What Should America Do With Its Nuclear Waste?

Currently there are about 80 locations in 35 states where spent fuel is being stored, with no long-term plans for disposal.

By Rebecca Tuhus-Dubrow

Today at 9:00 a.m. EDT

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A little more than a decade ago, Marni Magda was reading Scientific American magazine in her living room when she came across an infographic titled "Aging Fleet under Review." Published shortly after an earthquake and tsunami caused meltdowns at Japan's Fukushima Daiichi nuclear plant, the two-page spread showed a map of nuclear facilities across the United States, with color coding to indicate seismic risk. Looking to her own region, coastal Southern California, Magda spotted a nuclear plant icon superimposed over an alarming shade of red. It represented the San Onofre Nuclear Generating Station, about 20 miles south of her city, Laguna Beach, and near multiple geological faults. "I realized as a California resident, we were in a great deal of trouble," she recalled recently.

For Magda, a retired elementary school teacher, the interpretive map has acquired a status akin to a sacred text; she kept it and had it laminated. She handed it to me as we sat at a table in her backyard, birds chirping riotously in a large orange tree heavy with fruit. She explained that soon after her wake-up call in 2011, she found other area residents who also feared that an earthquake or tsunami could lead to a nuclear disaster in Southern California. She began attending marches in the state park adjacent to the plant, holding banners aloft and chanting, "Shut it down!"

The plant, which had about 2,000 employees and produced enough electricity to power 1.4 million homes, had operated since 1968. The looming domes of its two reactors were visible to drivers on Interstate 5, a heavily trafficked freeway, and to surfers who trekked from all over the world to catch waves at famed beaches nearby. The utility company that ran the plant, Southern California Edison (SCE), assured the public that the facility could withstand any plausible seismic or weather event. But in 2013, SCE announced that San Onofre would be decommissioned for a different reason: Flaws had been discovered in the steam generators. Many community members hailed the decision as a victory. "Oh, I was thrilled," Magda, now 75, told me. "I was absolutely thrilled."

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The celebration, however, was short-lived. Magda and other activists realized that all of the high-level radioactive waste that had accumulated at the plant over the course of its lifetime — 1,600 tons of spent fuel rods — would remain at the site for the foreseeable future. Although the federal government is legally responsible for disposing of commercial spent nuclear fuel in a permanent underground repository, there has been no plan for fulfilling that obligation since the Obama administration halted the project at Nevada's Yucca Mountain in 2010. There are currently about 80 locations in 35 states — mostly at operational and decommissioned nuclear plants — where spent fuel is being stored indefinitely.

Since the San Onofre plant shut down, Magda has been trying to get the spent fuel moved to a more suitable site and to ensure that, until then, it is stored as safely as possible. As of 2017, she has represented her local chapter of the Sierra Club on the Community Engagement Panel, an entity established by SCE that holds quarterly meetings with the public. In her garage, she showed me a gray filing cabinet with four vertically stacked drawers, her granddaughter's teal bike propped up against the side. The drawers contain hundreds of manila files with hand-scrawled labels: "Western Interstate Energy Board," "Sierra Club — Comments on Scoping Process," "Thick vs. Thin Canisters & Corrosion Cracking." Inside the folders are notes from meetings, business cards of public officials, news

clippings, academic papers and government reports. In addition to earthquakes and tsunamis, Magda and other activists are worried about coastal erosion and sea level rise caused by climate change. “We can’t leave it here,” Magda says.

The question of what to do with the nation’s spent nuclear fuel has recently garnered renewed attention. This is thanks in part to U.S. Rep. Mike Levin (D-Calif.), who represents the district encompassing San Onofre and has taken up the cause as one of his signature issues. An environmental lawyer by training, he told me he ran for Congress partially to make progress on reviving the nation’s stalled efforts. In January 2019, he established a task force of local stakeholders to study the situation at San Onofre. He has also co-founded the bipartisan Spent Nuclear Fuel Solutions Caucus, with Rep. Rodney Davis (R-Ill.), and introduced the Spent Fuel Prioritization Act, which would ensure that the material is moved first from the most sensitive locations, including San Onofre.

Among scientific experts and government officials, there is broad consensus that the optimal solution is to eventually bury nuclear waste in a deep geological repository. But that is a long-term goal, and in the near future, Levin and many others are pushing for “consolidated interim storage.” This would mean that the spent fuel scattered at sites across the country would be moved to one or more facilities, in appropriate settings, that would be devoted entirely to safely storing the fuel until a geological disposal facility is ready.

There is also agreement, of a limited sort, between many nuclear opponents and supporters on the importance of addressing the waste issue. But for many opponents, such as Magda, the waste is a reason to abandon this form of energy altogether. By contrast, supporters of nuclear power — the generation of which does not emit greenhouse gases — seek to resolve the spent fuel issue to clear hurdles to its expansion. A better waste management strategy is essential if nuclear power, which provides almost half of the country’s low-carbon electricity, is to play a meaningful role in a future energy system that does not rely on fossil fuels. To reach its goal of net-zero emissions by 2050, the Biden administration has called for substantial investments in nuclear reactors. “The United States views nuclear energy as a pivotal technology in the global effort to lower emissions, expand economic opportunity, and ultimately combat climate change,” Energy Secretary Jennifer Granholm has said in a statement.

Despite recent momentum to break the spent fuel impasse, the obstacles are considerable. “Frankly we have a real problem in the U.S., not just at San Onofre,” Levin told me. “San Onofre is just the symptom, with 9 million people within 50 miles and two earthquake faults and rising sea level. The actual problem is that we’ve got nowhere to move it to.”

In a landmark 1957 report by the National Academy of Sciences, “The Disposal of Radioactive Waste on Land,” the authors proposed that the most viable method would be to inter it deep underground, preferably in salt mines. In the ensuing years, different ideas — including burying the waste in ice sheets and shooting it out into space — were thrown around. But the enduring conventional wisdom favors the original idea of deep geological repositories.

The 1982 Nuclear Waste Policy Act was the first major law to address spent nuclear fuel, and assigned the federal government the task of constructing and operating such facilities. By that time, there were dozens of commercial nuclear plants that had been accumulating spent fuel and storing it on-site with no plans for disposal. According to the law, the Department of Energy was required to move promptly to site two geological repositories for permanent disposal.

In 1987, however, amendments to this law identified only a single location: Yucca Mountain, about 90 miles northwest of Las Vegas. The selection was based on the Energy Department’s assessment of the site’s geological features and was also thought to reflect political dynamics at the time. In the state, the legislation became known as the “Screw Nevada Bill.” Nevada’s powerful long-serving senator, Harry M. Reid, made it his mission to see that this

repository would never come to pass. In 2010, the Obama administration announced that it would withdraw the license application to the Nuclear Regulatory Commission for the project. “We’re done with Yucca,” Carol Browner, President Barack Obama’s energy adviser, said. (The United States does have a deep geological repository for defense waste, in New Mexico, but not for commercial spent fuel.)

“Frankly we have a real problem in the U.S., not just at San Onofre,” says U.S. Rep. Mike Levin (D-Calif.). “… The actual problem is that we’ve got nowhere to move [spent nuclear fuel] to.”

Meanwhile, Obama’s secretary of energy convened the bipartisan Blue Ribbon Commission on America’s Nuclear Future to devise a new strategy. The commission issued a report in January 2012. “The overall record of the U.S. nuclear waste program has been one of broken promises and unmet commitments,” the report stated.

The report’s first recommendation, highlighting its importance, was a “consent-based approach to siting future nuclear waste management facilities” for both permanent underground disposal and temporary aboveground storage. That is, instead of selecting sites based strictly on physical characteristics, the new approach would solicit volunteers, and engage communities, states, tribes and other stakeholders to obtain their approval before proceeding with plans. This idea was built around observations of more successful programs in other countries, including Finland and Sweden. The goal is “to work with the community to find out what they need, what they want, from their point of view, not from our point of view,” Tom Isaacs, a veteran nuclear waste expert who served as lead adviser to the commission, told me. This could mean jobs, investment in parks and schools, or other forms of compensation.

The Blue Ribbon Commission report was widely regarded as a seminal document in nuclear policy circles. But until recently, virtually no progress had been made toward implementing its recommendations, which included developing one or more geological disposal facilities as well as one or more consolidated storage facilities. (The Trump administration briefly tried to revive the Yucca Mountain plan, then reversed course.) “I’m both happy and sad that 10 years later, they’re still looking at that report,” Isaacs told me — proud that it is still a go-to resource for those working on the issue but frustrated that so little has changed.

The spent fuel at San Onofre is stored in 123 canisters, in what’s called an independent spent fuel storage installation (ISFSI, pronounced “ISSfuhsee”). Contrary to the popular impression of nuclear waste as

green goo, the fuel rods consist of solid pellets, each slightly larger than a pencil eraser. The fuel rods, bundled into fuel assemblies, were retrieved from the reactors over the course of decades. After cooling for at least five years in pools of water, they were transferred into stainless-steel canisters, with walls five-eighths of an inch thick. Workers then transferred the loaded canisters, each of which weighs 50 tons, to a concrete pad overlooking the ocean and lowered them into stainless-steel cavities beneath the pad's surface.

When I visited the site recently, on a bright, gusty day, I was led by John Dobken, San Onofre's public information officer, and Jerry Stephenson, the ISFSI engineering manager, through security and outside to the concrete pad. On our way, we passed workers in hard hats engaged in the ongoing demolition of the plant — major decommissioning work is expected to continue through 2028 — as well as the construction of a rail yard. It was a reminder that radioactive spent fuel is not the only kind of waste produced by nuclear plants: Millions of pounds of metal and steel, and tens of thousands of titanium tubes, will eventually be loaded onto rail cars and shipped away, some to be recycled, some to a landfill. One day, according to the plan, the spent fuel will be shipped away on this rail line as well, though no one knows to where.

Out on the concrete pad, in my immediate vicinity, I could see a partially demolished industrial site; farther out, it looked like a commercial for a seaside vacation. The pad is elevated above sea level, but the ocean is about 100 feet away, behind a sea wall. "Dry fuel storage is very self-sufficient," Stephenson said. "There's no fans, there's no cooling systems; it just sits there, fat, dumb and happy, as I like to say."

We could not see the canisters, which were below our feet, inside the enclosures. Dobken told me that each canister was surrounded on the sides by 10 feet of concrete, as well as a three-foot reinforced concrete slab at both the top and the bottom, all of which blocks radiation that isn't shielded by the stainless steel. According to SCE, the canisters were designed to handle any earthquake that could occur in the area and up to 125 feet of water. (There are two sections of the ISFSI with somewhat different designs; the older one is farther from the shore, above grade, and built for inundation by 50 feet of water.)

When I mentioned that I felt warm air emanating from the enclosures, Stephenson explained that vents allow air to continuously cool the spent fuel, and the air comes out heated. "I joke that we should put a little restaurant out here and serve drinks," he said. He assured me that almost no radiation was escaping. A radiation monitor installed on the pad showed a reading of 13 microrem per hour, just slightly higher than the area's natural background radiation. (For context, over the course of a cross-country flight passengers — because they are closer to the sun — are exposed to about 3,500 microrem, or 3.5 millirem.)

How dangerous is this material? As with everything related to nuclear power, answers to that question are highly polarized. As is so often the case, you can tell where someone stands by the language they use: Opponents call the substance "waste" and the sites where it's stored "waste dumps." Proponents tend to call it "used fuel," as opposed to "spent," to indicate that it has the potential to be recycled; they see it less as a threat than as a resource. These differences in perspective have been underscored by recent events. The attack on Ukraine's Zaporizhzhia nuclear plant proved to anti-nuclear advocates that the energy source is unacceptably risky; pro-nuclear people see the geopolitical situation as a sign that Europe needs more nuclear power to pry itself from dependence on Russian oil and gas.

The fear of this substance, whatever we might call it, is hardly without basis. The 1957 National Academy of Sciences report stated, "Unlike the disposal of any other type of waste, the hazard related to radioactive waste is so great that no element of doubt should be allowed to exist regarding safety." Being in the same room with unshielded nuclear waste, fresh out of the reactor, could very quickly give you a fatal dose of radiation.

Proponents argue that these hazards are real but entirely manageable. As Maria G. Korsnick, president and CEO of

the Nuclear Energy Institute, put it in a recent New America webinar, "We know exactly where it is, we know exactly what it is, and it's being very safely stored. … There's other forms of generation that create waste, many of which you're breathing." James Lovelock, the British scientist best known for originating the Gaia hypothesis, the idea that life on Earth interacts with the planet to form a self-regulating system, is a champion of nuclear energy. "The nuclear waste is a minor burial problem, but the carbon dioxide waste will kill us all if we go on emitting it," he wrote in a 2009 book.

"The overall record of the U.S. nuclear waste program has been one of broken promises and unmet commitments," a bipartisan report states.

Another point of contention involves the prospect of recycling. "One man's trash is another man's treasure," said Korsnick in the webinar, noting that "the thing we call waste" has more than 90 percent of its potential energy still untapped. The United States has eschewed reprocessing because of concerns about proliferation — that is, the risk that the material could be diverted for weapons — but other countries, such as France, do reprocess used fuel in civilian nuclear reactors. Recently, fresh interest in this option has emerged in the States. In March, Oklo, an advanced nuclear start-up, along with Deep Isolation, a company focused on nuclear waste disposal, won a $4 million grant from the Energy Department to develop the nation's first nuclear fuel recycling and disposal facility.

Some of these divergent views, and gradations in between, are apparent in the community surrounding San Onofre. The community has been vigilantly monitoring the decommissioning process, with a contingent of activists who are critical of SCE. The Community Engagement Panel's meetings have been well attended, and before they shifted online because of the pandemic, often raucous. David Victor, a professor of public policy at the University of California at San Diego, was tapped by the utility to lead the panel. "I've visited many plants in various state of closure," he told me. "I've never seen this degree of public engagement."

Rob Howard worked at the plant for 31 years. During that time, "I did pretty much everything," he told me recently over a turkey sandwich, when we met at a cafe. In addition to working as a reactor operator and on the decommissioning, he was heavily involved in the union. Since being laid off in 2020, he started an energy consulting firm called Zodiac Solutions and has participated in both Levin's task force and SCE's Community Engagement Panel.

Howard grew up in Memphis, as the son of a Baptist preacher. After a stint in the Navy, he was hired at San Onofre in 1989. His experience as a Black man in the nuclear industry gave him a distinctive, nuanced perspective. It wasn't always easy; the industry is overwhelmingly White. At work, as in the rest of his life, he explains, he was obliged to put himself "in a position where people aren't afraid of me. I cross the street before you do because I don't want you to accuse me of anything. I can't get angry at work. The onus is on me to keep you from being fearful."

Nonetheless, he appreciated the economic security his career gave him. He has lived a good life with his wife and two children in Oceanside, a beach community not far from San Onofre. In fact, he felt an unexpected affinity with his job. “Nuclear power, I kind of had a kinship with it,” he told me, “because I knew people were afraid of it, and I knew what that felt like.”

As for the spent fuel, he says he is not particularly concerned about the risks, at least in the near term. But he supports efforts to move it, and he believes hosting it could present significant opportunities for the right community. He’s skeptical, however, that the government will exhibit the “cultural competence” to engage these communities in a constructive way. “I’m not saying the people who are doing it are bad people. But I always tell people: It’s not your intent. What’s the impact of your work? Are you actually having real conversations, and the people who you’re talking to, do they trust you?”

Other area residents are focused less on moving the fuel and more on addressing what they see as deficiencies in the current storage system. They were alarmed by a “near miss” incident in August 2018 when a canister was improperly lowered into an enclosure and was briefly wedged there. The Nuclear Regulatory Commission later reported that “the canister could have dropped 18 feet into the storage vault if the canister had slipped off the metal flange,” and it identified “multiple performance deficiencies.” SCE also did not notify the NRC Operations Center in a timely manner. In the aftermath, the utility instituted new training and procedures. But some community members have raised questions about the integrity of the canisters and the plans for addressing any problems that might arise.

Another reason some activists place less emphasis on moving the fuel is that they doubt it will happen in their lifetimes. “The idea of ‘just get it out of there’ is a convenient motto,” says Cathy Iwane, a yoga instructor and American activist who was living in Japan at the time of the Fukushima accident and now lives in Del Mar, another city in Southern California. (She serves as secretary of the Coalition for Nuclear Safety, an umbrella group of concerned organizations and individuals.) But Iwane and others are also wary of foisting their problem on a less affluent community. They believe that consolidated interim storage would inevitably drag on longer than promised. Iwane acknowledges that “some disenfranchised community will get infrastructure, equity and money,” but notes that “they will also be saddled with the nation’s radioactive waste.”

During the past decade, as the stalemate in the United States has continued, a handful of other countries have made progress in planning for the disposal of their nuclear waste. Finland is very close to opening the world’s first geological repository for spent fuel, and Sweden is not far behind, while Canada has narrowed its search to two possible host communities. They all followed the principles of consent-based siting: They invited communities that were potentially interested to engage in a dialogue, learn about the possibilities without making a commitment, and discuss their priorities and concerns.

According to Tom Isaacs, who is now an adviser to both SCE and Canada’s Nuclear Waste Management Organization, the Canadians pay candidate communities to do “visioning exercises.” “They give them money to do the work to say, ‘Where would we like our community to go? How could this help us? What would we need in order for this facility to make our community better?’”

I spoke with Penny Lucas, the mayor of Ignace, Ontario, one of the two final candidate communities in Canada. She told me that the economy in Ignace had been based on mining — for gold, palladium and other metals — and forestry. But in recent decades, the mines have become less active, and the population has shrunk to about 1,300 people, roughly a fifth of whom are Indigenous and the rest White. She sees a nuclear waste repository — which would be about 22 miles away, in an uninhabited area — as an economic development opportunity. “There’s the possibility of getting our students, the younger generation, educated and ready for when the project does come here, then they’ll be able to apply for the jobs that would come along,” she says. Other workers would also presumably

move to town, bringing ancillary benefits like new shops and restaurants.

Is she worried about safety? “Everybody hears the word ‘nuclear’ and they panic,” she responds. “Everything in life is a risk. We understand that. The forestry, the mining, all the things our community has been involved with already.” The question, she says, is “how you’re going to manage those risks.”

“If you had a situation where you felt something was inherently safe and you could get revenue for the next hundred years, would you take the deal?” asks Hobbs, N.M., Mayor Sam Cobb.

In the United States, we are nowhere near siting a permanent repository, but the Energy Department has begun working toward a program for interim storage facilities, with a budget of $20 million allocated for each of the past two fiscal years. In December, the department issued a request for information on consent-based siting for such facilities, inviting any member of the public to submit comments on what such a process should look like. The Energy Department’s developing approach “centers equity and environmental justice” and “makes the needs of people and communities central,” Kim Petry, the agency’s acting deputy assistant secretary for spent fuel and waste disposition, said in a virtual meeting with SCE’s Community Engagement Panel in February. In terms of how they will define consent, Petry told me: “It will be based on what the communities want. One community might want a referendum. One might want their state legislatures to vote on it.” She promised “close collaboration with these communities.”

Although the government is not yet at the stage of negotiating with towns or cities, two corporate ventures have engaged in talks with communities in New Mexico and Texas about potentially hosting interim storage sites through private initiatives. That is, the initiatives would be for-profit enterprises led by the companies — Holtec and Orano — that manufactured the spent fuel canisters, although they would still need approval from the Nuclear Regulatory Commission.

Hobbs, N.M., is one of these communities; the proposed site is 35 miles from the closest population center. The four co-owners of the land — Hobbs, neighboring Carlsbad, and their respective counties — entered into an agreement with Holtec. In exchange for the land, Hobbs would get jobs associated with the storage and royalties from Holtec’s gross revenue. (The majority of the town’s population, according to 2020 Census data, identifies as both Hispanic/Latino and White.) In terms of community consent, Hobbs Mayor Sam Cobb told me there has been no

formal mechanism to gauge it. According to Cobb, at public meetings, many more people have expressed support than opposition. In the state legislature, however, bills have been introduced to block the site from proceeding.

When I asked Cobb about the possibility of becoming a de facto permanent storage site, he replied with his own question: "If you had a situation where you felt something was inherently safe and you could get revenue for the next hundred years, would you take the deal?"

Marni Magda, the retired teacher, believes that the waste at San Onofre is stored as safely as possible. She even flew with other members of the Community Engagement Panel to a Holtec factory in Turtle Creek, Pa., in 2018 to learn about the canisters and considers them "top-of-the-line." Still, her mind is not eased. "There are so many things we don't have control of," she told me.

Magda points out that for real progress to occur, the law needs to change so that Yucca Mountain is not the only permissible site for a permanent repository. Levin has not yet introduced legislation to change that, but he told me he plans to. One arguable reason for optimism is that an improved waste management strategy, unlike so many other causes, has bipartisan support. "Nuclear waste doesn't care if you're a Democrat or a Republican," Levin says.

But the challenges are formidable. Isaacs, the veteran nuclear waste expert, told me that in other countries there are higher levels of trust in the government and in fellow citizens. "One of the reasons it works so well in Finland is that they have an ethic where they don't believe their neighbors would do anything to harm them, or the environment." Americans have a long history of distrust of the nuclear industry and, especially in recent years, have been increasingly suspicious of both the government and one another. Certain aspects of our political system — such as the power of states — pose additional hurdles.

Though Isaacs considers San Onofre's storage "perfectly safe," he does agree that the status quo — with the spent fuel languishing at sites scattered across the country, in communities that didn't sign up to host it — is undesirable. "We know what we have to do. We know we have to do it," he says. "We're the ones who created the waste; we're the ones who benefited. We need to not simply pass this off to future generations and say, 'Look, this is your problem.' "

Rebecca Tuhus-Dubrow is a journalist based in Southern California. She is working on a book about the future of nuclear energy.

Indian Point
Radioactive Liquid Effluents

Dave Lochbaum
March 12, 2022

	Processed Waste (LW & NCD)	Unprocessed Waste (SGBD, SFDS, USFD)	Volume of Dilution Water
	Gallons	Gallons	Gallons
2005	3,756,640	**89,557,020**	734,420,400,000
2006	3,492,460	56,217,504	737,062,200,000
2007	2,861,069	50,194,200	737,062,200,000
2008	3,471,325	52,180,834	750,271,200,000
2009	2,768,606	53,813,466	726,495,000,000
2010	2,977,309	47,446,728	715,927,800,000
2011	**4,874,121**	51,726,444	739,704,000,000
2012	3,479,251	50,088,528	750,271,200,000
2013	3,769,849	65,965,746	742,345,800,000
2014	2,922,359	49,480,914	739,704,000,000
2015	3,693,236	53,760,630	752,913,000,000
2016	3,310,175	39,014,102	710,644,200,000
2017	2,483,292	48,899,718	776,689,200,000
2018	3,920,431	52,624,656	797,823,600,000
2019	2,818,801	56,587,356	**805,749,000,000**

Annual discharges of water from Indian Point Units 1, 2 and 3 into the Hudson River. Maximum volumes of each category shown in enlarged boldface type.

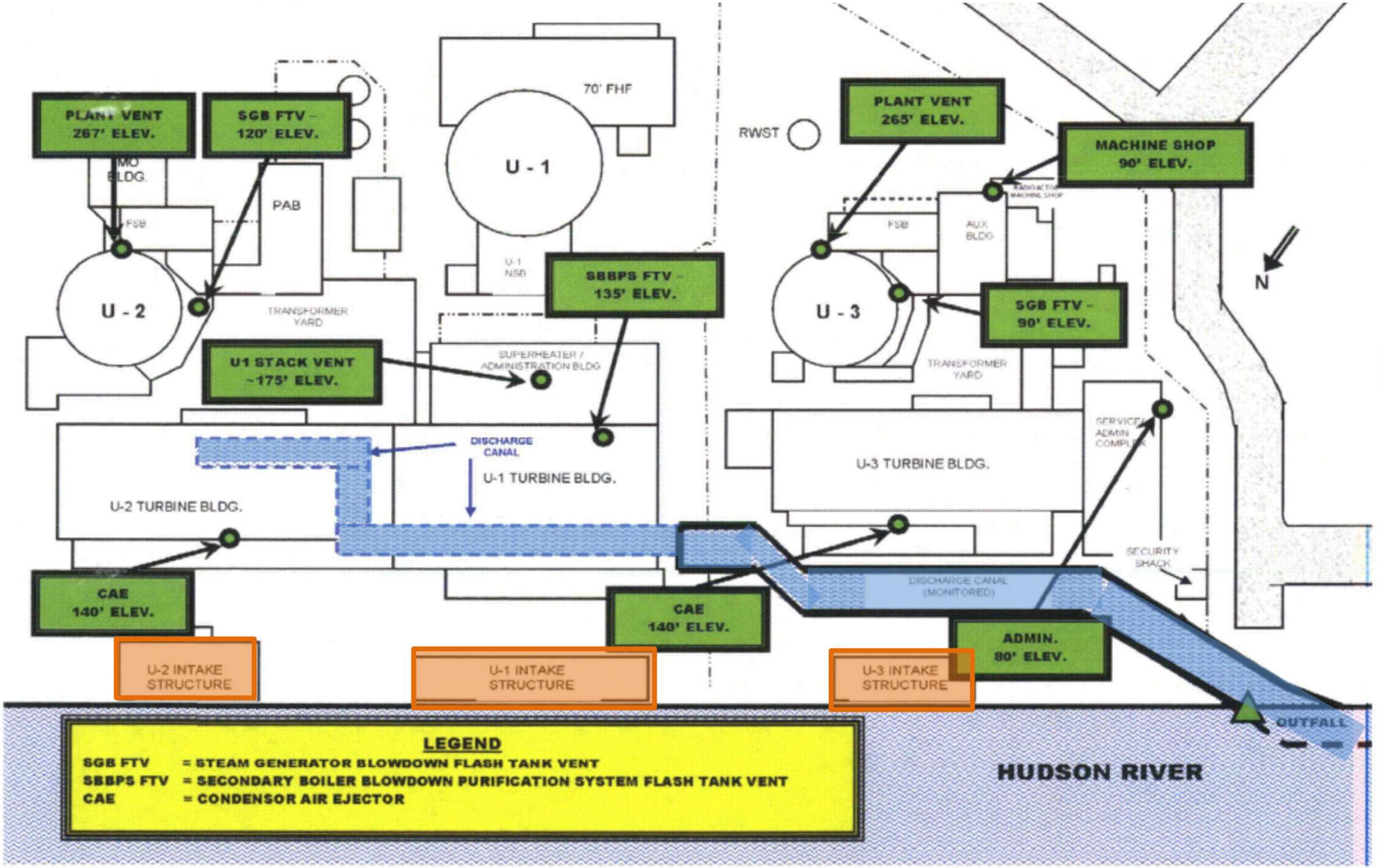
Source: Owner's annual effluent reports to the NRC (e.g. ML061240373)

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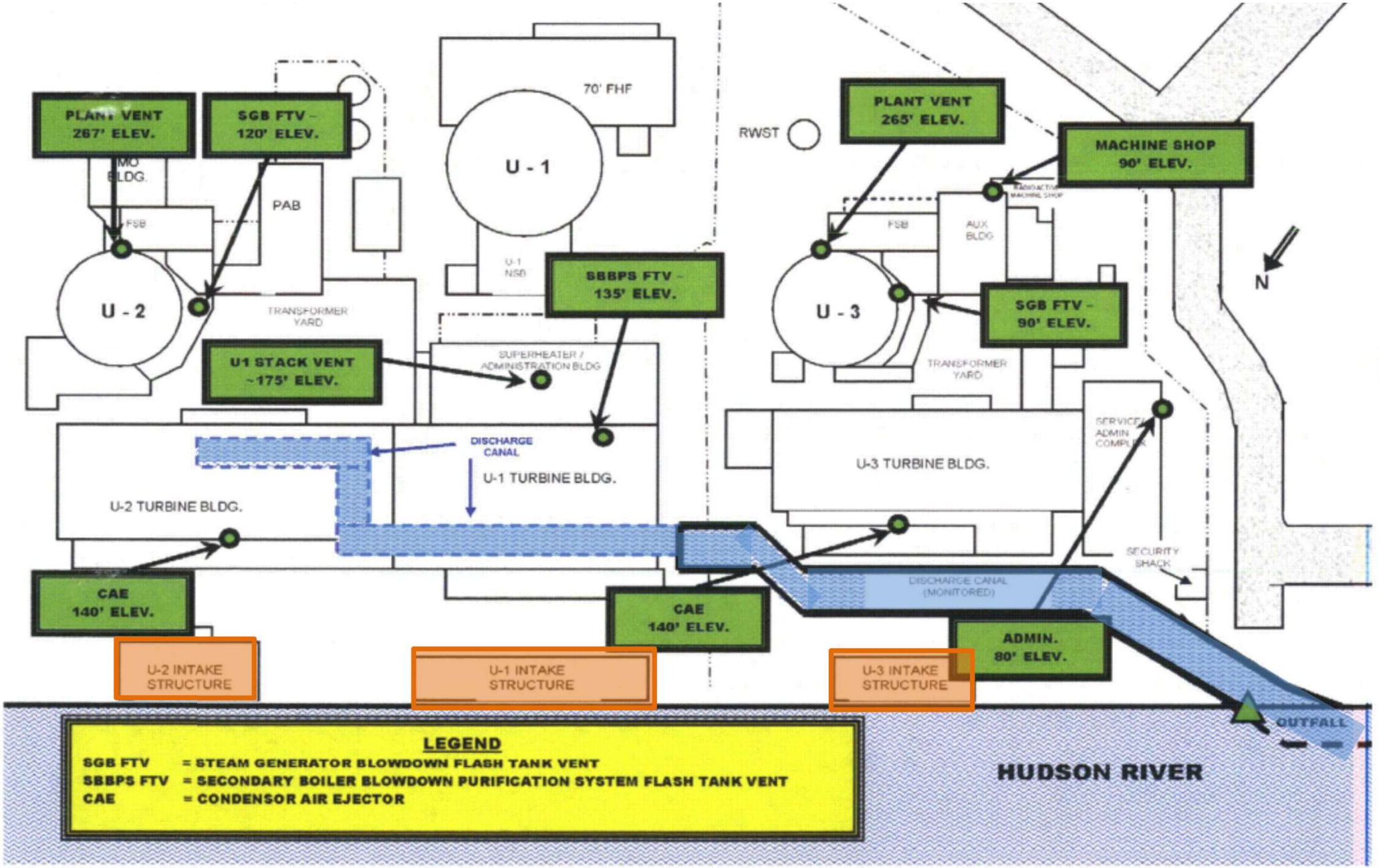
Dilution water is clean, uncontaminated water into which the processed and unprocessed waste streams are routed before discharge to the river.

Source: Owner's annual effluent reports to the NRC (e.g. ML061240373)

Dilution water enters via the intake structures, flows through the condensers and other heat exchangers before flowing via the discharge canal to the river.



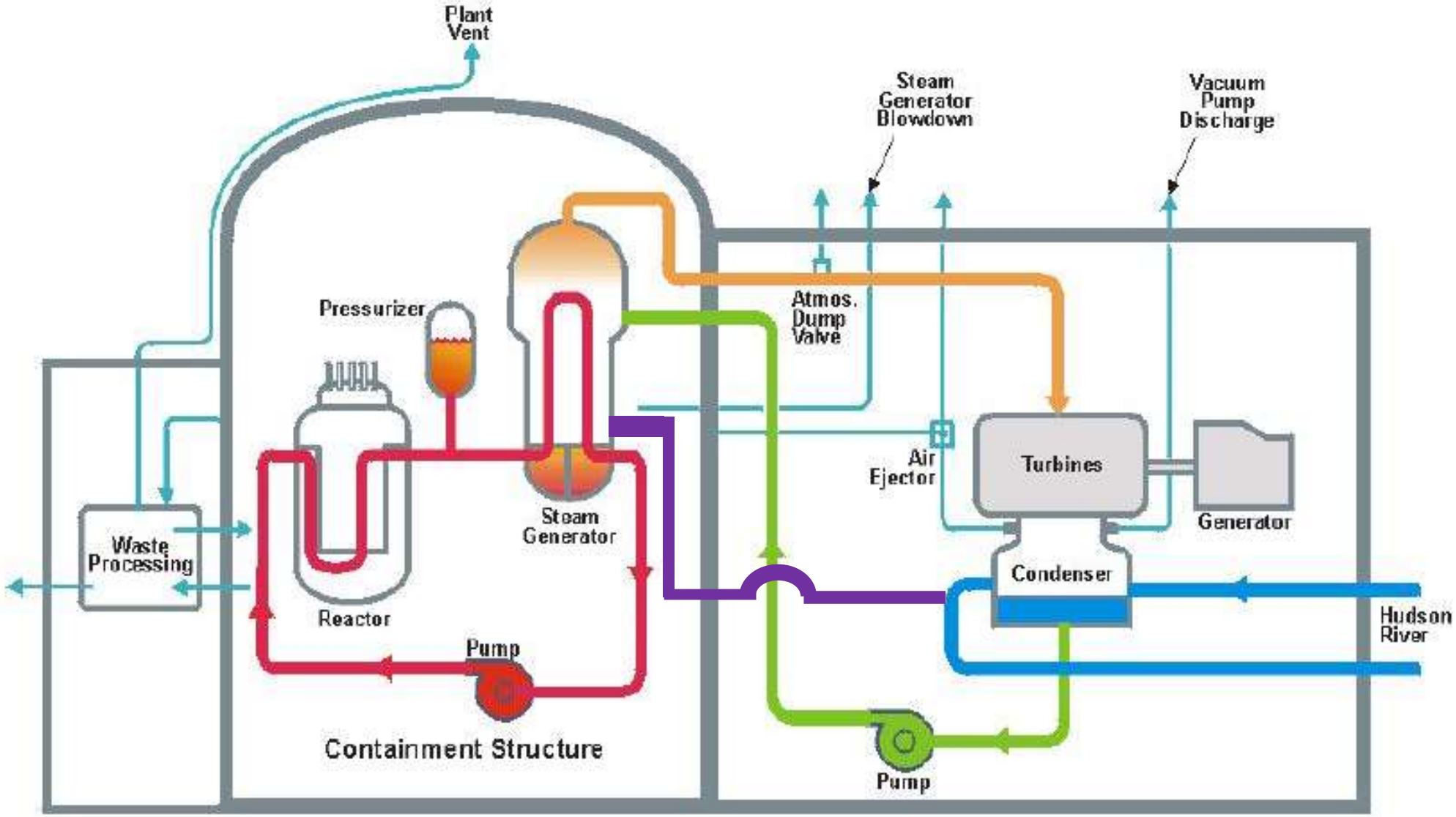
The main condensers and other exchangers are designed such that if a tube leaks, river water leaks in rather than contaminated water leaking out



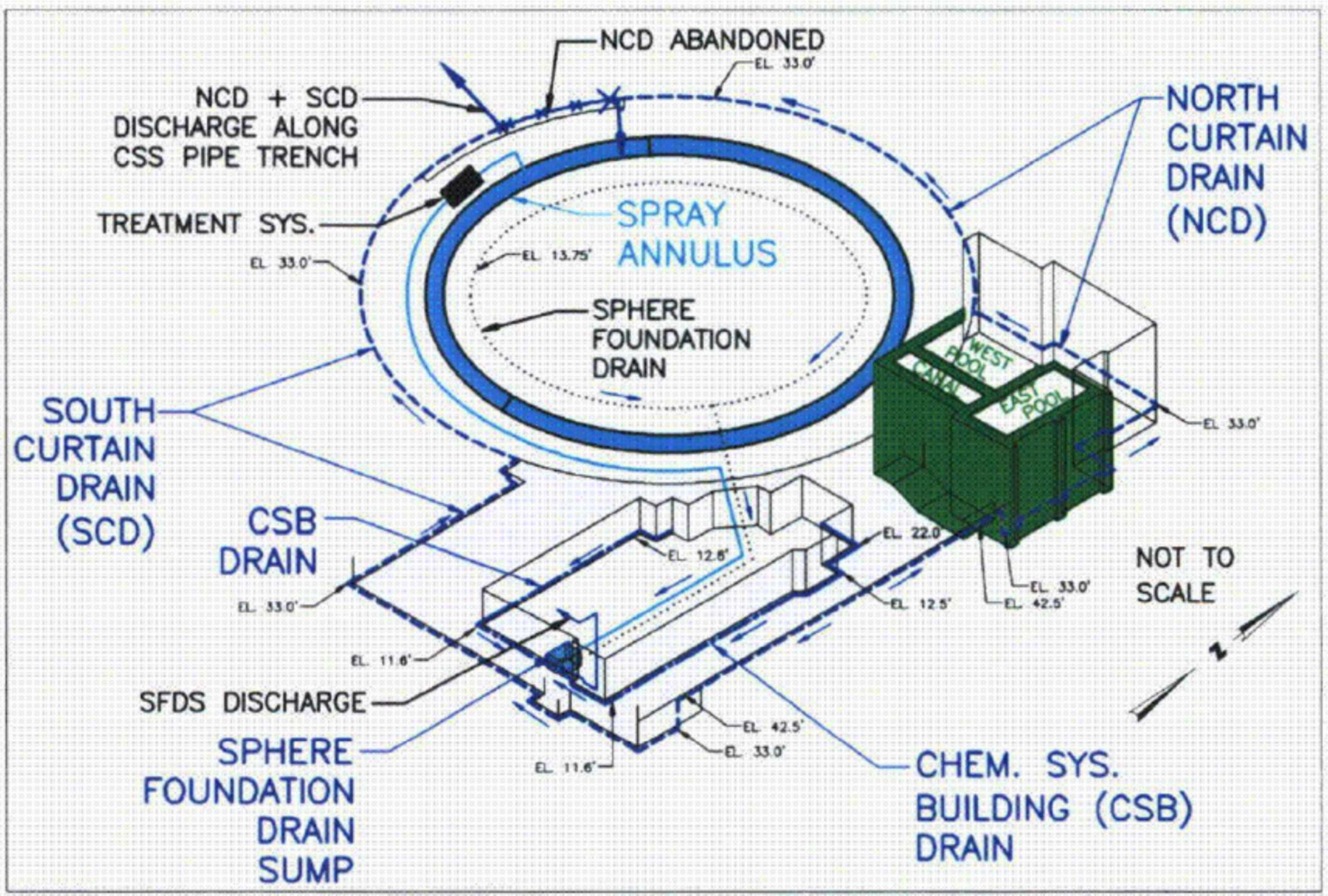
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Unprocessed waste water includes the Steam Generator Blowdown (SGBD) flow and the Sphere Foundation Drain Sump (SFDS) flow. While unprocessed, these flows are monitored and controlled to avoid excessive releases.

Source: Owner's annual effluent reports to the NRC (e.g. ML061240373)



The magenta line represents the Steam Generator Blowdown line. Some of the water from the outside of the many tubes inside the steam generators is discharged to control the water chemistry of the secondary loop. Unless a tube leaks contamination from the primary loop, this flow is clean water.



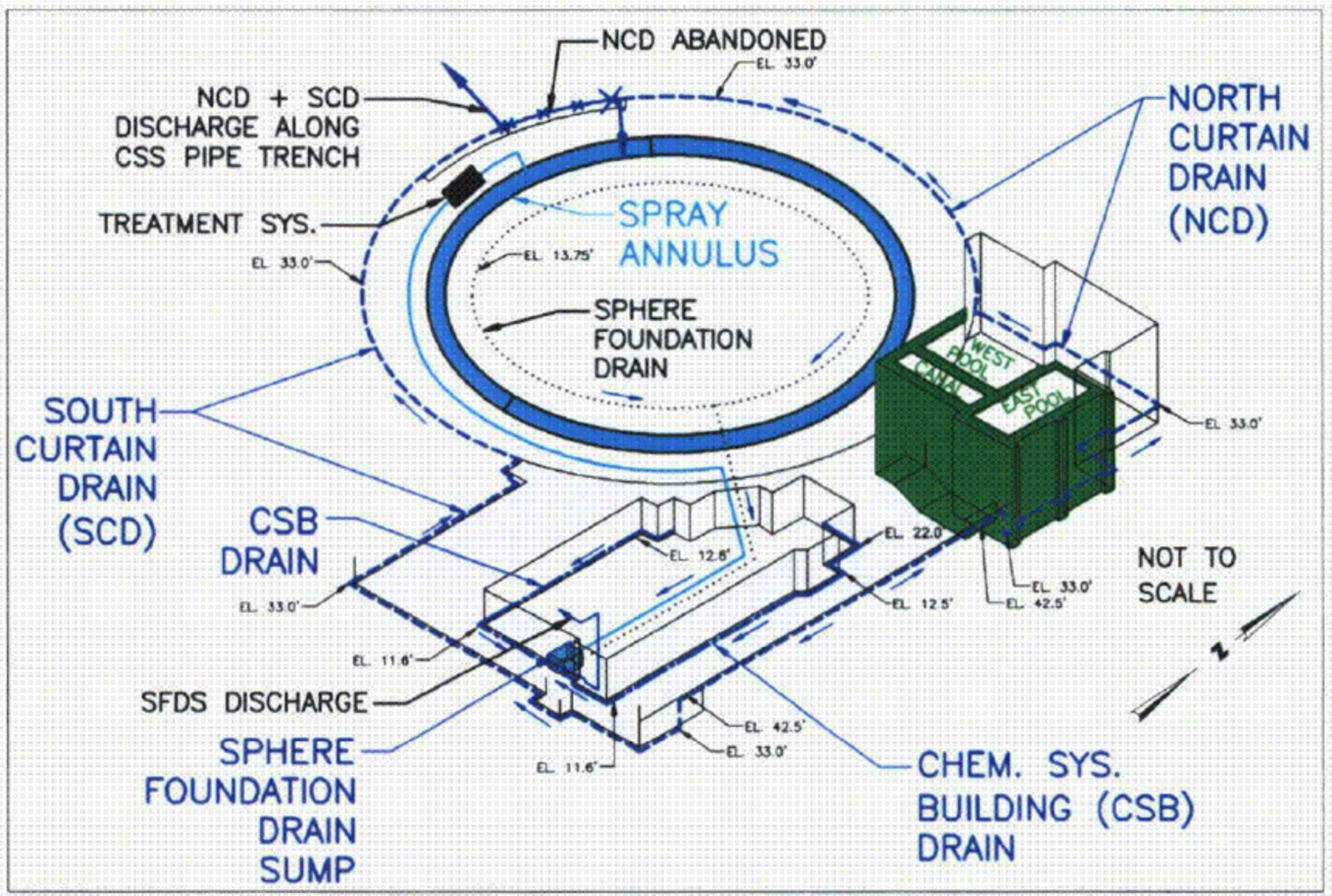
The Sphere Foundation Drain Sump flow includes water spilled in or leaking into the Unit 1 containment.

Source: ML080320540

	Processed Waste (LW & NCD) Gallons	Unprocessed Waste (SGBD, SFDS, USFD) Gallons	Volume of Dilution Water Gallons
2005	3,756,640	**89,557,020**	734,420,400,000
2006	3,492,460	56,217,504	737,062,200,000
2007	2,861,069	50,194,200	737,062,200,000
2008	3,471,325	52,180,834	750,271,200,000
2009	2,768,606	53,813,466	726,495,000,000
2010	2,977,309	47,446,728	715,927,800,000
2011	**4,874,121**	51,726,444	739,704,000,000
2012	3,479,251	50,088,528	750,271,200,000
2013	3,769,849	65,965,746	742,345,800,000
2014	2,922,359	49,480,914	739,704,000,000
2015	3,693,236	53,760,630	752,913,000,000
2016	3,310,175	39,014,102	710,644,200,000
2017	2,483,292	48,899,718	776,689,200,000
2018	3,920,431	52,624,656	797,823,600,000
2019	2,818,801	56,587,356	**805,749,000,000**

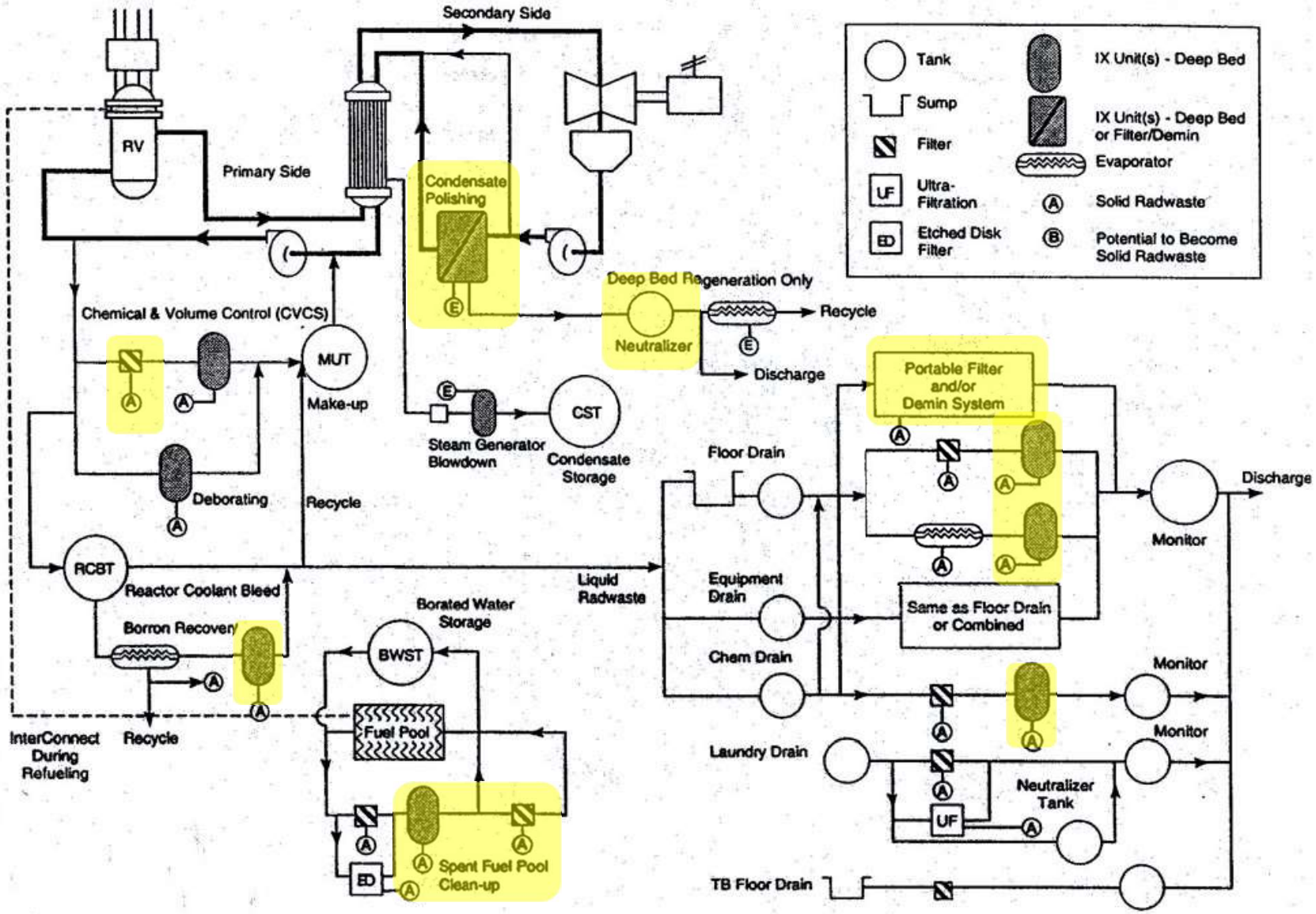
The processed waste water constitutes the lowest volume but highest radioactive content of the discharges to the Hudson River. It consists of water released from the Liquid Waste (LW) systems and the water released from the North Curtain Drain (NCD) system.

Source: Owner's annual effluent reports to the NRC (e.g. ML061240373)



Due to leakage of water from the Unit 1 spent fuel pool (shown in green), the North Curtain Drain has contained radioactively contaminated water.

Source: ML080320540



The Liquid Waste systems use filters to remove particles from water and polishers (demineralizers) to remove dissolved materials. Note that the discharge pathways have Monitors to check the radiation levels of the effluent flows.

Source: ML12151A437

Entergy

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2.5 Batch Releases:

1. Airborne

Table 2.5-1 - Airborne Batch Releases

Unit 1 and 2 Airborne Releases		Qtr 1	Qtr 2	Qtr 3	Qtr 4	2019
Number of Batch Releases		51	52	51	60	215
Total Time Period	(min)	2800	2750	2470	3300	11320
Maximum Time Period	(min)	85	101	85	173	173
Average Time Period	(min)	54.9	52.8	48.4	55	52.8
Minimum Time Period	(min)	20	3	20	12	3

Unit 3 Airborne Releases		Qtr 1	Qtr 2	Qtr 3	Qtr 4	2019
Number of Batch Releases		27	25	17	14	83
Total Time Period	(min)	2040	2400	2480	1850	8770
Maximum Time Period	(min)	168	193	542	223	542
Average Time Period	(min)	75.5	95.9	146	132	106
Minimum Time Period	(min)	5	4	1	1	1

2. Liquid

Table 2.5-2 – Liquid Batch Releases

Unit 1 and 2 Liquid Releases		Qtr 1	Qtr 2	Qtr 3	Qtr 4	2019
Number of Batch Releases		5	13	2	0	20
Total Time Period	(min)	481	1200	139	0	1820
Maximum Time Period	(min)	114	99	69.5	0	114
Average Time Period	(min)	96.2	92.3	96	0	90
Minimum Time Period	(min)	90	65	43	0	43

Unit 3 Liquid Releases		Qtr 1	Qtr 2	Qtr 3	Qtr 4	2019
Number of Batch Releases		40	29	28	5	102
Total Time Period	(min)	4470	3220	3100	555	11345
Maximum Time Period	(min)	119	124	117	115	124
Average Time Period	(min)	112	111	111	111	111
Minimum Time Period	(min)	107	105	107	108	105

Federal regulations require all liquid and gaseous releases of radioactive materials to be monitored and the totals reported to the NRC annually.

NRC inspectors periodically audit the monitoring and reporting processes.

Source: https://adamswebsearch2.nrc.gov/webSearch2/main.jsp?AccessionNumber=ML20136A402

Entergy

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Table 6-1 Summation of Dose Assessments

Year: 2019		Total Body	Max Organ
40 CFR 190 limit ===→	IPEC	25 mrem	75 mrem
Routine Airborne Effluents[1]	Units 1 and 2	1.46E-03	1.46E-03
Routine Liquid Effluents	Units 1 and 2	5.08E-04	7.65E-04
Liquid Releases of C^{14}	Units 1 and 2	1.17E-03	5.83E-03
Airborne Releases of C^{14}	Units 1 and 2	6.51E-02	3.26E-01
Routine Airborne Effluents[1]	Unit 3	3.14E-03	3.14E-03
Routine Liquid Effluents	Unit 3	8.12E-05	2.79E-04
Liquid Releases of C^{14}	Unit 3	1.17E-03	5.83E-03
Airborne Releases of C^{14}	Unit 3	6.18E-02	3.10E-01
Ground Water & Storm Drain Totals	IPEC[2]	5.69E-05	2.30E-04
Direct Shine from areas such as dry cask storage, radwaste storage, SG Mausoleum, etc.	IPEC[3]	3.00E-01	3.00E-01
Indian Point Energy Center Total Dose, per 40 CFR 190	IPEC	4.34E-01	9.54E-01

Note 1: Routine airborne dose in this table is conservatively represented as a sum of Iodine, Particulate, and Tritium dose (excluding C-14, in mrem) with a mrem term added from noble gas gamma air energy (mrad, expressed as mrem). This 'addition' does not represent a real dose and is listed here solely to help demonstrate compliance with 40CFR190. (Doses by type of release and comparison to the specific limits of 10CFR50 Appendix I are summarized on the following pages.)

Note 2: Groundwater curie and dose calculations are provided in Attachment 2.

Note 3: 40CFR190 requires the reporting of total dose, including that of direct shine. Direct shine dose from sources other than dry cask are indistinguishable from background. Direct shine dose is determined from TLDs near the dry cask area and site boundary, compared with REMP TLDs and historical values, and corrected with occupancy factors to determine a bounding, worst case assessment of direct shine dose to a real individual. Details of each year's dose evaluation are available on site.

Federal regulations further require assessment of the radiation dose to the public from the released radioactive materials.

Federal limits on radiation dose to the public

In 2019, radiation total body doses to the public from releases to the water were 0.005508 millirem from Units 1 and 2 and 0.0000812 millirem from Unit 3 -- well below the federal limit of 25 millirem

Source: https://adamswebsearch2.nrc.gov/webSearch2/main.jsp?AccessionNumber=ML20136A402

	Fission and Activation Products	Tritium	Dissolved and Entained Gases	Gross Alpha	Total Curies
	Curies	Curies	Curies	Curies	
2005	0.075	1272.000	0.075	0.000	1272.150
2006	0.059	1558.000	**0.382**	0.000	1558.441
2007	0.054	1468.000	0.040	0.000	1468.094
2008	0.069	667.021	0.038	0.000	667.127
2009	0.063	1859.000	0.009	0.000	1859.071
2010	0.067	1390.000	0.001	0.000	1390.067
2011	0.056	1907.000	0.025	0.000	1907.081
2012	0.047	1989.000	0.002	0.000	1989.050
2013	0.076	**2045.000**	0.003	0.000	**2045.079**
2014	0.040	640.000	0.000	0.000	640.041
2015	0.077	1972.000	0.012	0.000	1972.089
2016	**0.138**	1083.000	0.000	0.000	1083.138
2017	0.080	1422.000	0.004	0.000	1422.084
2018	0.090	1358.000	0.001	0.000	1358.090
2019	0.039	832.000	0.001	0.000	832.040

This table shows the amounts of radioactivity in water discharged to the Hudson River. Tritium forms the primary constituent of radioactivity releases. Tritium is a radioactive isotope of hydrogen. When tritium forms part of a water molecule, it is virtually impossible to remove from water by filters, polishers, and demineralizers. Maximum amounts of each category shown in enlarged boldface type.

Source: Owner's annual effluent reports to the NRC (e.g. ML061240373)

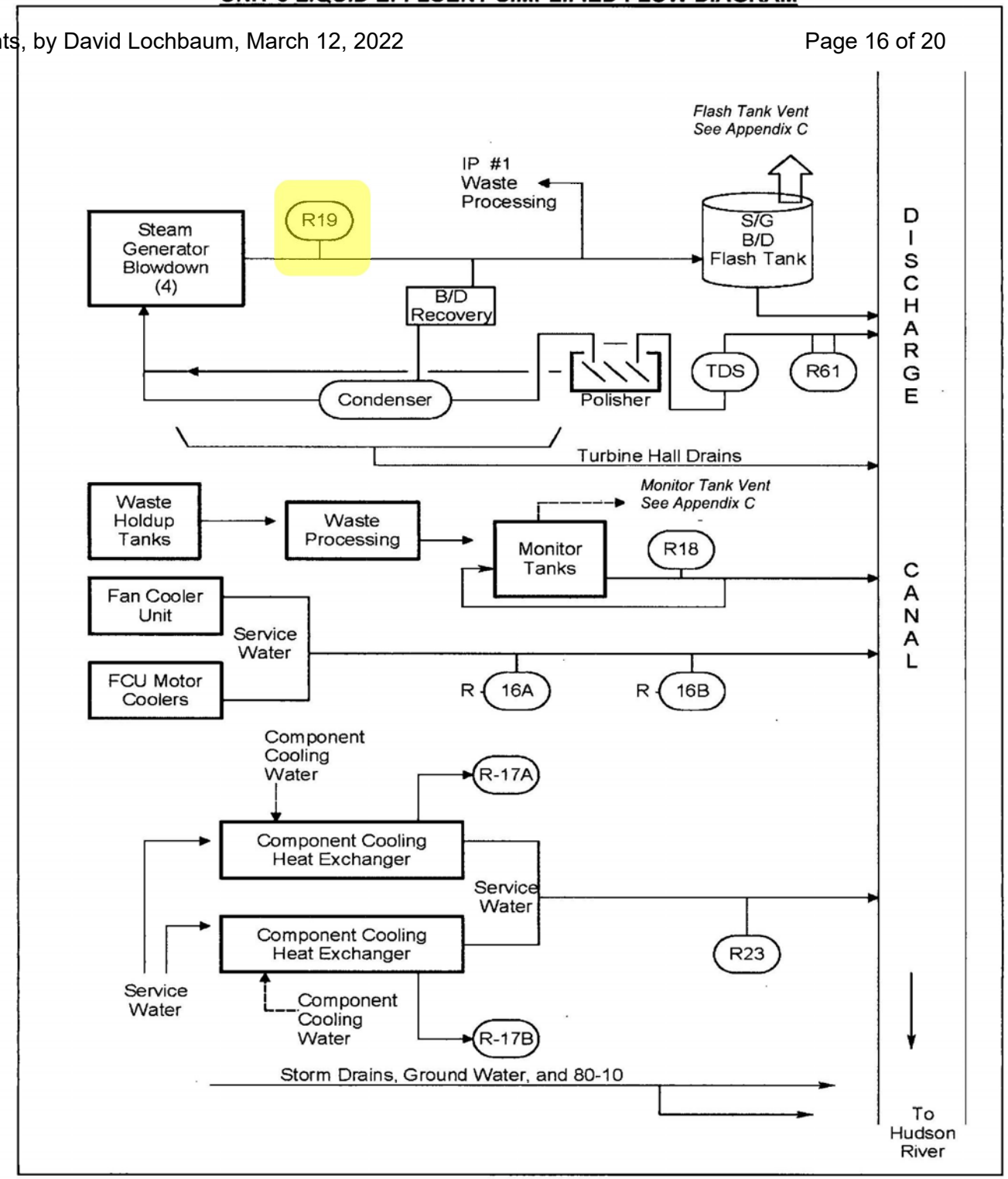
	Total Whole Body Dose	Total Body Dose Limit (40 CFR 190)	Fraction of Limit
	millrem	millrem	
2005	0.001256	25	0.0050%
2006	0.001007	25	0.0040%
2007	0.000855	25	0.0034%
2008	0.000767	25	0.0031%
2009	0.001149	25	0.0046%
2010	0.000688	25	0.0028%
2011	0.000748	25	0.0030%
2012	0.000576	25	0.0023%
2013	0.001375	25	0.0055%
2014	0.0004589	25	0.0018%
2015	0.001247	25	0.0050%
2016	0.001091	25	0.0044%
2017	0.000784	25	0.0031%
2018	**0.001947**	25	**0.0078%**
2019	0.0005892	25	0.0024%

This table shows the total body dose to the public from the radioactivity in water discharged to the Hudson River. The doses are small fractions of the federal limit. Maximum amounts of each category shown in enlarged boldface type.

Source: Owner's annual effluent reports to the NRC (e.g. ML061240373)

Releases of radioactively contaminated water to the Hudson River are monitored and controlled.

For example, R-19 is a radiation monitor in the Steam Generator Blowdown line to the discharge canal.



Source: ML13157A133

TABLE 1 – 2 Unit 3 Effluent Radiation Monitor System Data

CHANNEL	MONITOR DESCRIPTION	SAMPLING LOCATIONS	TYPICAL RANGE [1]	EFFLUENT CONTROL FUNCTIONS
R-12	Containment Gas Monitor	Samples drawn from 32 and 35 Containment Fan Coolers	9.2E-8 to 9.2E-2 µCi/cc	Containment Ventilation Isolation
R-14	Plant Vent (PV) Radiogas Monitor	Installed within the plenum of the Plant Vent, 105' elevation	1.6E-7 to 1.6E-1 µCi/cc	Secures waste gas tank release, isolates containment, aligns PV charcoal
R-15	Condenser Air Ejector Monitor	Adjecent-to-line detector, on the exhaust header, 53' Turbine Hall	2.8E-7 to 2.8E-1 µCi/cc	On alarm, diverts air ejector exhaust to VC and secures steam to priming air ejectors re-heaters
R-20	Waste Gas Disposal System Monitor	Adjacent to line, on suction to waste gas compressors	1E-2 to 1E+3 µCi/cc	None. This setpoint is based on limiting 50,000 Ci per tank, per RECS D3.2.6.
R-27	Plant Vent Wide-Range (Accident) Monitor	Drawn from inside Plant Vent to fan house near 80' airlock	Ch1-3) E-7 to E+5 µCi/cc Ch4) 10 to E+13 µCi/sec	(Same functions as R-14)
R-46	Administration Building Vent Radiogas Monitor	4th Floor Administration Building Monitor Exhaust Plenum for Controlled Areas	1E+1 to 1E+6 cpm (approx 5.0E-8 to 5.0E-2 µCi/cc)	None
R-59	RAMS Building Vent Radiogas Monitor	55' RAMS Building Monitor Exhaust Plenum	1E-6 to 1E+2 µCi/cc	None
R-16 A/B	Fan Cooler and Motor Cooler Service Water Return	Adjacent to service water return line from V.C. fan cooler units and motor coolers	7.1E-7 to 7.1E-1 µCi/ml	None
R-17 A/B	Component Cooling System pump outlet	Adjacent to line monitors on each pump outlet	2.3E-6 to 2.3E-1 µCi/ml	None. These setpoints are based on early indication of RCS leak into CCW.
R-23	Component Cooling Heat Exchanger Service Water Monitor	Adjacent to line, mounted on SW return from Component Cooling Heat Exchanger	1.3E-6 to 1.3E-2 µCi/ml	None
R-18	Waste Disposal Liquid Effluent Monitor	In-line monitor on monitor tank recirc pump discharge	4.0E-8 to 4.0E-2 µCi/ml	Terminates monitor tank release on alarm
R-19	SG Blowdown Monitor	PAB blowdown room monitors steam generator blown	7.0E-8 to 8.2E+2 µCi/ml (using 2 ranges, per RG 1.97)	Closes blowdown isolation valves and SG sample valves
R-61	Condensate Polisher Facility (CPF) Regen Waste Release Monitor	Recirc line of HTDS/LTDS tanks in CPF (used during a primary to secondary leak).	1E-7 to 1E-1 µCi/ml	Terminates HTDS or LTDS tank release. Applicable only in a primary to secondary leak, as defined in RECS D1.1.

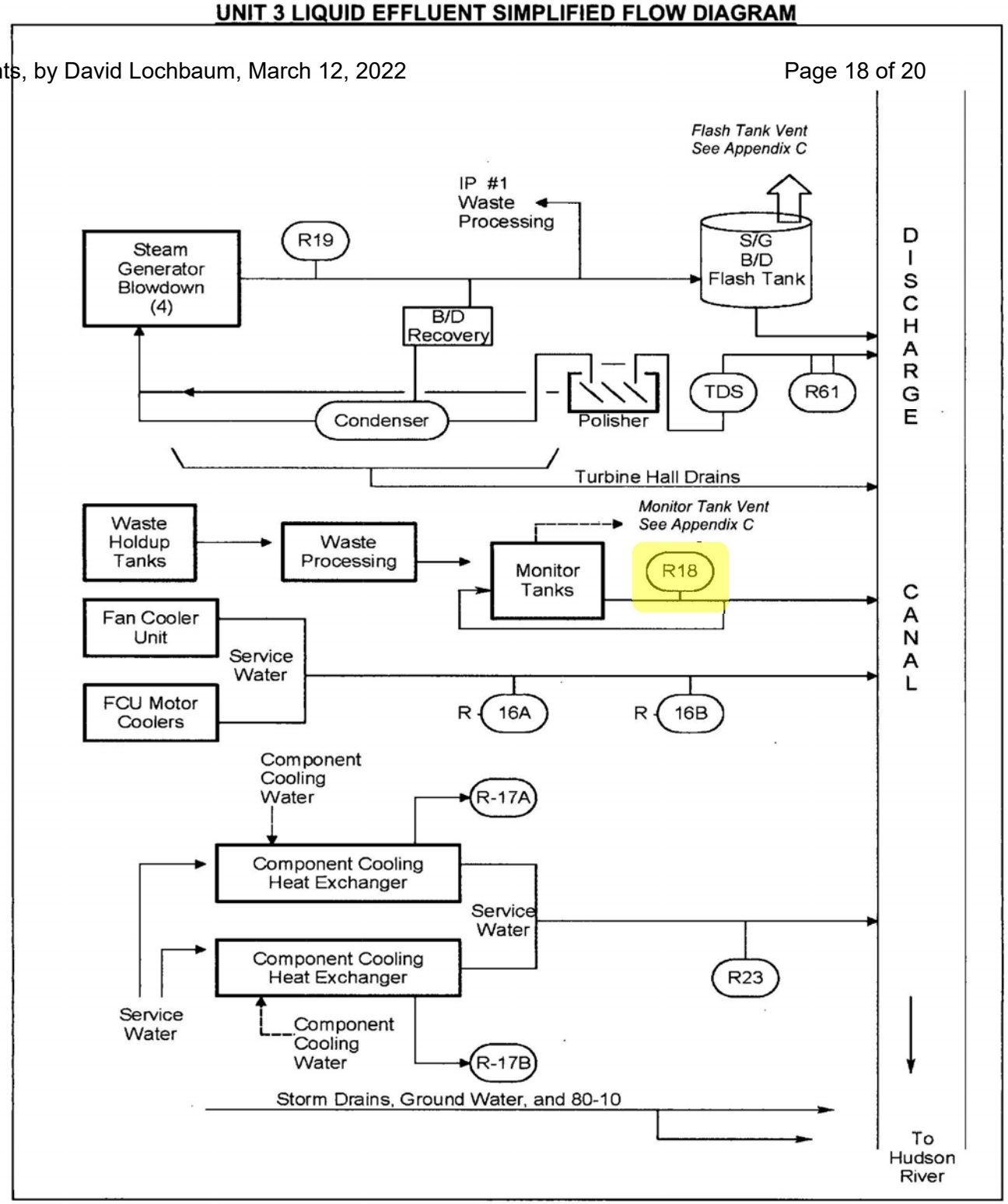
[1] Actual Ranges of Rad Monitors (in Engineering Units) are a function of the selction of isotopes (average energy) and other factors.

R-19 does more than passively monitor the radioactive content of the water flowing passed. If that level rises too high, it will trigger closure of valve to stop the release to the Hudson River.

Source: ML13157A133

Releases of radioactively contaminated water to the Hudson River are monitored and controlled.

For example, R-18 is a radiation monitor in the line from the waste tank to the discharge canal.



Source: ML13157A133

TABLE 1 – 2 Unit 3 Effluent Radiation Monitor System Data

CHANNEL	MONITOR DESCRIPTION	SAMPLING LOCATIONS	TYPICAL RANGE [1]	EFFLUENT CONTROL FUNCTIONS
R-12	Containment Gas Monitor	Samples drawn from 32 and 35 Containment Fan Coolers	9.2E-8 to 9.2E-2 µCi/cc	Containment Ventilation Isolation
R-14	Plant Vent (PV) Radiogas Monitor	Installed within the plenum of the Plant Vent, 105' elevation	1.6E-7 to 1.6E-1 µCi/cc	Secures waste gas tank release, isolates containment, aligns PV charcoal
R-15	Condenser Air Ejector Monitor	Adjecent-to-line detector, on the exhaust header, 53' Turbine Hall	2.8E-7 to 2.8E-1 µCi/cc	On alarm, diverts air ejector exhaust to VC and secures steam to priming air ejectors re-heaters
R-20	Waste Gas Disposal System Monitor	Adjacent to line, on suction to waste gas compressors	1E-2 to 1E+3 µCi/cc	None. This setpoint is based on limiting 50,000 Ci per tank, per RECS D3.2.6.
R-27	Plant Vent Wide-Range (Accident) Monitor	Drawn from inside Plant Vent to fan house near 80' airlock	Ch1-3) E-7 to E+5 µCi/cc Ch4) 10 to E+13 µCi/sec	(Same functions as R-14)
R-46	Administration Building Vent Radiogas Monitor	4th Floor Administration Building Monitor Exhaust Plenum for Controlled Areas	1E+1 to 1E+6 cpm (approx 5.0E-8 to 5.0E-2 µCi/cc)	None
R-59	RAMS Building Vent Radiogas Monitor	55' RAMS Building Monitor Exhaust Plenum	1E-6 to 1E+2 µCi/cc	None
R-16 A/B	Fan Cooler and Motor Cooler Service Water Return	Adjacent to service water return line from V.C. fan cooler units and motor coolers	7.1E-7 to 7.1E-1 µCi/ml	None
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[1] Actual Ranges of Rad Monitors (in Engineering Units) are a function of the selction of isotopes (average energy) and other factors.

R-18 does more than passively monitor the radioactive content of the water flowing passed. If that level rises too high, it will trigger closure of valve to stop the release to the Hudson River.

Source: ML13157A133

Millions of gallons of radioactively contaminated water were released to the Hudson River each year.

The pathways were monitored and controlled to reduce the amount of radioactivity in the releases to ensure the radiation doses to the public from discharged liquids were below, far below, the federal limits.

Designing a consent-based siting process to locate a deep geological repository for spent nuclear fuel and high-level waste in the United States: Perspectives of key stakeholders

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Executive Summary

E.S. 1.0 Introduction

Reviews of efforts to site facilities to safely manage spent nuclear fuel and high-level waste in the United States point to multiple failures (Rosa et al. 2010; Blue Ribbon Commission 2012; Brunnengräber et al. 2018). The causes of failure are both technical and socio-political, but community and state opposition has been notably effective at stopping facility siting. Many countries, including Canada, Sweden, Finland, Germany, Japan, and the United Kingdom, have responded by embracing the idea that a would-be host community consent to the design, construction, and operation of disposal facilities (Ramana 2013; Metlay 2013; Brunnengräber et al. 2018). While repeatedly suggested in the United States since the 1980s, the concept of consent-based siting (CBS) was never fully embraced (Shrader-Frechette 1993; Sachs 1996). The Biden Administration has begun taking small steps toward developing a consent-based approach almost a decade after President Obama's Blue Ribbon Commission on America's Nuclear Future (BRC) recommended it to select communities willing to host one or more geological repositories and/or interim storage facilities. Since the BRC report was published in 2012, calls have continued for a consent-based process in the United States (NWTRB 2021; Tuler and Webler 2021; Reset Steering Committee 2018; Jenkins-Smith et al. 2012; Bipartisan Policy Group 2017; GAO 2021; Bowen 2021).

However, the application of "consent" in the US nuclear waste context remains quite vague. The BRC defined consent as: "affected communities have an opportunity to decide whether to accept facility siting decisions and retain significant local control" (BRC 2012: 47). In 2016-17 the Department of Energy (DOE) held a series of open meetings with publics and stakeholders across the country where they asked people to help clarify a consent-based siting process. Based on what it heard, DOE (2017) proposed eleven design principles for a consent-based process. These include voluntariness, informed participation, and transparency among others. While this was a good start, these recommendations still beg numerous questions, including: what is an affected community; how does a community decide; how can voluntariness be assured, especially when proposals are coupled with incentives; when in the process is consent sought; and is consent a singular decision or are there opportunities to withdraw?

Clearly, there is a need for a deeper inquiry into the controversial elements of a consent-based siting (CBS) process. Toward that end, we inquired into how individuals who are engaged in planning for nuclear waste management in the United States envision a consent-based process for siting one or more deep geologic repositories.[1] We identified 35 issues associated with the design of CBS process. Our investigation engaged a small number of key officials, scientists, activists, and members of the nuclear industry. Each person responded to these 35 issues and our analysis identified points of agreement and disagreement along with explanations and justifications. Several points of consensus were identified. While we found a few points of strong disagreement, other apparent disagreements may reflect slightly different priorities or understandings of what should be done in practice. On the whole this study represents the first empirical deep inquiry into the beliefs and values of a diverse group of highly engaged and knowledgeable individuals in the nuclear waste management policy space in the USA.

[1] We conceived of this project and decided to focus on deep geological repositories before the DOE issued an RFI about consent-based siting for interim storage facilities.

E.S. 2.0 The concept of consent

Scholars and policy makers from medicine, research ethics, development projects in indigenous communities, and democratic theory have defined principles and practices for "voluntary informed consent" (McIlwain 2011; Faden et al. 1986; Webler and Tuler 2020; Goodland 2004; Owen & Kemp 2014; MacKay 2004; Environmental Law Institute 2004). These define processes whereby those being asked to consent should adequately understand the risks and benefits and voluntarily give or withhold consent without coercion or manipulation before any substantive decision is made. Consent seekers have duties to share relevant information in a way that is comprehensible, promotes understanding of risks and benefits, and informs decisions.

Consent in the context of medical treatment and research ethics relates to individuals, and these fields have helped inform the idea of community consent. For example, free, prior, informed consent (FPIC) -- a notion that has been promoted by the United Nations in the context of large-scale development projects in indigenous communities, including dams, ports, and mines -- is based fundamentally on the concepts of autonomy, self-determination, and understanding that are found in medical and research ethics (Sawyer and Gomez 2012; Hanna and Vanclay 2013) and human rights (Owen & Kemp 2014). Key is the belief that a community should decide for itself whether to accept the risks and benefits associated with new infrastructure and be able to negotiate for packages of benefits to off-set risks associated with the project that leave the community better off. Yet at the same time, compensation packages should not be coercive, which can occur if people live in a state of such desperation that any offer with benefits is irresistible, even if it contains significant additional risks (di Nucci 2019). The exact nature of an FPIC process is dependent on local procedures and institutions, customary law and practice, as well as international guidelines and principles that demand minimal standards be met.

E.S. 3.0 Methods

To interpret how people think differently about a consent-based siting process in the context of nuclear waste management, we used Q Method. This is a type of discourse analysis that integrates quantitative and qualitative analyses to understand points of view on a subject among a population of interest.

After securing approval from our institutional review board, we recruited individuals that have been deeply engaged with policy and regulatory questions associated with managing commercial spent nuclear fuel and high-level radioactive waste in the United States. Twelve people participated in the study. We promised all of them confidentiality. They come from non-governmental organizations, federal agencies, state agencies, the nuclear industry, tribes, research institutes, and policy think tanks. They have varying opinions about the role of nuclear energy, whether new legislation is required to initiate a consent-based process for a repository or consolidated interim storage, and who should have responsibility for carrying out a consent-based siting process. They generally agreed or strongly agreed that a well-run consent-based process will increase the odds that one or more sites will be successfully selected for a permanent geologic repository and that a well-run consent-based process will increase the odds that multiple communities will volunteer for consideration.

Participants were provided 35 statements that described potential features of a consent-based process and asked to sort and rank the statements on an ordinal scale with two subjectively anchored endpoints (most agree, least agree) based on this prompt:

> *These statements refer to a consent-based siting process to locate, build, and operate one or more deep geological repositories in the United States to store spent nuclear fuel and high-level wastes. As you think about how the U.S. should carry out a consent-based siting process, sort the cards to reflect how you think.*

Factor analysis was used to analyze the data. Factor analysis identifies a handful of underlying variables that account for variance among a larger group of measured variables. In this study the factor analysis reduced the complexity of our twelve Q sorts to four factors or variables. In Q research these are called "social perspectives" because they are shared viewpoints. Further research could use survey methods to measure the prevalence of these perspectives in a larger population of interest.

E.S. 4.0 Results: Some agreement, critical differences

Four social perspectives emerged from the analysis. We represent these as narratives, and each describes a particular orientation toward how a consent-based process should be designed, based on the 35 statements:

- Perspective A: Get to Yes expediently
- Perspective B: Seek acceptance by gaining trust
- Perspective C: Promote inclusion and transparency for informed community choice
- Perspective D: Develop legitimacy for the process and outcomes

We described each perspective in detail. We then compared the four perspectives on the three key attributes of consent: autonomy, adequate understanding, and voluntariness. Each of the four perspectives include features meant to demonstrate and ensure that autonomy, understanding, and voluntariness are achieved. However, they create the structures and procedures to achieve these attributes in different ways.

Three main findings emerge from our study.

First, among our small group of highly knowledgeable people who are deeply engaged in nuclear waste management policy in the United States, we found important areas of agreement about how a consent-based siting process should be run. These areas of agreement are reflected both in the four perspectives and in the individual Q sorts. It is widely believed that the process must be voluntary and contain considerable opportunities for public engagement and learning so that people are informed about the risks and benefits of consenting to the construction of a deep geological repository in their community. Toward this end, it is vital that communities receive funding to hire independent expertise, that information is made widely available, and that sufficient time is given to allow the community to learn and form a collective opinion. It is also widely recognized that Tribes are sovereign nations that do not need state approval if they choose to enter into a contract with the federal government. State oversight was accepted for non-tribal communities, who are legitimately under the authority of state government. Any well-run consent-based siting process will need to find an appropriate way to engage all relevant levels of government. Our participants also agreed that the facility must be held to stringent and appropriate technical standards for health and safety.

Second, differences of opinion were rarely polar opposites. Differences about process design for consent-based siting in the four perspectives often reflect a matter of emphasis rather than deep disagreement. The differences in perspectives reflect patterns among participants' Q sorts. When individuals ranked a statement differently than others, our discussions with them made apparent that they were choosing to emphasize the features differently than others. For example, some

placed more emphasis on ensuring understanding and others placed more emphasis on ensuring voluntariness, but all respondents felt both principles were vital. Differences are often a matter of emphasis or a belief that if one process feature would be obtained others would follow.

Third, in a few instances the differences we uncovered were strong, and they may pose significant challenges for the organization responsible for designing and carrying out a successful consent-based siting process. For example, a choice between who consents – local officials or the community members at-large – may be cause for conflict. We also found strong differences of opinion as to whether a process should focus on siting a repository or on designing the entire waste management system. This issue is already arising as a point of contention as Congress has instructed the DOE to develop a consent-based siting process for interim storage facilities. We also found disagreement about how much leeway a community should have to withdraw consent that it had issued. Finally, we found polarized opinions about how central the pursuit of trust by the organization responsible for implementing the process should be. There is not consensus about whether trust is needed for the process to function or if trust is a product of a well-run process.

In addition to these points of agreement and disagreement, there are many details about context and preferences that have yet to be understood sufficiently to allow for the design of a process that is likely to be widely accepted as fair, legitimate, and competent. Furthermore, the robustness of some differences we identified is difficult to ascertain because they may be rooted in a lack of understanding. For instance, one statement asserted that the Atomic Energy Act should be revised to give states more authority over environmental dimensions of the facility, but several participants ranked that statement in the middle of the distribution or on the "less agree" end because they were unfamiliar with the law.

E.S. 5.0 Conclusion

This study shows that achieving a successful consent-based siting process will require navigating challenging trade-offs, even while there are substantial areas of agreement about features important to the design of the process. Our study was designed to elicit from highly knowledgeable people who are deeply engaged in nuclear waste management policy in the United States areas of agreement and disagreement about what a consent-based process for siting one or more deep geologic repositories. We endeavored to gather information from people with diverse views. However, the four perspectives we identified may be incomplete. Engaging with more stakeholders may yield additional perspectives. Further work on these issues is warranted.

Risk characterization should result from a dialogue among experts, officials, publics, and stakeholders (NRC 1996). Meaningful characterization of risk cannot be based solely on the calculation of probability of a hazard event occurring times magnitude of the consequence, but must also consider qualitative dimensions of risk that also matter to people. In addition, there are no objective standards by which to design a legitimate, fair, and competent process (Tuler and Webler 2010; Webler and Tuler 2006).

This suggests that, without interrogating the nuances of how stakeholders believe a consent-based process should be designed, the responsible authority may find itself undermining what it hopes to achieve. Loose use of the term "consent" and a lack of critical reflection about how a consent-based process should run may lead to conflict, further erosion of trust, and exacerbate the challenge of crafting a process perceived as legitimate to the public and stakeholders – and contribute to the landscape already littered with failures, further ossifying the historical stalemate of the past 70 years. The organization charged with the responsibility to design and carry out a consent-based process has a considerable amount of leg work to do, both to understand what is desired and to

craft a design that will meet conflicting preferences. A systematic effort to go beyond generating lists of what stakeholders want or value is needed. There is a need to both understand where there is agreement and disagreement and then to create opportunities to discuss how to overcome differences. Given the current legal context, the DOE can – and should – begin this process, even if it will not ultimately remain the responsible authority for designing and implementing the process.

End of Executive Summary

Designing a consent-based siting process to locate a deep geological repository for spent nuclear fuel and high-level waste in the United States: Perspectives of key stakeholders

1.0 Introduction

Spent nuclear fuel and high-level waste in the United States from commercial nuclear reactors and defense-related activities present a problem that will not go away. The longest-lived isotopes can be dangerous for up to a million years. Most planning for disposal considers time frames of 10,000 to 100,000 years. In a more immediate sense, identifying a location to isolate and dispose of spent nuclear fuel and high-level waste has been a challenge for all countries with nuclear power plants (Di Nucci and Brunnengräber 2017; Metlay 2013). The United States made its initial consideration of a site in Lyons, Kansas in the early 1970s (GAO 2021). The Yucca Mountain site was chosen by an act of Congress and, while it remains the only legal option today, most recognize it is no longer feasible and new sites will be needed.

Reviews of efforts to devise a plan to safely manage spent nuclear fuel and high-level waste in the United States point to multiple failures (Rosa et al. 2010; BRC 2012; Brunnengräber et al. 2018). They are both technical and socio-political. What were once thought ideal locations, such as salt domes, have turned out not to be and technical debates about appropriate engineering continue. Top-down planning, distrust in responsible institutions, political interference, and public opposition have stalled efforts. Numerous proposals for how to tackle the challenge have been made (OTA 1985; NRC 1990; NRC 2001; NRC 2003; NWTRB 2015; GAO 2021). While there is broad agreement that storage in deep geologic repositories is the best option, some question their safety and debates continue about how and where to locate them.

Many countries, including Canada, Sweden, Finland, Germany, Japan, and the United Kingdom, have embraced the concept of consent for locating spent nuclear fuel and high-level waste storage and disposal facilities (Ramana 2013; Metlay 2013; Brunnengräber et al. 2018). While repeatedly suggested in the United States since the 1980s, the concept was never fully embraced (Shrader-Frechette 1993; Sachs 1996). The Biden Administration has begun taking small steps toward developing a consent-based approach almost a decade after President Obama's Blue Ribbon Commission on America's Nuclear Future (BRC) recommended it to select communities willing to host one or more geological repositories and/or interim storage facilities. To forge a more successful path, the BRC called for a consent-based approach in which communities with adequate knowledge of risks, benefits, and technical requirements could volunteer to host one or more geological repositories and/or interim storage facilities. During President Obama's second term, the Department of Energy (DOE) made progress on defining what such a process might look like (DOE 2017; Richter et al. 2022), but that initiative was squelched by the incoming Trump Administration. Calls have continued for a consent-based process in the United States (NWTRB 2021; Tuler and Webler 2021; Reset Steering Committee 2018; Jenkins-Smith et al. 2012; Bipartisan Policy Group 2017; GAO 2021; Bowen 2021).

Scholars and policy makers from medicine, research ethics, development projects in indigenous communities, and democratic theory have defined principles and practices for "voluntary informed consent" (McIlwain 2011; Faden et al. 1986; Webler and Tuler 2020; Goodland 2004; Owen & Kemp 2014; MacKay 2004; Environmental Law Institute 2004). These frameworks define processes whereby those being asked to consent should do so without coercion or manipulation, have the power to say "no," and adequately understand the risks and benefits. Consent seekers must share relevant information in a way that is comprehensible, promotes understanding of risks and

benefits, and informs decisions. Finally, consent seekers should acquire consent prior to making a decision or taking action.

Consent in the context of medical treatment and research ethics relates to individuals, and this has helped inform the idea of community consent. For example, free, prior, informed consent (FPIC) -- a notion that has been promoted by the United Nations in the context of large-scale development projects in indigenous communities, including dams, ports, and mines -- is based fundamentally on the concepts of autonomy, self-determination, and understanding that are found in medical and research ethics (Sawyer and Gomez 2012; Hanna and Vanclay 2013) and human rights (Owen & Kemp 2014). Key is the belief that a community should decide for itself whether to accept the risks and benefits associated with new infrastructure and be able to negotiate for packages of benefits to off-set risks associated with the project that leave the community better off. Yet at the same time, compensation packages should not be coercive, which can occur when there is an unjust distribution of risks or harms and some people live in a state of desperation (di Nucci 2019). The exact nature of an FPIC process is dependent on local procedures and institutions, customary law and practice, as well as international guidelines and principles that demand minimal standards that must be met.

However, the application of "consent" in the US nuclear waste context has been left quite vague. The BRC defined consent as: "affected communities have an opportunity to decide whether to accept facility siting decisions and retain significant local control" (BRC 2012: 47). The DOE (2017) took that definition a step further by proposing eleven design principles for a consent-based process. These include principles of voluntariness, informed participation, and transparency. Recommendations such as these still beg numerous questions, including: what is an affected community; how does a community decide; how can voluntariness be assured, especially when proposals are coupled with incentives; when in the process is consent sought; and is consent a singular decision or are there opportunities to withdraw?

We inquired into how individuals who are deeply engaged in planning for nuclear waste management envision a consent-based process for siting one or more deep geologic repositories. An in-depth study was needed because planners and stakeholders often agree on overarching concepts and still disagree strongly about process designs in specific situations (Tuler and Webler 2010; Webler and Tuler 2006). Extensive experience and guidance support the need for those designing processes to match the process with the context (NRC 1996; NRC 2008). The results of our analysis suggest that there is no consensus about what would be the best process in this case, even as people may mostly agree about general principles such as voluntariness. There are many details about context and preferences that have yet to be understood adequately to design a process that is likely to be widely accepted as fair, legitimate, and competent. This poses a significant challenge for those responsible for designing a process that will not lead to a repeat of the historical stalemate of the past 70 years. Without interrogating the nuances of how stakeholders believe a consent-based process should be designed, the responsible authority may find itself undermining what it hopes to achieve. The path forward lays with continuing the work of diagnosing both the situation and preferences of stakeholders rather than rushing to initiate a new siting process.

2.0 Methods

To investigate how different people think about the concept of consent in the context of nuclear waste management, we used Q Method. This is a type of discourse analysis that integrates quantitative and qualitative analyses to understand the points of view on a subject that are present in a population of interest. It has been used to investigate a variety of environmental and hazard

management issues (McKeown & Thomas 1988; Tuler & Webler 2006; Tuler and Webler 2009). In Q Method, researchers gain access to various perspectives on a topic by having participants do a Q sort. A small number of strategically selected people with different, but well-thought-out opinions, sort a group of statements according to their personal opinions (Danielson et al. 2010). After securing approval from our institutional review board, we recruited individuals that have been deeply engaged with policy and regulatory questions associated with managing commercial spent nuclear fuel and high-level radioactive waste in the United States. Twelve people participated in the study. We promised all of them confidentiality. They come from non-governmental organizations, federal agencies, state agencies, the nuclear industry, tribes, research institutes, and policy think tanks. They have varying opinions about the role of nuclear energy, whether new legislation is required to initiate a consent-based process for a repository or consolidated interim storage, and who should have responsibility for carrying out a consent-based siting process. They generally agree or strongly agree that a well-run consent-based process will increase the odds that one or more sites will be successfully selected for a permanent geologic repository and that a well-run consent-based process will increase the odds that multiple communities will volunteer for consideration.

Each participant did a ranked sorting of statements that described potential features of a consent-based process. The statements were assembled from a review of public comments (e.g., DOE 2016), reports (e.g., DOE 2017; Reset Report 2018; Tuler and Webler 2016; IRG 1979; Bipartisan Policy Center 2016; DOE integrated waste management and consent-based planning report 2016; DOE Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste 2013), and published research articles (e.g., Kunreuther et al. 1993) on the topic of siting one or more repositories. In our review, we extracted 183 statements and grouped them into broad categories. From these groups we sampled a set of 35 statements. These comprised the Q sample (Table 1). Results depend heavily on the statements included in the Q sorts. If researchers do not include all the relevant statements about the topic of interest, people may not be able to express their specific points of view – which may result in important social perspectives remaining hidden from view. A preliminary set of 34 Q statements were reviewed by two people knowledgeable about consent-based siting and nuclear waste disposal. Based on their recommendations, we removed two statements, added three others, and reworded some others.

In Q method, inverted factor analysis is used to identify patterns among the individual Q sorts. Thus, the sample is not the people who sort the statements, but the statements that people sort. In fact, Q method gets its name because of the letter Q's proximity to the letter R—the abbreviation for an important statistic used in survey research. The inventers of Q Method were attempting to emphasize the differences with survey research. In Q Method, the "population" is the "concourse" of statements that have been said or written on the topic. Completed Q sorts are the variables.

Participants were provided the statements on 2" x 3" cards and asked to sort and rank the statements on a table top, using the format in Figure 3, based on this prompt:

> *These statements refer to a consent-based siting process to locate, build, and operate one or more deep geological repositories in the United States to store spent nuclear fuel and high-level wastes. As you think about how the U.S. should carry out a consent-based siting process, sort the cards to reflect how you think.*

This technique has participants rank items on an ordinal scale with two subjectively anchored endpoints (most agree, least agree). There is no neutral point (see Figure 1). A participant may

agree with all the statements, but they still need to distinguish relative levels of agreement. The sorting sheet encourages a normal distribution not because it is required for the statistical analysis, but because Q Method researchers find it helpful to the participant. If participants refuse to abide by the normal distribution, that is acceptable. Once the person completed the Q sort, we asked them to demarcate a line that separates statements deemed *essential* versus *important* and statements deemed *agreeable* versus *disagreeable*. We also ask them to reflect on the pattern of cards they created. Notes from this conversation help in the interpretation of the results. All the Q sorts were conducted over zoom during the fall of 2021.

Factor analysis was used to analyze the data. Factor analysis identifies a handful of underlying variables that account for variance among a larger group of measured variables. In this study the factor analysis reduced the complexity of our twelve Q sorts to four factors or variables. In Q research these are called "social perspectives." Each is a particular ordering of the Q statements, with rankings and z-scores calculated to express the relative importance of each statement. We investigated three, four, and five factor solutions. We tried various attempts at hand rotation but ended up using varimax solution as the one that produced the clearest demarcation among perspectives without producing split factors. Ken-Q Desktop Analysis was used for the analysis (KADE 2022).

Factor-loading scores were computed to show how similar each participant's sort is to each perspective (see Table 2). Usually, people load highly on only one factor, but sometimes they have low factor loading scores on multiple factors. In the language of Q Method, these people are "confounders." Confounders have a perspective that adopts elements of two or more perspectives and the analysis must pay special attention to these. In our analysis, one participant had weak loadings on two factors (Participant 12, see Table 2). Correlation coefficients are calculated to describe how independent the perspectives are from each other.

Table 1: The thirty-five statements and their rankings within each of the four perspectives derived in the analysis. Lower numbers are associated with stronger agreement.

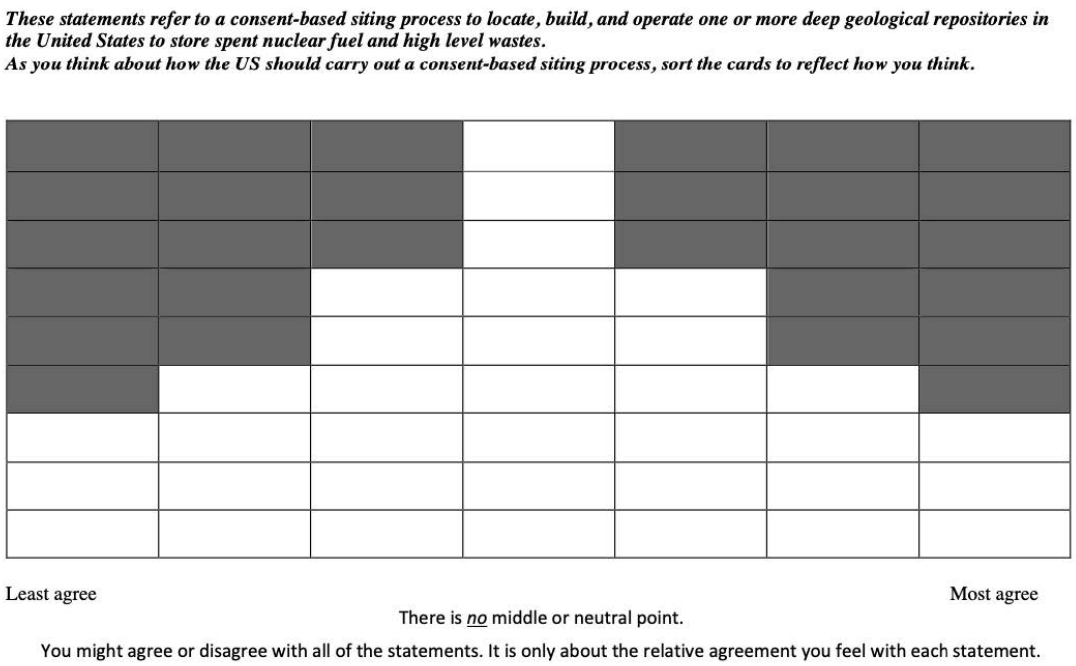
Statements	Perspectives			
	A	B	C	D
1. Elected representatives (city council members, mayors, county supervisors, and tribal council leaders) should be the ones who determine community consent.	4	19	35	21
2. A public referendum or poll of the entire community - not just the elected officials - should determine community consent.	33	26	3	27
3. A Tribe's decision to issue consent should be contingent on state approval.	31	32	33	33
4. A non-tribal community's decision to issue consent should be contingent on state approval.	30	20	22	26
5. Congress should be able to override decisions by communities or states to give or refuse consent.	32	33	34	25
6. Municipalities adjacent to the host community should not have a role in consenting to the facility.	21	29	25	23
7. All communities impacted by transport routes must also consent to the facility.	35	30	31	35
8. The process must be insulated from election cycles and politics.	8	6	9	32
9. Stakeholders and the public should have a meaningful role in defining standards for selecting and licensing a facility.	28	9	16	3
10. Stakeholders and the public should have a meaningful role in designing the procedural features and activities of the consent-based process.	20	11	17	2
11. The responsible authority must demonstrate that it is listening to the public and stakeholders.	22	7	20	1
12. An independent group with diverse representation should be set-up to monitor and assess the process from inception to completion.	13	3	7	30
13. This process should focus on overcoming distrust rooted in past history in nuclear waste management.	26	14	32	24
14. The process needs to be given adequate time. The responsible authority should not rush the process and allow deadlines to be flexible.	23	31	26	11
15. The process should begin by clearly defining criteria and standards for community consent	16	10	5	15
16. The process should begin by clearly defining technical criteria and standards for acceptable locations.	3	16	13	4
17. A safety case needs to be made for the design of a facility before a community, state and/or tribe is asked to consent	1	23	12	12
18. The process must consider the potential impacts upon future generations.	5	17	6	6
19. Once an agreement in reached and construction begins, the host community, state, and/or Tribe should be empowered to maintain oversight and participate in monitoring.	15	4	15	5

20. There should be funding for tribes, states, and local communities to acquire independent expertise to evaluate proposals.	14	12	1	10
21. The community should become better off by agreeing to host a facility; it should be empowered to negotiate for benefits.	7	8	24	7
22. Incentives are bribery, they should be prohibited.	34	34	21	34
23. The process must be absolutely voluntary and free of all coercion.	19	13	14	22
24. A potential host community that volunteers should be able to withdraw itself from consideration only under specific conditions, such as engineering changes, violation of safety standards, new information, and the like.	9	22	30	20
25. The process should be designed to maximize participation by stakeholders and the public.	27	24	2	8
26. The consent-based process should promote dialogue.	17	18	23	17
27. Special effort must be made to inform and engage economically disadvantaged groups that could possibly be affected.	10	28	18	14
28. The responsible authority should ensure accessibility of information by all stakeholders and the public (e.g., by translating materials in multiple languages, having a local library, putting documents on the web, and so on)	11	27	8	18
29. Full disclosure of decision-relevant information should be required at all stages of the process.	12	15	4	19
30. A prospective host community must be satisfied that they sufficiently understand the nature and consequences of risks and benefits before they consent.	6	21	19	16
31. Interested communities should conduct a community plan, economic development, or visioning activity to help a community articulate what type of future it wants before deciding whether to pursue hosting a facility.	24	5	28	13
32. A consent-based process should configure the entire waste management system simultaneously – repositories, interim storage, and transportation routes – rather than in a piecemeal fashion.	2	1	11	31
33. A consent-based process should not lead to the violation of prior promises and agreements.	25	25	29	28
34. The responsible authority needs to demonstrate that is trustworthy.	18	2	27	9
35. Congress should amend the Atomic Energy Act to remove exemptions from environmental laws for spent fuel and high-level waste.	29	35	10	29

Table 2. Factor loadings of each participant on the four perspectives. Statistically significant $p < 0.05$ associations are highlighted.

Study participant	Perspective A	Perspective B	Perspective C	Perspective D
1	0.8446	0.2043	-0.0292	-0.0278
2	0.7977	0.1877	0.1598	0.1848
3	0.1258	0.5266	0.6535	0.1612
4	0.4713	-0.1802	0.0566	0.6522
5	0.172	0.2395	0.044	0.8275
6	0.1855	0.8247	0.0165	0.3242
7	0.0188	0.0962	0.095	0.7919
8	0.2732	0.7425	0.0557	-0.1003
9	0.0596	0.0686	0.8966	-0.0675
10	0.1699	-0.2134	0.6573	0.4711
11	0.557	0.3239	0.2939	0.3259
12	0.5765	0.1492	0.1174	0.4426
% variance explained (total = 71%)	20	16	15	20

Figure 1. Template for rank ordering statements



3.0 Results

In this section we first describe the four social perspectives that emerged from the analysis, clarifying their salient features and then compare them on three key aspects of consent: autonomy, adequate understanding, and voluntariness. In the narratives we refer to statements and their rankings by indicating the statement number and the rank order number of the statement in the narrative (Figure 3). We refer to the organization that will be responsible for designing and implementing the consent-based process and the waste management strategy as the "responsible authority" because it is unclear if this will ultimately be the Department of Energy or another organization.

3.1 Perspective A: Get to Yes expediently

In this perspective, the focus is on obtaining consent from a community expediently by getting the science right and ensuring the community understands the risks and benefits. The key is to ensure, foremostly, that a strong and accepted argument is made that the facility will be safe. This is done in two ways. First, with a solid safety case (17-*1st)*. While this would seem to be of obvious importance, only this perspective ranked this statement in the top ten. One of the people who strongly shaped this perspective reported that a key mistake made with Yucca Mountain was that Nevada was offered a chance to reject the facility before a safety case was made. Second, it is vital that technical criteria for site acceptability be defined at the onset (16-*3rd)*.

This perspective holds that the entire waste system should be designed simultaneously (32-*2nd*), but in the interest of expediency it is not necessary to implement it all at once. One participant noted that it could take another 15 years to get an interim fuel storage facility sited and that planning on all fronts—repository, interim storage, and transportation corridors—needs to start now. Also related to expediency, this perspective stands out for agreeing most strongly that a community should be able to withdraw consent under certain conditions, which may become more constrained as the process continues (24-*9th*). Only this perspective had that statement in the top ten.

There is a risk that time will be wasted striving to secure consent only to have Congress or states intervene or the community change its mind and refuse to give consent because it feels it will not be made better off. To increase the potential for a durable decision, the process should promote the autonomy of the host community by insulating the process from election cycles and politics (8-*8th*), insulate it from state (4-*30th*) and Congressional (5-*32nd)* interference, and ensure the community is, on the whole, made better off (21-*7th*).

While important focus is placed on safety, logistics, and expediency, Perspective A also recognizes that the process needs to win community consent by getting the participation right. Central here is achieving competent community understanding (30-*6th,* 28-*11th,* 29-*12th*). This perspective asserts that the community must be satisfied that it understands the risks and benefits before it consents (30-*6th)*. This statement was ranked higher in this perspective than any other. To ensure community understanding of risks and benefits, the process should engage economically disadvantaged populations (27-*10th*), consider the potential impacts to future generations (18-*5th*), and have the process overseen by an independent monitor and assess the process from inception to completion (12-*13th*).

However, maximizing participation is not emphasized for two reasons. First, the focus is on creating opportunities for meaningful participation rather than about numbers of people at a meeting (25-*27th*). Second, those associated with this perspective believe that local elected representatives should be the ones who issue consent (1-*4th*). Perspective A is alone in making this point strongly.

Leaving it up to a referendum (2-*33rd*) would lead to failure. One person noted: "If you left the siting of critical infrastructure up to referendums, we'd never build anything anywhere, ever." Another person said, "A well-funded referendum can get a 60% 'no' vote on anything."

3.2 Perspective B: Seek acceptance by gaining trust

For Perspective B, the focus is on winning community consent by demonstrating trustworthiness (34-*2nd*), having an independent and diverse group oversee the entire process (12-*3rd*), and configuring the entire waste management system simultaneously (32-*1st*). A process designed with these features will ensure that "everything else will fall into place," according to one of the study participants. Trustworthiness is further developed by the responsible authority demonstrating that it is listening to the public (11-*7th*) and the community continuing to play a role in monitoring the facility once it is built (19-*4th*).

Among all the perspectives, this one has the strongest views on keeping to a strict timetable (14-*31st*), suggesting that this view is more concerned with the dangers of delay or the danger that communities are coerced into accepting revisions to the original agreement. The individual who loaded highest on this perspective noted that, "Once consent is issued, it should not be open to constant renegotiation," as is happening at proposed locations for consolidated interim storage facilities in New Mexico and Texas. Still, there are limits to what can be achieved and, like all the other perspectives, this one is not enthusiastic about requiring neighboring communities or transport communities to consent (6-*29th*, 7-*30th*), mainly because it could drag out the timetable and make success even more elusive.

This perspective emphasizes the autonomy of the consent-granting community. It is vital that: the community continue to have a role in monitoring the facility once it is built (19-*4th*); the process be insulated from election cycle politics (8-*6th*); Congress not be able to override decisions by communities or states to give or refuse consent (5-*33rd*); and that the community be empowered to negotiate for benefits that will make it better off (21-*8th*). Uniquely, this perspective does not emphasize whether consent should be issued by elected representatives or by a public referendum (1-*19th*, 2-*26th*). This perspective stands out by strongly holding that a community should articulate what it seeks to gain from hosting a repository (31-*5th*); this can be a way to ensure that the elected officials will be informed by a deep understanding of the residents' views. It also believes that it is important that publics and stakeholders help decide how consent is issued (10-*11th*) and that they help design the consent-based process (15-*10th*).

Less emphasis is placed on making a safety case (17-*23rd*), ensuring access to all information (28-*27th*, 29-*15th)*, or defining technical criteria for acceptable locations (16-*16th*). This is not the say these features are unimportant, it is just that, compared to the others, this perspective puts the spotlight on community autonomy and trust-building behaviors.

3.3 Perspective C: Promote inclusion and transparency for informed community choice

According to Perspective C, a successful consent-based siting process must empower the community to reach a competent decision – whether it is a yes or a no. Foremost is the importance of funding so that communities can hire their own experts (20-*1st*) to best understand risks and benefits of a proposed repository. To further promote understanding, all information must be disclosed (29-*4th*), translated into appropriate languages, and made widely available (28-*8th*).

It is also important to maximize participation (25-*2nd*) because the decision to issue consent or not should be made with input from the entire community (2-*3rd*) and not only by elected officials (1-*35th*). One person noted that, in some states and municipalities, referenda are not permitted. Other

voting mechanisms may be needed. Committing to this definition of consent at the start of the process is vital (15-*5th*) because "vague criteria are a recipe for failure," according to a person strongly associated with this perspective. Engaging economically disadvantaged groups is also important (28-*8th*) because they often bear an unjust burden of risk and the proposed project should not contribute to that injustice. Participants associated with Perspective C noted that, if these things are done, then stakeholders and the public will have a meaningful role in defining standards for selecting and licensing a facility (10-*17th*). A requirement that the community should become better off by agreeing to host a facility (21-*24th*) is ranked lowest in this perspective compared to the others because of the belief that it is not always clear who will benefit (those already in power vs. poorer or marginalized members of the community) and if the benefits will emerge as promised.

Coupled with a focus on inclusion and transparency is attention to empowering the local community, state, and/or tribe. For example, there is strong support for the community to participate in continuous monitoring once the facility is built (12-*7th*). If the community has power, then trust is not so central a consideration (13-*32nd*, 34-*27th*).

This perspective strongly rejects the idea that Congress should be able to override local, state, or tribal decisions (5-*34th*). Although one participant pointed out that this may only be possible to achieve by amending the Constitution. Uniquely, Perspective C supports the idea that Congress should amend the Atomic Energy Act to remove exemptions from environmental laws for spent fuel and high-level waste (35-*10th*). This, along with other features related to funding and information disclosure, will help to ensure that an adequate safety case is made for the design of a facility (17, *12th*).

3.4 Perspective D: Develop legitimacy for the process and outcomes

Perspective D emphasizes a process that will lead to a decision – whether yes or no – that is viewed as legitimate. Unlike the others, this perspective is narrowly focused on siting a repository (or repositories) without consideration of how the entire waste management system will be configured (by rejecting 32-*31st*). The idea that the entire system could be configured at once is deemed impractical.

Legitimacy can be achieved by the responsible authority demonstrating it is listening to publics and stakeholders (11-*1st*) in the design and implementation of the process. This means giving the public meaningful roles in designing the consent-based process (10-*2nd*) and a lack of emphasis on pre-determining who should express consent - the elected officials (1-*21st*) or the broad community via a poll or referendum (2-*27th*). Gaining legitimacy is further supported by involving the public and stakeholders in designing the standards for selecting and licensing a facility (9-*3rd*) and defining the technical criteria and standards for acceptable locations (16-*4th*). And, once a facility is built, the community ought to continue to play a role in the oversight of operations (19-*5th*).

Furthermore, those associated with this perspective see value in going slowly by taking the time needed to build solid understandings that will inform a decision to issue consent or not (14-*11th*). This feature distinguishes Perspective D from all the others. Reference was made to the Canadian process and how it is working without a timetable. Interestingly, Perspective D sees no need to establish an independent group with diverse representation to monitor and assess the process from inception to completion (12-*30th*). One person associated with this perspective feels that the NRC can do this job well. Another said that independent evaluation is a "recipe for naval-gazing." The responsible authority must demonstrate trustworthiness (34-*9th*), but the process is not about overcoming past distrust (13-*24th*).

This is also a perspective that acknowledges that decisions will be based on values and politics, whether we like it or not. The idea of insulating the process from elections is deemed undemocratic and illegal (8-*32nd*). Democratic values also drove some participants to highlight that the community should be empowered to negotiate for benefits that end up making it better off (21-*7th*, 22-*34th*) and that the process maximize participation by publics and stakeholders (25-*8th*).

4.0 Discussion

4.1 Individual vs. group perspectives

Q method is designed to identify a small set of perspectives that describe how participants think about a topic. The perspectives that emerge are a way of describing composite views that generally represent sub-groups within a wider population. Factor-loading scores are computed to show how similar each participant's sort is to each perspective. When a participant loads highly on a factor that means he or she largely agrees with it. A lower loading score means there are likely to be some details differentiating the individual's view and the collective perspective.

As the loading scores of each participant in Table 2 suggest, there can be deeper nuances among individual perspectives. One participant put it this way: "My ranking may have been significantly different on a few of the individual statements that most strongly correlate with [a Perspective], but overall, the narrative closely captured my perspective, and as you know, different responders focus on different portions of statements." For example, while being most closely associated with Perspective A, Participant 12 felt that it does not emphasize strongly enough the importance of the implementing organization building and maintaining trust. Similarly, Participant 1 felt that Perspective A does not fully emphasize the important need for sustainable multi-generational consent and federal funding. Participant 10, most strongly associated with Perspective C told us the need for a safety case and technical criteria are not as strongly emphasized as he/she believes. These differences, however, do not undermine the relevance or validity of the results. When asked for feedback, all participants indicated they largely agree with the perspective that they are most strongly associated with, as measured by their loading scores.

4.2 How the factors emphasize principles of informed consent

Core principles associated with the concept of informed consent in medicine, ethical of human subjects in research, international infrastructure development, and political theory include qualities and responsibilities obligatory of the consent-seeker and the consent-giver, including voluntariness, seeking consent prior to any action, and achieving (mutual) understanding though deliberation (Webler and Tuler 2021). Implicit to consent is the principle of autonomy or self-determination: an individual or community should know its self-interests and decide for itself whether to accept the risks and benefits associated with a proposed action, such as whether to accept treatment for an illness, participate in research, or accept new infrastructure.

Each of the four perspectives include features meant to demonstrate and ensure that autonomy, understanding, and voluntariness of risks and benefits are achieved in the design of a consent-based process for siting a deep geologic repository (or repositories). However, they create the structures and procedures to demonstrate these aspects in different ways. They also emphasize these principles in different ways in the decision processes they envision. In the following sections we refer to statements by number in Table 2. The figures in this section represent the z-scores of the statements. A z-score of +1 means the statement ranked one standard deviation above the mean for statements in that perspective. Statements with more positive z-scores were agreed to more strongly.

4.2.1 Self-determination

In medical ethics, informed consent presumes that the consent giver – the patient - is autonomous. Autonomy includes awareness of self-interests and a capacity to decide what option is in one's self-interest, such as preferences for risks, benefits, and trade-offs among different options. Democratic political theory highlights individual autonomy, the idea that individuals have the essential right to decide for themselves what is in their self-interest.

We included several statements about a community's ability to decide for itself whether to consent or not consent to a proposed repository (see Figure 2). When comparing the four perspectives, we found a sharp disagreement on whether a community should issue consent via public referendum or by vote of elected officials. Perspective A gives the power to elected officials and Perspective C gives the power to the community via a referendum or poll. Those associated with Perspectives B and D believe that communities should choose for themselves the option they view as most appropriate.

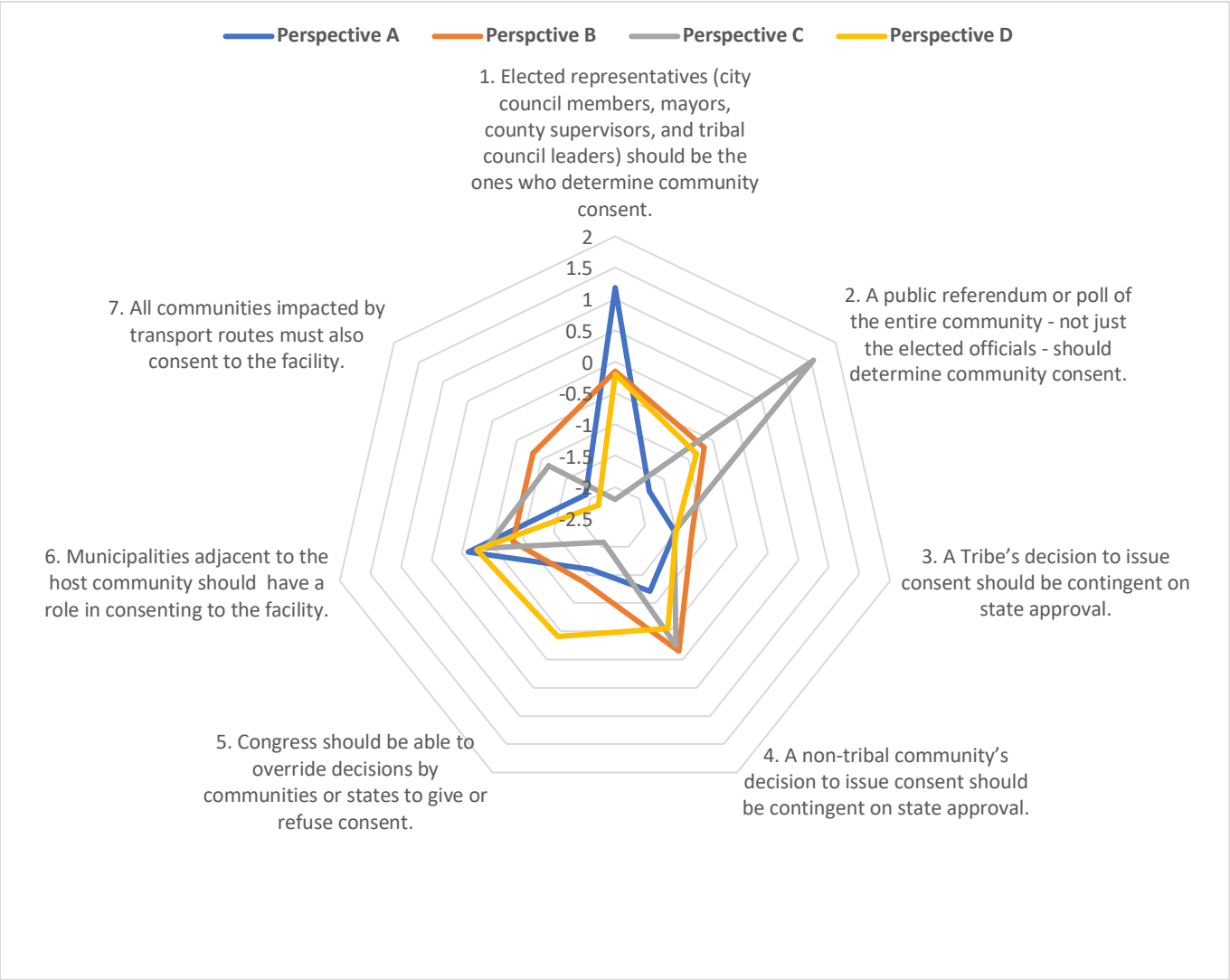
Results also show that the perspectives distinguish between tribal and non-tribal communities' autonomy. There was widespread and strong agreement that Tribes are sovereign nations that do not need state approval to enter into a contract with the Federal Government (3) but more willingness to accept that decisions by non-tribal communities *should* be subject to state approval (4).

There are also differences about Congressional influence in the process. Three perspectives oppose Congress being able to override a decision to give or refuse consent (5). Perspective D is more resistant on the grounds that it is impossible to stop (short of a Constitutional amendment) and it is inconsistent with American democracy, where Congress is the ultimate legislative body.

All perspectives agree that neighboring communities ought to have some role in the process, but they have different ideas about how (6). One person suggested "a seat at the table but no vote." Another noted, "It's complicated. Where do you draw the line?"

All perspectives also agree that communities impacted by transport routes should *not* be asked to consent (7), but, as one participant said, they ought to participate in the planning: "It is not that communities along the transportation routes should be excluded from the process, that is not what I am saying, but to ask them to affirmatively consent is contrary to our principles of representative democracy and contrary to the commerce clause."

Figure 2. How perspectives rank statements associated with self-determination



4.2.2 Understanding

In our study, six statements are associated with learning and understanding (Figure 3). The idea that a consent giver should understand the relative risks and benefits of a decision is a core principle of informed consent. Deliberation is a key means by which people achieve understanding (Webler and Tuler 2021). All perspectives agree that dialogue is important, however none of them assign a high important to this statement (26). Some people classified this as "motherhood and apple pie" and assume it would emerge as a matter of good practice; therefore, they put the statement in the middle of their distribution. In the post Q sort interview, several participants told us that statements ranked higher are "foundational." By this they mean that, if those are successfully implemented, everything else will fall into place. Another person gave a different explanation: "Dialogue is important. We want this to go faster, but if we don't talk, we end up decades behind. We are constantly torn between taking too long and not doing enough." Similarly, participants in the study support funding communities to hire independent expertise (20), but again, most seem to assume this will emerge as a matter of good practice.

The rankings of additional statements related to learning and understanding reveal differences of emphasis among the perspectives. Overall, Figure 3 reveals that Perspective B has lower rankings on all the statements while Perspectives A and C have the highest.

Providing funding to communities so that they can hire independent experts (20) is a statement that received support across all perspectives, but was championed by Perspective C.

Accessibility of information (28) and full disclosure (29) were two statements that received varied levels of support. In general, Perspectives A and C agreed strongly with these while Perspective B and D had less enthusiasm. One of the caveats participants added about full disclosure of decision-relevant information (29) is that proprietary information should not be shared. However, another claimed that it is absurd to think there will be any proprietary information. Another interpreted this statement as referring to whether the DOE should be transparent about its intentions and asserted that a community cannot consent if they don't really know what DOE is thinking. But others pointed out that there are good reasons why DOE should not make publicly available preliminary reports or internal discussions that never lead to formal agency positions.

Of great interest is the low emphasis given by Perspectives B, C and D to the statement about communities being satisfied they understand the risks and benefits before consenting (30). One person explained that, if dialogue happens, then understanding will result. Another pushed back on the "sufficiently understand" part of the statement saying, "There will always be some uncertainty." Although Perspective A has the highest emphasis, the level of support was moderate. This surprised us, but participants explained that while they agreed with this, they wanted to emphasize more specific statements.

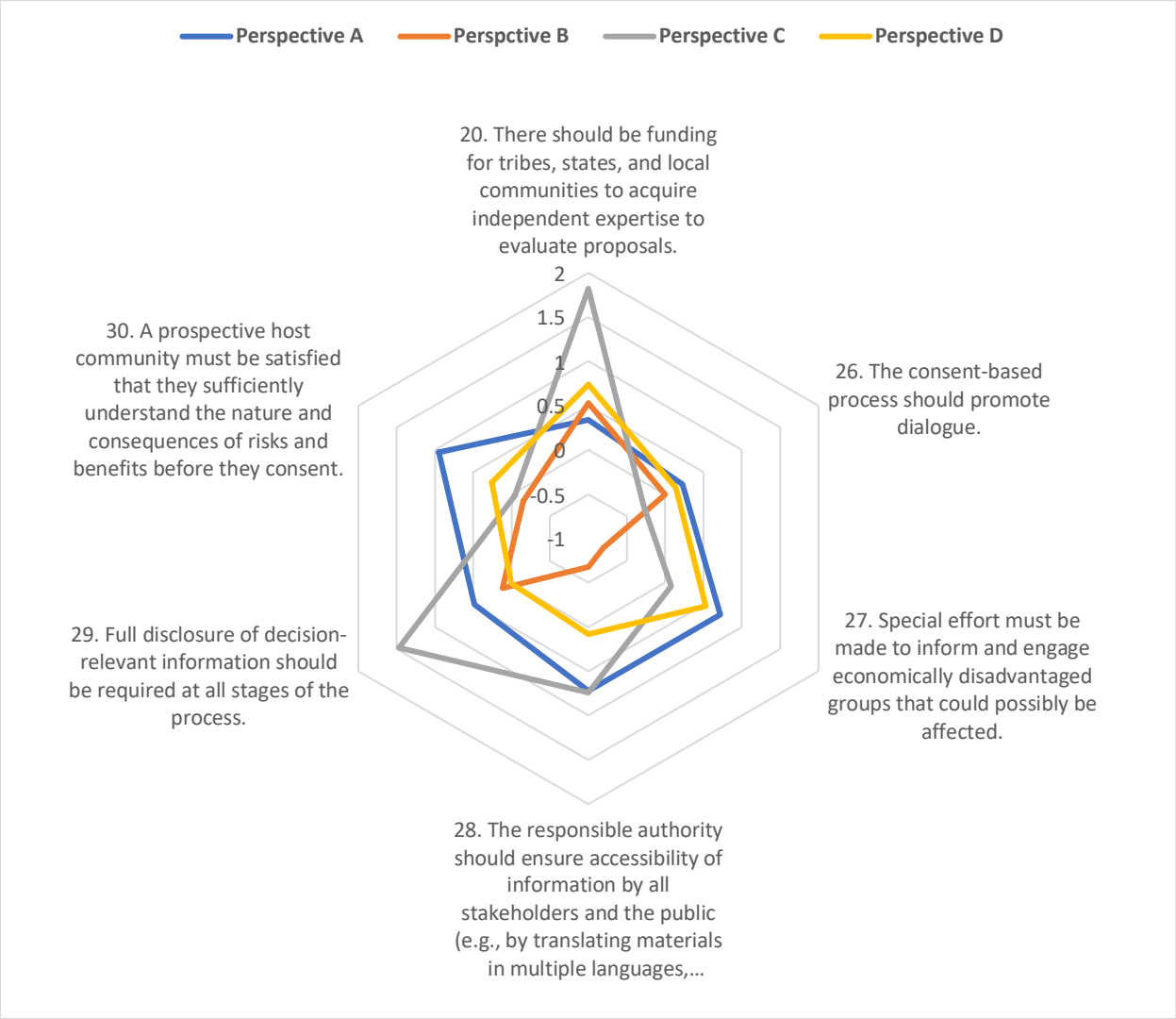
4.2.3 Voluntariness

Each perspective highlights ideas associated with achieving voluntariness, but these are not among the most highly ranked statements in any perspective (Figure 4). Statements 23 and 24 raise the topic of voluntariness explicitly. Statement 22—which states that incentives are bribery and should be prohibited—highlights the possible role that incentives can play in coercing a community or leading to the perception that it was coerced into agreeing to host a repository.

The idea that a process needs to be given adequate time and have flexible deadlines is also associated with achieving voluntariness (14). There was wide variation in how this statement was supported across the perspectives. Perspective B was the least supportive of flexible timetables, focusing on the need to be expedient. Perspective D was the most supportive of flexibility because pushing decisions to be made by a deadline could be coercive. Others took a lesson from the Nuclear Waste Policy Act noting the futility of legislating a timetable. Yet three of the four perspectives recognized that some timetable was essential. One participant from Perspective A noted, "You need a hard stop otherwise the decision just gets batted around from one administration to another."

Perspectives A, B, and D all disagree strongly that incentives are bribery (22), arguing that no community would volunteer if it did not receive compensatory benefits. But Perspective C exhibits more support for the idea that incentives *could be* bribery and thereby illegitimate, particularly in economically depressed communities. One participant recommended that incentives be scrutinized, but how this should happen is unclear.

Figure 3: How the four perspectives rank statements associated with achieving understanding

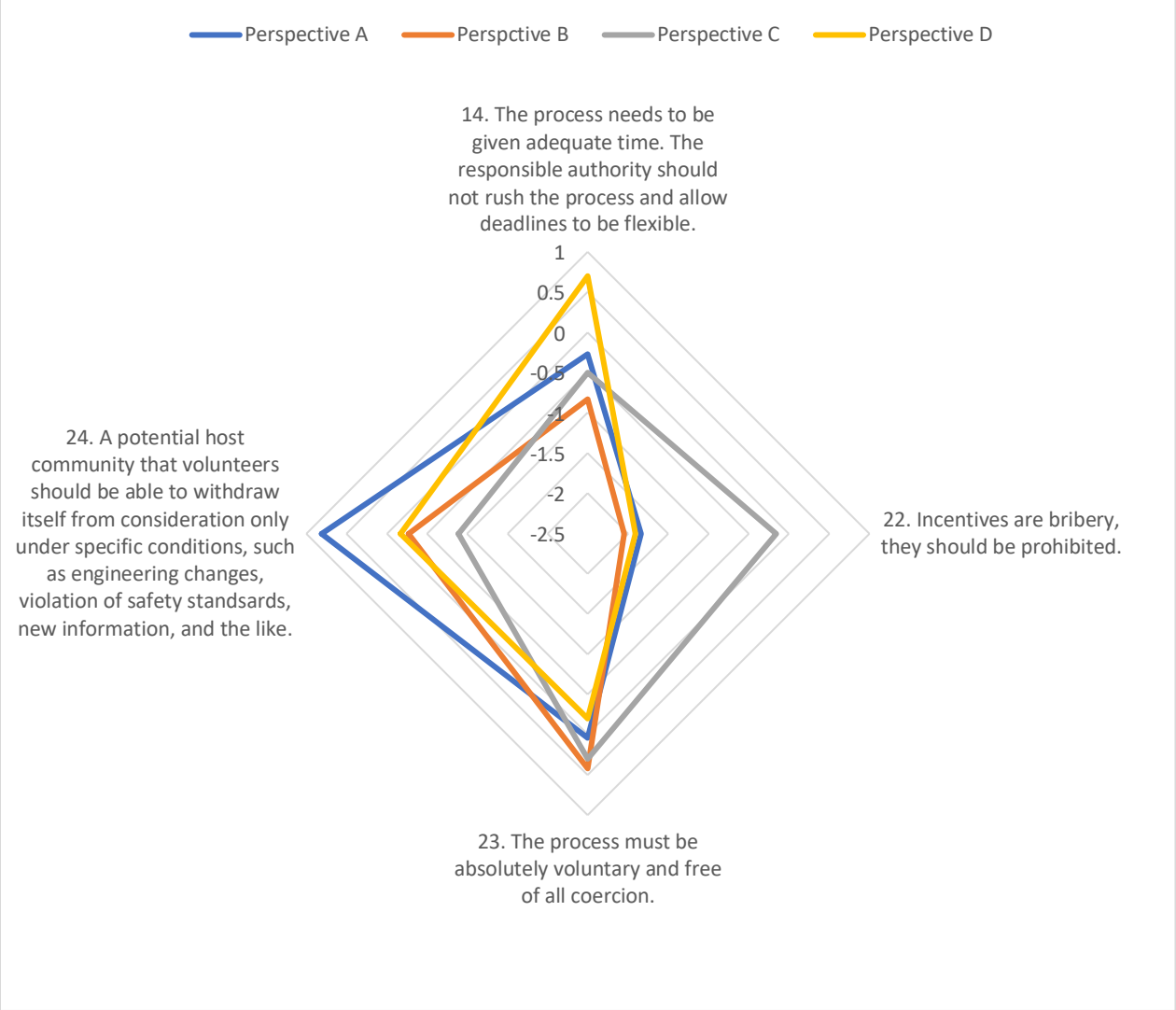


Statement 24 addresses the matter of a community retracting consent. Perspective A, more than the others, believes that a potential host community that volunteers should be able to withdraw itself from consideration only under specific conditions, such as engineering changes, violation of safety standards, new information, and the like. Perspective C takes the opposite view: that a potential host community should be able to withdraw without such restrictions. The other perspectives hold viewpoints between these.

The relative lack of emphasis on a requirement for voluntariness may be an artifact of how participants were asked to rank order statements using the template in Figure 1. As we noted above, several participants told us that statements ranked higher are "foundational." By this they mean that, if those are successfully implemented, everything else will fall into place. In other words, voluntariness can emerge when participation is meaningful, information is shared to promote

understanding of risks and benefits, and the like. What is viewed as "foundational" differs, however, among the perspectives, as evidenced above.

Figure 4: How the four perspectives rank statements associated with voluntariness



4.3 Unresolved questions for designing a consent-based process

In the following sections we discuss how the similarities and differences among the perspectives raise challenges for the design of a consent-based process that is widely accepted.

4.3.1 Who issues consent?

Clearly, an important consideration in a consent-based process is: who consents for whom? We asked participants to respond to two statements that express very different ideas: letting elected community officials decide or holding a popular vote (e.g., poll or referendum). These options appeared in our review of public comments in previous discussions of consent-based siting. They have also arisen in other contexts, such as in Canada's search for a community to volunteer to host a permanent repository.

There are significant differences among our perspectives. Perspective A argued against referenda because they give too much power to opponents, they can mislead or confuse people by wording a question in a particular manner, and money can play an outsized role. Perspective A instead supported giving the power to elected officials because that system gives an opportunity for social interest groups to influence the outcome, which is a feature essential to liberal democracy. On the other hand, Perspective C, which supported polls or referenda, pointed to gerrymandering as corrupting elected public representation. One participant also noted that referenda are illegal in some jurisdictions.

Perspective B and D do not feel comfortable choosing between these two options. Several reasons were given. One point is that the autonomy of the community should be respected, and the method not imposed. Another point was that the two choices are linked – and ought to be linked. Elected officials should make the formal decision about consent, but only after extensive consultations and deliberation within a community. That is, the elected officials should represent the will of the community, and a referendum can be a useful way to get a sense of public opinion.

All perspectives agreed that adjacent and transport communities should not be required to consent. Mostly, participants explained that it was impractical because nuclear waste is stored all around the country and it would be impossible to secure consent from dozens or possibly hundreds of communities. Two people commented that spent nuclear fuel and high-level waste are already moved through communities without their consent. One noted that communities do not need to consent to other hazardous compounds moving through their communities. However, while disagreeing that consent should be obtained from these communities, meaningful opportunities for them to participate in planning a waste management system are essential.

4.3.2 Can Congressional meddling be avoided – and is that even desirable?

The power of Congress to influence plans for spent nuclear fuel and high-level waste repositories raises significant questions for local and state self-determination. Autonomy of communities – the right to decide for themselves what is in their self-interest – is a core characteristic for consent-givers to make legitimate expressions of agreement for an action. If Congress can override a community's decision, then it is not truly autonomous.

The participants in our study expressed different views on the role and power of Congress in a consent-based process. One respondent expressed the view that Congress *should* be able to influence the process as that is a basic feature of democracy. In addition, flexibility and adaptability in a long-term incremental process will be needed. One participant stated, "We *want* Congress to be able to respond to changing conditions." However, many of our participants were of the opinion that isolating the process from Congress's meddling would be a good thing. Many of these participants commented on "the election cycle problem." One participant associated with Perspective C told us that their low rankings of statements 5 and 8 have to do with the dysfunction and legacy of "our Congress now and our political institutions now." One person pointed out that if the process to locate a deep geologic repository takes fifteen years, we are talking about "seven Congressional elections and any number of local elections."

One of the most formidable challenges is how to stop Congress from influencing the process as elected officials change. Participants expressed a wish that Congress would simply establish the process and then leave it to run its course. Many noted that while it is desirable to stop Congressional meddling, achieving that would take "magic and a lot of pretending." Another

participant noted that the only way to do this would be through a constitutional amendment, saying,

> *"I am not sure that just passing laws will be enough because they can be changed. The thing that is hardest to change is the Constitution. It is not totally facetious to say that nuclear waste is important enough and long-lived enough that we need to enshrine the technical requirements and the consent requirements in the Constitution so they cannot be easily jiggered after the fact. Yucca Mountain is a good example of that. Once it was determined that Yucca could not meet the then EPA standards DOE said change the standards and Congress let them do it."*

4.3.3 Should it be a systemic or incremental approach?

Public comments shared during the Department of Energy's meetings about a consent-based process revealed different preferences for how the design of a waste management system should be approached: to take a systems approach to design or to go about the process one element at a time. For example, a public comment was that "facility siting should not be addressed in isolation from other program components" (DOE 2016, pg. 35). In our study, Statement 32 asserted that the system (e.g., repositories, interim storage, transportation corridors) should be designed in unison. We found significant differences on this matter.

Perspectives A and B ranked this statement first and second, respectfully. One person who ranked this statement high complained that the Private Fuel Storage site on the Goshute Reservation in Utah was licensed and then not allowed to operate (Jefferies 2007). Perspective D ranked this statement among the lowest because it is viewed as impractical or impossible to do.

A participant associated with Perspective C thought the statement was too narrow and hence did not rank it as high as they might have otherwise, telling us:

> *"We cannot solve a problem without knowing the scope of the problem. You cannot decide on repositories without knowing how much spent fuel will need to be put in them […] To configure the whole system would mean determining when we are shutting down all the power plants and when are we deciding not to have advanced reactors."*

Another person split the difference saying that "We need to design the whole system, but we don't need to license everything at the same time."

4.3.4 How and when should criteria for community consent be developed?

Who determines the process is a critical aspect of a collaborative decision making process (NRC 1996). We included two statements that speak to who should have a role in designing the procedural features and activities of the consent-based process (10) and who should define criteria and standards for community consent (15). In all four perspectives these statements were ranked on the positive end of the spectrum. Statement 10 was the 2^{nd} most highly ranked statement in Perspective D, while statement 15 was ranked 5^{th} in Perspective C.

Two individuals thought that consent cannot be defined upfront, because there are too many unknowns. Consequently, communities ought to have more experience and learning under their belt before deciding how they want to measure consent. Still another person argued for determining criteria for consent early on because vague criteria are "a recipe for failure." For example, one participant associated with Perspective C told us that criteria for consent will likely change over time and "to actually do a technically sound and publicly accepted consent process is going to take decades, so to say that people like me saying this is what consent should look like, well there will need to be people involved in the consent process that are not even born yet, so this will

change over time." Another stated that we need a "launching point" but "it will be interesting to see in a geological sense how things shift over decades and centuries because institutions will change. The notion of representation will change, but the wastes will not for thousands of years." Others told us that they did not rank statements 10 or 15 at the highest levels because, while seen as valuable things to do, they were not more important than features.

4.3.5 How to proceed with a deficit of social trust?

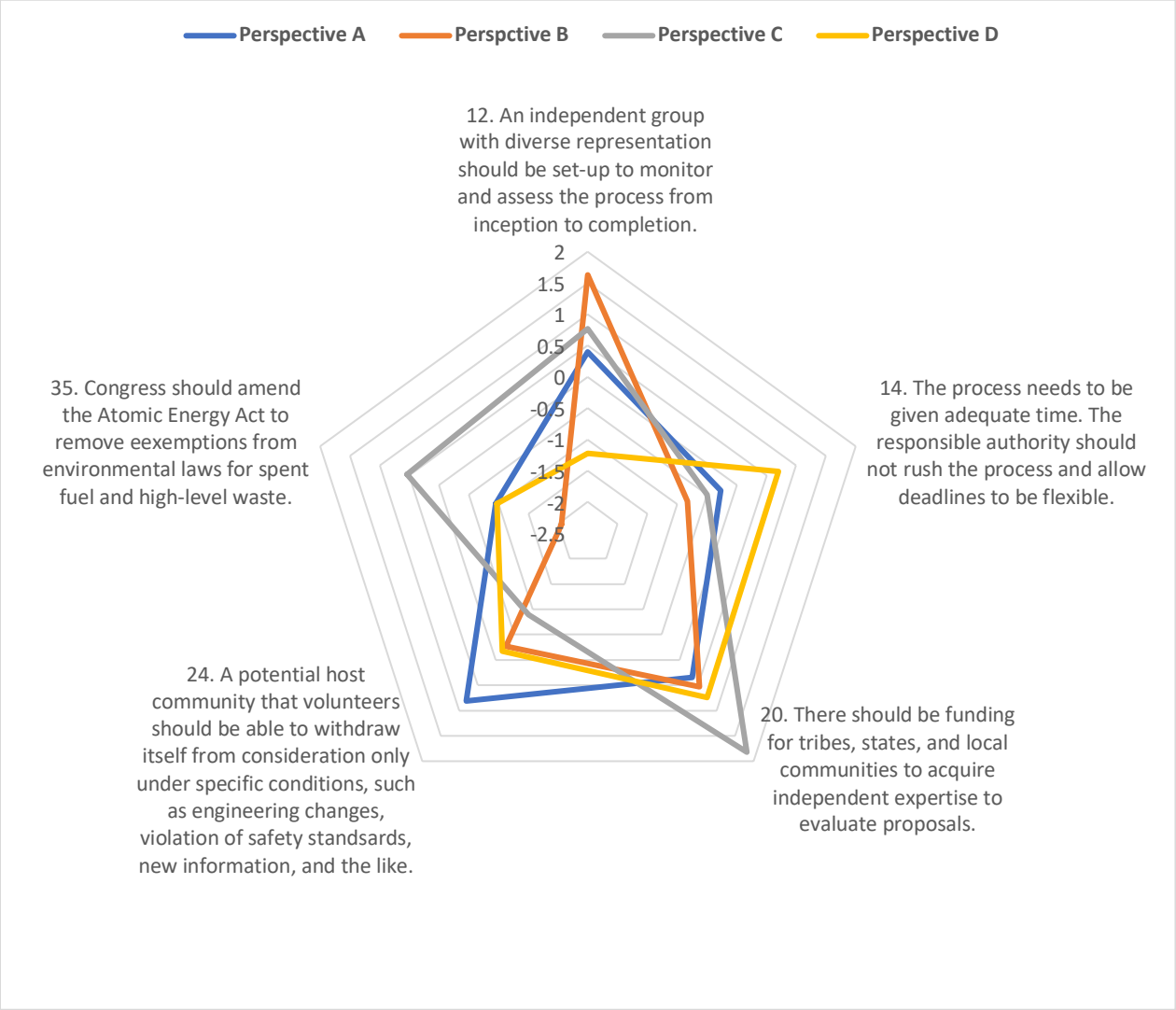
Social distrust is a significant impediment to developing a strategy for nuclear waste management (Tuler et al. 2013; Gupta et al. 2020). One of the most controversial statements in our study was: *The responsible authority needs to demonstrate that it is trustworthy (34)*. Among our participants, this statement was ranked all across the board. Some thought it the most important element to a good process. Many placed it somewhere in the middle, while others put this statement last even noting they disagreed strongly with it. It was the second highest statement in Perspective B and the ninth lowest in Perspective D. A related statement, *The process should focus on overcoming distrust rooted in past history in nuclear waste management (13)*, received modest support across all perspectives, with its highest ranking in Perspective B.

In conversations with our participants, we often heard that the Department of Energy and the Nuclear Regulatory Commission have a problem with public trust. But while some thought it vital that whatever organization will be the responsible authority needs to gain public trust, others saw that as "impossible" or "impractical." They reasoned that locating one or more deep geologic repositories would be controversial and likely to produce winners and losers; not the best recipe for gaining trust.

However, a common view among the participants was that a successful process will require confidence and trust, but these must be earned and can only develop over time by demonstrating they are deserved. This can be accomplished via different mechanisms, including creating and strengthening systems of oversight (statements 12, 20, 35) and being flexible in the face of new information (statements 14 and 24). The relative rankings of these statements are shown in Figure 5. In the set of statements, we included an idea being promoted by some stakeholders to strengthen the regulatory power of states by amending the Atomic Energy Act to remove exemptions from environmental laws for spent nuclear fuel and high-level waste (Fettus 2021; statement 35). Several of our participants were not aware of these exemptions and tended to place the statement somewhere in the middle of the distribution. Another person ranked this statement last saying "It ain't gonna happen." Not surprisingly, the statement was ranked most highly (10th overall) in Perspective C, which emphasizes transparency and empowering the local community, state, and/or tribe.

The rankings of the statements shown in Figure 5 within the perspectives are suggestive of a desire to develop "critical trust," which, "can be conceptualized as a practical form of reliance on a person or institution combined with some healthy scepticism (sic)" (Poortinga and Pidgeon 2003, pg. 971). Each perspective emphasizes such features, but in different combinations. For example, even though the statement that the responsible authority needs to demonstrate it is trustworthy (34) is ranked *27th* in Perspective C, features that can promote critical trust are supported. These include statements related to access to information (28, 29) and the statement about insulating the process from short-term political considerations (8).

Figure 5: How the four perspectives rank statements associated with trust



5.0 Conclusion

Three main findings emerge from our study.

First, among our small group of highly knowledgeable people who are deeply engaged in nuclear waste management policy in the United States, we found important areas of agreement about how a consent-based siting process should be run.

Second, differences of opinion were rarely polar opposites

Third, in a few instances the differences we uncovered were strong, and they may pose significant challenges for the organization responsible for designing and carrying out a successful consent-based siting process.

Among those who participated in our study, it is widely believed that the process must be voluntary and contain considerable opportunities for public engagement and learning so that people are informed about the risks and benefits of consenting to the construction of a deep geological repository in their community. Toward this end, it is vital that communities receive funding to hire independent expertise, that information is made widely available, and that sufficient time is given to allow the community to learn and form a collective opinion. It is also widely recognized that Tribes are sovereign nations that do not need state approval if they choose to enter into a contract with the federal government. State oversight was accepted for non-tribal communities, who are legitimately under the authority of state government. Any well-run consent-based siting process will need to find an appropriate way to engage all relevant levels of government. Our participants also agreed that the facility must be held to stringent and appropriate technical standards for health and safety.

Of course, views about what is needed and what is appropriate can vary, as this study has demonstrated. We identified differences among the perspectives about how to design a consent-based process:

- *Who issues consent and for whom?*
- *Can Congressional meddling be avoided – and is that even desirable?*
- *Should it be a systemic or incremental approach?*
- *How and when should criteria for community consent be developed?*
- *How and when can a* community withdraw consent in the process?
- *How to ensure a community is sufficiently informed to make a responsible judgment?*
- *How to proceed with a deficit of social trust?*
- *How to ensure that compensation is not coercive?*

Differences can arise across stakeholder groups and communities and within them as well. Some differences about process design for consent-based siting in the four perspectives reflect a matter of emphasis rather than deep disagreement. The differences in perspectives reflect patterns among participants' Q sorts. When individuals ranked a statement differently than others, our discussions with them made apparent that they just chose to emphasize the features differently than others. For example, some placed more emphasis on ensuring understanding and others placed more emphasis on ensuring voluntariness, but all respondents felt both principles were vital. Differences are often a matter of emphasis or a belief that if one process feature would be obtained others would follow.

Other differences are more fundamental. For example, a choice between who consents – local officials or the community members at-large – may be cause for conflict. We also found strong differences of opinion as to whether a process should focus on siting a repository or on designing the entire waste management system. This issue is already arising as a point of contention as Congress has instructed the DOE to develop a consent-based siting process for interim storage facilities. We also found disagreement about how much leeway a community should have to withdraw consent that it had issued. Finally, we found polarized opinions about how central the pursuit of trust by the organization responsible for implementing the process should be. There is not consensus about whether trust is needed for the process to function or if trust is a product of a well-run process.

In addition to these points of agreement and disagreement, there are many details about context and preferences that have yet to be understood sufficiently to allow for the design of a process that is likely to be widely accepted as fair, legitimate, and competent. Furthermore, the robustness of some differences we identified is difficult to ascertain because they may be rooted in a lack of

understanding. For instance, one statement asserted that the Atomic Energy Act should be revised to give states more authority over environmental dimensions of the facility, but several participants ranked that statement in the middle of the distribution or on the "less agree" end because they were unfamiliar with the law.

Our study was designed to elicit from highly knowledgeable people who are deeply engaged in nuclear waste management policy in the United States areas of agreement and disagreement about what a consent-based process for siting one or more deep geologic repositories. We endeavored to gather information from people with diverse views. However, the four perspectives we identified may not represent stakeholders that were not part of the study. Further work on this issue is warranted.

Risk characterization, including the process by which it occurs, should result from a dialogue among experts, officials, publics, and stakeholders (NRC 1996). Meaningful characterization of risk cannot be based on the calculation of probability of a hazard event occurring times magnitude of the consequence, but rather through consideration of multidimensional and qualitative dimensions that matter just as much to people as probabilistic risk. In addition, there are no objective standards by which to design a legitimate, fair, and competent process (Tuler and Webler 2010; Webler and Tuler 2006).

Resolving the differences made apparent in this study poses a significant challenge for the organization that will be responsible for designing a process. Loose use of the term "consent" and a lack of critical reflection about how a consent-based process should run may lead to conflict, further erosion of trust, and exacerbate the challenge of crafting a process perceived as legitimate to the public and stakeholders – thus, reinforcing the historical stalemate of the past 70 years. The organization charged with the responsibility to design and carry out a consent-based process has a considerable amount of leg work to do, both to understand what is desired and to craft a design that will meet conflicting preferences. A systematic effort to go beyond generating lists of what stakeholders want is needed. There is a need to both understand where there is agreement and disagreement and then to create broad and meaningful opportunities with stakeholders to discuss how to overcome differences. Given the current legal context, the DOE can – and should – begin this process, even if it will not ultimately remain the responsible authority for designing and implementing the process.

Acknowledgments

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION IV
1600 EAST LAMAR BOULEVARD
ARLINGTON, TEXAS 76011-4511

March 14, 2022

Mr. Doug Bauder, Vice President
and Chief Nuclear Officer
Southern California Edison Company
San Onofre Nuclear Generating Station
P.O. Box 128
San Clemente, CA 92674-0128

SUBJECT: SAN ONOFRE NUCLEAR GENERATING STATION – NRC INSPECTION REPORT 05000361/2022-001 AND 05000362/2022-001

Dear Mr. Bauder:

This letter refers to the U.S. Nuclear Regulatory Commission's (NRC's) inspection conducted on February 14-17, 2022, at the San Onofre Nuclear Generating Station (SONGS), Units 2 and 3. The NRC inspectors discussed the results of this inspection with you and members of your staff during a final exit meeting conducted on February 17, 2022. The inspection results are documented in the enclosure to this letter.

This inspection examined activities conducted under your license as they relate to public health and safety, the common defense and security, and to confirm compliance with the Commission's rules and regulations, and with the conditions of your license. Within these areas, the inspection consisted of selected examination of procedures and representative records, observations of site meetings, performance of independent radiation measurements, and interviews with personnel. Specifically, the inspectors reviewed decommissioning planning activities for SONGS Units 2 and 3, and the implementation of the fire protection program.

Based on the results of this inspection, the NRC has determined that one Severity Level IV violation of NRC requirements occurred. The violation related to the licensee's failure to implement the Fire Protection Program as required by 10 CFR 50.48(f)(1), regarding combustible materials. Since the licensee placed the deficiency into its corrective action program, the safety significance of the issue was determined to be low, and because the violation was non-repetitive and not willful, then this violation is being treated as a Non-Cited Violation (NCV), consistent with Section 2.3.2.a of the NRC Enforcement Policy. The current NRC Enforcement Policy is included on the NRC's Website at (https://www.nrc.gov/about-nrc/regulatory/enforcement/enforce-pol.html). This NCV is described in the subject inspection report.

You are not required to respond to this letter unless the description herein does not accurately reflect your corrective actions or your position. However, if you contest the violation or significance of the NCV, you should provide a response within 30 days of the date of this inspection report, with the basis for your denial, to the U.S. Nuclear Regulatory Commission, ATTN: Document Control Desk, Washington, DC 20555-0001, with copies to: (1) the Regional

Administrator, Region IV, and (2) the Director, Office of Enforcement, U.S. Nuclear Regulator Commission, Washington, DC 20555-0001.

In accordance with 10 CFR 2.390 of the NRC's "Agency Rules of Practice and Procedure," a copy of this letter, its enclosure, and your response, if you choose to provide one, will be made available electronically for public inspection in the NRC Public Document Room or from the NRC's Agencywide Documents Access and Management System (ADAMS). ADAMS is accessible from the NRC's Website at http://www.nrc.gov/reading-rm/adams.html. To the ext possible, your response should not include any personal privacy or proprietary information so that it can be made available to the public without redaction.

If you have any questions regarding this inspection report, please contact Ms. Stephanie Anderson at 817-200-1213, or the undersigned at 817-200-1249.

Sincerely,

Signed by Warnick, Gregory on 03/14/22



Gregory G. Warnick, Chief Decommissioning, ISFSI, and Operating Reactor Branch
Division of Radiological Safety & Security

Docket Nos. 50-361; 50-362 License Nos. NPF-10; NPF-15

Enclosure:
Inspection Report 05000361/2022-001, 05000362/2022-001

SAN ONOFRE NUCLEAR GENERATING STATION - NRC INSPECTION REPORT05000361/2022-001; 05000362/2022-001 - DATED MARCH 14, 2022

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U.S. NUCLEAR REGULATORY COMMISSION

REGION IV

Docket Nos.	05000361; 05000362
License Nos.	NPF-10; NPF-15
Report Nos.	05000361/2022-001; 05000362/2022-001
Licensee:	Southern California Edison Company
Facility:	San Onofre Nuclear Generating Station, Units 2 and 3
Location:	5000 South Pacific Coast Highway San Clemente, California
Dates:	February 14-17, 2022
Inspectors:	Stephanie G. Anderson Senior Health Physicist Decommissioning, ISFSI, and Operating Reactor Branch Division of Radiological Safety and Security
	John P. Reynoso, Health Physicist Decommissioning, ISFSI, and Operating Reactor Branch Division of Radiological Safety and Security
Approved By:	Gregory G. Warnick, Chief Decommissioning, ISFSI, and Operating Reactor Branch Division of Radiological Safety and Security

EXECUTIVE SUMMARY

San Onofre Nuclear Generating Station, Units 2 and 3
NRC Inspection Report 05000361/2022-001; 05000362/2022-001

This U.S. Nuclear Regulatory Commission (NRC) inspection was a routine, announced inspection of decommissioning activities being conducted at the San Onofre Nuclear Generating Station, Units 2 and 3. In summary, the licensee was conducting these activities in accordance with site procedures, license requirements, and applicable NRC regulations.

Decommissioning Performance and Status Review at Permanently Shutdown Reactors

- The licensee was implementing the decommissioning activities in accordance with the regulations and license requirements. The inspectors determined that the licensee was adequately controlling decommissioning activities and radiological work areas at the facility. (Section 1.2)

Fire Protection Program at Permanently Shutdown Reactors

- The NRC determined that one Severity Level IV non-cited violation of 10 CFR 50.48(f)(1), occurred based on the licensee's failure to verify all combustible materials had been removed within 35 feet of hot work activities. (Section 2.2)

Report Details

Summary of Plant Status

On June 12, 2013, the Southern California Edison Company (SCE), the licensee, formally notified the NRC by letter that it had permanently ceased power operations at the San Onofre Nuclear Generating Station (SONGS), Units 2 and 3, effective June 7, 2013. The licensee's letter is available in the Agencywide Documents Access and Management System (ADAMS) under (ADAMS Accession No. ML131640201). By letters dated June 28, 2013 (ADAMS Accession No. ML13183A391), and July 22, 2013 (ADAMS Accession No. ML13204A304), the licensee informed the NRC that the reactor fuel had been permanently removed from SONGS, Units 3 and 2, reactor vessels as of October 5, 2012, and July 18, 2013, respectively.

Upon docketing of these certifications, and pursuant to Title 10 of the *Code of Federal Regulations* (CFR) 50.82(a)(2), the SONGS, Units 2 and 3, facility operating licenses no longer authorized operation of the reactors or emplacement or retention of fuel into the reactor vessels. In response to the licensee's amendment request, the NRC issued the permanently defueled technical specifications on July 17, 2015 (ADAMS Accession No. ML15139A390), along with revised facility operating licenses to reflect the permanent cessation of operations at SONGS, Units 2 and 3.

The licensee submitted its Post-Shutdown Decommissioning Activities Report (PSDAR) on September 23, 2014 (ADAMS Accession No. ML14269A033), which is required to be submitted within 2 years following permanent cessation of operations under 10 CFR 50.82(a)(4). The PSDAR outlines the decommissioning activities for SONGS, Units 2 and 3. By letter dated August 20, 2015 (ADAMS Accession No. ML15204A383), the NRC informed the licensee that the PSDAR contained the information required by 10 CFR 50.82(a)(4)(i). The current version of the PSDAR is dated May 7, 2020 (ADAMS Accession No. ML20136A339).

The licensee submitted a license amendment request dated December 15, 2016 (ADAMS Accession No. ML16355A015), to revise the Permanently Defueled Emergency Plan (EP) into anIndependent Spent Fuel Storage Installation (ISFSI) Only Emergency Plan (IOEP), and to revise the emergency action level (EAL) scheme into ISFSI-Only EALs for SONGS, Units 1, 2, and 3 ISFSI. The proposed changes reflect the new status of the facility, as wellas the reduced scope of potential radiological accidents, since all the spent fuel has beenmoved to dry cask storage within the onsite ISFSI.

The NRC issued amendments to the SONGS operating licenses to allow transition to an IOEP and EAL scheme on November 30, 2017 (ADAMS Accession No. ML17310B482). The NRC inspectors determined that the SONGS IOEP and associated changes provide reasonable assurance that adequate protective measures can and will be taken in the event of a radiological emergency at the SONGS facility. The changes were reviewed, and appropriate conforming changes were properly addressed in the applicable revision and sections of the SONGS Updated Final Safety Analysis Report.

License Amendment 169 (Unit 1), 237 (Unit 2), and 230 (Unit 3) were submitted on December 15, 2016, (ADAMS Accession No. ML16355A014) and approved by the NRCby letter dated January 9, 2018 (ADAMS Accession No. ML17345A657). These license amendments changed the operating licenses and technical specifications to reflect the removal of all spent nuclear fuel from the SONGS, Units 2 and 3 Spent Fuel Pools (SFPs) and its transfer to dry

cask storage within an onsite ISFSI. These changes fully reflect the permanently shutdown status of the decommissioning facility, as well as the reduced scope of structures, systems, and components necessary to ensure plant safety since all spent fuel has been movedto the SONGS ISFSI.

The changes also made conforming revisions to the SONGS, Unit 1 technical specifications and combined them with the SONGS, Units 2 and 3 technical specifications. This license amendment became effective as of the date the licensee submitted a written notification to the NRC that all spent nuclear fuel assemblies had been transferred out of the SONGS SFPs and placed in storage within the onsite ISFSI. In a letter to the NRC dated August 7, 2020, (ADAMS Accession No. ML20227A044) the licensee has certified that all spent fuel has been removed from the SFPs of Units 2 and 3. Accordingly, SONGS entered their ISFSI-Only Technical Specifications, EP, and Security Plan on August 10, 2020.

On December 20, 2016, the licensee announced the selection of AECOM and EnergySolutions as the decommissioning general contractor for SONGS. The joint venture between the two companies is called SONGS Decommissioning Solutions (SDS). The SDS organization manages the decommissioning activities as the decommissioning general contractor, which is described in the licensee's PSDAR.

The California Environmental Quality Act is the state equivalent of the Federal National Environmental Policy Act. For SONGS, the California State Lands Commission (CSLC) performed the California Environmental Quality Act review, which was triggered by the need to establish the final disposition for the offshore conduits that are under a CSLC lease. On February 11, 2019, the Final Environmental Impact Report was released by the CSLC. The CSLC held a public meeting on March 21, 2019, to consider the Final Environmental Impact Report and a lease application to decommission the offshore infrastructure associated with SONGS, Units 2 and 3. On October 17, 2019, the California Coastal Commission approved, with conditions, the Coastal Development Permit to begin decontamination and dismantlement (D&D) of the above grade structures at SONGS, which authorized active decommissioning activities atthe site. Now that all spent fuel has been removed from the SFPs to the ISFSI, SDS has begunactive decommissioning of the site. During the inspection week, SDS was actively completing vertical cuts on the A-Ring of the Unit 3 core barrel and removing parts of the Unit 2 and 3 turbine systems and structures.

- **Decommissioning Performance and Status Review at Permanently Shutdown Reactors (71801)**

- Inspection Scope

  The inspectors reviewed documents, interviewed plant personnel, and conducted site tours to assess the licensee's performance in the following areas:

  - Status of decommissioning and verify whether the licensee was conducting decommissioning and maintenance activities in accordance with regulatory andlicense requirements;

  - Licensee awareness of work activities to assess their control and conduct of decommissioning;

- Status of the licensee's decommissioning staffing, personnel qualifications, and training requirements, including that of the contracted workforce, to ensure that license requirements were met, as applicable to the current decommissioning status;

- Whether the licensee was identifying problems related to decommissioning andmaintenance activities at an appropriate threshold and entering them into the corrective action program;

- Performed plant tours to assess field conditions and decommissioning activities; and

- Observed and assessed the status of facility housekeeping.

1.2 Observations and Findings

The licensee submitted its PSDAR on September 23, 2014, as required under 10 CFR 50.82(a)(4). The PSDAR provides the general dates for each decommissioning phase implementation period and associated activities for that period. The licensee stated that the implementation of the activities described under each period may overlap and not necessarily be implemented consecutively. The site is in Period 4, "D&D (Decontamination and Dismantlement) Dry Storage," which began with the completion of fuel transfer and extends through the completion of D&D work.

The inspectors attended meetings that included discussion of decommissioning activities as well as the current plant status for each day. The meetings provided participants with useful information about the daily status of plant activities. The inspectors performed tours of the facilities, radiation waste and safety equipment buildings, Unit 2 and Unit 3 containment buildings, and along the east road of the plant. Plant staff appeared to be knowledgeable of site conditions and based on observations, the inspectors determined that the licensee was adequately maintaining the material condition of the facilities, as well as the structures, systems, and components that are necessary for safe decommissioning. General observations by the inspectors identified good housekeeping practices, and appropriate radiological postings and labeling. The inspectors did not identify any radiation area that was not adequately identified and posted by the licensee.

The licensees decommissioning contractor, SDS, is performing, in the Unit 2 and Unit 3 containment buildings core barrel demolition with ongoing preparations for reactor head and vessel internals segmentation. This includes making modifications inside the containment buildings, including removal of large components and pressurizer interference. The inspectors toured the Unit 2 and Unit 3 containment buildings and evaluated the site personnel were focusing on safety, adherence to procedures, and radiological precautions as directed by regulatory and procedural requirements.

The inspectors requested various legacy documents and interviewed SCE and SDS staff to verified that the licensee has appropriately identified and stored in accordance with quality assurance requirements records important to decommissioning as defined in 10 CFR 50.75(g).

The inspectors evaluated the licensee's decommissioning cost planning and assessment, being an important part of the decommissioning process. The inspectors determined that the licensee's cost planning and assessment were inclusive of current and planned major decommissioning activities as identified in the PSDAR. The inspectors also determined that licensee funding and expenditures were tracking as planned by the licensee with no significant deviations to expenditures up to current date nor major deviations from the decommissioning schedule.

1.3 Conclusion

The licensee was implementing the decommissioning activities in accordance with the regulations and license requirements. The inspectors determined that the licensee was adequately controlling decommissioning activities and radiological work areas at the facility.

- **Fire Protection Program at Permanently Shutdown Reactors (64704)**

- Inspection Scope

The inspectors reviewed documents and interviewed plant personnel to assess the licensee's performance in the following areas:

- Assess whether the licensee has an effective decommissioning fire protection program that is maintained and implemented to address the potential for fires that could result in the release or spread of radioactive materials;

- Verify in the absence of spent fuel in the spent fuel storage pool the decommissioning fire protection program ensures adequate protection from the fire-induced release of radioactive material from contaminated plant areas and combustible waste products; and

- Performed plant tours to assess field conditions and the storage of combustible materials.

2.2 Observations and Findings

Title 10 CFR 50.48(f) states, in part, that the licensee shall maintain a fire protection program to address the potential for fires that could cause the release or spread of radioactive materials onsite or result in a localized radiological hazard. The inspectors reviewed the licensee's fire protection program for compliance with regulatory and license requirements. The inspectors reviewed the fire protection program as defined by Procedures SDS-FP1-PGM-0001, "SDS Fire Protection Program," Revision 8, and ENG-16, "Fire Protection Program," Revision 1.

Regulatory Guide 1.191, "Fire Protection Program for Nuclear Power Plants During Decommissioning and Permanent Shutdown," describes the methods acceptable to the NRC for complying with the NRC's regulations for fire protection programs for licensees in decommissioning. This regulatory guide is referenced in the licensee's implementing procedures, and the inspectors compared the licensee's fire protection program to the guidance provided in the regulatory guide.

The licensee's fire protection program records included a detailed fire hazards analysis. This document provided an analysis of the various plant areas and the fire protection requirements for those areas. The licensee fire protection program procedures described the staff responsibilities, program elements, and records requirements.
In addition, procedures were developed to implement the various program attributes such as system operations, maintenance, design control, staffing, and training.

According to 10 CFR 50.48(f), the objectives of the fire protection program are to:

- reasonably prevent fires that could result in a radiological hazard from occurring;
- rapidly detect, control, and extinguish those fires that do occur; and (3) ensure that the risk of fire-induced radiological hazards to the public, environment and plant personnel is minimized. The inspectors compared the licensee's fire protection program against the objectives provided in the regulations.

To prevent fires from occurring, the licensee established and implemented administrative procedures for fire prevention control of transient combustible material and control of ignition sources. The inspectors conducted site tours to confirm that the procedure controls were being implemented. In particular, the inspectors toured the 63' elevations in the Unit 2 and Unit 3 containment building, where majority of the work activities are occurring. The inspectors concluded that the licensee was not effectively controlling combustible materials around ignition sources in these areas in accordance with procedure requirements.

The NRC evaluated the licensee's implementation of procedures and determined that the licensee's failure to implement the control of ignition source procedure was a violation of 10 CFR 50.48(f)(1), which requires, in part, that licensees maintain a fire protection program to address the potential for fires that could cause the release or spread of radioactive materials, including reasonable preventing these fires. The SDS Procedure, SDS-FP1-PCD-0015, "Control of Ignition Sources," Revision 8, Step 4.1.8, requires, to verify all Class "A" combustibles within 35 feet of hot work have been removed or are shielded with approved welding curtains, welding blankets, or welding pads."

Contrary to the above, on February 16, 2022, during the NRC inspectors walkdown of the Unit 2 Containment, the inspectors identified multiple pieces of Class "A" combustible material, to include non-covered wood and a plastic bag of radiation protection trash within the 35 feet of the hot work activity. The inspectors also identified multiple pieces of 4x4 wood planks directly under a steel plate where the crew was performing the hot work activity. The 4x4 wood planks were not covered in fire blankets to prevent sparks from catching the wood on fire.

This violation was evaluated to be a Severity Level IV violation using Section 6.3.d of the NRC Enforcement Policy, dated January 14, 2022, regarding the failure to implement procedures, which has a low safety significance.

Upon identification, the licensee entered the issue into its corrective action program as SDS Condition Report # SDS-001299. The licensee took the following immediate actions: (1) removed the combustible materials from the area; (2) performed walkdowns through containment to verify any other combustible materials that potentially could be in an area where hot work will be performed; and (3) performed a stand-down with craft personnel to reinforce expectations on combustible materials around hot work activities.

Since the licensee placed the deficiency into its corrective action program, the safety significance of the issue was determined to be low, and because the violation was not willful or repetitive; therefore, this violation was treated as a non-cited violation (NCV), consistent with Section 2.3.2.a of the NRC Enforcement Policy (NCV 05000362/2022001-01, Failure to verify all combustibles had been removed when performing hot work).

The inspectors reviewed the licensee's ability to rapidly detect, control, and extinguish fires. Fire suppression systems were in service to include automatic sprinkler systems and fire extinguishers located throughout the plant. The inspectors also reviewed the fire brigade staffing requirements, training records, and the memorandum of understanding with the offsite fire brigade. All staff training requirements were completed satisfactorily.

2.3 Conclusion

The NRC determined one Severity Level IV NCV of 10 CFR 50.48(f)(1), occurred based on the licensee's failure to verify all combustible materials had been removed within 35 feet of hot work activities.

3 Exit Meeting Summary

On February 17, 2022, the NRC inspectors presented the final inspection results to Mr. Doug Bauder, Chief Nuclear Officer and Vice President Decommissioning, and othermembers of the licensee's staff. The inspectors asked the licensee whether any materials examined during the inspection should be considered proprietary. No proprietary information was identified with the exception of all SDS procedures and documents reviewed during the inspection, which were marked as proprietary.

SUPPLEMENTAL INSPECTION INFORMATION

KEY POINTS OF CONTACT

Licensee Personnel

A. Bates, SCE, Regulatory Affairs and Oversight Manager
S. Mannon, SDS, Program Director and Regulatory Manager
L. Rafner, SCE, Regulatory Affairs
M. Morgan, SCE, Regulatory Affairs
R. Kalman, SDS, Executive Sponsor
W. Richter, SDS, Fire Marshall
D. Arai, SCE, Senior Nuclear Engineer
A. Hinojosa, SDS, Engineer

INSPECTION PROCEDURES USED

IP 71801 Decommissioning Performance and Status Review at Permanently Shutdown Reactors

IP 64704 Fire Protection Program at Permanently Shutdown Reactors

LIST OF ITEMS OPENED, CLOSED, AND DISCUSSED

Opened/Closed

05000362/2022001-01	NCV	Failure to verify all combustibles had been removed when performing hot work

Discusse

None

LIST OF ACRONYMS

ADAMS	Agencywide Documents Access and Management System
CFR	Code of Federal Regulations
CSLC	California State Lands Commission
D&D	Decontamination and Dismantlement
EAL	Emergency Action Level
EP	Emergency Plan
IOEP	ISFSI-Only Emergency Plan
ISFSI	Independent Spent Fuel Storage Installation
NCV	Non-Cited Violation
NRC	Nuclear Regulatory Commission
PSDAR	Post-Shutdown Decommissioning Activities Report
SCEC	Southern California Edison Company
SDS	SONGS Decommissioning Solutions
SONGS	San Onofre Nuclear Generating Station
TS	Technical Specification

SONGS Stakeholders: Assurance of Impermanence Key to Waste Facility | March 11, 2022

Owners and neighbors of the San Onofre Nuclear Generating Station say a successful consent-based siting approach for a consolidated interim storage facility to hold the nation's spent nuclear fuel hinges on demonstrable progress toward the creation of a permanent repository and reassurance that the fuel can be stored safely.

Many local residents remain concerned about the indefinite presence of spent nuclear fuel stored on-site at the shuttered power plant. Southern California Edison, the plant's owner and operator, says the federal government is long overdue in delivering on its promise of a permanent repository for the waste.

SCE, along with the SONGS Community Engagement Panel, activist group Action for Spent Fuel Solutions Now, and San Diego Gas & Electric, which has a 20-percent ownership stake in SONGS, in responses to the U.S. Department of Energy's request for information echoed comments made at a recent meeting of the SONGS CEP. Developing a consent-based approach that incorporates social equity and environmental justice to identify an interim storage facility for spent nuclear fuel is likely to be a lengthy process, but has a stronger chance of being successful than other approaches, they said.

The SONGS CEP said international best practices in Finland, Sweden and Canada indicate that consent-based siting leads to real progress and that DOE would do well to actively solicit potential communities and create an environment in which it is easy for interested communities to step forward. An adaptive, phased-management approach to consolidated interim storage is also consistent with best practices, the panel said. State government opposition to interim or permanent facilities stands to present a particular challenge in the U.S., and the SONGS respondents suggested that proactive outreach to state governments would be key to securing cooperation to site and build a facility.

The CBS effort "must emphasize the clear and demonstrable fact that commercial SNF has been safely transported and stored for many decades and continues to be safely stored today at multiple locations around the country," SCE President and CEO Steve Powell said in the utility's March 4 response [DOE-HQ-2021-0032]. He added that nuclear power plants were sited with the intent of safely and efficiently generating electricity. "These requirements are not necessarily the same as those for interim or long-term SNF storage with respect to environmental and safety considerations."

"The disposition of spent fuel is more of a socio-political issue than a technical challenge," area activist group ASFSN said in its response to the RFI. The group said it appreciates DOE's effort to incorporate social science into the process, and underscored that the benefits to host communities must be effectively communicated.

SCE in its response cited "positive examples" in the U.S. and abroad in which host communities consented to store nuclear waste, whether from weapons or power production. The utility noted that the success stories are the result of sustained, years-long efforts to build trust and engage with local communities, states and tribes. "Potential host communities must feel invited to the process and able

to have a meaningful impact on siting considerations, but also means to substantially prosper from being involved in the process," Powell said.

Public education and outreach campaigns and the assurance that an interim site would not become permanent would be critical to securing a site for an interim facility, the SONGS respondents said. They emphasized the view that shuttered facilities, including SONGS, should have priority in relocating spent fuel since the plants cannot be fully decommissioned while fuel remains on-site, and suggested that an autonomous federal waste-management organization insulated from the shifting priorities and reversals of varying administrations be created.

"Nuclear utility customers already have prepaid for the disposal of spent fuel," SCE said, pointing out that SONGS customers have paid nearly $1 billion into the federal Nuclear Waste Fund, consistent with their obligations under the Nuclear Waste Policy Act.

–Abigail Sawyer

To: consentbasedsiting@hq.doe.gov
From: Action for Spent Fuel Solutions Now
Date: March 4, 2022
Subject: RFI: Consent-Based Siting and Federal Interim Storage

To Whom it May Concern:

Action for Spent Fuel Solutions Now (ASFSN) is a new coalition of local governments, elected officials, utilities, environmental groups, labor leaders, Native American leaders, business organizations and other community members who support the relocation of spent nuclear fuel to a federally licensed facility. Our founding members include representatives from the County of Orange, County of San Diego, City of Riverside, Southern California Edison (SCE) and San Diego Gas & Electric (SDG&E).

Our coalition applauds the recently released *Request for Information (RFI) on Using a Consent-Based Siting Process to Identify Federal Interim Storage Facilities* as an important step in restarting the federal spent fuel management program. The disposition of spent fuel is more of a socio-political issue than a technical challenge. We appreciate the Department of Energy's (DOE) efforts to incorporate social science into the process to find solutions for our nation's spent nuclear fuel, and we are thankful for the opportunity to provide a response to the RFI. We also support any future efforts the DOE may undertake to implement a robust consent-based siting process.

The following summarizes our input on consent-based siting for consolidated interim storage (CIS), which is rooted in international best practices for achieving informed consent and a commitment to stakeholder engagement, equity, and long-term community partnerships. In addition, please find below the information about our organization requested in the RFI:

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Thank you again for the opportunity to comment on your consent-based siting process. We look forward to continued progress at the national level as we work together to find storage – and disposal – solutions for spent nuclear fuel.

Area 1: Consent-Based Siting Process

1. **How should the Department build considerations of social equity and environmental justice into a consent-based siting process?**

   Advocating for equity-informed, best practice-based criteria for confirming community consent is among ASFSN's core values. As a result, we strongly support an approach that prioritizes stakeholder engagement, social equity and environmental justice. A transparent and successful consent-based

process must first seek to educate stakeholders in prospective host communities about spent nuclear fuel, including potential safety and environmental risks, as well as the measures taken to ensure safety during both construction and operation of a consolidated interim storage facility. This foundation of knowledge is critical to addressing any concerns and obtaining informed consent as the process unfolds.

Ensuring community members fully understand the science, risks and potential benefits of hosting a spent nuclear fuel storage facility requires a thoughtful approach to outreach and education. We believe the DOE's efforts should accomplish the following:

- **Engage a broad range of stakeholders within potential host communities.** Local governments and other community leaders will undoubtedly play a critical role in a consent-based siting process. However, equity and social/environmental justice considerations require an approach that prioritizes dialogue with disadvantaged communities and other hard-to-reach audiences. These stakeholders may ultimately bear the risks of any adverse effects associated with spent nuclear fuel storage and, as a result, must fully understand the potential hazards and have the opportunity to address any concerns. To establish an ongoing conversation, the DOE and its representatives must work to build trust, demonstrate a commitment to transparency, and use face-to-face, grassroots-oriented tactics that educate while also making community members feel like true partners in the process.

- **Maintain consistent engagement that begins early and continues until host communities are comfortable.** International case studies suggest that true, informed consent can only be achieved after an extended engagement process during which the siting authority builds a long-term partnership with individual potential host communities. We believe a consent-based siting process in the United States should adhere to this best practice by following an adaptive, phased approach and acknowledging that community consent occurs as the culmination of an ongoing two-way conversation that takes place over the course of time. Before making a final decision, the stakeholders most affected must have ample opportunities to learn about spent nuclear fuel storage and its risks, ask questions, provide input on matters of interest, discuss incentives, and collaboratively identify fair and equitable solutions.

- **Communicate consistently through a wide range of channels to reach diverse communities.** In any community, stakeholders prefer different modes of communication. Some individuals may also face challenges due to unreliable Internet access, lack of a permanent address and other barriers to participation. Tribal nations and other stakeholders may also have cultural preferences and language barriers. A successful outreach program, therefore, relies on a wide variety of communications designed to reach every stakeholder in their preferred manner. Specific tactics could include, but are not limited to, conducting in-person outreach at homes, community events and other easily accessible locations; disseminating messages through traditional media and digital platforms, as well as non-traditional means such as school and church newsletters; distributing direct mail pieces; and holding meetings at multiple times during the day to accommodate work schedules and childcare needs. Information about opportunities to engage in the discussion should also be widely publicized to maximize participation.

- **Use accessible language that doesn't rely on technical jargon.** Spent nuclear fuel – and the implications of storing it in one's community – is a highly complicated topic for those outside the industry. Effectively educating the public on this issue so they are able to meaningfully participate in the process requires simple messaging free of technical language that can be readily understood by a wide variety of stakeholders. Information should also be introduced in easily digestible amounts over time – phase by phase – both to ensure understanding and prevent the public from becoming overwhelmed.

- **Translate all materials and utilize bilingual outreach representatives.** In order to fully understand the issues and participate in the discussion, stakeholders must be given the opportunity to engage using the language with which they feel most comfortable. It is our understanding that the DOE intends to translate materials into a range of languages, and we strongly support this approach. Outreach representatives conducting face-to-face interactions must likewise be able to converse fluently in these languages and, ideally, connect on a cultural basis.

2. **What role should Tribal, State, and local governments and officials play in determining consent for a community to host a federal interim storage facility?**

   Consent must ultimately come from all members of host communities – including tribal, state and local governments – at the end of a lengthy education and engagement process. We anticipate local leaders will play a more in-depth role in the consent-based siting process. This role should be broad and clearly defined at the outset. It should also include ample opportunities to help identify risk mitigations, benefits and incentives for their communities, as well as the ability to exercise authority and provide oversight where possible within the broader regulatory framework.

3. **What benefits or opportunities could encourage local, State, and Tribal governments to consider engaging with the Department as it works to identify federal interim storage sites?**

   This question is best answered by the communities, tribal nations, and states in the vicinity of potential sites for interim storage facilities. However, the DOE should be open to a range of incentives for potential host communities. Specific benefits cannot be identified until these communities (and the tribal, state and local governments that represent them) have provided their input. We expect the benefits will vary across different communities based on local priorities. Some potential incentives may include financial and economic benefits such as jobs, training and community investment to mitigate any risks and costs associated with hosting a spent fuel storage facility. Other opportunities could focus on investments in social, cultural and economic prosperity, as envisioned by community members.

   It is also appropriate and necessary to provide financial support and other resources such as access to technical experts as they conduct their own investigation in tandem with the DOE's ongoing dialogue.

4. **What are barriers or impediments to successful siting of federal interim storage facilities using a consent-based process and how could they be addressed?**

Several challenges related to public education and outreach are summarized in our response to Question 1 above, along with a suggested course of action to overcome them. In short, we believe the DOE must make it easy for all stakeholders to understand the issues, participate in engagement opportunities and, if applicable, provide their consent at the end of the process.

Successfully siting a consolidated interim storage facility will also require greater stability and consistency at the national level. To that end, the DOE and decision-makers in Congress might consider creating a new autonomous waste management organization with reliable funding in the longer term. This approach, while challenging, is grounded in international best practices and will likely help achieve the ultimate goal of finding federal solutions for our nation's spent nuclear fuel.

Finally, we can foresee cases where local stakeholders interested in exploring CIS face potential state government opposition. To address this, we suggest that the DOE conduct proactive outreach to state governments about the department's consent-based siting efforts and develop a program to facilitate local, state and federal dialogue. DOE's experience and expertise make the department uniquely qualified to offer insights to local and state leaders to facilitate informed decisions whether to consider exploring a federally licensed CIS.

5. How should the Department work with local communities to establish reasonable expectations and plans concerning the duration of storage at federal interim storage facilities?

We believe interim storage sites should not become permanent by default due to the absence of a disposal solution. Providing potential host communities with a reasonable expectation about the duration of storage will require demonstrated progress toward a repository concurrent with the consent-based process for consolidated interim storage or, at minimum, a continued link between a repository and interim storage as established in current law. To help expedite solutions for spent nuclear fuel, however, we also support Congressional action to modify the link between CIS construction and construction authorization for a repository.

7. What other issues, including those raised in the Draft Consent-Based Siting Process, should the Department consider in implementing a consent-based siting process?

We would suggest an adaptive phased management approach to consolidated interim storage, which is consistent with long-term management best practices adopted by other countries with spent fuel management programs, including Finland, Sweden, Canada and others. History tells us that the spent fuel landscape changes over time. It is impractical to map out in detail every step on the path to solutions for interim storage and permanent disposal. Instead, adaptive phased management allows for flexibility in the pace and manner of implementation. It accounts for sustained stakeholder engagement along with the incorporation of new knowledge throughout the process, such that the DOE can check and adjust at the end of each phase before moving on to the next one.

Spent fuel from shutdown plants, such as the San Onofre Nuclear Generating Station (SONGS), should also be prioritized for removal over operating plants that continue to generate nuclear waste.

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Area 2: Removing Barriers to Meaningful Participation

5. What information do communities, governments, or other stakeholders need to engage with the Department on consent-based siting of federal interim storage facilities?

Our input on barriers to meaningful participation; necessary resources such as financial support and technical and legal expertise; and engagement with tribal, state and local governments is summarized in our responses to Area 1. However, our general feedback on Question 5 is as follows. In addition to establishing a low bar for participation, the DOE must work to ensure the process is fair and transparent. Public education efforts should also include discussions on issues such as transportation and emergency planning, as well as the duration of storage and timing for a permanent geologic repository. Finally, as the department embarks on a consent-based process, it is important to recognize that unanimous consent may not be possible. The process should, therefore, seek to build understanding and establish a meaningful dialogue with those most affected.

Area 3: Interim Storage as Part of a Waste Management System

3. To what extent should development of an interim storage facility relate to progress on establishing a permanent repository?

As noted above, we would like to see the DOE focus on interim storage over the next several years while promptly restarting work in pursuit of a repository. Due to the challenges inherent in siting a permanent repository, current law is likely to impede progress on interim storage construction when the consent-based process is complete. The DOE must, therefore, determine what changes to the Nuclear Waste Policy Act are needed (and when) to modify the link between CIS construction and construction authorization for a permanent repository, and then build support. This approach will allow interim storage to move forward while providing more certainty for host communities about the timing of a repository.

We recommend that DOE establish a working group to collaborate on changes needed to federal law. Action for Spent Fuel Solutions Now stands ready to support such an effort to explore authorizing language and appropriations needed to advance the broader waste management system here in the U.S. Our coalition also is well positioned to advocate for passage of such a legislative package.

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RE: Responses to DOE RFI: Consent Based Siting and Federal Interim Storage

Area 1: Consent-Based Siting Process

1. How should the Department build considerations of social equity and environmental justice into a consent-based siting process? First and foremost, the Department needs to engage in the congressional process needed to put into action a key, long-delayed recommendation from the Blue Ribbon Commission final report of January, 2021:

> The overall record of DOE and of the federal government as a whole, however, has not inspired widespread confidence or trust in our nation's nuclear waste management program. For this and other reasons, **the Commission concludes that a new, single-purpose organization is needed to provide the stability, focus, and credibility that are essential to get the waste program back on track**. We believe a congressionally chartered federal corporation offers the best model, but whatever the specific form of the new organization it must possess the attributes, independence, and resources to effectively carry out its mission. [emphasis added]

In recent public forums (i.e., DOE presentation on Consent Based Siting provided to the San Onofre Community Engagement Panel, February 10, 2022) the DOE representative

(Dr. Kimberly Petry) referenced on multiple occasions the need to solve the "back-end problem of waste storage" because new reactor development (to solve climate change) would be impeded until that question was resolved. Further, a representative of the Nuclear Energy Institute was included in the panel discussion, and spoke of NEI's alliance with DOE and echoed Dr. Petry's thoughts with regard to new nuclear power development hinging on waste solutions.

An agency (DOE) whose mission includes the promotion and development of new nuclear energy sources cannot be trusted to equitably and justly provide a solution to the legacy problem of civilian nuclear waste accumulation. This bifurcation of "promotion" (or "advocacy") versus regulation was addresses half a century ago in the federal decision to split the Atomic Energy Commission's similar, duel-role and create the Nuclear Regulatory Commission exclusively for regulatory oversight.

Current communities where high-level, legacy civilian radioactive wastes are stored (and not candidate sites for potential "new" nuclear reactors") want a solution *now*. Whether this solution has as its byproduct the ability to enable *new* nuclear power facilities is independent from their immediate needs, and further discussion of such potential only dilutes the pressing legacy concerns. It is logical to understand why such candidate communities might view with suspicion the current DOE's exhortations on the need for new nuclear power (to address climate change) as encouraging an expedient answer to the waste storage dilemma, rather than delving with greater sincerity of thought into a legacy waste solution that is *just and equitable* when viewed in a longer, intergenerational context.

Until the DOE and Congress can agree on this split role and create a new agency with the sole mission of solving the legacy civilian radioactive waste dilemma, potential host communities may rightfully view with skepticism whether the DOE is diligently serving their needs or acting in furtherance of the goals of the commercial nuclear power sector.

2. What role should Tribal, State, and local governments and officials play in determining consent for a community to host a federal interim storage facility? None, until these entities have reached out to their own communities for input (polls, public

meetings, etc.) and can demonstrate that they have elicited all opinions/options from those that they claim to represent. *When* that has been achieved, the Department needs to hire representatives from any communities where waste storage potential meets "technical, geographical, and scientific standards" to sit in on all advisory panels that would craft this decision-making process.

3. What benefits or opportunities could encourage local, State, and Tribal governments to consider engaging with the Department as it works to identify federal interim storage sites? "Benefits and opportunities" cannot be decided without first presenting to potential host communities a clear understanding of and analysis of the risks to the environment, real estate values, and health consequences that might arise.

4. What are barriers or impediments to successful siting of federal interim storage facilities using a consent-based process and how could they be addressed? The predominant barrier is DOE people coming into communities with a "we understand more than you do" top-down attitude and not completely disclosing why it has been so historically difficult to cite a permanent repository for over five decades.

5. How should the Department work with local communities to establish reasonable expectations and plans concerning the duration of storage at federal interim storage facilities? First, the Department needs to license a *permanent repository*, thereby demonstrating that the "interim" storage will really be interim.

6. What organizations or communities should the Department consider partnering with to develop a consent-based approach to siting? For a start, cease spending time (and resources) considering states that can or will never become a waste site (permanent or interim.) Secondly, stop returning to those same states (and/or others that may meet technical, geographical, scientific criteria) with the same old, and some new "we're listening and we believe in consent" buzzwords and expect anyone to believe you (since the agency's actions to date do not validate its actions).

7. What other issues, including those raised in the *Draft Consent-Based Siting Process* (*www.energy.gov/sites/prod/files/2017/01/f34/Draft Consent-Based Siting*

Process and Siting Considerations.pdf), should the Department consider in implementing a consent-based siting process? The Department cannot move forward without the full "consent" of Congress, so you might just start there.

Area 2: Removing Barriers to Meaningful Participation –

RESPONSE: Same answers as in AREA 1

1. What barriers might prevent meaningful participation in a consent-based siting process and how could those barriers be mitigated or removed?

2. What resources might be needed to ensure potentially interested communities have adequate opportunities for information sharing, expert assistance, and meaningful participation in the consent-based siting process?

3. How could the Department maximize opportunities for mutual learning and collaboration with potentially interested communities?

4. How might the Department more effectively engage with local, State, and Tribal governments on consent-based siting of federal interim storage facilities?

5. What information do communities, governments, or other stakeholders need to engage with the Department on consent-based siting of federal interim storage facilities?

Area 3: Interim Storage as Part of a Waste Management System –

RESPONSE: Same answers as in AREA 1 and AREA 2

1. How can the Department ensure considerations of social equity and environmental justice are addressed in developing the nation's waste management system?

2. What are possible benefits or drawbacks to co-locating multiple facilities within the waste management system or co-locating waste management facilities with manufacturing facilities, research and development infrastructure, or clean energy technologies?

3. To what extent should development of an interim storage facility relate to progress on establishing a permanent repository?

4. What other issues should the Department consider in developing a waste management system?