500 ionizations of water molecules, which are the primary component of the cytoplasm of the average human cell.^{53,54}

Routine emissions of tritium from reactors in recent years are mainly from spent fuel pools.⁵⁵ Some pool water evaporates (since the spent fuel is hot, so is the pool water) and is emitted into the atmosphere; like other moisture in the air. Since the end of nuclear weapons testing, nuclear power reactors (including spent fuel pools) and discharges from reprocessing plants have become the main sources of new, routine tritium contamination of the atmosphere and discharges to surface water. The releases from one power plant reactor to another can vary by orders of magnitude. Tritium emissions to the air from nuclear plants generally affect the radioactivity in rain and snow in the general vicinity of the plant, and the tritium content of local water bodies.

Tritium releases are increasing in the last few decades due to higher fuel loads, requiring more boron in the spent fuel pools to capture neutrons.⁵⁶

Most nuclear power plants in the United States have had tritium leaks at levels exceeding the drinking water limit of 20,000 picocuries/L. According to the NRC, reactors also routinely discharge tritium directly into water bodies – rivers, lakes, and oceans. Soil can become contaminated due to the contamination of rainfall and leaks from the reactor and its extensive underground piping system. Plants can absorb tritium from the moisture in the air, from the water, and the soil. The issue of radioactive food and water is being almost universally ignored, especially regarding the developing fetus. There is no independent way for communities near nuclear plants to verify the accuracy of the discharges measurements and release estimates.

Tritiated water is rapidly incorporated into all parts of the human body through drinking water, food, or absorption through the skin. Ingested tritium oxide is also almost completely absorbed, moving easily from gastrointestinal organs to the bloodstream, and the skin can also absorb tritium, in particular from tritiated water vapor. Regardless of the route of intake, tritium is distributed uniformly throughout the body within two hours.⁵⁷

The cytoplasm occupies most of the volume of the cell and consists primarily of water which can be ionized by tritium's beta particles. Once tritium crosses a cell membrane, it's excess energy will usually be deposited entirely within that cell leaving extensive damage.⁵⁸ Beta particles from tritium or any other beta emitter, "ionize" molecules, including water, creating hydroxyl radicals (OH), the most reactive of Reactive Oxygen Species (ROSs). Tritium can then act as essentially a Trojan horse causing damage and destruction to the cell from the inside.⁵⁹



Other environmental toxins also promote excessive ROS production in cells, which means that things like smoking cigarettes, breathing community air pollution, and exposure to other environmental contaminants only add to the damage from radiation exposure.

While the transgenerational impact of radiation to nuclear DNA is controversial, what is less controversial, but often ignored, is the impact of radiation on Mitochondrial DNA (MtDNA). MtDNA, inherited only from the mother, is responsible for a cell's ability to convert energy from food into the useable form, ATP. MtDNA resides outside the nucleus, scattered throughout the cytoplasm. **For a variety of reasons MtDNA is about ten times more sensitive to damage from ionizing radiation than nuclear DNA.⁶⁰ It may represent the radiation target of greatest concern.** The incorporation of tritium into the molecules of long-lived cells (e.g., neurons and oocytes) results in significant, persistent doses over the lifetime of the cells.⁶¹

Radionuclides in the mother can reach a fetus via the fluids exchanged between the two. Some of them, like tritium concentrate in the fetus compared to the mother (as noted above) which makes the impact on overall public health even greater.⁶²

Impaired mitochondrial function is a hallmark of aging and is involved in many different disease states, including neurodegenerative diseases, diabetes, cancer, and autoimmune disorders. Damage to mtDNA can have profound systemic impacts on health, far beyond cancer.

Mitochondria are the core of the energy system of all multicellular animals, plants and fungi. Thus ecological toxins, including radioactive materials, that cause mtDNA mutations create risks that can reverberate throughout entire biological world.

Children are not only more sensitive to radiation, but because their activity is closer to the ground, have much more hand to mouth activity, and require more food and water, they are 3-5 times more exposed to internal radiation compared to an adult.

Because tritium is essentially radioactive hydrogen, making water radioactive, it is virtually impossible to filter out of municipal water systems. It can gain access to the body easily through food, water, and skin absorption, and can travel anywhere in the body, easily crosses the placenta and contaminates the developing embryo or fetus. Tritium and radioactive zinc-65 are unique among radioactive isotopes in that they concentrate on the fetal side of fetal/maternal interface such that levels in the fetus are greater than maternal levels.

Harm to the fetus is where ultimately the greatest impact on public health is found with virtually all environmental contaminants, including radioactive metals, and this is particularly true of Tritium. No environmental toxin that crosses the placenta can be considered “weak” because of the ability to irreversibly interfere with fetal organ formation with life-long consequences.

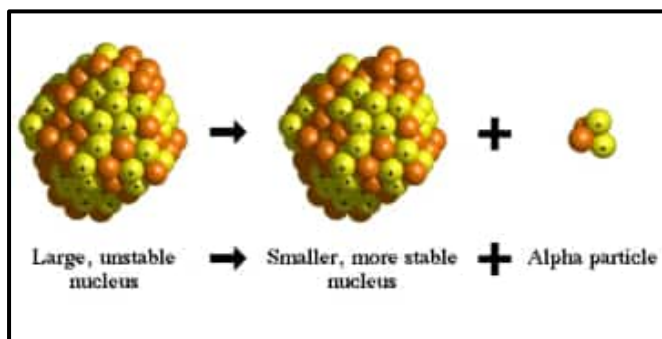
That there are intergenerational effects is clearly indicated by the proven transfer of radionuclides to the fetus. If the fetus is female then her eggs are also developing in utero, proving that up to three generations can be harmed by one exposure. Radionuclides with longer half-lives can similarly impact the fetus by pre-conception exposure of the mother.

3. Alpha Particles

Because alpha particles are heavier than other particles they can do more damage than lighter particles, causing genetic mutations and cancers and other diseases of the gastrointestinal tract, lung, liver, bone, and blood.

For a given dose of radiation, alpha particles have far more energy than beta particles, and they deposit much more energy per unit of distance, “Linear Energy Transfer,” than beta particles and x-rays. They cause multiple

ionizations and free radical formations within a small area. They have been described as the most powerful force in the universe.



Four alpha particles are emitted from every radon atom that is inhaled in our respiratory tract. As alpha particles pass through lung cells they cause significant DNA damage of multiple types in a small cluster of cells. Although cells are normally reasonably adept at repairing DNA damage, alpha particle damage is more severe (double strand breaks) than more common DNA damage, such as from x-rays, and much more difficult to repair. This means there is no safe amount of alpha particle exposure. There is no dose of alpha particle radiation that does not cause DNA damage.⁶³

One millionth of a gram of Depleted Uranium (DU) can be fatal. A depleted uranium particle of this dimension is estimated to consist of 210 billion atoms of the uranium isotope U238. Such a particle yields 1,000 alpha particles per day. Each alpha particle emits 4-9 MeV (million

electron volts). It only takes 6-10 electron volts to break a DNA strand. By this calculation it is easy to see how it could take merely one millionth of a gram of plutonium, uranium, or DU to cause a fatal cancer, something warned about by Manhattan scientist, nuclear physicist, chairman of the National Defense Research Committee (NDRC), and later President of Harvard U., James Bryant Conant.⁶⁴

4. Regulations and research: conflicts of interest, political interference

It's important to know the limitations of available radiation research. The Energy Department is the main source of funding for radiation health research, which is much like having the tobacco industry be responsible for the research on the hazards of tobacco smoking.

The Nuclear Regulatory Commission (NRC) was created by Congress in 1974 to be an independent agency to supervise and ensure the safety of civilian use of radioactive materials, nuclear reactors, and waste storage. The fact that no more than 3 of the 5 seats can be of the same political party speaks to the fact that concerns about political influence entered into its original formation. Nonetheless it has a long history of being manipulated by politics and the nuclear village.

For example, Dr. Gregory Jaczko was appointed chairman of the NRC by Pres. Obama in May 2009. He resigned in 2012 under pressure from Congressional Republicans because he was pursuing tighter safety regulations.

The Trump Administration has hollowed out the NRC and made the entire nuclear industry much more of a threat to public health and safety, and a clear financial conflict of interest for the President. Elon Musk's DOGE purge of government agencies included the firing of 100 NRC staff. In May 2025, Trump tightened control over the NRC, eroding the independent oversight of the nuclear industry. He issued an executive order gutting radiation standards and required that the NRC must send new rules regarding reactor safety to be approved by the Trump White House. The move should be terrifying to anyone aware of the danger of nuclear reactors.⁶⁵ In June Trump fired the chairman of the NRC, Christopher T. Hanson. The first time any president has ever fired an NRC Commissioner. Not only is there obviously no nuclear expertise in the White House, but Trump has demonstrated repeatedly a shocking ignorance of anything related to science and a disdain for any kind of environmental protection or control of pollution or toxins.

This is a radical departure from the independence the NRC has been granted under previous administrations. Previously, the NRC's five commissioners would vote on draft rules and final rules for nuclear reactors. Their votes would be publicly recorded as would the reasoning for their decision. But now, the commissioners will carry out their votes in a closed session and pass the rule to the White House Office of Information and Regulatory Affairs, which sits within the Office of Management and Budget. This executive order is intended to speed the licensing of new reactors like SMRs, and it is a clear sacrifice of nuclear expertise for a political agenda of promoting the nuclear industry.

Moreover Trump has created a corrupt, clear conflict of interest in decisions made by the NRC and federal policy in general. His Truth Social media company has recently merged with TAE Technologies, that is trying to develop nuclear fusion for power plants.²⁸² The merger must be approved by federal regulators, some of whom were appointed by Trump. Many nuclear experts note that the problems with nuclear fusion are insurmountable, rendering it incapable of being cost effective or safe.

The Trump Administration has hollowed out the NRC and made the entire nuclear industry much more of a threat to public health and safety, and a clear financial conflict of interest for the President.

5. Radiation and Cardiovascular Disease

The association between circulatory disease mortality and low and moderate doses of ionizing radiation is even stronger than the association with cancer. Overall radiation-related mortality is about twice what can be explained just by estimates for cancer.⁶⁶ Nuclear plant workers also carry the burden of a higher risk of cardiovascular disease.⁶⁷ As with cancer, women have a greater risk of cardiovascular disease on exposure to radiation.⁶⁸

6. Radiation and neurologic outcomes

Of children born to mothers who survived the WWII bombings in Hiroshima and Nagasaki, 45% showed intellectual disability.⁶⁹ Numerous studies have shown a negative impact of small increases in fetal radiation exposure and intellectual capability.^{70,71,72}

The Teratology Society says the brain is vulnerable to any teratogenic exposure throughout the pregnancy and early post-natal period. The type of birth defect will depend on the stage of the pregnancy during the exposure.

There is no threshold for “severe mental retardation” caused by radiation exposure between the 8th and 25th week of pregnancy. A linear no-threshold for impact means that exposures during this period would be expected to produce the severe disabilities.^{73,74} Children exposed to the radiation from the Chernobyl accident manifested higher incidences of cognitive impairment, dementia, and depression.²⁵³

There is remarkable, compelling evidence radiation from the Nevada nuclear weapons testing had a significant negative impact on the intellectual capability of Utah’s children. There was a slow, slight decline in SAT scores of high school students nationally beginning in 1963, 18 years after atomic weapons testing started releasing radiation into the US atmosphere when high school seniors were born. But in 1975, the largest drop in verbal SAT scores occurred, 18 years after the largest amount of radioactive fall-out ever measured descended on the US (303 kilotons) in 1957. Birth defects and infant mortality were also extraordinarily high in 1957.

Scores for children in western states dropped 19 points, the average drop nationally was 13 points. But by far the largest drop in SAT scores occurred in Utah, 26 points, where the largest amount of radiation fell 18 years before. The decline decreased proportional to the distance from Utah. Scores dropped only 2 points in Ohio. Then in 1976 scores started to rise again. Eighteen years earlier, only 18 kilotons were released. Another drop in scores occurred in 1978-79, 18 years after 1960, when another large release occurred, and again Utah had the highest drop, 11 points. Utah had the highest radioactive iodine levels in milk.

Among American students born in 1952-53, 189,300 US students scored above 600 in the verbal SAT. But for the birth years 1957-58, only 110,300 students scored above 600, a drop of 42%. In 1967-68 33,200 scored above 700. In 1975, 18 years later, only 14,800 scored above 700.⁷⁵

7. Impact on Reproduction

Geneticist Hermann Muller, founder of the American Society of Human Genetics, and recipient of the 1946 Nobel Prize for discovering that genetic mutations and chromosomal rearrangements were caused by x-rays, wrote a report in 1964, *Radiation and Heredity*, predicting the gradual reduction of the survival ability of the human species as the exposure to ionizing radiation increased.

The testes are highly sensitive to radiation because cells that produce sperm cells, spermatogonia, are rapidly dividing and thus vulnerable to DNA damage. Radiation can kill these cells or cause mutations that reduce their ability to mature into healthy sperm. Indeed, sperm counts have dropped over 50% worldwide in the last several decades,⁷⁶ and numerous and varied environmental toxins are likely one reason. It is not yet clear how radiation may contribute to that decline.⁷⁷

Radiation has been found to have multiple types of impacts on reproduction. Reproductive cells (gametes) are present at all stages of the human lifecycle. Therefore, radiation exposure at any time during the life cycle has the potential to harm reproductive cells, and therefore subsequent generations. For example, radiation slightly decreases the number of girl babies born most likely because chromosomes in sperm are less well insulated than those in eggs, and the X chromosome in sperm is a much bigger, and therefore easier target than the Y chromosome.⁷⁸ The authors of the study that verified this after Chernobyl stated, “Our results contribute to disproving the established and prevailing belief that radiation-induced hereditary effects have yet to be detected in human populations. We find strong evidence of an enhanced impairment of humankind’s genetic pool by artificial ionizing radiation.”

Radiation can cause early failed pregnancies which are hard to detect because women may not realize they are pregnant during the early phase. Similarly, it reduces fecundability and therefore fertility. It can produce a variety of teratogenic effects, especially during the most sensitive period of organogenesis.

8. Genotoxicity of radiation

Radiation can cause damage and mutations to DNA some of which can be repairable and but not others. These effects may not become manifest for many years after exposure. For example, some survivors of the nuclear bombings of Japan are still dying from the damaged DNA many decades after, from cancer and other diseases.⁷⁹ Strontium is particularly damaging to DNA because it is chemically similar to phosphorus. In DNA, each phosphate group confers a strong negative charge shaping its structure. They connect to two sugar molecules via covalent bonds creating the rigidity needed for the double helix. This bond also protects the genetic code from degradation.

That there can be multi-generational harm from radiation is established by the proven transfer of radionuclides from the mother to the fetus, and the detrimental health outcome can be manifest at any point during the lifecycle of the exposed individual's offspring.^{80,81,284} However, it is difficult to attribute causality to the radiation for specific health consequences, because it may also be caused by other toxic exposures.

Children who were exposed to Chernobyl radiation, in utero or after birth, or born to irradiated fathers, or parents environmentally exposed, show increased genetic damage and instability.^{251,252} According to Chernobyl Children International, in the Ukraine fall out zone, 6,000 children are born annually with genetic heart defects. There has been a 250% increase in congenital birth deformities in children born in the Chernobyl fallout area since 1986. In Belarus, 85% of children are deemed to be Chernobyl victims with genetic changes. There has been a 38% increase in malignant tumors, a 43% increase in hematologic illnesses, and a 63% increase in musculoskeletal disorders.²⁵⁴

Many Chernobyl "liquidators" (clean-up workers exposed in the weeks, months and years after the accident, 97%t were men) received high doses of radiation. Children they conceived after the accident compared to their own siblings conceived before the accident demonstrated a 700% increase in DNA damage.²⁵⁸

Many of the diseases caused by radiation were found in the children and grandchildren of those exposed, i.e. soldiers, uranium miners, workers at uranium mills, radium factories, Manhattan Project, Nevada Testing Range, and nuclear submarines. Most DNA mutations are recessive, which means the large majority of genetic damage does not become manifest until several generations after the original exposure.

Female bodies are more susceptible to biologic harm from ionizing radiation, especially young females. Of the atomic bomb survivors in Japan, girls aged 0-5 had twice the rate of developing cancer than boys of same age over the next 60 years.^{82,83,84,85,86,87} While it is not known why females experience more damage, there is some evidence that it is secondary more reproductive tissue with females.^{88,89,90,91,92} Radiation causes cancer, heart disease, and strokes more often in women.⁹³

Dr. Ramiro Garzon, Professor of Medicine and Chief of Hematology and Hematological Malignancies at the U. of Utah and Huntsman Cancer Institute, said in a private conversation

with the author that based on known radiation patterns of the atmospheric nuclear weapons tests in Nevada, and the distribution of the fatal diseases Amyotrophic Lateral Sclerosis and pulmonary fibrosis, those two diseases also have a connection to radiation exposure.

Toxic chemicals and radiation can act synergistically to cause biologic harm and disease in humans. In fact, this provides a useful strategy to treat some types and stages of cancer. Rachel Carson noted in 1962 that all industrial chemicals become far more dangerous by interaction with strontium-90.

Naturally occurring radiation is part of the global environment with variability in levels around the planet. But humans and other organisms are healthier in areas of low natural radiation compared to areas of high natural radiation.⁹⁴

9. Medical Radiation

Amplifying this increasing awareness of radiation risk are multiple studies published in the last few years documenting increased health risks from radiation exposure secondary to medical tests and procedures.^{95,96,97,98} In one study, researchers estimated over 100,000 cases of cancer are caused per year among the 63 million people who receive a CAT scan that year.⁹⁹ One study compared the radiation exposure of 4-5 CAT scans as comparable to someone being 2-3 miles from the atomic bombs blasts over Hiroshima and Nagasaki.¹⁰⁰ The average lifetime dose of diagnostic medical imaging has increases by seven times since 1980.

10. Nuclear Radiation Impacts on Wildlife

The book *Killing Our Own* cites interviews with numerous people whose farms were within a few miles of the Three Mile Island and observed a dramatic increase in death and disease on their farms--birth defects, illnesses, and reproductive failures among their livestock and pets, even before the accident, with more afterwards. People who kept ducks cited 290 eggs, none of which hatched. Cat litters were born badly deformed, rabbits and goats stillborn, squirrels, calves born blind and with bones too soft to stand. Trees lost their bark and gardens wilted overnight.

There is good reason for many farm animals to have more symptoms from radiation. Cats and rabbits are much smaller, reproduce more quickly, at earlier ages. Most farm and wild animals keep their mouths and noses constantly to the ground for grazing and hunting. That means they absorb more radioactive fallout particles from the air, water, soil, vegetation, and animals they eat, and more gamma radiation from the ground.¹⁰¹

Similar reports have filed been in communities around other nuclear plants like the Vermont Yankee plant on the Connecticut River, the Nile Mile Point and Fitzpatrick reactors in New York, the Shippingport reactor near Pittsburgh, the Beaver Valley reactor in Pennsylvania, the Arkansas Nuclear One, and the Rocky Flats reactor in Colorado.

11. Regulatory failure

From the beginning, the federal regulatory infrastructure has been compromised by conflicts of interest with industry. The Atomic Energy Commission (AEC), the first regulatory agency, was simultaneously expected to both promote and regulate nuclear power. Although the AEC was converted into the Nuclear Regulatory Commission (NRC) because of perceived bias for industry, the NRC and later the Department of Energy, were staffed by largely the same personnel and influenced by the same institutional culture, perpetuating a posture of industry favor.

Current radiation standards are based on the assumption that a radiation exposure will have a relative biological effectiveness factor of one — that is, the measure of harm is equal to the amount of energy deposited in the tissue and therefore equal to the radiation dose. But the model used today by international agencies formulating safety standards for internal radiation is largely the same model that was developed during the Manhattan Project more than 75 years ago, before the discovery of DNA, the molecular basis of biological life.

Exposure to an alpha particle that kills a few rapidly dividing stem cells during the early life stages of human development—germinal, embryonic, or fetal--can have a dramatically different effect than the same exposure to an adult. Repair of cell damage, or replacement of cell death in an adult is done constantly, but in an embryo can be catastrophic. Radiation standards based on average exposure to an entire body or even to an entire adult organ, are incapable of providing adequate protection from these potentially teratogenic early life exposures.

In a blatant effort to suppress the societal upheaval of the Fukushima disaster, Japan raised the official level of “acceptable radiation” exposure by 20 times after the accident, without any medical studies to back up the dramatically relaxed standard.¹⁰²

Regulatory standards for public exposure to radiation are grossly inadequate. Embryos, fetuses, and children and females of all ages are far more sensitive to radioactivity than what can be tolerated by the “standard adult male” (previously described) that has been used as the basis for nuclear licensing decisions. The United States Code of Federal Regulations, 2018 edition, Chapter 10: Part 20 ‘Standards for Protection Against Radiation’ contains eight references to ‘reference man’ as the basis for regulation and calculation of acceptable radiation exposure.¹⁰³

As previously mentioned females are far more vulnerable, especially the youngest females, who can be seven times more sensitive than the “reference man.”^{104,105} This has resulted in a significant underestimation of population harm from radiation. Standards, and therefore policies based on those standards, that don’t protect such a large portion of the population, cannot be considered “safe” for society at large.

The primary basis for establishing permissible radiation doses was established by extrapolating the results of the survivors of the Japanese bombings of WWII. Yet those were high dose, single radiation events, not the same at all as what we are exposed to in 2026.

Dr. Rosalie Bertell, an epidemiologist who specialized in the effects of ionizing radiation, said the first “permissible dose” of radiation was established by the AEC based on the capacity of American hospitals to care for cancer cases caused by that dose of radiation.

The first “permissible dose” of radiation established by the AEC was based not on a dose that would not cause cancer, but on the capacity of American hospitals to care for the number of cancer cases caused by that dose of radiation.

The permissible dose was calculated to be that to which all members of the United States population could be exposed without producing more cancers than could be cared for by the medical establishment.¹⁸

Because tritium is the radioisotope most responsible for routine radioactive emissions from nuclear power plants, experts not connected to the nuclear industry advise that a tightening of the drinking water standard to 400 picocuries per liter (from the current 20,000 picocuries per liter) is needed to protect the population at large, especially for the protection of fetal development.¹⁰⁶ Bear in mind this only applies to public water systems. People dependent on private wells have no such protection.

On Jan. 12, 2026, the Trump Administration announced they were killing the Dept. of Energy’s long time radiation safety standard. They ended the department’s use of the As Low As Reasonably Achievable — or “ALARA” — principle, which has long been a bedrock of nuclear regulation. ALARA is based on the idea that any radiation exposure carries risks, but it allows for low doses if necessary to permit nuclear projects. This is a clear capitulation to the nuclear industry and is based solely on politics, having nothing whatsoever to do with a change in science. The change will ease permitting for nuclear power plants, and it will upend an established “safety-first culture” governing permits.

4. Nuclear Fuel Cycle—Radiation released at every phase

As long as nuclear reactors continue operation, nuclear waste will constantly be generated across the world. **Radiation is released and public health is harmed by every phase of the nuclear fuel cycle**--uranium mining, milling, yellow cake production, fuel rod manufacturing, and transportation to the plant. Routine operation of nuclear plant itself releases a steady stream of radioactivity into the nearby ecosystem. The eventual decommissioning of the plant becomes another source of releases into the environment. Furthermore, every phase of the nuclear cycle also produces its own waste stream, which are addition sources of environmental radioactivity.

A. Front End Releases and Waste

Uranium is a common metal found throughout the world in soil, rocks, rivers, and sea waters. It is about 500 times more abundant than gold. Uranium ores can contain anywhere from .03% to 20% uranium.

Recently international companies have exploited extremely weak mining laws in places like Africa, and to that extent, the “nuclear renaissance” represents an endangerment of local communities left with the radioactivity and contaminants of the process.

Uranium is extracted either through mining or through chemical extraction, i.e. in situ leaching.



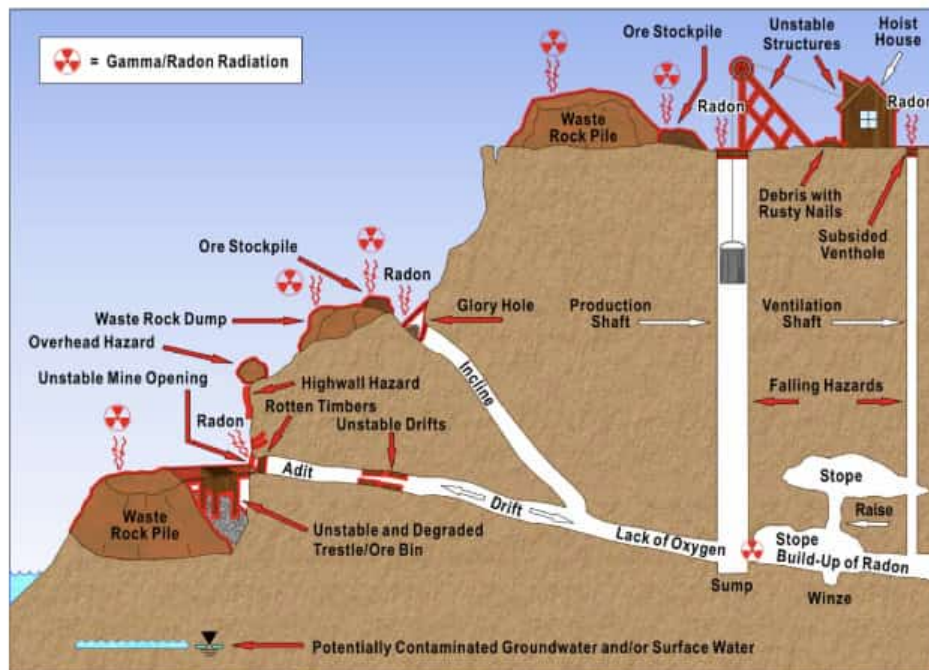
The following is a summary of uranium mining from Peter Diehl of the WISE Uranium Project.¹⁰⁷

To keep groundwater out of a mine during operation, large amounts of contaminated water are pumped out and released to rivers and lakes. When the pumps are shut down after closure of the mine, there is a risk of groundwater contamination from the rising water level.

The next source of environmental radioactivity are the piles of waste rock, which often contain elevated concentrations of radioisotopes compared to normal rock. The US EPA estimates there are 15,000 sites plagued with abandoned uranium mine waste scattered throughout the Western US.²³¹



Radon vent for Beaver Shaft
uranium mine, near center of
town of La Sal in Southern
Utah
Courtesy Sarah Fields
Uranium Watch



Typical features and source of hazards of a uranium mine, Dept. of Energy
https://www.energy.gov/lm/articles/defense-related-uranium-mines-report-congress-august-2014?nrg_redirect=423374



Enormous waste rock piles in Ronneburg, Germany, 1990. These piles release radioactive dust and radon into the environment. Diehl, Peter. Uranium Mining and Milling Wastes: An Introduction. WISE Uranium Project. <https://www.wise-uranium.org/uwai.html>



Waste rock pile from LaSal, Ut, uranium mine
Courtesy of Sarah Fields, Uranium Watch

All these piles threaten people and the environment after shut down of the mine due to their release of radon gas and seepage water containing radioactive and toxic materials. Radon emits alpha particles and when inhaled precipitates as radioactive metals within our lungs. Radon has a short half-life of 3.8 days, meaning it is highly radioactive, and decays into another highly radioactive element, polonium-210. Radon is also a major component of the risk of lung cancer from smoking cigarettes.¹⁰⁸

In the USA, in situ or “heap leaching” is often used as alternative to underground mining. With “heap leaching,” usually with sulfuric acid, waste piles present a hazard because of release of dust, radon gas and leaching liquid. Leaching of uranium leaves radioactive contaminants for centuries and possibly permanent contamination of ground water. In situ leaching eliminates the need for large tailings piles, but it is impossible to restore natural conditions in a leaching zone.

Waste sludge is left behind these operations which contains about 85% of the initial radioactivity of the ore, primarily in the form of thorium-230 and radium-226, and left over uranium. In this form the hazardous materials become more susceptible to dispersion throughout the environment and increase human exposure. The sludge also contains non-radioactive, but toxic heavy metals like arsenic.

Uranium milling usually occurs near mines, converting crushed ore into “yellow cake” and packing it into steel drums. Although most of the uranium has been extracted, the waste at this point has not become less hazardous. Most of the total radioactivity is still there, new chemical contaminants are present, and these toxins are now more mobile in the environment. The tailings emit thorium-230, radium-226, and radon-222 for tens of thousands of years. These emissions constitute the most serious long-term hazard generated from uranium mining. Radionuclides contained in uranium tailings emit 20 to 100 times as much gamma-radiation as natural background levels on deposit surfaces. Radon gas is heavier than air and spreads far and wide, allowing widespread contact with humans.

Particles from uranium mill tailings in New Mexico have been traced as far as the East Coast. The dispersal of tailings by wind or water, or by leaching, can carry radioactive and other toxic materials to surface or ground water. All the tailings piles (except for one abandoned site located in Canonsburg, PA) are located in the West, especially Utah and Colorado. The tailings piles were usually constructed with no linings to protect ground water, so the toxic radioactivity seeped into regional aquifers.

In addition to radioactive releases from normal operations, between 1959 and 1977, fifteen accidental releases occurred, including seven dam breaks, six pipeline failures, two floods in uranium tailings. Ten of these events sent radioactivity to a major waterway,

Specific examples:

- Grants, New Mexico, USA, 1977: spill of 50,000 tons of sludge and several million liters of contaminated water.
- Four months before the Three Mile Island accident in 1979, at Church Rock, New Mexico, the largest release of radioactive materials in US history occurred: a spill of more than 1100 tons of acidic, radioactive and heavy metals contaminated uranium sludge from a failed tailings dam. The contaminated water flowed into the Puerco River for 80 miles downstream, burning children who were playing in it and immediately killing livestock drinking from it. It destroyed the only source of water for many Navajo families. The mill restarted only four months later even though the radioactive disaster was still spreading.
- 1984, Key Lake, Saskatchewan, Canada: spill of more than 100 million liters of contaminated liquids.
- The Stava tailings dam failure (July 19, 1985, Trento, Italy)
- Omai Tailings Dam Failure, Guyana, November 16, 1995
- The Los Frailes tailings dam failure (Apr 1998, Aznalcóllar, Spain)
- The Aurul S.A. tailings dam failure (Jan 2000, Baia Mare, Romania)
- The Aitik tailings dam failure (Sep 2000, Gällivare, Sweden)
- The Inez coal tailings dam failure (Oct 2000, Kentucky, USA)
- The Sebastião das Águas Claras tailings dam failure (June 2001, Minas Gerais, Brazil)
- The San Marcelino tailings dam spill (Aug/Sep 2002, Zambales, Philippines)

Since 2000 there have been 111 major tailings pile dam failures from mining operations of all kinds.¹⁰⁹

Hydraulic barriers is a series of collection wells that pull contaminated water out, treat it with reverse osmosis, mix it with pure water, and pump it back into aquifers. They have been used to help contain the underground spread of uranium tailings. But barrier attempts have used enormous amounts of clean water to do so, sacrificing their purity, and are far from adequate long term solutions.¹¹⁰

All over the West, areas surrounding uranium mill tailings sites and other shuttered nuclear operations, are having to be abandoned under the supervision of the Dept. of Energy. There are over 500 abandoned uranium mines in Navajo Nation alone.¹¹¹ Most of the 200 million tons of uranium mill tailings scattered throughout the country continue to lie exposed to wind and rain. In some cases children have been playing in the tailing, considering them huge sand piles.¹¹²

When the surface of the pile dries out, the fine sands are blown by the wind over adjacent areas.

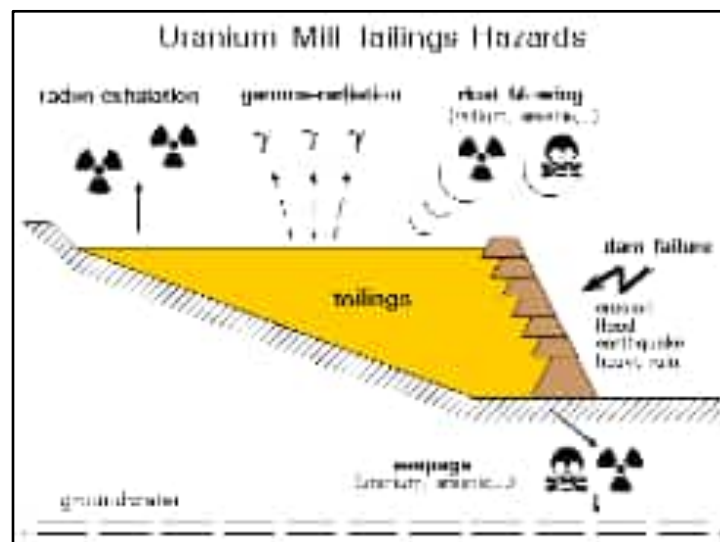


Diagram from WISE Uranium Project
<http://wise-uranium.org/uwai.html>

In late 1970s numerous experts sounded alarms about the public's exposure to these tailings. Dr. Chauncey Kepford, Radiation Chemist, State College of Pennsylvania, said in 1977 hearings the NRC has grossly underestimated the health effects of radon. Tailings from the fuel needed to operate Three Mile Island for just one year could cause a million cancer cases over time.¹¹³ Dr. William Lochstet, at Penn State U. said operation of a single uranium mine could result in 8.5 million deaths over time.¹¹⁴ Dr. Robert O. Pohl from Cornell said the potential health effects from mill tailings could completely dwarf those from the rest of the nuclear fuel cycle and add significantly to the worldwide toll of death and mutations.¹¹⁵ In 1977, Dr. Walter H. Jordan on the NRC, said the NRC "had underestimated radon emissions from tailings piles by a factor of 100,000. It is very difficult to argue that deaths to future generations are unimportant."¹¹⁶

It is questionable whether covering the tailings with dirt provide meaningful protection from radon in the long term and huge strip-mining operations would be required to accomplish that.

High rates of illnesses and reproductive failures in livestock have been found among ranches and farms near these tailings as well as high rates of childhood leukemia^{117,118,119} and birth-defects in the states of New Mexico, Arizona, Colorado, and Utah.¹²⁰



Atlas Corp. uranium mill tailings, Moab, Utah, USA, 1966 (U.S. DOE), contained 10 million tons of mill slurry.



Tailings dust, Moab, Utah Grand Canyon Trust. Uranium Mining and Activities, Past and Present.
https://www.grandcanyontrust.org/wp-content/uploads/2024/11/gc_agfUraniumUpdate.pdf

After mining and milling the ore, the uranium is converted into a chemical concentrate, known as 'yellow cake', which can then be transported over long distances. The extraction and purification of uranium processes all generate radioactive residues. Yellow cake is then sent to plants for further enrichment and fuel manufacturing. For most nuclear reactors the yellow cake is converted into a gas, uranium hexafluoride (UF_6). The UF_6 is then moved into large cylinders where it solidifies, and then is shipped in large metal containers to an enrichment plant, which increases the percentage of U_{235} , the fissionable isotope from the usual .7% to 3-5% of the total uranium. There centrifugation throws the heavier U_{238} out to the walls of the centrifuge, leaving the U_{235} . This step, the most expensive and sensitive, is carried out in an isotopic separation plant. Enriched uranium is then used to make fuel assemblies which can then be loaded into the core of a nuclear reactor.



Typical nuclear fuel assembly

The by-product of the enrichment phase is a considerable amount of depleted uranium (DU) which is stockpiled. DU is about 40% less radioactive than natural uranium. It is 1.6 times denser than lead and has properties that make it more lethal as ammunition, and for that it was used for the first time in the first Gulf War. Like other heavy metals, it has significant chemical toxicity in addition to its radiotoxicity.¹²¹

All isotopes of uranium release alpha particles which has been previously discussed, and that represents a serious health hazard if DU particles are inhaled or ingested. The use of DU has led to the suspicion of high rates of cancer, leukemia, immunosuppression, birth defects, miscarriage, premature birth, anemia, and other illnesses in Iraq, especially in children, and especially in cities where US military operations were most intense.¹²²

Official Iraqi statistics indicate that by 2005, cancer rates had increased by an astonishing factor of 40. That may be underestimating it because public health care only covers half the population, and there are no statistics kept for private health care.¹²³

There was a dramatic increase in rates of cancer, especially blood cancers, and infant mortality compared to other middle eastern countries in a small survey done 6 years after Gulf War II, by

British researchers.¹²⁴ A 2021 review of all available research found an increase in multiple adverse health outcomes associated with DU exposure, although with an existing bias.¹²⁵ A more recent study in 2024 found that patients with leukemia from multiple regions in Iraq had significantly higher blood levels of uranium compared to healthy patients.¹²⁶

In animals, nephrotoxicity and neurotoxicity are prominent outcomes.¹²⁷ Not surprisingly research funded by the US government disputes adverse health effects from DU.

There is only one enrichment plant in the US, Urenco USA, in Eunice, NM, owned by foreign companies. An expansion of the facility necessitated by a revival of the nuclear industry could release over 250 pounds of radioactive uranium dust into the air each year.

After enrichment, the UF_6 is converted to uranium dioxide (UO_2) as a powder which is then baked at high temperature to make ceramic pellets. The uranium pellets are then loaded into long metal tubes made of zirconium. Multiple zirconium rods together become a “fuel assembly.” Fission in the fuel assemblies heats water, creating steam, which then drives turbines to generate electricity. Fuel rods last about 3-6 years, and every year about 30% of the fuel rods are changed out. After removal, the spent fuel rods are left in pools of water. After 40 years the radioactivity and heat have cooled to the point where the uranium and plutonium can be either reprocessed for more fuel or stored in ceramic casks.

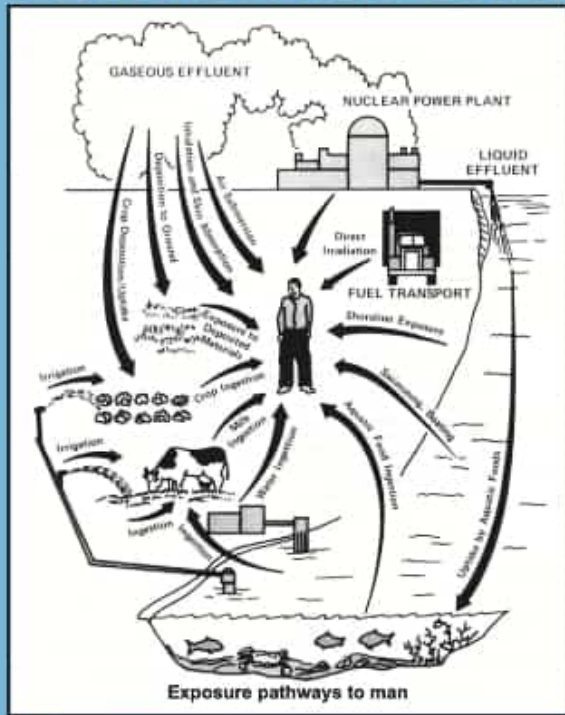
All these phases of the nuclear fuel cycle, as well as the eventual decommissioning of a nuclear facility, also generate low and/or intermediate level radioactive waste. This includes, for example, water purification resins, paper tissues, used gloves, discarded tools and equipment.

B. Reactor Emissions and Waste

A typical nuclear reactor harbors as much radioactivity as 1,000 Hiroshima bombs.¹²⁸ All nuclear plants release a steady stream of radiation into the environment during normal operations. A reactor’s fuel rods, pipes, tanks and valves can and do leak. The older the plant and the equipment, the more likely there are radiation leaks. One of the primary sources of the leaks is the gradual breakdown of the fuel sheathing in the superhot reactor core. Under normal operations, lethal radioactive isotopes of iodine, strontium, cobalt, carbon, cesium, and noble gases are emitted. Others like tritium are flushed out into water discharged to local rivers, lakes and oceans. Neutrons and gamma radiation can escape the containment vessel at the top of the reactor.

**A typical nuclear reactor harbors as much
radioactivity as 1,000 Hiroshima bombs**

ROUTINE RADIOACTIVE RELEASES FROM U.S. NUCLEAR POWER PLANTS



↑ A DIAGRAM PUBLISHED IN 1977 BY THE U.S. NUCLEAR REGULATORY COMMISSION

Some of the reactor's radioactive water is intentionally removed from the reactor vessel to reduce the chemical corrosion known to damage valves and pipes. The water is filtered and then either recycled back into the cooling system or released into the environment, usually a near-by water body. **A 1000-MW pressurized-water reactor with a cooling tower extracts 20,000 gallons of water per minute from a source such as a river, lake or ocean water for cooling, then circulates it through a 50-mile network of pipes, returns 5,000 gallons of that to the same body of water, and releases the remainder to the atmosphere as vapor. A 1000-megawatt reactor without a cooling tower takes in about 25 times that amount of water--as much as one-half million gallons per minute. The discharge water is contaminated with radioactive elements in amounts that are not precisely known or knowable, but are biologically active.**¹²⁹

Government regulations allow radioactive water containing "permissible" levels of contaminants to be released to the

environment. Permissible does not mean safe. Detectors at reactors are set to allow radioactive water to be released, unfiltered, if radioactivity is below "permissible" legal levels.

Some radioactive gases filtered from the reactor's cooling water are contained in "decay" tanks for days before being released into the atmosphere through filtered rooftop vents. Liquids and gases are retained in tanks so that the shorter-lived radioactive materials can break down before the batch is released to the environment, but that break down is not 100%. For some radioactive elements--tritium, xenon, and krypton--it is not feasible to capture them from water with filters. Some gases leak into the power plant buildings' interiors and are released during periodic "purges" and "venting." These radioactive gases contaminate not only air but ultimately soil and water.

The NRC relies upon self-reporting and computer modeling from reactor operators to track radioactive releases and their dispersion. A significant portion of the data for contaminant concentrations is estimated or extrapolated, but not real. **An accurate accounting of**

radioactive emissions released to the environment from reactors and the entire nuclear fuel life cycle processes does not exist. Absence of data cannot be equated with absence of harm. Depending on the specific isotopes, a nuclear reactor's emissions can continue emitting radioactivity for millions of years.

Nuclear proponents characterize all these radioactive releases as small, but there is no such thing as acceptable exposure for everyone in the population at large, especially for fetuses, infants, and children, as previously discussed. Furthermore, if the radioactivity from nuclear plants can be characterized as small, then when millions of people are exposed to small increases in risk, the end result will still be thousands of victims. When billions are exposed to small increases in risk, the number of victims will be in the millions. The health risks of radiation certainly include cancer, but because chromosomes play such an integral part in the proper functioning of all organ systems, many other diseases and poor outcomes can also be provoked by chromosomal damage. And that includes the capability of being passed on to subsequent generations.¹³⁰

1. Reactor Waste: Playing With Fire

Radioactive waste will continue to be generated for as long as nuclear technologies, including especially nuclear reactors, are employed. The amount of high-level, spent fuel waste is increasing in the United States by 2,000 metric tons per year.

After the fuel is removed from the reactor core, it is placed in deep water storage pools for four to five years, the time needed to let the most active fission products decrease or disappear, and the heat to dissipate. In the US, most spent nuclear fuel is stored, densely packed in these specially designed pools at individual reactor sites around the country. In the US **these pools are already holding 3-4 times more spent nuclear fuel than the original designed intended.**¹³¹



Spent fuel pool
Nuklearna
elektrarna Krško.
"Spent Fuel
Pool."
[https://www.nek.
si/en/how-nek-
works/spent-fuel-
pool](https://www.nek.si/en/how-nek-works/spent-fuel-pool)

A loss of water or circulation in one of these pools for any reason could cause a catastrophic fire because if the zirconium cladding were exposed to air and steam, it would catch fire at 800-100 degrees C. Such an event “could dwarf the horrific consequences of the Fukushima accident,” according to Edwin Lyman, physicist at the Union of Concerned Scientists.

Nuclear expert, Frank Von Hippel says, “The Fukushima accident could have been a hundred times worse had there been a loss of the water covering the spent fuel in pools associated with each reactor. That almost happened at Fukushima in Unit 4.”¹³² Such a fire could force the relocation of 8 million people, cause \$2 trillion in damages, and render an area 60 times larger than the exclusion area of Chernobyl uninhabitable.^{133,134}

NRC waste-storage regulations have been dependent on the eventual opening of a permanent waste repository. This has allowed plant operators to legally store spent fuel in onsite cooling pools for longer periods, and at greater densities than was originally intended. And yet, incredibly, these pools lack defense-in-depth such as secondary containment and their own back-up power. About one third of these pools are several stories above ground. This is the quintessential ticking time bomb.

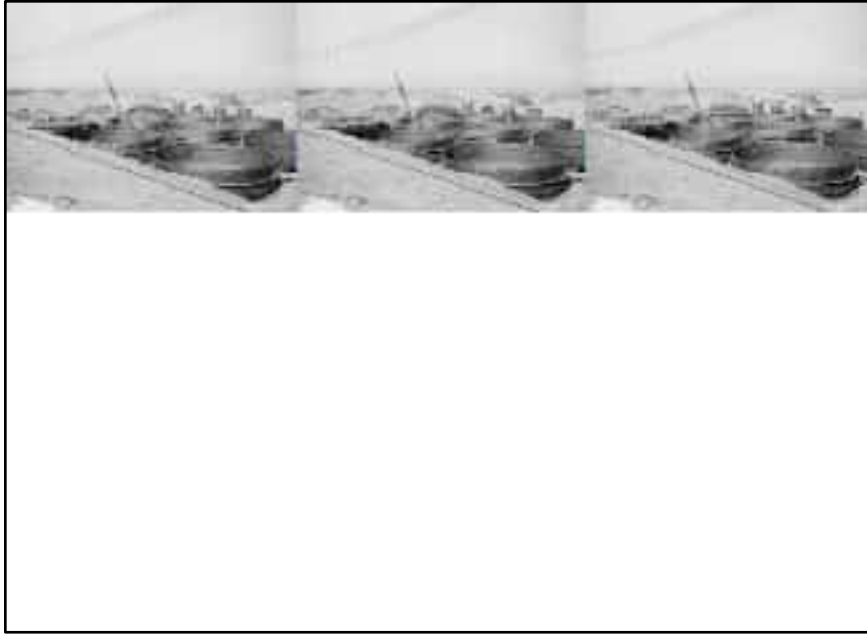
This vulnerability could have made the Fukushima accident could have been much worse were it not for an accidental water leak from unintentional source kept water levels from dropping in the spent fuel pool.¹³⁵ If that spent fuel pool had caught on fire, Naoto Kan, Japan’s Prime Minister at the time, said, “[W]e would have to evacuate 50 million people. It would have been like losing a major war...I feared decades of upheaval would follow and would mean the end of the State of Japan.”¹³⁶

Greenpeace demonstrated how easy it would be for terrorists to crash a drone into the building of spent fuel pool in France.¹³⁷ A 2016 study concluded if a fire occurred at the Limerick boiling water reactor near Philadelphia, radioactive fallout could force approximately eight million people to relocate and result in \$2 trillion in damages.¹³⁸

In recent years, the NRC has increased the overall risk of nuclear power, allowing US utilities to use what is called “high-burnup fuel.” This permutation of fuel rods accelerates thinning and rust formation on the zirconium fuel cladding, making it brittle and more likely to fail.

There are 69 different radionuclides being released by spent nuclear fuel rods, dominated by the potent beta emitter Cesium 137. Meanwhile, the waste stockpiled above ground around the power plants is steadily accumulating and exposed to the elements.

After removal from fuel pools, the waste is still highly radioactive and embedded in dry casks (ceramic or glass/ceramics cylinders) for longer term storage. These dry casks represent less hazards for the environment than that of spent fuel pools, but none of these dry casks have been licensed for, or are suitable for, permanent storage. The final disposal of these vitrified waste cylinders has yet to be decided, there is no eminent solution, and by itself represents an unequivocal, prohibitive barrier to expanding the industry.¹³⁹



The disposal of high-level nuclear waste requires a deep geological repository, but none have been approved anywhere in the world. Across every region, the nuclear industry has struggled with the problem of long-term management of nuclear waste and by products of the industry.

Hanford storage tanks, photo, Dept. of Energy

There have many examples of abject failures, with public health consequences. At Hanford in Washington state, lies the worst radioactive waste contamination in the Western Hemisphere. It was once home to nine nuclear weapons production reactors. Over 53 million gallons of radioactive waste are still being stored in short term underground tanks that were only designed to hold the waste for 20-30 years, yet are now around 60 years old. One third of the 177 tanks are leaking, some for 50 plus years from structural stress and corrosion, and are leaking into the soil, the aquifer 200 ft below, and into the Columbia River seven miles away. In some tanks the waste is so hot, both temperature and radioactivity, that the contents of the tanks boil and must be stirred regularly, and that must continue for tens of thousands of years. The waste is also a threat to release radioactivity into the atmosphere.

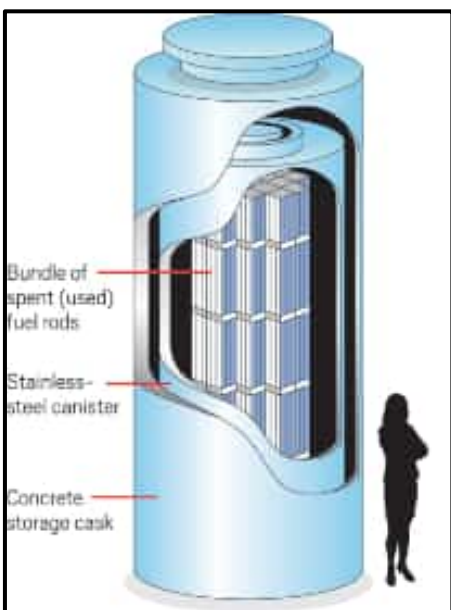
Clean-up costs estimated at \$100 billion, and delays in “glassification” mediation projects are as long as building a nuclear plant.¹⁴⁰ In an investigative piece the Los Angeles Times wrote that “The scope of the problem is staggering. It has been estimated, for example, that there is more radioactivity stored at the single Washington (Hanford) reservation than would be released during an entire nuclear war.”¹⁴¹

The cause of the looming disaster at Hanford is two fold. One, the tanks are old and were never suitable for storing massive amounts of the toxic waste long term, and two, so many involved failed to do their job and made numerous mistakes. At the very least that is a manifestation of the very difficult job they faced.

Hanford is hardly alone in the peril it represents. At West Valley Demonstration Project in NY, a commercial reprocessing facility of high-level waste was stored in poorly designed tanks causing groundwater contamination and threatening nearby communities. Rocky Flats in CO, near

Denver, is the site of a weapons production operation that is now a superfund site contaminated with plutonium, posing a risk to the long-term health of residents in the area decades after the facility was shut down. The Fernald Feed Materials Plant in Ohio was a uranium processing facility that leaked radioactive dust and contaminated groundwater over decades.

Current methods of storing high level liquid nuclear waste, such as from weapons production, involves embedding the waste in what is presumed to be a long-lasting matrix like glass or ceramic, then placing that matrix in stainless steel canisters (“dry cask storage”), then



Credit USNRC

storing the cannisters in a deep geological formation well isolated from exposure of any kind, i.e. weather, floods, earthquakes, terrorists, etc. Spent fuel rods are stored in similar stainless steel and cement lined silos. With no permanent storage site yet, interim storage of these dry casks is merely stacking them surrounding the nuclear plant, an unsustainable strategy.

But beyond the problem of no country having found a suitable deep repository, a recent study has found that in the presence of water, the interface of stainless steel and glass or ceramic matrices accelerates corrosion of both the matrices and the stain less steel.²⁶¹ In other words, even if a deep repository could be located and become politically acceptable, this strategy still won't safely isolate the waste.

After 70 years, the nuclear industry in the US and the rest of the world still has no long-term solution to high level nuclear waste. Every new nuclear site will become a de facto nuclear waste storage site in perpetuity.

After 70 years, the nuclear industry in the US and the rest of the world still has no long-term solution to high level nuclear waste. It is dangerous, irresponsible, disingenuous or naïve to think that the waste problem has finally been solved or will be solved. It is especially troubling that **future generations have no say in current decision making, yet they will be left with a legacy of unmanageable, deadly nuclear waste on a time scale far longer than that of the entire course of human civilization. Every new nuclear site will become a de facto nuclear waste storage site.**

This injustice will only be perpetuated and magnified by the deployment of SMRs because they actually generate more waste per gigawatt than conventional reactors.²³²

C. Reprocessing and nuclear weapons proliferation

Reprocessing is not currently done in the United States. If a reprocessing is decided upon, the spent fuel is transported to a reprocessing plant where it is stored again a few more years in a local pool. Reprocessing involves separating what can be recycled – uranium and plutonium – from what is classified as true waste.

In France and the UK, spent fuel rods are often reprocessed into plutonium-239, by bombarding U-238 with neutrons. Plutonium (named for Pluto, the God of Hell) can then be used for nuclear weapons, or for fuel for breeder reactors. Plutonium, like uranium is a potent alpha emitter. Plutonium has to be separated from spent fuel by dissolving it in boiling concentrated nitric acid. Multiple waste streams are created by these physical and chemical processes, including high level radioactive liquid waste. High levels of radioactivity are also discharged into the atmosphere and the marine environment. It has been estimated that reprocessing alone accounts for about 80-90% of the total radiation dose to the public of the French and UK nuclear industries.¹⁴²

Reprocessing has been a financial and environmental disaster with reprocessing plants like other nuclear plants experiencing cost overruns, design flaws, losing money and eventually having to incur massive costs related to waste management and decommissioning.

It takes about 18 lbs of plutonium to make a nuclear bomb. As of 2019 the world's stockpile of plutonium was about 520 tons, 290 of which is in civilian custody.¹⁴³

This inventory is a costly liability and a target for terrorists.

C. Decommissioning

After a nuclear plant shuts down, the plant is still home to low level, intermediate, and high level radioactive waste, in a combined “care and maintenance” phase for 50-80 years, before the final phase of decommissioning even begins. The European Commission estimates that Europe is facing \$253 billion in costs for nuclear waste management and plant decommissioning which is outstripping available funds by \$120 billion.

The health consequences of all these phases of the nuclear process are not reduced in any way by SMRs compared to current reactors.

The authors of the previously mentioned study on SMRs found that “small modular reactors will generate at least nine times more neutron-activated steel than conventional power plants. These radioactive materials have to be carefully managed prior to disposal, which will be expensive.”²³³

Some of these SMR designs involve chemically exotic fuels and coolants that will require costly chemical treatment prior to disposal. These researchers estimated that the radiotoxicity of plutonium in the spent fuels from SMRs would 50% greater than from a conventional nuclear reactor per unit of energy produced. The authors were quick to point out that they are not the ones that should be doing these kinds of studies, it should be required of those companies seeking to receive federal support and grants.²³⁴

5. Cost— Bankruptcies, Cost Overruns, Public Bail-Outs

In the beginning of the nuclear power plant era, proponents claimed that nuclear power would produce electricity that was “too cheap to meter.” But private companies wouldn’t touch it, and it was only with heavy, multi-pronged federal subsidies did the industry get off the ground. Ever since the Manhattan Project, nuclear power has depended entirely on government subsidies to survive. But with those subsidies, nuclear power can be highly profitable. In many cases, utility rate increases have been forced upon the public to bail out nuclear plants that would otherwise would have had to close down.

John Rowe, the former board chair and CEO of Exelon, America's largest producer of nuclear power with 22 nuclear power plants, said in March 2012 that nuclear power is not economically feasible. "I've never met a nuclear plant I didn't like . . . but it just isn't economic, and it's not economic within a foreseeable time frame."¹⁴⁴

Nuclear power is essentially one of the government’s biggest proverbial welfare queens. It’s the most expensive and dangerous way ever devised to boil water. Efficiency is very poor. Nuclear plants have the lowest thermodynamic efficiency of any thermal power plant. Two thirds of the energy produced by the reactor core of a U.S. nuclear power plant are lost as waste heat discharged to the environment, adding to atmospheric heat.^{145,146} They produce 40% more waste heat into rivers than coal or oil power plants.

“A fixed amount of money spent on a new nuclear plant means much less power generation, a much longer wait for power, and a much greater emission rate than the same money spent on WWS [wind, water, and sunlight] technologies.”

**Dr. Mark Jacobsen
Stanford University**

A. Large Nuclear Plants—Long Delays and Large Cost Overruns

Between 1960 and 2000, over 100 nuclear reactors were constructed across the United States. The logic was similar to those being made today on behalf of SMRs--economies of scale would drive down costs. Not a single one of these reactors were built on time or within budget. Every single one was dependent on massive taxpayer subsidies and ratepayer bailouts. Not one proved financially viable or cost-competitive with conventional power sources.²⁴¹ For nuclear plants begun after 1970, cost overruns have averaged 241%. Many of the projects were abandoned after construction was already underway. The VC Summer dual reactor project in South Carolina was abandoned in 2017 with \$9 billion in sunk costs.¹⁴⁷

The George W. Bush Administration proposed building 36 new, full size nuclear reactors. From that proposal came the only nuclear plant built in the United States in the 21st century, the Vogtle reactors #3 and #4 in Georgia, which was finished in 2023, seven years late and \$17-19 billion over budget. Georgia's residents are hardly thrilled to be paying for nuclear reactors that were supposed to cost \$14 billion and ended up costing \$36.85 billion,¹⁴⁸ the most expensive power plants ever built anywhere on earth. The average household paid about \$1,000 in up-front costs for these reactors. State regulators will ultimately decide if they will be forced to continue paying billions more. Vogtle reactors #1 and #2 had come on line in 1986 and 1987 at a cost overrun of 1,200%.

The Georgia Public Service Commission saddled rate payers with all the cost overruns. The construction delay only increased Georgia Powers profits, because the rate payers were stuck with the bill.²⁷⁷ Some of the key promises of Vogtle — like building modules offsite and shipping them for cheaper on-site assembly construction, did not materialize. Construction delays sent Westinghouse Electric Co. into bankruptcy.¹⁴⁹

In 2002, Finland contracted Areva/Siemens to build the first new nuclear reactor in Western Europe in more than a decade, at a site next to two existing reactors. It was originally projected to provide 1,600 MW, cost \$3 billion euros and begin operation in 2009. It ended up coming on line in 2023, 21 years later, 14 years after schedule, costing over \$11 billion euros. It first came on line in Sept. 2022, but numerous faults and disruptions since then, such as cracks in all four of the feed water pumps, delayed full operation for another year. The reactor has been a “financial catastrophe” for Areva and Siemens, bankrupting Areva.^{150,151,152}

B. SMRs Will Not Be Cheaper Without Compromising Safety

SMRs will not be cheaper than large, conventional reactors. Initial capital costs would actually be greater for SMRs compared to larger nuclear plants.^{153,154} Materials cost per kilowatt of reactor actually go up as the size goes down. Similarly, the cost per kilowatt of secondary containment, control systems, instrumentation and emergency management increase as the size of the reactor goes down. Scientists from Westinghouse, one of the companies involved in SMR technology, calculated in 2007 that the capital cost of four 335 MW SMRs was slightly greater than that of one 1340 MW reactor.

Uranium resource requirements and hence fuel costs, are expected to be higher compared to larger reactors, with increased risk of nuclear proliferation.¹⁵⁵

In order to reduce costs, manufacturing would likely be moved overseas to countries such as China where lack of quality controls on many other manufactured products have created serious public health problems (heavy metal tainted jewelry, melamine contaminated milk powder, multiple toxins in drywall, faulty vaccines, and cereulide contaminated infant formula). Quality control problems on consumer products is one thing, but on a nuclear reactor of any size it can precipitate global disaster, especially if more than one reactor is compromised because of a flawed manufacturing process.

Vendors are also citing operating cost savings related to weakening some of the nuclear regulatory and safety requirements. The industry argues that regulatory requirements for SMRs in areas such as emergency planning, and staffing for control rooms and security can be weakened or eliminated because SMRs contain smaller quantities of radioactive isotopes than large reactors and therefore pose lower risks to the public. SMR vendors have emphasized that reducing security staffing is critical for the economic viability of their projects. One vendor was quoted in congressional testimony as stating, "Whether SMRs get deployed in large numbers or not is going to come down to O&M [operations and maintenance]. And the biggest variable that we can attack directly is the security issue." This is promotion of cost savings at the expense of safety precautions.¹⁵⁶

Per kilowatt-hour produced, the afore mentioned NuScale proposal to build a 460-megawatt, 6-unit SMR in Idaho was estimated to cost even more than the Vogtle reactors in Georgia. Levelized costs compare the total lifetime cost of building and running a plant to lifetime output of electricity. The levelized cost of electricity for the now-cancelled NuScale project was estimated¹⁵⁷ at around \$119 per megawatt-hour (without federal subsidies), whereas land-based wind¹⁵⁸ and utility-scale solar¹⁵⁹ now cost below \$40/MWh. For a fixed amount of money spent on a new nuclear plant, less power will be generated, a much longer wait for power will be inevitable, and a much greater emission rate of pollution and greenhouse gases, than the same money spent on truly renewable technologies.

As of 2025, the only SMRs approved in a G7 country is a series of four of them in Ontario Canada. The price tag is currently \$12.5 million per megawatt, as opposed to \$2 million per megawatt for natural gas.^{235,236}

The cost of long-term nuclear waste clean-up escalates just like nuclear power plant construction. It jumped \$100 billion in just one year, 2017-2018, to a total of nearly \$500 billion.¹⁶⁰

C. Connection to Nuclear Weapons

Since the beginning of the nuclear era, the nuclear power industry has had a strong connection to nuclear weapons, and not just because of the common technology. The birth of nuclear power, heralded with the previously mentioned US government's campaign, "Atoms for Peace," in the 1950s, came about for two reasons. One, as a public relations afterthought in the government's attempt to soothe public anxiety about "mutually assured destruction" from a nuclear holocaust.

Two, nuclear reactors were a means of producing plutonium for weapons. In fact, the first nuclear reactors were named “dual-purpose reactors,” i.e. for generating electricity and producing weapons. The private companies pitching to build the first reactors all agreed that, “no reactor could be constructed in the very near future which would be economic on the basis of power generation alone.”¹⁶¹

A country that can enrich uranium, can produce enough highly enriched uranium for a nuclear weapon within months, which makes monitoring proliferation extremely difficult. The average nuclear plant produces enough plutonium every year to produce 100 nuclear weapons. The world is awash in plutonium. India eventually developed plutonium-based weapons technology from their nuclear power technology that was shared with them by the Atoms for Peace program. Iran has been trying to follow the exact same path.

Driving down the costs of new nuclear power technology depends in part on the concept of selling that technology to other countries. Widespread, global use of this technology in countries without social stability and capable of providing the necessary security is an enormous risk for more countries to obtain the necessary plutonium for developing nuclear weapons.

6. What You Don’t Know About the High Profile Accidents

A. Three Mile Island



<https://www.ctvnews.ca/photos/2025/01/27/10-of-the-worst-nuclear-accidents-in-history/>

Unit 2 reactor of the Three Mile Island nuclear complex in Pennsylvania had been rushed into operation by its owners apparently for tax purposes on Dec. 28, 1978. In the next 3 months, two valves broke during a turbine test, then a throttle valve began to leak, then a pump blew a seal, then another pump failed.

Then the complex had what was thought at the time to be the most significant nuclear accident in the world at 4:00 am on March 28, 1979, three months after startup of the newly built reactor. Feedwater pumps stopped, control room operators misread their instruments and made wrong decisions, the core lost water and heat and pressure began to rise rapidly. Radioactive water poured on to the floor of the containment building, and into the near by Susquehanna River. Radiation escaped into the air over central Pennsylvania.

Initially, the public was told there were no radiation releases. The public was then told the releases were controlled and done purposely to alleviate pressure on the core. Then the official story was the radioactive releases were “insignificant,” comparable to “a gnat’s eyelash.” All three statements were false. Later the public was told there was no melting of fuel inside the core. But robotic cameras later showed a very substantial portion of the fuel did melt, and later evidence indicated that the accident came within 30-60 minutes of becoming a complete core melt down. Initially, the public was told there was no reason to evacuate. However, Pennsylvania Governor Richard Thornburgh then evacuated pregnant women and small children. Unfortunately, he waited until two days after the accident and many people were sent to nearby Hershey, which had been blanketed by fallout.¹⁶²

Stack monitors were later determined to be saturated with the maximum amount of radioactive isotopes the monitors could handle making them unusable for accurate monitoring. The NRC later had to admit to Congress it did not know, and still does not know, how much radiation was released at Three Mile Island, or where it went. Nonetheless, the official government position on the Three Mile Island accident still is, “No public health or safety consequences from the TMI-2 accident,” a preposterous statement given that significant radiation was released from the accident, documented by non-government, non-industry scientists.

Arnie Gunderson, a leading technical expert on nuclear engineering, challenged official pronouncements on both radiation releases and health impacts. Gunderson says: "When I correctly interpreted the containment pressure spike and the doses measured in the environment after the TMI accident, I proved that **TMI's releases were about one hundred times higher than the industry and the NRC claim, in part because the containment leaked.**"¹⁶³

This supports epidemiologic research that shows an increase in the rates of multiple cancer types up to six years afterwards that corresponds to areas of higher radiation within a ten mile radius around the reactor.¹⁶⁴ Because of the typical multi-decade time lag between exposure and the development of most solid tumors, even this study is likely to vastly underestimate the cancer burden from the radiation.

The government made “average dose” estimates received by people in the region, stating they would be the equivalent of a single x-ray. Even if true, that is misleading on its face. One x-ray is enough to cause damage to an embryo or fetus which is why we no longer x-ray pregnant women unless it is literally a life and death situation. Furthermore, averages ignore, likely purposefully, that the fall-out would not have been evenly distributed, and could easily have been concentrated in specific areas.¹⁶²

In fact, there was a statistically significant increase in infant mortality and hypothyroidism in the months following the accident among the population within a ten mile radius of the plant and higher still within a five-mile radius of the plant. In Harrisburg, hard hit by a radiation plume, there was a 400% increase in neonatal deaths, i.e. deaths within the first 30 days of delivery over the previous year, and a 3,000% increase from two years prior.¹⁶⁵

Anecdotally physicians in the area saw a sudden surge in patients with vague, otherwise inexplicable symptoms, like unusual rashes, “sun burns,” allergic reactions, dermatitis, skin lesions, itch, and people complaining of a metallic taste in their mouths, a common complain of people exposed to other radiation accidents.

The federal government did virtually nothing to study the health of the region’s population afterwards. The state of Pennsylvania was even worse. It deleted cancers from the public record, suspended the state's tumor registry, misrepresented impacts it could not hide, including an apparent tripling of the infant death rate in nearby Harrisburg.¹⁶⁶

A radio documentary highlighted the very disturbing experience of the people of central Pennsylvania. For example, farmers reported a spike in health problems with their farm animals as soon as the first unit of the plant opened in 1974, five years before the accident. But they saw a dramatic increase in birth defects, stillbirths and miscarriages among farm animals after the accident. Entire beehives died immediately. Reproductive rates among the region’s cows and horses plummeted. There were many reports of dramatic decreases in pet fertility, pets being stillborn, and born with birth defects. Birds disappeared. There was wide spread defoliation of trees in the area, and fruit trees produced deformed fruit. Much of this was documented by an investigative team from the newspaper reporting by the Baltimore News-American.

A class action lawsuit was filed by 2400 area residents for the accident destroying their lives and livelihoods. But they have been denied access to the federal court system, which claims there was not enough radiation released to do such harm. But the owners of the plant quietly paid out millions to families of children that were born with various birth defects, in exchange for their silence.¹⁶⁷

The containment building of Unit 2, the unit involved in the accident, was encased in concrete, but is still highly radioactive and there is the concern that more radioactivity remains in the area than has been advertised.

The Trump Administration is pushing a restart of Three Mile Island Unit I, which was shuttered in 2019, with a \$1 billion loan offer to Constellation Energy to support a Microsoft data center’s electricity demand.

B. Simi Valley, So. California

In 1959 the worst nuclear accident in US history occurred in Simi Valley, Southern California. The melt down of an experimental reactor released between 80¹⁶⁸ and 1000¹⁶⁹ times the radioactive Iodine released during the Three Mile Island accident.

Atomic veterans were told by the Defense Nuclear Agency that their internal doses of radiation were negligible. But documents showed that was not true. The AEC told the public “no release of radioactive materials to the plant or its environs occurred and operating personnel were not exposed to harmful conditions.” Twenty years later that lie was exposed and the AEC knew it at the time. For example, an internal memo stated that one air sample had registered radiation 300 times the maximum permissible level.¹⁷⁰ A lawsuit was filed on behalf of over 100 residents 45 years later.

B. Chernobyl



A Chernobyl liquidator pushes a stroller with a baby that was found abandoned a few days after the accident in the village of Tatsenki. The liquidator found the infant while measuring radiation levels. <https://rarehistoricalphotos.com/chernobyl-liquidator-1986/>

On April 26, 1986 the fourth unit of the Chernobyl nuclear plant exploded, causing the world’s most serious nuclear accident. The plant explosion was not reported for two days, and by then the radioactivity had been detected by monitors in Sweden and other Northern European countries. Over 4,760 sq. miles of surrounding territory in Ukraine and Belarus had to be abandoned. Design flaws had led to a power surge that caused a series of explosions that blew off the top of the reactor.

Initially authorities tried to use robots to remove the dangerous debris, but after only a few days, the high levels of radiation damaged the machine’s electronic circuitry, so they recruited human “liquidators” to help with clean up and build the first cement containment structure, i.e. “sarcophagus.”

The WHO and IAEA have claimed that the Chernobyl accident caused only 43 acute deaths and 4,000 cases of fatal cancers. UNSCEAR claims that about 30 workers died from acute radiation, and beyond that, approximately 5,000 cases of thyroid cancer, eventually resulted in 14 deaths. Both claims are preposterously low.²⁴⁹

A 327 page article, written in 2007 by non-government Russian scientists, translated from Russian and published by Annals of the New York Academy of Sciences: *Consequences of the Catastrophe for People and the Environment*, included information from 5,000 published studies, and concluded about 1 million people had died by 2004 from the Chernobyl accident, including 170,000 in North America, 750 million people received significant radiation over half of which fell outside of Russia, and that the global public health consequences are still increasing, not decreasing.¹⁷¹

Nineteen years after the accident, a press release from the Ukrainian embassy in Paris had announced that 2,646,106 Ukrainians must be recognized as victims of the catastrophe, among whom one third are children. And of the more than 800,000 original Ukrainian liquidators, about 15% of them, i.e. 120,000, had died by 2005. Of those still living,” 94% “were ill” and/or disabled in 2005. A recent investigation by the BBC offers statistics closer to these latter numbers.^{250, 172} True to form, the IAEA claims that health studies on liquidators have “failed to show any direct correlation between their radiation exposure” and cancer or other disease.²⁵⁰ Around 40,000 people were hospitalized in the few months after the accident for acute radiation illnesses. As of 2018, the Ukrainian government was paying benefits to the widows of 36,525 men they recognize as having died from radiation, and 1.8 million Ukrainians have the government status of “victims of the disease,” including 377,589 children.²⁵⁰ Death rates in the most heavily exposed areas of Ukraine are about 60% higher compared to the national average in Ukraine.

German scientists made much more alarming assessments of the Russian and European health consequences from Chernobyl, including that 90% of the disease burden related to human genetic damage would show up in unexposed, subsequent generations, and that up to 1 million pregnancies in Europe were lost due to the accident.¹⁷³ Greece, Germany, Wales/Scotland, and the United States showed unusually large increases in leukemia diagnosed in infants before age one if they had been born immediately after relatively low-dose exposures from the 1986 Chernobyl meltdown.^{174,175,176} A significant increase in perinatal mortality was found in Bavaria in 1987, a year after Chernobyl, which corresponded to peak Cesium concentrations in pregnant women.^{177,178}



Child post open heart surgery for congenital heart disease. Photo from Chernobyl Children International, <https://tinyurl.com/4huz7n78>

British pediatrician Dr Rachel Furley, who makes regular visits to treat children in Belarus, says that females who have lived their lives in the fallout zones of Ukraine and Belarus are now old enough to have their own children. Many children are being born with hideous birth defects



Google earth photo of Chernobyl sarcophagus

including missing limbs and even two heads. She says half of the 800 children her charity helps have thyroid cancer.²⁵⁵

The largest wildlife census of its kind conducted in Chernobyl has revealed that mammals are declining in the exclusion zone surrounding the nuclear power plant. The authors stated, “The truth is that these radiation effects were so large as to be overwhelming.” The findings included observations that birds living around the site of the Chernobyl nuclear accident have 5% smaller brains, an effect directly linked to lingering background radiation.¹⁷⁹ Wild boars in Germany are still radioactive, in part from

Chernobyl and from earlier weapons testing.²⁵⁶ Sheep in the UK were radioactive for over 25 years afterwards.

Dr. John Gofman (mentioned in more detail later in this report) calculated that there would be in the range of 1,000,000 cancers caused from the cesium₁₃₇ released from the Chernobyl meltdown, in addition to other widespread health effects.

Radioactive releases had gone on for ten days before helicopters were able to dump 5,000 tons of sand, clay, lead, and boron on to the plant. Because of the ongoing radioactive emissions from the plant, and risk of even more releases, the Russian government hastily built a containment structure around the destroyed plant within months after the accident. Eventually a more permanent containment dome, “the Chernobyl sarcophagus,” at the cost of \$2 billion, was built and moved over the reactor, in a major engineering feat completed in 2017.

The sarcophagus was needed because the radioactive contamination from the accident spread throughout the entire globe. **But only 3% of the total reactivity within the reactor was launched into the atmosphere, 97% of the reactivity remains on site, some of which was exposed to the elements.**²⁵⁵

The Chernobyl nuclear disaster cannot be viewed as a single moment in history—it was the beginning of a long, slowly evolving public-health crisis that continues to expand nearly four decades later.

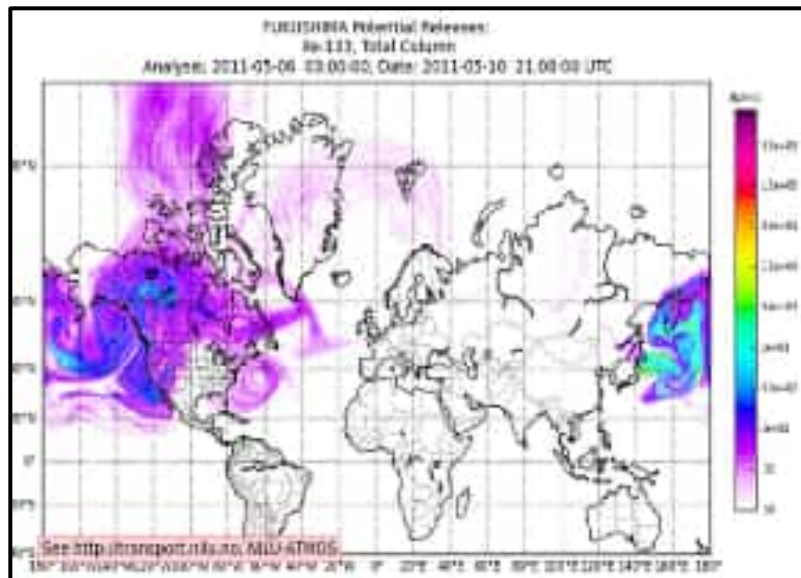
D. Fukushima



<https://cosmoscience.in/fukushima-nuclear-disaster/>

On March 11, 2011, a major nuclear accident started at the Fukushima Daiichi Nuclear Power Plant in Ōkuma, Fukushima, Japan. The initial cause was a large earthquake which caused an electrical grid failure and damaged nearly all of the power plant's backup energy sources. The subsequent loss of water to cool reactors after shutdown compromised containment and resulted in the release of radioactive contaminants into the surrounding environment. Four reactors were damaged and three had core melt downs. It is regarded as the worst nuclear incident since the Chernobyl disaster.

Shortly after the disaster, the American Nuclear Society released a statement that “No public ill health effects are expected.” The Nuclear Energy Institute similarly stated, “No health effects are expected among the Japanese people.” On March 15, 2011, to alleviate public fears, President Obama publicly stated, “The nuclear release from Japan will dissipate by the time it gets to Hawaii, much less the US mainland.” Yet according to the Norwegian Institute for Air Research, using models and direct measurements, radiation blanketed North America and the Western US and Canada within 10 days (see map below).



Apparently at the request of the Japanese government two months later, the US EPA decreased the frequency of measuring radioactivity in air, rain, milk, and drinking water to quarterly from weekly just seven weeks after airborne Fukushima fallout began arriving in the US. That made studying the effects much more difficult.

The Asahi Shimbun newspaper reported on July 21, 2012 that Japanese workers were told to cover their dosimeters with lead and lie about radiation levels they were exposed to.¹⁸⁰ In the early days after the accident, to calm public fears and obscure the radiation impacts from the accident, the NRC officially doubled the baseline annual public radiation dose from the environment by adding an estimation of what people were being exposed to with medical procedures. According to the NRC this dose, “has not been shown to cause humans any harm.” That was never true, but found even more false by studies published since (see previous section on harm from x-rays)

UNSCEAR’s 2013 report on Fukushima stated that prenatal exposures from the accident “were not expected to increase the incidence of spontaneous abortions, miscarriages, perinatal mortality, congenital effects or cognitive impairment”¹⁸¹

A team of international experts estimated that the radiation release from the accident was far greater than the Japanese government had claimed. For example, they calculated that the amount of Cesium 137 released was 43% of that from Chernobyl, that the radioactive noble gas Xenon was more than twice as high as what was released in Chernobyl. Radioactive clouds reached North America five days after the accident, and Europe a week later.¹⁸² Citizen testing found levels of Cesium in multiple hot spots in Tokyo as high as those in the evacuated areas around Chernobyl, but Tokyo was never evacuated.¹⁸³

These “hot spots” were likely caused by a newly discovered hazard from nuclear meltdowns, Cesium rich microparticles (CsMPs). These particles are glassy spheres released from reactor melt downs, small enough to be inhaled into the tiny air sacs of the lungs, i.e. 2 microns and smaller. They don’t readily dissolve, are much more radioactive than soluble cesium

Cesium rich microparticles (CsMPs) released from Fukushima represent an entirely different level of health hazard

particles, and will likely remain actively emitting radiation longer inside the body, likely at least for months, implying a much greater potential for toxicity. And per unit of mass, CsMPs are much more radioactive than even spent reactor fuel. These CsMPs were found to contain 10,000 times more radioactive Cesium than previously recognized soluble particles.¹⁸⁶ This significantly enhances the estimates for doses of internal radiation based on previously assumed soluble cesium.^{184,185} Radioactive xenon measured at Richmond, WA was found to be 40,000 times higher than normal background levels in the weeks following Fukushima.¹⁸⁷

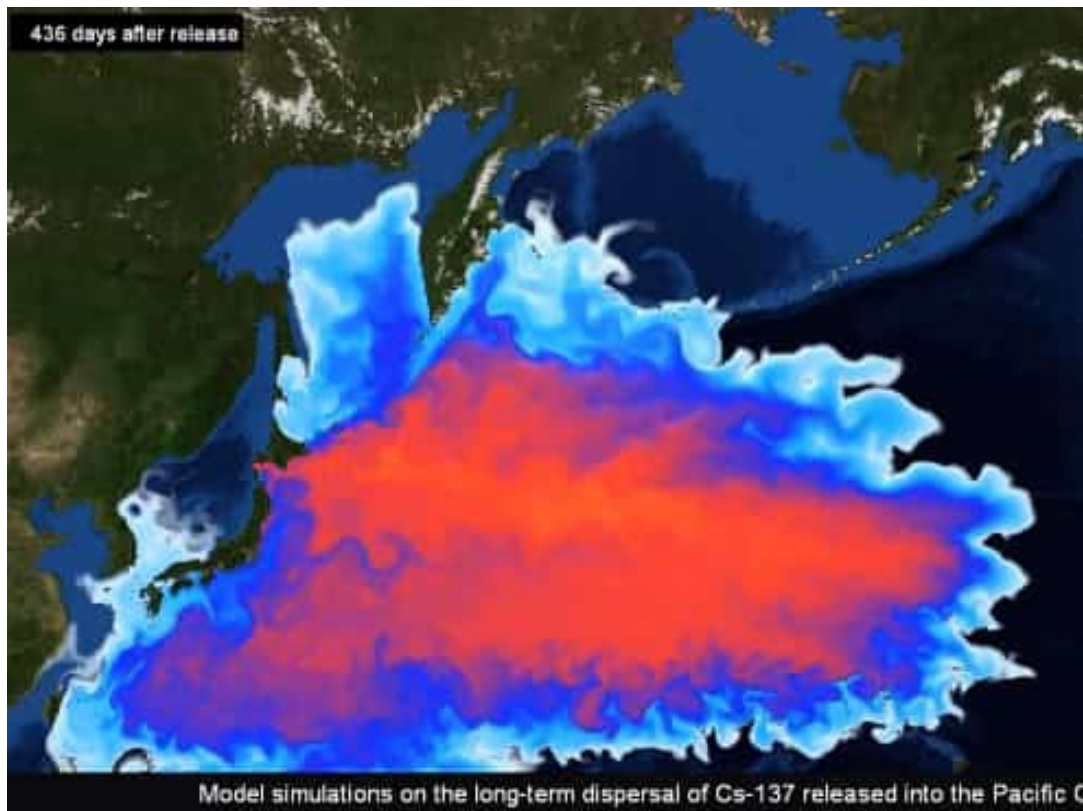
Ten weeks after the accident there was a 35% spike in infant deaths in 122 cities in the United States compared to the same time the year before. Extrapolating that data to the rest of the country suggests that nearly 14,000 newborns may have perished in the United States from the Fukushima meltdown.^{188,189} In the areas around the doomed plant, rates of perinatal deaths were increased 6.4% as far out as 2019.¹⁹⁰ One year after the accident, increased Cesium 134 and 137 were detected in tuna off the coast of California.¹⁹¹

After the accident, water was still needed to cool the very hot, melted nuclear fuel debris, and that need will continue for at least 30 years. Twelve years after the accident the capacity of the onsite 1,000 storage tanks had been reached and Japan made the decision to then release the radioactive waste water into the Pacific Ocean, which began in 2023 and is expected to continue until 2050. China and South Korea slammed the decision. The United States gave tacit approval. The IAEA approved of it, downplaying the risks.

The water is contaminated with over 60 different radionuclides and nonremovable contaminants like tritium and carbon -14. “Weakly radioactive” is a misnomer as was explained earlier. This release has been controversial because it was done primarily as a cost saving to Japan.¹⁹²



Tank farm at Fukushima, from which radioactive water is being released into the Pacific Ocean. Photo, The Asahi Shimbun, Nov. 7, 2022. <https://www.asahi.com/ajw/articles/14762193>



Germany's GEOMAR institute's modelling predicted it would take about two years for the toxic water to reach the Hawaiian Islands.

China banned fish imported from Japan as a result of the contaminated water release.

Once radioactive water is released into the Pacific Ocean it will be dispersed throughout the world's oceans and can also contaminate groundwater near coastal regions.¹⁹³ Two years after the accident, the WHO released a study claiming the accident was unlikely to cause an increase in the incidents of any cancer, a simply preposterous and disingenuous claim. Eight years after the accident, Fukushima-originated Cesium 134 was detected for the first time in the Arctic Ocean ($1.1\text{--}1.5\text{ Bq m}^{-3}$), Bering Sea ($1.4\text{--}1.8\text{ Bq m}^{-3}$), and Chukchi Sea ($1.2\text{--}1.6\text{ Bq m}^{-3}$)¹⁹⁴

A 2015 study from the University of Southern California. concluded that the Fukushima disaster would have been prevented if international best practices and standards had been followed.²³⁷

The tsunami was not the root cause of the disaster. Instead, “‘arrogance and ignorance,’ design flaws, regulatory failures and improper hazard analyses doomed the coastal nuclear power plant even before the tsunami hit.” The diesel generators that were supposed to provide back-up power with the loss of electricity were in fact “the linchpins” in that 22 of 33 back-up generators had been washed away. Of the 33 power lines to these generators, 31 were obliterated by the tsunami. The cooling mechanisms thus failed and the reactors overheated.

TEPCO, the owner and designer of the plant, relied solely on inhouse engineering instead of independent experts, and they underestimated the height of the cliff wall needed to protect from a major tsunami, ignoring warnings from Japanese scientists. The year before an 8.8 magnitude earthquake hit Chile, which should have been a wake-up call to build the cliff wall that was breached higher than they did.

7. Safety: Accidents, Carelessness, and Increasingly Dangerous Environment

Federal law (the Price-Anderson Act of 1957), grants immunity to the US commercial atomic power industry from the consequences of major accidents it might cause.²⁸³ So far, worldwide, 1.5% of nuclear power plants have had a melt-down. As bad as Three Mile Island, Chernobyl and Fukushima disasters were it is only by luck or coincidence that they weren't even worse. Robert Alvarez, an Institute for Policy Studies senior scholar, served as a Senior Policy Advisor to the Secretary of Energy during the Clinton administration says that a fire in just one spent fuel pool could render an area uninhabitable 60 times larger than that created by Chernobyl.¹⁹⁵

Wikipedia gives detail on over 100 significant nuclear accidents (defined as causing loss of life or significant cost) throughout the world since the 1950s. And that's not counting countries like China, Russia, and others that do not make that information public. The United States, that has the most nuclear reactors, has had 56 of those accidents.²³⁹

In a special report, 24/7 Wall Street compiled a list of accidents at nuclear plants between 1990 and 2022 reported by the International Atomic Energy Agency. There are 921 incidents involving nuclear power plants or other radiological mishaps.²⁷⁵

The United States has 31 boiling water reactors (BWR) with pools elevated several stories above ground, similar to those at the Fukushima Dai-Ichi station. This risks of having above ground spent fuel pools should be obvious.

Throughout world since 1975, there have 148 failures of large dams. In the US 34 reactors are downstream of 50 dams. The NRC has calculated that there is a one in four chance that one of those dams will fail in the next 30 years clearly jeopardizing the safety of any of those reactors.

For the first time in history, a major war is being waged in a country with multiple nuclear reactors and thousands of tons of highly radioactive spent fuel. Ukraine's 15 commercial nuclear reactors, including Europe's largest plant, are at risk of catastrophic damage that could render vast areas of Europe uninhabitable for decades.

Safety of nuclear plants requires protection against human error caused accidents, extreme weather events, and terrorism. For the first time in history, a major war is being waged in a country with multiple nuclear reactors and thousands of tons of highly radioactive spent fuel. Ukraine's 15 commercial nuclear reactors, including Europe's largest plant, are at risk of catastrophic damage that could render vast areas of Europe uninhabitable for decades. Russia is constantly attacking Ukraine's energy infrastructure and menacing some of Ukraine's nuclear power plants with drones forcing Ukraine to cut electricity production from the plants. The Ukraine government has warned, "The world must pay attention to Russia's unacceptable and reckless behavior, putting hundreds of millions of Europeans at direct risk,"²³⁸



Hole in the \$2 billion gigantic Sarcophagus placed over the still radioactive Chernobyl reactor, Feb. 2025, caused by a Russian drone attack. 97% of the reactor's original radioactivity remains inside the destroyed reactor.

The Iran War started by Pres. Trump has further elevated the risk of drone terrorist attacks on energy facilities

throughout the world, especially to nuclear plants.

Only one SMR plant (two 35 MW reactors) has operated commercially since 2020 (Russia's Akademik Lomonosov). Russia's standard for safety and public health protection has never been something the world should consider as standard for anyone else. Several others have since been licensed, including one in Wyoming. But this is not a track record extensive enough to justify confidence of safety.¹⁹⁶

Most US reactors were built in the 1970s and 80s. As of 2023, 87 of 92 nuclear reactors have been granted 20 year extensions of the original 40 year licenses. As these reactors age along with their equipment, which is degraded by the radioactivity, then the risk of an accident steadily goes up. The concrete used in nuclear plants becomes increasingly brittle with ongoing exposure to radioactivity, increasing the risk of catastrophic failure.

The issue of safety goes far beyond the power plant itself. Safety is a critical issue for every phase of the nuclear fuel cycle, and the nuclear industry and governments throughout the world have had an appalling track record on safety. Every year the NRC and Dept. of Transportation are supposed to track several thousand shipments of radioactive material-- waste, ores, fuel, medical isotopes—over American roads, rail, water, and airways. A data base has been compiled of over 600 transportation incidents on all major continents, involving every mode of transportation and virtually all forms of nuclear materials.¹⁹⁷

Under the Reagan Administration, the NRC began allowing hospitals and research centers to burn their low-level waste in the open air, or dump them down drains into the public sewer systems.¹⁹⁸

Decades ago the AEC dumped at least 50,000 barrels of nuclear waste into Atlantic and Pacific Oceans, and the Gulf of Mexico. At just one large weapons and nuclear waste site in Aiken, So. Carolina, 111 waste accidents were reported just before 1981, and 1,000 sq. miles around the plant have been contaminated by plutonium from a weapons production reactor and reprocessing plant.¹⁹⁹

At numerous other military nuclear waste sites, like Lewiston, NY, it wasn't so much accidents as a completely cavalier approach to nuclear waste, which included merely dumping on open ground, exposed to all the elements, and washing into nearby creeks. At a nearby Manhattan Project site 37 million gallons of radioactive chemical waste was dumped into unmonitored wells and rusting barrels stacked along the roadside.²⁰⁰

Poor handling of nuclear waste in the Ural Mountains of the Soviet Union caused a massive explosion killing at least hundreds of people and likely thousands in 1957-1958. The Soviets muzzled news of disaster, and the US CIA played along, another example of nuclear countries colluding to muzzle information about nuclear accidents and prevent public fear. The Western press didn't find out about it until 20 years later.²⁰¹ Fourteen lakes were contaminated by the blast, and 30 small towns destroyed. Homes were burned to prevent people from re-entering them.²⁰²

SMRs' capability of placement underground is being promoted as providing increased safety. However, emergency diesel generators and electrical switchgear at Fukushima Daiichi were installed below grade to reduce their vulnerability to seismic events, but this increased their susceptibility to flooding. In the case of an accident and for decommissioning, a reactor and its waste buried underground would be much more complicated, difficult, and costly to deal with.

Some SMR vendors emphasize that their designs are "passively safe," i.e. without the need for electrically driven pumps or operators actions. However, no credible reactor design is completely passive and can shut itself down and cool itself in every circumstance without need for intervention. Passively safe reactors generally require some equipment, such as valves, that are designed to operate automatically but are far from 100% reliable.

As we learned from the Fukushima disaster, the idea that safety is enhanced with multiple smaller reactors is flawed because grouping of multiple reactors together can place all of them at risk even if an event only initially compromises one of the modules. The NRC has acknowledged that some of its current regulations and procedures do not account for events affecting multiple units on a site. The NRC's guidance for probabilistic risk assessment, an analysis tool which is used in many regulatory applications, does not require the consideration of multiple-unit events. This would be completely inappropriate with multiple SMRs in a close group.

SMR vendors are pushing the NRC to allow SMR owners to reduce emergency planning zones and the numbers of required operators and security officers. With international terrorism still a critical, ongoing consideration, and with climate change provoking more extreme weather which increases the vulnerability of all nuclear plants, reducing security requirements for nuclear power plants, regardless of their size, would be a cost savings achieved only by accepting intolerable risk.

The Nuclear Regulatory Commission has a long-standing policy that new nuclear reactors, large or small, are not required to be safer than operating reactors. That does not provide any confidence that SMRs will provide safer operations than existing reactors, and the safety claims about SMRs have not been tested in the real world.

The Union of Concerned Scientists (UCS) point out that reducing safety and security requirements for SMRs could facilitate their sale to utilities or other entities in the United States and abroad that do not have prior experience with nuclear power. Some SMR vendors argue that their technology is so safe that it can be deployed to remote areas, military bases, and countries in the developing world that have relatively low electric demand and no nuclear experience or emergency planning infrastructure. It is unrealistic, irresponsible and frankly dangerous to assume the near-term availability of SMRs which have never been tested and built, are so safe they can be shipped around the world without the need to ensure the highest levels of competence and integrity of local regulatory authorities, plant operators, emergency planning organizations and security forces.

Indeed, the concerns raised by the UCS are starkly illustrated by the nuclear scandal in South Korea, arguably a stronger democracy than the United States, reported in the NY Times on Aug. 3, 2013.²⁰³ The report revealed bribery and faked safety tests for critical plant equipment, exposing a culture of collusion, similar to that found in Japan, which has undermined the safety of their nuclear program. Close ties between South Korea's nuclear power companies, their suppliers and testing companies have led South Korea's prime minister to liken the industry to a mafia. Trusting many other countries with far worse reputations than South Korea to operate SMRs is willful blindness to the risks.

The United States is hardly any more trustworthy on nuclear safety standards. In a clear capitulation to Big Tech and nuclear industry companies that want SMRs to supply electricity to their massive AI data centers, and for the express purpose of meeting an arbitrary deadline of building three experimental nuclear reactors by summer of 2026, the Trump Administration has gutted multiple nuclear safety standards after meeting secretly with members of the industry and specifically shutting out the usual input from the public.²⁰⁴

The Trump Administration has gutted numerous nuclear safety standards after meeting secretly with members of the industry and specifically shutting out the usual input from the public.

The new orders slash about two thirds of the hundreds of pages of requirements for security at the reactors. What remains from this “nuking” of the safety regulations includes less protection for groundwater and the environment, less record keeping, more radiation exposure for workers before an official accident investigation is required. The Trump orders strip out critical guiding tenets of nuclear safety, such as the "As Low As Reasonably Achievable" (ALARA), which requires nuclear reactor operators to keep levels of radiation exposure below the legal limit if “reasonably” possible. The new rules also eliminate the requirement to use the "best available technology" to protect water supplies from the discharge of radioactive material, such as the afore mentioned tritium. President Trump’s declaration that "It's [nuclear] become very safe and environmental, yes 100%."²⁰⁵ is hardly reassuring or a representation of any miraculous safety breakthroughs.

The Trump Administration’s approach to reactor safety is a shocking endangerment of the United States and the entire world. Just as disturbing is the nuclear industry’s eager reception of those weakened regulations. Their cavalier attitude is reminiscent of Slim Pickens in the classic, satirical comedy, *Dr. Strangelove*, but without the comedy part. Pickens plays Major T.J. (“King”) Kong, a bomber pilot whose mission is to drop a nuclear bomb on Russia which will begin the mutually assured destruction of the world. When the bomb doors won’t open he manually opens the doors and gleefully rides the bomb like a bull as it plummets toward oblivion, waving his Stetson like a rodeo rider.



The Wasatch Front’s vulnerability to earthquake would make those kinds of cost savings unacceptably dangerous. **The US Geological Survey puts the probability of one or more Wasatch Front earthquakes at 6.75 magnitude or greater at 43% in the next 50 years, and a 57% probability of one or more of 6.0 magnitude or greater.**²⁰⁶

The climate crisis is already increasing risks and challenges for nuclear power plants. Extreme weather events such as floods, hurricanes, heat waves and droughts, are already affecting the operation and electricity production of nuclear power plants. Higher temperatures of the water used to cool nuclear power plants can lead to loss of power output secondary to decreasing thermal efficiency.²⁰⁷

The warming of rivers and rising temperatures can weaken the cooling of power plants and equipment. Nuclear reactors in the United States and France are often shut down during heatwaves, or see their activity drastically slowed. They may have to acquire waivers to operate with cooling water above regulated temperatures. Nuclear plants that need water for cooling need to be sited near rivers, lakes, and coastlines for a source of water, so they are susceptible to flooding, and with the climate crisis that risk will increase.

France, with one of the largest nuclear power fleets in the world, can provide around 70% of the country's energy from nuclear. But in 2022, the country's nuclear power output dwindled to 40%, because of drought and heat waves.²⁰⁸

A 2020 Moody's analytic report found climate crisis related rain storms and flooding at plants along the East and Gulf Coast may "inundate" the facilities and "damage transmission lines or substations, hindering a plant's ability to deliver power." In 2012, 12 nuclear plants were in the direct path of Hurricane Sandy which caused various degrees of emergency shutdown at five nuclear plants in the northeast due to high water levels and the storm's impact on the electrical grid.^{209, 210}

There have been numerous incidents throughout the world of fish kills shutting down nuclear power plants. Power plant water intake systems draw in large volumes of water for cooling and can create significant kills of fish populations for two reasons. 1. Impingement, i.e. when fish are trapped against the intake screens by the force of the water. 2. Entrainment happens when smaller organisms, such as fish eggs, larvae, and small fish, are drawn through the cooling system, where they are exposed to high temperatures, pressure changes, and mechanical stress. When intake screens are clogged, power has to be ramped down quickly.

In 2025, millions of fish were killed after getting trapped in the Bruce Power nuclear plant's intake system on the shores of Lake Huron, forcing the plant to reduce power production.²¹¹ Over the last 60 years these incidents have occurred in England, France, South Africa, South Korea, and the United States.

Jellyfish blooms are increasing with warmer water temperatures from the climate crisis and increasing marine pollution. Nuclear plants in Sweden, Israel, Japan, Scotland, and France have experienced forced shut downs because of jellyfish clogged intake screens, some have required emergency action literally within minutes. Cleaning those screens are difficult, time consuming, and dangerous.^{212,213,214,215} Warmer water temperatures from the climate crisis and from power plant thermal effluents will increase these kinds of incidences with jellyfish.²¹⁶

Warmer water temperatures have, in and of themselves, created massive fish kills which have actually clogged the water intake to power plants. Sudden plant shut downs causing sudden releases of cold water have also caused mass fish kills.

Nuclear reactors are never really "off." So, even when they are not producing electricity, nuclear reactors still need cooling which means they still need water. That water is increasingly too warm or too scarce, especially in the summer when it's hot and demand for electricity increases.

There have been instances in the past where thermoelectric plants have had to curtail production because their exhaust water exceeded allowable temperatures. And yet, despite a myriad of potential problems and two decades of climate warnings, it is sobering to note that none of the US reactors were built to account for any of this. Most SMR designs will still need water for cooling and will be vulnerable to water scarcity and high temperatures.

SMRs are likely not safer than larger reactors on a per kilowatt-hour basis. For example, large reactors are required to have an expensive containment structure that theoretically would sequester 90% of radioactivity that would be released from a core meltdown. But if a reactor one fifth as large, without a containment structure (which SMR salesmen are proposing are not needed), has a core melt down, it would release even more radioactivity into the environment.

If under the premise of less danger these SMRs are built near population centers like what Gov. Cox wants for Brigham City, then more people could be exposed to high levels of radiation from an SMR accident in an urban setting. And if the site has multiple reactors like was planned with NuScale, then the risk is proportional to the number of reactors. In fact, as happened with Fukushima, an accident in one reactor can lead to a chain reaction damaging any or all of the others.

After the Fukushima disaster, The NRC spent a year devising a list of twelve post-Fukushima safety improvements to require in the United States but chose to demand only three and then gave the industry up to five years to comply. The NRC requires operators of plants found to be vulnerable to severe accidents to fix the problem “only if a cost-benefit analysis shows that the financial benefit of a safety backfit -- determined by assigning a dollar value to the number of projected cancer deaths that would result from a severe accident -- outweighs the cost of fixing the problem.”

SMRs do not solve the problem of storage of spent nuclear fuel, the most dangerous kind of nuclear waste as previously discussed. Any community like Brigham City with one or more SMRs in the middle of a population center will have to store the waste on site, for at least 200,000 years, close to tens of thousands of people. There is already more than 90,000 metric tons of high level nuclear waste in the United States in need of long term storage. The cost to store nuclear waste in the United States as of 2018 is about \$500 million a year. That must continue for thousands of years, long after the all the nuclear plants have had to shut down, and no revenue stream is being generated to pay for that, a colossal financial and safety burden for future generations.

A 2022 study from Stanford and the University of British Columbia found that overall SMRs are inferior to conventional reactors on the problem of “radioactive waste generation, management requirements, and disposal options.” They involve more “neutron leakage,” than conventional reactors which makes surrounding structures of steel and concrete more radioactive, making eventual disposal and decommissioning more dangerous, necessary, and expensive. Further, this increased leakage affects the amount and composition of their waste streams, like spent fuel rods. The study estimated that the volume of spent nuclear fuel would increase 2-30 times, with at least 50% more radioactivity than large-scale reactors, and with some designs the waste stream

would also require “exotic fuels and coolants” requiring costly chemical treatment prior to disposal.

With SMRs the amount of high-level nuclear waste would actually increase between 2 and 30 times, and with 50% more radioactivity compared to large-scale reactors.

8. Climate impacts – Nuclear is No Answer to the Climate Crisis

The world’s climate scientists are in virtually unanimous agreement that we are facing a climate crisis on an unprecedented scale.

Furthermore, over the last three years, global warming has increased faster than at any previous time in recorded history, and has breached the threshold of 1.5° C, red line for avoiding catastrophic feedback loops calculated a decade ago. “Nature has so far balanced our abuse,” says Johan Rockström, a leading Earth systems scientist. “This is coming to an end.”²⁴⁷ Once tipping points kick in it is essentially game over for

an inhabitable global climate. This threat to the human race likely even exceeds that of nuclear war. Any argument that more nuclear power will help mitigate the climate crisis is either disingenuous or willful ignorance, and is nothing more than sticking our heads in the sand.



Newstalk ZB. Protesters mock climate change lack of action.
December 7, 2014.

<https://www.newstalkzb.co.nz/news/national/protesters-mock-climate->

A 2024 report from the Institute for Energy Economics and Financial Analysis found that SMRs are still “too expensive, too slow to build, and too risky” to meaningfully help the world transition from fossil fuels in the coming 10 to 15 years. Because of the multiple tipping points warned about by climate scientists, that is too distant a time frame to provide benefit to the energy demand/climate crisis equation. Stabilizing the climate is an emergency, nuclear power is far too slow to be a significant contributor to solutions.

Furthermore, nuclear power is a wolf in zero-carbon clothing. There is no such thing as a zero carbon emission nuclear plant. Over a 100 year life cycle, a nuclear plant’s carbon emissions are not zero, but about one fourth that of a natural gas plant. Overall, emissions from new nuclear

plants are 78 to 178 g-CO₂/kWh. (grams of CO₂ equivalents per kilowatt of electricity produced) Uranium mining and enrichment is particularly carbon intensive.²⁴⁸

Doubling the capacity of nuclear power worldwide in 2050 would only decrease greenhouse gas emissions by around 4%. But in order to do that, the world would need to bring 37 new large nuclear reactors to the grid every year from now, year after year, until 2050—completely unrealistic.

All nuclear plants also emit 4.4g-CO₂e/kWh from the water vapor and heat they release. This contrasts with solar panels and wind turbines, which reduce heat or water vapor fluxes to the air by about 2.2 g-CO₂e/kWh for a net difference from this factor alone of 6.6 g-CO₂e/kWh. The typical reactor takes 10-19 years to build, as opposed to 2-5 years for utility solar or wind.²⁴⁸

The Intergovernmental Panel on Climate Change concluded that the economic, social, and technical feasibility of nuclear power have not improved over time.

Jacobson, M.Z. Evaluation of Nuclear Power as a Proposed Solution to Global Warming, Air Pollution, and Energy Security, in 100% Clean, Renewable Energy and Storage for Everything, Cambridge University Press, New York, 427 pp., 2020
<https://web.stanford.edu/group/efmh/jacobson/WWSSBook/WWSSBook.html>
 December 22, 2019

Table 3.5. Total 100-year CO₂e emissions from several different energy technologies. The total includes lifecycle emissions, opportunity cost emissions, anthropogenic heat and water vapor emissions, weapons and leakage risk emissions, and emissions from loss of carbon storage in land and vegetation. All units are g-CO₂e/kWh-electricity, except the last, column, which gives the ratio of total emissions of a technology to the emissions from onshore wind. CCS/U is carbon capture and storage or use.

Technology	^a Lifecycle emissions	^b Opportunity cost emissions due to delays	^c Anthropogenic heat emissions	^d Anthropogenic water vapor emissions	^e Nuclear Weapons risk or 100-Year CCS/U leakage risk	^f Loss of CO ₂ due to covering land or clearing vegetation	^g Total 100-year CO ₂ e	Ratio of 100-year CO ₂ e to that of wind-onshore
Solar PV-rooftop	15-34	-12 to -16	-2.2	0	0	0	0.8-15.8	0.1-3.3
Solar PV-utility	10-29	0	-2.2	0	0	0.054-0.11	7.85-26.9	0.91-5.6
CSP	8.5-24.3	0	-2.2	0 to 2.8	0	0.13-0.34	6.43-25.2	0.75-5.3
Wind-onshore	7.0-10.8	0	-1.7 to -0.7	-0.5 to -1.5	0	0.0002-0.0004	4.8-8.6	1
Wind-offshore	9-17	0	-1.7 to -0.7	-0.5 to -1.5	0	0	6.8-14.8	0.79-3.1
Geothermal	15.1-55	14-21	0	0 to 2.8	0	0.088-0.093	29-79	3.4-16
Hydroelectric	17-22	41-61	0	2.7 to 26	0	0	61-109	7.1-22.7
Wave	21.7	4-16	0	0	0	0	26-38	3.0-7.9
Tidal	10-20	4-16	0	0	0	0	14-36	1.6-7.5
Nuclear	9-70	64-102	1.6	2.8	0-1.4	0.17-0.28	78-178	9.0-37
Biomass	43-1,730	36-51	3.4	3.2	0	0.09-0.5	86-1,788	10-373
Natural gas-CCS/U	179-405	46-62	0.61	3.7	0.36-8.6	0.41-0.69	230-481	27-100
Coal-CCS/U	230-935	46-62	1.5	3.6	0.36-8.6	0.41-0.69	282-1,011	33-211

9. Water Consumption

Like other thermal electrical generating plants, nuclear plants need water for cooling. The two main cooling techniques employed in nuclear reactors are “once-through cooling systems” and recirculating cooling systems. Once-through systems withdraw large amounts of water from a near-by water source to absorb thermal energy created by the reactor, and then release the water back at a higher temperature. The water “used” is not necessarily the same as the water “consumed” or lost. This technique requires substantial water withdrawals and can lead to thermal contamination, adversely affecting aquatic ecosystems.

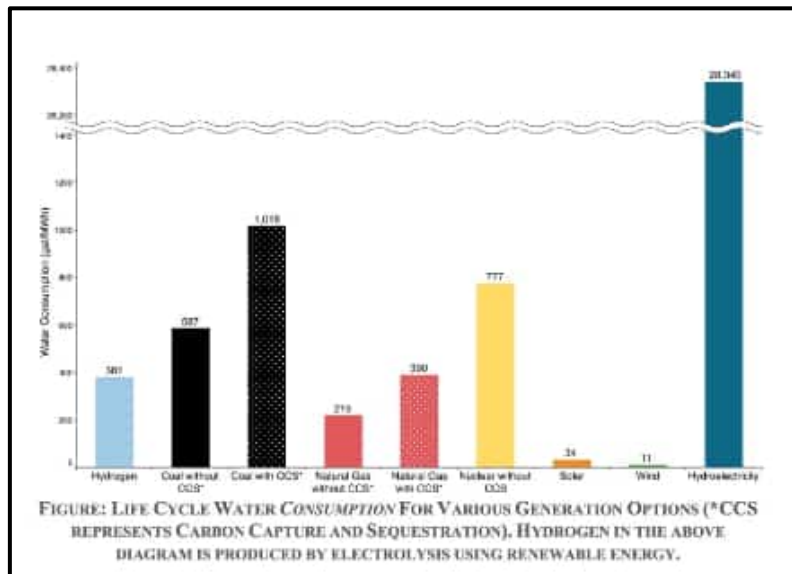
On the other hand, recirculating systems periodically cool water in a tower before recirculating it through the plant. This technique reduces water withdrawal from the source (river, lake, ocean), but recirculating systems still need “makeup water” to offset evaporation, blowdown, and other losses. Furthermore, the cooling process leads to the evaporation of hot water into the atmosphere, contributing to the water loss rate.

In either case the water loss is similar to, or slightly more than that associated with a coal fired power plant. In a desert, facing persistent and worsening drought, the water demands of nuclear reactors should disqualify it as a solution to future electricity needs.

Plant and Cooling System Type	Water Usage (gal/MWh)	Typical Water Consumption (gal/MWh)
Fossil/biomass/waste-fueled steam, once-through cooling	20,000 to 50,000	~300
Fossil/biomass/waste-fueled steam, pond cooling	300 to 600	380-480
Fossil/biomass/waste-fueled steam, cooling towers	500 to 600	~480
Nuclear steam, once-through cooling	25,000 to 60,000	~400
Nuclear steam, pond cooling	500 to 1100	400-720
Nuclear steam, cooling towers	800 to 1100	~720

Table 1: Comparison of water requirements for fossil fuel and nuclear power plants. Source: [EPRI](#)

With funding from the Utah Legislature, the University of Utah Energy and Geosciences Institute did a study in 2023 examining water consumption from various energy production operations demonstrating that nuclear plants consumed more water than coal plants that did not have carbon capture and sequestration.²⁵⁷



The study concluded that water consumption for the cancelled NuScale SMRs would consume more water per unit of electricity produced than coal powered plants if they used proven cooling technology. Regarding NuScale’s claim they could have used dry cooling and therefore no water, it should be noted that no nuclear plant in the world has been successful with that technology.

10. Scientists Who Have Opposed Nuclear Power

Politics has always obscured, if not smothered the science of nuclear weapons and nuclear reactors. Fear of communist Russia and the reluctance to criticize America’s nuclear weapons program suppressed public criticism of both nuclear weapons testing and nuclear power until the late 1950s when “the Red Scare” mindset started to wane. Slowly scientists started speaking out about the biological damage caused by radiation exposure. When two Colorado scientists, Dr. Ray Lanier and Dr. Theodore Puck, expressed concern about the public’s exposure to radiation, the governor of Colorado called for them to be arrested.

These scientists had started explaining to the public that Geiger counter readings did not tell the whole story about radiation. Specifically, that when beta and alpha particles were inhaled or ingested they represented a much greater risk of biologic damage than the external radiation picked up the Geiger counters. Soon after, Dr. Stanley Livingston, Chairman of the Federation of American Scientists and a physics professor at the MIT, said scientists were growing apprehensive “that we may soon reach a level of radiation in the atmosphere which would be dangerous genetically to the future of the race.”²¹⁷

Dr. Karl Z. Morgan, director of the Oak Ridge Health Physics Lab during that era, reflected in 1980. “It became unpatriotic and perhaps unscientific to suggest that atomic weapons testing might cause deaths throughout the world from fallout.”²¹⁸

To voice concerns about radiation was equated with treasonous support of Russian propaganda. Nonetheless, Nobel Prize winners, Linus Pauling, Albert Schweitzer, Hermann Muller, and other prominent physicists and medical experts like Bruce Wallace, Harold Knapp, Alice Stewart, Dr. Ralph Lapp, Dr. Arthur Tamplin, Dr. Curtis Stern, Dr. Barry Commoner, E.B. Lewis, and George Beadle, president of the American Association for the Advancement of Science, raised objections about public exposure to radiation from the nuclear industry. Muller had won the Nobel Prize for discovering that X rays caused genetic mutations.

Stewart found that X rays during the first three months of pregnancy increased the risk of a childhood cancer by ten times.²¹⁹ Stewart's work completely upended the medical community's understanding of the risks of radiation during fetal development and caused the practice of X-raying a woman's pelvis to determine her capability of a vaginal delivery to be abandoned.

By 1956 the move to halt nuclear testing became part of the Democratic Party platform. Nonetheless the nuclear bomb tests continued.

In Jan. 1958, Linus Pauling collected 11,021 signatures on a petition from scientists representing 50 nations, including 216 from the Soviet Union, 701 from Britain, and 1,161 from Japan. The petition called for a halt of nuclear testing, and included this phrase. "Each nuclear test spreads the added burden of radioactive elements over every part of the world...Each added amount of radiation causes damage to the health of human beings all over the world and causes damage to the pool of human germ plasm such as to lead to an increase in the number of seriously defective children that will be born in future generations." The US federal government responded by stripping him of federal research funds. Eventually he was awarded the Nobel Peace Prize for it, the only two-time Nobel Prize winner in modern history.

Despite more than ten years of nuclear bomb testing, the AEC had never bothered to assess the impact of nuclear fallout on public health.

Dr. John Gofman was probably the most qualified person in the United States, if not the world, to opine about the risks of nuclear radiation. Gofman was a member of the original team of Manhattan Project scientists, a pioneer in radiation research who co-discovered the fissionability of uranium 233 and was credited with isolating the world's first milligram of plutonium. He was also one of the world's most important researchers on cholesterol's impact on heart disease, establishing what is "good" and "bad" cholesterol. The Journal of Clinical Lipidology named him the Father of Clinical Lipidology.

Goffman started out a cheerleader of the weapons testing and the nuclear industry. He was chosen by the AEC to conduct the first comprehensive program to study the health effects of radiation in 1963, essentially to undermine the anti-nuclear crusading of Linus Pauling. But he was compelled to change his mind by his own research. By 1969 he and Dr. Arthur Tamplin called for a ten-fold reduction in the AEC's maximal permissible radiation exposure of the public from nuclear reactors. He constantly stood up to government pressure to suppress what he knew about radiation's health dangers and set an unprecedented example of scientific integrity.

Gofman's public statements lead to the formation of the US National Academy of Sciences (NAS) Biological Effects of Ionizing Radiation (BEIR) I Committee in order to evaluate his and Tamplin's concerns about radiation exposure. The BEIR Committees, eventually there were seven of them, have confirmed the LNT (linear non-threshold) dose response model, suggested by Gofman and Tamplin, which established the tenet that there is no safe threshold of radiation exposure. These two scientists probably had more to do with public perception of the risks of nuclear power and the ultimate restraining of expansion of the industry than any other experts. This risk assessment has also been duplicated and accepted for other environmental contaminants like chemical exposures.²²⁰

In 1979 Gofman made this public statement:

"In the mid-'50s—when the toxicity of low-dose radiation was still uncertain—we were testing nuclear bombs in the atmosphere and launching the Atoms for Peace Program. It should have been clear to me, even then, that both atmospheric bomb-testing and nuclear power constituted experimentation on involuntary human subjects, indeed on all forms of life. I am on record in 1957 as *not* being worried yet about fallout and still being optimistic about the benefits of nuclear power. There is no way I can justify my failure to help sound an alarm over these activities many years sooner than I did. I feel that at least several hundred scientists trained in the biomedical aspect of atomic energy—myself definitely included—are candidates for Nuremberg-type trials for crimes against humanity through our gross negligence and irresponsibility. Now that we *know* the hazard of low-dose radiation, the crime is not experimentation—it's *murder*."^{220,221}

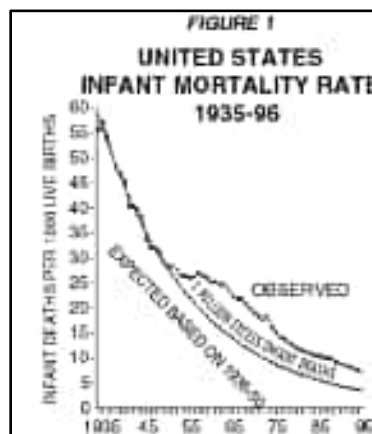


University of California, Berkeley Graduate Division. John W. Gofman. <https://grad.berkeley.edu/news/profiles/john-gofman/>

Goffman's books, **Radiation and Human Health (1981)**, **Radiation-Induced Cancer from Low Dose Exposures: An Independent Analysis (1990)**, and **Radiation from Medical Procedures in the Pathogenesis of Cancer and Ischemic Heart Disease (1999)**, were key to disproving the existence of a safe dose of radiation. He explained how the studies of the Hiroshima and Nagasaki survivors were inappropriately used as the basis for radiation risk estimates, but were never designed to find genetic health effects in future generations, so any claims of no transgenerational health effects are not valid.

He calculated that without any accidental releases and with 99.9% containment, 4 times as much cesium-137 is routinely released from 100 (1000 megawatt) nuclear reactors operating for 25 years as was released by the Chernobyl disaster.

The first scientist to try to quantify the number of deaths from nuclear weapons testing in the US was Dr. Ernest Sternglass, a physicist, a University of Pittsburgh School of Medicine professor, and friend and colleague of Albert Einstein. He published research in 1969 theorizing that the steady decline in infant mortality in the US of 4% a year due to medical advancements, had abruptly stopped during the era of weapons testing, and then the steady decline resumed when the testing stopped. He calculated that 375,000 American babies likely died, and he theorized the nuclear radiation exposure to the country had caused it. He also postulated that 2 million fetuses had also perished. He was vigorously attacked by the nuclear industry and their allies.²²²



In a panic, the AEC commissioned a study that concluded the number was closer to 4,000. Goffman later concluded that Sternglass was right.²²¹

Sternglass conceived and directed the “Tooth Fairy Project” that measured strontium 90 in 5,000 baby teeth, the only study to measure radioactivity in human bodies among those living near nuclear plants. He was viciously targeted by non-health professionals in the nuclear industry and their allied politicians.

Dr. Robert Pendleton, a Utah radiologist, sounded the alarm of radiation leaks from even underground nuclear tests. On July 7, 1962, Pendleton was in Big Cottonwood Canyon with students taking measurement of environmental radioactivity. He said then, “A cloud of radioactive material came over and all the measurements began to go nuts. I recognized that we

were getting fallout and took the students off the hill and back down in the valley.”²²³ The cloud of fallout had increased radioactivity readings by a factor of 100, yet it was only an underground test, a hydrogen bomb nicknamed, *Sedan*.²²⁴

Dr. Pendleton continued a campaign of warning against underground testing throughout the 1960s. In an article in *Science* magazine he made the case that the thyroids of many thousands of Utah people were seriously threatened even by underground nuclear detonations in Nevada and children in their first two years of life put at the greatest risk of all.²²⁵

“Surely each person to be showered with radioactive dust from engineering tests should be fully informed of this possible hazard, and should be given a chance to decide whether the risk is justified,” Pendleton told *Science Digest* in 1967.²²⁶ Pendleton was rewarded for his warnings by being stripped of his federal research funds. Underground tests continued until 1992.

All these scientists were attacked by our government and industry in various ways and made huge personal sacrifices in their careers by expressing their opinion. But their scientific conclusions have stood the test of time.

11. Conclusion

The track record of the nuclear industry is itself a bright red flag warning about the danger of allowing it to expand. There is no comparable source of power that has the potential to inflict environmental carnage and public health devastation on an unimaginable scale, reaching every corner of the globe.

Nonetheless, a putative nuclear power “renaissance” is promoted every few years by lobbyists from the industry. But the current objections to nuclear power are essentially the same as those that have been raised for several decades, no matter the size of the reactor. “Fun size” reactors (SMRs) do not solve any of the multiple problems with nuclear power plants. They still represent a public health threat through routine radiation release from every phase of the nuclear fuel cycle. Costs are prohibitive and major delays are inevitable. Reducing costs by eliminating safety measures, as is being promoted by nuclear lobbyists, should be viewed by everyone as alarming and unacceptable.

The danger of global contamination from a major accident has been exposed enough times to disqualify it from becoming an expanded source of electricity in the future. The long-time frame required to safely construct nuclear plants means, for that reason alone, more nuclear power will not help mitigate the climate crisis. As the Western US sinks ever deeper into a water crisis, nuclear plants should be disqualified from being part of future energy sources on that basis.

The Trump Administration’s callous disregard for safety regulations, the rapid advance of the threat of weather extremes from the climate crisis, and the accelerating danger of widespread spread regional and international military conflicts from the US war on Iran and the Russian war on Ukraine, all combine to create an environment of ever-increasing risk to the safety of all nuclear plants. And that obviously adds to the reasons not to build new ones.

SMRs do not solve any of the inherent problems with nuclear power—cost, danger, radiation exposure, safety, and waste storage. In fact, they will actually aggravate most of them. The requirement to sequester high-level waste in perpetuity should be recognized as an intolerable burden to place on future generations. And for that reason, relying on more nuclear power, regardless of reactor design or size, would be a massive moral failure of current generations.

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