NUCLEAR WASTE MANAGEMENT ORGANIZATION
SOCIÉTÉ DE GESTION DES DÉCHETS NUCLÉAIRES

Status of National Used Fuel/ High-Level Radioactive Waste Management Programs

Many countries are developing plans for, or are proceeding with, programs for the long-term management of used nuclear fuel or high-level radioactive waste. Several countries have advanced programs regarding the siting of long-term management facilities.

	RESEARCH PROGRAM	SITING PROCESS FOR USED FUEL/HIGH-LEVEL WASTE	PLANNED REPOSITORY OPERATION
Canada **WASTE AGENCY:** NWMO **OPERATIONAL NUCLEAR POWER PLANTS:** 20 **% NUCLEAR ELECTRICITY:** 16 **NATIONAL DECISION FOR USED FUEL/ HIGH-LEVEL WASTE MANAGEMENT:** geological repository **POTENTIAL ROCK TYPE(S) FOR REPOSITORY:** crystalline & sedimentary	» Technical research to support development of the siting process and to refine technology for long-term used fuel management » Social research program on best practices for citizen engagement, community impacts and dialogue » Co-operation agreements with national radioactive waste management organizations: SKB (Sweden), Posiva (Finland), Nagra (Switzerland) and Andra (France) » Active participant with international research organizations: Nuclear Energy Agency (NEA) and International Atomic Energy Agency (IAEA)	» Collaboratively developed a process to select a site with interested individuals and organizations under Adaptive Phased Management in 2008 and 2009 » Siting proposal developed in 2009 and siting initiated in 2010 » Initial screening, then feasibility studies in potential candidate areas followed by more detailed studies in potential host communities » Selection of a preferred site for a deep geological repository (DGR) followed by an Environmental Assessment and licensing approval process	» Earliest possible date for deep geological repository (DGR) operation is likely in the late 2030s » Currently, for conservative cost estimating purposes, the assumed date for DGR operation is 2035

	RESEARCH PROGRAM	SITING PROCESS FOR USED FUEL/HIGH-LEVEL WASTE	PLANNED REPOSITORY OPERATION
China **WASTE AGENCY:** CNNC **OPERATIONAL NUCLEAR POWER PLANTS:** 11 (28 under construction) **% NUCLEAR ELECTRICITY:** 2.3 **NATIONAL DECISION FOR USED FUEL/ HIGH-LEVEL WASTE MANAGEMENT:** geological repository **POTENTIAL ROCK TYPE(S) FOR REPOSITORY:** crystalline	» China National Nuclear Corporation (CNNC) developing transportation and repository technology for used CANDU fuel and high-level waste from reprocessing used Light Water Reactor fuel	» Siting process started in 1985 » Preliminary site characterization activities at a potential site (Beishan region, Gansu province in the Gobi desert in northwest China) for a site-specific Underground Research Laboratory (URL) and future geological repository » Site drilling program began in 2000 » Siting program consists of 3 phases: » Phase 1: Basic Study and Site Selection (2009-2020) » Phase 2: In-Situ research and development in URL (2020-2040) » Phase 3: Repository Construction (2040-2050)	» Deep geological repository (DGR) operation by 2050

Finland

WASTE AGENCY:
Posiva

OPERATIONAL NUCLEAR POWER PLANTS:
4

% NUCLEAR ELECTRICITY:
25

NATIONAL DECISION FOR USED FUEL/ HIGH-LEVEL WASTE MANAGEMENT:
geological repository

POTENTIAL ROCK TYPE(S) FOR REPOSITORY:
crystalline

RESEARCH PROGRAM

- Joint research and development program with SKB (Sweden) and other national organizations including NWMO (Canada)
- Demonstration of underground technology at Äspö Hard Rock Laboratory in Sweden
- Development and demonstration of copper used fuel containers
- Construction of ONKALO underground characterization facility started in 2004 and will end in 2011
- Confirming site suitability at Olkiluoto

SITING PROCESS FOR USED FUEL/HIGH-LEVEL WASTE

- Siting process started in 1980s
- Site identification from 1983 to 1985
- Preliminary site characterization and feasibility studies at 5 potential sites from 1986 to 1992
- Detailed site characterization and feasibility studies at 2 nuclear sites (Olkiluoto and Loviisa) from 1993 to 2000
- Posiva proposed Olkiluoto site in 1999
- Host municipality approved Olkiluoto site in January 2000
- Finnish government approved siting decision-in-principle in December 2000
- Finnish parliament ratified siting decision-in-principle in May 2001

PLANNED REPOSITORY OPERATION

- Deep geological repository (DGR) construction licence application by 2012
- DGR operation by 2020

France

WASTE AGENCY:
Andra

OPERATIONAL NUCLEAR POWER PLANTS:
59

% NUCLEAR ELECTRICITY:
78

NATIONAL DECISION FOR USED FUEL/ HIGH-LEVEL WASTE MANAGEMENT:
geological repository

POTENTIAL ROCK TYPE(S) FOR REPOSITORY:
sedimentary

RESEARCH PROGRAM

- Research and development program driven by national legislation in 2001
- Crystalline studies based on foreign Underground Research Laboratories (URLs) (e.g. Canada, Sweden)
- Sedimentary studies at Bure URL
- Study reports and recommendation submitted in 2006
- National law of 2006 gives research and development direction and schedules
- Reprocessing of most used fuel – capacity is about 1,700 t HM/year
- Assessment of industrial feasibility of partitioning and transmutation by 2012
- Transmutation pilot facility by 2020

SITING PROCESS FOR USED FUEL/HIGH-LEVEL WASTE

- Planned to develop Underground Research Laboratories (URLs) in crystalline rock and sedimentary rock starting 1991
- Sited Bure URL in sedimentary rock in 1994
- Law of 2006 requires final repository to be located in same host rock formation as the URL (thus in sedimentary rock near Bure URL)
- Siting studies near Bure region started in 2007
- Final site selection for a reversible geological repository by 2015

PLANNED REPOSITORY OPERATION

- Reversibility issue subject to national debate by 2012
- Application for deep geological repository (DGR) construction licence for high-level waste, used fuel and long-lived intermediate-level waste by 2015
- DGR operation by 2025

	RESEARCH PROGRAM	SITING PROCESS FOR USED FUEL/HIGH-LEVEL WASTE	PLANNED REPOSITORY OPERATION
Germany **WASTE AGENCY:** BfS **OPERATIONAL NUCLEAR POWER PLANTS:** 17 **% NUCLEAR ELECTRICITY:** 33 **NATIONAL DECISION FOR USED FUEL/ HIGH-LEVEL WASTE MANAGEMENT:** geological repository **POTENTIAL ROCK TYPE(S) FOR REPOSITORY:** salt, crystalline & sedimentary	» Research on salt for a deep geological repository (DGR) started in 1967 at the Asse mine » Federal Office for Radiation Protection (BfS) conducting research for used fuel and high-level waste management » Co-operative research with other national radioactive waste management organizations	» Siting process started in 1973 » Gorleben salt dome selected for national repository for radioactive waste in 1977 » Site investigations at Gorleben stopped in 2000 » AkEnd Committee issued technical siting process recommendation in 2002 » At least 2 sites required for underground exploration	» Deep geological repository (DGR) operation to be determined

	RESEARCH PROGRAM	SITING PROCESS FOR USED FUEL/HIGH-LEVEL WASTE	PLANNED REPOSITORY OPERATION
India **WASTE AGENCY:** AEC **OPERATIONAL NUCLEAR POWER PLANTS:** 17 **% NUCLEAR ELECTRICITY:** 2.6 **NATIONAL DECISION FOR USED FUEL/ HIGH-LEVEL WASTE MANAGEMENT:** geological repository **POTENTIAL ROCK TYPE(S) FOR REPOSITORY:** crystalline	» Atomic Energy Commission (AEC) conducts research on repository development and siting at Bhabha Atomic Research Centre (BARC)	» Siting based on technical process to identify repository site in stages » Focus of siting activities in northwest Rajasthan region	» Not known

	RESEARCH PROGRAM	SITING PROCESS FOR USED FUEL/HIGH-LEVEL WASTE	PLANNED REPOSITORY OPERATION
Japan **WASTE AGENCY:** NUMO **OPERATIONAL NUCLEAR POWER PLANTS:** 55 **% NUCLEAR ELECTRICITY:** 30 **NATIONAL DECISION FOR USED FUEL/ HIGH-LEVEL WASTE MANAGEMENT:** geological repository **POTENTIAL ROCK TYPE(S) FOR REPOSITORY:** crystalline & sedimentary	» Japan Atomic Energy Commission (AEC) decided on a geological repository for high-level waste in 1976 » Research and development conducted by various organizations: PNC, JNC, JAEA, etc. » Developing Underground Research Laboratories (URLs) in both crystalline rock (Mizunami) and sedimentary rock (Horonobe)	» In 2000, Law on Final Disposal of Specified Radioactive Waste requires geological repository for high-level waste from reprocessing » NUMO siting process started in 2002 » Open solicitation for candidate sites sent to all municipalities » Siting process based on volunteerism envisions selection of Preliminary Investigation Areas (PIAs), followed by selection of Detailed Investigation Areas (DIA) at candidate sites for underground studies and analyses » Toyo town in Kochi prefecture applied as a volunteer area for feasibility studies in January 2007 » Following a municipal election, Toyo town withdrew its application in April 2007 » Japanese siting process is evolving	» Deep geological repository (DGR) operation by 2040

	RESEARCH PROGRAM	SITING PROCESS FOR USED FUEL/HIGH-LEVEL WASTE	PLANNED REPOSITORY OPERATION
Sweden **WASTE AGENCY:** SKB **OPERATIONAL NUCLEAR POWER PLANTS:** 10 **% NUCLEAR ELECTRICITY:** 50 **NATIONAL DECISION FOR USED FUEL/ HIGH-LEVEL WASTE MANAGEMENT:** geological repository **POTENTIAL ROCK TYPE(S) FOR REPOSITORY:** crystalline	» Joint research and development program with Posiva (Finland) and other national organizations including NWMO (Canada) » Demonstration of underground technology at Äspö Hard Rock Laboratory in Sweden » Development and demonstration of copper used fuel containers	» Siting process started in early 1990s » Feasibility studies in 8 municipalities » Local referenda held in Storuman (1995) and Mala (1997) » Further evaluation of potential host communities » Detailed underground evaluation of 2 potential candidate sites in Östhammar and Oskarshamn from 2002 to 2008 » SKB selected the Forsmark site in Östhammar in June 2009	» Deep geological repository (DGR) construction licence application in 2011 » DGR operation by 2025

	RESEARCH PROGRAM	SITING PROCESS FOR USED FUEL/HIGH-LEVEL WASTE	PLANNED REPOSITORY OPERATION
Switzerland **WASTE AGENCY:** Nagra **OPERATIONAL NUCLEAR POWER PLANTS:** 5 **% NUCLEAR ELECTRICITY:** 40 **NATIONAL DECISION FOR USED FUEL/ HIGH-LEVEL WASTE MANAGEMENT:** geological repository **POTENTIAL ROCK TYPE(S) FOR REPOSITORY:** sedimentary	» Nagra has been conducting research on developing a deep geological repository (DGR) for used fuel and high-level waste since 1972 » Research and development program examined DGR feasibility in crystalline rock (e.g. Grimsel Underground Research Laboratory) and sedimentary rock (e.g. Mont Terri Underground Research Laboratory) » Co-operative research with other national radioactive waste management organizations » Research and development focus on sedimentary rock	» Siting process started in 1972 » Initial siting focus was on crystalline rock (Project Gewähr, 1985); only 2 potential candidate areas were identified » Recently, siting focus has been on sedimentary rock (Project Opalinus Clay, 2002) » Zürcher Weinland has been identified as a potential siting region for a deep geological repository (DGR) » In 2005, Swiss government issued the *Nuclear Energy Act* and requested Nagra to identify other alternative siting regions » In 2007, Swiss Federal Office of Energy issued draft Sectoral Plan for Geological Repositories for public review » In 2008, Swiss Federal Council approved the strategic part of the Sectoral Plan for Geological Repositories. Potential sites are being evaluated in a step-wise process.	» Deep geological repository (DGR) operation by 2040

United Kingdom

WASTE AGENCY:
NDA

OPERATIONAL NUCLEAR POWER PLANTS:
19

% NUCLEAR ELECTRICITY:
20

NATIONAL DECISION FOR USED FUEL/ HIGH-LEVEL WASTE MANAGEMENT:
geological repository

POTENTIAL ROCK TYPE(S) FOR REPOSITORY:
crystalline

RESEARCH PROGRAM

- Nuclear Decommissioning Authority (NDA) responsible for research and development program, previously conducted by NIREX (Nuclear Industry Radioactive Waste Executive)
- Co-operative research with other national radioactive waste management organizations
- Committee on Radioactive Waste Management (CoRWM) issued recommendation for phased deep geological disposal in 2006
- Conducting a Managing Radioactive Waste Safely (MRWS) programme

SITING PROCESS FOR USED FUEL/HIGH-LEVEL WASTE

- Siting process started in 1979 and terminated in 1981
- In 2007, Nuclear Decommissioning Authority (NDA) established the Radioactive Waste Management Directorate (RWMD) to devise a geological disposal solution for high-level waste
- In 2007, Department of Environment, Food and Rural Affairs (Defra) issued framework document for implementing geological disposal for broad public consultation and dialogue. Siting a geological repository will be based on a voluntarism and partnership approach
- In June 2008, UK government invited communities for “no commitment” discussions on hosting a deep geological repository (DGR)
- Implementing the siting process will include:
  - Preparatory studies
  - Surface-based investigations
  - Borehole drilling
  - Site selection
  - Regulatory review and approval
  - Construction
  - Operation
  - Closure
- In 2010, several communities have expressed interest in learning more about hosting a DGR

PLANNED REPOSITORY OPERATION

- Deep geological repository (DGR) operation by 2040

United States of America

WASTE AGENCY:
DOE

OPERATIONAL NUCLEAR POWER PLANTS:
104

% NUCLEAR ELECTRICITY:
19

NATIONAL DECISION FOR USED FUEL/ HIGH-LEVEL WASTE MANAGEMENT:
geological repository

POTENTIAL ROCK TYPE(S) FOR REPOSITORY:
volcanic tuff & other

RESEARCH PROGRAM

- Department of Energy (DOE) disposal research and development focused on deep geological repository (DGR) designs and site characterization activities in unsaturated volcanic tuff at Yucca Mountain, Nevada
- Reprocessing used fuel ended in 1977 (civilian) and 1992 (defence)

SITING PROCESS FOR USED FUEL/HIGH-LEVEL WASTE

- National screening of 9 candidate sites reduced to 3 sites from 1983 to 1986
- Congress directed Department of Energy (DOE) to study only 1 site, Yucca Mountain, in 1987
- Yucca Mountain is located near US nuclear weapons test site in Nevada, about 160 km north of Las Vegas
- Secretary of Energy recommended Yucca Mountain to the President in 2002
- Governor of Nevada submitted notice of disapproval in 2002 – overridden by Congress
- President approved Yucca Mountain site in 2002 – State of Nevada have strongly opposed Yucca Mountain Project
- In June 2008, DOE submitted deep geological repository (DGR) licence application to Nuclear Regulatory Commission (NRC)
- In February 2009, the US administration indicated that Yucca Mountain is no longer an option – Blue Ribbon Commission on US nuclear future formed to provide recommendations for developing a safe, long-term method to manage nuclear waste

PLANNED REPOSITORY OPERATION

- To be determined

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