

The benchmark core is based on the innovative core concept with sodium plenum above the core which is foreseen for the Russian fast reactor BN-800.

Seven solutions from six countries have been provided for the sodium void reactivity effects and other design parameters. Since only material compositions and geometry were defined for the benchmark model, each participant had to use his own cross-sections and calculational tools.

The main aim for this benchmark is to elaborate the effectiveness of the sodium plenum for sodium void effect reduction and to find the degree of agreement in the prediction of a near-zero sodium void effect. As had been shown in chapter 5.2 and as it is summarized below, this aim has been reached largely.

Concerning the sodium void effect, the main results of the seven contributions and their intercomparison are the following:

- a) The application of transport theory is necessary when voiding of zones above the core or of follower positions is considered. Therefore all following conclusions are based on transport theory results.
- b) The different solutions for the void effect of the fissile and internal breeder zones (called core in the following) are in the range of $+1.36 \pm 0.29$ % $\Delta\rho$.
- c) Voiding additionally the zones above the core reduces the void effect by about 1.3 % $\Delta\rho$ to a value close to zero, the average being (0.06 ± 0.23) % $\Delta\rho$. This drop in reactivity by about -3 \$ should be an important benefit for the transient behaviour of the core, especially in those cases when the sodium boiling process expands into the plenum region.
- d) When followers are voided additionally the overall void effect is increasing by 0.1 - 0.2 % $\Delta\rho$.
- e) For the correction for the heterogeneity of the wrapper steel and the interstitial sodium three solutions give a negative value of -0.25 % $\Delta\rho$, whereas one solution gives a positive effect of +0.2 % $\Delta\rho$. Here some further investigations seem necessary.

The overall picture of the comparison is very satisfactory, especially in view of the facts that

- the benchmark core is a complicated system
- the different contributors used very different data and methods

- the sodium void effect is a very complex parameter with largely compensating positive and negative components.

Finally, it can be stated that the reduction of the total sodium void effect by implementing the sodium plenum above the core is achieved without penalties for other core parameters as it is the case in other near-zero SVE concepts such as pancake or radial heterogeneous cores. The only drawback of the plenum implementation is a slight reduction of the breeding ratio due to the axial breeder suppression which would be a disadvantage in case that strong breeding is requested.

The benchmark has shown that the overall sodium void effect of the benchmark core with its specified properties is close to zero and that it might be even slightly negative if the negative heterogeneity correction (about $-0.2 \% \Delta \rho$) is taken into account.

One can therefore conclude that the effectiveness of the design decisions having been introduced into the BN-800 reactor core are confirmed by this international benchmark.

With respect to the general feasibility of a near-zero void worth core two restrictions have to be made. The first one concerns the calculational uncertainty of the sodium void effect which at present is estimated to up to $\pm 0.7 \% \Delta \rho$ and in view of which each nominal value has to be seen. The second one is due to some special design features of the benchmark core (mainly the low burn-up) and the too thin pin steel plugs layer which tend to make the sodium void effect more negative.

The comparison of the other operational parameters has also shown very good agreement. The average values and their total spread are:

k_{eff}	1.0049	± 0.0087	
compensating rods worth	3.94	± 0.23	$\% \Delta \rho$
safety rods worth	3.66	± 0.33	$\% \Delta \rho$
breeding ratio, fissile zones	0.610	± 0.018	
int. breeder	0.090	± 0.002	
axial breeder	0.171	± 0.010	
radial breeder	0.129	± 0.004	
total	1.001	± 0.030	
reactivity loss per 30 efpd	0.58	± 0.06	$\% \Delta \rho$
max. linear rating, inner core	443	± 6	W/cm
outer core	451	± 7	W/cm

All total spreads are smaller than the uncertainties in the prediction of these parameters, with the exception of the k_{eff} .