Development of an innovative corrosion monitoring methodology for the French radioactive waste disposal application

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The Industrial Centre for Geological Disposal (Cigéo[1]) is the French project for a deep disposal facility for radioactive waste. It is designed to dispose of high-level waste (HLW) and intermediate level long-lived radioactive waste (ILA-LL). The facility will operate for about a hundred years; time during which the integrity of the structure should be closely monitored and surveyed (i.e. reversibility period). For HLW, disposal cells consist of micro-tunnels (see Fig. 1). Cigéo's design is based on the use of proven materials, of which carbon steel materials play a vital role from a safety assessment point of view.

This concept involves multiple successive barriers: first, the vitrified radioactive waste (1) that is confined within a stainless-steel container (2). This “primary package” is overpacked with a carbon steel container (3). Secondly, this radioactive package is hosted in a dead-end micro tunnel constituted by a carbon steel casing (API 5L X65 grade) (4) surrounded by a layer of a cement grout (5) that is finally in contact with the geological Callovo-Oxfordian claystone (6).

On the other hand, SCCoDRa[2] (French acronym for “Monitoring of metallic components corrosion for radioactive waste disposal”) is a 4 year industrial project that focuses on the development of innovative corrosion monitoring tools for CIGEO, in order to detect and monitor the corrosion of the carbon steel casing of the micro-tunnels disposal for HLW facility.

SCCoDRa monitoring approach consists in gathering innovative technologies from the fields of NDT (Non-DestructiveTesting), electrochemistry and electrical drop-potential techniques.

The adopted approach of SCCoDRa project consists in a three step-program starting with the choice of dedicated monitoring techniques followed by the development of those techniques and finally the validation on reduced models. The specificity of the project relies on the ability to detect and monitor a wide range of corrosion mechanisms (uniform corrosion, pitting, crevice corrosion, SCC…) and kinetics over very long-time scale in a highly radioactive environment with high geometric limitations for sensors installation.

The first phase of the project achieved in the selection of techniques to constitute a complete monitoring system: Guide Waves Tomography (GWT), Acoustic Emission, electrochemical probes (Linear Polarization Resistances, Electrochemical Noise), Distributed Open circuit potential measurements and electrical resistances sensors. The coupling of such techniques should provide both qualitative and quantitative information of the two sides of the casing (external and internal) and considering the wide range of expected corrosion mechanisms during the reversibility period (100 years).

[1] Centre Industriel De Stockage Géologique

[2] Suivi et Contrôle de la Corrosion des composants métalliques pour le stockage des Déchets Radioactifs