Short Note on the LB=8 Covariance Processing

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Introduction

The LB=8 section is designed to represent the fluctuations of a cross section within an energy interval for which the average covariance data are given in other sections. The objective and the description in the manual are fine, but the equation in the manual completely defeats the objective. The issue has been the subject of many discussions in the past, but no remedial action was taken. The equation is:

$$VAR_{jj} = F_k \, \Delta E_k/\Delta E_j \text{ , where } E_k \le E_j \le E_{j+1} \le E_{k+1}$$

where:

VAR_{jj} is the variance in the user energy group j in the interval ΔE_j from E_j to E_{j+1},
F_k is covariance element given in the file
k is the suffix for the energy group in which the covariance data are given,
j refers to the user energy group contained within a covariance data group k.

Immediately we see that the contribution to the variance is small when the user group is much broader than the data group, but the variance may become arbitrarily large as the user group becomes narrow. This is clearly nonsense, because arbitrarily large contribution to the variance also occurs in realistic cases where an energy-group boundary of the user grid is nearly (but not exactly) coincident with the covariance data grid, that might be due to numerical roundoff. Another out-crying example is the variance of the cross section at an energy point, which is equivalent to the situation where the user group *j* is infinitely narrow.

Alternative definition

An alternative convention for defining the variance without changing the formats is proposed:

$$VAR_{jj} = F_k \, (1 - \Delta E_j/\Delta E_k) \text{ , where } E_k \le E_j \le E_{j+1} \le E_{k+1} \qquad (2)$$

which implies that the variance in user groups equal or wider than the covariance data group is described by the data given in other sections. In energy intervals that span only

part of the covariance data energy group the variance is increased by up to F_k for pointwise data and zero for broad groups.

The above definition places reasonable bounds on the uncertainty for pointwise data as well as for broad user-defined energy groups. Furthermore, it seems likely that evaluators ignored equation (1), which would require them to know the user-defined energy grid, and coded the data logically according to the description; this approach is consistent with equation (2). The practical impact of the proposed change on existing data is therefore minimal. However, the algorithms in the processing codes would nee to be changed accordingly.

Implication on the Formats

For backward compatibility it is desirable to keep the features that were legal in the format at some stage. Unfortunately there is no place in the formats for LB=8 to add a switch about the alternative definition. A reasonable choice is to define LB=9 with the definition of VAR_{jj} as given by equation (2).

The necessary changes in the manual include the following:

- Replace all references to "LB=8" with "LB=8 and 9"
- Replace the last paragraph on Page 33.1 and the first paragraph on Page 33.12 with the text below:

Begin quote:

In general, each F_k characterizes an uncorrelated contribution to the absolute variance of the indicated cross section averaged over any energy interval (sub-group) ΔE_j that includes a portion of the energy interval ΔE_k.

In an LB=8 sub-subsection the variance contribution to the processed group variance for the energy group (E_j,E_{j+1}) is inversely proportional to its width ΔE_j when (E_j,E_{j+1}) lies within (E_k,E_{k+1}) and is obtained from the relation

$$VAR_{jj} = F_k \, \Delta E_k/\Delta Ej \, , \text{ where } E_k \le E_j \le E_{j+1} \le E_{k+1}$$

Such situation may occur in fine-group resonance tables, but may cause processing difficulties, where the user's energy grid and the covariance data grid are nearly coincident. The variance defined by LB=8 is not applicable to pointwise data.

In an LB=9 sub-subsection the variance contribution to the total variance of a parameter is given by:

$$VAR_{jj} = F_k \, (1- \Delta E_j/\Delta E_k) \text{ , where } E_k \le E_j \le E_{j+1} \le E_{k+1}$$

The variance remains finite and is applicable to pointwise cross sections. It may represent structure that is implicit in scattered experimental data, in which the resolution is not sufficient to determine the detailed shape.

End quote.