The Design of Disposal Areas for High-level Long-lived Waste for the Andra Project: a Strong Challenge Requiring Demonstrations - 9018

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ABSTRACT

Following the feasibility study submitted in 2005 and in the framework of the *Planning Act of 28 June 2006,* Andra launched a new study phase with a view to optimising the design of the geological repository for high-level and intermediate-level long-lived radioactive waste.

Technical and economic issues relating to a repository for high-level long-lived waste (HL-LL) are especially significant. Today, several options are revisited in order to address as best as possible certain issues, including the design of the components for disposal cells, the thermal sizing of the module and the selection of specific architectures for both the disposal module and the disposal area.

In order to support technico-economic studies, a series of tests and demonstrators was initiated. Some of those tests have now been completed, while others are under way or yet to come.

The most significant tests and demonstrators in terms of their impact on the design of the Hl-LL disposal area refer to the following aspects: the connection mode of the cell sleeve, the connection mode of the closure of the cell sleeve (bottom plate and radiation-protection plug), the sizing of the cell sleeve, the search for other materials than steel, the cell-sealing mode, the cell-excavation mode, the emplacement of waste packages in the disposal cell, drift-construction methods (support, sleeve, transport of concrete) and, lastly, the formalisation of the thermal characteristics of the host rock. Aspects relating to disposal packages are not addressed here.

INTRODUCTION

In 2005, Andra presented the design of an underground repository for high-level long-lived (HL-LL) and intermediate-level long-lived (IL-LL) radioactive waste to its supervisory authorities. The feasibility studies constituting the *Dossier 2005* [1] were approved by the relevant authorities controlling Andra's activities. The *Planning Act of 28 June 2006* prescribes Andra's work schedule in order for the future geological repository to be commissioned by 2025.

A new study phase was launched in 2006 with a view to optimising the design, although it may mean to re-examine certain previous decisions, and to presenting safety, reversibility and design options in 2009. Once those choices will be reviewed by the Nuclear Safety Authority (*Autorité de sûreté nucl*éaire – ASN) and the National Review Board (*Commission nationale d'évaluation* – CNE), more detailed design studies will be initiated in order for a creation-licence application to be submitted in 2015. In addition, a public debate is scheduled to take place early in 2013.

The disposal of HL-LL waste, which is the topic of this paper, constitutes an important part of the project. Although the volume of such waste represents less than 10% of IL-LL waste, their impact is predominant on the overall project, especially in terms of radiological inventory, excavated volume, spatial footprint and costs. Hence, the *Dossier 2005* announced an excavated volume of close to 4 million cubic metres for the HL-LL area alone against only 1.8 million cubic metres for the IL-LL area. The thermal power of HL-LL waste is responsible for their major impact on the repository.

Consequently, the technical and economic issues relating to the repository for HL-LL waste are significant, and will be described below. Future studies will propose appropriate responses to those stakes. The studies will be based on experiments and technological demonstrators, which are implemented in surface workshops or in Andra's Underground Research Laboratory straddling the Meuse and Haute-Marne Districts in Eastern France. Some demonstrators are already completed and others are under construction or scheduled to be built over the coming years. They will be described in the last part of this article.

REMINDER ABOUT THE REFERENCE CONCEPT

The concept selected by Andra in its feasibility study (*Dossier 2005*) is briefly summarised below. The description starts with the waste and continues up to the final disposal area.

HL-LL waste packages

HL-LL waste includes fission products and minor actinides that are separated during fuel processing. Their high β-γ activity releases a significant amount of heat, which decreases over time, mainly in proportion to the radioactive decay of medium-lived fission products, such as caesium 137 and strontium 90. The conditioning of such waste in "primary packages" consists in embedding them in a glass matrix contained in a stainless-steel envelope. The size of the repository itself is set with a view to accommodating approximately 36,000 primary packages, corresponding to a total volume of slightly more than 6,000 m^3.

Primary packages are laid out in overpacks and both constitute the actual "disposal packages". The use of an overpack is necessary due to the phenomenological specificities of the so-called "thermal" phase during which the temperature of the package gradually rises to its "thermal peak", then decreases. The phenomena of that phase increase the leachability of the glass matrix, influence the behaviour of its radionuclide content and embrittle the stainless-steel envelope protecting the primary package against corrosion during the thermal phase

The selected solution for its simplicity and its robustness with regard to current knowledge and techniques is to use an individual overpack made of non-alloy steel, measuring 55 mm in thickness. It consists of a frame and a cover made of the same material. Once the primary package is introduced in the frame, the cover is welded to the latter by electron-beam welding. The cylindrical shape of the overpack minimises internal voids within the disposal package, since it matches exactly the shape of the primary package. Plans call for fitting disposal packages with ceramic pads in order to prevent the direct contact of the steel of the overpack with the steel sleeve the disposal cells.

The age of the disposed waste varies between 20 years for the least exothermal packages and 70 years for the most exothermal ones.

HL-LL disposal cells

The reference concept for HL-LL waste consists of a horizontal dead-end tunnel (Figure 1) that is lined with a metal sleeve and measures approximately 700 mm in diameter. In order to facilitate the demonstration of its technical feasibility, the length of the disposal cells was limited to 40 m in the *Dossier 2005*.

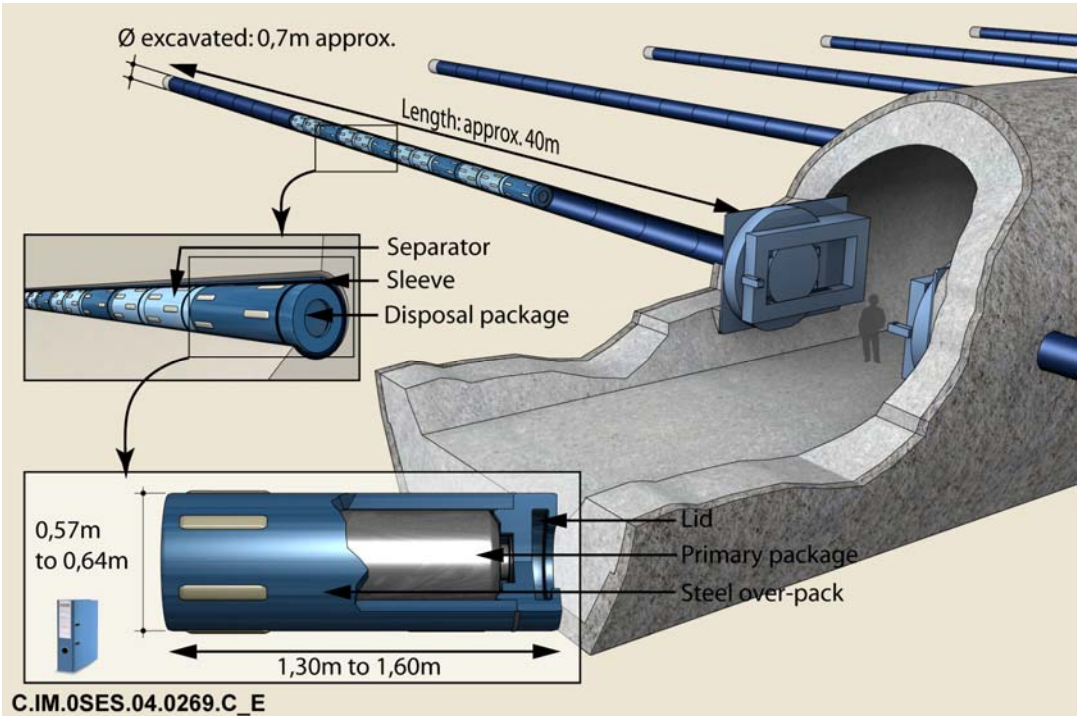

Figure 1: Selected concept in 2005 for the HL-LL waste repository

The design work dealt notably with the following topics: the appropriate spacing between packages and between cells, for thermal reasons; the control of the damaged argillite zone by limiting voids in the cells, cell sealing and resulting provisions for the cell head.

The cell includes an “effective part”, which is intended for the disposal of waste packages, and a cell head, which is designed to seal the cell. Any excess heat released by the waste must be evacuated in order not to alter the containment qualities of the rock. The selected concept ensures that the heat may only be evacuated by passive conduction through the geological formation; no ventilation is required in the process. In order to comply with the 90°C thermal criterion at contact with the rock, some packages may only be disposed of side by side after a very long storage time. However, it is possible to dispose of them earlier provided that they are spaced apart sufficiently to reduce the average thermal flow. The solution consists in installing inert spacers between packages and to adjust the length of those spaces in relation to the thermal power of the packages involved.

The use of a steel sleeve is justified by its mechanical strength and its usability for handling packages in the cell. The sleeve is in direct contact with the formation. At the feasibility-study stage, the purpose of selecting a suitable steel grade is to minimise the effects of galvanic corrosion; hence, studies have been conducted on a slightly-alloyed steel of a similar or close grade to the one used for package overpacks.

The sleeve must be thick enough to ensure the mechanical strength of the cell and to support the thrust of the pushing tool during excavation. Resistance calculations led to a pre-sized thickness of 25 mm.

Once the packages are in place, the cell head is sealed by a swelling-clay plug, which is mechanically blocked by a concrete bulkhead.

HL-LL disposal modules

Disposal cells are laid out on each side of an access drift and spaced apart by 8 to 13 m from each other, depending on the thermal power released by the waste. Such spacing, as well as the distance of the packages between them, is derived from a so-called “thermal design” calculation.

In order to ensure evacuation in case of fire, access drifts are grouped by three: cross drifts allow personnel to move between drifts if they need to reach rapidly a space that is not filled with smoke (fresh air is injected constantly in two drifts out of three).

Grouped in three, access drifts constitute the operational modules. Each module includes three access drifts, cross drifts and 150 to 200 disposal cells. The number of cells depends on the length of the access drifts (limited conservatively to 600 m in the *Dossier 2005*) and on the distance between cells (as prescribed by thermal design). Access drifts have an excavated diameter in the order of 8 m.

HL-LL disposal area

The disposal area consists of *n* operational modules on both sides of a series of connecting drifts. The *Dossier 2005* quoted that there were 24 operational modules. Connecting drifts have an excavated width in the order of 7 m and an effective width in the order of 6 m. Each series includes four connecting drifts.

MAJOR TECHNICAL AND ECONOMIC ISSUES CONCERNING THE DESIGN OF HL-LL WASTE DISPOSAL CELLS

The major technico-economic issues relating to the design of HL-LL waste disposal cells concern the design of the cell components, the cell length, the thermal sizing of the module and the choice of architectures for the disposal module and zone. Although those various aspects are not independent from each other, they are described one by one below.

Design of cell components

The design of the selected disposal cell in the *Dossier 2005* (see above) provides the first unoptimised response to a set of long-term safety and operational requirements. Such design rests mainly on the introduction of a metal liner in the formation. The metal nature and thickness of the liner, the type of formation, the dead-end design of the cell and the reversibility prescription all induce building constraints and investment costs.

Hence, although the metal is only slightly alloyed, it generates a significant cost, since close to 10,000 t of steel sleeve will be installed in the formation.

In addition, the formation, which consists of argillite at very great depth, will not likely withstand a deferred implementation of the supports without scaling (resistance to uniaxial compression of 12 to 40 MPa, for an *in-situ* stress in the order of 12 to 20 MPa): that is the reason why we consider installing the sleeve as excavation progresses in order not to leave the excavation without support. That method requires excavating the cell with a retractable tool in the sleeve, and deferring the installation of the closing plate of the cell at its furthest end from the drift. Lastly, the time-dependent behaviour of the formation leads to designing connections (not only between sleeve components, but also at both ends of it), in order to counter argillite infiltrations within the sleeve during the reversibility phase.

Another issue related to the search for a possible means to ensure water-tightness, although the topic is not a functional requirement of the concept. However, the water impermeability of the sleeve would extend the longevity of the overpack around the package. Designing a water-impermeable sleeve during the entire reversibility period (at least 100 years) implies welding the various connections at full thickness. The welding times, which are very long in principle, increase significantly the cell-construction costs and strain the construction schedule.

An additional issue is whether or not steel should continue to be considered. In fact, over the very long term, steel generates hydrogen due to anoxic corrosion. Although it was established that hydrogen was not able to alter the containment properties of the host rock, it would be preferable to minimise the resulting quantities. Other potential materials are faced with various problems regarding feasibility, chemical compatibility with the waste, and cost. However, according to the initial studies conducted by Andra, granite may also be suitable. Consequently, opting for granite would require reconsidering the overall design of the disposal cell for HL-LL waste, including the thickness of the sleeve, connections between tube elements, the thermal design of the area and, last but not least, investment costs.

Determination of the length of a disposal cell for HL-LL waste

The concept presented in the feasibility study of the *Dossier 2005* is conservative and proposes that disposal cells be 40 m in length, with about 30 m dedicated to waste packages and the remaining 10 m for sealing the cell. The economic stake is obvious: to increase the “effective length” of the cell in order to minimise the fixed costs for sealing purposes (currently 25% of the total length). An increase in the effective length of the cell would reduce the total number of cells, and consequently, shorten the length of the access drifts. Given the fact that the scenario presented in the *Dossier 2005* includes 5,000 cells (i.e., equivalent to close to 200 km in length), the economic issue is very important and is estimated at approximately 20% of the civil-engineering costs of the HL-LL waste area [2].

On the other hand, extending the length of cells poses two problems. First of all, it is important to verify the feasibility of the cell itself in terms of excavation (machinery power, deviation risks) and of the mechanical strength of the sleeve (thermo-mechanical strength, thrust resistance, buckling strength). It is also important to ensure the possibility of pushing waste packages over large distances and to retrieve them over the same distances, if need be, since package retrieval constitutes one of the aspects of reversibility.

Thermal sizing of the module

The main challenges relating to thermal sizing are twofold.

The first challenge for the proposed concepts relates to a conceivable preliminary storage period before emplacing the waste in a repository. Prolonging the storage time decreases the thermal power of the waste and will have a strong impact on the final footprint of the repository and, consequently, on its cost (see below). However, it would extend the transient storage phase, with its accruing operating costs, and would delay the implementation of the required disposal means for ensuring the final security of the waste. Consequently, the challenge is primarily technical, economic and political.

The second challenge concerns the repository footprint and its cost. For a given preliminary storage period, in fact, it is necessary to identify the geometry of the disposal modules corresponding to the smallest total excavated volume possible and being consistent with the temperature limit value. Such temperature limit must be verified during a relatively short period (in the order of a decade once the waste has been emplaced in the repository, a period during which occurs the “thermal peak”. The layout of the packages in cells and of the cells in the disposal modules depends essentially on that particular phase in the repository’s lifetime. It should be remembered that a temperature limit of 90°C at the contact point with the rock was selected for calculation purposes.

In terms of design, several aspects were explored. It was proposed, for instance, to adapt the loading phase. However, that strategy does not provide any gain in compactness. Constructive requirements consisting in increasing the exchange surfaces between packages and the geological environment (e.g., finned sleeve) were also explored. Those measures, which help reducing the surface flow, have a limited interest, because the gains they provide in terms of compactness are more or less compensated by the increase in cell-construction costs. The ventilation of the cells was also addressed, but was discarded at the current study stage, because preference was given to a passive heat-removal solution that requires no human maintenance. In the end, it is the spacing between packages and between disposal cells that plays the major role.

Quite obviously, some of the aspects mentioned above influence thermal sizing: design choices (nature of materials, diameter of sleeve, etc.) and a specific cell length require the thermal criterion to be verified.

Layout of the disposal module and of the disposal area

Defining the cell concept and the thermal sizing are necessary, but are not sufficient in order to develop an architectural scheme. After determining the diameter of the cells, their length, their spacing, the number of packages per cell, the next step is to design a consistent layout with requirements relating to long-term safety (minimisation of hydraulic flows in order to retard and to mitigate radionuclide migration towards the biosphere), to operational safety (minimisation of the risk of operating incidents, compliance with professional health and safety conditions) and to consistency with waste-package flows and worksite flows.

Technico-economic issues relating to architectural design are not negligible. All drifts being taken into account, the number and section involved constitute significant variables in the total cost of the repository (drifts represent 98% of the excavated volume of the HL-LL waste area), and those variables depend directly on the main requirements mentioned above.

Hence, the “dead-end” configuration of modules, as selected today for long-term safety-related reasons (minimisation of hydraulic flows, including in case of seal failures or external intrusions), leads to prescribe modules made up of at least three drifts, for instance, in order to ensure the safe evacuation of personnel in case of fire. Similarly, security considerations in case of fire require minimum distances between crosscuts, thus increasing the total length of the drifts and the number of intersections. However, intersections increase repository costs by introducing complexity in the building methods. A last example would be ventilation, since additional ducts or return airways are required. Consequently, a significant part of repository costs is governed by operational-safety requirements that do not have a direct link with the selected concept for the disposal cell.

The number of drifts and their section depend also on the flow of operating and worksite machinery. It was decided to separate nuclear operating flows from the construction-worksite flows. Such principle is based on two strategies: for intermodular spaces, there are two types of drifts, each one having its own function; in intramodular spaces, nuclear flows are only authorised after the final completion of the construction, thus imposing additional constraints on the schedule. With regard to sections, they are defined in relation to circulating clearance limits and crossing requirements.

A significant stake at the crossroad between operational safety and flow management concerns the definition of appropriate means to manage flows within those drifts. In that field, the search for an optimal technico-economic solution requires that the gains provided by a larger number of drifts or by drifts with wider cross-sections be assessed.

To the conservative design of the HL-LL waste area described in the *Dossier 2005* (see above) will follow an optimised design, which is currently under study. Examples of response to the challenges listed above include the number of connecting drifts, which may be reduced in each series from four to three, or even to two, and the length of access drifts, which may be increased from 600 to 800 m in each module. Both changes combined together would save approximately 5% of the civil-engineering costs of the HL-LL waste area [3].

DEMONSTRATIONS IN SUPPORT OF THE OPTIMSATION OF THE REPOSITORY DESIGN FOR HL-LL WASTE

Andra is currently studying various design options with a view to responding to the major stakes mentioned above. The study programme relies on several items, including a series of tests and demonstrators that are already under way or planned.

The difference between tests and demonstrators is based on the more or less fragmentary character of the tested component or process. The term “test” applies to very fragmented elements, whereas the term “demonstrator” is rather restricted to integrated assemblies. That semantic distinction, if need be, is made in the following paragraphs.

Tests and demonstrators relating to the disposal-cell design for HL-LL waste

The connection mode between the sleeve elements will need to be tested. If tightness is sought, welded connections would be tested (full-thickness connections in approximately 10 passes). Inversely, mechanical connections would be tested (e.g., threaded or clamped connections). Workshop tests are scheduled in 2011 or 2012.

Connections between sleeve sections must be completed by a closure at the end of the cell (bottom plate) and by a radiation-protection plug at the cell head. Current design studies will orient which types of test will be conducted. The bottom plate may be screwed (mechanical strength) and welded. The radiation-protection plug may be welded. Workshop tests are scheduled in 2010 or 2011.

The sizing of the sleeve is the subject of calculations and experimental verifications. Hence, plans call for the Underground Laboratory to carry out a thermal-elongation test on a tube inserted into the formation in order to quantify deformations and thermo-mechanical stresses induced by an increase in temperature.

The search for other materials than steel has already included various tests in 2008. Sleeve sections in granite were manufactured (Figure 2). Thanks to a method combining coring and wire-sawing, prototypes were built measuring slightly over 2 m in length, with an internal diameter of 620 mm and a thickness of 85 mm. Joints were also tested on mock-ups in order to find a suitable mechanical connection that would rely on a granite sleeve during excavation. Complementary tests are scheduled (strength tests). If Andra continues on that lead, more thorough demonstrations will be set up. More particularly, it would be appropriate to work on life-scale connections and to characterise the impermeability level of the granite sleeve.

Figure 2: Prototype of sleeve element made of granite

Lastly, the design of the HL-LL waste cell must integrate its own sealing mode. According to the *Dossier 2005,* the "temporary" sleeve at the cell head ought to have been replaced by a swelling-clay core and a concrete foundation over the new length of 8 to 10 m being exposed. Since 2005, calculations have shown that maintaining in place the "temporary" sleeve did not compromise the long-term safety of the repository. It is therefore proposed today to keep the sleeve at the cell head. Various tests will be carried out between 2010 and 2012 in order to validate that proposal. Tubing-spear tests and a full cell-sealing demonstrator are scheduled at the Underground Laboratory.

Excavation-related tests and demonstrators of a disposal cell for HL-LL waste

The excavation of HL-LL waste disposal cells will be the subject of demonstrators as early as 2009.

The first test campaign, scheduled in 2009, will seek to find a suitable method to excavate disposal cells measuring 20 m in length and a nominal diameter of about 700 mm. Various orientations in relation with lithostatic stresses will be tested. The implementation of the sleeve will be concomitant with excavation operations, or deferred, depending on the circumstances involved, in order to assess whether it is feasible or not to leave an excavation without support for a few hours in order to facilitate the excavation work and the installation of the bottom plate (which would then be assembled in a workshop on a sleeve section). Other tests phases beyond 2009 will gradually lead to the construction of a full demonstrator of a disposal cell for Hl-LL waste measuring 40 m in length. The excavation of a longer cell will be contemplated, if nominal cells prove successful.

Several excavation methods are currently being considered. The one to be tested in the Underground Laboratory consists of a motor-activated rotating cutterhead. Since the motor remains in the drift, the activity involves drilling and not microtunnelling. The muck is removed by a dry-process worm, which activates in turn its rotating movement to the cutterhead. Drilling is guided by a laser-type aiming device and the cutterhead is led by four hydraulic pads (Figure 3). The cutterhead is retractable through the sleeve thanks to the rotation of the external bits.

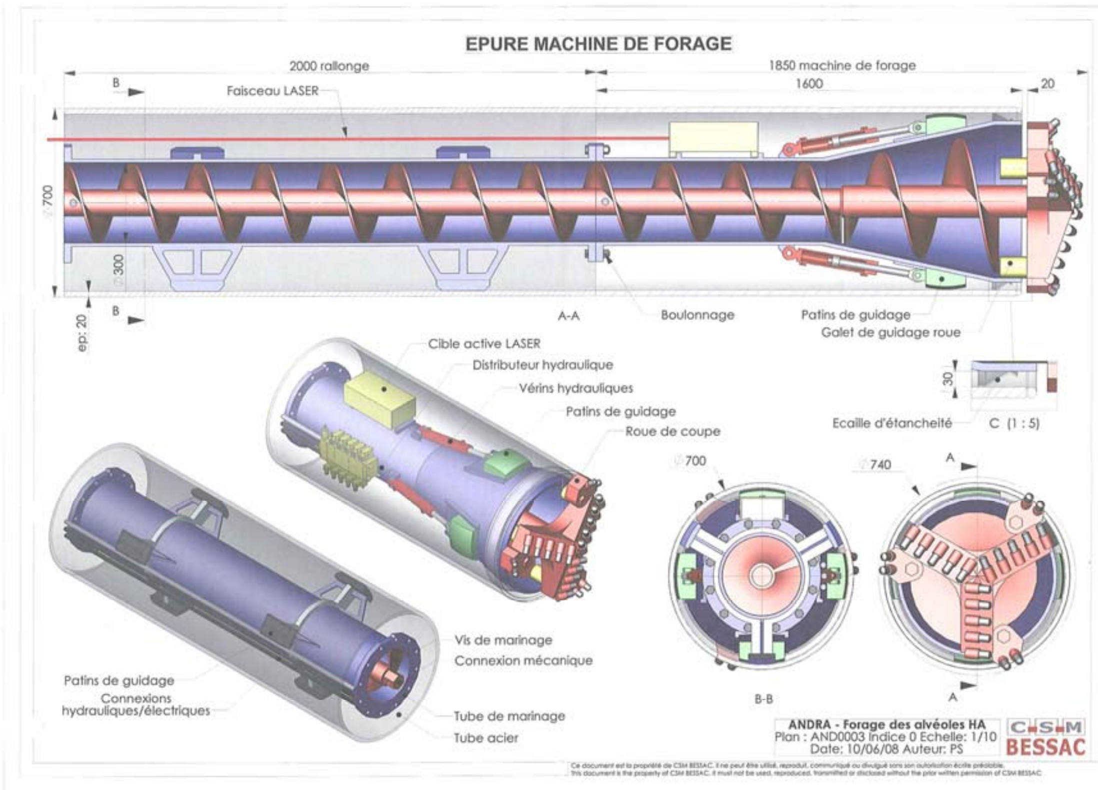

Figure 3: Drill-head principle for testing the excavation of disposal cells for HL-LL waste

Tests and demonstrators relating to the emplacement of HL-LL waste packages

The emplacement of disposal packages in the cell is the key activity in the process, and from that standpoint, it must be tested and demonstrated, especially in order to determine the length of the cell.

Andra is investigating two emplacement methods.

The first one consists in pushing the packages one by one, or by groups or two or three, down to the bottom of the cell.

A “pushing robot” prototype was designed and tested between 2003 and 2006 in the framework of the European Project on Engineering Studies and Demonstrations of Repository Design, otherwise known as ESDRED [4]. The process has proven feasible. The prototype robot progresses one step at a time and pushes forward a disposal package sliding on its ceramic pads. Fitted with two toric inflatable jacks, the robot is backed up by the sleeve when pushing the package weighing about 2 t. Three horizontal hydraulic cylinders allow the body of the robot to stretch and to retract by 500 mm as it advances in the sleeve. Air, oil and electricity are provided through umbilical cords. A metal cable ensures the retrieval of the robot in case of failure or the retrieval of packages once they are secured to the robot.

The feasibility of that prototype has led Andra to build a full demonstrator in 2007-08 (Figure 4). The demonstrator has the same functions and characteristics as the prototype. Improvements were introduced at the level of the robot (single umbilical cord, pneumatic motorisation). The demonstrator, which was assembled in a workshop, is adapted to the underground context and the exiguity of the drift. The shuttle carrying the disposal package, the shielded-door system in the cell head and the docking system between the former and the latter were also integrated in the demonstration with all simulated dynamic positioning and docking problems, as well as the main ultimate emergency solutions.

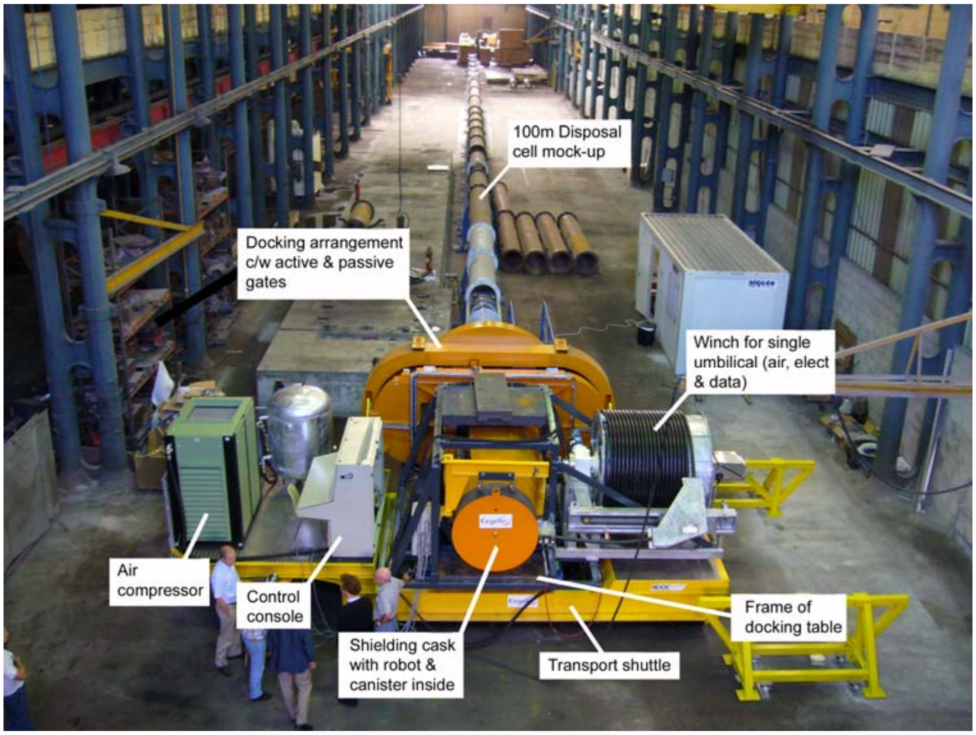

Figure 4: Demonstrator of pusher robot with docking shuttle

Results are satisfactory: packages were pushed one by one, then two by two, and finally three by three, at an average travel speed of 1 m/min inside a sleeve measuring 100 m in length. That distance allows Andra to contemplate extending disposal cells from a package-handling standpoint. The possibility to retrieve packages from the disposal cell was also demonstrated.

The second emplacement method consists into depositing them one by one at the cell head and to push the package string as it forms gradually. The advantage of the second method, which had not been investigated for the preparation of the *Dossier 2005,* resides in the fact that no engine is introduced in the cell. Time savings are also expected. The second mode is designated by the term "external system", although two external systems are actually intervening alternately in the process.

The first system pushes the package string in order to free an open space at the cell head. The thrust is provided by an electric jackscrew of about 150 t to be sized in relation to the number of packages to be pushed, and consequently, in relation to the length of the cell. The second system deposits the next package in the freed space thanks to a pushing chain with a capacity of a few tonnes. At the end of the process, the full package string is pushed over about 10 m in order to empty the cell head.

A pushing-chain prototype will be built in 2009 and tested in a workshop test bench measuring about 10 m in length. Ultimately, although an exact date has not been set yet, a full demonstrator will be constructed in order to address the interface issue with civil engineering. In fact, external-pushing systems exert a proportional reaction to the thrust. In the case of a full package string, the required reaction reaches significant values in the order of 30 to 150 t, depending on the number of packages being pushed. Consequently, it will be necessary to determine and to test anchoring points in the drift or on the sleeve head. The demonstration may ultimately involve also package retrieval.

Tests and demonstrators relating to the construction of the disposal area for HL-LL waste

It is not conceivable to cover the entire complexity of the HL-LL waste area with a single demonstrator. On the other hand, certain specific items are the subject of tests and demonstrations.

Hence, demonstrators are scheduled in order to characterise suitable design/construction methods for connecting drifts. Comparisons are made between drifts with “flexible” lining (shotcrete, bolts, supporting arches or compressible wedges) drifts with “rigid” lining (directly-poured concrete). Thanks to such drift demonstrators, the flows of heavy items are also at stake. In fact, a drift with a thick concrete lining increases the muck and concrete flows, since the excavated volume is larger than that of a drift with a thinner lining. The flow increases are reflected on the traffic of worksite machinery and, consequently, on conveying-track and ventilation requirements. Consequently, those demonstrators have an indirect influence on the design of the underground architecture. They will be built in the Underground Laboratory starting in 2010.

In the same line of thought, concrete-pumping tests may be conducted in order to confirm the feasibility of that process in the context of an underground repository. In fact, concrete pumping is contemplated today over the last two kilometres of the drift network leading towards the concreting worksite in order to reduce the traffic of concrete-mixer trucks. The number of connecting drifts per cluster is also at stake, since that methodology is not compatible with all concrete types and is not as flexible as road transport, although it has proven operational over kilometric distances. Such conditions call for more detailed studies, or even a demonstration, which, if confirmed, would need to be implemented over a longer term depending on the types of concrete being selected.

Lastly, various experiments designed to measure thermal characteristics were and will be conducted in the Underground Laboratory. Those tests consist in introducing a heat probe in the formation and to measure thermal propagation. Digital_formalisations are used to derive values on the thermal conductivity and specific heat of the argillites, while distinguishing any potential anisotropies. Those values are also used in the thermal sizing mentioned above.

CONCLUSION

The often-innovative character of underground repository projects leads to launching new technological tests and demonstrators, and Andra’s repository concept for the disposal of HL-LL waste is no exception. The tests and prototypes initiated in the framework of the feasibility study supporting the *Dossier 2005* are followed today by other indispensable demonstrations in order to respond to the major challenges raised by the concept.

Some of those demonstrations are in direct line with the prototypes of the *Dossier 2005*. Such is the case, for instance, of the “pusher robot” for emplacing waste packages in the disposal cell. Other demonstrations relate to new pathways with a view to integrating them in the creation-licence application to be submitted in 2015, with a variant involving the emplacement of packages by an ”external system” as a likely part of that category. Further demonstrations also relate to pathways that may be confirmed only later in the case of waste that will be accommodated within the repository well after its commissioning in 2025. The granite sleeve is currently considered as an example of the latter category.

For that demonstration programme, Andra is relying on a diversified international industrial network. For underground demonstrators, The Agency is using the Meuse/ Haute-Marne Underground Laboratory. Demonstrators being tested on the ground surface are presented in the Technological Centre, located close to the Laboratory.

Planning for such tests and demonstrators extends over several years. A large part of the effort will be provided until 2012 in order to nurture the public debate scheduled in 2013.

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