

Challenges in Modelling of Passive Heat Removal Systems for Small and Micro Modular Reactors

Mihael Boštjan Končar*, Jörg Starflinger, Mihael Sekavčnik, Mitja Uršič

Small Modular Reactors: The Key to a Decarbonized Energy Future



Decarbonization of Diverse Energy Sectors:

- I. Load-following Operation → **Replacing Coal & Gas Plants**
- II. High-temperature Heat Supply → **Industrial Applications**
- III. Synthetic Fuels → **Transport**

Use of Advanced Nuclear Fuels → **Entering Circular Economy**

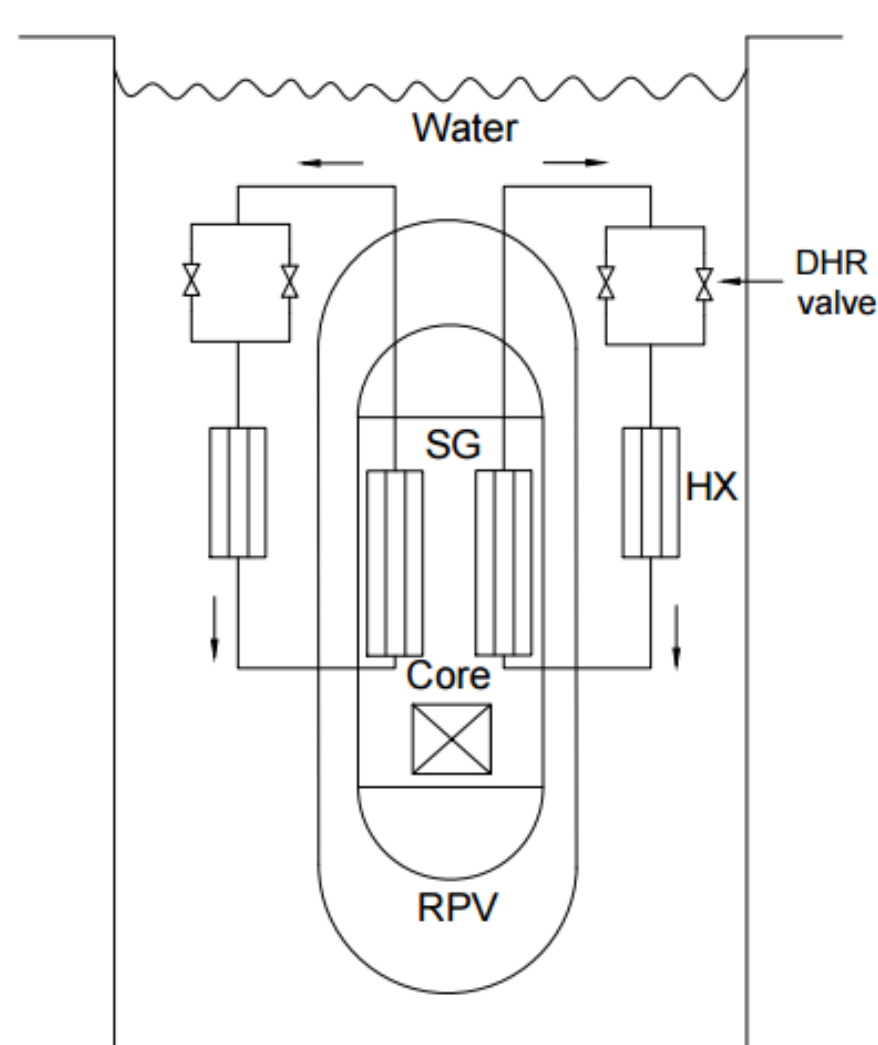
New Business Models → **Industry Investors & Sector Coupling**

Advantages of Implementing Passive Safety Systems in SMRs

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|--|--|---|
| <ol style="list-style-type: none"> i. Integral RCS design ii. Lower core power capacity iii. Large surface to volume ratio iv. Large primary coolant inventory per MW_{th} v. Smaller reactor core power density vi. Large secondary coolant inventory vii. Taller reactor pressure vessel | | <ol style="list-style-type: none"> i. Reduced accidents initiators ii. Lower decay heat iii. Easier heat removal → single phase flow iv. Large heat sink; Enhanced buoyancy; Slow transient v. Larger thermal-hydraulics margin → Long term HR vi. Passive heat removal and containment cooling vii. Enhanced heat removal via natural circulation |
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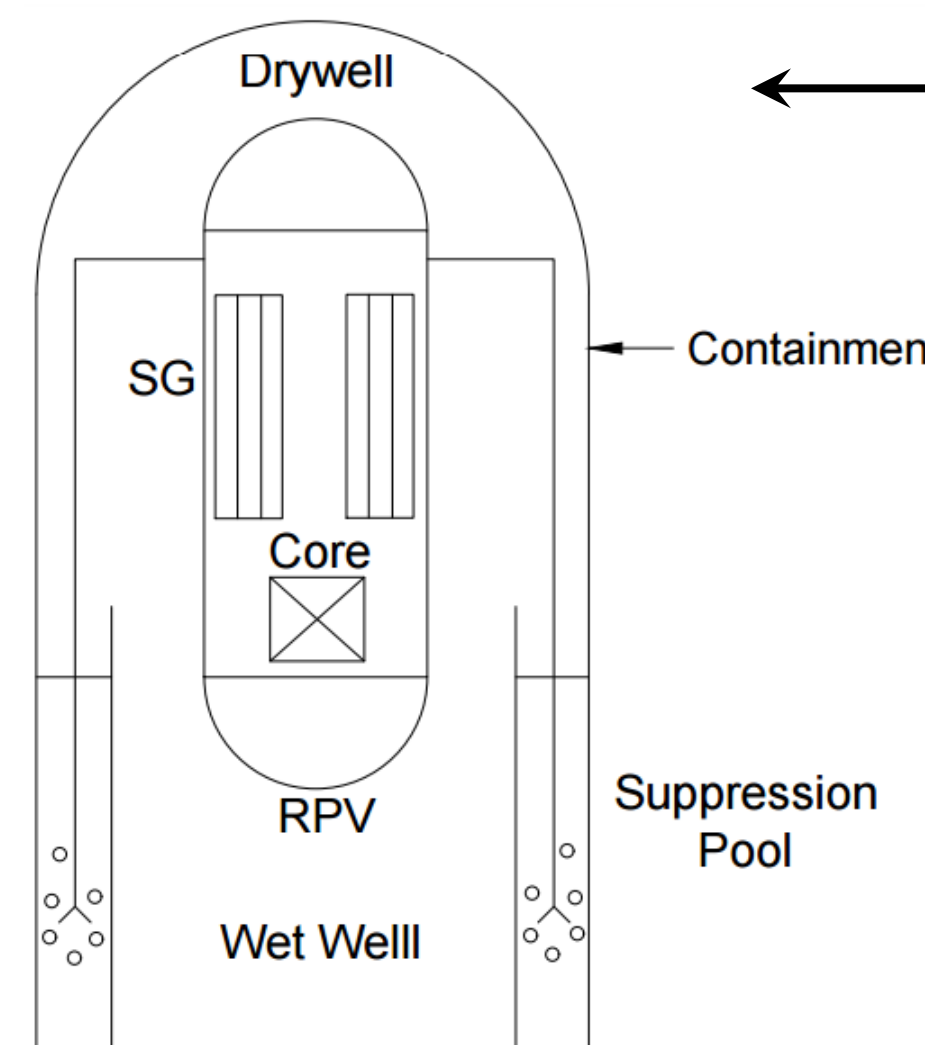
Passive Safety Systems in SMRs

Residual Heat Removal



Reprinted from: C. Zeliang, et al, Energies 13-11, 2020.

Depressurization System



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Open Issues in Modelling with Integral Codes

Helical Coil SG	Bayonet HEX	Compact Plate HEX	Heat Pipes	Heat Dissipation to UHS	Free Convection on Containment
Modelling of secondary flows Turbulence models development	Modelling of friction losses and heat transfer CFD & Experiments	Refinement of existing models to include effect of embossing patterns	Development & validation of heat transfer models Experiments & CFD	Development of 3D modules to simulate two-phase flow (boiling)	Experimental data for high Rayleigh numbers ($Ra > 10^{12}$)

