

Q&A with Deep Isolation COO Rod Baltzer

Deep Isolation was founded by the father-daughter team, Elizabeth Muller and Richard Muller, to develop an innovative solution to the impasse of nuclear waste disposal that prioritizes environmental protection and community partnerships. Stakeholders and community engagement are at the center of the company's solution design, believing that greater participation from the communities can bring mutually beneficial solutions to address the disposal of spent nuclear fuel.

The company was founded in 2016 and continues to gain traction through a public-private partnership approach. The company is headquartered in Berkeley, California, and has offices in Washington, DC, the United Kingdom, and Japan. It has partnerships with Bechtel and NAC International and an established working relationship with Schlumberger, all of which enable its capability to deploy its solution globally. The company has received accolades for its emerging technology in clean energy technology, and CEO Liz Muller was named by *Business Insider* as a "Clean Energy Rising Star." Kari Hulac, Deep Isolation's Social Media and Communications Manager, hosts a podcast titled *Nuclear Waste: The Whole Story*, which features experts and stakeholders that represent different aspects of nuclear waste disposal. More information can be found on the company's website at www.deepisolation.com.

SpentFUEL first wrote about Deep Isolation in our June 1, 2018 issue (No. 1213), which provided an overview of the company's technology, and we have regularly covered each new development since. Just last week, for example, we covered the company's announcement it had signed a contract to study deep borehole disposal for research reactor fuel in Slovenia.

Carlyn Greene, UxC's Senior Vice President, Spent Fuel, recently interviewed via email Rod Baltzer, Chief Operating Officer of Deep Isolation. Before going to Deep Isolation, Baltzer was the President and Chief Executive Officer of Waste Control Specialists, LLC, a leading provider of services for low-level radioactive waste, mixed low-level waste, and hazardous



waste.

Carlyn Greene: *Rosa Parks famously said, "One person can change the world." In the case of Deep Isolation, the company took on a challenge that entire governments have attempted to address, but have thus far largely failed, with a few notable exceptions. What inspired the confidence that Deep Isolation could finally break through this stalemate?*

Rod Baltzer: We are confident we can help solve this problem because our solution uses proven technologies, already standardized by the oil and gas industries, to dispose of waste in boreholes – a cost-effective, easier to deploy option with a flexible design that's suitable for multiple geologies. In 2019, we successfully demonstrated our proposed use of this drilling technology with a live public demo in Texas where we emplaced and later retrieved a prototype nuclear waste canister from a deep horizontal borehole – something that many in this industry were skeptical of. Achieving this milestone gave us, and the nuclear industry, solid evidence that we were on the right path. Soon thereafter, we began forging relationships with industry leaders. These partnerships showed us that not only we were on the right path, but that the industry was open to borehole disposal and confident in what we're doing.

We also draw inspiration from Liz Muller, our CEO. She is an environmentalist and, along with our co-founder, Richard Muller, discovered that directional drilling technology could be used to take on this global challenge. Her experience and activism in understanding and addressing climate change gave her unique insight to see that nuclear energy was necessary to fight the current climate crisis but not without fulfilling our inherent responsibility to permanently dispose of the waste that has already been generated over the past 60 years.

CG: *Deep Isolation is the only privately funded company in the world that is developing a nuclear waste disposal solution for spent fuel and high-level waste. Have any governments studied this possibility, or are all of the potential repositories mined geologic repositories?*

RB: We're not the first to explore using deep boreholes for nuclear fuel and high-level waste. The idea of accessing deeper, more isolated geologic formations is obviously compelling, and the US government considered it as early as 1957 for liquid wastes. Sandia National Laboratories has

researched this, as well, along with others in the UK and Sweden, but we are the first private company to pursue deep boreholes using private funding, and we were the first private company to demonstrate our horizontal borehole concept. As a result, we are seeing renewed interest from governments and organizations around the world, especially in locations where mined repositories are not feasible (due to size, cost or other concerns). We've completed multiple feasibility studies for entities interested in boreholes for disposal and are talking to a dozen governments on three continents.

CG: In her blog, Liz Muller wrote that she was inspired to do big things to help fight climate change. How do you foresee your waste disposal solution as contributing to that cause?

RB: We believe that nuclear power is a clean carbon-neutral power source and that reducing our reliance on fossil fuels will assist in the fight against global warming. But, as Liz often says, how can nuclear be considered clean energy if there's not a solution for the waste? One drawback to nuclear power has been the lack of waste disposal options. For example, a national poll Deep Isolation recently sponsored found that more than half of Americans would be likely to support nuclear power if there was a waste solution. We believe answering the waste question could lead to wider adoption of nuclear energy.

CG: The US Congress has become so polarized and paralyzed that it's hard to imagine progress being made on an issue like nuclear waste disposal since the spent fuel and HLW is being safely stored where it is. That's not the ideal solution, by any means, but do you have the support of any legislators in either the House or the Senate? It would take more than one or two. Are there still staunch "Yucca Mountain or nothing" members of Congress after all these years?

RB: Nuclear energy has bipartisan support in Congress, and we have seen the same commitment to back-end disposition strategies for both DOE's HLW and commercial SNF. We have always been encouraged by the efforts from leaders of both parties to support the clean-up mission of DOE facilities across the complex. This Congress has been forward thinking and supportive of innovations in waste disposal, and we are encouraged by their willingness to embrace technology and collaborate across the aisle.

CG: What changes would need to be made to the Nuclear Waste Policy Act (NWPA) that could possibly enable your technology to be implemented in the US for commercial spent fuel?

RB: We believe the NWPA could be amended to allow DOE to conduct activities for an additional disposal option. This doesn't require the termination of the Yucca Mountain Project, but does allow the government to see what else is available and technologically viable.

CG: The Obama administration considered the idea of a

Industry Calendar

- November 1-2, 2021
Decommissioning Strategy Forum
<https://www.decommissioningstrategy.com>
JW Marriott Las Vegas Resort & Spa
Summerlin, NV
- November 3-5, 2021
RadWaste Summit
<https://www.radwastesummit.com>
JW Marriott Las Vegas Resort & Spa
Summerlin, NV
- November 1-5, 2021
Intl Conference on Radioactive Waste Management
<https://www.iaea.org/events/international-conference-on-radioactive-waste-management-2021>
Vienna, Austria
- November 30 – December 2, 2021
WNE – World Nuclear Exhibition 2021
<https://www.world-nuclear-exhibition.com>
Paris Nord Villepinte, Paris, France
- November 30 – December 3, 2021
2021 ANS Winter Meeting and Technology Expo
<https://www.ans.org/meetings/wm2021/>
Washington, Hilton, Washington, DC
- February 8-10, 2022
NEA Workshop on Developing Safety Cases
<https://tinyurl.com/n5adts8j>
Crowne Plaza Bucharest, Bucharest, Romania
- August 28 – September 1, 2022
PATRAM
<https://www.patram.org>
Acropolis Exhibition Centre, Nice, France

Details are available at:
<https://www.uxc.com/c/data-industry/Calendar.aspx>

separate repository for defense waste, because that inventory is fixed and known, and the defense waste potentially could be disposed of sooner than commercial spent fuel. Is that something you are pursuing?

RB: Some of the defense waste is smaller in form and may be well suited for deep borehole disposal. This would be of interest to Deep Isolation.

CG: In March 2018, former NRC Chair Kristine Svinicki responded to questions submitted by Senators Shelley Moore Capito and Sheldon Whitehouse, who asked if the NRC is authorized, under the Nuclear Waste Policy Act, the Atomic Energy Act, and/or any applicable NRC regulations to accept from a private entity an application for a license for the permanent disposal of spent fuel and high-level radioactive waste. She said the NRC is not authorized to license any entity other than DOE to permanently dispose of spent fuel and HLW. She did say, however, that DOE "could enter into a contract with a private entity to prepare, or to support preparation of such an application on behalf of DOE, and the existence of such a contract would not affect the NRC's

authority.” This response appears to present one possibility under which you could submit a license application for your deep borehole disposal facility to the NRC by going through the Department of Energy. Do you think DOE would support your solution? Maybe as the Department kicks off its work to talk to communities as part of its consent-based siting groundwork, your technology could be presented as an option, if DOE were open to that.

RB: It is always good to have options and yes, we would be happy to provide information to communities that were interested in borehole disposal. The NWPA requires that the DOE be the applicant for a disposal facility, however we do believe that private companies have a lot to offer to the process and can help break the stalemate that the back-end has been plagued with for so many years. A public-private partnership is something that we believe the government should consider and would be beneficial to realizing a disposal solution.

CG: The NRC and the DOE are starting to focus on environmental justice, which is not a new issue, but I’ve never heard either agency mention it as a focus before. With the ability to have much smaller repositories that could be built in a state for all the power plants in that state (for example), that would alleviate many environmental justice (and transportation) arguments. Do you see this new focus as an advantage?

RB: Environmental justice is a complicated issue and deserves the focus it is getting. We are not sure that locating the site to serve all of a state’s power plants would alleviate the environmental justice arguments, but we do think our community-focused consent-based approach and solution is in line with finding the right approach to mitigating environmental justice concerns.

We seek to partner with communities and states that have a strong understanding of the benefits that could be realized from permanently isolating the waste.

CG: How many repositories – built in strategic locations around the country to avoid the need for large transportation campaigns – would be needed in the U.S. if all the commercial spent fuel that is not yet in dry storage were disposed of in a Deep Isolation repository?

RB: An advantage of our borehole solution is that it is modular so it can be scaled to a variety of desired configurations. It could be deployed at one centralized facility, near individual power plants or in regional repositories. The number of regional repositories would depend on the area served, geology and other factors.

CG: How have you been received in communities where you’ve done your test drilling? DOE did not have much success with test drilling a few years ago but I’m sure the trust issue was a big part of that resistance. How are you planning to gain the trust of a community?

RB: When we did our first Deep Isolation’s test demonstration in Cameron, Texas, in 2019, our first priority was to meet with the local leadership and elected officials. We prioritized this effort before we planned the details of the technical demonstration so that we could earn the support and confidence of the community.

We earned the community’s support by listening to their concerns not only about the project, but about other experiences the town had been through in which promises from outside interests were not kept and they felt taken advantage of. The community was included in each stage of the planning process, and on the day of the demonstration, several residents attended and voiced their support for Deep Isolation.

CG: Since most (maybe all) countries with nuclear plants require the utilities to deposit money into a fund managed by the government or some sort of waste management organization (like NWMO in Canada), your contracts are most likely to be with a government agency rather than directly with a utility, correct?

RB: Yes, nuclear waste disposal is a government’s responsibility, though in the case of new nuclear plants being built, we could foresee working with, for example, an advanced reactor company to establish a waste disposal plan even before the plant was built, of course having that be subject to approval based on governmental regulations.

CG: Do you see your prospects for a contract to be higher in countries that are emerging nuclear countries, like Estonia, or in countries that have taken a “wait and see” approach to disposal, versus countries that have established disposal programs?

RB: We’ve seen interest from a wide variety of inventory types from countries worldwide, so there isn’t a common pattern. What is striking is the level of interest and optimism in investigating borehole disposal options.

CG: Is any region of the world more open to your solution? Where do you expect your first contract to be?

RB: We’ve already completed several preliminary study contracts, including for a government, an advanced reactor company in Estonia, and the Electric Power Research Institute, but we can’t speculate on where we think our first repository will be.

CG: How many canisters of commercial spent fuel would typically go in one borehole – acknowledging that the repository will be site specific and depend on the geology. And how many assemblies in each canister?

RB: Deep Isolation’s current calculations for horizontal boreholes call for the emplacement of nuclear waste in corrosion-resistant canisters (typically 9 to 13 inches in diameter and 14 feet long) deep into rock that has been stable for tens to hundreds of millions of years. Each canister contains a single spent fuel assembly from a Pressurized Water Reactor

(PWR). A 1-kilometer-long disposal section holds about 150 canisters. An array of 10 parallel disposal sections holding a total of 1,500 PWR assemblies would accommodate the waste being produced by a 1,000 MWe nuclear power plant in 30 years.

CG: How does the cost of your solution compare to the cost for a single mined repository in a country?

RB: Our early cost estimates show our solution to be about half the cost of a mined repository based on published budget estimates from Canada, the UK, Sweden, and the US. Key drivers of the borehole repository cost-effectiveness include lower costs for construction, operation and transportation.

CG: Utilities have been moving toward high-capacity storage systems so anything already in dry storage would have to be repackaged, but you could load your smaller capacity canisters directly from the pool. How long would the discharged spent fuel need to be cooled before it could be disposed of in the borehole repository?

RB: We are working to more accurately determine the performance envelope for the maximum allowable decay heat load (and thus minimum fuel age) of various borehole repository configurations. Current calculations for 30 year aged fuel in our reference design show very large margins to temperature limits, and thus we have strong reason to believe that the minimum fuel age can be significantly reduced, possibly to the minimum age required for transportation in casks (7 years after discharge).

CG: How could you help the utilities speed up the decommissioning process and return the sites to greenfield status promptly?

RB: Since deep boreholes would be easier to deploy and could be located at the site of a decommissioned nuclear power plant versus having to transport the waste potentially long distances to a centralized mined repository, it would follow that this could help save time, but decommissioning a plant is a very complex and lengthy process that we would only be one part of so we can't comment on its overall impact as this objective wouldn't be part of our work scope.

CG: Your solution seems to me to be a good fit for countries that have small nuclear programs where the cost of implementing a mined deep geological repository could be prohibitive instead of paying for other countries with larger established waste programs to accept their waste.

RB: Yes, we agree that this is one of the advantages of our deep borehole solution. It avoids the need to transport nuclear waste over long distances and would be more socially equitable and cost-effective.

CG: Thank you, Rod, for taking time to provide such informative responses to our questions. We look forward to watching further developments both technically and commercially and will continue to cover Deep Isolation in SpentFUEL.

Top Story

SKB to submit “extensive documentation” so that Clab expansion can be approved by the Environmental Court

On August 26, the Swedish government decided to separate the application for an expansion of Sweden's Clab interim storage facility from SKB's application for a comprehensive final repository (*SF* No. 1375 August 27, 2021). This decision went against what SKB, SKB's owners (the Swedish utilities), and most of the consultative bodies thought was the best way forward, including the directly affected municipalities of Oskarshamn and Östhammar.

The case is now with the Swedish Radiation Safety Authority (SSM) and the Land and Environmental Court. On September 8, SKB stated on its website, “The situation regarding the court process that awaits in the next step of the permit examination is still uncertain, but it is clear that SKB needs to produce extensive documentation so that the interim storage part can be examined separately.”

SKB will “do its utmost” to see that the expansion of the Clab facility is approved so that electricity production from Sweden's nuclear power plants is not at risk. SKB will also continue to urge the government to make a decision on the rest of the final repository case, noting that the government has said publicly that the basis for decisions on the final repository can be ready within a few months.

SSM will require new safety reports about the expansion of the interim storage facility. SKB's previously submitted safety reports have been intended for the entire final repository system, which includes the storage facility expansion, an encapsulation plant, and a deep geologic repository.

The Clab safety reports will be done in three steps, with the first being that SKB will prepare a preliminary safety report. That report will have to be reviewed and approved, then a “renewed” safety report will be prepared, which also must be approved before the facility can begin test operations. SKB said, “After an additional safety report, the plant may be taken into regular operation. It is an extensive and advanced test that will now be done on the intermediate storage only.”

SKB noted that the decision to separate the decision on the Clab expansion and the rest of the disposal system “still appears to be risky, with unclear consequences.” Vattenfall – one of SKB's owners – informed power market operator Nord Pool AS on August 31 that it will be forced to cease operations at four of its five reactors in Sweden by 2025 if a decision on a final repository is not made. Vattenfall said the government's decision to separate the Clab expansion from the repository application, and the resulting likely delay on a decision about the repository, essentially rules out the possibility of restarting four units at the Ringhals and Forsmark