



Designer / Operator work program for the radiation protection design of EPR2

Sébastien POIRRIER, Matthieu LONGEOT (Edvance)

ISOE European symposium
4 June 2024

PROJECT'ED

Summary

I. Introduction

II. Designer / Operator work program for RP at design stage

III. OPEX and lessons learned to inform decisions for an ALARA design

IV. On-site technical workshops

V. Capitalization of EPR NPP OPEX

VI. Conclusion and perspectives

I. Introduction

Scope:

- Design phase of EDF New Build projects (EPR, EPR2, EPR1200, Nuward)
- **Edvance** (an EDF and Framatome subsidiary): entity in charge of the **EPCC** (Engineering, Procurement, Construction and Commissioning) **of nuclear islands** for EDF New Build projects

EPR2 project:

- **3 twin units** in France on existing NPP sites (Penly, Gravelines, Bugey) + option for 8 additional units
- **Optimization of design and construction** using experience from EPR projects (Flamanville 3, ...), keeping the same high safety performance as EPR
- **Standardization** of components, systems engineering (**PLM**) and **digitalization** (3D/4D mock-ups)
- Same RP objectives as EPR: collective dose objective of **0.35 person.Sv/y/unit averaged over 10 years, EVEREST mode** (“entry in blue” in clean zones of the controlled area)

see presentation at ISOE International symposium (Tours, 2022) for more details

Objective of the presentation:

Present the designer / operator work program initiated for EPR2, with illustrative examples of application

- **Context**: the EPR2 RP design work applies the **EDF RP design referential** (requirements, recommendations, ...)
- **Principles**: **Develop and strengthen interactions** between the RP design teams and the operator
- **Outcome**: **Global improvement of plant design** accounting for future activities during plant operating life

II. Designer / Operator work program for RP at design stage

II.1. Context and objectives of the work program

Efficient **interfaces between design stakeholders** are a strong basis for a successful design work, **but is it sufficient?**

Experience and lessons learned from previous EPR projects => **Operators' involvement** as early as possible in the design have **very positive impacts**:

- Facilitating the design progress – *e.g. definition of **clear objectives**, recommendations and best practices*
- Giving advice based on their experience, avoiding re-work – *e.g. design changes of building arrangement, civil works, system design*

Objective of the operators' involvement: To ensure that the design allows the future performance of activities on the plant under similar or improved conditions compared to operating plants – *e.g. accessibility to a room or a system component*

The **advantage** of this program is also for the operators who will start and run the plant:

- To get familiar with the plant during design and construction,
- To contribute to the design and to learn more about the history of design choices.

II.2. The Operator: essential actor to share OPEX and participate in the design

Work program is shaped to feed the RP design activities with operating experience (OPEX) from the French fleet and to facilitate the availability of key stakeholders.

Besides getting OPEX, the **main goals** of the work program are:

- **To facilitate the collection of operating experience and feedback from operating NPPs for RP design activities**
 - To support the decision-making process in design phases – *optimization, best practices, etc.*,
 - To serve as input data – *e.g. dose rate measurements, radiation shielding solutions* – for design studies such as radiation exposure assessments,
 - To allow comparisons between design data and operating plant data – *e.g. radiation source terms, radiological zoning and contamination levels in rooms of the plant*,
 - To document a clear status on various topics as a way of developing knowledge for all design stakeholders such as design architects, layout teams, system's designers, radiochemistry teams, etc.
- To involve the operators in the design work, with high value added from NPP OPEX
 - For transverse topics such as the preparation and performance of main outage activities, decontamination means, site logistics, etc.

Organizational aspects around the work program:

- **A RP lead** coordinates the actions and organizes **regular meetings** to progress the topics according to the project schedule.

II.3. Skills development in RP team and challenges of the work program

An important topic of the work program is networking of designers **with operators** of French NPPs:

- Workshops with operators (and partner companies) on a wide range of RP topics,
- On-site to benefit from a **site walkthrough** focusing on several aspects of interest.

Examples of topics: *EVEREST mode, fixed/mobile radiation shielding equipment, radioactive waste management, space reservation for temporary storage and outage activities.*

=> Outcome of these workshops/visits: a) **Skills development** for RP Design team; Better **understanding** of operator constraints on site.

On-site immersion (several months) by EDVANCE RP Eng. => another way to improve skills.

The main challenges of the work program are:

- To identify the expert entities / key actors able to share their knowledge on very specific topics related to plant operations,
- To involve multiple design stakeholders whenever needed
-> e.g. layout, HFE (human factor eng.), conventional H&S



Several topics of interest are identified for the work program. Some of which discussed for illustration in the next slides.

III. OPEX and lessons learned to inform decisions for an ALARA design

III.1. Introduction: Importance to specify at the appropriate requirement

Another objective of the work program is to **ensure robustness of the installation for activities with high RP stake**, i.e. to implement design measures addressing the exposure risk in a proportionate manner.

To do so, designers collect key informations from operating plants, i.e. **recommendations, good practices, innovations** to lower external exposure, contamination risk, and the radioactive waste volumes.

These topics are often very transverse, **requiring a leader (other than RP) to plan the multidisciplinary approach** “at the right time” that can deal with numerous constraints including RP.

A few examples:

- **Logistics** (setdown areas, management of scaffolding, installation of airlocks, containers, mobile equipment, etc.),
- **Management of contamination** in rooms (confinement; collection of leaks, ease of decontamination),
- Space reservation and arrangement of **exit of “ZppDN”** (= area of possible production of nuclear waste),
- Management of **radioactive waste** (filters, resins, etc.).

Use of OPEX and effort of optimisation proportionate to the RP stake is also applied for the preparation of **modifications after start-up (EPR FA3)**.

III.2. RP source terms

Design source terms in the systems :

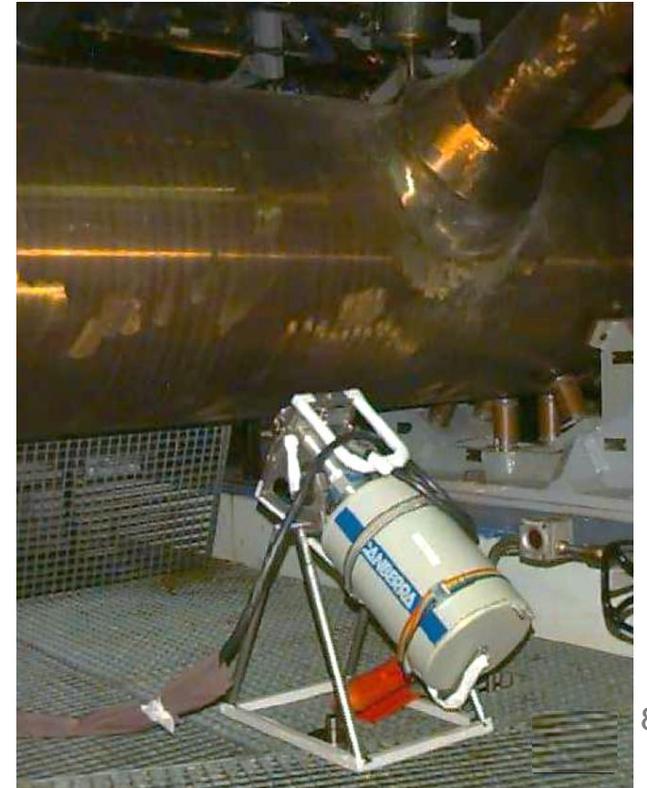
- mostly derived from radionuclide activity **measurements** on Fr. fleet (e.g. **spectrometry** measurements with EMECC system),
- with some **data processing** to account for differences in terms of system design and functioning.

One challenge is to have reliable data for the design: a good design depends on a **good representativeness** of such radiation source terms. This is not always possible for a New Build, especially when reactor technology and design differ (e.g. materials used).

The work program:

- Facilitates **data collection**, i.e. :
source term dose rate measurements during outage, with comments accompanying the data to understand how these were obtained.
- Foresees that designer RP team expresses need of **new measurements**.

***EMECC** HPGe spectrometry measurement device to characterize surface contamination inside the systems
=> here the RCS hot leg*



III.3. Dose rate and contamination zoning assessments

Operators are asked to participate in radiological zoning design reviews to provide a **critical opinion based on experience**.

- **Likelihood of the estimated dose rate levels** in a room => to avoid oversizing of shielding
- **Operator's ambitions of keeping some specific rooms "radiologically clean"** => design features such as:
 - Absence of radioactive system parts likely to leak,
 - Avoiding spread of contamination (direction of air transfer).

In the design process, it is required to **confirm that the defined dose rate and cleanliness objectives are respected**. If not, this could have a significant design impact or could transfer the risk to plant operating life.

For that purpose, the work program also includes activities to **compare zoning design data and operating plant data** to lower the risk of over-estimating or under-estimating the radiation exposure risks.

III.4. Radiation shielding devices

For the radiological design zoning to meet the expectations in future plant operating life, the shielding needs are assessed wherever the RP design studies highlight that dose rate could exceed the defined limit.

Operators are involved for contribution to the assessment, particularly:

- To share **OPEX on removable permanent shielding** added after plant start-up,
- To help define the most practical solution accounting for all constraints.

At design stage, the main objective is to anticipate and define shielding needs:

- To **reserve the required space** as soon as possible,
- To **foresee anchor plates** in civil works structures, for supporting structures instead of scaffolding for **easy installation of temporary shielding** (lead blankets),
- To design removable permanent shielding if relevant.

Removable permanent shielding around radioactive systems



III.5. Site logistics and contamination matters

A very important contribution from the operators (and partner companies) is about the **experience in preparing and performing inspection/maintenance activities** to derive best practices and recommendations for design.

This includes the **cleaning and decontamination activities for pools and system components** (tanks, heat exchangers, sumps) prior to access for inspection/maintenance.

Design recommendations based on OPEX are about:

- Upstream/downstream **pipng connections**,
- Strategy for the **collection of effluents**,
- Location of **accessways** (e.g. tank manhole),
- RP features for **confinement** of radioactive matter during high contamination risk activities (**airlocks, filtration, etc.**),
- **Free space** required,
- **Transfer of equipment and tools** to and from the work area.

Example: permanent spray lines for rinsing of pool walls.

IV. On-site technical workshops

The work program gives a framework for members of the RP design teams **to go on NPPs site** for technical **workshops** and site walkthrough with special focus on difficulties and areas of design improvement for a better future operation. Nuclear Installation under construction like ITER is also subject of visit and workshop.

Sites that have welcomed the RP design teams between 2022 and 2024:
Penly (1300 MWe), Civaux (N4), Chooz (N4) and ITER (see [Appendix](#)).



Penly NPP



Civaux NPP, with EVEREST mode

V. Capitalization of EPR NPP OPEX

The ongoing start-up of the **EPR at Flamanville 3** requires the RP design teams to provide continuous support to the operator:

- **Start-up dose rate** measurement campaigns,
- Definition of **EPR FA3 source term monitoring** measurement program (first outage).

OPEX from EPR FA3 plant operations starts to be collected and will serve as input for EPR2 design (building and room arrangement, general layout, system design, etc.).

EDF-EDV technical exchanges with TVO (on site visit) -> allow to bring **OPEX from the EPR at Olkiluoto 3** both on: **RP data** (dose rate and contamination level) and on **radiochemistry data** (volume activity in the systems).



FA3 preparation of start-up measurements



OL3 measurements in 1st outage

Conclusion

The designer-operator work program initiated in 2021 for EPR2 is:

- a **challenge**
- but is already fruitful for many design RP topics.

RP awareness of design stakeholders (layout, ventilation, systems, ...) has improved
=> operator's contributions illustrate how RP matters shall drive some design choices.

OPEX from French and international NPPs and input from operators are key:
=> already examples of **high added value to design work** (requirements, recommendations and solutions).

This work program is **evolutive by principle**
=> reshaped as frequently as necessary to provide food for thought at the right time of the project.

This work program is a good practice at design stage to establish for upcoming EDF New Build projects (e.g. Nuward).

Perspectives

The work program could be the workstream for **RP design needs beyond regulatory requirements** to be addressed e.g. actions to cascade EDF RP design internal rules.

Example: measurements on EPR FA3 for the sake of performance of EPR2 design calculation schemes applied to RP.

Another outcome of the work program could also be the production of a prescriptive documentation for the future operator (and partner companies).

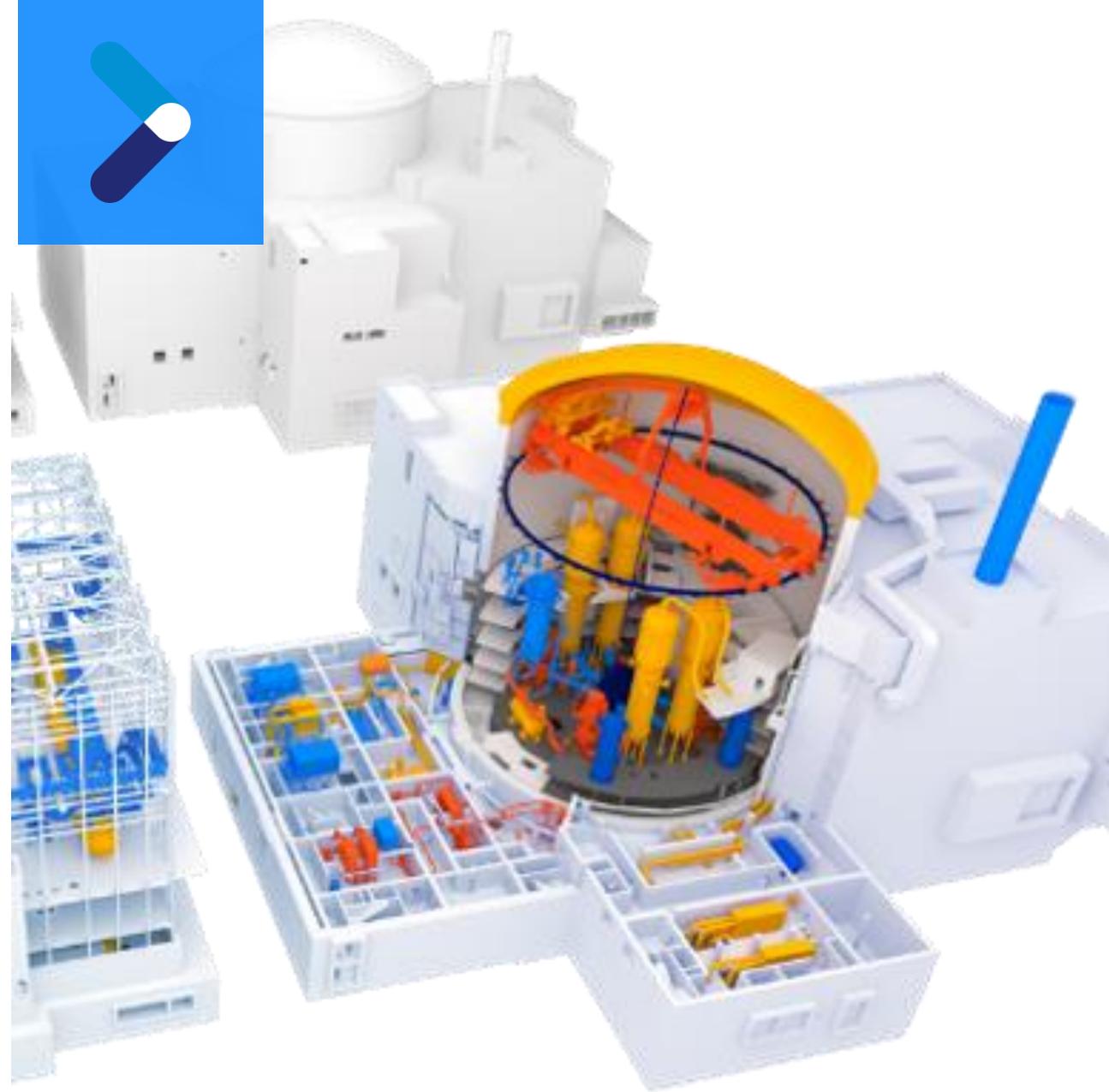
The objective would be to **trace expectations of actions to be performed during plant operating life**, decided at design stage jointly between designers and operators.

Examples of actions to be performed during plant operating life:

- *planned decontamination,*
- *temporary shielding installation (dose rate reduction),*
- *operating instruction for the use of spray lines for rising of pool walls,*
- *possibly operating procedures for the sake of source term reduction, like for ex.:*
 - > *chemical and radiochemical procedures during cold shutdown (H2 injection, ensure high pH (via Boron-Lithium coordination, optimized purification flow rates via RCV [CVCS], ...)*

Thank you!

Any questions?



Appendix

Visit of EDF / Edvance and workshop with RP team of a nuclear installation under construction: **ITER**
A way to exchange RP design good practices, methods/tools and cascade of regulatory requirements.



