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Summary Report of Second Consultants' Meeting

Beta-decay and decay heat

held in collaboration with WPEC Subgroup 25
Validation of Fission Product Decay Data for Decay Heat Calculations
OECD/NEA, Paris, France

NEA Data Bank, Paris, France

3 May 2006

Prepared by

Alan L. Nichols
IAEA Nuclear Data Section

June 2006

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Abstract

Participants at an IAEA Consultants' Meeting at IAEA Headquarters on 12-14 December 2005 debated the needs for additional decay data to be measured and entered in the various decay-data libraries for decay heat calculations. Specific recommendations and actions arose from this meeting in 2005, and were addressed further at another IAEA Consultants' Meeting on 3 May 2006 prior to a full meeting of the OECD/NEA Working Party on International Nuclear Data Evaluation Cooperation (WPEC). Decay-data requirements were reviewed during the course of the discussions, and a relatively comprehensive list of radionuclides was prepared to be recommended for TAGS measurements (total absorption gamma-ray spectroscopy). This meeting was organized in collaboration with the OECD/NEA Data Bank through Subgroup 25 of the WPEC.

June 2006

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1. INTRODUCTION

A previous IAEA Consultants' Meeting held in Vienna on 12 to 14 December 2005 resulted in discussions on the suitability and completeness of various national and international decay-data libraries for decay heat calculations [1]. These nuclear applications libraries include JEFF-3.1, JENDL FP Decay Data File 2000 (hereafter JENDL-FPDD) and a preliminary version of ENDF/B-VII. Quantitative studies and confident predictions of the resulting decay heat from post-irradiated nuclear fuel are extremely important for the safe and economic operation of nuclear power plants and subsequent fuel element storage and processing. A significant amount of nuclear data needs to be known with sound estimates of their uncertainties: neutron cross-sections, fission yields and decay data (fission products and actinides – half-lives, and mean light-particle (beta) and electromagnetic (gamma) energies).

Prior to reporting to the OECD/NEA Working Party on International Nuclear Data Evaluation Cooperation (WPEC) on 4-5 May 2006, Subgroup 25 of the WPEC held a one-day meeting at the NEA Data Bank, Paris, in collaboration with the IAEA Nuclear Data Section, to review their analyses of the decay data needs for decay heat calculations (Appendix 1). A primary aim was to initiate actions to produce a well-defined list of fission-product radionuclides for future TAGS measurements (total absorption gamma-ray spectroscopy) in order to assist and guide experimentalists.

Participants elected Dr. T. Yoshida as Chairman, and A.L. Nichols as Secretary for the meeting. The provisional agenda was accepted as appropriate (Appendix 2). Apologies for absence were received from Berta Rubio (IFIC, Valencia, Spain) and Mark Kellett (IAEA Nuclear Data Section).

2. PREVIOUS MEETING AND ACTIONS ARISING

The minutes of the Consultants' Meeting on 12-14 December 2005 were accepted as a true record of events without any corrections or modifications.

2.1. Actions

2.1.1. Understand and resolve some of the discrepancies between libraries – Bersillon/Yoshida/Kellett/Sonzogni by May 2006.

While some specific features of these discrepancies had been satisfactorily addressed by Bersillon (^{89}Sr , ^{96}Sr), much remained unresolved as noted in a paper prepared by Bersillon, January 2006 ("Some comments on the discrepancies between libraries for the nuclei of the first list"). Some debate concerning these nuclides occurred during the course of this second meeting, but actions still remain with Nichols (^{87}Br), Yoshida (^{92}Rb , ^{96}Y , ^{98}Nb , ^{102}Tc , ^{135}Te and ^{142}Cs) and Bersillon (^{97}Sr) concerning the justification for these individual radionuclides to be recommended for TAGS measurements.

ACTION remains.

2.1.2. Identify any additional decay heat measurements from Japan – Yoshida by end of January 2006.

ACTION completed: ^{235}U and ^{237}Np measurements on Yayoi.

2.1.3. Provide comprehensive list of decay heat measurements – Mills by end of January 2006.

ACTION completed (including provision of Tobias data).

Concern was expressed with respect to the discrepancies between ORNL decay heat benchmark data [2] and other such data sets at cooling times beyond 1,000 secs.

ACTION: Ian Gould (ORNL) to determine the extent of this disagreement of the ORNL decay heat measurements of Dickens et al. [2] with other earlier studies, and issue a statement concerning data validity.

2.1.4. Introduce requests for required TAGS measurements in NEA High Priority Request List – Henriksson.

ACTION still on-going – dependent on agreed output from this meeting.

2.1.5. Contact Idaho National Laboratory (INL) to obtain raw TAGS data of Greenwood et al. [3] – Sonzogni by end of January 2006.

ACTION withdrawn – raw TAGS data of Greenwood et al. are unavailable.

2.1.6. Undertake analyses of INL TAGS data (if available) – negated by unavailability of data.

2.1.7. Undertake detailed comparisons of INL TAGS radionuclides (JENDL-FPDD, JEFF-3.1 and INL TAGS) – Kellett and Yoshida by end of March 2006.

ACTION completed by Bersillon.

2.1.8. Contact laboratories where TAGS measurements might be undertaken – Gelletly et al. by end of January 2006.

ACTION completed – studies continue at the University of Jyväskylä, Finland, and are envisaged at IPN-Orsay, France.

2.1.9. Convene meeting of representatives from industry, laboratory managers and experimenters to resolve manpower and resource issues – Gelletly et al. by mid-2006.

ACTION on-going – meeting has now been scheduled for 17 July 2006 at IPN-Orsay (proposed measurements planned on ALTO facility at IPN-Orsay).

2.1.10 Undertake TAGS measurements of a small number of key nuclides at existing facilities – Gelletly et al.

ACTION on-going – see Section 3.6.

2.1.11. Organise inclusion of the Greenwood et al. (and other TAGS) data into an appropriate database – Henriksson et al.

ACTION on-going - create a TAGS database as data become available (but INL TAGS data are unavailable (see above) – continue action with any other TAGS data).

3. PRESENTATIONS

3.1. Decay heat calculations with preliminary ENDF/B-VII library (A. Sonzogni, NNDC, Brookhaven National Laboratory, USA).

The TAGS measurements of Greenwood et al. [3] have been introduced into ENSDF, and the resulting decay-data file used to calculate the total, beta and gamma energy components of the decay heat for various fissioning actinides (^{235}U and ^{239}Pu). These data were compared with the recommended Tobias

decay-heat data [4, 5]. Sonzogni noted that the new decay database will be adopted in the ENDF/B-VII library, and included the following new features:

- (a) used BrICC internal conversion coefficients (Kibedi et al. analyses of Band and Raman model [6]);
- (b) mean beta energies for a number of 2nd forbidden non-unique transitions (not relevant to decay heat calculations);
- (c) half-life values from Möller 1997 for some fission products below $T_{1/2}$ of 1 sec [7].

Sonzogni also intends improving the X-ray and Auger-electron data of this library.

Sensitivity studies included increasing the electromagnetic energy component by 50%, and decreasing the light-particle energy component by 50%. A check was made of the main contributors to the electromagnetic decay heat with respect to their Q-values, known/unknown decay scheme, and possible presence of the pandemonium effect (lack of valid gamma-ray data), along with TAGS measurements having been/not been performed at INL. This exercise generated two priority lists of radionuclides that have incomplete decay schemes and/or evidence of pandemonium (for ²³⁵U and ²³⁹Pu fission) – these fission-product nuclides were introduced into the provisional tabulation of “Radionuclides recommended for TAGS measurements” (Table 2 of INDC(NDS)-0483, January 2006).

3.2. Decay heat calculations with JEFF-3.1 library (R.W. Mills, Nexia Solutions, BNFL, UK).

Mills stressed the importance of decay heat calculations for the safe handling of spent nuclear fuel from the point of view of transport, storage and reprocessing. Validation is also required for short cooling times in terms of the total, beta (light particle) and gamma (electromagnetic) decay heat and their uncertainties.

Decay heat calculations have been carried out for ^{235, 238}U and ^{239, 241}Pu thermal neutron-induced fission pulses based on various JEF decay data libraries (JEF-1, JEF-2.2 and JEFF-3.1) and the FISPIN inventory code. The majority of these data sets exhibit calculation/experiment (C/E) ratios that vary by factors of -0.8 to +1.15 over a cooling time of 10⁵ secs (most significant C/E deviations occur with the ²³⁹Pu beta and gamma decay components).

3.3. Assessment of TAGS data on the gamma decay heat for ²³⁵U and ²³⁹Pu with JEFF-3.1 (C.J. Dean, Serco Assurance, Winfrith, UK).

The gamma contributions to decay heat in fission pulses on ²³⁵U and ²³⁹Pu have been studied over 1 to 10⁴ secs (2.8 hours). These calculations involved a number of important variations:

- (a) predictions using mean gamma energies from Greenwood et al. (TAGS) [3];
- (b) predictions using mean gamma energies from Rudstam;

and their comparison with Tobias’ standards [4, 5], and the recent measurements at Lowell, Yayoi and ORNL. The Tobias decay heat standards are based on least-squares fits to fifty-four ²³⁵U and twenty-eight ²³⁹Pu measurements. Dean noted that UK and Japanese decay heat calculations involve the adoption of thermal fission yields for both thermal and fast spectral studies, while French studies are based on fast yields for fast reactors and thermal yields for thermal reactors.

Important observations include the following:

- (a) introduction of Rudstam mean gamma energies [8] for important radionuclides without discrete emission data exhibits no improvement over JEFF-3.1;
- (b) introduction of the existing TAGS mean gamma energies of Greenwood et al. [3] shows a significant improvement relative to JEFF-3.1 for both ^{235}U and ^{239}Pu , particularly for cooling times from 20 to 200 secs;
- (c) calculations tend to underpredict decay heat relative to benchmark experiments;
- (d) Tobias' standards data are generally higher than the experimental data up to ≈ 100 secs [4, 5].

3.4. Remarks on decay heat calculations (O. Bersillon, CEA Bruyères-le-Châtel, France).

Bersillon reported on comparisons of JEFF-3.1 with JENDL-FPDD decay data files. Q-values in these two libraries can differ by as much as 40%, despite the known similarities over the previous 15 years between these data for the nuclides of greatest interest in the Audi and Wapstra atomic mass tables. The most up to date atomic mass tables should be used (AME2003) in the various decay data libraries [9], and such adoptions impact directly on the energies of the individual beta transitions that would need to be adjusted in the files. Comparisons had also been made between the equivalent Rudstam and Greenwood et al. data, which were found to exhibit differences of 20 to 25% in their mean beta energies. Bersillon noted significant differences in the mean energy data for both ^{140}Cs and ^{144}La that could be resolved by TAGS. In particular, ^{144}La would appear to possess an extremely complex decay scheme that could be better addressed by adopting the TAGS data of Greenwood et al. [3].

After some debate, participants agreed that specific issues noted by Bersillon in January 2006 need to be addressed by individual participants (Bersillon, Nichols and Yoshida), as specified in Section 2.1.1.

3.5. Assessment of TAGS measurements from studies of JENDL-FPDD and JEFF-3.1 data libraries (T. Yoshida, Musashi Institute of Technology, Japan).

Decay heat calculations of the gamma (electromagnetic) component after a fission pulse in ^{239}Pu were used to study the impact of introducing the Greenwood et al. TAGS data into JENDL-FPDD and JEFF-3.1. While these modifications to the JEFF-3.1 library improved the fit of the resulting decay heat calculations towards the benchmark measurements, the same additions to JENDL-FPDD resulted in remarkable deviations from these same integral data. Yoshida was able to use these calculations and knowledge of the half-lives, Q-values of the various fission products and the following criteria to produce a list of radionuclides that merit TAGS studies:

- (a) contribution to the difference between JEFF-3.1 and JENDL-FPDD is greater than 1% of the total difference in the beta and gamma decay-heat components;
- (b) highest evaluated nuclear level is less than 70% of the known Q-value.

The resulting list of radionuclides included high priority $^{98, 101}\text{Nb}$ and $^{102, 104, 105}\text{Tc}$; and medium priority ^{100}Zr , $^{99, 102}\text{Nb}$, $^{103, 105}\text{Mo}$ and $^{103, 106, 107}\text{Tc}$. These radionuclides were introduced into the provisional tabulation of "Radionuclides recommended for TAGS measurements" (Table 2 of INDC(NDS)-0483, January 2006).

3.6. TAGS experimental status

Gelletly (University of Surrey, UK) queried the emphasis on TAGS measurements. All participants agreed that an ideal resolution of current decay-data issues would also have to include well-defined decay schemes derived from high-resolution gamma-ray spectroscopy. Nevertheless, reliable mean decay data are sufficient for the resolution of decay heat issues. On this basis, TAGS measurements of

the important fission-product nuclides are critical in design and safety assessments of advanced reactor systems such as Generation-IV and beyond.

Tain (IFIC, Spain) summarized on-going negotiations with experimental research institutes that possess or are planning to assemble facilities suitable for TAGS studies. The ALTO facility is in the process of being designed and assembled at IPN-Orsay – this apparatus should become available within 2 years, and has the capability of studying refractory radionuclides which is an important feature with respect to specific fission products of interest (Nb, Tc and Mo). One envisaged problem will be any request to study radionuclides that undergo delayed neutron emission; consideration is being given to such nuclides in order to avoid possible errors in any TAGS measurements (DESPEC).

Algora (IFIC, Spain) described recent TAGS measurements at the University of Jyvaskyla that focused on $^{102, 104, 105}\text{Tc}$. Difficulties had been experienced with preparing the ^{102}Tc source, but he was in the process of analysing the $^{104, 105}\text{Tc}$ data to produce mean beta and gamma energies. A new proposal had also been prepared to undertake further measurements at the University of Jyvaskyla:

		Q_{β} (keV)	$T_{1/2}$ (secs)
^{102}Tc	\rightarrow ^{102}Ru	4532	5.28
^{103}Tc	\rightarrow ^{103}Ru	2662	54.2
^{103}Mo	\rightarrow ^{103}Tc	3750	67.5
^{105}Mo	\rightarrow ^{105}Tc	4950	35.6
^{106}Tc	\rightarrow ^{106}Ru	6547	35.6

and possibly $^{98, 101}\text{Nb}$ and ^{107}Tc . A laser ionization process is required to produce “clean” isotopic sources.

Additional discussion included the identification of suitable journals for the publication of TAGS data directed towards the resolution of decay-heat calculations for nuclear power plant: *Phys. Rev. C*, *Nucl. Sci. Eng.*, *Nucl. Instrum. Meth. Phys. Res. A or B* and *Appl. Radiat. Isot.*

4. CONCLUDING REMARKS

Various presentations at the two Consultants’ Meetings have assisted greatly in the assembly of a list of radionuclides recommended for TAGS measurements (Table 1). This list has been refined over the previous 5 months, but still requires further analysis and clarification as indicated in the comments column. Comparisons between the relevant files in JENDL-FPDD and JEFF-3.1 (and ENDF/B-VII) are particularly important, and need to be made as soon as possible, particularly with respect to identifying the origins of the mean energy data in the specific JENDL-FPDD files. All actions that arose from the meeting on 3 May 2006 or remain outstanding from December 2005 are listed in Appendix 3.

Good progress is being made in the identification of suitable TAGS facilities in Europe. The plans for ALTO at IPN-Orsay represent an exciting opportunity for undertaking TAGS for some of the more refractory radionuclides to be found in Table 1. Full support should be given by Subgroup 25 and WPEC to the experimental team as they begin negotiations with the management of the IPN-Orsay facility.

A report was prepared for the main WPEC meeting under the authorship of T. Yoshida as coordinator of Subgroup 25 (Appendix 4). This report covered the work undertaken over the previous 12 months, and included both Consultants’ Meetings in December 2005 and May 2006. No further Consultants’ Meetings are envisaged within the terms of reference of Subgroup 25. Rather, a final report will be prepared before the end of calendar year 2006 for submission to WPEC, recommending a well-defined list of fission-product radionuclides for TAGS measurements in order to improve decay heat calculations without resorting to theory. Progress made by the experimentalists over 2006-2008 will be

monitored by staff of the IAEA Nuclear Data Section, and further meetings are envisaged after the IPN-Orsay studies have begun, hopefully in approximately 2 years time.

Table 1: Requested TAGS Measurements.

Radionuclide	Priority	Q_{β} -value (keV)	Half-life	Comments
35-Br-86	1	7626(11)	55.1 s	
35-Br-87	1	6852(18)	55.65 s	[see Action table] Extremely complex decay scheme with substantial gamma component - large uncertainties in the mean gamma energy arises from significant disagreements between the various discrete gamma-ray measurements. Also (β^- , n) branch.
35-Br-88	1	8960(40)	16.36 s	(β^- , n) branch.
36-Kr-89	1	4990(50)	3.15 min	Incomplete decay scheme
36-Kr-90	1	4392(17)	32.32 s	Incomplete decay scheme
37-Rb-90m	2	6690(15)	258 s	Repeat of INL TAGS measurement – data check.
37-Rb-92	??	8096(6)	4.49 s	[see Action table] Small (β^- , n) branch.
38-Sr-89	??	1493(3)	50.53 d	[see Action table]
38-Sr-97	2	7470(16)	0.429 s	[see Action table] Extremely short half-life (0.429 s), and possible (β^- , n) branch.
39-Y-96	??	7096(23)	5.34 s	[see Action table]
40-Zr-99	3	4558(15)	2.1 s	
40-Zr-100	2	3335(25)	7.1 s	
41-Nb-98	??	4583(5)	2.86 s	[see Action table]
41-Nb-99	1	3639(13)	15.0 s	
41-Nb-100	1	6245(25)	1.5 s	
41-Nb-101	1	4569(18)	7.1 s	
41-Nb-102	2	7210(40)	1.3 s	
42-Mo-103	1	3750(60)	67.5 s	
42-Mo-105	1	4950(50)	35.6 s	
43-Tc-102	??	4532(9)	5.28 s	[see Action table]
43-Tc-103	1	2662(10)	54.2 s	
43-Tc-104	??	5600(50)	18.3 min	[see Action table]
43-Tc-105	??	3640(60)	7.6 min	[see Action table]
43-Tc-106	1	6547(11)	35.6 s	
43-Tc-107	2	4820(90)	21.2 s	
51-Sb-132	1	5509(14)	2.79 min	
52-Te-135	??	5960(90)	19.0 s	[see Action table]
53-I-136	1	6930(50)	83.4 s	Incomplete decay scheme
53-I-136m	1	7580(120)	46.9 s	
53-I-137	1	5877(27)	24.13 s	(β^- , n) branch.
54-Xe-137	1	4166(7)	3.82 min	Incomplete decay scheme
54-Xe-139	1	5057(21)	39.68 s	
54-Xe-140	1	4060(60)	13.6 s	
55-Cs-142	??	7308(11)	1.69 s	[see Action table] (β^- , n) branch.
56-Ba-145	2	5570(110)	4.31 s	Repeat of INL TAGS measurement – data check.
57-La-143	2	3425(15)	14.2 min	Repeat of INL TAGS measurement – data check.
57-La-145	2	4110(80)	24.8 s	Repeat of INL TAGS measurement – data check.

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 Validation of Fission Product Decay Data for Decay Heat Calculations
 OECD/NEA, Paris, France
 3 May 2006, 09:00 – 18:00

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International Atomic Energy Agency

Consultants' Meeting (CM) on

Beta-decay and decay heat

held in collaboration with WPEC Subgroup 25

Validation of Fission Product Decay Data for Decay Heat Calculations

OECD/NEA, Paris, France

3 May 2006, 09:00 – 18:00

AGENDA

1. Welcome and practical matters
2. Approval of the Agenda
3. Approval of the summary record from the last meeting held at the IAEA as a Consultants' Meeting on Beta-decay and decay heat, December 2005
4. Review of Actions
5. Status of database studies and the experimental facilities for new measurements
6. Review of recommendations and new actions
7. Any other business
8. Date and place for the next meeting

APPENDIX 3

LISTS OF ACTIONS:

Actions related to Bersillon paper: “Some comments on the discrepancies between libraries for the nuclei of the first list” Olivier Bersillon, January 2006 – (“first list” is Table 2 of INDC(NDS)-0483, January 2006).

Nuclide	Comments	Action
⁸⁷ Br	(a) 10% difference in E_γ between JEFF-3.1 and JENDL.* (b) $E_\gamma = 3087 \pm 771$ keV in JEFF-3.1 (UKPADD-6.4), while $E_\gamma = 3340$ keV with no uncertainty in JENDL.* Large uncertainty of 25% is difficult to understand in UKPADD.	A.L. Nichols
⁹² Rb	Large differences in E_β and E_γ between JENDL* and JEFF-3.1 (from ENSDF). E_γ for JENDL* appears to be abnormally small.	T. Yoshida
⁸⁹ Sr	$E_\beta = 585 \pm 234$ keV and E_γ close to zero in JEFF-3.1 (LNHB).	O. Bersillon
⁹⁷ Sr	E_β and E_γ in JEFF-3.1 come from NUBASE ($E_\beta = E_\gamma = Q_\beta/3 = 2456$ keV), and are in good agreement with Rudstam values. Adopt Rudstam uncertainties?	O. Bersillon
⁹⁶ Y	(a) JEFF-3.1 (from ENSDF) recommends β -transition to the daughter ground state of 95.5%, which is compatible with the low E_γ in JEFF but not the high E_γ in JENDL.* (b) Check β intensities and their origins in ENSDF; re-assess data in JENDL.*	O. Bersillon T. Yoshida
⁹⁸ Nb	JEFF-3.1 and JENDL-3.2* data have origins in ENSDF, but they exhibit significant differences in E_β and E_γ . Does this arise from Gross Beta Theory input in JENDL?	T. Yoshida
¹⁰² Tc	Same as ⁹⁸ Nb.	T. Yoshida
¹⁰⁴ Tc	JEFF-3.1 data exhibit a good energy balance, and originate from ENSDF. Why are TAGS measurements required?	T. Yoshida
¹⁰⁵ Tc	Same as ¹⁰⁴ Tc.	T. Yoshida
¹³⁵ Te	Same as ⁹⁸ Nb.	T. Yoshida
¹⁴² Cs	(a) Decay scheme is well-defined, and the pandemonium effect should not be large. (b) $E_\gamma = 675$ keV in JEFF-3.1 (from ENSDF), while $E_\gamma = 1787$ keV in JENDL.* (c) Reconsider the JENDL* evaluation – update, and assess the need for Gross Beta Theory input.	T. Yoshida
¹⁴⁵ Ba	Energy balance is very poor due to problems in quantifying β feeding – new evaluation is merited.	ENSDF evaluator
¹⁴³ La	Same as ¹⁴⁵ Ba.	ENSDF evaluator
¹⁴⁵ La	Same as ⁹⁸ Nb.	T. Yoshida

* JENDL refers to the JENDL FP Decay Data File 2000 (JAERI 1343 (2001)) in this listing (referred to generically as JENDL-FPDD in the text of the minutes).

ACTIONS

Action	Responsible Member	Deadline	Status
Introduce requests for required TAGS measurements in NEA High Priority Request List.	Henriksson	when appropriate	Dependent on the output from participants of this Subgroup (still on-going).
Convene meeting of representatives from industry, laboratory managers and experimenters to resolve manpower and resource issues.	Gelletly	mid-July 2006	Meeting scheduled for 17 July 2006 at IPN-Orsay.
Undertake TAGS measurements of a small number of key nuclides (e.g., 43-Tc-102, 56-Ba-145, 57-La-143, -145) at existing facilities.	Algora/Tain		On-going (see Section 3.6).
Organise inclusion of the Greenwood <i>et al.</i> and other TAGS data into an appropriate database.	Henriksson	when appropriate	Preparation of such a database is long term (Greenwood <i>et al.</i> data are unavailable) – will assemble other TAGS data as they become available.
Determine the extent of the disagreement of the ORNL decay heat measurements of Dickens <i>et al.</i> with earlier studies (cooling times beyond 1,000 secs).	Gould	September 2006	

WPEC Sub-group 25: Validation of Fission Product Decay Data for Decay Heat Calculations

Report to WPEC, May 2006

T. Yoshida (Sub-group Coordinator)
Musashi Institute of Technology, Tokyo

1. Kick-off Meeting at Vienna

An IAEA Consultants' Meeting on "Beta-decay and decay heat" was held at IAEA Headquarters on 12-14 December 2005, as a kick-off meeting for the joint effort of the decay-heat specialists and the TAGS measurement group. All the second-day participants among those listed in the Appendix agreed to join WPEC Subgroup 25, followed by a further participation of three Japanese scientists. The summary report of this meeting was prepared by A.L. Nichols as INDC(NDS)-0483.

2. Recommendations and Actions from the Vienna Meeting

- (1) Discrepancies between existing 21st century libraries. Assessment is required to understand precisely the nature of individual differences between JENDL-FPDD-2000 and JEFF-3.1.
- (2) Provisional list of nuclides to be studied using TAGS. Need to identify the nuclides worthy of new TAGS measurements, in part through action (1).
- (3) Experimental studies

Participants believe that accurate measurements of the average beta- and gamma-energies can be made by means of the TAGS technique. Measurements of ground state transitions are also essential. Though existing experimental facilities should be used for some particular cases, a dedicated facility should be setup at a particular accelerator where sufficient beam time can be devoted to these measurements in a systematic way.

- (4) Library of TAGS data

Data derived from TAGS should be collected and recorded so that proper use can be made of the TAGS results. The contents of this new database should be made widely available, and should not be restricted to decay heat applications.

3. Second Meeting

A second SG25/Consultants' Meeting on "Beta-decay and decay heat" was held on 3 May 2006 at the NEA Headquarters, Issy-les-Moulineaux, France, in advance of the annual WPEC meeting. All relevant decay databases and decay heat analyses were re-assessed, and actions were agreed to complete this particular aspect of the work in preparation for a definitive list of fission-product radionuclides recommended for TAGS measurements. The provisional list of TAGS radionuclides has increased further to approaching 35-40 (from the original list of 15 radionuclides).

Proposed measurement facilities were described, including plans for TAGS studies at IPN-Orsay. Further discussions are required to solicit full support and agreement by IPN-Orsay personnel (to use ALTO facility).

No further SG meetings are envisaged at this time – a final table of recommended radionuclides for TAGS will be agreed on the basis of the two meetings, and a SG report will be produced before the end of 2006.

APPENDIX

LISTS OF PARTICIPANTS

IAEA Consultants' Meeting *Beta-decay and decay heat* at Vienna, 12-14 December 2005

ALGORA, Alejandro	Institute de Fisica Corpuscular, Valencia
BERSILLON, Olivier	CEA/DAM, Bruyères-le-Châtel
GELLETTY, William	University of Surrey, Guilford, Surrey
HENRIKSSON, Hans	NEA Data Bank, Issy-les-Moulineaux
JACQMIN, Robert*	CEA/DER, SPRC, Cadarache
KELLETT, Mark A.	IAEA Nuclear Data Section, Vienna
MENGONI, Alberto*	IAEA Nuclear Data Section, Vienna
NICHOLS, Alan L.	IAEA Nuclear Data Section, Vienna
RUBIO, Berta	Institute de Fisica Corpuscular, Valencia
SONZOGNI, Alejandro	NNDC, Brookhaven National Laboratory, Upton
TAIN, Jose Luis	Institute de Fisica Corpuscular, Valencia
YOSHIDA, Tadashi	Musashi Institute of Technology, Tokyo

* Attended only on the first day as advisers/observers

SG25/CM *Beta-decay and decay heat* at NEA Data Bank, 3 May 2006, additional:

GAULD, Ian	ORNL (represented by DUNN, M)
KATAKURA, Jun-ichi	Nuclear Data Center, JAEA, Tokai
MILLS, Robert	Nexia Solutions, Sellafield
DEAN, Christopher	Serco Assurance, Winfrith

Other SG25 participants:

OYAMATSU, Kazuhiro	Aichi Shukutoku University, Nagoya
TACHIBANA, Takahiro	Waseda University, Tokyo
ROQUE, Benedicte	CEA/DER, SPRC, Cadarache

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