Summary

Community Symposium of Decommissioning San Onofre
San Clemente, California
October 19, 2013

On June 7, 2013, civic and environmental activists won a big victory when the troubled San Onofre nuclear plant ceased operations permanently. The current dispute over defective technology between Edison and Mitsubishi confirms how necessary this outcome was.

Environmental and citizen groups had only a short time to celebrate averting the risk posed by continued operation of the plant. Almost immediately it became clear that this site, wedged between Interstate 5 and the Pacific shoreline, poses a huge challenge of radioactive nuclear waste stored at the plant.

Much of the waste is a form of “high burn-up” fuel that is at least twice as radioactive as conventional fuel. Large uncertainties persist regarding how to store this fuel, where the waste will ultimately be sited, and for how long. Billions of dollars of expense will be required to manage these problems. These aspects of “decommissioning” San Onofre were secondary during the shutdown debate – but now they loom large.

At the October 19 Community Symposium on Decommissioning San Onofre, three nationally-regarded authorities addressed the challenges and concerns:

Dr. Arjun Makhijani, expert on Hardened On Site Storage of nuclear waste and long-term management of high-level waste. Dr. Makhijana is President of the Institute for Energy and Environmental Research.

Dr. Marvin Resnikoff, advisor to government, industry and environmental groups on nuclear waste management issues. Dr. Resnikoff is Senior Associate at Radioactive Waste Management Associates.

Dr. Donald Mosier, expert on the public health effects of radiation. Dr. Mosier is a member of the Department of Immunology, Scripps Research Institute, and City Council member, Del Mar, California.

Co-sponsors of the Symposium included Residents Organized for a Safe Environment (ROSE), Sierra Club Angeles Chapter, Peace Resource Center of San Diego, San Clemente Green, Women’s Occupy, Citizens Oversight Project, and San Onofre Safety.

Charge to the Symposium by Event Organizers

Gene Stone, ROSE

We are safer now that San Onofre is shut – but we are not safe. Our immediate task must be to assure that best practices are applied to minimize the ongoing risks here. Our ultimate task is to reinvigorate the national dialog on how to deal with nuclear waste.

Carol Jahnkow, Peace Resource Center

Educate, motivate, activate – that is our goal. We did it in the shutdown and now we've got to do it in the cleanup.

Gary Headrick, San Clemente Green

How can crucial questions be addressed honestly, openly, certainly, and as soon as possible? An independent perspective is essential.

Ray Lutz, Citizens Oversight

In a situation like this, the focus of community oversight is not to obstruct but to work at solving mutual problems through a cooperative, vigilant process driven less by costs than by a commitment to best practices.

Presentations by the Expert Panel to the Symposium

Professor Donald Mosier, Department of Immunology & Microbial Science, The Scripps Research Institute,
and City Council member, Del Mar, California.

Is any dose of radiation safe? No. Any level can be dangerous. We now know why very low doses can cause cancer.

Exposure to 10,000 milli-sieverts is deadly. Exposure to 1,000 brings sickness and is cancerous. The rate during the Fukashima crisis was 400 per hour. A CAT scan is 20 to 60. A mammogram is .4. A dental x-ray is .005 – and requires you to wear a lead apron.

In fact, current exposure guidelines are out of date and far too high. Low doses can involve high risks. For example, women under 40 with no family cancer history should not have mammograms, which are more likely to create cancer than background levels in the environment.

We now understand cancer genomics because we can now sequence the entire human genome. This enables comparison of normal and cancer genes. Mutations in the body occur from both types of gene. Each cancer involves hundreds of mutations. Inherited mutations where family history includes cancer are a significant risk. But 80% of mutations associated with cancer occur during one's lifetime while only 20% are inherited.

Many sites in the body are hyper-sensitive DNA regions highly vulnerable to cancer factors. Notable among these are gene-regulatory sites that serve as accelerators or brakes on gene activity. Most vulnerable of all are DNA repair genes. These are areas of rapid change, which provide openings for cancerous mutation.

The effects of exposure to cancer factors are cumulative. This is why repeated exposure matters. What add one more insult to the mix?

A 15-country study of long-term exposure to radiation followed 400,000 workers for 12 years and found the elevated risk was double for nuclear industry workers exposed annually of up to 50 milli-sieverts. This accounted for an extra 5,200 deaths over the 12 years, but the chief risk is 20 – 30 years out.

Japan has increased the allowable dose from 1 to 20 milli-sieverts. A dose of 1 is much safer than a dose of 20 and 20 per year is safer than 20 in one dose – but still not safe. The Japan health agency says it expects no detectable increase in the cancer rate from Fukashima – but the increase won't show up for 20 years.

For us on the other side of the Pacific, the risk has mostly passed. Don't avoid blue fin tuna – but don't eat too much. Closer to Fukashima, the risk has not yet diminished. Radiation in fish 15 miles offshore from the plant is continuing to increase.

There is no reliable survey data on the health of San Onofre workers. The amount of radiation releases is not monitored at any point near the site. Data from Europe suggest San Onofre workers face a doubling of cancer risk. The NRC has not dealt with this even though EPA limits are one-tenth the levels allowed by the NRC.
The Union of Concerned Scientists is a good source on these issues.

Dr. Marvin Resnikoff, Senior Associate, Radioactive Waste Management Associates

The NRC doesn't have all the answers. Sometimes citizens have to force the issue by getting involved in the proceedings of regulatory agencies. Educate yourselves on the minutiae of safety. Continue to question authority. Work to empower independent voices that have demonstrable expertise. Challenge the NRC and Edison to be sure they are employing the best possible technology in every regard.

As an example, a team I led studied whether you could entomb a reactor for 30 years and then take it apart. We founds this would not work and that either safe storage or immediate dismantling were the only options. Science Magazine said this changed the course of decommissioning.

What does San Onofre look like now? What are the radiation levels? San Onofre is a "pressure water" reactor in which hot water goes through a steam generator. Holes developed in the piping and thus shut down the plant. Where is the radiation in a reactor? Radiation levels get higher as you get closer to nuclear fission. There is 1 rem per year of radiation in the atmosphere versus 2 to 4 rems per hour inside the "biological shied" at a nuclear plant. Inside the inner shields this rises first to 1,500 rems per hour and then to 80,000 rems per hour as you approach the innermost core, which is at 600,000 rems per hour (3 million curies).

There are two decommissioning alternatives. Most utilities dismantle the reactor promptly, put it in SafeStore, and walk. Connecticut Yankee has fuel storage sites plus separate storage of reactor components. At Three Mile Island, the reactor was shielded by being taken apart under water, which was then put through exchange purifiers similar to those used on water used while the reactor is operating.

At San Onofre all fuel is now out of the reactor. Spent fuel is in pools and casks. A period of 15 to 20 years will be required for fuels in pools to cool before casking. Cobalt 60 has a half-life of five years but nickel 63 and 59 decay very slowly. It is likely that waste will be at San Onofre for some time. The hope is that some fuel will be moved from the site by 2020. This may be optimistic. Buildings will be taken down but casks will be stored on site.

Edison has said spent fuel will be removed from the pool by 2034. After that, San Onofre will consist entirely of fuel casks or silos in a Stonehenge configuration. What remains? A fuel mausoleum and the conversion of a valuable site into a wasteland. San Onofre has a “blockhouse” configuration of 176 modules, including 10 for the reactor.

To be casked, fuel must be at least partly spent; if not, uranium 235 would pose a danger. The fuel assemblies at San Onofre are 14.5 feet long. Rods are inserted into a cask under water, lifted and drained, filled with helium to test for leaks, sealed and put in a dry shield canister. Stored fuel is passively cooled by airflow with cool air entering from bottom vents and exiting at the top of each blockhouse. In experience to date with dry casks, the only leakage detected has been of the helium with which casks are filled because it is better than air as a heat conductor.

We should be very concerned about the challenge of storing high burn fuel. There is the timing issue of a long cool-down period for fuel used at 67 megawatt-days per metric ton. How did San Onofre get permission to operate at this level? The question has not been analyzed and San Onofre has put little or no high burn fuel in storage. Indeed, no form of storage has yet been approved for fuel this hot.

Fuel assembly cladding is of thin tubes with uranium stacked inside like poker chips. Prolonged heat can make the cladding on assemblies very brittle, increasing the risk that broken rods will get into the casks or even into the environment. The hottest fuel must be stored on the outside, with cooler fuel inside. The total heat in each canister is crucial. Currently, if a fuel rod is damaged it is put in a protective container. But there is no clear procedure for taking fuel out of a cask after 20 years.

NUHOUMS and Hold Tech are storage systems with similar capabilities. The first holds the array in a horizontal position, the second in a vertical position. Casks now store 24 fuel assemblies and Edison is seeking permission to store 32. This is not safe for storage and transportation of high burn fuel. An NRC hearing in Washington, D.C. on November 18 – 19 will explore the impact of high-burn on spent fuel assemblies.

All nuclear reactors are on a waterside location. At some point will spent fuel be consolidated at a site away from the water? If the time comes to move casks to another location, the fuel array is removed and put in a transfer pack – a.k.a., a transportation over-pack – for rail transport with a lead shield and a suspension system to cushion impacts. A rail spur needs to be built at San Onofre.

Each spent fuel rod weighs 1,000 pounds, so each 24-pack weighs12 tons. Add a steel canister, a cask of concrete, an over-pack plus a rail car and the total can weigh 200 tons. The truck array required to move the over-pack would need to be 220 feet long, which is why rail may be more feasible.

The U.S. Navy must close its Idaho storage site by 2035 and is putting spent fuel into transportable, geologically storable casks – but there is no location licensed to receive them. Similarly, a canister can go into a transportation over-pack and be removed from San Onofre but there is no place to put it. The endgame for San Onofre is to be using transportation over-packs as the safest and best casking – but there still has to be a depository.

Hazards at nuclear plants are greatest when the reactor is operating. Storage problems are orders of magnitude less than operational problems. But road or rail transport also involves hazards. Nuclear plants are covered by Price-Anderson insurance, which kicks in when an accident is at a serious level. Absent that, Edison has minimal insurance to cover accidents. Once spent fuel is in dry storage, the Department of Energy has responsibility, including the cost of fuel transfer from pools.

Edison lists a $300 million charge on both Unit 2 and Unit 3 at San Onofre to remove fuel to a remote site despite the fact that the Department of Energy is supposedly going to pay. This could be a case of double accounting. We should also be aware that even though San Onofre has $2 billion for each Unit, experience suggests the cost of decommissioning is always more than estimated

Nuclear plants are in decline in the U.S. – six have been shut in the past year. Older plants are primary candidates for shutdown, especially “boiling water” reactors of Mark I vintage similar to Fukashima.

Fukashima is still bleeding after two years. New requirements coming out of the Fukashima experience could impose costs that will shut down plants. For example, suppose Diablo Canyon faces State of California requirements for cooling towers and seismic retrofit.

Dr. Arjun Makhijani, President, Institute for Energy and Environmental Research

The domes are the most visible part of a nuclear plant. They exist to protect against meltdown of the reactor core. Once the reactor is shut, the domes are just decoration.

After a nuclear plants ceases operation, a large part of the risk remains, especially the spent fuel pools. A dry cask fire would create only about 1.5% as much radiation as a fuel pool fire.

Can we enhance the rate of decay or neutralize radioactive elements?

Every element in a spent fuel rod has its own rate of decay, from days to thousand of years. One part of spent fuel – plutonium – can be reprocessed and used again by separating fuel elements. But this is costly and generates more waste than is saved by reusing the fuel.

Reprocessing is done mostly by using reactors. This creates the irony of building more reactors to reduce radiation problems – a logical contradiction. Utilities will build reactors if they can do it using other people’s money, as happens when ratepayers provide the dollars and government provides loan guarantees.

Fresh fuel rods of regular nuclear fuel are 3.3% Uranium 235 while high burn is 4% or more. Most of the mass of a rod is uranium 238, some of which becomes plutonium as the rod is used. The most serious issue is that U.S. nuclear plants produce enough plutonium for 30 nuclear bombs a year.

Ironically, the danger this poses becomes greater over time as other radioactive elements decline. Early on the fuel is theft-proof but after 300 – 400 years the cesium is gone and humans can approach nuclear waste without risk. But at the point the waste could be stolen for its plutonium. We are now looking at a qualitatively different problem – a nuclear weapons proliferation problem. Today’s cask storage systems need to be hardened to resist terrorist attack. In the farther future, storage needs to be theft-proof.

All nuclear plants release tritium into the atmosphere on an episodic basis. Data from Europe suggests that "spikes" related to such releases are dangerous. These heightened levels should show up in rainfall, and can become concentrated in the food chain and in water.

A long-term contaminant is cesium 137, whose radionuclides evaporate into the air. From five years on, cesium 137 is a big concern. At Chernobyl, cesium was deposited in lead and strictly controlled at 15 curies per square kilometer. If 10% of the cesium there were released with a steady wind into the air through a fuel pool fire, thousands of square miles of land would be contaminated.

Another environmental contaminant is strontium 90, which does not vaporize but pollutes water through the cycle of storms, rain and runoff. Strontium 90 also interacts strongly with the human skeletal structure.

San Onofre has 3200 – 3400 spent fuel assemblies. Radioactive waste at San Onofre is 120 million curies. A curie is a lot of radioactivity. Each curie represents 37 billion radioactive disintegrations per second.

San Onofre has been using high burn fuel to reduce refueling and permit longer continuous operation. But doubling the burn in a fuel rod doubles the heat load. After ten years, high burn rods are twice as hot as conventional rods. This means you don't want to pack them in too densely. San Onofre has been authorized to use fuel rods that run hotter and contain more radiation but they seem to have exceeded to NRC high burn limit of 62.5 gigawatts. What we know about spent fuel in dry storage is based entirely on experience with low-burn fuel.

Why high-burn was authorized at San Onofre without knowing how it might affect storage is a huge concern. We need to press the NRC on high-burn research. There are 95 failed fuel assemblies at San Onofre. We don't know if any contain high-burn.

The longer rods are used the greater risk they will be damaged. Casking is the "least awful" option. Pool storage is worse than dry storage because a lot of radiation is in play, creating about 100 times as much risk. Generally, emptying spent fuel pools and putting the rods in dry casking is a good idea. But after a certain duration we don't know how safe the casks are.

Given the time period, we need to study casks more closely. The greatest risk during decommissioning is in maintaining pool storage and in dealing with dry casks that are good only for 20 years. We don't want to be transferring spent fuel from one cask to another if an assembly has been damaged. And in actual experience, there has never been a transfer from one dry cask to another under any circumstance.

Since the mid-1990s, the NRC has been reluctant to impose costs and has emphasized approaches that seem to have positive cost-benefit like high-density storage. In Waste Confidence hearings the NRC has said "indefinite" storage would have minimal environmental impact because the fuel would not degrade significantly. But the canisters would degrade, and we would repeatedly have to transfer waste to new storage.

The best kind of on-site storage has these characteristics: low visual signature ("low to the ground"), which may include berms; the best casks, which currently may be the triple-top German model; and the best seismic science on withstanding earthquake shocks.

The practical problems in storing or reprocessing waste are severe. If spent fuel stored on site cannot be transferred to a remote site, it will be necessary over time to transfer fuel from one cask to another. No one knows how to do this, especially if the casks are damaged.

For that reason, we need a deep geological repository. We have done a terrible job on a national repository in this country. We need to work on a repository. All other solutions are much less adequate. A worst-case event on the surface, especially in a sensitive area like San Onofre, is an order of magnitude more severe than worst-case in deep geologic storage, Our goal should be to store waste in a way where the worst-case is not catastrophic.

Selection of a U.S. repository site should be an “informed consent” process based on scientific knowledge. Otherwise it will be a political process that risks environmental injustice. A repository is a “mine” with its own complex set of interactions that go beyond the geology of the site before the mine is built. Let’s take a decade to study this and figure it out.

There is an International Atomic Energy Agency but the discussion of nuclear waste issues is informal and ad hoc rather than focused. The organizations representing repositories have budgets collectively in the billions of dollars but there is no international organization addressing waste.

Why aren’t the U.S. government and international agencies thinking more about precluding unacceptable consequences? One reason is a kind of “risk analysis” that cancels out the seriousness of outcomes by rating the worst cases as extremely improbable. Yet at Chernobyl and Fukashima they have happened.