ZPR-6 Assembly 7 Corrective Factors

The specifications of this experiment are provided on the "International Handbook of Evaluated Reactor Physics Benchmark Experiments" under the name "ZPR-LMFR-EXP-001" in the Liquid Metal Fast Reactor chapter.
The homogeneous R-Z model and associated dimension are shown in Fig. 1 and homogeneous compositions are in Table I (both taken from the benchmark DVD).

For the deterministic model (one quarter only of the geometry was described) the following meshing has been used with equidistant points in the same region:

Axis							
R	Point	1	24	54	74	85	
	Dimens.	0.0	24.3435	80.7984	112.2504	140.2589	
Z	Point	1	51	64	69	74	80
	Dimens.	0.0	76.2813	101.7257	106.6800	110.5357	121.9200

The following S_4 angular data have been used. Just a reminder that directions with zero weight are used only for improving convergence on the curvilinear derivative term and should not affect the final result if not used, as it is the case of some S_n codes (e. g. TWOTRAN, TWODANT).

Direc.	Weight	η	μ
1	0.0000000E+00	-0.8819200E+00	-0.4714000E+00
2	0.8333331E-01	-0.8819200E+00	-0.3333333E+00
3	0.8333331E-01	-0.8819200E+00	0.3333333E+00
4	0.0000000E+00	-0.3333333E+00	-0.9428100E+00
5	0.8333331E-01	-0.3333333E+00	-0.8819200E+00
6	0.8333331E-01	-0.3333333E+00	-0.3333333E+00
7	0.8333331E-01	-0.3333333E+00	0.3333333E+00
8	0.8333331E-01	-0.3333333E+00	0.8819200E+00
9	0.0000000E+00	0.8819200E+00	-0.4714000E+00
10	0.8333331E-01	0.8819200E+00	-0.3333333E+00
11	0.8333331E-01	0.8819200E+00	0.3333333E+00
12	0.0000000E+00	0.3333333E+00	-0.9428100E+00
13	0.8333331E-01	0.3333333E+00	-0.8819200E+00
14	0.8333331E-01	0.3333333E+00	-0.3333333E+00
15	0.8333331E-01	0.3333333E+00	0.3333333E+00
16	0.8333331E-01	0.3333333E+00	0.8819200E+00

Corrective factors have been calculated with the ENDF/B-VII cross section data. In tables II and III we provide the corrective factors for the homogenous R-Z model for Monte Carlo (MC) and deterministic S_4P_1 33 group calculations. Spectral indices have been calculated at the central location. Corrective factors are calculated as the ratio between the values obtained by the detailed Monte Carlo calculation and those obtained by the corresponding approximated calculation.

Figure 1. R-Z homogeneous model

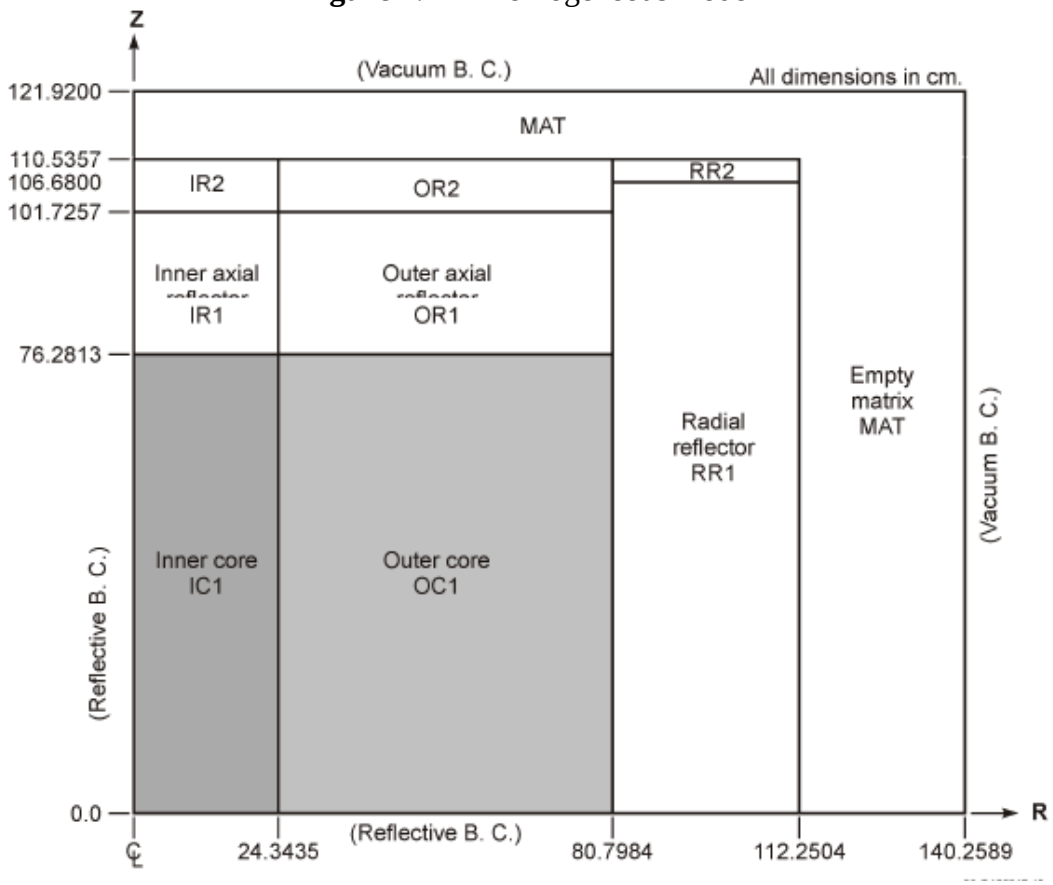

Table I. Homogeneous R-Z compositions.

Nuclide	Inner Core IC1	Outer Core OC1	Inner Axial Reflector 1 (IR1)	Inner Axial Reflector 2 (IR2)
^{240}Pu	1.17621E-04	1.17551E-04	0.00000E+00	0.00000E+00
^{241}Pu	1.32171E-05	1.50239E-05	0.00000E+00	0.00000E+00
^{235}U	1.26065E-05	1.26448E-05	8.29422E-05	8.65264E-05
^{238}U	5.79290E-03	5.81017E-03	3.71167E-02	3.87479E-02
^{239}Pu	8.86521E-04	8.86314E-04	0.00000E+00	0.00000E+00
^{238}Pu	3.33012E-07	4.68474E-07	0.00000E+00	0.00000E+00
^{242}Pu	1.40289E-06	1.76343E-06	0.00000E+00	0.00000E+00
^{241}Am	3.12449E-06	2.58715E-06	0.00000E+00	0.00000E+00
Cr	2.69312E-03	2.68787E-03	1.64641E-03	1.44970E-03
Ni	1.19777E-03	1.18818E-03	6.89374E-04	6.07516E-04
Fe	1.28729E-02	1.32415E-02	6.06025E-03	5.25530E-03
^{27}Al	4.02097E-06	1.63640E-05	0.00000E+00	0.00000E+00
^{23}Na	9.27911E-03	9.11269E-03	0.00000E+00	0.00000E+00
^{16}O	1.37692E-02	1.42601E-02	0.00000E+00	0.00000E+00
C	3.66420E-05	3.40451E-05	3.67281E-05	2.71677E-05
Mo	2.36058E-04	2.38695E-04	1.06205E-05	1.00416E-05
Mn	2.25629E-04	2.23933E-04	1.43193E-04	1.27167E-04
Cu	2.46769E-05	2.48245E-05	1.97417E-05	1.90679E-05
Si	1.62355E-04	1.54889E-04	1.06228E-04	9.52030E-05
Ca	2.13014E-06	2.09220E-06	0.00000E+00	0.00000E+00
Cl	2.98536E-07	2.96680E-07	0.00000E+00	0.00000E+00
^{59}Co	8.32422E-07	1.69933E-07	0.00000E+00	0.00000E+00
Nuclide	Outer Axial Reflector 1 (OR1)	Outer Axial Reflector 2 (OR2)	Radial Reflector (RR1)	Matrix (MAT and RR2)
^{240}Pu	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
^{241}Pu	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
^{235}U	8.26986E-05	8.54980E-05	8.66555E-05	0.00000E+00
^{238}U	3.70115E-02	3.82849E-02	3.88076E-02	0.00000E+00
^{239}Pu	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
^{238}Pu	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
^{242}Pu	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
^{241}Am	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
Cr	1.65503E-03	1.46815E-03	1.17821E-03	1.19186E-03
Ni	6.92826E-04	6.15041E-04	4.75780E-04	4.82129E-04
Fe	6.08806E-03	5.31944E-03	4.23998E-03	4.31040E-03
^{27}Al	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
^{23}Na	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
^{16}O	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
C	3.66408E-05	2.73038E-05	1.85721E-05	1.98538E-05
Mo	1.06734E-05	1.02040E-05	8.18136E-06	8.27768E-06
Mn	1.43786E-04	1.28519E-04	1.04936E-04	1.06060E-04
Cu	1.98177E-05	1.92138E-05	1.70748E-05	1.71923E-05
Si	1.06088E-04	9.54624E-05	6.76848E-05	6.88726E-05
Ca	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
Cl	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
^{59}Co	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00

Table II. Corrective factors for R-Z homogeneous **Monte Carlo** calculations.

Parameters	MC Detailed	MC R-Z Hom.	**Corr. Fact.**	Experiment
K_{eff}	1.00094 ±7 pcm	0.98680	**1.01433** ±100pcm	1.00051 ±230pcm
F49/F25	0.9093 ±0.0065	0.9213	**0.9870** ±1.0%	0.9435 ±2.1%
F28/F25	0.0224 ±0.0002	0.0214	**1.04673** ±1.0%	0.0223 ±3.0%
C28/F25	0.1336 ±0.0008	0.1388	**0.9625** ±1.0%	0.1323 ±2.4%

Table III. Corrective factors for R-Z homogeneous **deterministic** calculations.

Parameters	MC Detailed	S_4 R-Z Hom.	**Corr. Fact.**	Experiment
K_{eff}	1.00094 ±7 pcm	0.98915	**1.01192** ±100pcm	1.00051 ±230pcm
F49/F25	0.9093 ±0.0065	0.9232	**0.9849** ±1.0%	0.9435 ±2.1%
F28/F25	0.0224 ±0.0002	0.0218	**1.0275** ±1.0%	0.0223 ±3.0%
C28/F25	0.1336 ±0.0008	0.1387	**0.9632** ±1.0%	0.1323 ±2.4%