

Deep Borehole Disposal Research in the United States - 17427

Timothy Gunter*, Geoff Freeze**

* U.S. Department of Energy, Office of Nuclear Energy, timothy.gunter@doe.gov

** Sandia National Laboratories, Albuquerque, NM, gafreez@sandia.gov

ABSTRACT

The U.S. Department of Energy (DOE) Office of Nuclear Energy (NE) manages a research and development (R&D) program for the disposal of spent nuclear fuel and high-level radioactive waste in the United States. Deep boreholes are being evaluated for disposal of some smaller DOE-managed waste as an alternative to disposal in a mined geologic repository.

The deep borehole disposal concept consists of drilling borehole(s) to a total depth of about 5,000 m (16,400 ft - or greater than three miles) into crystalline basement rock, placing waste packages in the lower emplacement zone portion of the borehole, and sealing and plugging the upper portion of the borehole. The required bottom-hole diameter of the borehole(s) depends on the waste package configuration for the reference concept, but ranges from 22 to 43 cm (8.5 to 17 inches).

Additional research and development is desired in several important areas for further consideration of deep borehole disposal of radioactive waste. A Deep Borehole Field Test (DBFT) will be conducted by DOE to further assess the viability of deep borehole disposal as an alternative for the disposal of smaller DOE-managed waste forms. The DBFT will be used to evaluate three main areas: 1) evaluation of the capability for drilling and construction of deep, large-diameter boreholes; 2) downhole scientific analyses to assess hydrogeochemical conditions that control waste stability and containment; and 3) engineering activities to assess the viability and safety of waste package emplacement and retrieval in deep boreholes.

The DBFT will include first drilling a characterization borehole, followed by an optional field test borehole, to a total depth of about 5,000 m (16,400 feet) into crystalline basement rock in a geologically stable continental location. The initial smaller-diameter characterization borehole will be drilled and completed to facilitate downhole scientific testing and analysis. If site conditions are found to be suitable, DOE intends to drill a larger-diameter field test borehole to evaluate emplacement activities using surrogate waste packages. The surrogate waste packages will not contain any radioactive waste, nor will any radioactive waste be used in these tests.

One of the advantages of deep borehole disposal is that it would give DOE the flexibility to consider options for disposal of smaller waste forms. Deep borehole disposal also potentially offers earlier disposal of some wastes than might be possible

in a mined repository, and could reduce costs associated with projected treatments of some wastes.

In order to accomplish the DBFT, DOE will require the support of multiple national laboratories, along with a site contractor to acquire a suitable test site and to manage the site and the required testing activities. DOE issued a competitive solicitation via a request for proposal (RFP) in July, 2015, which requested proposals to provide a test site and site management services. The contract was awarded in January, 2016, to a team led by Battelle Memorial Institute which included a proposed test site in Pierce County, North Dakota. After efforts to acquire both the initial test site in North Dakota and an alternative proposed site in Spink County, South Dakota were unsuccessful, activities were suspended.

The experiences in Pierce County, ND and Spink County, SD highlighted the importance of public engagement and support for the DBFT, and that relevant levels of government and other public stakeholders should be involved from the beginning. Using the lessons learned in North and South Dakota, DOE issued a new RFP on August 22, 2016 which emphasized local, state, and tribal (if applicable) government engagement, as well as public and other stakeholder involvement ahead of proposal submittals and throughout the contract execution phases. The new RFP allowed for multiple initial awards and multiple phases of contract execution.

In December, 2016, DOE announced the selection of four companies — AECOM, ENERCON, RE/SPEC, and TerranearPMC — to begin exploring the possibility of conducting a DBFT under the terms of the new RFP. Ultimately, only one site will be chosen for the field test.

INTRODUCTION

The U.S. Department of Energy (DOE) Office of Nuclear Energy (NE) manages a research and development (R&D) program for the disposal of spent nuclear fuel and high-level radioactive waste in the United States. Deep boreholes are being evaluated for disposal of some smaller DOE-managed waste as an alternative to disposal in a mined geologic repository. Additional research and development is desirable in several important areas for further consideration of deep borehole disposal of radioactive waste. A Deep Borehole Field Test (DBFT) is being conducted by DOE to further assess the safety and viability of deep borehole disposal as an alternative to mined geological repositories for the disposal of some smaller DOE-managed waste forms. DOE is using a competitive solicitation to acquire one or more suitable test sites along with a site contractor to manage the site and coordinate the testing activities.

DISCUSSION

Since 2010, the DOE Office of Used Nuclear Fuel Disposition, an office under the Deputy Assistant Secretary (DAS) for Fuel Cycle Technologies Research and Development within the DOE Office of Nuclear Energy, has managed a multi-million-dollar R&D program for the disposal of spent nuclear fuel and high-level radioactive waste in the United States. In October, 2016, a new DAS for Spent Fuel and Waste Disposition was established to manage the waste management functions within the Office of Nuclear Energy. Although essentially the same office as the former Office of Used Nuclear Fuel Disposition R&D, R&D efforts are now managed by the Office of Spent Fuel and Waste Science and Technology (SWFS&T). The R&D program is implemented through the Used Fuel Disposition Campaign which consists of multiple national laboratories funded to execute the SWFS&T planned R&D activities.

The R&D program consists of multiple activities focused on various aspects of storage, transportation and disposal of spent nuclear fuel and high-level radioactive waste. Disposal related R&D activities continue to further the understanding of long-term performance of disposal systems in three main geologic rock types: clay/shale, salt, and crystalline rock. Evaluations are also continuing to determine the feasibility of directly disposing existing single (storage only) and dual-purpose (storage and transportation) spent-fuel canisters in a mined repository. One priority R&D activity for DOE is to evaluate the feasibility of deep borehole disposal as an alternative to mined geological repositories for the disposal of some smaller DOE-managed waste forms. R&D to further evaluate the feasibility of and advance the concept of deep borehole disposal is consistent with implementation of the DOE *Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste* [1]. One of the advantages of deep borehole disposal is that it would give DOE the flexibility to consider options for disposal of smaller DOE-managed waste forms. Deep borehole disposal also potentially offers earlier disposal of some wastes than might be possible in a mined repository, and could reduce costs associated with projected treatments of some wastes.

The deep borehole disposal concept consists of drilling a borehole or an array of boreholes to a total depth of about 5000 m (16,400 ft - or greater than three miles) into the crystalline basement rock, placing waste packages in the lower emplacement zone portion of the borehole, and sealing and plugging the upper portion of the borehole. The required bottom-hole diameter of the borehole(s) depends on the waste package configuration for the reference concept, but ranges from 22 to 43 cm (8.5 to 17 inches). A generalized concept of deep borehole disposal is shown in Figure 1.



Fig. 1. Generalized schematic of the deep borehole disposal concept.

Additional research and development is desirable in several important areas for further consideration of deep borehole disposal of radioactive waste. A Deep Borehole Field Test (DBFT) is planned to be conducted by DOE to further assess the safety and viability of deep borehole disposal as an alternative for the disposal of smaller DOE-managed waste forms. The DBFT will be used to evaluate three main areas: 1) evaluation of the capability for drilling and construction of deep, large-diameter boreholes; 2) downhole scientific analyses to assess hydrogeochemical conditions that control waste stability and containment; and 3) engineering activities to assess the viability and safety of package emplacement and retrieval in deep boreholes.

The DBFT will include first drilling a characterization borehole, followed by an optional field test borehole, to a total depth of about 5,000 m (16,400 feet) into crystalline basement rock in a geologically stable continental location. The initial smaller-diameter characterization borehole (8-1/2 in. bottom-hole diameter) will be drilled and completed to facilitate downhole scientific testing and analysis. If site conditions are found to be suitable to continue testing, DOE intends to drill a larger-diameter (17 in. bottom-hole diameter) field test borehole to evaluate larger-diameter deep drilling, and also to evaluate surface handling and emplacement activities using surrogate waste packages. The surrogate waste packages will not contain any radioactive waste, nor will any radioactive waste be used in these tests.

In order to accomplish the DBFT, DOE will require the support of multiple national laboratories, along with a site contractor to acquire a suitable test site and to manage

the site and the required testing activities. To acquire a suitable test site and management contractor, DOE used the government procurement process and ran a competitive solicitation. The preference was for a site that was not federal property and that would encourage partnerships with industry, universities, and state and local agencies.

To initially determine whether or not there was sufficient interest in the private sector to participate in the DBFT, and to measure the interest of communities in hosting a DBH Field Test, DOE issued a Request for Information (RFI) in October, 2014 [2], seeking input on these topics. Responders to the RFI were requested to include at a minimum their extent of interest in providing a host site for the DBFT; identification, ownership and description of any proposed host site; and discussion of how any proposed host site would meet the given preferred location guidelines and state and local government approval requirements. Additional information could also be included relevant to any other suitable characteristics or advantages of a proposed host site. A community hosting the DBFT could benefit by gaining a more thorough understanding of the local subsurface geologic and hydrologic characteristics that may permit better community management of local resources. Economic and scientific aspects of the DBFT could also benefit the local community, policy decision makers and regulators, local and state government, universities, and other regional stakeholders in other subsurface technical areas such as geothermal energy production, fossil energy production, and carbon sequestration.

Based on positive responses to the RFI received in December, 2014, DOE prepared and issued a Sources Sought and a draft Request for Proposal for public comment in April, 2015 [3]. Taking into consideration the comments received in May, 2015, the final RFP was issued in July, 2015 [4, 5], which requested proposals by September, 2015, to provide a test site and site management services. The acquisition was conducted on a full and open competitive basis. Based on the evaluation criteria in the RFP, the submitted proposal(s) were evaluated and the contract was awarded in January, 2016, to a team led by Battelle Memorial Institute which included a proposed test site in Pierce County, North Dakota.

After the contract award, Battelle working with their team member, the University of North Dakota Energy and Environmental Research Center (EERC), intensified efforts in the local area to secure the test site. Battelle's public affairs program utilized a variety of communication methods, including conducting open houses, attending meetings of the County Commission and Zoning Board, and other appropriate stakeholder interactions. This effort was ultimately unsuccessful due to public concerns that the test site could eventually be used as a radioactive waste disposal site. Strong opposition was expressed by local residents, which in part prompted the Pierce County Commission to issue a temporary moratorium on deep borehole drilling in Pierce County. Subsequently, the Pierce County Commissions issued a letter to EERC on March 1, 2016, indicating that the moratorium would remain in place indefinitely and requesting that the EERC, Battelle and DOE cease consideration of anywhere in Pierce County as a site for the DBFT. This request was honored and DOE ceased efforts to secure a test site in Pierce County for the DBFT.

The existing contract with Battelle allowed Battelle to identify an alternate site if the initial site turned out to be unavailable, and Battelle then began investigating other potential sites. Based on site suitability evaluations and evidence of potential public and state support, Battelle then proposed Spink County, South Dakota as a potential site for the DBFT. Battelle initiated discussion with local residents and local public officials regarding their acceptance of conducting the DBFT in Spink County. Although initial interest was seemingly positive, ultimately local public opposition arose over concerns that the test site would eventually be used as a radioactive waste disposal site, and also concerns were expressed about potential impacts to the local aquifer. Once it became apparent that the DBFT was not supported by the local community, DOE suspended siting activities in Spink County, South Dakota. After carefully considering all available alternatives, DOE and Battelle mutually agreed to end the DBFT contract and siting efforts for the DBFT were suspended.

The experiences in Pierce County, North Dakota and Spink County, South Dakota highlighted the importance of public engagement and community support for the DBFT, and that all relevant levels of government and other public stakeholders should be involved from the beginning of siting considerations.

Using the lessons learned in North and South Dakota, DOE issued a new RFP on August 22, 2016 [6] which strongly emphasized local, state, and tribal (if applicable) government engagement, as well as public and other stakeholder involvement ahead of proposal submittals and throughout the contract execution phases. This revised approach focused much more on initial public interaction and gaining acceptance of the host community. Although this new approach contains aspects of consent, it is not a full consent-based siting approach that is being developed by the DOE for siting future waste storage and disposal facilities that will actually involve the storage or disposal of spent nuclear fuel and high-level radioactive waste. The approach also allowed for multiple initial awards and multiple phases of contract execution, during which down-selects may be made based on contractor team performance and success with local community acceptance, and to ultimately have one contractor team actually execute the DBFT and drill the characterization borehole.

New proposal(s) were received in September, 2016, and four contract awards were announced in December 2016: AECOM which is exploring a site in Texas, ENERCON which is exploring a site in New Mexico, RE/SPEC which is exploring a site in South Dakota, and TerranearPMC which is also exploring a site in New Mexico. It is expected that each of the contracting teams selected by DOE will each work closely with the communities surrounding their proposed test sites to reach cooperative and mutually beneficial agreements before any drilling takes place. Only those teams that establish an agreement with the local community will go forward in the competition for the final site selection. This phased approach allows DOE to move forward with a contractor team that has established a successful community partnership. It is expected that only one of these sites will ultimately be chosen for the DBFT.

CONCLUSIONS

Completing the DBFT will increase scientific understanding of the potential uses for crystalline rock formations, both for disposal of certain types of radioactive waste and for other purposes such as geothermal energy development. However, public engagement and support is paramount to successfully siting a location for the DBFT, and relevant levels of government and other public stakeholders should be involved from the beginning of siting considerations. DOE has structured a revised procurement process that emphasizes local, state, and tribal (if applicable) government engagement, as well as public and other stakeholder involvement ahead of proposal submittals and throughout the contract execution phases. This revised approach focuses much more on initial public interaction and gaining acceptance of the host community. The revised procurement also allowed the option to award multiple contracts and then down-select to one contractor team to execute the DBFT. Four new contracts were awarded in December 2016: AECOM with a potential site in Texas; ENERCON with a potential site in New Mexico; RE/SPEC with a potential site in South Dakota; and TerranearPMC with a potential site also in New Mexico. DOE looks forward to working with the selected contractor teams and potential communities to discuss this project and its importance in advancing the energy, environmental, and security interests of the United States.

REFERENCES

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