



The Role of URL in the Development of SNF and ILW Disposal Programs

Deep geological disposal facilities are a new kind of nuclear facilities. They bear unusual features :

- Underground environment (around 500 m deep)
- Relatively large (tens of kilometers of galleries)
- Long operational periods (around a century or over a century)
- Ongoing nuclear operations and constructions - Coactivity
- Designed to ensure safety over very long time periods of more than 100 000 years

Decision making requires practical demonstrations of key technical elements in order to demonstrate the robustness of the proposed design and to establish confidence.

Underground research laboratories (URLs) play an important role in these scientific assessments and demonstrations by providing a realistic environment for characterizing and testing the selected rock, technical approaches, materials and equipment.

For acquiring geological information at a representative scale and in constructional and operational feasibility, only URLs can provide reliable in situ data. URLs can also provide tangible benefits in enhancing participation by the general scientific community and confidence amongst both technical and nontechnical stakeholders



Generic URLs

The earlier generic URLs were developed :

- to substantiate the initial repository concepts for disposal facilities
- to examine specific aspects of the near field reactions
 - Stripa Mine (Sweden) and Grimsel (Switzerland) in Granite / Mol (Belgium) in Clay provided valuable geohydrological information on host rocks at typical depth of 200-400 m and also developed technologies for measuring thermodynamic, geophysical and geochemical properties

Later URLs generic URLs were developed

- to gather data for safety demonstrations (coupled or low evolving phenomena)
- to test and to validate technologies that could reduce cost and/or simplify repository design without compromising safety
 - Äspö (Sweden) in Granite or Mont Terri (Switzerland) in Clay

Generic URLs are usually located at sites with geological properties that are similar to those being considered for the proposed disposal option.

Other URL sites are chosen for their different rock characteristics from the proposed host formation which provide valuable comparisons between the preferred disposal option and the generic site.

Generic URLs play a unique role for international collaborations or comparisons of options and concepts:

- They may be used to gather useful or complementary information in advance or in complement to those gained in the National program (eg to gain experience prior developing the National URL)



Site Specific URLs

Site specific URL are build at the location of the future DGR or at very close distance.

They offer the most representative conditions and enable to acquire the most representative data on the envisaged host-rock.

Work in site-specific URLs permit to continue and to deepen the site characterization program.

- surface investigations cannot provide all the required information
- direct access to the host rock is required to make progress such as validation of models by in situ tests, optimization of excavation techniques, etc.)

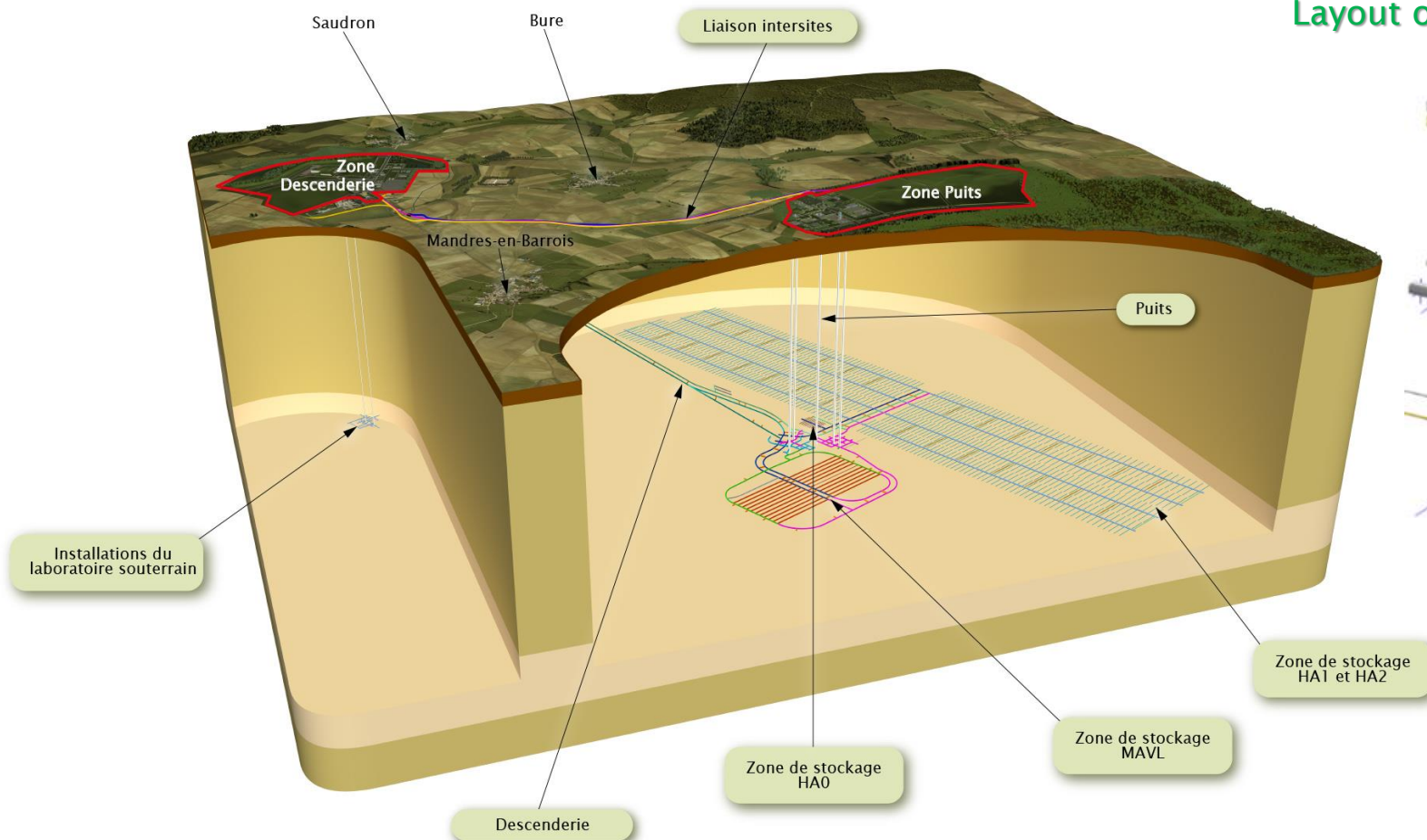
In designing/constructing/operating a site-specific URL program, it is crucial

- to minimize the extent of damage to the host-rock, especially in parts of the architecture that will play a crucial role for long-term safety
- to avoid a large number of boreholes drilled from the surface except where they are subsequently assimilated by underground access.

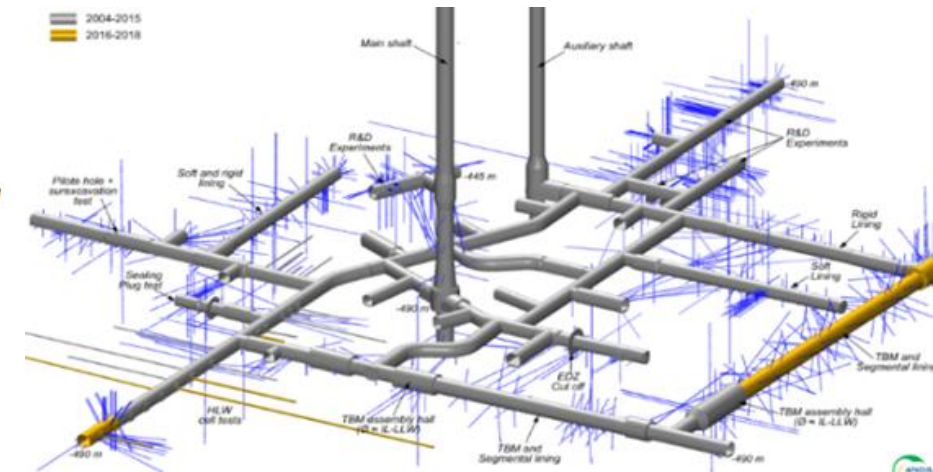
Site specific URLs are usually designed to test the methodologies, techniques and equipment developed for the URL in “real” (or close to real) situation.



Cigéo - Development of a DGR in the Close Vicinity of the URL (both located in Bure)



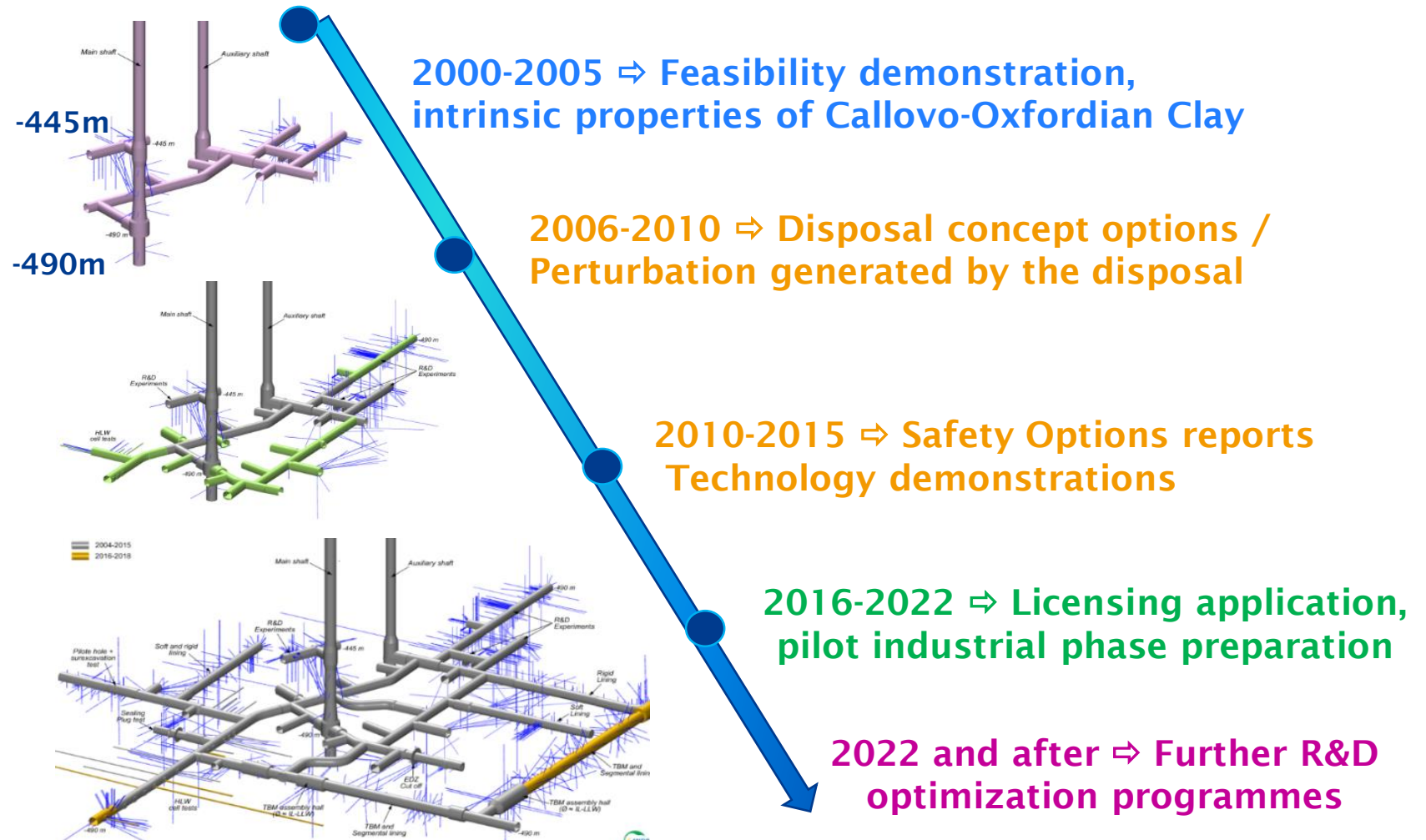
Layout of the Bure laboratory in 2022 operated by Andra (the French waste management agency)



Interestingly, while Andra operates the site specific URL in Bure, IRSN (the French TSO) operates a small generic URL in Clay in Tournemire where complementary studies are carried out.

The Progressive R&D Program in the French Site Specific URL - 1

A gradual R&D program, phased and organized in coherence with the regulatory and design processes, is run in the URL and in surface laboratories, in collaboration with Andra's national and international partners.

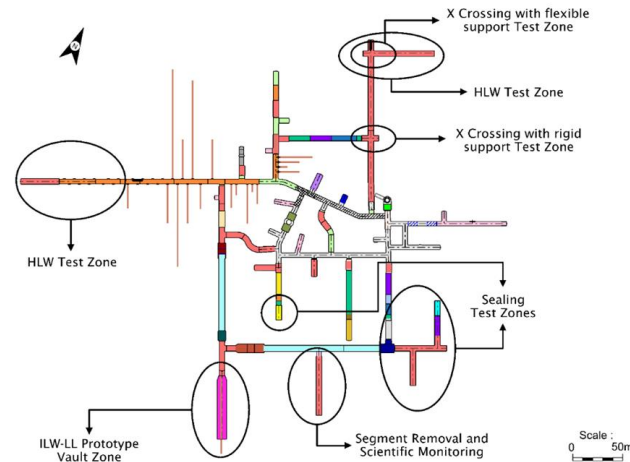


The Progressive R&D Program in the French Site Specific URL - 1

The URL may :

- Provide **enough place/room** and access to perform the experimental program (disturbed and undisturbed rock mass), and avoid interferences
- Allow the execution of **tests and samplings in “repository like”** conditions in support of the **safety demonstration**
- Test, validate and optimize **construction technics**
- Give enough **flexibility for experimental program up-dates** and potential developments

The HLW R&D program (in the URL, in surface facilities and in Cigéo itself) will be going on. It is organized to accompany the successive operations programmed in Cigéo.



URL – some figures :

- At a depth of 500 m
- 2 shafts / 2 km of drifts
- 1,000 boreholes
- 1 million data per day
- 18,400 measurement points
- Already 20 years of research
- Operations due at least until 2030



The operations in the underground laboratory are technically supported by the Centre de Meuse-Haute-Marne (CMHM):

- A perennial observatory of the environment (OPE) set-up in 2007
- A technological exhibition facility built in 2009
- A geological core sample library built in 2012
- An environmental specimen bank built in 2014

The Essential Roles of the URL in Bure - Science

Since the very first start of its construction, the URL has been a great tool to gather scientific and technological knowledge and to characterize the geology of the site and in particular the clay host-rock:

- Right from the start of the digging of the vertical shafts by blasting and during the construction of all horizontal galleries, data were collected to characterize the geological context, to confirm or modify the design of the structures and to improve the efficiency of the underground work.



The Essential Roles of the URL in Bure – Safety and Security

The safety demonstration of a deep geological disposal facility (operations and after closure) should be progressively established and deepened by carrying out safety assessments (early siting / design stage / construction stages / periodic update)

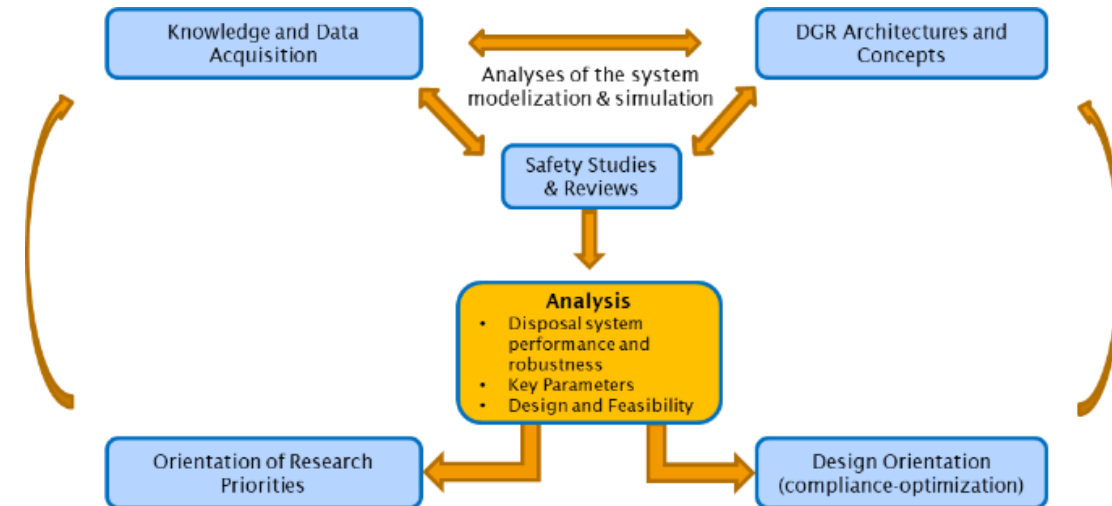
In the case of the Cigéo project, 3 major assessments reviews were carried out by the Safety authority in 2005, 2009 and 2016

- Feasibility / Improvements of operational and long-term safety analysis and potential reversibility / Safety options

The iterative safety assessments benefited from the quality of the results from the URL and HLW management R&D program. They were key to reduce the uncertainties and to provide a firm ground for the review conclusions and follow-up decisions.

Construction work and the operations of the URL provided feedback on underground working and intervention conditions:

- Rescue team trainings / intervention material tests / security procedures / workforce development / preparation for work in the DGR





The Essential Roles of the URL in Bure – Environmental Impact Reduction

The objective of a deep geological repository (DGR) is to protect the environment and the human health:

- its first objective should be to keep its environmental impact as low as possible
- considering the growing sensitivity of the public to the degradation of the environment, high environmental standards avoid to fuel oppositions with valid reasons for concerns

An underground research laboratory (URL) bears many features that resemble those of the future DGR

- shafts, galleries, ventilation and excavated material handling operations
- for the operator, the way the environmental impacts of the URL are managed (avoided, reduced or compensated) can be seen as a good practice and preparation for the future DGR / For the Public, it will be an indication on how serious and trustful the HLW program may be considered

In the case of the French URL in Bure, valuable feedback was gained eg. from :

- the management of digging construction activities and stockpiles / Monitoring and surveillance of water local resources / Treatment and discharge of collected ground water and effluents
 - The lessons learnt were used for the environmental design of Cigéo

Andra launched in 2007 the scientific project of a perennial observatory of the environment (OPE).



The Essential Roles of the URL in Bure – Stakeholder's Involvement

On a practical basis and within the limits of its own responsibilities and regulatory duties, Andra conducts exchanges with the public and stakeholders prior to every decision and major orientations of the project (for example prior decisions on the location of Cigéo's underground and surface infrastructure or on the preferential transport routes to the facility):

- basic information meetings, events or distribution of publications, surveys, questionnaires and participative work-gatherings on specific subjects, citizen's conference...
- Andra always publicly explains why it may not follow some recommendations originating from the public

Andra also communicates regularly with the local information commission (CLIS) and answer every question asked.

To illustrate its transparency, Andra organizes visits of the URL for all stakeholders and "open-door week-ends" where the public may visit its installations.

The years of exchanges at the national and local levels, the broad information provided and the transparency and openness promoted by Andra for the URL have contributed to build confidence in the DGR Project.



To Go Further

"Underground Research Laboratories (URL)" / Radioactive Waste Management NEA/RWM/R(2013)2 / February 2013

- [78122-rwm-url-brochure.pdf \(oecd-nea.org\)](https://www.oecd-nea.org/rwm/78122-rwm-url-brochure.pdf)

"Important roles of underground research laboratories for the geological disposal of radioactive wastes: an international perspective", Stefan J. Mayer, Philippe Van Marcke, Haeryong Jung, Paul Thompson, and Govatsa Acharya, (2023) Geological Society, London, Special Publications Volume 536 Pages 297 - 309

- [Important roles of underground research laboratories for the geological disposal of radioactive wastes: an international perspective \(lyellcollection.org\)](https://www.lyellcollection.org/doi/10.1017/S0022267323000000)

"The Use of Underground Research Laboratories to Support Repository Development Programs: A Roadmap for the Underground Research Facilities Network", Sandia, SAND2015-9427, October 2015

- <https://www.osti.gov/servlets/purl/1225846>

"The French Underground Research Laboratory in Bure: An Essential Tool for the Development and Preparation of the French Deep Geological Disposal Facility Cigéo", Pascal Claude LEVERD (2023) Journal of Nuclear Fuel Cycle and Waste Technology (in Press)

- [:: Journal of Nuclear Fuel Cycle and Waste Technology :: \(jnfcwt.or.kr\)](https://www.jnfcwt.or.kr)



Onkalo – Development of the URL into a Nuclear Facility

