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Site Guidelines for a Deep Borehole Field Test (H11B-1325)

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ABSTRACT

The US DOE Office of Nuclear Energy Used Nuclear Fuel Disposition Campaign (UFDC) is initiating a Deep Borehole Field Test (DBFT), without use of any radioactive waste, to evaluate the geoscience and feasibility of the Deep Borehole Disposal concept for radioactive wastes (Arnold et al., 2009; SNL 2012, 2013; Kuhlman et al., 2015a,b; DOE 2015). DOE has identified Sandia National Laboratories (SNL) as the Technical Lead for the UFDC DBFT Project, with the role of supporting DOE in (i) developing the overall DBFT Project Plan, (ii) management and integration of all DBFT Project activities, and (iii) providing Project technical guidance to DOE, other DOE National Laboratories, and university partners. The DBFT includes drilling one Characterization Borehole (CB-8.5" diameter), followed by an optional Field Test Borehole (FTB), to a depth of about 5,000 m (16,400 feet) into crystalline basement rock in a geologically stable continental location. The DBFT CB will be drilled and completed to facilitate downhole scientific testing and analyses. If site conditions are found to be favorable, DOE may drill the larger-diameter (17") FTB to facilitate proof-of-concept of handling, emplacement, and retrieval activities using surrogate waste containers. Guidelines for favorable DBFT site geohydrochemical and geomechanical conditions are discussed and status of the DBFT Project is provided.

Status Deep Borehole Field Test Acquisition of Site and Services

- **Request for Information solicited input and interest from States, local communities, individuals, private groups, academia, or any other stakeholders who were willing to host a DBH Field Test**
  - *Posted to via Federal Business Opportunities (FedBizOps, www.fbo.gov) on October 24, 2014*
  - *Responses received on December 8, 2014 (45 days)*
- **Sources Sought and Draft Request For Proposal (RFP)**
  - *Posted on FedBizOps on April 7, 2015*
  - *Feedback received on May 5, 2015*
- **Final RFP (Solicitation Number DE-SOL-0008071; DOE 2015)**
  - *Pre-solicitation notice posted on June 22, 2015*
  - *Final RFP posted on FedBizOps on July 9, 2015*
  - *Proposals due and received September 23, 2015*
  - *Contract award anticipated by early 2016*

Site Evaluation Process – RFP Criteria

- **Three Technical Criteria:**

  Criterion 1. Availability and Geologic Conditions of Proposed DBFT Site
  - *Technical site guidelines*

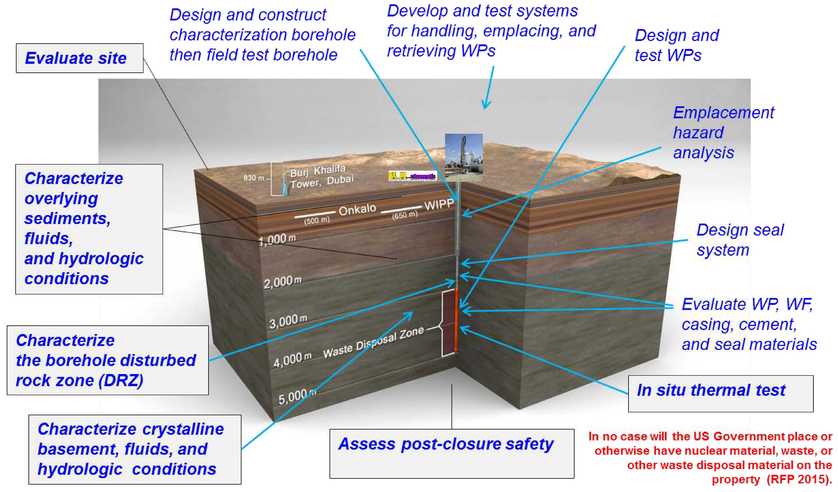
  Criterion 2. Organization and Qualifications
  - *Site management team experience, expertise, knowledge, and capabilities*

  Criterion 3. Proposed Approach
  - *Methodology for successful accomplishment*
- **Three Additional Criteria**

  Nontechnical criteria for DOE procurement

Objectives of the Deep Borehole Field Test

Synthesize field test activities, test results, and analyses into a comprehensive evaluation of concept feasibility



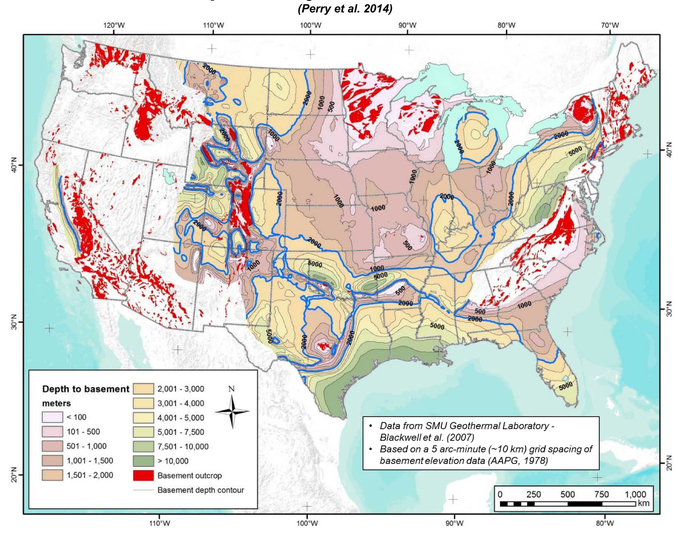
In no case will the US Government place or otherwise have nuclear material, waste, or other waste disposal material on the property (RFP 2015).

Deep Borehole Field Test: Technical Site Guidelines

- **The site area should be sufficient to accommodate:**
  - Two drilling operations with boreholes nominally separated by at least 200 m;
  - Surface facilities
    - *To support the drilling operations;*
    - *For sample management and on-site data collection;*
    - *For evaluation of handling operations for surrogate (mock-up) waste containers; and*
    - *For site operation needs*
  - Sites with ample open area surrounding the drilling site would be preferred.
  - The site area should be outside of wetlands areas and should be outside of 100-year flood zones, with ample access for heavy equipment needs.
- **Depth to crystalline basement –**
  - Less than 2 km (1.2 miles) depth to crystalline basement

Depth to Crystalline Basement

(Perry et al. 2014)



- **Lack of conditions associated with fresh ground water flow at depth –**
  - Geologic information and bases should include conditions/features (and the technical bases for those identified) that provide evidence of the absence of recharge at depth. This could include (but is not limited to)
    - *Lack of significant topographic relief that would drive deep recharge,*
    - *Evidence of ancient groundwater at depth, and/or*
    - *Data suggesting high-salinity groundwater at depth*
- **Geothermal heat flux –**
  - Geologic information and bases should include evidence of the geothermal gradient and/or geothermal heat flux at the proposed site
    - *A heat flux of less than 75 mW/m^2 is preferred*
- **Low seismic/tectonic activity –**
  - Less than 2% probability within 50 years of peak ground acceleration greater than 0.16 g (generally indicative of area of tectonic stability)
  - Distance to Quaternary age volcanism or faulting greater than 10 km
  - Geologic information and bases should provide evidence of the aspects listed above, as well as any evidence that is available on
    - Existence, and orientation, of any foliation in the crystalline basement rocks
    - The horizontal stress state at depth in the crystalline basement rocks
      - Lack of steeply dipping foliation or layering is preferred
      - Low differential horizontal stress is preferred
- **Crystalline basement structural simplicity –**
  - Lack of known major regional structures, major crystalline basement shear zones, or major tectonic features
  - Geologic information and bases should include identification of major regional structures, basement shear zones, or other tectonic features within 50 km of the proposed site

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Deep Borehole Field Test Technical Site Guidelines (Continued)

- **Low potential for interference with testing from other surface and subsurface usage –**

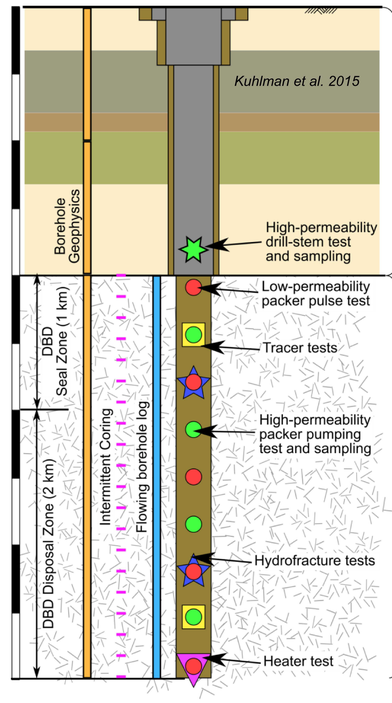
  Information and bases provided for the proposed site should identify any previous or current uses of the surface and/or subsurface that could interfere with the test investigations. Such activities include but are not limited to
  - *Wastewater disposal by deep well injection,*
  - *CO_2 injection,*
  - *Oil and gas production,*
  - *Mining,*
  - *Underground drinking water extraction, and*
  - *Strategic petroleum reserve sites*

  Absence of potential resources in the crystalline basement and sedimentary overburden is preferable

  The information and bases provided for the proposed site should identify existing drinking water aquifers and any previous or current uses of the surface and/or subsurface (such as listed above) within 30 km of the proposed site as far back as available records indicate
- **Lack of *existing*/*previous* surface or subsurface anthropogenic radioactive or chemical contamination –**

  Information and bases provided for the proposed site should identify any *previous or current* anthropogenic radioactive or chemical contamination within 10 km of the proposed site

Characterization Borehole: Profile Data



- **Borehole Geophysics**
- **Coring/Cuttings/Rock Flour**
  - **Mineralogy/petrology**
  - **Fluid samples from cores**
    - ***Bulk composition (salinity; rock equilibration)***
- **Sample-based Profiles**
  - **Fluid density/temperature/major ions**
  - **Pumped samples from high-*k* regions**
  - **Samples from cores in low-*k* regions**
- **Drilling Parameters Logging**
  - **Mud fluids/solids/dissolved gases**
  - **Torque, weight-on-bit, etc.**
- **Testing-Based Profiles**
  - **Static formation pressure**
  - **Formation hydraulic/transport properties**
  - ***In situ* stress (hydrofrac + breakouts)**

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