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CORROSION INDUCED BY LOW-ENERGY RADIONUCLIDES

Modeling of Tritium and Its Radiolytic and Decay Products Formed in Nuclear Installations

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Chapter 4

STRATEGY FOR CONTROLLING CORROSION

First of all, the following question can be asked: why carry out corrosion tests?

Before answering this question, we must recognize that there are very few laboratories in the world that use highly concentrated tritium and tritiated water. Our laboratory is the only one in France. It is not a question of tritiated water traces present in light water, but the reverse. We do not work with light water as is the case in PWR or other nuclear reactors. No steel or super stainless alloy has been previously tested in this highly concentrated tritiated aqueous medium by anyone in France. By its nature, this medium is very reactive and its properties are completely different from the light water in nuclear power stations, which although it can be activated, contains much lower concentrations of radiolytic hydrogen peroxide, among other species, than in our closed storage units. In addition, we are not confronted with microbial corrosion as in the secondary circuits of PWR power stations. No living species could withstand the tritiated water concentrations we have. The behaviors and the types of corrosion of stainless steels or superalloys are thus completely different in our installations and no comparison is possible. After this digression, in answering the question, our corrosion tests, which are specific to tritium, must make it possible:

- to study the initiation and evolution of corrosion phenomena in the presence of tritium, concentrated tritiated water and radiolytic species,
- to select materials best adapted to the envisaged use in concentrated tritiated media,
- to know and understand their behavior in the various tritiated media,
- to monitor their corrosion resistance in a well-specified tritiated medium.

Finally, to reach the overall goal, the operator of a tritium gas and tritiated water nuclear processing installation, must, to ensure its correct operation and safety, apply a material and equipment maintenance and monitoring policy as well as an on-going survey of new materials for replacing corroded components. If he does not apply this policy and is satisfied with a simple monitored storage system, his installation will soon become obsolete with respect to those of other potential competitors in the tritium market for nuclear fusion. To avoid this, he must implement resources for monitoring and follow-up of the most highly stressed and defective components as well as for specialized examinations that can be directly applied to his installations. Various inspection methods have been extensively used to meet these requirements. These make possible: (1) analysis of tritiated water and tritium for its radiolytic species and impurities. This knowledge makes it possible to determine