EDF PROGRAM FOR CLEANING OF PWR HIGH DOSIMETRIC NPP

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ABSTRACT

In 2002 EDF's PWR presented important disparities on their integrated dose results. In order to treat the PWR with highest dose per shutdown ratio, EDF/DPN (Nuclear Production Division) decided to develop an engineering project for "PWR high dosimetry cleaning". A specific financial support and staff resource is allocated to each reactors of this project. The project has already been applied on three reactors: Chinon B2 (2004), Flamanville 1 (2006), Gravelines 3 (2007) and is in progress for Bugey 2 (2008).

INTRODUCTION

During the power operation of a nuclear reactor, corrosion products from the primary circuit undergo activation through their circulation in the reactor core. These activated products can be integrated in the oxide layer that builds up during the power operation on the primary piping. Additionally, highly radioactive particles can fall by gravity to the bottom of the reactor vessel, these being highly mobile, they can be dispersed in the whole primary system by the water movement during the shutdown of the Unit. These particles will become hot spots when trapped in special features of the primary cooling circuit and its auxiliaries.

This contamination of the primary circuit leads to high dosimetry of the personnel during the maintenance of the Unit. To decrease the dose integrated during the maintenance operations, curative actions must be taken to eliminate hot spots and fixed contamination, as well as actions to prevent new contamination.

PROJECT DESCRIPTION

The project is based on a general approach characterized by a plan of action for each NPP including those preventive and curative actions. The organization of the project is assigned to CIDEN[1] which acts as an interface between NPP engineering staff and specialized engineering units. The objectives are to reduce and maintain as low dose rate exposure as possible.

Preventive and curative actions are based on the following items:

- technical training by national expert,
- good practices and advices in operation of reactor,
- radwastes,
- detection and measurement,
- modification of installation,
- decontamination operation.

For example, 21 actions are in progress for the treatment of Flamanville 1. Two interlocutors share the responsibility of each action: one from the NPP team, one from the engineering units. The whole interlocutors constitute the "cleaning team" of the reactor.

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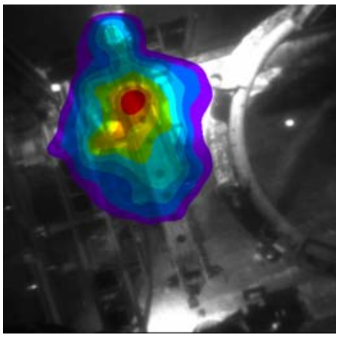
[1] Centre d'Ingénierie de Déconstruction et d'Environnement

EXAMPLES OF PREVENTIVE AND CURATIVE ACTIONS

- **Diagnostic of the pollution**

For each PWR concerned, the studies begin with a diagnostic of the origins of the contamination, the type of pollution, its form (mobile hot spots, oxide layers) and its localisation. Many types of measuring equipment are used to make a radiological diagnostic (portable gamma-ray spectroscopy, video cartography, and gamma camera system).

Video cartography



Gamma camera

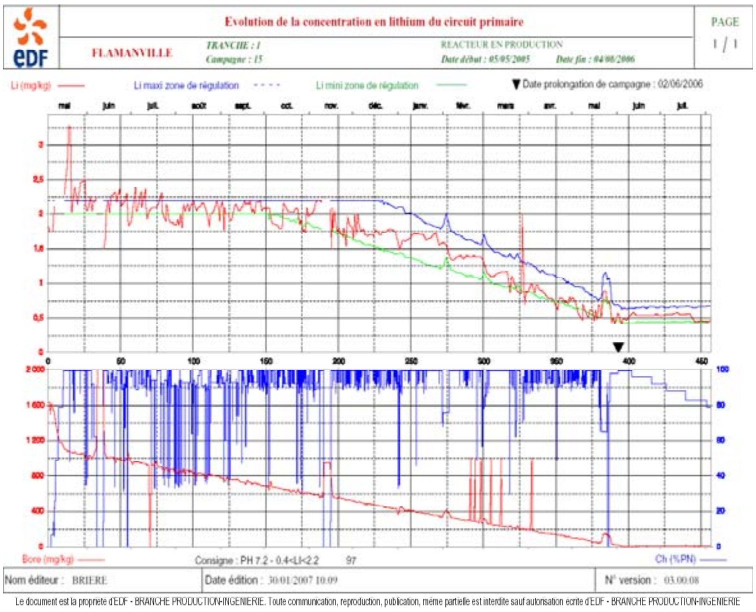
Gamma ray spectroscopy

- **A particular study of operation of reactor**

The aim of this study is to detect and prevent wrong practices in the exploitation of the reactor, especially during the period preceding the shutdown of the reactor:

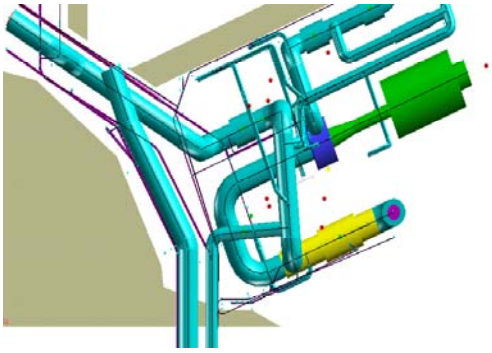
- Chemical control of primary system (respect of the Bore/Lithium coordination),
- Optimization of the purification period (longer purification period).

It's important to notice that good practices applied at one PWR can carried out to the other reactors of the NPP.



- **Estimation of the dose gain**

Experience in decontamination process associated to chemical knowledge, leads to a DF[2] per system for each decontamination scenario. Those DF are then used on a 3D local modelling in order to estimate DRRF [3] per area and a dose gain. This study allows finding out whether the operation is profitable or not. Those models are also used to optimise the design of biological protection.



3D modelling

- **Decontamination process**

As a result at this diagnostic of the pollution, a mechanical or chemical process optimised for the decontamination is chosen. The main operations are:

Emmac chemical process

➢ <u>Chemical decontamination</u>

The target of this decontamination is the RHRS and CVCS, specially the heat exchangers and the associated valves. A large amount of the fixed activity is displaced, in one loop, during a liquid circulation of an oxydo-reduction solution ("Emmac[4]" process).

Perch for under water cleaning

➢ <u>Pools' decontamination</u>

Hot spots and surface contamination often leads to a high dose rate exposure in nuclear pools. Divers can work underwater on the decontamination of those areas. Special perch can also be designed for under water cleaning, and cerium gel or decontamination foam can be used for dry cleaning.

➢ <u>Tanks' decontamination</u>

These decontaminations are targeted on vent and drain system and liquid waste treatment system tanks. Liquid circulation can be held if the dose rate exposure is too high, and then mechanical process such as high-pressure cleaning are used directly in the tank.

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[2] Decontamination factor
[3] Dose rate reduction factor
[4] EDF oxydo-reduction process qualified for use in nuclear systems

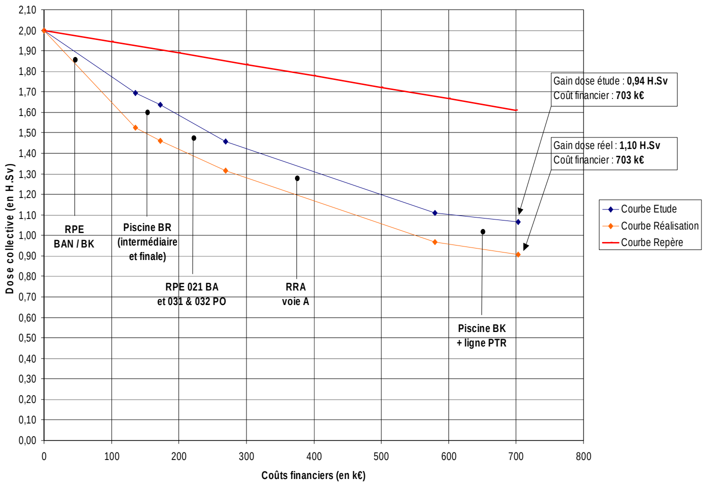
The operations of decontamination are executed during the intended shutdown, with no impact on the critical path of the shutdown. A great importance is also given to the analysis of the decontamination and to maintaining the level of cleanliness during the five years following the intervention. All those elements are added to a global decontamination experience that is the basis of the incoming decontamination (such as systems targeted, optimised process and duration).

RESULTS AND PROSPECTS

The average dose gain is estimated to 1 H.mSv per reactor treated for the five following years. No gain can be estimated for preventive action but, after the planned shutdown, dose decreases in the whole reactor and not only in the areas concerned by decontamination actions. It shows that "good practices" are well integrated.

For curative action, a cost/profit analysis is established first to prove the interest of each operation face to a reference curve, then to confirm the results after the aimed shutdown.

After the operations that will be held in Bugey in October 2008 (RHRS/CVCS chemical decontamination and VDS principal tank decontamination) the project will enter a new phase. As the results are good in terms of dose reduction, optimization of cost, and communication on NPP, EDF's wishes to continue this project with a wider scope.



Indeed the way of proceeding is more and more precise (decontamination targets and associated process) and the most problematic reactors have been treated. Now the objective is to move from specific actions for problematic reactors to a more generic approach:

- decontamination of specific systems in many reactors each year (for curative actions),
- larger studies and communication of "good practices and advices" (for preventive actions).