RADIOLOGICAL CHARACTERIZATION OF V1 NPP TECHNOLOGICAL SYSTEMS AND BUILDINGS - ACTIVATION

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INTRODUCTION

V1 NPP at Jaslovske Bohunice site has been finally shutdown after 28 years of successful operation in 2006 (Unit 1) and 2008 (Unit 2). At present, both units (WWER type reactor 440/230) are finally shutdown and since July 2011 under decommissioning license. The preparation of V1 NPP decommissioning has been supported and partly financed by the Bohunice International Decommissioning Support Fund (BIDSF), under the administration of the European Bank for Reconstruction and Development. From 06/2008 to 12/2011 AMEC Nuclear Slovakia, together with partners STM Power and EWN GmbH, carried out BIDSF B6.4 project - Decommissioning database development (DDB).

B6.4 PROJECT CHARACTERIZATION

The main purpose of the B6.4 project was to develop a physical and radiological inventory database to support V1 NPP decommissioning process planning and performance. The following key project tasks have been established:

1. DDB design
2. Historical site assessment
3. Documentation review and site survey resulted to Physical inventory
4. Measurement and sampling resulted to:
    - Hazardous material inventory
    - Radiological inventory including contamination and activation

AMEC Nuclear Slovakia was mainly responsible for DDB design, planning documents for physical and radiological characterization, implementation of physical inventory within the plant's controlled area, radiological site survey including sampling and analyses and at last characterization of activated equipment and civil structures based on measurement, sampling and analyses. In the sections below, a methodology, measurements techniques and summarized results from radiological characterization of activated components are described in detail.

RADIOLOGICAL CHARACTERIZATION OF ACTIVATED EQUIPMENT AND CIVIL STRUCTURES

One of the specific deliverable tasks within the B6.4 project was the characterization of activated equipment and civil structures based on measurement, sampling and analyses performed on the samples. The scope of this specific deliverable task consisted of:

1. Categorization of activated components
2. Development of single working programs for their radiological monitoring and sampling
3. Preparation of sampling device and revision of all handling equipment
4. Dose rate monitoring and sampling of:
    - Civil structures from reactor shaft on both units – stainless steel cladding, standard & baryte concrete

- Reactor internal components placed in V1 NPP HLW storage, (so called „Mogilnik“) - connection rods, absorbers of control rod assemblies and neutron flux measurement channels
- Reactor pressure vessel and shielding assemblies at both units of V1 NPP, reactor internals from Unit 2 of V1 NPP
- Storage grids of spent fuel cooling pond

5. Analysis of samples
6. Determination of radiological inventory including activity values (Bq), radionuclide vectors and dose rates
7. Import of radiological data for activated components into DDB

During sampling, mainly remotely controlled sampling device and radiation resistant camera with LED lightening for visual checking of all performed activities was used. Subsequently gammaspectrometry and hard-to-detect analyses have been applied to samples.

Sampling of activated civil structures from reactors shaft on both V1 NPP units

Before the sampling process itself, the working program for concrete sampling using manual core drilling device or standard drilling with sample suction was prepared. This program defined also sampling points necessary for successful characterization of reactor shafts concrete activation level at both units. Samples were fragmented to thin discs with aim to define activation level in dependence on depth. Totally 8 boreholes were done in both reactors shafts, approximately 100 samples were prepared from steel lining, concrete, reinforcement and baryte concrete.

Sampling and monitoring of activated components placed in V1 NPP HLW storage (Mogilnik)

Prior to sampling of selected activated components placed in V1 NPP HLW storage, the categorization of connection rods, absorbers of control rod assemblies and neutron flux measurement channels used throughout the operational history was carried out. The basic parameter for grouping of more than 700 components placed in the storage was their position within the core and duration of their use inside the reactor. For sampling of activated components stored in HLW storage itself, a remotely controlled sampling device with drilling head on linear guideway and with sample suction into sample carrousel was used. There have been 80 samples taken in total in the form of swarfs from 40 selected connection rods, absorbers and KNI channels stored in V1 NPP HLW storage. Dose rate during monitoring along the height of component reached in some cases the level of 30 Sv/h at sampling spot. Considering dose rate values measured during monitoring of activated components along their height whereas the measured values range in several order of magnitudes, it was decided to categorize individual components not as the whole ones but in parts.

Sampling and monitoring of reactor and its internals

The following components have been chosen as the subject of sampling and monitoring:

1. Internals of RPV, Unit 2: Protective tube unit, Core basket, Reactor cavity
2. Selected shielding assemblies, both units
3. RPV itself: Basic material sampled from outer side in reactor shafts – bottom part, Unit 1, 2; Internal cladding of RPV, Unit 2

Two kinds of sampling equipment were used during sampling:

1. Manual drilling equipment with sample capture used for sampling of basic material of RPV from the outer side of vessel for both units
2. Remote control sampling equipment (the same one as for HLW storage sampling) used for sampling from RPV internals, RPV internal cladding material and shielding assemblies.

There have been 34 samples taken in total in the form of swarfs, whereas depth of sampling ranged from 2 to 5 mm. Dose rate monitoring along the height of component reached in case of shielding assemblies the level of 500 Sv/h at 10 cm distance on air.

Sampling of storage grids of spent fuel cooling pond

In addition to all the above reactor sampling, three samples in total from storage grids of spent fuel cooling pond at V-1 NPP, unit 1 were taken manually using drilling equipment with sample capture. An average dose rate did not exceed the level of 350 μSv/h. The laboratory analysis on the samples confirmed the activation.

ACTIVATION RESULTS

In total, 125 samples have been taken from all activated components. As a result, totally 19 different radionuclides vectors have been specified for all activated components from both V1 NPP units. The list of analyzed radionuclides is in accordance with requirements for near surface repository at Mochovce site. Based on radionuclide vectors, the radiological inventory including all radiological parameters for all activated components has been determined. Total inventory of V1 NPP activated components determined on due date 30.9.2011 represents the value of 2,61E+17 Bq.
For future handling with activated components it is necessary to take into consideration also surface contamination by radioactive media. Level of contamination is negligible comparing with activation but it can cause radioactive aerosols production during manipulation.
Finally, obtained unique data on activated components are represented by 1118 DDB items with 45000 parameters. These data have been imported into database developed within B6.4 project.

CONCLUSION

The scope and level of detail of the data were in compliance with MARSSIM methodology for preliminary radiological characterization of V1 NPP activation. All the works on activation inventory were carried out from 04/2011 to 12/2011. The main reason for performing measurement and sampling on activated components resulted from inaccessibility of historical experimental data from the activation. Therefore, radiation survey for Unit 2 reactor internals, RPV basic material on both units as well as selected shielding assemblies for both units and storage grids of spent fuel storage pool, Unit 1 of V1 NPP was implemented and successfully finalized.