HP-BWR 2009

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Water Cooled Reactors 2009

Concept of a

HIGH PRESSURE BOILING WATER REACTOR HP-BWR

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1. Safety is improved

2. Environment friendly

3. Cost effective, simple

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The time has come to move a step further and develop an improved type of power reactor

Common sense, public confidence and economic considerations demand, that a new design should not be a big leap from the presently functioning devices however it should be a significant improvement

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The HP-BWR
High Pressure Boiling Water Reactor
is benefiting of the operating experiences, combines the advantages and leaves out the disadvantages of the traditional BWRs and PWRs

The best parts of the two traditional reactor types are used and the troublesome components are left out

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1.Safety is improved

- Gravity operated control rods
- Large space for the cross formed control rods between fuel boxes
- Bottom of the reactor vessel without numerous control rod penetrations
- All the pipe connections to the reactor vessel are well above the top of the reactor core
- Core spray is not needed
- Internal circulation pumps are used

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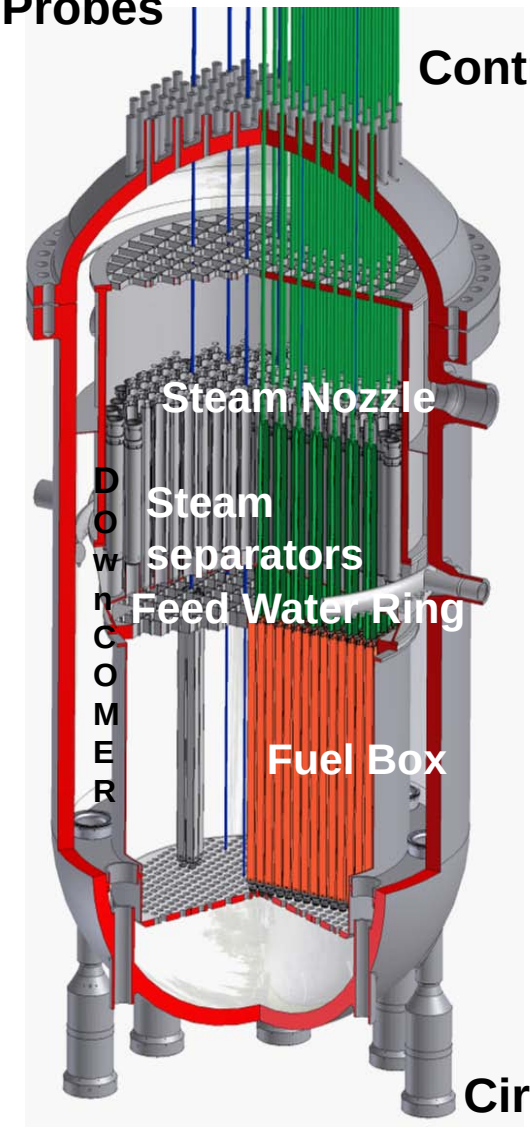

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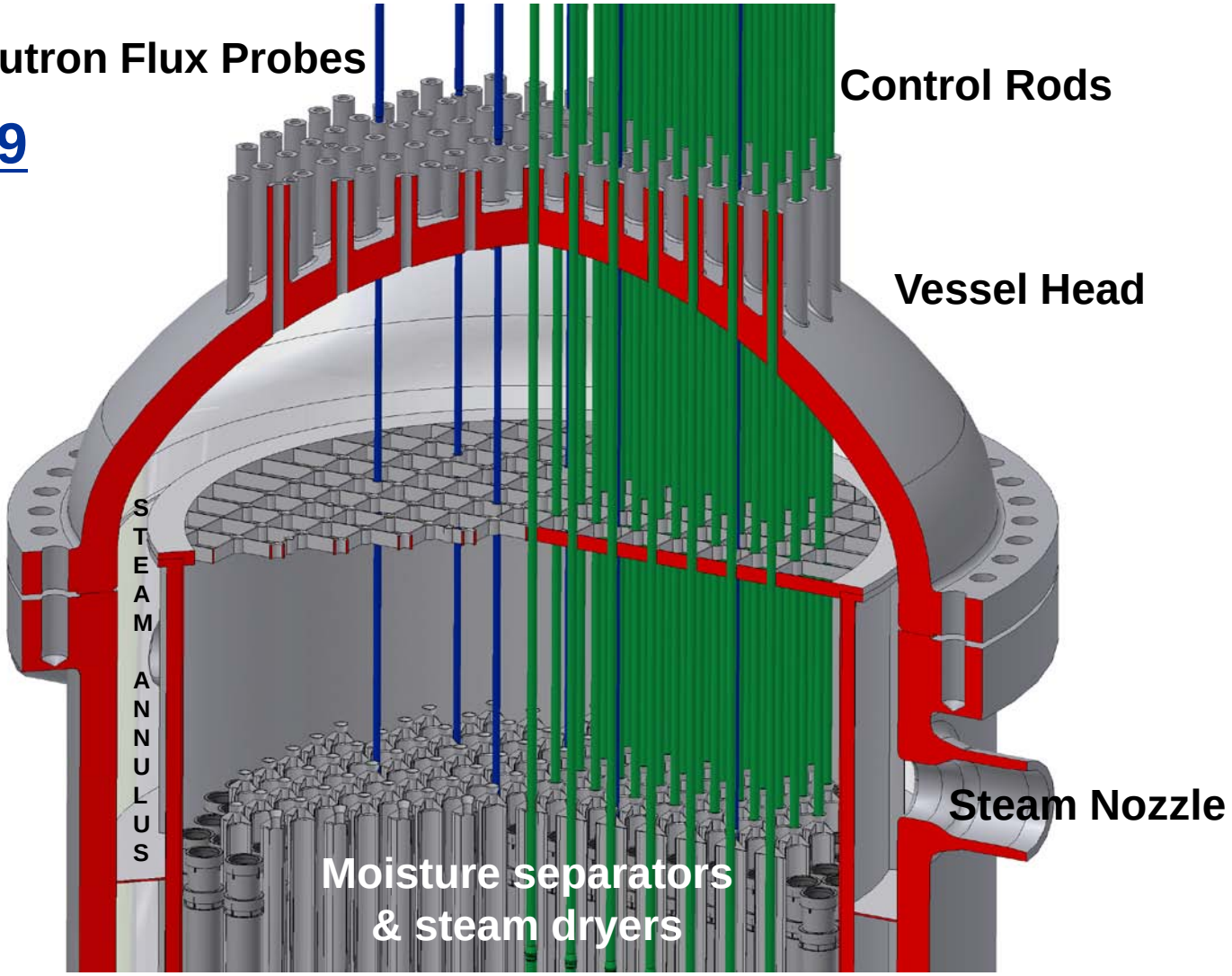

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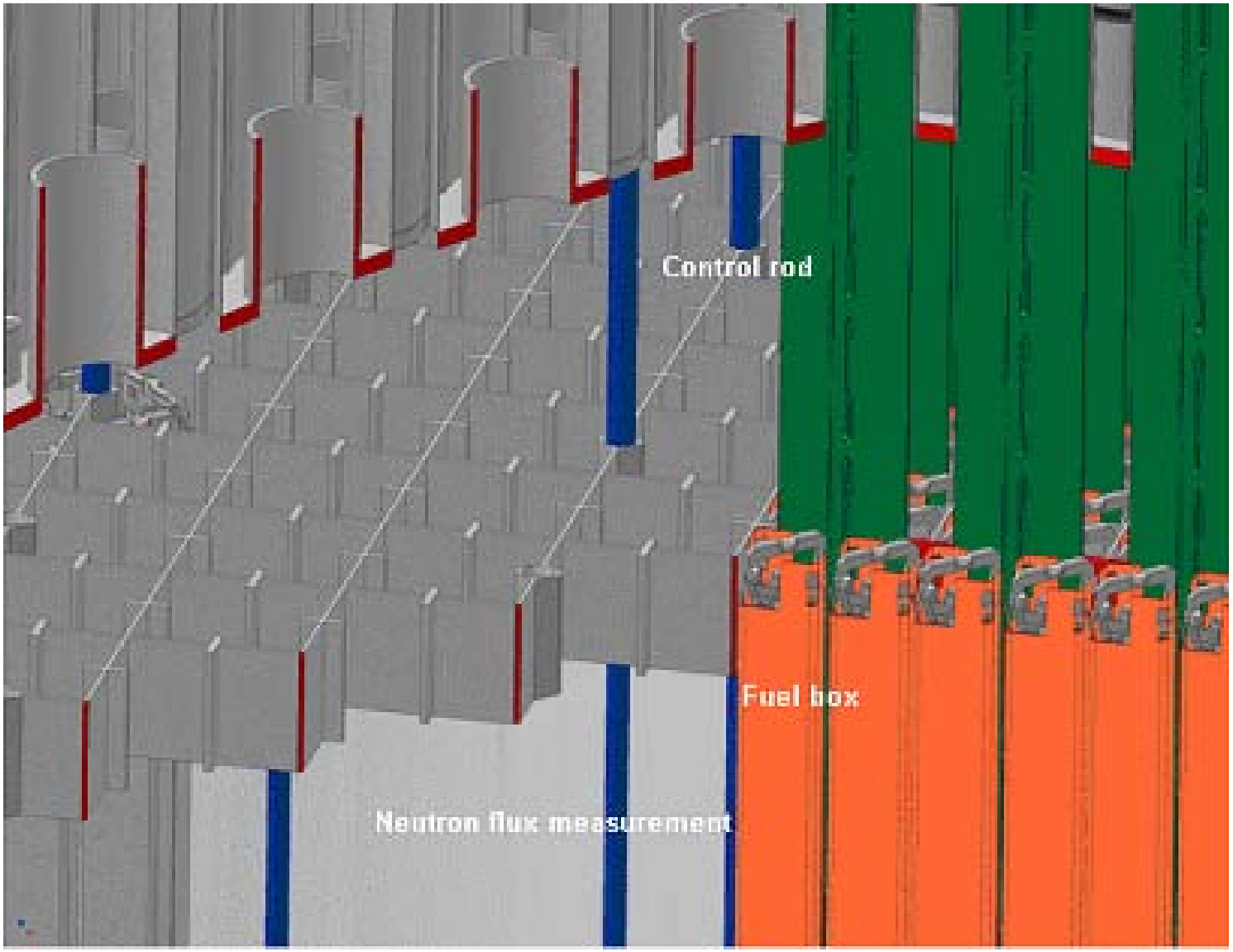

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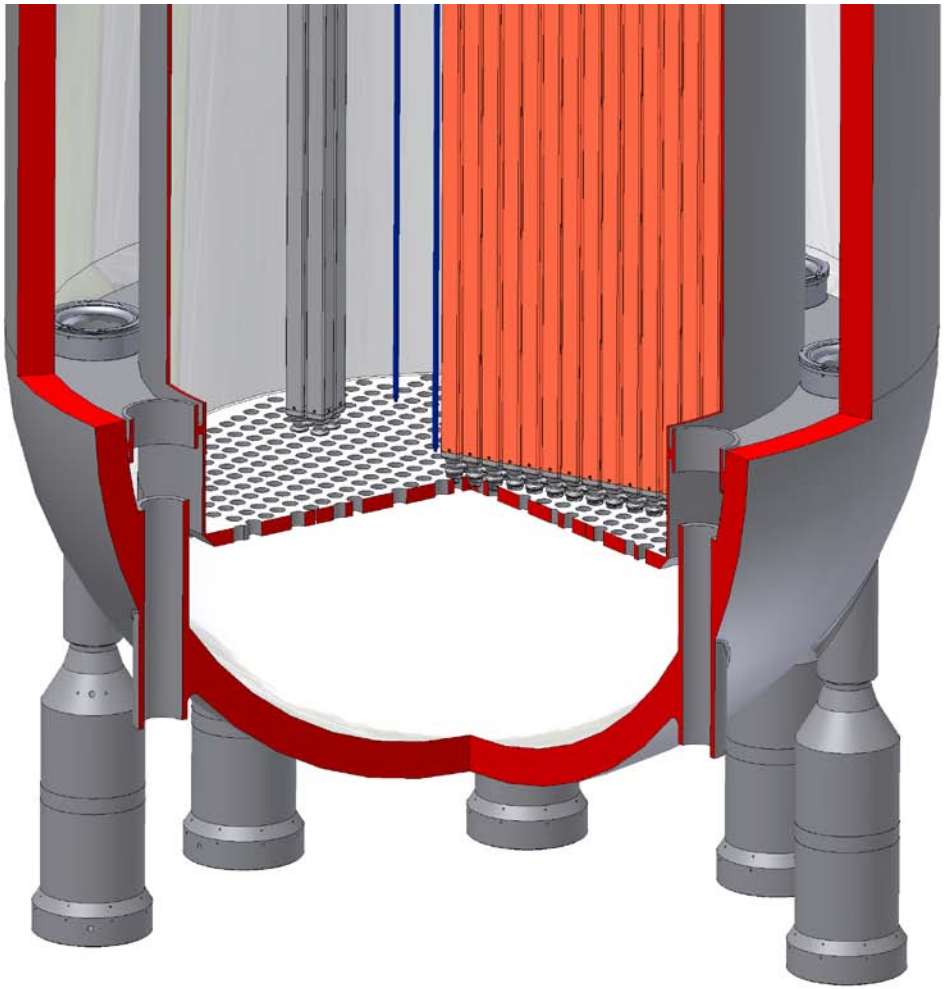

Bottom of the Reactor Vessel

smooth not perforated

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Comparison

	BWR	HP-BWR
Feedwater temperature	486.6 K	486.6 K
Outlet void temperature	559 K	617.8 K
Pressure in the steam dome	7 MPa	15.5 MPa
Inlet temperature to the core	550.29 K	582.3 K
Inlet core quality	-3.909E-02	-0.254
Outlet quality from the core	0.128	0.323
Total Mass Flow Rate from the core	13634 [kg/s]	5955 [kg/s]
Total Mass Flow Rate in the steam lines	1795 [kg/s]	2026 [kg/s]
Total Mass Flow Rate through the pumps	13634 [kg/s]	5955 [kg/s]
Total Power Coefficient	-1.64e-4 [Δk/%]	-4.4e-4 [Δk/%]

Comparison between BWR and HP-BWR calculated with the RELAP5 (Mod3.3 Patch02) and PARCS code

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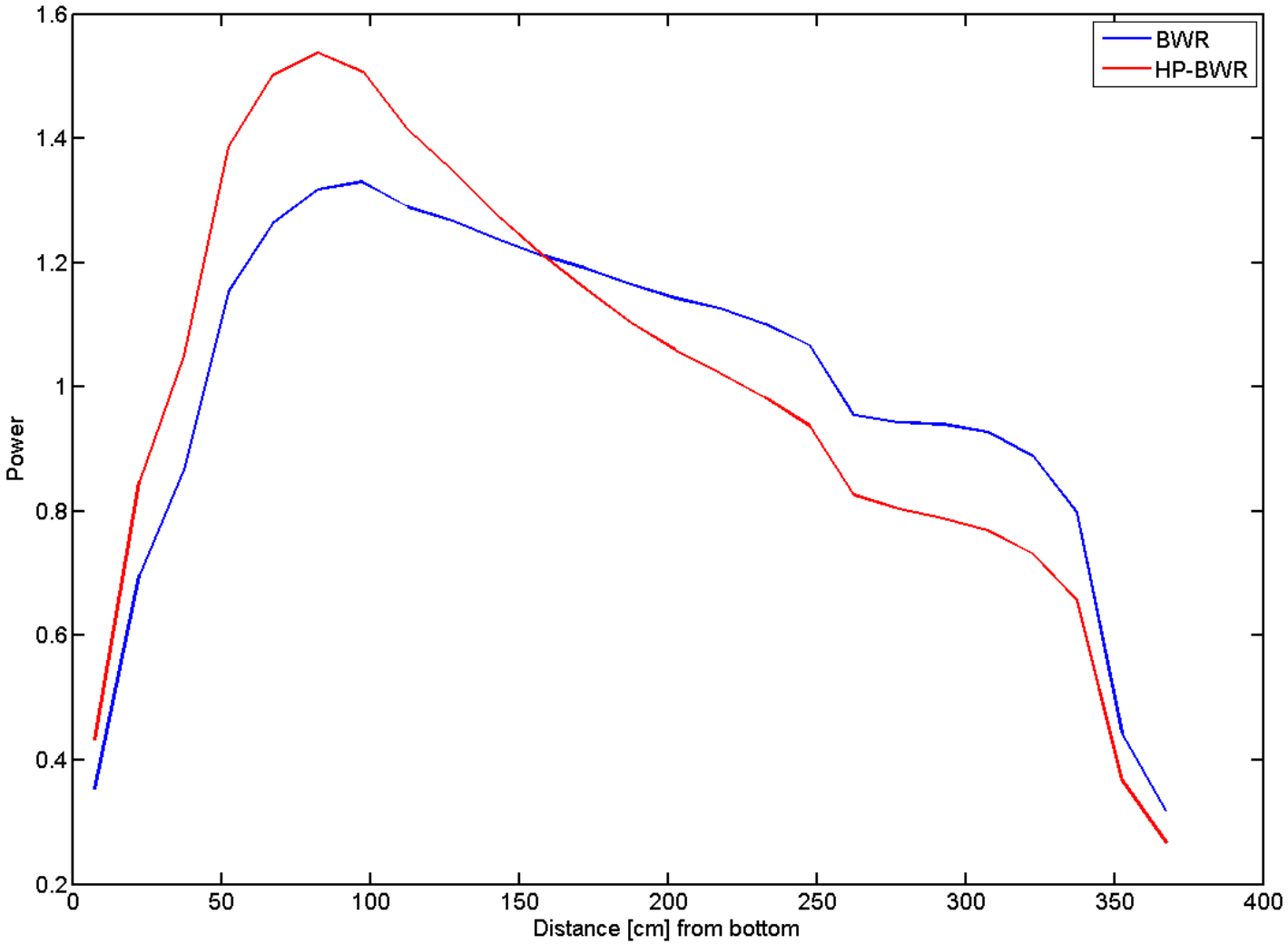

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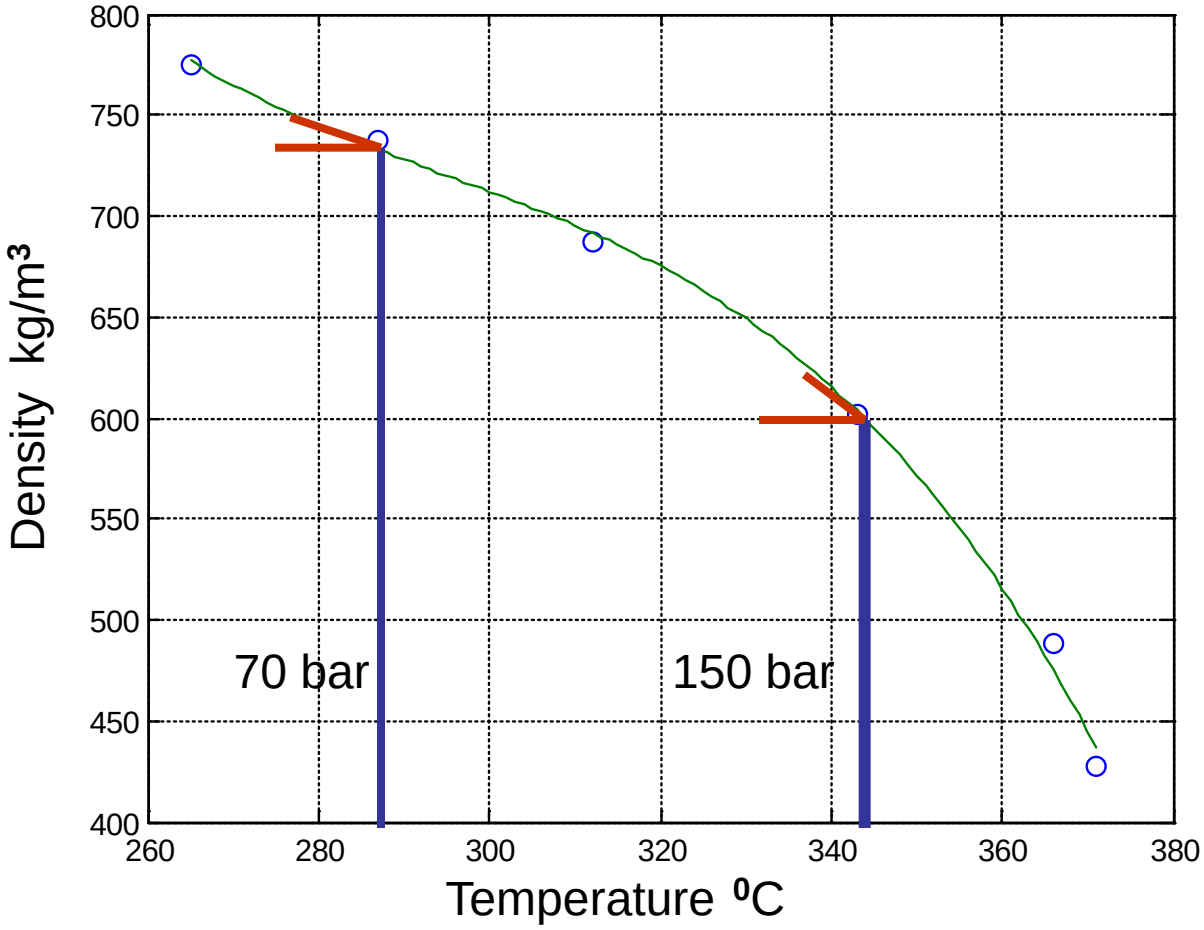
3rd Degree Polynomial Fitting, Saturated Water Density vs. Temperature



It is obvious that the gradient **kg/m³/⁰C** at 150 bar is steeper then at 70 bar

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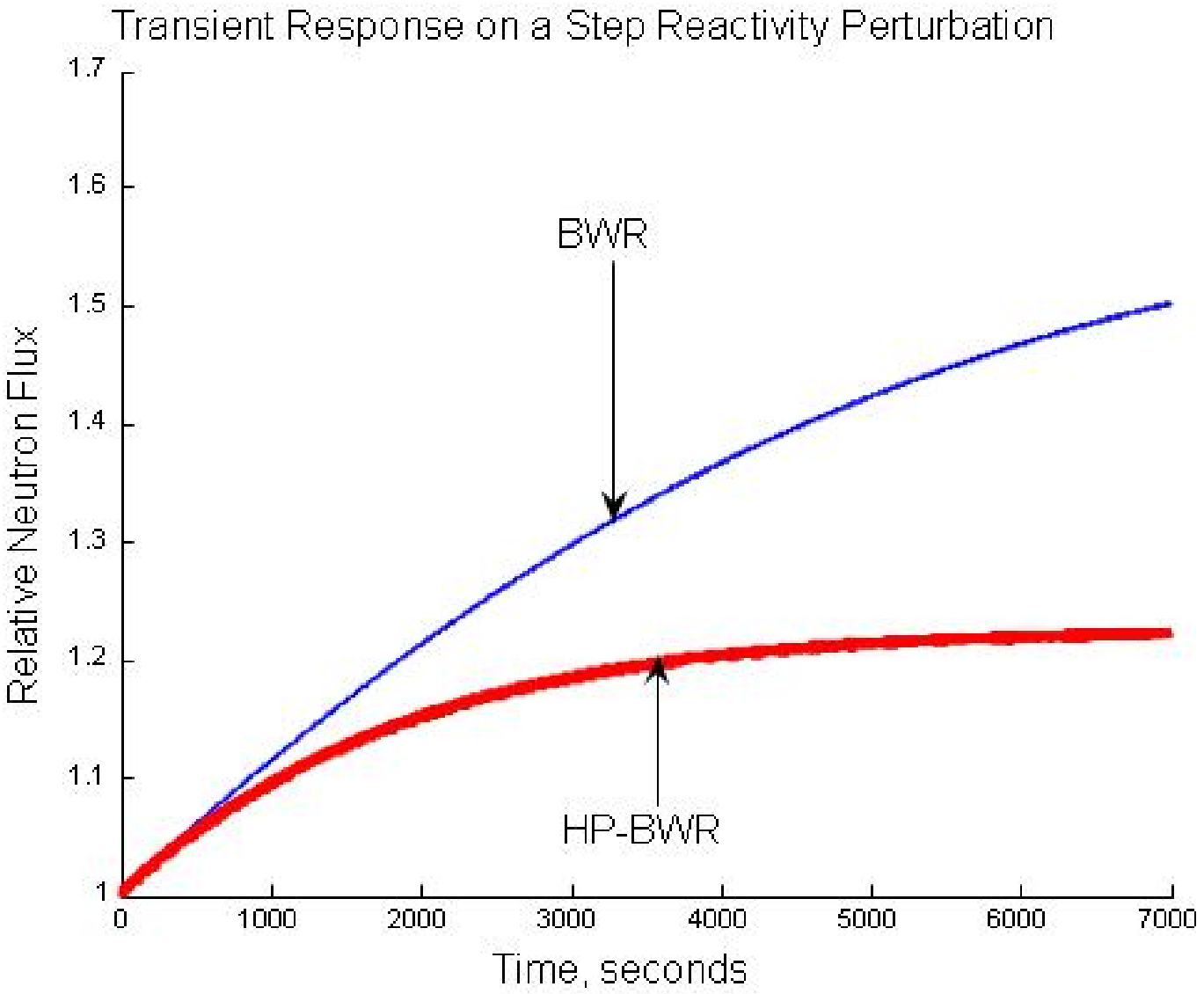

Long term stability without the use of any control system calculated with the MATLAB code
Inherently stable reactor

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Improved thermal efficiency

is attained by feeding the turbine with steam at 343°C (15.16MPa) instead of 286 °C (7MPa)

Carnot cycle theoretical efficiency $(T_{Hot} - T_{Cold})/ T_{Hot}$

This gives for a BWR ~ 46 % and for the HP-BWR ~ 51 %
at $T_{Cold} = 300\ ^0K$
an increase by a factor of 1.109
Assuming the same improvement ratio, today's efficiency of ~ 33 % would increase to ~ 37 %
this is supported by the analysis of the Rankine cycle

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The HP-BWR utilizes the fuel more efficiently, therefore releases less warm cooling water to the environment per produced kWh and consequently produces less waste then the traditional reactors

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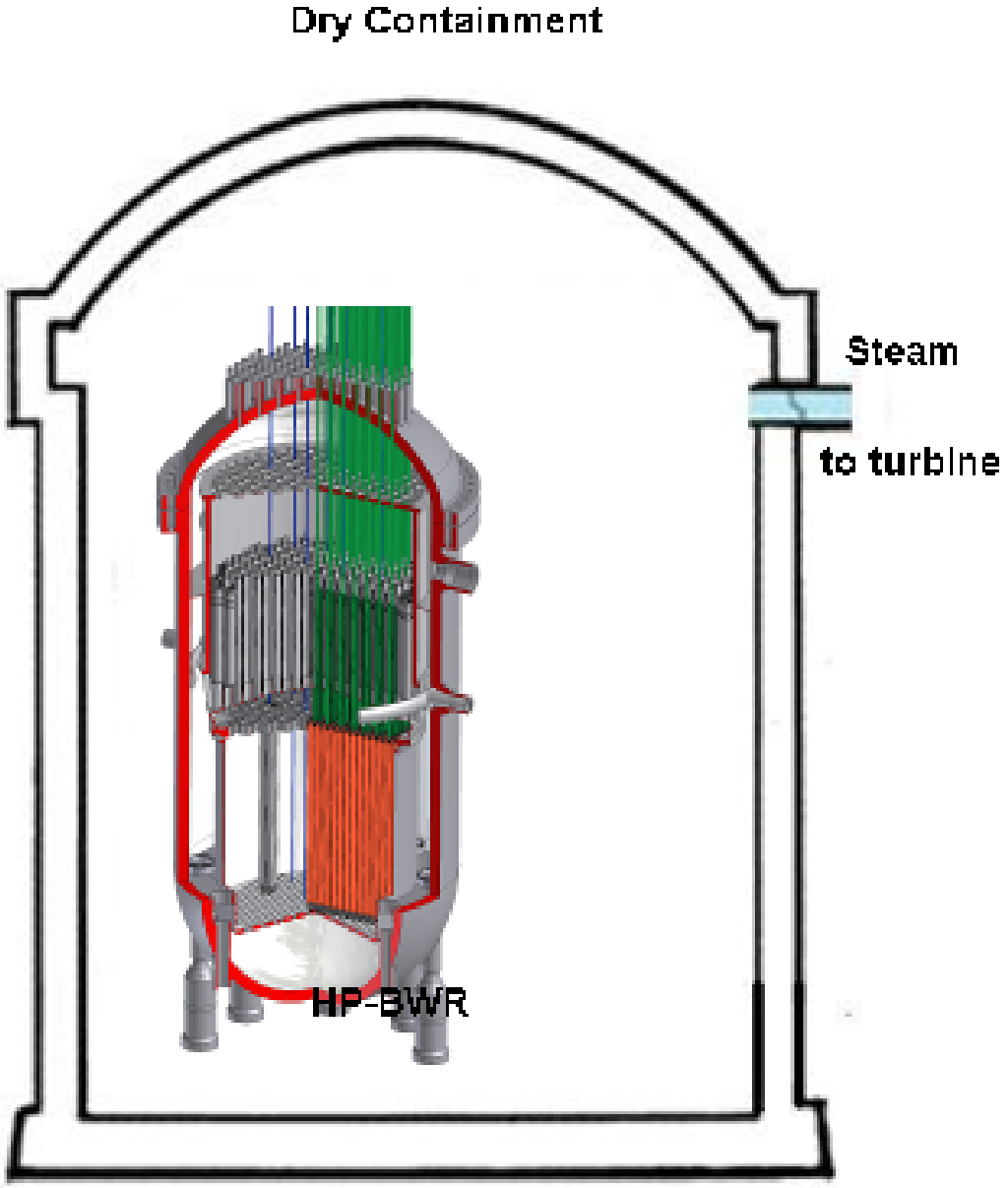

HP-BWR in a dry containment

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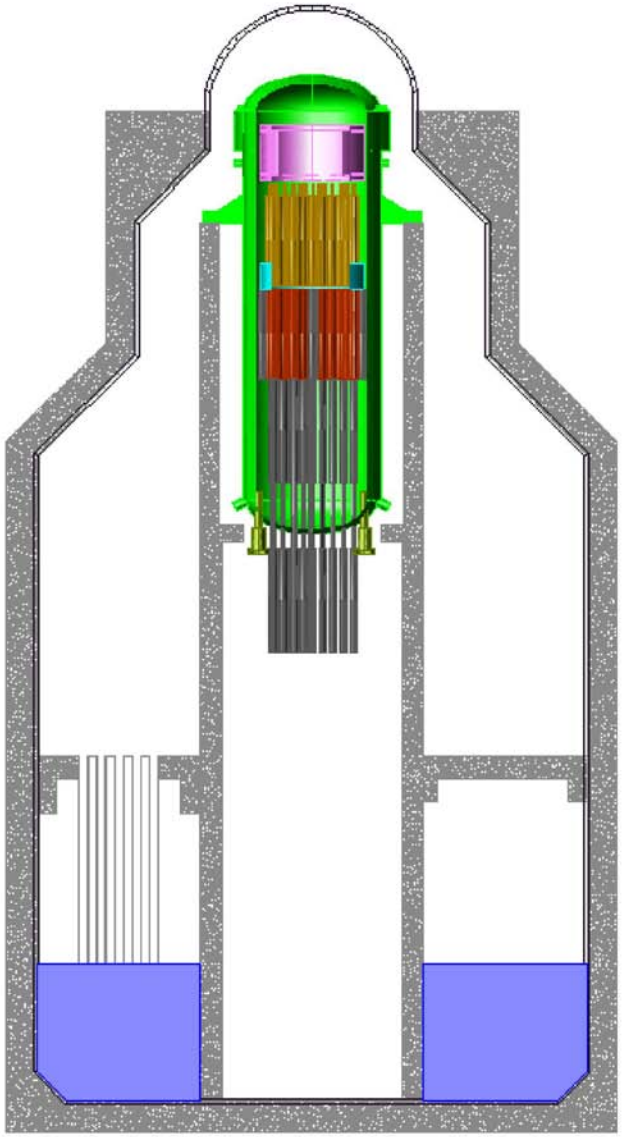

The Closed Down Barsebäck BWR

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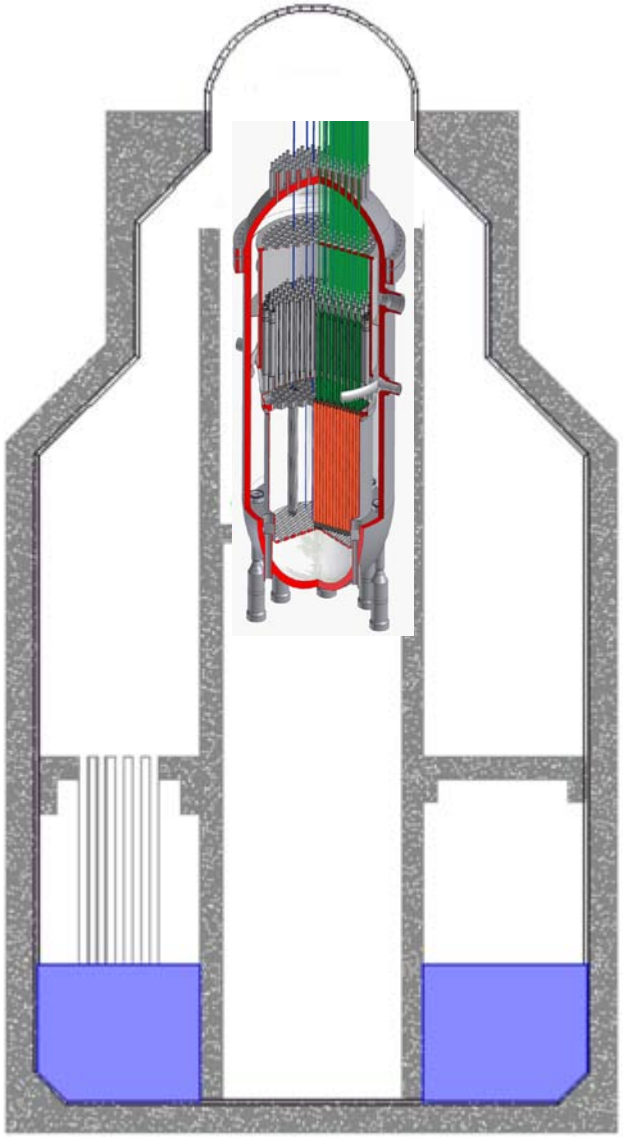

Proposal to Refurbish Barsebäck with a HP-BWR

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As a previous IAEA employ I would like to thank IAEA for the opportunity - that as a reactor inspector on leave from Sweden –I became an IAEA employ to participate in IAEA's OSART and ASSET missions. Also as an active member of the International Electrotechnical Commission (IEC) got the possibility to visit nuclear installations in Europe, Asia and America. This way it was possible to gain insight of the operational experiences of most reactor types and produce this article