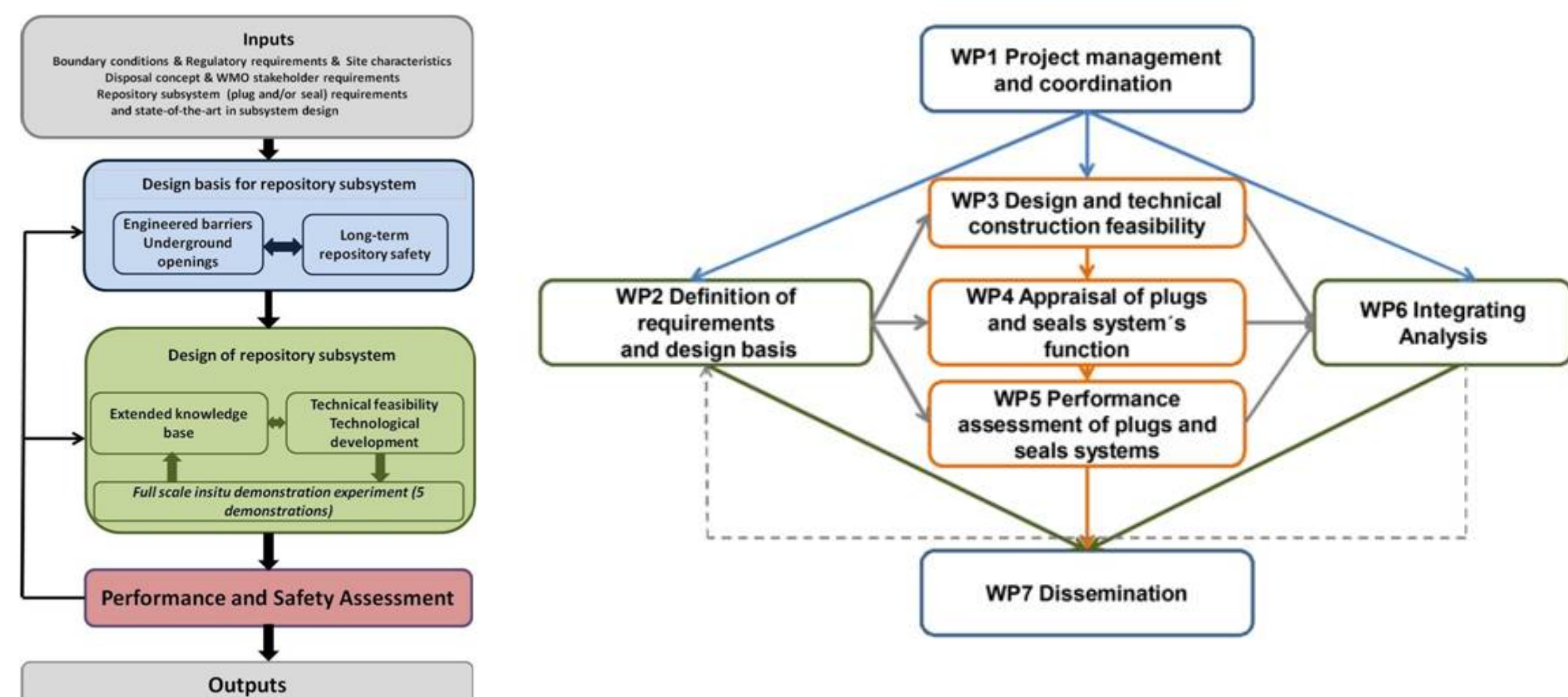


DOPAS is a four year (2012-2016) cooperative project, financially supported by the **European Union (EC)** within the frame of the 7th Framework Program for Nuclear Research and Training (**EURATOM**). Its coordinator is **POSIVA** (Finland) :

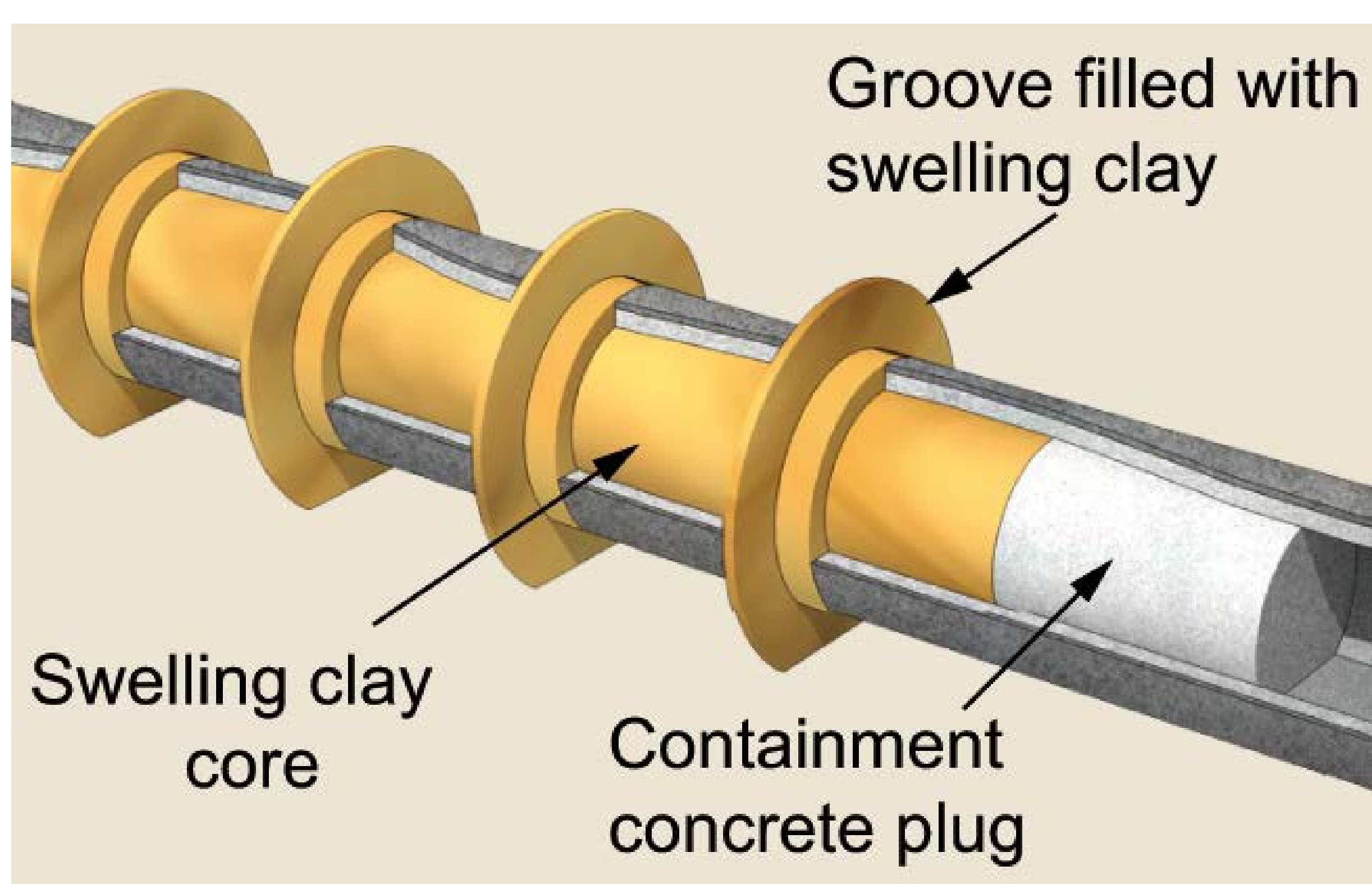


It involves **14** Partners coming from organizations responsible for implementing radioactive waste management in the EC & Switzerland, as well as from private companies or research institutes and universities with extensive experience in clayish / bentonitic & cementitious materials, modelling, instrumentations & risk analysis, monitoring, and stakeholder engagement. FSS is one of the **4** Full Scale Experiments carried out within DOPAS and is of concern for the French Deep Geological Repository (**DGR**) concept.

The successful implementation of a deep geological repository program for radioactive waste relies on a **sound long term safety strategy** and on a solid scientific and engineering basis as well as on social aspects such as stakeholders' acceptance.

The repository **closure** (by backfilling and **sealing**) policy is considered as instrumental in serving both technical and social objectives. It is not only essential to underpin the **long term safety strategy** and the quality of the associated engineering, but it is also an important tool of communication, contributing to the public confidence building in the repository long term behaviour.

## Drift Sealing Concepts in the French DGR

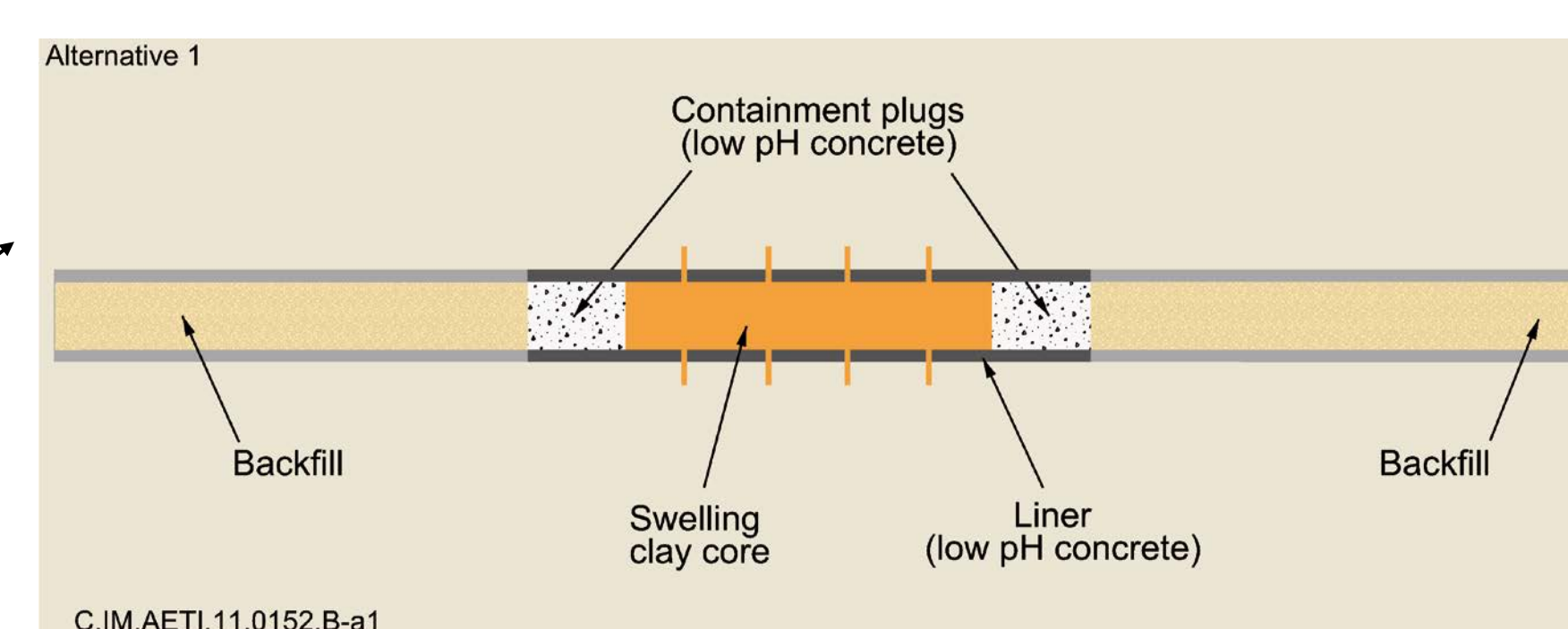
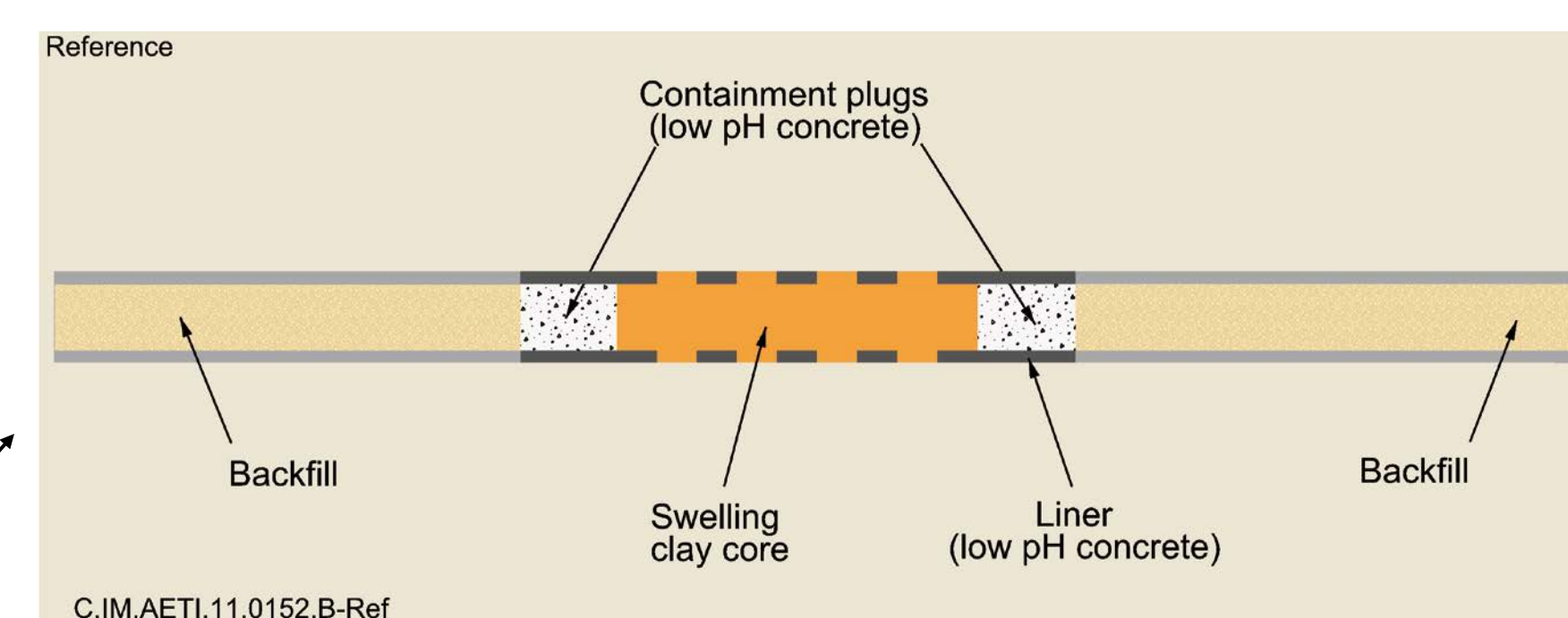


At time of DGR progressive closure, the sealing of horizontal drifts and disposal caverns must be assured by the construction of a specific barrier .

This seal is composed of a swelling clay core (bentonite) with 2 low pH concrete containment plugs, one at each end. The remaining part of the drift is backfilled with the original excavated material.

In the **reference** design, the seal is installed in a section of the drift where the concrete liner will have been partly dismantled, allowing a direct contact between the argillite formation and the bentonite core, whose swelling pressure should be as close as possible to 7 MPa.

In the **alternative** design, a thin groove is excavated at the extrados of the drift liner and filled with bentonite at direct contact with the argillites , providing an EDZ cut-off. The bentonite swelling pressure in the groove should be around 3 to 5 MPa.



## The FSS Experiment Objectives & Schedule

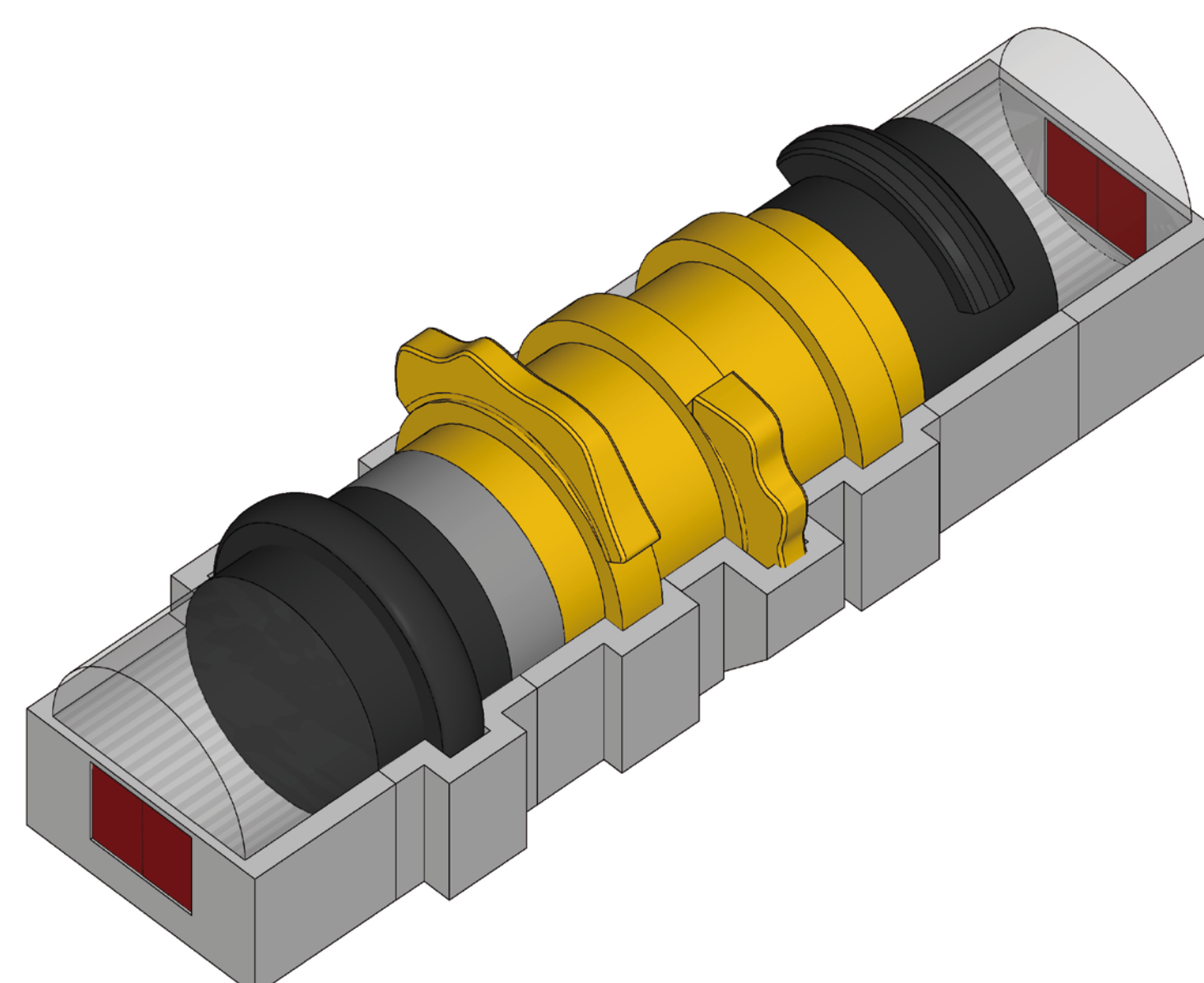
The FSS experiment conducted at Saint-Dizier, near the Bure Laboratory (URL) is a full scale construction test of the reference concept. It aims at:

- 1) Demonstrating the industrial capacity to satisfactorily emplace large volumes of low pH concrete (shotcrete & cast concrete). Low pH value is equal or less than 11,
- 2) Demonstrating the industrial capacity to satisfactorily emplace large volumes of swelling clay (bentonitic material) at a satisfactory specific gravity value,
- 3) Defining the operational constraints linked to emplacement activities and compatible with the mechanical or hydraulic properties allocated to the seal components,
- 4) Defining and operating the commissioning means necessary to check the compatibility of the work during emplacement operations,
- 5) Defining and operating the commissioning means necessary to check the compatibility of the work after emplacement operations,

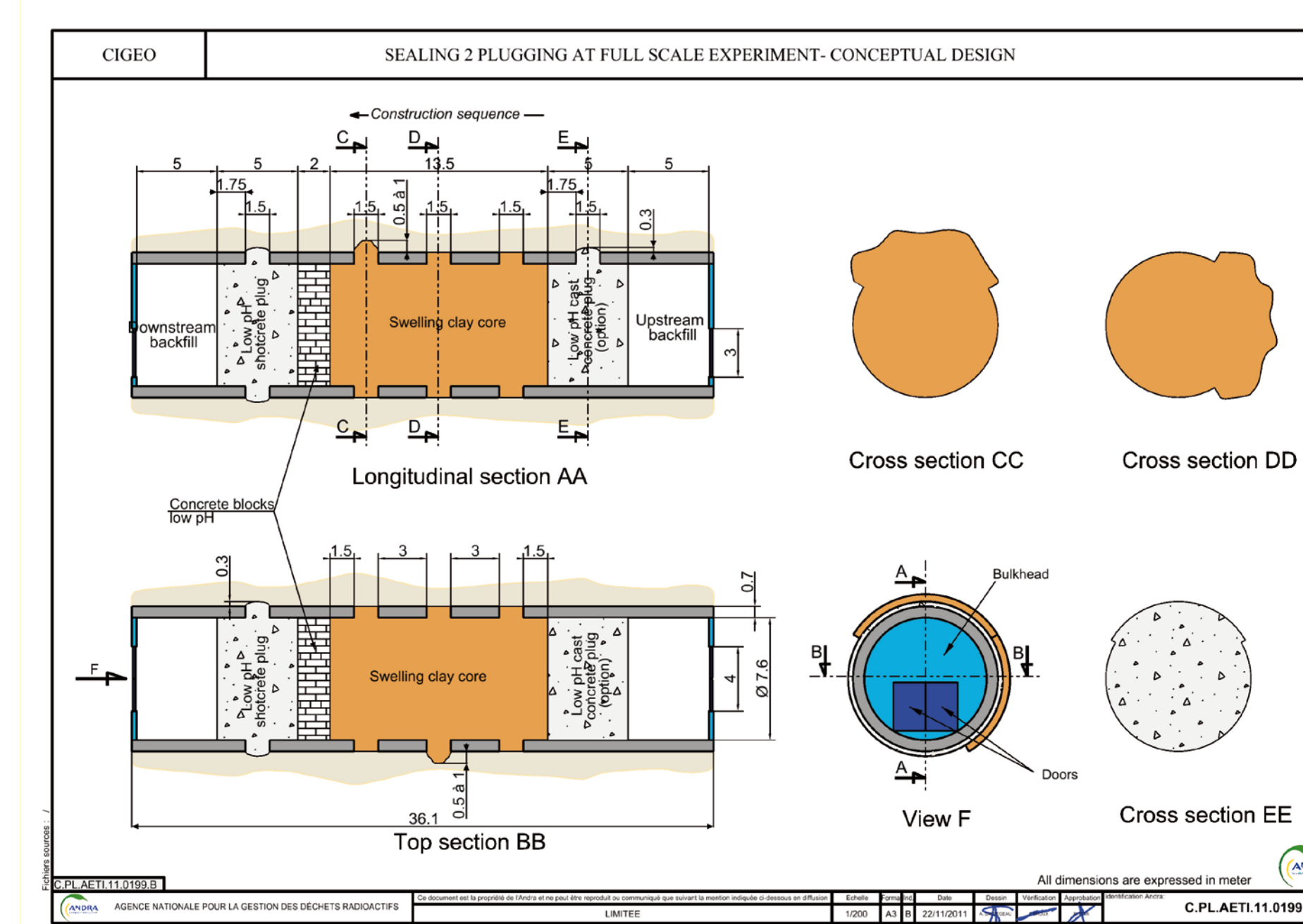
The FSS experiment is completed by a forced saturation test, which is conducted with the same swelling clay material at a lower scale (REM experiment, also carried out within the DOPAS Project). The main milestones are:

- 1) Studies, formulations & characterization of materials : end 2012-mid 2013,
- 2) Construction of seal components: mid 2013 – end 2013,
- 3) Commissioning : end 2013 – beginning 2014,
- 4) Dismantling – Report & communication: end 2015.

### 3D view of the FSS experiment in its box (drift model) with the breakouts (recesses) in the argillite formation



### Longitudinal section view of the FSS experiment



### The bentonite swelling core construction challenge:

- Some **750 m<sup>3</sup>** of pellets/powder admixture to be prepared, conveyed in DGR environmental conditions and emplaced so as to reach an effective density value as high as possible, with almost no residual vacuum in *summital* recesses. No segregation of pellets and powder is allowed. Height of core is up to 10 m with a natural slope of some 25-30 %.
- Observation windows will be positioned at relevant places on the test box frame, to check segregation, residual vacuum, subsidence, stability of slope.

The low pH concrete containment plug construction challenge: some **250 m<sup>3</sup>** for each plug (cast concrete and shotcrete), minimum cracking and shrinkage, limited curing temperature, minimum residual vacuum in summital recesses.

### The beginning of low pH concrete formulation conception:



- Extraction of the solution to be measured
- Continuous agitation of the solution
- Measure of pH value



The FSS test box (DGR drift model at scale 1)

### The beginning of bentonite admixture & filling conception:



In a first time the best possible arrangement of the pellets dropped in the box is looked after, and for that purpose the effective bentonite density in the cylinder box is measured with a scale.

Andra acknowledges the scientific support of NAGRA and the technical contribution of the consortium of companies in charge of implementing FSS : Eiffage TP, CEA-LECBA, Laviosa-MPC, SOLEXPARTS

The research leading to these results has received funding from the European Union's European Atomic Energy Community's (Euratom) Seventh Framework Programme FP7/2007-2013 under Grant Agreement no 323273 for the DOPAS project