

FRENCH URL PROJECT CONTEXT, SCHEDULE AND CONTENTS

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ABSTRACT

Bure's URL project is one of the components of the French research program dedicated to the study of HLLLW (High Level Long Lived Radioactive Waste) disposal in geologic repository. The goal of this project is to gain a better knowledge of a site capable of hosting such a facility. The project, launched in 1994, unfolds in three phases: the Siting Phase (1994-1996), the Licensing Phase (1997-1999) and the ongoing URL Phase (1999-2005). The final milestone (end of 2005) consists of a report, which will be submitted to the government authorities.

The URL is situated in the Callovo-oxfordian argilite forming part of the Jurassic formation of the Parisian Basin. It consists of surface facilities, two shafts (an access shaft and a ventilation shaft) and a network of drifts (constructed at a depth of 490m) in which the scientific experiments will be carried out.

These experiments are derived from three major questions raised by the design studies of the repository: What is the containment performance of the argilite? What would be the disturbances generated by an underground repository? Is it possible to upscale the findings observed in the URL to the scale of a potential repository?

The status of the project as of January 2002 is the following: 90% of the surface facilities are constructed and the depth reached on the access shaft is 150m.

The findings of this project should bring answers to the three major questions mentioned here above and will be used to improve the site models in the framework of the long-term performance assessment.

Keywords: France, Waste Management, Disposal, Underground Laboratory, Research Program

INTRODUCTION

Bure's URL project is one of the components of the French research program dedicated to the study of HLLLW (High Level Long Lived Radioactive Waste) disposal in geologic repository within the framework of the 1991 Radioactive Waste Act. Pursuant to the said act, the objective of the URL project is to participate in the "*evaluation of options for retrievable or non-retrievable disposal in deep geologic formations*". More precisely, the goal of this URL, which is situated 300 km East of Paris, is to gain a better knowledge of a site capable of hosting a geologic repository.

SCHEDULE

This program was launched in 1994. The unfolding of this project can be divided in 3 phases:

- the siting phase (1994-1996),
- the licensing phase (1997-1999),
- the URL phase (2000-2005).

This schedule is illustrated by figure 1.

The Siting Phase

A mediation mission, appointed by the government, identified in 1993 a number of French “departments” deemed as favorable from a scientific standpoint as well as from a political one. Then, at the very beginning of 1994, three areas were granted to ANDRA by the government for geological investigation. During the 1994-1996 period, ANDRA accordingly implemented a geological investigation program in these three granted zones.

The area concerned by the Bure project straddles two departments (Meuse and Haute-Marne) in eastern France. In this area ANDRA’s research program was divided in the three following phases:

- Regional synthesis: During the first months of 1994 ANDRA analyzed the existing documents and works findings coming mainly from the petroleum research activities carried out previously in this area. In this regard the reports of the seismic and drilling campaigns were very useful.
- Preliminary investigation: From mid 1994 until the end of 1995 ANDRA carried out its own seismic and core drilling campaign. These works consisted in the following tasks: geological mapping, hydrogeological inventory, two boreholes located 10km North-West of the site (one was 1101 m deep and the other was 102 m), one deep borehole (922m deep) 5 km South of the site, one borehole (522m) located on the site itself and a 2D seismic survey around the proposed site (15 km of profiles).
- Site confirmation phase: Then from the end of 1995 to mid 1996 ANDRA drilled 3 additional boreholes: 2 of them were located on the site (105 m and 425 m deep) to confirm the feasibility of the shaft sinking and a third one located 10 km North-West of the site was dedicated to the study of the hydrogeology of the overburden.

The findings of the works carried out in this area was the identification of an argillite layer, located at a depth of about 500 meters deep and 120 meters thick. This formation was considered as favorable to host an URL. On the basis of these findings, ANDRA made the basic design of an appropriate URL and established the licensing documents. The license application was then lodged with the administration at the end of 1996.

The Licensing Phase

The license application was analyzed and reviewed according to the French procedures and to the provisions of the 1991 Radioactive Waste Act. The administrations in charge of reviewing the documents were the Nuclear Safety Authority (DSIN) and the local administration. In addition, the project was subject to a public hearing and to the votes of the local elected assemblies. Moreover the National Review board (CNE) analyzed the scientific component of the project. Eventually, every concerned entity provided recommendations.

Then the government made the decision on the basis of these recommendations and granted authorization to construct and operate Bure’s URL through a decree issued in August 1999.

The URL Phase

The URL phase is characterized by the simultaneity of two kinds of concurrent and interwoven activities: the scientific research activity and the URL construction works.

The scientific activities are schematically divided in 3 steps:

- the 3D seismic and core drilling campaign from December 1999 until October 2000,
- the geologic survey of the shafts and drifts excavation from October 2000 until the end of 2003,
- the underground experiments from mid 2002 until the end of 2005.

The construction of the URL facilities started in February 2000 and should last until 2004. The shaft sinking, which is indeed the first experiment, will last 2 years: from the end of 2000 until the end of 2002.

The Final Milestone

The final milestone (2006) will consist of a report submitted to the government and reviewed by the National Review Board (CNE) and the Nuclear Safety Authority (DSIN). Then the government should decide either to launch a repository project, to continue the scientific research or to give up any geologic repository related activities. In any case if a repository had to be constructed a new legal framework would have to be set up.

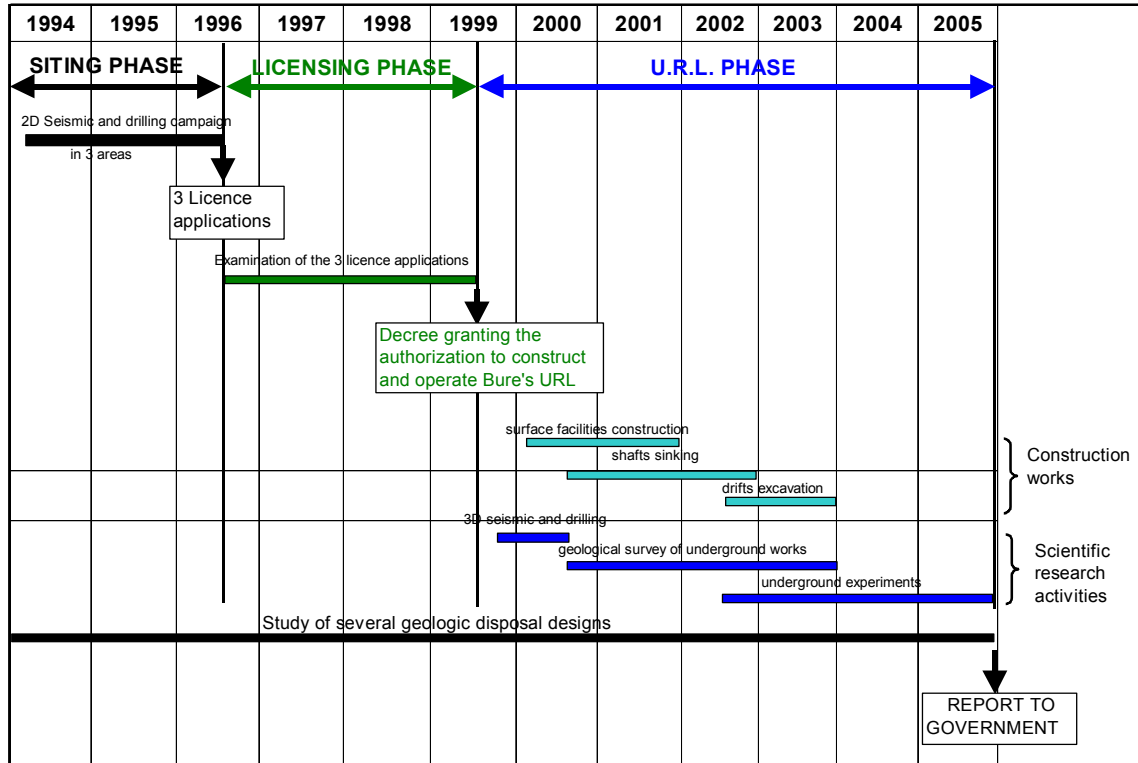


Fig. 1 - General Schedule

GEOLOGY OF BURE'S SITE

The Bure site belongs to the Jurassic formation of the eastern part of the Parisian Basin. It is located in a favorable area of about 400 km². This area is bordered by 2 crustal faults to the West and South and by a graben to the East. In this area the layers have a low dipping and show a great continuity of facies characterising a stable sedimentary deposit without heterogeneity or important discontinuity. Schematically the geology consists of the following layers

- from surface to 160m: series of limestone and marl layers (Tithonian and Kimmeridgian),
- from 160m to 420m: stable and non aquiferous limestone (Oxfordian),
- from 420m to 540m: **Host formation** = argilite of the Callovo-Oxfordian
- below 540m : non aquiferous limestone (Dogger)

This geology is illustrated by figure 2 hereunder.

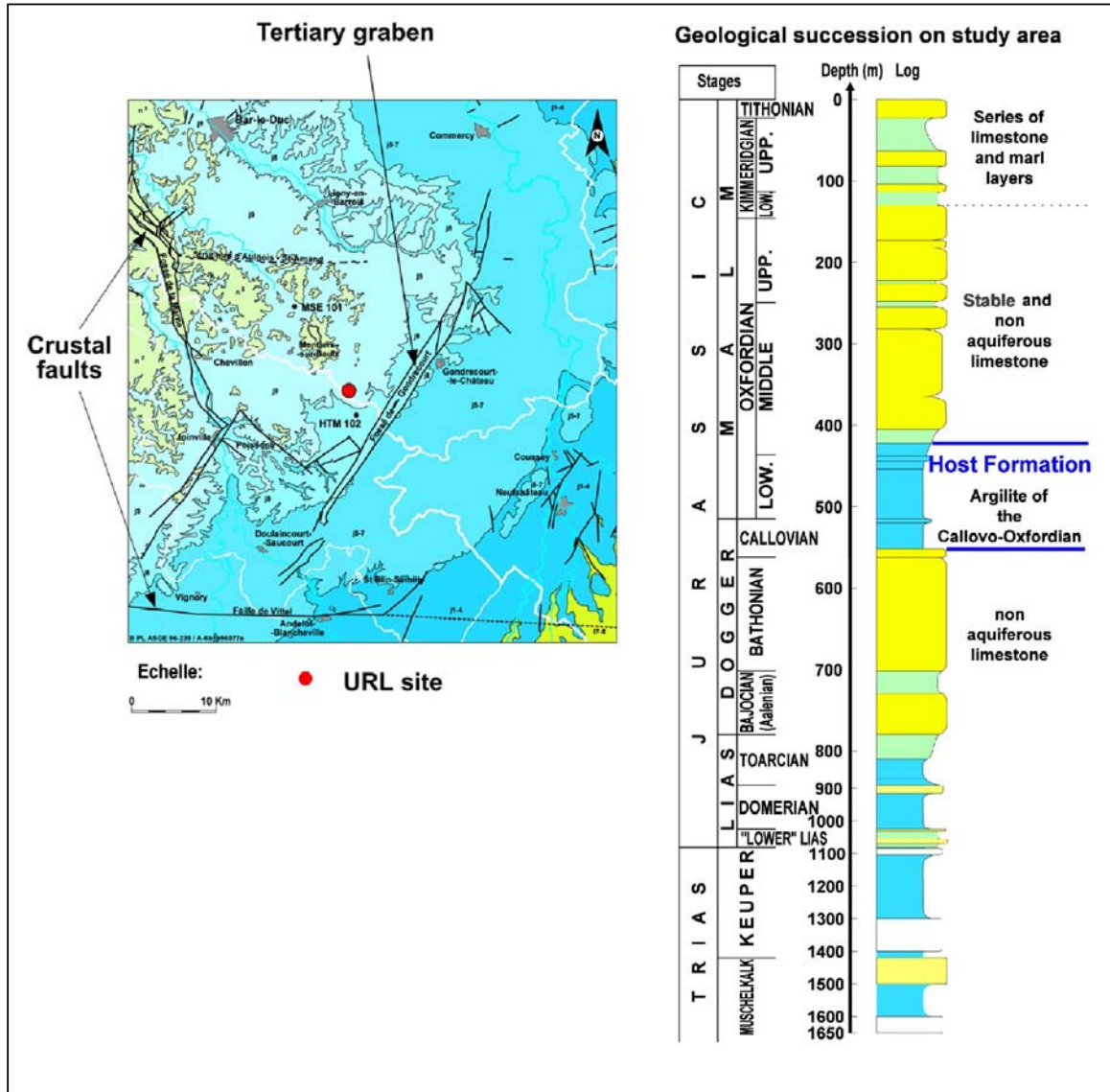


Fig. 2 - Geology of the site

The host formation of the Callovo-Oxfordian (120m thick located between 420 and 540m depth) is a carbonaceous silty argilite containing about 45% clay minerals, 25% quartz and 30% calcite. Its main features are set forth in the Table I hereunder.

Table I. Main features of the host formation

		Value range	Average
Physical properties	Density	2.32 - 2.61	2.42
	Water content (%)	2.8 - 8.7	6.7
	Porosity (%)	9 - 18	14
Hydrogeological properties	Permeability (m/s)	10^{-11} - 10^{-13}	10^{-12} m/s
Thermal properties	Conductivity ($\text{W m}^{-1} \text{K}^{-1}$) (parallel)	1.35 - 1.65	1.47
	Thermal capacity ($\text{J m}^{-3} \text{K}^{-1}$)	$1.9 \cdot 10^6$ - $1.2 \cdot 10^6$	$2.05 \cdot 10^6$
	Coefficient of expansion (K^{-1})	$0.8 \cdot 10^{-5}$ - $6.2 \cdot 10^{-5}$	$1.7 \cdot 10^{-5}$
Mechanical properties	Simple compressive strength (MPa)	12 - 49	26
	Simple tension strength (MPa)	0.9 - 5.4	2.6
	Young modulus (MPa)	2300 - 11000	4900
	Poisson ratio	0.17 - 0.4	0.3

URL's DESIGN

The URL is only a research tool and in no case the first step of the repository construction. The use of radioactive waste, even for research purposes, is strictly forbidden in these facilities. The design of the URL is based on these considerations.

Bure's URL consists schematically of three parts: the surface facilities, the shafts and the galleries.

The Surface Facilities

The surface facilities are spread out over an area of 17 hectares. They are divided in 3 parts:

- a zone dedicated to the public information which includes a car park and a visitor center,
- a technical zone which notably houses the headframes of the shafts, a core house, a building dedicated to the preparation of the experiments and several other technical buildings
- a zone dedicated to the muck pile.

The Shafts

For safety reasons there are two shafts: an access shaft (5 meters in diameter) and a ventilation shaft (4 meters in diameter). They are 100 meters distant from each other and 500 meters deep. The personnel transportation, the muck extraction and the air intake are performed through the access shaft. The air exhaust and the emergency personnel transportation are performed through the ventilation shaft. These shafts are equipped with a concrete lining and a drainage system. A small experimental "niche" will be excavated from the access shaft at a depth of 445 meters.

The Galleries

The network of galleries will be constructed at a depth of 490 meters. Its total linear length is 1 kilometer. It is divided into three categories:

- the drifts dedicated to the technical facilities,
- the drifts dedicated to the experiments,
- two drifts dedicated to the geologic exploration of a bigger volume than that dedicated to the implementation of the experiments: one will be upward and the other downward.

The Figure 3 shows a 3D view of the URL and the location of the scientific experiments.

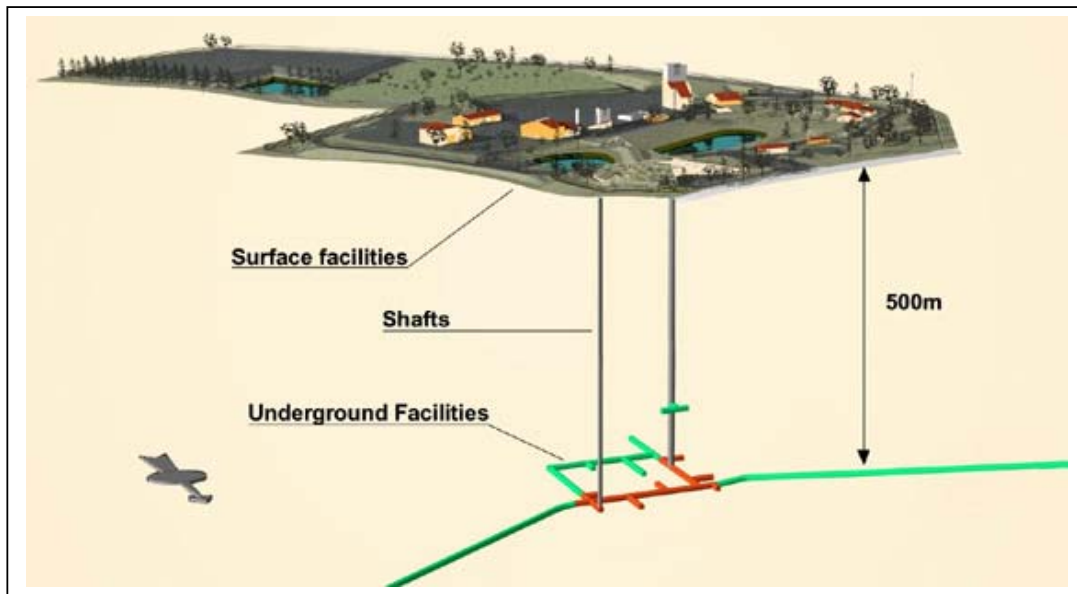


Fig. 3 - 3D view of the URL

OBJECTIVES AND CONTENTS OF THE SCIENTIFIC PROGRAM

The scientific program of Bure's URL project is derived from the questions raised by the conceptual design studies of the repository. These studies take into account three categories of Waste: B Waste (technological waste, hulls and end-caps), C Waste (vitrified Waste produced by the reprocessing) and Spent fuel. For each category ANDRA is considering several options of disposal structures. The area of the general repository layouts containing these structures would range from 3 to 6 km².

These studies raise two major questions:

- *What is the containment performance of the argilite?*
- *What would be the disturbances generated by an underground repository?*

The main research tool used by ANDRA to answer these questions is the URL. But since the URL is much smaller than a repository a third question has to be asked:

- *Is it possible to upscale the findings observed in the URL to the scale of a potential repository?*

In summary the contents of the scientific program is based on these three questions. Each question generates a number of survey, field operations or experiments. Some of these tasks were carried out during the siting phase, some are currently (or will be) conducted during the URL phase and some others, which started during the first phase, will be completed during the second one.

The containment aspect requires a detailed knowledge of the geological (lithologic, mechanical, hydrogeological and chemical) features of the host formation at the scale of the URL. The research tools chosen in this regard are the following:

- coring, logging and testing operations in boreholes drilled from the surface of the URL site during the siting phase as well as during the URL phase prior to the kick off of the construction ,
- geological surveys during the sinking operations of the shafts (URL phase): From the surface to the bottom the geologists will observe and study the walls of the shaft every 2.5 m.
- geological surveys during the excavation of the underground galleries (URL phase),
- an underground experiment dedicated to the geomechanical characterization of the argilite (URL phase): More precisely the aim of this experiment is to measure the short term and medium term

- deformability parameters of the argilite as well as the in situ stresses.
- an underground experiment dedicated to the measurement of the parameters governing the advective flows in the host formation, notably the gas migration processes and the osmotic effects (URL phase),
- underground water sampling for chemical and isotopic analyses (URL phase): The goals of this experiment are the following: pH and Eh measurement, Fluid sampling for chemical and isotopic analysis and rock core samples for mineralogical analysis and extraction of porewater.

The disturbance aspect requires to observe and measure the mechanical, hydrogeological and chemical modifications of the site, which will be generated by the construction of the URL. The research tools chosen in this regard are the following:

- a set of 12 environmental boreholes drilled in 500 m radius circle of the access shaft equipped with temperature and pressure gauges as well as for water sampling (URL phase),
- a series of sets of geomechanical sensors installed in small boreholes drilled from the shaft (vibration transducers and extensometers) (URL phase)
- an underground experiment aimed at measuring the impact of shaft sinking on the hydro-mechanical properties of the argilite (URL phase): this experiment called “shaft mine by test” will be carried out from a “niche” located at a depth of 445 m during the sinking of the access shaft. The sensors will be installed in boreholes drilled from the niche. During the duration of the measurement phase the “drilling and blasting” method of sinking will be temporary given up and a hydraulic hammer will be used.
- an underground experiment aimed at measuring the impact of drift excavation on the hydromechanical properties of the argilite (drift mine by test) (URL phase),
- an underground experiment aimed at measuring the impact of thermal stress on the properties of the argilite (chemistry of the porewater, mineralogy of the argilite and thermo-hydraulic-mechanical couplings) (URL phase).

The upscaling aspect requires a study of the potential lateral variation of the host formation as a result of its diagenetic and sedimentary history as well as of its tectonic evolution. The research tools chosen in this regard are the following:

- coring, logging and testing operation in 2 deep boreholes distant of a few km radius circle from the site (see siting phase),
- a 2 D seismic campaign (see siting phase),
- a 3D seismic campaign (URL phase)

STATUS OF THE PROJECT AS OF JANUARY 2002: SHAFT SINKING UNDER PROGRESS

30 ANDRA employees (scientists, mining engineers, civil engineers and administrative personnel) are present on the construction site. The total number of people working on the site including the contractors is about 150.

90 % of the surface facilities are constructed. As far as the core of the URL is concerned, the sinking operations are currently under progress on both shafts. The sinking method is the conventional drilling and blasting technique, which enables the geologists to survey the walls of the shafts after each blast. The depth reached in January 2002 is 150m. From a legal standpoint this operation is carried out in compliance with a very stringent legal framework that matches a high level of safety. Indeed, since the goal of the project is not to operate a mine, the underground activities of the URL are not subject to the mining regulations. As a consequence the sinking equipment and procedures must be compliant with the French “labor code” as well as with the European directives. For example the personnel must be transported in an additional cage specifically dedicated to this function and compliant with the European lift directive instead of in the usual “kibble” used for the muck extraction. As a result the sinking operation is carried out thanks to a specific multistage sinking platform, which was custom designed as a prototype. The figure 4 shows a global view of the construction site.



Fig. 4 - Assembling of the sinking platform

CONCLUSION

The findings of this scientific program should bring answers to the three major questions raised by the study of the geologic disposal: containment, disturbances and upscaling. The results will also be used to improve the site models in the framework of the long-term performance assessment.

All of these research works will be regularly reviewed by the National Review board (CNE) and by the Nuclear Safety Authority (DSIN) to keep informed all of the stakeholders and give the government all of the required elements to make a decision in 2006.