EDF GENERAL METHODOLOGY TO ASSESS WORKER EXPOSITION AND ENVIRONMENTAL IMPACT CAUSED BY WORK DURING DISMANTLING - LACK OF KNOWLEDGE AND TRACKS TO IMPROVE IT

AN OPERATION TYPE: THE CASE OF BUGEY 1

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1. Introduction

The EDF dismantling activity represent an important topic for EDF. This presentation develop the methodology used to assess worker radiation protection.
This methodology is elaborate to assess worker exposition and environmental impact caused by work during dismantling.
Otherwise, we identify lake of knowledge in some topics and a few tracks are studies to improve it.

2. Decommissioning at EDF

In 2009, 9 EDF units are under decommissioning (see Figure 1).

- One pressurized water reactor (PWR): Chooz A (300 MWe) in operation between 1967 and 1991. The particularity of the unit is that it was built in a cavern, which acted as a natural containment building.
- One heavy water reactor (HWR): Brennilis (70 MWe) in operation between 1967 and 1985.
- Six graphite gas cooled reactors (GCR):
    - Chinon A1 (70 MWe) in operation between 1963 and 1973,
    - Chinon A2 (200 MWe) in operation between 1965 and 1985,
    - Chinon A3 (480 MWe) in operation between 1966 and 1990,
    - Saint-Laurent A1 (480 MWe) in operation between 1969 and 1990,
    - Saint-Laurent A2 (515 MWe) in operation between 1971 and 1992,
    - Bugey 1 (540 MWe) in operation between 1972 and 1994.
- One fast breeder reactor (FBR): Creys-Malville (1240 MWe) in operation between 1986 and 1997.

Figure 1. EDF units under decommissioning in 2009

3. Specificities of dismantling activities

Dismantling activities present specificities in comparison with activities during reactor operation and outages:
- Lack of feedback experience: most of the time, dismantling activities are new or even unique tasks, for which there is no feedback experience, while most of the outage activities are performed every year in each unit.
- Difficulties to accurately evaluate radiological conditions for dismantling activities, in particular due to:
    - The lack of knowledge about the history of reactor operation,
    - The impossibility to perform direct measurements on the field or because only old radiological maps, not adapted to the work to be performed, are available,
    - The constant evolution of the source term: the decrease of the source term during the work following the removal of equipments or because of radioactive decay,
    - The changing of doses rates in radioactive waste storage.
    - The dose rate is important near equipment close to the core.
- Difficulties to accurately evaluate the exposed workload, in particular for tasks, which last months or even years.
- Waste management: many waste of different natures and types (VLLW, LLW, ILW), in particular waste that are not present during reactor operation, must be managed.
- The evolution of the installation configuration during the works make important "worker safety" problem.
- The problem of contamination induce by thermal cutting.
- The problem of discharge, in particular for public enquiries.
- The choice of partial or total release of the sites.

These specificities induce that the approach for preparing dismantling jobs should slightly differ from the preparation of routine jobs. For instance, in some cases, criteria used during outage to evaluate radiological stakes of activities are not adapted to dismantling activities.

4. Development of dismantling scenarios

The choice of reference scenario is made in several steps (combination of ideas, pre design, detailed design) taking into account all the industrial actors involved in decommissioning activities
Ultimately, leading to:
- the files in order to obtain the dismantling authorization decree from public power
- in support of that: a safety report and support studies

A multi-industrial team supports the development of the scenario (civil engineering, waste, decommissioning technology, radiation protection, safety, security, environment, etc.).
For the ENVIRONMENT, the choice can be oriented according to environmental requirements, notably filtration. In general, the constraints are proportional to those of the radioprotection but are weaker (for example in case of thermal cutting of activated structures).

For the WASTE, the choice of cutting types is important. We have three main analyze :
- Absolute requirement to limit cutting:
    - Less releases,
    - Fewer doses,
    - Less wastes generated,
    - Less road/rail transports,
    - Lower costs

In all cases, prefer one piece removal (case of Vessel, Steam Generator, etc)
- Only envisage cutting if this is obligatory.

For Radioprotection, we analyze :
- the significant parameters that influence design choices
- the studies include, among others:
    - a detailed analysis of working conditions,
    - a detailed doses study reliable to the scenario.It is note that the estimate dose (EDP) is in direct interaction with the scenario that is the object of review if the dosimetry associated with some operations is not judged acceptable. We also analyze the radioprotection consequences in case of an incident and/or accident.

We identify the need for a lock-out period between the choice of scenarios and the reliable issues, which are :
- The doses at working places,
- The environmental impact studies,
- The waste studies.

If one of these issues is unacceptable, the scenarios will need to be reconsidered.
For the environment "issue", we need to make the impact study which is linked with :
- Source term released to the environment,
- Impact on water, on air.

This term is similar to the impact assessments issued for the operating units and will not be developed here (same methodology, same tools, same references)
In general, for EDF's operating units, the impact is low and in the case of "mixed" sites (ie operating unit and dismantling unit):

The Impact of the dismantling unit is less than the Impact of the operating unit.

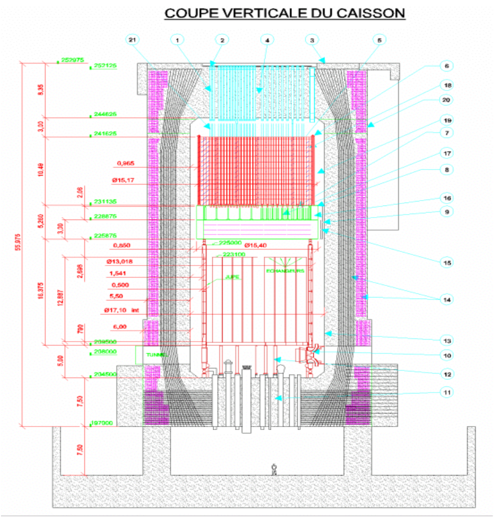
The source term released into the environment depends on :
- the planning of the operations,
- the radiological inventory :
    - coming from activation due to the neutron flow
    - coming from contamination by corrosion products
- The release into the "intra muros" (water and air) vectors is calculated by a cascade of factors correlated to the choice of cutting types (MDM, AWJ, mechanical cutting, plasma, etc.)
- The releases in the environment are a function of the type of filtration in operation.

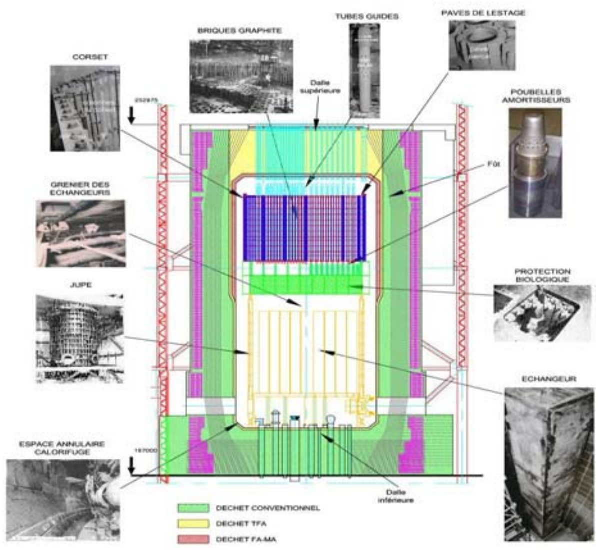
For the Radioprotection "issue", we need to make an estimation of doses at working places :- Forecasting the linking of dismantling operations
    - Data arising from planning of operations (number of participants, protective equipment, complexity of work, etc.)

- Knowledge of the source term and dose rates (conditions of work)
    - Source term: characterization by sampling, measurement, knowledge of the history of the installation, code simulations (neutrons and activation calculations)
    - Iterations of calculations (with samplings measurements results) are necessary to take into account impurities generating significant activities if they are unknown at the time of the supply.
    - Dose rates and zoning are defined on mapping completed with situ studies and by simulation thanks to the structures activation data.
- Internal contamination and exposure
    - All attentions are given in order to get internal doses which must be considered as negligeable in EDF sites
    - the internal doses are not taken into account in the working studies- Levels of contamination measured on-site: they are estimated on future sites and based on coefficients of resuspension specific to the types of work undertaken.

We use the PANTHERE code to evaluate the planned dose rates which are estimated in the framework of the scenario studies with variable installation configurations that no longer correspond to the initial state :
    - to support the technical choices - to define a reference scenario
    - and evaluate the working dose rates.

It is use to establish the scheme zoning of the affected areas during the decommissioning.**Example of BNI N° 45: Bugey-1**The schema show the internal structure of the plant and the PANTHERE model.





Dismantling scenario and principles for Bugey 1- <u>Underwater dismantling of internal equipment</u>
- <u>Opening of the upper slab</u>
- <u>Top-down dismantling</u>
    - Biological protection of operators via a screen of water
    - Teleoperation close up
    - Technical flexibility (management of uncertainties)
    - Industrial feasibility (Fort St Vrain Feed Back)
    - Use of thermal tools and several workstations

<u>The five main steps of the dismantling are :</u>1.Dismantling structures outside the 'caisson'
2.Extraction of operational waste
3.Dismantling of the caisson
    - Preliminary operations
    - Opening of the BTS
    - Dismantling of upper internal equipment
    - Cutting of the activated civil structures
    - Lowering of the platform
    - Dismantling of the plates and support area
    - Total discharge of the caisson
    - Dismantling of lower internal equipment
    - Treatment of the lower part of the shaft
4.Decontamination
5.Remediation of the site
RP calculations – input data – source term The Main characteristics of the sources are :
- Already discharged uranium fuel.
- Most activated areas: stainless steel structures located close to the core
- Main radio-element: ^{60}Co from the neutron activation by filiation of the ^{59}Co and ^{58}Fe present in the steel structures
- Only the activated structures are modeled – the contamination is not taken into account (distribution is too heterogeneous)

The Reported sources for the calculations are :
- Complex and detailed spatial distribution of the sources

- The majority of the source term is based on CEA/SERMA calculations:
The mapping of the flows in the reactor with the help of the TRIPOLI.3 code (future TRIPOLI.4)
The Calculation of the activations with the help of the code system DARWIN/PEPIN.2 :
- Certain sources have been recalculated analytically on the basis of base equations of the neutron activation (so as to adjust the impurity rates to the re-estimated values).We evaluate the radiological state of the caisson in 2010The estimated values of tThe values are based on measures taken on location (concrete boring, probes, sampling, entries into the caisson) and calculated with PANTHERE code.
The scheme show the methodology to discharge and cutting of the ‘caisson’ activated civil structures.

The main radioprotection results for Bugey 1 are :A collective dose estimated to 2.2 h.Sv
The main part of the doses are :
- for waste 20 %
- for heat exchangeur 14 %
- for work place erection 10 %

For the radioactive releases, we have an annual activities releases for gaseous and liquid radioactive waste for :
•Tritium
•Carbon 14
•Other products of β/γ transmitter fission and activation
5. Some lines of thought for the future
The radiological inventory is the “Keystone” of the dismantlingWe need to improve few topics1.Calculations
In particular:
- Long-distance flow of neutrons (“biasing” method with cooperation of CEA)
- Quantification of uncertainties
- Quantification of radiation source by ‘reverse calculation’ from the mesurated doses .
- Development of “REMCO” software to quantify the radionuclides transfers on several substrates as steel, concrete, bore carbure (partnership with Ecole des Mines and CNRS)
2.Measures for consolidating the calculations:
•Work closely with the calculator
•Definition of a range of equipment
From the more traditional (Gamma camera, CZT spectroscopy, ISOCS (soils, GC), Traditional core boring)
To the more recent (US “TRUPRO” core boring - US Feed Back, surface measurements in order to replace core boring -CEA, Kourtchatov, EDF/R&D, Tritium measures in the soil via vapor injection - EPRI/USA, Soil excavation ‘SGS system’ -issued from DOE studies).
3.Growth of Feed Back US (10 sites, 10 commercial reactors dismantling)
The Main lessons are :
- Importance of monobloc discharge (Safety, Authority and ANDRA to be trained)
- Choice of cutting techniques (importance of mechanical choice and choice of AWJ, MDM)
- Importance of prototype tests at a good scale (not only tool tests) and moke-up
- Water treatment, purification rate of flow,
- Management of soils and ground waters (4 sites have been or are in the process of being released as “green field” sites)
4.Some additional pieces of information are necessary :
- on Inhalation risk : Importance of optimized approach about inhalation?
- on Definition of detailled studies of alpha on type working posts : E.g. at Saint-Laurent, drawing inspiration from what has been done for the operating units with EDF/R&D :
•Resuspension factors
•Size of aerosols
•Solubility…- on Decontamination of concrete:
•Technical alternatives in order to reduce of RP constraints (less trying work)
•Use of air sensors

- Alpha working places

6. conclusion

One of the main problems for dismantling activities is the lack of feedback experience and each site is different and need specific studies with a general methodology.