

Radioactive Wastes from Nuclear Reactors

Questions and Answers

Dr. Gordon Edwards at the
San Diego Symposium, July 24, 2024

The Samuel Lawrence Foundation, in cooperation with the Scripps Oceanography Institute, held a one-day symposium on Radioactive Wastes (from Nuclear Reactors) in San Diego California on July 24, 2024. Gordon Edwards was on one of the panels, remotely, and was asked to answer four questions. Here are the questions and the answers.

QUESTION 1

Gordon, let's start with you. The San Onofre nuclear power plant — known as SONGS — was permanently shut down in 2013 and began decommissioning in 2014, about a decade ago. The name of this panel is, again, "Why Are We Worried?" so please tell us precisely why we should indeed be worried.

Dr. EDWARDS RESPONSE

Good question. If nuclear power were just generating electricity and nothing else, it would be safe. But it also mass-produces deadly radioactive poisons that were never found in nature before the nuclear age began, just 85 years ago.

For instance, nuclear fuel can be safely handled before it goes into the reactor, but after it comes out, it is millions of times more radioactive — and it will kill any nearby human being in a matter of seconds by means of an enormous blast of gamma radiation.

What makes the used fuel suddenly so dangerous? Well, inside the fuel, there are literally hundreds of brand new varieties of radioactive elements that are created by the splitting of uranium atoms — for example, iodine-131, cesium-137, strontium-90. These are radioactive varieties of non-radioactive elements that exist in nature all around us. They are human made radioactive poisons They're like evil twins.

For example, ordinary table salt has a little bit of iodine added to it. It's not radioactive. The iodine goes to the thyroid gland and helps to prevent a terrible disfiguring disease called goiter. Well, nuclear plants produce radioactive iodine. It also goes to the thyroid gland and causes cancer. 6000 children in Belarus had to have their thyroid glands surgically removed because of radioactive iodine from the Chernobyl nuclear accident of 1986, in Ukraine.

Meanwhile, in northern England and Wales, for 30 years after the Chernobyl disaster, sheep farmers could not sell their meat for human consumption when it was contaminated with radioactive cesium. To this day, hunters in Germany and Austria who kill a wild boar cannot eat the meat because of radioactive cesium contamination from Chernobyl. It's in the soil.

You know, everything is made up of atoms. The only difference is that a radioactive atom will explode. It's called an "atomic disintegration". Radioactive atoms are like little time bombs. If they explode inside you, they damage living cells, especially DNA molecules. When DNA is damaged, it may make things grow in an unnatural way. Radiation-damaged cells can and do develop into cancers of all kinds.

What's worse, If the reproductive cells are damaged, the eggs or the sperm, genetic illnesses can be passed on to children, and grandchildren. And this danger remains as long as the radioactive wastes remain, which is essentially forever.

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Every radioactive material has a half-life – that’s how long it takes for half of the atoms to disintegrate. Some have very long half-lives. Plutonium-239, for example, has a half-life of 24,000 years. That’s five times longer than the Egyptian Pyramids have existed. And when a plutonium atom disintegrates, it turns into another radioactive material that has a half-life of 600 million years.

So radioactive wastes remain dangerous for millions of years. They are the most toxic wastes ever produced by any industry, ever. These poisons are essentially indestructible. Countless billions of dollars are planned to be spent to keep these materials out of the food we eat, the water we drink, and the air we breathe. At Hanford, in Washington State, the radioactive clean-up is estimated to cost more than \$300 billion according to the US General Accounting Office. By building more reactors, we are just adding to the burden.

In reality, the ultimate products of a nuclear reactor are radioactive wastes and plutonium which remain dangerous for millions of year. The electricity is just a little blip on the screen, a short-term benefit for just a few decades. The radioactive legacy lasts forever.

QUESTION 2 – FOLLOWUP

Gordon, can you put some of this in context? Tell us about the history of nuclear waste — because it takes anywhere from decades to millions of years to lose its half-life toxicity. So, for example, what about the radioactive waste from the very first nuclear power plant, built in 1951 in Idaho? Is that nuclear waste able to be recycled? Would that solve the nuclear waste problem?

Dr. EDWARDS RESPONSE

Well, you know, the very first reactors did not produce electricity. They were built for the express purpose of creating plutonium for atomic bombs. Plutonium is a uranium derivative. It is one of the hundreds of radioactive byproducts created inside every uranium-fuelled reactor. Plutonium is the stuff from which nuclear weapons are made. Every large nuclear warhead in the world’s arsenals uses plutonium as a trigger.

But plutonium can also be used as a nuclear fuel. That first power reactor that started up in 1951 in Idaho, the first electricity-producing reactor, was called the EBR-1 -- it actually suffered a partial meltdown. EBR stands for “Experimental Breeder Reactor” and it was cooled, not with water, but with hot liquid sodium metal.

By the way, another sodium-cooled electricity producing reactor was built right here in California, and it also had a partial meltdown. The dream of the nuclear industry was, and still is, to use plutonium as the fuel of the future, replacing uranium. A breeder reactor is one that can “burn” plutonium fuel and simultaneously produce even more plutonium than it uses. Breeder reactors are usually sodium-cooled.

In fact sodium-cooled reactors have failed commercially all over the world, in the US, France, Britain, Germany, and Japan, but it is still the holy grail of the nuclear industry, the breeder reactor, so watch out.

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To use plutonium, you have to extract it from the fiercely radioactive used nuclear fuel. This technology of plutonium extraction is called reprocessing. It must be carried out robotically because of the deadly penetrating radiation from the used fuel.

Most reprocessing involves dissolving used nuclear fuel in boiling nitric acid and chemically separating the plutonium from the rest of the radioactive garbage. This creates huge volumes of dangerous liquid wastes that can spontaneously explode (as in Russia in 1957) or corrode and leak into the ground (as has happened in the USA). A single gallon of this liquid high-level waste is enough to ruin an entire city's water supply.

In 1977, US President Jimmy Carter banned reprocessing in the USA because of fears of proliferation of nuclear weapons at home and abroad. Three years earlier, in 1974, India tested its first atomic bomb using plutonium from a Canadian research reactor given to India as a gift.

The problem with using plutonium as a fuel is that it is then equally available for making bombs. Any well-equipped group of criminals or terrorists can make its own atomic bombs with a sufficient quantity of plutonium – and it only takes about 8 kilograms to do so. Even the crudest design of a nuclear explosive device is enough to devastate the core of any city.

Plutonium is extremely toxic when inhaled. A few milligrams is enough to kill any human within weeks through massive fibrosis of the lungs.

A few micrograms – a thousand times less– can cause fatal lung cancer with almost 100% certainty. So even small quantities of plutonium can be used by terrorists in a so-called “dirty bomb”. That's a radioactive dispersal device using conventional explosives. Just a few grams of fine plutonium dust could threaten the lives of thousands if released into the ventilation system of a large office building.

So beware of those who talk about “recycling” used nuclear fuel. What they are really talking about is reprocessing – plutonium extraction – which opens a Pandora's box of possibilities. The liquid waste and other leftovers are even more environmentally threatening, more costly, and more intractable, than the solid waste. Perpetual isolation is still required.

QUESTION 3

Let's talk about rolling stewardship. From what I've read of your work, it seems even the way we think about nuclear waste is problematic. We think of it as something we can almost literally sweep under the rug, but that's not exactly going to work. But you've suggested that rolling stewardship is an alternative to deep geologic disposal. Tell us more about rolling stewardship.

Dr. EDWARDS RESPONSE

Rolling Stewardship is a concept put forward by the National Academy of Sciences in connection with other long-lived toxic wastes like heavy metals and asbestos. When we do not have a genuine waste solution, we must not abandon it. We must continue to look after it on an intergenerational basis, passing the responsibility, the knowledge and the resources to the next generation, with the object of continually improving safe storage.

For the first thirty years of the nuclear age, until mid 1970s, no one knew about radioactive

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waste. The nuclear industry did not tell anyone about it. People were told that nuclear power is clean. And they believed it. But it was not true.

In the mid-1970s, radioactive waste suddenly became public knowledge. Major reports in several countries called for a halt to nuclear power unless the problem is solved. The waste problem became an existential problem for the industry. In self-defence, the industry claimed – without real evidence – that they had a solution: “Bury the waste in an undisturbed geologic formation”. But of course, the moment you dig, it is no longer undisturbed. We have seen three deep underground repositories for lower level radioactive waste fail – two in Germany, and one near Carlsbad New Mexico. As for high-level radioactive waste, the USA has tried eight times to locate a deep underground disposal site, and they have failed all eight times.

Here in California, in 1976, hundreds of thousands of people signed a citizen’s initiative bill to stop any new reactors from being built in the state because there is no waste solution. That bill was passed into law, and it is still the law. The California Legislature asked the Energy Resources and Conservation Commission to determine if there is a safe disposal method. After 2 years of intensive public hearings the verdict was “no”.

The Commission Chairman said : *“We think it probable that [safe permanent disposal] will never be demonstrated. Excessive optimism about the potential for safe disposal [of nuclear wastes] has caused backers of nuclear power to ignore scientific evidence pointing to its pitfalls. That’s the real crux of what we found -- that you have to weigh scientific evidence against essentially engineering euphoria.”*

Emilio Varanini III, Chairman,
California Energy Resources and
Conservation Commission, 1978

Rolling Stewardship is not a solution to the radioactive waste problem, but an acknowledgment that we do not have a solution. Instead of assuming a solution exists, we should recognize that there is no proven solution.

Instead of abandoning the waste, we should monitor it and make sure it is retrievable.

Instead of waiting for the containers to fall apart underground, we should repair and repackage and improve safety measures from one generation to the next. Instead of walking away from the waste, we should keep it under close surveillance.

Leakage from an underground burial chamber will not be detected until it is too late. Rolling Stewardship allows us to take timely action to stop the leak and prevent recurrence.

Instead of closing the door on research to find a genuine solution to the waste problem, Rolling Stewardship will ensure that we keep that quest at the forefront of human consciousness.

This may sound idealistic, but in fact it is simply realistic. The worst thing about self-deception (thinking you have a solution when you don’t) is that you end up with a radioactive mess – a vastly inferior and dangerous form of rolling stewardship – and very much costlier, because it was not planned at the outset.

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We know how to package these wastes well enough to keep the radioactive contents out of the environment. The containers should be thick-walled, very robust, and built to last. They should not be right beside major bodies of water. They should be subject to Hardened On-Site Storage well away from the shore.

The main reason waste storage is currently so unsatisfactory is that the industry has told us it is only temporary. We have to stop thinking that way.

Since we do not have a solution, Rolling Stewardship is what we do in the meantime to keep ourselves and our environment safe from the radioactive legacy of the nuclear age.

QUESTION 4 – FOLLOWUP

It seems there is a connection — at least in name — between one of the most famous ever Surrealistic paintings and rolling stewardship: “The Persistence of Memory.” Tell us about that aspect of rolling stewardship.

Dr. EDWARDS RESPONSE

That’s an interesting point. One of the worst things about abandoning radioactive waste is that, over the very long term, amnesia sets in. Everyone forgets where the waste is or what it is or how to contain it. So when it leaks out into the environment – and it will leak out sooner or later – no one knows how to even detect it or to deal with it.

Rolling Stewardship, on the other hand is predicated on the persistence of memory. The knowledge of these highly toxic wastes and how to deal with them must be kept alive from generation to generation because it remains an ongoing risk.

In 2019 I attended a 3-day conference in Stockholm about how to warn future generations about the legacy of radioactive waste that we are leaving behind. We do not know what languages people will be speaking in 2,000 years, or 10,000 years.

So how do we warn them? Do we put up a sign saying “Do not dig here”? Will they understand the sign? And if they do understand it, will they obey it? If I were a future archeologist who came across such a sign, I would say to my team “Hey guys, Let’s dig here!”

The Stockholm Conference was a fascinating affair. One-third of the participants were nuclear scientists from several countries. One-third were independent commentators and critics of nuclear power, such as myself. And one-third were librarians, archivists and curators who knew little about radioactive waste, but lots about preserving Records, Knowledge and Memory (RKM). The conference was an outgrowth of the European Nuclear Energy Agency’s “RKM Project”, already working eight years on this exact question.

We were all keenly aware that the problem under consideration is similar to the problem of communicating with extra-terrestrial intelligence. How do we communicate with others, with no assurance that they understand any human languages that are used in the 21st century?

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One of the advantages of Rolling Stewardship is that we can more easily pass on knowledge, information and advice from one generation to the next – rather than trying to communicate with a completely unknown society of the future, thousands of years away from us.

We can still leave records for future societies, but each generation can review the adequacy of those records and try to improve them.

It became evident during the conference that if we want to communicate with future generations we have to begin by communicating with the present generation. If we cannot tell people today the truth about radioactive wastes, what hope do we have of telling future civilizations?

One of the conclusions of this conference was that decision-making about radioactive wastes can no longer be left solely in the hands of the nuclear industry and its captured regulator, the NRC. We have to plan now to address the future. This is a societal problem, not just an industry problem.

We need radioactive waste and nuclear decommissioning agencies that are independent of the promoters of nuclear energy, whether commercial or governmental.

We need agencies whose sole focus is the protection of people and the environment.

We need agencies that can communicate openly and transparently with citizens about the nature of the radioactive waste problem and the range of possible options.

The Age of Nuclear Energy will come to an end, but the Age of Nuclear Waste will continue forever – unless we learn how to completely eliminate that radioactive legacy permanently. At present we have no idea how to do that.

As long as we continue to operate old nuclear reactors and build new ones, we are simply compounding an already intractable problem. No matter how fast we bury the old waste, the surface of the Earth will always be prone to catastrophic releases from the freshly produced nuclear wastes which accumulate every day in the cores of operating reactors and in the immediate vicinities of those plants. Burial is no solution as long as the industry is growing, or even continuing with the status quo.

California was wise to pass a law in 1976 that phases out the production of new nuclear waste, by banning the building of any new nuclear plants. It is time for other states and other nations to follow suit.