# NSC Expert Group on Improvement of Integral Experiments Data for Minor Actinide Management

## Needs and Motivations

The Expert Group on Integral Experiments for Minor Actinide Management (EG on IEMAM) has reviewed the existing integral experiments for MA management and identified a lack of experiments and insufficient accuracies in several areas. In many cases, useful results are not fully available, because of proprietary considerations. Moreover, EGIEMAM performed uncertainty analyses and target accuracy assessments and confirmed needs for improvements of nuclear data. After reviewing the integral experiments, EGIEMAM recognized that there exists only limited number of facilities and limited expertise and resources (materials, manpower, funding). Therefore, there is a need to prepare for a concerted effort paving the way for a common experimental program where resources can be optimized towards improving the MA nuclear data knowledge. In conclusion, EGIEMAM has recommended integral measurements, complementary to parallel efforts for differential measurements (to be coordinated by WPEC), for the following nuclides of MA from viewpoints of design of transmutation systems and of fuel cycles: $^{237}$Np, $^{241}$Am, $^{242m}$Am, $^{243}$Am, $^{242}$Cm, $^{243}$Cm, $^{244}$Cm and $^{245}$Cm.

## Scope

To improve knowledge of MA nuclear data and to support the MA management technology development with reliable accuracy, and sufficient anticipation, the EG pointed out that many additional integral data are still necessary. The first step in this direction requires pooling resources and identifying qualified facilities, personnel, measurement techniques, and available supplies of materials to target experiments to meet specific MA data needs. From the lessons learned, two major categories, reactor physics and irradiation experiments, require specific actions by international collaboration.

**Objectives**

The following will be conducted and reported to NSC.
The proposed areas of work are:

1. Identifications of systems of interest and associated target uncertainties
2. Joint design of reactor physics MA measurements in selected facilities
   - Selection of reactions and nuclides to be measured including assessment of the new measurement techniques/data, and specifications of the integral experiments including target uncertainties and suitability for benchmarking purposes
   - Consideration and determination of facilities and required expertise and resources
   - Development and coordination of the experimental program (including assessment and sharing of resources and results, time schedule, cost…)
3. International collaboration of irradiation program for MA
   - Selection of reactions and nuclides to be irradiated including assessment of the new measurement techniques/data, and specifications of the integral experiments including target uncertainties
   - Selection of irradiation facility
   - Considering preparation of the samples and resources for irradiation and time schedule for irradiation
   - Considering evaluation of the experiment and potential benchmarking for future studies
   - Development and coordination of the irradiation program (including assessment and sharing of resources and results, time schedule, cost …)

**Links to other groups**

The expert group will work in co-ordination with the Working Party on Scientific Issues of Reactor Systems (WPRS, including IRPhE Project), Working Party on Scientific Issues of Fuel Cycle (WPFC), of The Working Party on International Nuclear Data Evaluation Co-operation (WPEC).
WPEC-SG39, CIELO,

4. **Identifications of systems of interests and associated target uncertainties. Consideration of request and priority list of nuclear reactions**

- Review of the request list from EGIEMAM (K. Tsujimoto)
- Presentation from Secretariat on related NEA activities on MAM
- Review of relevant activities in WPEC and WPFC (M. Salvatores, G. Palmiotti)
- Proposal of uncertainties analysis for $^{241}$Am from UK (A. Barnes)
- Preliminary $^{241}$Am Uncertainty Analysis (G. Palmiotti)

5. **Joint design of reactor physics MA measurements in selected facilities**

- Review of candidate experimental facilities with respect to the available experimental tools and time schedule of existing experimental program and future plan: VENUS-F (Belgium, A. Kochetkov), FCA (Japan, K. Tsujimoto)
- Review of new experimental techniques recently developed (G. Imel and B. Geslot)
- Selection of measurements of the nuclides reflecting discussion about agenda item 4
- Review of the past collaborative experiments for planning of new experimental program: IRMA (MASURCA) (M. Salvatores, G. Palmiotti), Delayed neutron measurement (FCA, MASURCA) (S. Okajima)
- Experimental data in IRPhE database suitable for consideration in benchmark analyses (E. Ivanov)

6. **International collaboration of irradiation program for MA**
   - Review of present status and future plan of irradiation facility, and availability of international collaborative irradiation experiment: ATR (USA, G. Youinou), JHR (France, P. Blaise), Joyo and Monju (Japan, K. Tsujimoto), TAPIRO (Italy, M. Carta)
7. **Possible impact on design applications**
   - Possible impact of the potential experimental program on reduction of uncertainties to meet target values (G. Palmiotti)
8. **List of actions**
9. **Date of the next meeting**
10. **Any other business**

8. The recommendations of EGIEMAM to additional integral experiments were the following:

- Reaction rate measurements
    - Measurement of the following data especially in fast system

      Capture: $^{237}$Np, $^{241}$Am, $^{243}$Am, $^{244}$Cm, $^{245}$Cm

      Fission: $^{245}$Cm
- Small sample reactivity measurements
    - Accumulation of data especially for Minor Actinides (MA) in fast system
    - Importance of pre-analysis (e.g., estimation of reactivity worth & sensitivity analysis)
- Mock-up experiments
    - Necessary of other experiments in future
    - Starting the design study on preparing the experiments
- MA sample irradiation experiment
    - Selection of reactions and nuclides to be irradiated including assessment of the new measurement techniques/data, and specifications of the integral experiments including target uncertainties

**33. E. Ivanov** (IRSN) presented "Experimental Data in the ICSBEP and IRPhE Databases Suitable for Consideration in Benchmark Analyses". DICE (ICSBEP database) and IDAT (IRPhE Database and Analysis Tool) were introduced and several data for integral validation of MA were shown. In the conclusion, the following were remarked:

- Data related to MA integral validation have been searched in the openly available ICSBEP and IRPhE databases.
- Very few integral parameters ($k_{eff}$, reaction rates, and sample reactivity) have been found that address identified needs to a limited extend.
- Majority of the data were measured on BFS1 facility, i.e., they are highly correlated via MA samples and major actinides loading.
- For the data mining from certain experiments, statistical analytical methods should be elaborated or developed.
- Evaluation of the experiments performed in the past would address some of the needs.
- New experiments, if they will be performed, should be carefully designed using best estimate techniques in order to provide accurate data that cover the variety of applications.

34. **G. Youinou** presented "MANTRA: An Integral Reactor Physics Experiment in the Advanced Test Reactor". Overview of the ATR and the MANTRA experiment was introduced. The objective of the MANTRA is to infer the effective neutron capture cross-sections of various materials ($^{232}$Th, $^{233}$U, $^{235}$U, $^{236}$U, $^{238}$U, $^{237}$Np, $^{239}$Pu, $^{240}$Pu, $^{242}$Pu, $^{244}$Pu, $^{241}$Am, $^{243}$Am, $^{244}$Cm, $^{248}$Cm, $^{149}$Sm, $^{153}$Eu, $^{133}$Cs, $^{103}$Rh, $^{143}$Nd, $^{145}$Nd, $^{105}$Pd, and $^{101}$Ru) for reactor physics in fast and epithermal spectra. As for the PIE status, MC-ICPMS measurements have completed for the Thin-B and Cd filtered samples and should be completed for the Thick-B filtered samples by the end of 2014. AMS measurements using the ATLAS facility at ANL is expected in 2015.

35. Possible next step (MANTRA-2) was briefly introduced. The MANTRA-2 will possibly be conducting experiments with actinides which were not covered in the MANTRA using different filters to simulate diverse neutron spectra. A separate experimental program was also suggested to be performed at a zero power facility:

- Measurement of fission rate spectral indices using fission micro-chamber can allow to assess the knowledge on a vast range of actinides (major and minors)
- Reactivity sample oscillations measurements (actinides and fission products)
- Flat/Steep adjoint experiments