



CENTRE D'ETUDE SUR L'EVALUATION
DE LA PROTECTION DANS LE DOMAINE NUCLEAIRE

CEPN

Decision-making method for the installation of valves remote controls at design stage of a NPP

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PROJECT'ED



Introduction

The **EDF radiation protection design referential** includes:

- Numerous requirements, recommendations and good practices to meet the RP objectives in terms of reduction of external exposure and contamination risk
- Rules, criteria and methods to help making the right decision for complex design topics

Some topics have been identified as requiring a new set of rules, or a new approach for RP optimization at design stage. The topic of **installation of valves remote control (VRC)** is one of these.

Other names: “remote valve actuators”, “remote drive” or “reach rods”, used to operate a hard-to-reach valve.

The design work for EDF New Build projects is ongoing: EPR2, EPR1200, Nuward.

The EPR design work and operating experience provides **important lessons learned** for new projects. One example is that the EPR shows a **significant increase in the number of VRCs** compared with previous PWR designs.

Edvance requested the help of CEPN to define a **methodology to assist in the definition of VRC needs** at design stage. The intent is to deal with multiple constraints including RP optimization.

The expected benefit is an **optimization of the number of VRCs** in new designs.

Initial design considerations

Required design input data:

- Information about the **room arrangement** (layout design teams) – *e.g. 3D mock-up, inventory of systems*
- Information about the **functioning of systems** (system design teams) – *to derive radiation source term assumptions*
- Assessment of **radiological zoning and ambient dose equivalent rates** (RP design team)

[**Step 1**] Identify all valves in the radiation controlled area, and their location / room

[**Step 2**] Identify valves for which the radiological ambient conditions justify **looking into design solutions respecting RP design requirements** (optimization of workers' exposure).

[**Step 3**] Identify the main contributions to the ambient dose equivalent rates in the room:

- Radioactive matter contained in the system on which the valve is installed?
- Other radiation sources / other radioactive systems installed in the same room?

[**Step 4**] Multiple design solutions are investigated:

- Layout design and/or system design changes – *e.g. relocation of the valve (see appendix)*
- Addition of permanent removable shielding or concrete shielding walls

[**Step 5**] In case a VRC is the preferred option:

- Assess the solution into details with a dedicated methodology
- Support the layout / system design work before validation

Illustration of VRCs

Example from EPR design : remote drives inside a room, with a concrete shielding maze and a wiremesh door at the entrance

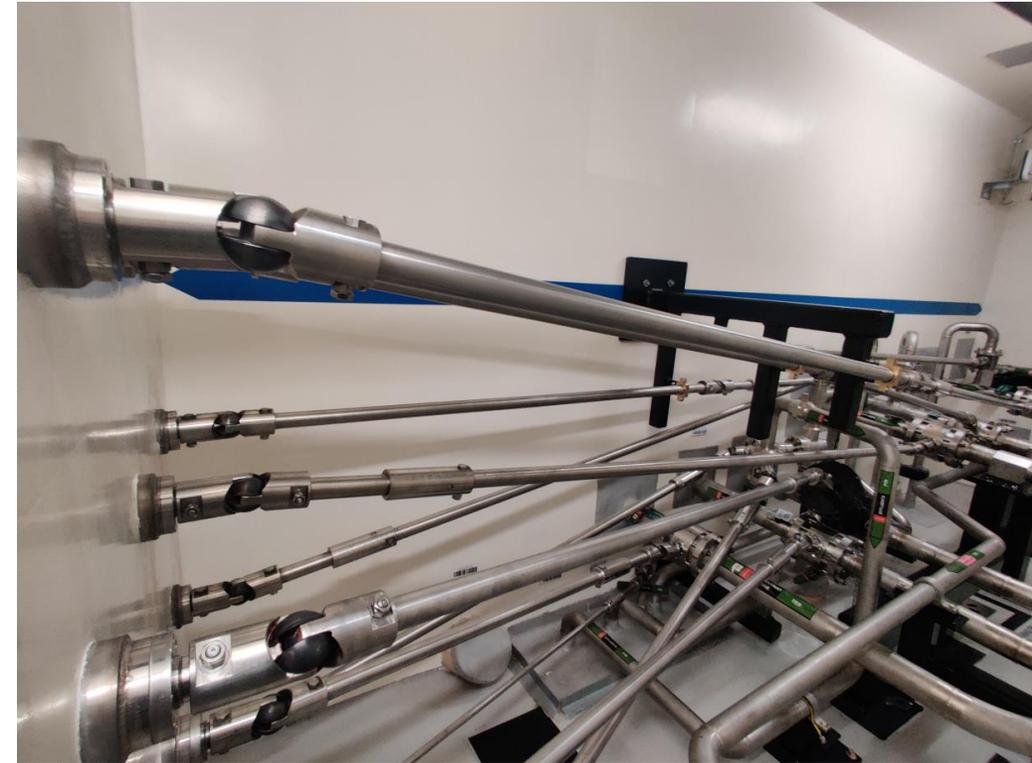
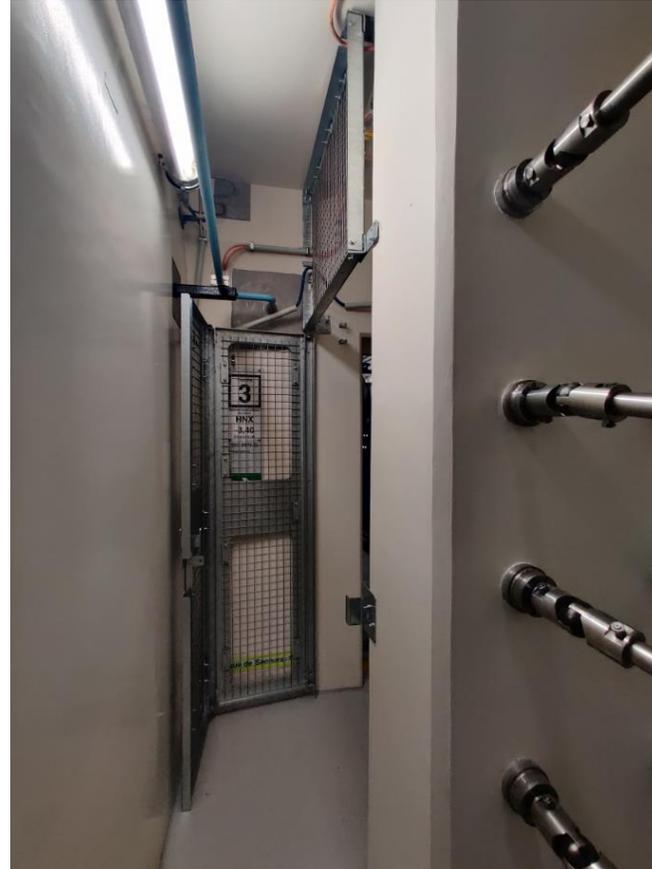


Illustration of VRCs

Example from EPR design : corridor with multiple remote drives and adjacent room where valves are located



Decision-making method for VRC installation (1/3)

Method based on a **successive evaluation of 8 criteria**:

- These criteria can be assessed independently of each other, but it is recommended that all of them be considered when making the final decision.
- The aim is to consider the situation beyond the "simple" optimization of external exposures.

The **minimum input data** to be considered when assessing the RP criteria are:

- The **dose rate at workplace** associated with the action "operate the valve",
- The **time required** to operate the valve and the **frequency** of valve operation,
- The **accessibility of the valve**, creating a greater or lesser time of exposed work.

Decision-making method for VRC installation (2/3)

[**Criterion 1**] Compliance with the annual individual dose constraint set by EDF

- Justification of the VRC if annual maneuvering dose without VRC > constraint
- Otherwise assess additional criteria

[**Criterion 2**] Annual dosimetric gain

- Justification of VRC if dose gain > 0
- Otherwise see additional criteria

[**Criterion 3**] Reasonable cost

- Monetary value of net gain in dose = reasonable cost
- Compared with VRC costs (installation, maintenance)
- Justification if VRC cost < Reasonable cost

Additional criteria:

- Radiological cleanliness
- Personnel safety
- Response time
- Material constraints
- Technical feasibility

Decision-making method for VRC installation (3/3)

After evaluating the main criteria:

- Summary of justifications
- Initial decision
- Sensitivity analysis
- Final decision

Other reasons for implementing a VRC:

- Avoid the presence of personnel or equipment in an area at risk of contamination or hazardous for personnel or equipment
- Improved access to the valve
- Reduced intervention time constraints
- Reduction of the integrated dose for radiosensitive components
- Functional grouping of controls for several system components

Conclusion

Direct benefit from the work presented:

- **Improved engineering design manual** – *the method is being integrated in the EDF RP design referential*
- Other design stakeholders have a **better understanding** of the specific topic of VRCs due to RP – *building layout architect, system designers, HFE (human factors engineering), operators*

Expected outcome of the application of the methodology:

- **Optimized specification of VRC needs** in a way that allows **meeting the RP design objectives** (individual and collective dose, contamination risk)
- Account for other important constraints when it comes to plant operations

OPEX from NPPs can also bring additional information for the detailed design and implementation of a VRC.
Example: horizontal VRC through shielding concrete walls or vertical VRC through shielding concrete slabs.

Thank you!

Any questions?



Decision-making method for VRC installation - Appendix

[Criterion 4] Radiological cleanliness

If there is a risk of contamination, it is justified to install a VRC in order to:

- Reduce the risk of spreading contamination
- Reduce access time (dressing/undressing, etc.)
- Avoid operating costs (reduced intervention time, cost of PPE, etc.)

[Criterion 5] Impact on safety

- Presence of a hazardous area for personnel/equipment
- VRC impact on the accessibility of other equipment located in the room

[Criterion 6] Impact on response time

- Need for rapid access and/or simplified operation of the valve
- VRC impact on the accessibility of other equipment in the room

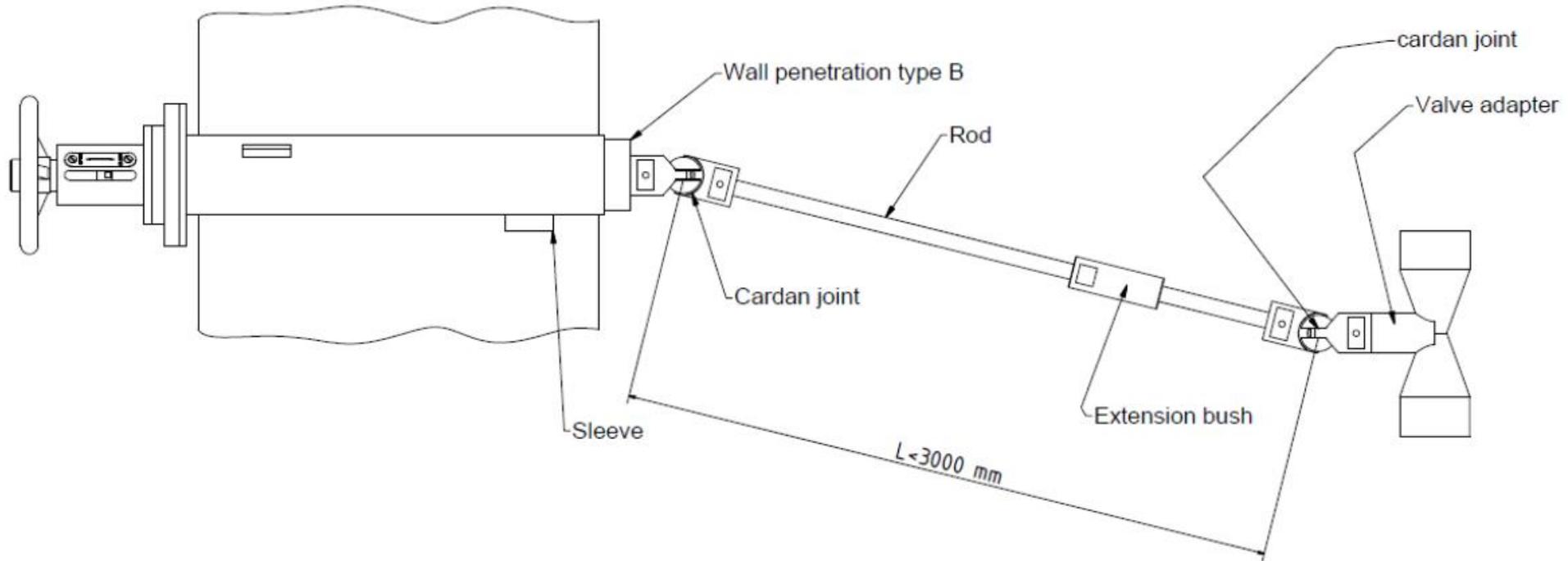
[Criterion 7] Physical constraints

- Need to reduce the integrated dose for various radiosensitive elements
- Need for functional grouping of controls for several system components

[Criterion 8] Feasibility

- Technical feasibility study confirming or refuting the justification

Additional information – Appendix



Standard remote drive arrangement

Additional information – Appendix

Dose rate thresholds may be defined to identify the cases requiring more thought on the VRC solution.

Then:

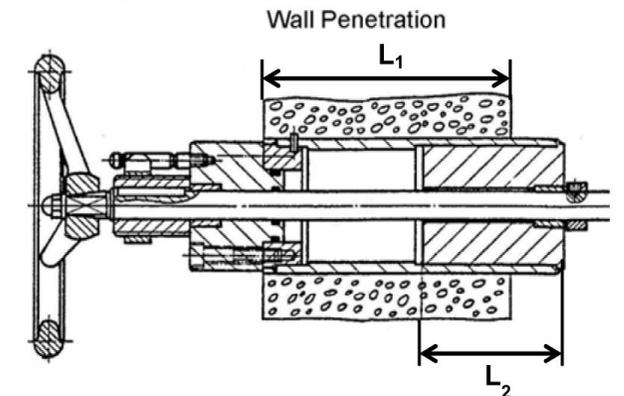
- Basic approach based on only two parameters:
 - Radiological zoning / ambient dose equivalent rate
 - Frequency of action
- Applicability limited to “simple” cases such as:
 - Low dose rate areas => solution: no VRC
 - High dose rate areas => solution: energized actuator

Situations addressed in design cover:

- Normal operating conditions
- Specific cases of temporary high dose rate – e.g. activities such as transfer of highly radioactive resins
- Accidental conditions for post-accidental accessibility (local actions)

In case of a VRC solution:

- The civil works penetration for the remote drive created a radiation streaming path
- Adequate shielding is needed (as for any other mechanical/electrical opening in shielding walls)



Handwheel

Additional information – Appendix

Examples from the collection of RP design rules for layout and system design:

- Increase distance from the radiation source for operational tasks (operating of valves, monitoring),
- Address cases of pressurized radioactive systems, in terms of inspection/maintenance tasks – RP optimization
- For pumps, heat exchangers, components ensuring activity retention, etc.
=> Rules about related valves – *e.g. installed in a separate location, good accessibility, etc.*
- Remote operation of valves from low radiation areas using appropriate actuators
- Care must be taken so that the measures used for reducing the doses in operation do not lead to increased doses during maintenance
- Valves and their arrangement designed so that a shield can be (temporarily) installed between the actuator and the valve body

