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Ultrasonic method to keep the Continuity of Knowledge of spent nuclear fuel from the Encapsulation Plant to the Geological Repository

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Nowadays several countries are planning to store nuclear spent fuel in long-term geological repositories. The fuel will be preserved for thousands of years inserted in copper canisters with iron inserts. In Sweden, after the encapsulation of the fuel, canisters will be welded and transported to the geological repository for the deposition in tunnels. During transport, the Continuity of Knowledge (CoK) of spent fuel must be kept. An option could be the identification of canisters. Traditional tagging methods do not fit all the requirements foreseen in this application and then alternative ideas should be developed. The method proposed by the Joint Research Centre of the European Commission, in collaboration with the University of Florence (Italy), could guarantee not only a unique label for each canister but also security against falsification attempts. The idea is to combine two fingerprints: the first (artificial signature) related to a configuration of chamfers arranged around the lid circumference and the second (natural or intrinsic signature) due the variation of the internal gap between lid and tube after the welding process. The geometry and position of chamfers are designed to maximize the ultrasonic echo without affecting too much the canister structure and minimize the influence on the mechanical properties of the canisters. The ultrasonic amplitude response (identification fingerprint) acquired by a rotating high frequency (10 MHz) transducer with a fixed height is strictly related to chamfers disposition and then it is unique for each container. However, in order to verify the originality of canisters, the internal gap between lid and tube is investigated. The ultrasonic response due to the inspection of the welding area is a "natural"fingerprint (authentication fingerprint) for canister because it is connected to the welding process and material properties. The identification and authentication of fingerprints can be combined by angular matching to increase the robustness of the method. The description of the method and the development and testing of the ultrasonic reading system are reported in the paper.

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