Introduction

A new expanded exercise to **update target accuracies for design** and **required cross section accuracies** to meet them has been recognized of relevance for the **NEA HPRL** update in order to provide potential experimental and evaluation priorities and to **support data files adjustments** based on selected integral experiments and improved adjustment methods as suggested in SG39.

This SG46 activity could be organized in **two phases**:

First phase: gathering data, agreed requirements and share of work (2019)

- List of available systems and models
- Select isotopes and reactions
- Available sensitivities
- New sensitivities
- Design requirements revision
- Available covariance data sets
- Share of work

Second phase: running target accuracies requirements (2019-2020)

- Definition of an agreed list of integral parameters to be accounted for
- Selection of one or more covariance data sets as initial uncertainties
- A-priori uncertainty analysis
- Use of nuclear data correlations in TAR: algorithm to be used
- Definition of experiment weights
- TAR calculations
- Analysis of results and rationale for their compilation/distribution

System	Model availability	Sensitivities (a)	Integral parameters (b)	Volunteer (c)
ABTR: 250 MWth – Na cooled; U-TRU-10Zr metal fuel; HT9(75%)-Na(15%) reflector; enrichment: 17%, MA: <1%; irradiation cycle: 109.8 days	SG26	TBD		
SFR: (Burner: CR=0.25) 840 MWth – Na cooled; U-TRU-Zr metal fuel; SS reflector; enrichment: 56%, MA: 10%; irradiation cycle: 155 days	SG26	TBD		
EFR: 3600 MWth – Na cooled; U-TRU oxide fuel; U blanket; enrichment: 22%, MA: 1%; irradiation cycle: 1700 days	SG26	TBD		
GFR: 2400 MWth – He cooled; SiC - (U-TRU)C carbide fuel; Zr3Si2 reflector; enrichment: 17%, MA: 5%; irradiation cycle: 415 days;	SG26	TBD		
LFR: 900 MWth – Pb cooled; U-TRU-Zr metallic alloy fuel; Pb reflector; enrichment: 21%, MA: 2%; irradiation cycle: 310 days	SG26	TBD		
ADMAB: ADS 377 MWth – Pb-Bi cooled; TRU nitride fuel; HT9 (70%) Pb-Bi (30%) reflector; enrichment: 32%, MA: 67%; irrad. cycle: 366 days. ADS oriented	SG26	TBD		
VHTR: TRISO fuel; enrichment: 14%; BU: 90 GW d/Kg	SG26	TBD		
Extended BU PWR: enrichment: 8.5%; burnup: 100 GW d/Kg	SG26	TBD		
ABR: oxide fuel, 1000 MWt, equilibrium cycle core (beginning of cycle compositions include higher actinides and fission products)	SG33	TBD		
ABR: metal fuel, 1000 MWt, equilibrium cycle core (beginning of cycle compositions include higher actinides and fission products)	SG33	TBD		
JOYO Experimental fast reactor (Japan)	SG33	TBD		
JSFR 750 MWe fast neutron core (Japan)	2D Model K.Yokoyama	JAEA?		JAEA?
MYRRHA (SCK-CEN): Pb-Bi cooled fast reactor experimental reactor. ADS demonstrator	MC model Critical; subcritical	TBD		
ALFRED (LFR) European lead-cooled FR	ENEA	ENEA		ENEA
DLFR (LFR) Westinghouse derived LFR	ENEA	TBD		ENEA
MOSART: MOlten Salt (Na,Li,Be/F) Actinide Recycler & Transmuter (MOSART) system fuelled with Pu plus minor actinide trifluorides (AnF3) from PWR spent fuel without U-Th	KIT EGIEMAM-II benchmark	Files available in 33 g		
Low coolant void SFR burner with low CR (~0.5-0.6) loaded with a significant amount of MAs (MA:Pu=1:2). This model is inspired by a 1500 MWth version of French ASTRID core	KIT EGIEMAM-II benchmark	Files available in 33 g		

Already many feedbacks.

To be updated at this meeting (e.g. several proposals on MYRRHA and ALFRED)

(e.g. ASTRID-like system to be included, CIEMAT)

- **Sensitivities to be provided in 7 energy groups ("energy bands")**

Group	Upper Energy	Group	Upper Energy
1	$1.96403\ 10^{7}$	5	$2.03468\ 10^{3}$
2	$2.23130\ 10^{6}$	6	$2.26033\ 10^{1}$
3	$4.97871\ 10^{5}$	7	$5.40000\ 10^{-1}$
4	$6.73795\ 10^{4}$		

- **Parameters to be accounted for in the target accuracies assessment could vary from system to system. K_{eff} is the basic parameter and a minimum requirement; reactivity coefficients are to be included when possible/available: e.g. coolant void coefficient, temperature coefficients, reactivity loss/cycle, control rod worth, delayed neutron fraction. Also: transmutation related parameters**
- **Formulations to be found e.g. in the SG26 final report. In the case of the low Na void SFR and of the MOSART cores, reactivity coefficient descriptions can be found in the EGIEMAM-II final report.**
- **Volunteer do provide sensitivities and uncertainty analysis using selected covariance data sets, as documented e.g. in SG33 and SG39 activity and reports. They contribute/perform the target accuracy requirement assessment, according to formulation prescribed, see below.**

Revised design target accuracies (preliminary)

All Fast Reactors and ADS systems Target Accuracies (1σ)

Multiplication factor (BOL)	200 pcm
Power peak (BOL)	1%
Burnup reactivity swing	200 pcm
Reactivity coefficients (Coolant void and Doppler – BOL/EOL)	5%
Control rod bank	3%
Single control rod	2%
Major nuclide density at end of irradiation cycle	1%
Other nuclide density at end of irradiation cycle	10%

ADS values and parameters to be revised (JAEA, E. Ivanov)

Target Accuracy (1σ) for UO_2- and PuO_2-Fuelled VHTR's

Criticality	300 pcm (operation and safety)
Local power (in fuel compact)	5% (1% in pin-wise fission rate of fresh fuel; 3% in main fissile isotope conc. of irradiated fuel)
Burnup (cycle length)	1% (⇒ ~ 500 MWd/t)
Doppler coefficient	20%
Moderator temperature coefficient	1 pcm/°C
Nuclide inventories at EOL	
Main fissile isotopes	3%
Fertile isotopes	5%
MAs and FPs	20%

VHTR values and parameters to be revised (E. Ivanov)

High BU PWR Target Accuracies (1σ)

k_{eff}	Doppler temperature coefficient	Burnup $\Delta\rho$	Transmutation
0.3%	7%	300 pcm	5%

Molten Salts Reactors (for details and definitions, see EGIEMAM-II final report)

k_{eff}	Temperature coeff. : α -total (pcm/K)	Total core temperature effect, α–core (pcm/K)	Burnup $\Delta\rho$	Isotope Transmutation	β_{eff}	Mean Neutron generation time (Λ)
0.3%	5%	5%	300 pcm	5%	3%	3%

MSR values and parameters to be revised (E. Ivanov)

1- Target accuracy assessment algorithms

As far as target accuracy assessment algorithms, it is suggested to generalize the standard formulation, described below.

"The unknown uncertainty data requirements di can be obtained (e.g. for parameters i not correlated among themselves), by solving the minimization problem:

$$\sum_i \lambda_i / d_i^2 = \min$$

(i = 1…I, I: total number of parameters), with the following constraints:

$$\sum_i S_{R_n i}^2 d_i^2 < \left(R_n^T\right)^2$$

(n = 1…N, N is the total number of integral design parameters),

where S_{Rn}^{i} are the sensitivity coefficients for the integral parameter R_n, and R_n^T are the target accuracies on the N integral parameters; λ_i are "cost" parameters related to each σ_i and should give a relative figure of merit of the difficulty of improving that parameter (e.g., reducing uncertainties with an appropriate experiment)".

To account for nuclear data correlations, it is suggested to use the generalized formulation given in the following reference:

G. Palmiotti et al "Nuclear Data Target Accuracies for Generation-IV Systems Based on the Use of New Covariance Data" Journal of the Korean Physical Society, Vol. 59, No. 2, August 2011, pp. 1264~1267