



# U.S. NUCLEAR WASTE TECHNICAL REVIEW BOARD

## SYNOPSIS OF BOARD REPORT

### Filling the Gaps: The Critical Role of Underground Research Laboratories in the U.S. Department of Energy Geologic Disposal Research and Development Program

A number of countries have operated underground research laboratories (URLs) in different types of potential host rocks to support the development of deep geologic repositories for the disposal of spent nuclear fuel (SNF) and high-level radioactive waste (HLW). URLs enable research and development (R&D) activities to be conducted under subsurface conditions and at scales relevant to specific repository environments. Since 2012, the U.S. Department of Energy (DOE) has collaborated in research conducted in several URLs located in Europe and Asia and its international collaborations now constitute an important component of its geologic disposal research. According to DOE, these international collaborations have been beneficial to its SNF and HLW disposal research program, particularly since 2010, when work on the Yucca Mountain repository stopped and DOE began generic research on alternative host rocks (crystalline, clay, and salt) and repository environments that are very different from the environment at Yucca Mountain.

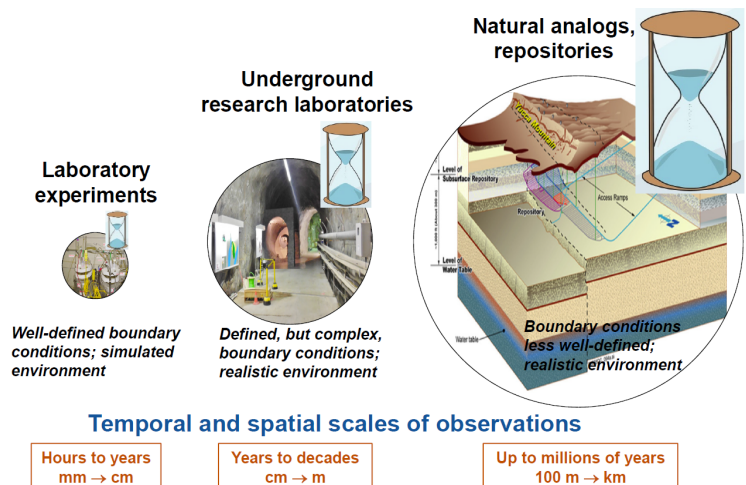
The U.S. Nuclear Waste Technical Review Board has reviewed the technical and scientific validity of DOE’s URL-related R&D activities and, in January 2020, published a report titled *Filling the Gaps: The Critical Role of Underground Research Laboratories in the U.S. Department of Energy Geologic Disposal Research and Development Program*. The report is based on information DOE and international experts presented at a workshop in April 2019 and at a Board fact-finding meeting with DOE in February 2019, and also from publications by DOE and others. In the report, the Board presented the following principal findings on DOE’s URL-related R&D activities.

- DOE participation in URL-related international research greatly benefits the U.S. geologic disposal R&D program by furthering its understanding of generic and site-specific disposal issues relevant to alternative repository host rocks and environments. DOE-funded R&D activities also are benefiting the URL-related research of other countries, especially in the area of complex analytical and numerical model/software development.

- The more developed repository programs in other countries have focused on creating and strengthening their safety cases and making them transparent to the public. Repository programs in other countries use URLs to explain the technical bases underlying their safety cases, periodically reassess knowledge gaps and define new activities to strengthen the technical bases, and demonstrate the technology that will allow implementation of the proposed safety concept.

- Countries with more developed geologic disposal programs have found domestic URLs essential to their repository programs. DOE needs domestic URLs to advance geologic disposal efforts over the

#### URLs bridge spatial and temporal scales



next decades and further its ability to train the next generation of scientists, engineers, and skilled technical workers.

- DOE's international URL collaborations have advanced its generic disposal R&D program, including development of modeling capabilities recognized internationally as state-of-the-art, but further work on its coupled thermal-hydrological-mechanical-chemical models and URL- and laboratory-based research can strengthen its program.

Based on these findings, the Board made the following recommendations in the report:

- DOE should expand its collaborative international URL activities to enhance its capacity for R&D of geologic repositories. To obtain maximum benefit from its international programs, DOE should consider (i) making use of R&D in URLs to address the technical needs for the design, licensing, construction, and operation of geologic repositories in different host rocks that consider the types of waste in the U.S. inventory; (ii) pursuing international URL R&D partnerships, including those involving non-nuclear waste applications (e.g., carbon sequestration) that require underground knowledge and operations, in which DOE could participate in the design, construction, and operational phases of the collaborations; and (iii) compiling best practices, innovative approaches, and notable successes and failures in public outreach, engagement, and risk communication from the experiences of URL programs in other countries.
- DOE should make systematic use of URL R&D results to regularly update generic repository safety cases that can be easily understood by and demonstrated to the public, including safety cases relevant to direct disposal of dual-purpose canisters in different host rocks.
- DOE should pursue one or more domestic URLs to advance the development and demonstration of disposal concepts and provide a platform for training the next generation of U.S. scientists, engineers, and skilled technical workers. DOE should evaluate whether underground sites in the U.S. with existing infrastructure could be used as generic URLs and whether use of existing facilities could be broadened (e.g., for more underground experiments or as training facilities) without impacting their primary missions. If DOE expands its domestic URL program in this way, then it should consider (i) broadening its URL R&D program from one focused on the technical issues relevant to post-closure repository performance to one that includes developing and demonstrating the construction and operational concepts for disposal; (ii) supporting larger, more formal training opportunities in underground disposal research in disciplines needed for the waste disposition mission; and (iii) making domestic URLs broadly accessible to researchers from the U.S. and other countries, including those outside the DOE geologic disposal R&D program.
- DOE should continue advancing its thermal-hydrological-mechanical-chemical-based research and model development and pursue more URL- and laboratory-based studies, particularly at elevated temperatures. In doing so, DOE should consider (i) designing and conducting technical activities in URLs to test hypotheses and assumptions, while at the same time remaining open to unexpected processes or behaviors; (ii) employing an iterative process involving laboratory experiments focused on fundamental processes, modeling, and field experiments and observations; (iii) including geomechanical constraints and thermal effects in fracture flow and transport models; and (iv) focusing on bedded salts and using the heater tests at the Waste Isolation Pilot Plant to improve the constitutive models of salt behavior.

### **The U.S. Nuclear Waste Technical Review Board**

is an independent federal agency established in the 1987 Nuclear Waste Policy Amendments Act.

The Board evaluates the technical and scientific validity of U.S. Department of Energy activities related to implementing the Nuclear Waste Policy Act. The Board also provides objective expert advice on nuclear waste management and disposal issues to Congress and the Secretary of Energy.

The Board's eleven members are nominated by the National Academy of Sciences and are appointed by the President.