International Atomic Energy Agency

INDC(NDS)-378
Distr. CI, G, NG

INDC **INTERNATIONAL NUCLEAR DATA COMMITTEE**

Report on the Consultants' Meeting on

"Preparation of the Proposal for a Coordinated Research Project to Update X- and γ-ray Decay Data Standards for Detector Calibration"

IAEA Headquarters, Vienna, Austria
24 - 25 November 1997

Edited by
A. Nichols and M. Herman

May 1998

IAEA NUCLEAR DATA SECTION, WAGRAMERSTRASSE 5, A-1400 VIENNA

Reproduced by the IAEA in Austria
May 1998

INDC(NDS)-378
Distr. CI, G, NG

Report on the Consultants' Meeting on

"Preparation of the Proposal for a Coordinated Research Project to Update X- and γ-ray Decay Data Standards for Detector Calibration"

IAEA Headquarters, Vienna, Austria
24 - 25 November 1997

Edited by

A. Nichols and M. Herman

Summary

The IAEA Nuclear Data Section had been charged by the International Nuclear Data Committee to consider the establishment of a Coordinated Research Project (CRP) to update the IAEA database of X- and γ-ray Standards for Detector Calibration. This CRP should re-define the radionuclides most suited for detector calibration, extending applications to safeguards, materials analysis, environmental monitoring, and medical uses. Hence, a Consultants' Meeting was arranged to assess the current needs, redefine the most suitable radionuclides, and advise the IAEA Nuclear Data Section on the need and form of such a CRP.

Contents

IAEA Consultants' Meeting on

"Preparation of the Proposal for a Coordinated Research Project to Update X- and γ-ray Decay Data Standards for Detector Calibration"

IAEA Headquarters, Vienna, Austria
24 - 25 November 1997

Introduction

The primary objective of the Consultants' Meeting on X- and γ-ray Decay Data Standards for Detector Calibration is to advise the IAEA Nuclear Data Section on the need and scope for a Coordinated Research Programme in this area (see appendix for list of attendees). Since the publication of IAEA-TECDOC-619 [1] in September 1991, a significant number of measurements have been published of direct relevance to the formulation of the decay database for the original 39 radionuclides; such measurements alone justify re-visits to the decay data of specific radionuclides within IAEA-TECDOC-619.

After extensive debate, the Consultants' Meeting broadened the radionuclide listing to encompass additional user applications beyond that of reference standards for γ-ray spectroscopy to γ-ray calibrants for environmental monitoring, safeguards, medical applications and materials analysis. Thus a list of 67/68 radionuclides (see Table 1) evolved for inclusion in a rejuvenated IAEA database from a combination of IAEA-TECDOC-619 [1], NPL Report RSA(EXT)53 [2], and an on-going international evaluation programme (involving LPRI, PTB, INEL and others), see Table 2. It should be noted that ^{161}Tb, ^{169}Yb and ^{170} Tm are included primarily as X-ray calibrants for diffraction spectrometry. While safeguards activities need to be accommodated when appropriate (e.g. ^{166m}Ho decay data), transactinide decay data would be best addressed in a separate CRP which is currently in the early planning stage (for example, ^{233}Pa, ^{235}U, ^{237}Np and ^{239}Pu, and U and Pu X-rays are better identified with a CRP on Transactinide Decay Data, planned to commence in 1999).

Radionuclides

Table 1 is judged to represent a comprehensive list of radionuclides for calibration purposes that should be considered as a suitable starting point by the proposed CRP to update X- and γ-ray Standards for Detector Calibration. Decay data to be recommended include half-lives, and X-ray and γ-ray emission probabilities; X-ray energies should be based on sound theoretical considerations, while γ-ray energies should be adopted from the most recent study of energy standards by Helmer and van der Leun. The consultants stress that the relevant decay data for a significant number of these radionuclides are currently being re-evaluated in a combined, international exercise led by the International Committee for Radionuclide Metrology (ICRM), coordinated by R.G. Helmer. These studies are indicated in Table 2, and should be taken into account by the IAEA-NDS CRP exercise.

X-ray Standards

Recommendations:

1. K X-ray data: Separate entries are recommended for $K_{\alpha1}$, $K_{\alpha2}$, $K_{\beta1}'$, $K_{\beta2}'$ transitions (primed values denote weighted averages for composite lines).
2. L X-ray data: Separate entries should be included for lines resolvable with state-of-the-art semiconductor detectors. A further option in a few selected cases of heavy elements would be to include separate entries for lines resolvable with diffraction spectrometers.
3. Summary tables: X-ray energies and emission probabilities for nuclides ordered according to Z and A.
4. Auxiliary tables: Fluorescence yields: A: K shell, B: L sub-shells (including the Coster-Kronig yields).
5. Auxiliary table: Recommended high-precision γ-ray data for energy and efficiency calibration in the X-ray region.

Internal Conversion Coefficients

The following procedure is recommended for the determination of internal-conversion coefficients. If an evaluation of the measured values results in a value with an uncertainty of less than 3%, it is recommended that the measured value be used. If this is not the case, it is recommended that the values interpolated from the table of Rösel et al. [3] be used for the range of atomic number for which they exist.

It is further recommended that, if possible, the CRP make available to all participants an interpolation routine and data file to undertake these calculations so that they are done consistently. This data file should be extended to low atomic numbers by including the Band values (this may require a Z-interpolation scheme).

The internal pair formation coefficients can be interpolated from the tables of Schlüter and Soff [4].

Higher γ-ray Energies

The Consultants' Meeting recommends that the new CRP extend the range covered by the evaluated data in IAEA-TECDOC-619 to higher energies. As a start in this direction, evaluations should be undertaken for the several nuclides that were collated in TECDOC-619, but not evaluated. These include the decay of ^{66}Ga (9.5h) with lines up to 4.2 or 4.8 MeV, and the thermal neutron capture reactions $^{14}N(n,\gamma)^{15}N$ with lines up to 10.8 MeV and $^{35}Cl(n,\gamma)^{36}Cl$ with lines up to 8.6 MeV. There are also a number of resonant proton capture reactions listed in TECDOC-619 which populate levels that decay via a small number of rays whose relative emission probabilities are well known (and usually near 1.0), with energies up to 10.8 and 13.9 MeV.