Open issues on the use of cross section adjustment after Subgroup 33: Need for a new Subgroup?

In the first Subgroup 33 intermediate report it was found out that the statistical adjustments methodologies in use worldwide are essentially equivalent. The subsequent document, summarizing the main conclusions of the results comparisons of a benchmark exercise, has indicated that sensitivity analysis requires careful use of existing methods and has pointed out the crucial role of the covariance data used, both those associated to the nuclear data and those associated to the integral experiments. This last result is very general and it confirms the findings of some previous adjustment study.

However, some important issues that need further investigation and consideration by an enlarged group of experts (i.e. with a wider participation of evaluators and nuclear data experimentalists) have also been pointed out.

In the past cross section adjustments were used as they are, i.e.as "face values" to be used directly in reactor design applications, often in association with the same calculation code system employed in the experiment analysis. Less frequently, the data adjustments for specific reactions and energy ranges have been used as indicators of potential areas for data improvement. The recent availability of high accuracy deterministic three-dimensional transport codes and the generalized use of powerful Monte Carlo based methods, has resulted in drastically reduced calculation approximation and uncertainties, making most of the observed discrepancy between calculation and experimental results dependent solely on cross sections inaccuracies and uncertainties. Therefore, the role for cross section adjustment is more and more perceived as that of providing useful feedback to evaluators and differential measurement experimentalists in order to improve the knowledge of neutron cross sections to be used in a wider range of applications. This new role for cross section adjustment requires to solve a new series of issues. In the following we will list, and this is not at all exhaustive, some of these outstanding issues.

A preliminary issue is that, before providing a useful feedback, one has to assess the reliability of a cross section adjustment. A unique formal method does not exist, but criteria have been suggested:

- Verification if the uncertainty of any observed C/E is larger than of that evaluated using cross section covariance. This should suggest inconsistency between cross section uncertainty and/or experimental ones
- Verification if the adjusted cross sections require corrections of the a-priori values outside the initial one-sigma uncertainty. Again this could suggest inconsistency in the starting covariance matrix.
- Large individual experiment contribution to a normalized χ^2 exceeding 1. This has been, in the past, interpreted as an inconsistency of that experiment with the rest of other experiments used in the adjustment. However, this also can be viewed as an inability of the a priori cross section covariance to accommodate the initial observed discrepancy on the C/E.

From the previous (certainly not exhaustive) list a strategy should be suggested in order to assess the validity of the initial cross section covariance employed in the cross section adjustment and of the credibility of the proposed adjustments.

Let's now to proceed to list issues more specific to feedback provided by the cross section adjustment that should define the objectives of a new Subgroup:

- Are the a-posteriori central values to be used exclusively as "face values" (as done in the past for fast reactor design in France, in Japan or in Russia)? In order to make this step one has to be absolutely sure that first the adjustment is reliable (see previous points) and secondly that all important contributions to an adjustment have been taken into account. For instance, are

all significant isotopes, reactions, and energy ranges included in the adjustment? However, as indicated previously, this approach provides in principle data to be used only in a specific reference design or for few other selected configurations, very close (in terms of sensitivity profiles) to the reference design and has only of limited impact on new evaluations.

- The same question applies to the diagonal values of the a posteriori covariance matrix. Are these values to be considered the new goal to be achieved in a new of evaluation of cross section data? For the uncertainties of cross sections that are deemed to be too low because of the inconsistencies observed in the adjustment, at the moment only a qualitative feedback can be provided. It will be more productive to find a formal way to provide a quantitative value.
- What use should be made of the off diagonal terms of the a posteriori nuclear data covariance matrix? After adjustment one obtains a full covariance matrix with many new correlations, positive or negative. In a traditional adjustment these terms are the ones that mostly contribute to the uncertainty reduction on the neutron reactor design integral parameters. Can we interpret these values as providing useful physical information to be transmitted as feedback, or are these just the result of a pure mathematical process?
- The cross section adjustment not only provides an a posteriori full nuclear data covariance matrix, but also a full covariance matrix between cross sections and experiments. Is there a role for these data that can be translated in a useful feedback?
- Is it possible, and if yes, how, to extrapolate the results of an adjustment to a different range of applications (e.g. different reactor systems) for which the adjustment was not initially intended? A formal method based on the inspection of sensitivity profiles could help to this goal. More generally, is it possible to apply systematically the adjustment methods to basic nuclear parameters, in order to avoid the dependence of a specific adjustment made at a multigroup energy level on the spectrum and composition characteristics of a reference system? Some attempts in this direction have been made by different groups, but no formal comparison has been made up to now.
- How can one provide guidelines to perform new experiments that were identified as needed by the cross section adjustment, based on quantitative criteria? Again, this task today is based essentially on qualitative indication and not on a real quantitative assessment.

Based on the previous list of issues, and if there is agreement on their importance, is there a need for a WPEC Subgroup where experts (evaluators, experimentalists and data users) can discuss them and come up with practical, as far as possible formal, and, in any case, general recommendations to be useful in support of new coordinated evaluation initiatives?