DICCA SEMINARS

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Location: A7 (Villa Cambiaso)

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The design of the Finnishdeep geological repositoryfor spent nuclear fuel. Amultidisciplinary challengeinvolving civil, chemical andenvironmental engineering

Deep geological disposal is one of the options for managing the spent nuclear fuel generated in nuclear power plants in many countries. In Finland, the spent nuclear fuel is planned to be disposed in a geological repository based on the KBS-3 (kärnbränslesäkerhet in Swedish, nuclear fuel safety) method. This method involves the excavation of caverns in crystalline rock at 400-500 m depth for disposal of the spent nuclear fuel in metal canisters surrounded by compacted bentonite (buffer) in vertical deposition holes (KBS-3V design alternative) or in horizontal deposition holes or drifts (KBS-3H design alternative). It is a multi-barrier system based on the multi-barrier principle: Radioactive materials are contained in a number of mutually supportive release barriers that are as independent as possible, so that failure of one release barrier does not jeopardise the functioning of the isolation.

The design of a deep geological disposal involves different disciplines that must work together for assuring a safety facility. The knowledge of the geology of Finland was necessary for finding the best alternatives for the emplacement of the facility. Once the emplacement was decided, it was necessary to perform a deep geological characterization, including surveys, for assuring the stability of the emplacement. The hydrogeological characterization was also an important issue. The excavation of caverns is a classical civil engineering work. Manufacturing the canisters, made in cast iron, copper and steel, is a metallurgical issue. The caverns will be filled with expansive clays, that will swell when the groundwater flows to the tunnels and deposition holes. It will be necessary to prepare the clay manufacturing compacted blocks and granules followed by their laying at the repository. The long-term safety requires to study the behaviour of the barriers during the next 100 000 years. Due to the spent nuclear fuel generates heat, the simulations must consider the heat flow, so thermal (T), thermo-hydraulic (TH), thermo-hydro-chemical (THC) and thermo-hydro-mechanical (THM) simulations are carried out for predicting the behaviour of the barriers in front of different situations like the hydration and swelling pressure development, changes of the chemistry of the groundwater or shearing due to rock displacements. There are other issues considered, like the microbiological activity, related to the canister corrosion.

The simulation of the disposal is performed with computer codes. These codes have implemented constitutive models that require parameters. These parameters can be obtained from laboratory tests. The constitutive models should also be validated, and the validation can be done with laboratory tests but in larger scale (mock-up tests) or with "in situ" tests, that can be in full-scale. Finally, it is necessary to give a legal frame to this process. Although it is not a technical issue, it is very important and should be considered continuously.

Short bio:

Xavier Pintado is civil engineer for the Technical University of Catalonia and has earned his doctoral degree in swelling clays as part of the engineered barrier system in spent nuclear fuel repositories at the same university. He has worked in highways and railways construction in Spain and in projects related with urbanization and drainage systems at the city of Barcelona. During the last fourteen years, he has worked on the design and safety assessment of the spent nuclear fuel repository that is under construction in Olkiluoto, an island located on the west coast of Finland.

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