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Summary Report

Third Research Coordination Meeting on Reference Database for Neutron Activation Analysis

IAEA Headquarters, Vienna, Austria
17 – 19 November 2008

Prepared by

Mark A. Kellett
IAEA Nuclear Data Section
Vienna, Austria

December 2009

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Abstract

The third meeting of the Co-ordinated Research Project on "Reference Database for Neutron Activation Analysis" was held at the IAEA, Vienna from 17 – 19 November 2008. A summary of presentations made by participants is given, reports on specific tasks and subsequent discussions. With the aim of finalising the work of this CRP and in order to meet initial objectives, outputs were discussed and detailed task assignments agreed upon.

December 2009

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1. Introduction

The aims of the Co-ordinated Research Project (CRP) on "Reference Database for Neutron Activation Analysis" are to improve the status of the database of nuclear constants for k_0-NAA, to contribute to the quantification of nuclear structure and decay data, and to remove or reduce some of the discrepancies that exist between the integral constants and values derived from differential data. This CRP originated following the support of the International Nuclear Data Committee (INDC) which advises the Nuclear Data Section (NDS) on nuclear data issues. The INDC recommended in the Summary Report of their meeting of May 2002, INDC/P(02)-23, that a CRP on "Reference Database for Neutron Activation Analysis" be initiated in 2005.

A complementary project is running at NAPC Industrial Applications and Chemistry Section on "k_0-IAEA Software Development for Neutron Activation Analysis". This software package has been chosen as the reference analysis tool for the current CRP and appropriate feedback is being provided.

The 1st Research Coordination Meeting (RCM) was held at the IAEA, Vienna, Austria, 3-5 October 2005, and is summarized in IAEA report INDC(NDS)-0477, the 2nd RCM was held at the IAEA, Vienna, Austria, 7-9 May 2007 and is summarized in IAEA report INDC(NDS)-0514, and the 3rd RCM was held at the IAEA, Vienna, Austria, 17-19 November 2008 and is summarized here.

A. L. Nichols, Head of the IAEA-NDS, opened the meeting and M. A. Kellett (IAEA-NDS), the Project Officer, presented some initial comments reiterating the aims and scope of the CRP. M. Blaauw (Delft University of Technology, the Netherlands) was elected Chair of the meeting and M. A. Kellett Rapporteur. Following the adoption of the Agenda (Appendix A) the Chair invited each participant (Appendix B) to present a summary of the work being carried out under the auspices of the CRP.

2. General Presentations

2.1 F. De Corte, Ghent University, Belgium

A summary of work carried out was presented, with emphasis on addressing tasks assigned at previous RCMs, including:

a) determination of peak areas from a supplied gamma spectrum using two pieces of software, i.e. *hyperlab* and *hypermet*, - results were supplied to M. Blaauw, task co-ordinator;

b) contribution to the detector efficiency calibration exercise - results supplied to Z. Revay, task co-ordinator;

c) recommendation of additional monitor materials, to be used for neutron spectrum characterisation, based on capture and/or threshold reactions and availability, i.e. ^{115}In, ^{64,68}Zn, ^{58}Ni, ^{54,58}Fe and ^{98,100}Mo;

d) assessment of availability and appropriateness of using SMELS (synthetic multi-element standard) material for comparative materials analysis. Following discussion with Peter Vermaercke (SCK·Mol, Belgium, the supplier of SMELS) it was judged to be appropriate for use in internal comparisons. CRP participants not having a sample can obtain one upon written request, but it was noted that no further production of SMELS was envisaged;

e) an electronic file containing half-life data had been extracted from the k_0 database and given to M. A. Kellett who had made a comparison with other suitable sources, in particular the JEFF-3.1 radioactive decay data sub-library. Following this a number of differences were identified owing to the different origins of these data. Generally the k_0 database takes half-life values from Isotope Explorer at Lawrence Berkeley National Laboratory (http://ie.lbl.gov/isoexpl/isoexpl.htm) and it was concluded that unless a specific problem exists, there was no specific need or desire to change these data;

f) missing ^{192}Ir experimental data, which were previously measured, have still not been found following the relocation of the laboratory;

g) newly measured ^{95,97}Zr k_0-values (Xilei Lin, Technical University of Munich) have been studied in great detail.

The Ghent University research reactor was shutdown in December 2003 and so no materials analysis by neutron activation analysis has been possible.

2.2 F. Leszczynski, Comisión Nacional de Energía Atómica, Argentina

Owing to the new RA-6 reactor core at CNEA a series of Monte Carlo calculations with MCNP5 were presented in order to determine the neutron spectral variation with burn-up. In particular three methods have been applied which couple a burn-up calculation with the MCNP5 calculation using:

a) the ORIGEN code and point-wise cross-sections to calculate the nuclide inventory for each burn-up step;
b) the DRAGON cell method with point-wise cross-sections to calculate the nuclide inventory for each burn-up step, and;
c) the DRAGON cell method with multi-group cross-sections to estimate an effective multi-group cross-section for the cell, based on the nuclide inventory for each burn-up step.

Results were presented for the integrated neutron flux in three broad energy groups versus burn-up, as well as, the detailed neutron spectra for a fresh core in two irradiation channels, calculated using both point-wise and multi-group cross-sections. The results from both methods are comparable. Results of the neutron spectra calculated for seven burn-up steps using multi-group cross-sections were also shown. In summary, neutron spectra for the new RA-6 reactor core as a function of burn-up have been determined and can be applied to different applications as required.

2.3 Z. Révay, Institute of Isotopes, Budapest, Hungary

Presented a summary of work on prompt gamma activation analysis (PGAA) being carried out at the cold neutron beam facility. In particular:

a) the neutron beam-line has been adjusted such that there is now no direct line of sight, meaning that the facility is truly a pure cold beam with an *f*-factor of ∞ (previously 60 000) and the flux has increased from $3x10^7$ to $1.2x10^8$ $n.cm^{-2}.s^{-1}$;
b) use of a beam-chopper allows both in-beam and chopped-beam measurements to be made;
c) completed in-beam k_0 measurements, which are particularly useful for relatively short-lived nuclei, were reported for 12 nuclei, and the results were generally consistent with theoretical and/or other measured values;
d) and earlier chopped-beam k_0 measurements were also reported for 20 nuclei (many having multiple peaks) - generally good agreement was seen in comparison with other measured values, with only a very small number requiring further investigation;
e) further in-beam and chopped-beam measurements have recently been undertaken and are still being analysed;
f) and, in particular, the effect of a non 1/v cross-section was studied and analysed in terms of an irregularity factor for five different neutron beams (three at Budapest, two at NIST) and the measured Westcott *g*-factors for four of these were presented.

Finally, future measurement plans were shown for ten (n, γ) reactions on ^{58}Fe, ^{64}Zn, ^{85}Rb, ^{93}Nb, ^{109}Ag, ^{130}Ba, ^{133}Cs, ^{152}Gd, ^{152}Sm and ^{169}Tm.

2.4 X. Lin, Technical University of Munich, Germany

Recent precise measurements of k_0-values for the two reactions $^{94}Zr(n, \gamma)^{95}Zr$ and $^{96}Zr(n, \gamma)^{97}Zr/^{97m}Nb$, which have been undertaken in the Garching reactor, were presented, including:

a) details of the procedure and constraints for k_0-value determination for high Q_0 reactions, irradiation conditions and measured neutron flux *f*-factors from bare monitors;
b) measured Cd-ratio values for two flux monitor reactions, $^{197}Au(n, \gamma)^{198}Au$ and $^{96}Zr(n, \gamma)^{97}Zr$, at a reduced power of 300 kW, which allowed the *f*-factor to be determined, including details of the full uncertainty budget;
c) measured *f*-factors from the two procedures above confirmed the very high thermal-to-epithermal neutron flux ratio, and highlighted the suitability of the Garching reactor for k_0-value determination for high Q_0-value reactions;
d) efficiency curve measurement for the hyper-pure germanium detector system, obtained using a

multi-source standard (Amersham QCY48), complemented with two additional multi-line sources (^{152}Eu and ^{133}Ba), including full uncertainties, in the energy range 50 keV – 2 MeV;

e) experimental results for the k_0-values, including full details of the components of the uncertainty budget;

f) experimental results showing the ^{96}Zr(n, γ)^{97}Zr/^{97m}Nb k_0-values determined at different reactor thermal power settings; and

g) brief information was presented on the details of the k_0-value measurement currently in progress for the ^{129}I(n, γ)^{130}I reaction.

It was concluded that these k_0-value measurements are consistent with previous measurements at other facilities and recommended values and De Corte complimented Lin on his meticulous and convincing work. It was suggested that; i) some of the γ-ray energy and emission probability data, used in the calibration of the hyper-pure germanium detector, might need to be re-checked and the Decay Data Evaluation Project (DDEP) was given as a suitable source for obtaining such data, and ii) that these newly determined k_0-values should be used to calculate Q_0-values, but attention must be paid to the true 1/v behaviour of the cross section.

2.5 P. Schillebeeckx, IRMM, Geel, Belgium

Presented details of the GELINA time-of-flight facility at the IRMM in Geel and current transmission/capture measurements being undertaken to improve the consistency between microscopic cross-section data and integral quantities through benchmark calculations. Particularly highlighted were:

a) a series of measurements of the ^{197}Au(n, γ)^{198}Au standard, resulting in a new evaluation from thermal to 100 eV (with the resolved and unresolved resonance regions to follow) and how these data compared particularly well with the ENDF/B-VII evaluation, whose thermal value is taken from the work of the IAEA standards group;

b) measurement of the ^{103}Rh(n, γ)^{104}Rh cross section, both thermal and in the resonance region, with the evaluation soon to be completed;

c) independent thermal cross sections measured for ^{1}H(n, γ), ^{10}B(n, α), ^{197}Au(n, γ) – both absorption and capture, and ^{103}Rh(n, γ);

d) a series of measurements of the ^{nat}Cd(n, γ) cross section (both capture and transmission) and the subsequent analysis with the REFIT code;

e) and a series of measurements of the $^{96,\ nat}$Zr, $^{182,\ 184,\ nat}$W (n, γ) cross section (both capture and transmission) are in progress.

2.6 R. B. Firestone, Lawrence Berkeley National Laboratory, USA

Presented a summary of work on the comparison of, and additions to, recommended k_0 factors and those calculated from basic nuclear data parameters, e.g. σ_0 and P_γ. In particular:

a) recommended k_0 factors from the De Corte k_0 database (*Atomic Data and Nuclear Data Tables* **85**, 47-67 (2003)) were compared with those calculated from i) evaluated thermal neutron radiative capture cross sections (σ_0) (from Mughabghab, *Atlas of Neutron Resonances*, Elsevier, 2006) and ii) the partial γ-ray thermal radiative cross sections (σ_γ (= $\sigma_0 P_\gamma$)) measured at the Budapest reactor, with P_γ values taken from either the *Table of Radionuclides*, BIPM, or the ENSDF database;

b) the agreement between the k_0 factors from these independent data sources is generally very good, although the variations between them indicate that both the k_0 and σ_γ databases can be improved by consideration of all data sources;

c) many additional recommended k_0 values have been calculated from these additional data sources;

d) three conflicting cases were highlighted for ^{23}Na, ^{41}K, ^{64}Ni(n, γ) where recent measurements at the Budapest reactor result in higher σ_0 values than those found from both De Corte and Mughabghab - new measurements are planned at the Budapest reactor by Révay and Simonits to investigate these problems;

e) goal is to recommend and publish a set of k_0, σ_γ and σ_0 values, for all known γ-rays from all thermal neutron activation products, as evaluated using standard statistical techniques, and this will be included in a first revision release of the Evaluated Gamma-ray Activation File (EGAF).

2.7 R. Jaćimović, Jožef Stefan Institute, Slovenia

Presented a summary of work carried out on the characterisation of the neutron spectrum in their 250-kW TRIGA Mk II reactor with graphite reflector. In particular:

a) a set of samples (Al, Au, Th, U, and Fe) were measured at maximum power, in the carousel,
b) a further set of samples (Al, Au, Th, U, and W) were measured at maximum power, both in the central core channel and in the carousel,
c) and Rh samples were measured in the pneumatic transfer channel, located on the edge of the core,

using the Cd-ratio method, from which the measured thermal and fast neutron spectra were compared with MCNP-5 full core model calculations.

A re-evaluation of earlier SMELS measurements was also presented, comparing versions 3 and 4 of the k_0-IAEA software. A favourable comparison was shown for the two versions against the reference values, except for the Se value in type III, which was almost 20% lower than the reference concentration. The P_γ values included in the software's database were shown to vary significantly from those recommended by F. De Corte.

[Upon later investigation by M. Blaauw (the author of the software), this discrepancy with ^{75}Se was indeed identified to be due to the P_γ values being incorrect in the software's database, and so these were corrected in the next release of the software.]

2.8 S. A. Jonah, Ahmadu Bello University, Nigeria

Presented a summary of work that has been carried out in order to characterise the reactor at Ahmadu Bello University, which is a miniature tank-in-pool low-power research reactor, including:

a) neutron flux measurements which showed the stability of the reactor over a several hour period of operation, and also allowed the characteristics of two new irradiation channels to be determined,
b) development of an MCNP-5 model of the reactor that is being run on a cluster of machines running LINUX. This model has been used to calculate the neutron energy spectrum in a standard 640 group structure in both inner and outer channels, and these results compare well with measurement, as do the neutron spectrum parameters, e.g. *f*-factors,
c) the fission spectrum averaged cross-section measurements showed reasonable agreement with evaluated sources, with further measurements planned. The measurements were made relative to both the ^{27}Al(n, p) and ^{197}Au(n, γ) cross-sections,
d) the k_0-IAEA software has been installed and testing has started - further work is required,
e) a measurement of the SMELS material is underway prior to analysis, and
f) the capability for measurements of σ_0 and I_0 using the Cd-ratio technique are being developed.

3. Task Specific Presentations

At the 2nd RCM two main tasks had been identified and allocated to task co-ordinators, who presented their findings.

3.1 Peak Area Determination, M. Blaauw

An updated analysis of the peak area determination task, running since the 1st RCM, was presented by M. Blaauw (Delft University of Technology, the Netherlands) based on the collation of the results obtained by the various participants who had been supplied with a combined ^{152}Eu and ^{22}Na γ-ray test spectrum obtained at Delft University of Technology using a 10% efficiency well-type detector. The participants had locally analysed this spectrum in order to obtain the areas of the numerous peaks, and their analyses were returned to the co-ordinator for comparison. The various observations include:

a) no participant had corrected for the ~4% dead time determined at the time the spectrum was measured (a constant 25 Hz pulse was used to check this),
b) some participants had used the inserted and therefore anomalous peak at 121.8 keV (which does not fit to the energy calibration curve) for their actual energy calibration (along with the 1408 keV peak), and this approach led to problems in identifying the energies for all other

peaks. The co-ordinator made an adjusted peak area file using the calibration approach followed by these participants, so that their analyses could then be correctly examined,

c) almost all participants quoted underestimated peak area uncertainties, except one, whose energy uncertainties were also very large (~10 keV) - probably these were the peak width uncertainties, rather than the uncertainty on the energy determined for the peak,
d) identification of small peaks was adversely affected by problematic energy calibrations,
e) the lack of dead-time correction, or not knowing whether one had been applied or not, reflects badly on the spectrum analysis software in not making it clear to users which corrections have been applied,
f) close attention needs to be paid in determining the initial energy calibration, i.e. more than two energy points should be used, and finally,
g) the co-ordinator felt that all participants were able to determine peak areas sufficiently well, albeit care should be taken with:
    i) initial energy calibration,
    ii) use of dead-time correction, and
    iii) accurate reporting of uncertainties.

The results and conclusions of this task will be included in the final report of the CRP.

3.2 Comparison of Detector Efficiency Calibration Methods, Z. Révay

Presented an updated summary of the detector efficiency calibration task, initiated at the 1^{st} RCM, but a second exercise was undertaken following the 2^{nd} RCM, when new spectra were supplied. These spectra were taken with an increased source-detector distance (now 23cm, instead of 5cm originally) owing to the problem of coincidence summing observed in the analysis of the original spectra.

The form of a semi-empirical efficiency curve was shown, which can be created by applying various corrections to the theoretical efficiency (geometric efficiency), e.g. absorption (in both the dead layer and the aluminium window), and the strongly energy-dependent components from the photo-electric effect, Compton scattering (single and multiple) and pair production (at higher energies).

The task involved using a supplied set of peak areas, energy and emission probabilities and source activities (all quoted with their associated uncertainties) to determine a detector efficiency curve. A number of analysis methods were compared particularly the use of a variety of different order polynomials. Concluded that:

a) published efficiency curves are far too generic to be used for a specific detector, if the required uncertainty level is to be achieved,
b) fitted functions do not normally follow any physically reasonable shape, i.e. as expected from a semi-empirical approach,
c) the more parameters that are used, the better the fit,
d) the mid-energy range should not be assumed to be linear, although this is often the case,
e) the curves received were comparable to a few percent, but many lacked appropriate uncertainty information.

The final conclusions of this exercise are that it is essential to locally measure the efficiency curve for one's own detector, as many systematic uncertainties disappear when the detector is used in the same environment, and that one should not adopt an efficiency curve from another laboratory - even though the respective detectors are "identical" - as the detection system and locality can affect performance and accurate knowledge of systematic uncertainties would be required.

The results and conclusions of this task will be included in the final report of the CRP.

4. Nuclear Constants in Relation to Differential Data

In order that neutron activation measurements and k_0-value determination can play a role in providing feedback to the differential cross-section data community, the calculational methodology using nuclear constants must be well-defined. A. Trkov (Jožef Stefan Institute, Slovenia) presented details of how this can be achieved and what measurements are required.

Definition of constants

He described how in a standard 1/E spectrum for a traditional 1/v absorber, the assumption that the Westcott *g*-factor is unity, is not always sound, but that this can be taken into account by measuring the *f*-factor for the facility, i.e. the ratio of the epi-thermal to thermal neutron flux. One actually measures an *effective f*-factor (not the *"true"* physically defined *f*-factor) meaning that the measured value is inherently corrected for the non-unity nature of the Westcott *g*-factor.

An alternative method to the traditional use of the cadmium ratio method was also described, whereby one measures simultaneously the sub-cadmium reaction rates for a sample relative to a standard. This method has the advantage that both the sample and the standard are measured under truly identical reactor conditions, as they are irradiated at the same time, but has the disadvantage that one introduces a dependence on the knowledge of the respective gamma emission probabilities. It was recommended that by using both methods a cross-check of their consistency could be achieved.

Neutron self-shielding

The MATSSF code has been developed to calculate the self-shielding factors in samples under irradiation and the validity of using this code was described, by comparing the factors calculated with other methods, including those from Chillian et al and the Monte Carlo technique. For self-shielding factors below 10%, all of the methods used are consistent to within 5%, and even for very complex matrices (where flux depression within the sample becomes important and self-shielding factor approach 100%) the methods of main interest are generally consistent to within 10-20%.

Neutron Spectrum Characterisation

This particular aspect of the work was reported at the previous meeting and by S. A. Jonah at this meeting. Complete spectrum characterisation has been carried out for the IJS TRIGA Mk-II reactor and also the Nigerian reactor. One point to note is that one needs reliable differential cross-section data for the various monitor reactions, as these are implicitly used in the measurement and characterisation of the spectrum.

Nuclear Data Considerations

It was concluded that when one is updating nuclear data at any stage of the procedure, in order to avoid creating inconsistencies in the basic nuclear data files, updates should only be applied to the complete file for a given nuclide, rather than by applying cross-nuclide corrections for one particular parameter. For example, a problem of consistency had been noted (and later corrected) when only the effective resonance energy was updated in a given nuclear data file.

Finally the relevant outputs from this part of the CRP were summarised as follows:

a) validation and delivery of the MATSSF code for self-shielding calculations,

b) validation and delivery of the GRUPINT code for reactor neutron spectrum manipulation,

c) validation and delivery of a group-wise activation library, and,

d) production of a journal paper (also to be included as a chapter in the final report) with a rigorous and self-consistent definition of basic nuclear data constants.

5. The k_0-IAEA Software Package

M. Blaauw presented details of the most recent developments to the k_0-IAEA software and database, many of which were a direct consequence of the code's use by the CRP participants, by making a demonstration of the package.

The most significant improvement to the usability of the package has been the production of a whole new set of help files and an improved user manual, along with a new computerised tutorial which now includes audio to explain the functionality of each menu item.

In terms of the physics within the package, the MATSSF code (detailed earlier) has also been included, allowing self-shielding factors to be calculated for a user-specified sample. The problem of the inclusion of the uncertainty on this calculated factor still needs to be addressed, in particular when the sample includes a complex matrix material. It is probably necessary to issue a warning to the user when this calculated factor affects the final concentrations by more than 3% or so.

Work has also been undertaken in terms of the quality assurance of the package, now allowing re-analysis of previously stored spectra and graphical/tabulated comparisons to be made for analyses carried out at different times. In this way the user can check the consistency of their results against both the time of the experiment and/or analysis.

6. Deliverables, Outputs and Tasks

The overall objectives and outputs of the CRP were well defined at the start of the project. Following the discussions during the meeting, they were restated for clarity:

1. The CRP will result in a selected set of newly measured k_0 and Q_0 values. These new values will be tested in the analysis of reference materials, and recommended to the wider k_0 community.
   (When conflicts arise between k_0 and Q_0 values measured at different facilities, an attempt will be made to reconcile them by means of the methodology described by A. Trkov.)
2. The CRP will produce a comparison database where the k_0, Q_0 and half-life values are compared with values in other databases. These results will be added to a new release of the Evaluated Gamma-ray Activation File (EGAF).
3. A k_0 consistent differential cross-section database of recommended data will be produced.

6.1 Chapters and Tasks for the Final Report of the IAEA CRP

The following remaining tasks have been assigned to the participants (identified by their initials), with expected completion dates:

Delivery date	Participant	Task
1 March 2009	ZR/SJ	Report k_0 values
1 March 2009	AT	Report on new Q_0, E_r
30 March 2009	FDC	Calculate k_0 values (from these Q_0 values)
15 April 2009	MB	Validate these k_0 values against reference materials already measured at TU Delft, including SMELS
1 June 2009	RBF	Compare k_0 values with the contents of EGAF

The following chapters will be included in the final report of the CRP and have been assigned to the participants as shown:

1. Introduction (expanded from the CRP proposal documentation), MAK
2. Summary of proficiency tests:
    a) Peak area determination, MB
    b) Detector efficiency calibration exercise, ZR
    c) SMELS analysis, MA, MAK
    d) Conclusions, All
3. Recommendations for experimental procedures (including software use and FDC's recommendations on additional monitor materials), MB
4. Newly measured data and validation (a-c, ZR, SJ, RJ/AT, XL):
    a) Efficiency calibration determination
    b) Neutron spectrum characterisation
    c) k_0, Q_0 measurements, FDC
    d) Validation against reference materials, MB
5. Comparison of k_0, σ_0, σ_γ, half-lives, Eγ, Pγ (EGAF), RBF
6. Comparison of neutron energy dependent cross-section data and Q_0, AT
7. Conclusions/recommendations, All
8. Appendix: k_0-IAEA software improvements resulting from the CRP, MB

7. Conclusions

During the CRP a compilation of newly measured k_0 and Q_0 values determined since 2003 has been produced, a number of which were measured within the CRP. These new values have been validated by analysis of previously measured reference materials. Hence these values form a basis for future recommendations and integration into the relevant international data libraries.

The k_0 database, including new measurements, was used to generate improved σ_0 and Pγ values for inclusion in the EGAF database. Thus the updated EGAF database will provide a self consistent set of k_0, σ_0 and Pγ values. These values can be considered for adoption in the next evaluation of k_0 values.

Consistent neutron energy dependent cross-section files have been produced through adjustment of existing evaluations to the relevant integral constants of k_0-NAA, i.e. σ_0, Q_0.

A significant number of improvements and enhancements have been made to the k_0-IAEA software owing to its use by participants, and corrections to the internal database have also been made.

The participants wished it to be noted that a continuing activity related to the collection of future measured k_0 values would be of great value to the neutron activation analysis community.

Appendix A

IAEA

3rd Research Coordination Meeting on

"Reference Database for Neutron Activation Analysis"

IAEA Headquarters, Vienna, Austria
17 – 19 November 2008
Meeting Room A2313

AGENDA

(As adopted at the meeting)

Monday, 17 November

08:30 - 09:30	**Registration** (IAEA Registration desk, Gate 1)
09:30 - 10:15	**Opening Session**
	Welcome address – A.L. Nichols (Head, Nuclear Data Section)
	Introductory Remarks – M.A. Kellett
	Election of Chairman and Rapporteur
	Discussion and Adoption of Agenda (Chairman)
	Review of Tasks/Actions from the 2nd RCM
10:15 - 11:00	**Administrative Matters**
	Coffee break
11:00 - 12:30	**Session 1: Presentations by Participants (All)**
	(15 minutes for each presentation and 5 minutes for discussion)
12:30 – 14:00	*Lunch*
14:00 - 15:30	**Session 1 (cont'd): Presentations by Participants (All)**
	(15 minutes for each presentation and 5 minutes for discussion)
	General Discussion
15:30 - 16:00	*Coffee break*
16:00 - 17:30	**Session 2: Discussion of the Final Results of the Various Test Cases (All)**
	Gamma spectrum analysis/peak area determination
	Detector efficiency calibration
	Materials analysis (SMELS)
	General Discussion of what can be used in the Final IAEA Technical Report

Tuesday, 18 November

09:00 - 10:15 **Session 3: Recommended use of Differential Data (A. Trkov)**
Relation between integral and differential data
Neutron spectrum determination / monitor reactions
Using differential data to calculate macroscopic NAA quantities, calculational method description, associated problems, etc.
Recommended differential data and an appropriate database
General Discussion

10:15 – 10:45 *Coffee break*

10:45 – 12:15 **Session 4: k_0-IAEA Software Package (M. Blaauw)**
Recent developments
Recommended use
General Discussion

12:15 – 13:30 *Lunch*

13:30 – 17:30* **Session 5: Contents of the Final IAEA Technical Report and Chapter assignment, Outputs (Database(s)) (All)**
Introduction/Conclusions/Recommendations (M.A. Kellett, …)
Evaluated Gamma-ray Activation File (R.B. Firestone)
Recommended k_0 (Q_0, σ_0, half-life, …?) values (F. de Corte, Z. Révay, …)
Description of the computational method and recommended microscopic cross-sections (A. Trkov, …)
Recommended software, k_0-IAEA and/or others, and "best practice" usage (M. Blaauw, …)
Recommended experimental procedures, pitfalls, etc. (Z. Révay, …)
General Discussion on the Final Report, Outputs and Timescales/Deadlines

***15:30 – 16:00** *Coffee break*

19:00 *Dinner at the "Zur Goldenen Glocke" Restaurant*

Wednesday, 19 November

09:00 - 10:30 **Session 6: Review of Tasks/Actions (All)**

10:30 – 11:00 *Coffee break*

11:00 – 12:30 **Session 7: Drafting of the Recommendations for the Final Report (All)**

12:30 – 14:00 *Lunch*

14:00 – 15:30 **Session 8: Drafting of the 3rd RCM Summary Report (Rapporteur, All)**

15:30 **Close of the Meeting**

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"Reference Database for Neutron Activation Analysis"
IAEA Headquarters, Vienna, Austria
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