



## Frame of Reference

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*"Tell us your phobias and we will tell you what you are afraid of." – Robert Benchley*

In early August of 1975, Typhoon Nina came crashing over Taiwan as a Category 3 storm. Heavy rainfall triggered massive flooding, resulting in the deaths of 29 people. As the storm crossed the Taiwan Strait into mainland China, biblical levels of precipitation fell over vast swaths of the Chinese countryside, ultimately causing the total collapse of the giant Banqiao Dam in Henan Province. Dozens of other hydroelectric dams fell like deadly dominoes, swamping millions of homes downstream and devastating entire communities. Although the scale of the catastrophe was initially covered up by the Communist Party of China (CCP), it is now estimated that at least 26,000 and as many as 240,000 people were killed.



### Dam collapse | Wikipedia

On July 6, 2013, a 73-car freight train operated by Montreal, Maine, and Atlantic Railway (MMA) derailed in the heart of the small town of Lac-Mégantic in the Province of Québec. The train was carrying Bakken crude and several cars exploded. The horrific inferno destroyed over 30 buildings, taking the lives of 47 innocent souls. The blast radius was estimated to be over a half-mile wide, and the blaze required approximately 150 firefighters to be extinguished. The tight-knit community of 6,000 people has been forever scarred by the incident.



### Horrific fire | Sûreté du Québec

That same year, two young mechanics died while servicing a wind turbine in Ooltgensplaat, The Netherlands. The pair were trapped on high as the fire approached them, and a gut-wrenching photograph of the two embracing moments before their tragic passing was widely circulated on the internet. One chose to leap nearly 260 feet to his death while the other succumbed to the smoke and flames. They are among the dozens of workers who have died while installing or servicing wind energy projects.

These deadly events occurred as a consequence of humanity's unrelenting pursuit of energy. Harnessing, storing, and transporting energy across long distances is inherently risky business, no matter the energy source. Society generally responds to these tragedies—and the hundreds of other similar examples we could have selected—in reasonable and measured ways. The world did not abandon hydroelectric power because of the possibility of freak occurrences like Typhoon Nina. On the contrary, millions of people still actively choose to live within the flood radius of a potential dam failure. Huge volumes of oil are still shipped by rail each day despite the deadly incident in Lac-Mégantic, and executive actions like scuttling the Keystone Pipeline only serve to fortify demand for such services for decades to come. Despite the horrific death of

those two young mechanics, government support for wind energy continues to grow exponentially. In all circumstances, risks were measured, tradeoffs were made, and society moved forward.

Why is nuclear energy treated so differently?

Unique among the primary energy providers, the civilian nuclear power industry has been the subject of a decades-long propaganda campaign whose aim is to stoke irrational fear to the point that the general population loses faith in the technology altogether. No risk is too small to amplify beyond all plausible proportion, no benefit too large to minimize into irrelevancy. As a result, much of the industrialized world is effectively being robbed of the true and full potential benefits of this nearly inexhaustible source of clean, safe, and reliable energy.

What are the genuine risks of nuclear technology, and how do they compare to other aspects of our everyday lives? What are the most common rhetorical sleights-of-hand used by the industry's opponents and how can its supporters counter them? Let's analyze the numbers, point out the logical fallacies, and reclaim the scientific high ground.

We begin with a bedrock axiom of the science of toxicology: risk is a function of both the underlying toxicity of the substance and its dose level—the former being an inherent aspect of the natural world, and the latter a highly variable measure that depends on several factors usually well within our control. In many instances, exposure to a small dose of a “highly toxic” substance can even save lives, as countless cancer survivors will attest. The same life-saving drug administered at scientifically validated dose levels can result in death by poisoning if consumed recklessly. The entire point of Phase I clinical trials is to determine the concentration at which the ratio of benefit-to-risk reaches its apex. Outside of the medical setting, we make such tradeoffs all the time, even if the underlying calculations are performed subconsciously. (This is why we find it acceptable to catch a whiff of chlorine bleach but few would be willing to drink it.)

Consider something as simple as the common campfire. A full toxicological workup of the molecular composition of wood smoke would reveal scores of known carcinogens, significant levels of dangerous fine particulate matter, and the deadly gas carbon monoxide. The US Environmental Protection Agency (EPA) estimates “*that wood smoke is 12 times more*

*carcinogenic than equal amounts of tobacco smoke, and that it stays active in the body up to 40 times longer.*” Moreover, campfires are the root cause of countless accidental forest fires, which have led to innumerable deaths and immeasurable property damage worldwide. Where is the campaign against roasting marshmallows over an open flame? Why haven’t we banned such activities? Shouldn’t the EPA establish a “safe seating radius,” scaled to campfire size and stratified by age or pre-existing medical conditions? Perhaps we should wear masks while fireside? Or simply observe summer bonfires by the lake through the lens of a telescope? One can’t be too safe, or can we?



How dare you | Shutterstock

By comparison, contemplate society’s wholly unjustified fear of radiation, despite its frequent beneficial use in many aspects of our everyday lives. Certain atomic nuclei are unstable and known to decay at fixed rates, releasing highly energetic particles of radiation in the process. Like all potential toxins, some forms of radiation are more dangerous than others, and the hazard is heavily dependent on the dose. We are capable of distinguishing between the radiation exposures received while eating a banana, getting an X-ray, or flying on a plane as being more manageable than dealing with the fallout of a full exchange of thermonuclear

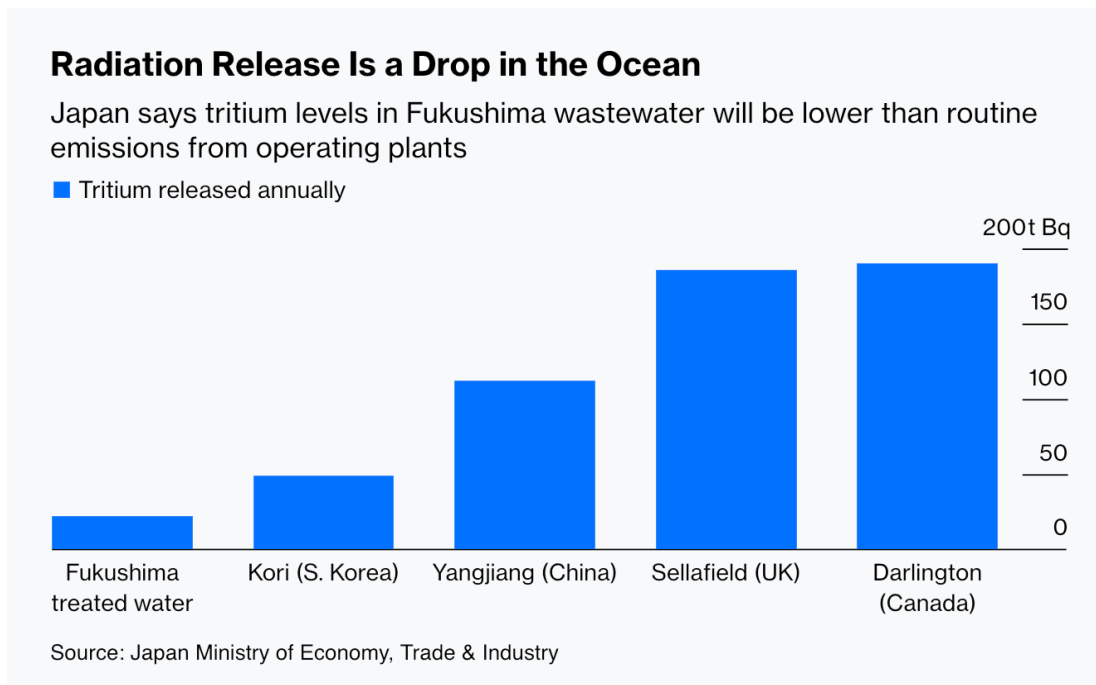
weapons by military superpowers. But for some reason, radiation associated with the civil nuclear energy sector is routinely conflated with the same risks presented by weapons of war. Here, we are led to believe that all radiation—real and imagined—is the functional equivalent of an existential threat to humanity itself, and no amount of prudently engineered redundancy suffices to assuage these radically unfounded fears. Sadly, this is all by design.

Nowhere are the ugliest tricks of the anti-nuclear propagandists on fuller display than in their cynically opportunistic response to the flooding of the Fukushima Daiichi Nuclear Power Plant in 2011. Like the collapse of the Banqiao hydroelectric dam, the accident at Fukushima was caused by a once-in-a-generation natural catastrophe—a tsunami struck Japan shortly after a giant earthquake shook the island nation—but in contrast to what happened in China decades prior, *nobody died from radiation* in the immediate aftermath. The official death toll directly tied to Fukushima now stands at one. (A singular fatality from cancer that occurred four years later has been officially ruled to have arisen from exposure to radiation stemming from the incident.) You could be forgiven if this information surprises you since countless newspaper articles place references to “Fukushima” and “radiation release” conspicuously near the total deaths and injuries from the *tsunami itself*.

For peak absurdity, consider the fabricated international uproar over Japan’s proposal to safely discharge back into the environment some of the 1.3 million cubic meters of seawater that have been sprayed onto Fukushima’s damaged cores to keep them from overheating. After 12 years of careful processing, authorities have eliminated “*enough of 62 of the 64 radionuclides to bring their concentration below Japan’s 2022 regulatory limits for water to be discharged into the environment.*” All that remains are moderate concentrations of relatively benign carbon-14 and tritium, and the release plan calls for a further 100:1 dilution with seawater as the material is slowly dispersed into the Pacific Ocean *over a period of 30 years*. Despite these herculean and wholly unnecessary measures, Hong Kong—acting at the behest of those in Beijing who would have undoubtedly dumped this water into the sea without telling anybody many years ago—recently announced its opposition to Japan’s plan. This “Fukushima Water” apparently carries the risk of poisoning the entire Pacific Ocean, a volume of water that measures 714 quadrillion cubic meters. Even the climate extremists at *Bloomberg* saw through the cynicism on display:

*“As understandable as such concerns might be, we must stick to the facts. The release is ‘consistent with relevant international safety standards,’ concluded the IAEA, and ‘will have a negligible radiological impact on people and the environment.’ The science at question here is settled: Tritium poses very little risk to human health in the quantities being discussed, which will be lower than before the accident even occurred. It’s why tritium is routinely released from nuclear plants as part of normal operations, including those much nearer Hong Kong. Given how little the public knows about this, or how nuclear power works in general, there seems a need for a comprehensive campaign to boost awareness.*

*For all the concern back in 2011, the United Nations Scientific Committee on the Effects of Atomic Radiation in 2015 concluded that the main effect on the Japanese public from the Fukushima disaster was on mental health. Presenting nuclear as a uniquely dangerous option, at a time when it has never been more important to combat climate change, only leaves us more dependent on burning coal and gas, as Japan has been forced to do to make up for its nuclear shortfall.”*



### Tritium levels | Bloomberg

This fear-fueled contrivance plagues the entire perception of nuclear waste. The very term “waste” represents a failure of branding on the part of the sector, as partially spent nuclear fuel (PSNF) can be recycled into “high-value, simple, safe energy products. Every atom. From new

*fuel to batteries.”* The comparatively tiny amount of PSNF sitting in secured locations around the world is indeed a rich source of potential energy—a gift to the next generation of scientists and engineers—not a condemnation of our grandchildren to mountains of deadly toxic solid waste.

According to the US Department of Energy (DOE), the entire fleet of US commercial reactors *“have generated about 90,000 metric tons of spent fuel since the 1950s. If all of it were able to be stacked together, it could fit on a single football field at a depth of less than 10 yards.”* Despite all the hysteria, to the best of our knowledge, not a single human being has ever been injured by exposure to these materials. If the industry were to be ordered to dispose of PSNF, safely doing so requires no technical inventions. As we described in a piece last year:

*“For long-term storage, the industry has proposed to sequester these containers hundreds of meters underground in deep geologic disposal facilities. This plan has met steep resistance from radical environmentalists at every step of the way. Selected for their geological stability (among other safety criteria), the facilities designed for handling nuclear waste in this way are the ultimate ‘set it and forget it’ trade. The odds of a piece of solid ceramic encased in a tomb of concrete and steel finding its way out of a subterranean prison in a manner that injures a living person are indistinguishable from zero. We’ll give you better odds of finding an actual angel at the head of a pin.”*





#### Wasted opportunity | Sandia National Labs

The civilian nuclear energy industry has done more to advance human flourishing than virtually any other sector. Day after day, it cranks out valuable, reliable, and carbon-free baseload power with predictable capacity factors. The industry has a near-perfect safety record, and data compiled by the U.S. Bureau of Labor Statistics proves *“that it is safer to work at a nuclear power plant than in the manufacturing sector, real estate, health care, leisure and hospitality industries, and financial sectors.”* Death rates per terawatt hour of electricity produced show that burning brown coal is at least a thousand times more risky than harnessing power from nuclear fission, and yet the world continues to burn record levels of the dirtiest of fossil fuels, all while denigrating the obvious solution.

Compared to the allegedly certain and catastrophic risks of climate change, nuclear power represents virtually no hazard whatsoever. It’s high time we demand a stop to this pretension.