DECONTAMINATION AND DISMANTLEMENT PLAN FOR INTERNATIONAL REVIEWING

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ПЛАН ПО ДЕЗАКТИВАЦИИ И ДЕМОНТАЖУ ДЛЯ МЕЖДУНАРОДНОЙ ИНСПЕКЦИИ

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When developing a decommissioning plan, several factors need to be included. First and foremost is the issue of outline and scope. Specific to the BN-350, are issues related to short term tasks required to support the safe storage of the reactor for the next 50 years, and long term tasks required to dismantle the reactor, leaving some sort of final state, (brown field, green field, etc.) In addition, issues such as personnel and physical safety as well as environmental concerns must be addressed to ensure the shut down and dismantlement of the reactor is done in a safe manner, both for personnel and the environment. In addition to being the base document in which to support work, a D&D plan can also be utilized to obtain financial resources necessary to complete the plan, as is the case for the BN-350 Reactor located in Aktau, Kazakhstan. By providing a clear and complete D&D plan, which includes costs and schedules for each item, it is anticipated that donor countries will have the ability to review, approve, and provide financial support to complete the work described in the plan.

Recently, a six-day workshop was held at the Kazakhstan Nuclear Technical Safety Center, in Almaty, Kazakhstan, to develop the beginning of a Decommissioning Plan for the BN-350. The decommissioning planning efforts performed thus far have attempted to resolve the issues of scope, format and content, as well as identifying personnel and environmental safety issues. The result of this workshop is a planning development guide that describes the overall document, format and content of each section. In addition, available information to complete each section, data gaps, and a method of closing the data gaps have been developed, resulting in a clear action for the authors of the decommissioning plan. This development guide is the basis of this paper.

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TURNING INTO CARBONATE THE RESIDUAL SODIUM LEFT IN BN-350 CIRCUITS MAY ALLEVIATE CONCERNS OVER THEIR LONG TERM SAFE CONFINEMENT

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РЕШЕНИЕ ПРОБЛЕМЫ БЕЗОПАСНОГО ХРАНЕНИЯ ОСТАТОЧНОГО НАТРИЯ В КОНТУРАХ БН-350 ПУТЕМ ПРЕВРАЩЕНИЯ ЕГО В КАРБОНАТ – ОПЫТ РАЗРАБОТКИ, ВЫПОЛНЕННЫЙ ДЛЯ ВЫВОДА ИЗ ЭКСПЛУАТАЦИИ СУПЕРФЕНИКСА

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After the coolant is drained from the reactor vessel and from the primary and secondary circuits of the BN-350 nuclear power plant, what sodium is left in ponds and films may amount to hundreds of kilograms. For the long term safe storage period which is to follow, preliminary safety analyses (e.g. derived from those made for French sodium cooled reactors) might show that the risks incurred through loss of leaktightness are significant.

The ingress of moisture into the circuits would generate, by reaction with the sodium, two undesirable products : sodium hydroxyde and hydrogene. Even when considering that water would enter the circuits progressively, so that the heat of the reaction does not give rise to over-pressure, two main risk factors remain.

- The behaviour of irradiated stainless steel in contact with solvated sodium hydroxyde over a 50 years time-span at temperatures which may reach 50°C is not perfectly known. Cracking cannot be ruled out, with ensuing leakage of radioactive chemicals from the primary circuit.
- As not only moisture, but also air ingresses, an oxygen - hydrogen mixture may accumulate for months or years, then explode at the most unfavourable circumstance, i.e. when operators, carrying out a monitoring or other task, bring very locally the temperature to inflammation value. The shock wave of this explosion is potentially devastating for the confinement.

In order to escape the high costs that would derive from the provision of a quality-complying monitoring of these risks and the associated preventive measures maintained over 50 years, research has been directed towards attaining a chemically inert state of the coolant residues, such that a degree of communication between the circuits and the environment might become acceptable.

The most promising solution to this challenge appears to be the carbonatation of the sodium residues, by progressive diffusion of an appropriate association of carbon dioxyde and water vapour through the inert gaseous medium which fills the circuits. The desired product is porous sodium hydrogenocarbonate.

Several tentatives have been made to this effect, with varied results. Tests carried out in the U.S.A. were reported to have led to the formation of a hard and impermeable crust over some sodium still in a metallic state. The accidental rupture of this crust, leading to the sudden contact of overlaying liquid with underlaying sodium would have unacceptable consequences. In France a full size experience was conducted on a drained sodium tank previously part of the Superphenix power plant. The carbonate took there a velvety form, which allowed the gaseous reactant to pass through easily and reach the sodium surface. No residual sodium was left. The carbonate could be readily removed with a vacuum cleaner. However the initial thickness of the sodium residues was not great : less than one centimeter.

Within the Superphenix decommissioning project, research is presently carried out by the Commissariat à l'Energie Atomique (CEA) to identify the parameters that influence the physical and chemical nature of the products obtained through carbonatation, as well as the celerity of the sodium layer thinning. The installation comprises several glove boxes where concentrations, temperatures, and gas flows are controlled; partial pressures, carbonate and sodium thicknesses are measured; the sodium is disposed in a large number of containers, so as to permit their periodical removal for analysis. Such effects as of container shape should also be assessed. Security is provided by constant hydrogen monitoring and the possibility to blow out the reactants if necessary.

A parallel modelisation is being fashioned by Electricité de France (EDF). Gas transfer at large and in the porosities is represented by a set of equations, taking into account the differing transport properties of carbone dioxyde, water vapour and hydrogen. Successive layers of reaction products may be considered. The modelisation comprises two essential parts, which address respectively the permeation propreties of the solid products and the convection / diffusion of the gasses. The influence of cristal hydratation should be assessed. Parameter values are drawn from early results obtained by CEA, and should allow in turn to orient the tests which are to follow, with increased efficiency as a likely outcome.

A final experience involving an intermediate size model with narrow spaces and other representative shapes, and reaction continued over a few months, should yield enough information for the mathematical model to project a realistic expectation of what the long term (over one year) injection of the proper gaseous mixture, at the right temperature, with the help of suitably arranged blowers, might bring about at Superphenix, an possibly at other sodium cooled reactors such as BN-350.

The residual sodium volume which is expected to remain after draining Superphenix' primary vessel is 6 metric tons, half of which is the film which covers the walls of the equipment, the other half in ponds up to 14 cm deep. Preliminary hypotheses made for safety assessments, considering that one or two centimeters of sodium would be carbonated, showed that, even with some sodium remaining in determined locations, the magnitude of the risks was significantly reduced.

However these hypotheses were not based on any scientific data. First tests made by the CEA showed a sodium layer 7 mm thick carbonated in one day and a half. Although convincing the Regulatory authority that the deepest sodium ponds are totally carbonated might prove impossible, which would likely force the operator to adopt some monitoring and mitigating provisions, these should be greatly reduced in comparison with the provisions required without prior carbonatation.

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