

話 題 (Ⅲ)

「放射化断面積に関する国際基準データライブラリーの  
創設」に関するIAEA研究協力計画第2回研究調整会合  
マドリッド工科大学、1996年5月13日～16日

日本原子力研究所

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「放射化断面積に関する国際基準データライブラリー (IRDF) の創設」に関するIAEA研究協力計画 (CRP)の第2回研究調整会合 (2nd RCM) に出席した。本CRPは中性子による放射化断面積にたいする幅広い分野からの要求に応えるために、国際的に基準となるデータライブラリーを各国の専門家の協力を得て創設することを目的としている。出席者はロシア3名、英国、オランダ、スペイン、ハンガリー、中国、日本各1名、IAEAの担当者1名、他にオブザーバーとしてイタリア及びスペイン各1名であった。

会議は先ず同大学核融合研究所所長G.Velarde教授の歓迎の挨拶で始まり、議長にロシア物理・動力研究所のIgnatyuk氏を選出した。その後1日半かけてIAEAと研究協力協定を結んでいる参加者が前回会合以来の研究活動を報告した。報告の内容は添付資料1 (議事日程) を参照。私は"Evaluation of Cross Sections for JENDL Activation Cross Section File 96"の標題でシグマ研究委員会の協力のもとで本年3月に完成したJENDL Activation Cross Section File 96について報告した。この報告ではJENDL Activation Cross Section File 96に収録されているデータは実験データを良く再現しており信頼できるデータであり、このファイルからIRDFに多くのデータを採り入れるべきであることを強調した。

2日目午後から討論に入り、(1)収納する反応、(2)ファイルフォーマット、(3)スターターファイルに採用するデータソース及び(4)その他の事項を次の通り決定した。

(1)IRDFに収納する反応

IRDFに収納する反応を決定した。IRDFに収納する反応のリストの作成が前回会合で英国AEA FusionのForrest氏に依頼され、約200反応のリストが1995年6月に本CRP参加者に配布された。これに対する本CRP参加者の意見を集約しそれをForrest氏が報告した。これに対して天体物理関係及びドシメトリー関係のデータが不備であるとの

指摘があったが、本CRP参加者にはこれらの分野の専門家はいないので天体物理関係はドイツ・カールスルーエ研究所のKaeppler氏に相談して決定し、またドシメトリー関係のリストは本年9月プラハで開かれるドシメトリー関係のワーキンググループ会合で関係者の意見を纏めて決定することにした。前回会合では荷電粒子入射反応のデータを収納することを決定したが、その後荷電粒子入射反応の新たなCRPが作られたので本CRPからはこれを除くことにした。その他慣性核融合関係から7反応追加することにした。高速増殖炉関係は本年6月のNEANSC評価国際協力ワーキングパーティ会合（米国、アルゴンヌ）での議論をふまえて追加決定をすることにした。

#### (2)ファイルフォーマット

西ヨーロッパからの参加者はIAEAで作られた国際核融合炉核データライブラリー(FENDL)と同じフォーマットでファイル化することを主張した。これに対しロシアからの参加者はFENDLのフォーマットは明確でないことを理由にENDF-6フォーマットを主張した。日本としてはJENDL Activation Cross Section File 96はENDF-5フォーマットでファイル化しているし、既にFENDLのフォーマットの決定の際にENDF-6フォーマットを主張した経緯もあり、ENDF-6フォーマットでファイル化することを主張した。両者の主張は一長一短があり、フォーマットの1本化は計れず、FENDLフォーマットとENDF-6フォーマットの両方のフォーマットでファイル化をすることを決定した。

#### (3)スターターファイルに採用するデータソース

FENDL選定委員会で議論の結果FENDLに採用されたデータは特に他に優れたデータがない場合そのまま採用し、FENDLより優れているとして提案されたものは検討した結果採用することにした。その他の反応のデータは個々に議論し、添付資料2の"Candidate selection"の表の通り決定した。今後別のデータを採用を要求する場合にはその妥当性の根拠を示し、CRPメンバーの多数決により決定する。

#### (4)その他の事項

来年6月イタリア、トリエステで開催される核データ国際会議に本CRP活動の要約を発表すること、各グループ間の協力を本CRPとして奨励することを決定した。次回（最終）本CRP会合は1997年9月か10月にオーストリア、ウィーンで開催する。また可能ならば1997年5月にイタリア、トリエステで開催される核データ国際会議の際にインフォーマルな会合を開催する。

## 2<sup>nd</sup> IAEA Research Co-ordination Meeting

on

### Establishment of an *International Reference Data Library* of Nuclear Activation Cross Sections

Madrid, Spain, 13 to 16 May 1996

Organized in co-operation with the Instituto de Fusion Nuclear  
de la Universidad Politécnica de Madrid

#### Monday, 13 May

9:30-10:00

Opening Session  
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- Opening of the meeting:  
Host (G. Velarde)  
IAEA (A.B. Pashchenko)
- Election of Chairman
- Adoption of Agenda and Time Schedule
- Announcement of Organizational Matters

10:00-13:30

Session 1: Progress reports by CRP participants on  
improvements/selection of evaluations for the IRDL.  
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Presentation by R. Forrest,  
"Preparation of Master List of Important Neutron Induced Reactions  
for IRDL".



Presentation by **J. Csikai**,  
"Some measured, calculated and evaluated activation cross sections  
from threshold to 20 MeV neutron energy"

Presentation by **O. Grudzevich**,  
"Validation and testing of selected evaluations"

Coffee break

Session 2 (cont'd)  
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Presentation by **J.M. Perlado**,  
"Nuclear Data Influence in Radiological Assessment in Recycling and  
Waste Management of Inertial Fusion Reactors".

Presentation by **R. Forrest**,  
"Maintenance of the European Activation File with SYMPAL".

- Discussion

13:30-15:00

Lunch break

15:00-17:30

Session 3: General discussion. Starter File and Structure of IRDL.  
Coordination of Activity.  
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- General discussion on selected evaluation for inclusion to the Reference Library.
- Creation of Starter File of IRDL:
  - format of evaluations,
  - structure of IRDL,
  - contributions and file exchange,
  - maintenance of IRDL,
  - access to the open area of IAEA/NDS Alpha server.
- Overview of current tasks, future scope the CRP and coordination of activity.
- Actions and deadlines.

## Wednesday, 15 May

- 9:00-13:30            Session 4: Conclusions and Recommendations  
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- Formation of Working Groups to draft the Conclusions and Recommendations.
  - Working group's sessions on drafting of meeting Conclusions and Recommendations.
- 13:30-15:00            Lunch break
- 15:00-17:30            Session 4 (cont'd)  
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- Working group's sessions on drafting of meeting Conclusions and Recommendations.

## Thursday, 16 May

- 9:00-13:30            Session 4 (cont'd)  
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- Completion of Working Group Reports.
- 13:30-15:00            Lunch break
- 15:00-17:00            Session 5: Final Considerations  
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- Discussion of Conclusions and Recommendations.
  - Corrections and Adoption of Final Reports.
  - Adoption of the Schedule of Work and Future Meeting.
  - Closing of the RCM.

## 2nd Research Co-ordination Meeting of the IAEA CRP on Establishment of an International Reference data library of nuclear activation cross sections

### Introduction

### Objectives

### Organisation

### Conclusions and recommendations

IRDL is a reference library for many applications. Astrophysics is one of the applications that it should be considered for. It was noted that the master list contains a list of reactions for astrophysics prepared by F. Kaeppler. However, it appears that this selection are for reactions where more accurate data are required, rather than a complete list of reactions important for astrophysics. It was agreed that A. Pashchenko and A. Ignatyuk will communicate with Kaeppler to obtain a more comprehensive list of reactions important for astrophysics. It will also be confirmed that the pointwise files (FENDL/A format) are suitable for use by the astrophysics community.

Dosimetry is another application that has been identified as relevant for IRDL. It was agreed that the current master list needs to be expanded to include additional dosimetry reactions. K. Zolotarev will take responsibility for extending the list. This new list will be presented at the next meeting of the Working Group on Reactor Dosimetry for VVER Type Reactors (Prague, 1-6 September 1996) and agreement from the dosimetry community obtained.

One of the recommendations of the 1st RCM (Debrecen) was that IRDL should include charged particle reactions. However because of the new IAEA CRP on charged particles (P. Oblozinsky, **name of CRP**) it was agreed that all information on charged particles already generated by the current CRP will be transferred to the new CRP. A. Pashchenko will be responsible for ensuring that this transfer is handled efficiently at the NDS.

The current energy range for the IRDL is 20 MeV. At this stage the energy range will not be extended to higher energies for all reactions, however if new files are submitted to NDS containing higher energy values then these data will be retained for that reaction. J. Csikai stated that several reactions for medical applications are required at energies greater than 20 MeV, it is the responsibility of the data producers to submit candidates containing higher energy data if necessary.

J. Sanz noted that it is necessary to include a further reaction ( $^{192}\text{Ir}(n,n')$ ) in the master list for inertial fusion applications. M. Perlado requested that a few additional capture reactions on fission products (Sr-90, Zr-93, Se-79, Sn-126, Cs-135, Cs-137) be included

in the master list as these appear to be very poorly known, yet are important for transmutation studies and fusion applications. Some additional reactions important for liquid metal fission reactors will be added after discussions at the next meeting of the Sub-group on Evaluation Co-operation (Argonne, June 1996). Several other additional reactions that should be added to the master list were noted. These will be communicated to A. Pashchenko.

It was noted that many of the evaluations presented by K. Zolotarev have involved renormalisation of EXFOR data due to changes in monitor cross sections. It was agreed that such a procedure is very valuable and should be applied more generally.

## File format

Since much of the starter file for IRDL will use FENDL/A-2 as the data source it was proposed that the FENDL/A file format (as originally defined for the EAF libraries) be adopted for IRDL. This was accepted with the following conditions:

- FENDL/A format is an accepted format for the activation community, however other users of the data require data in ENDF-6 format. It was therefore agreed that IRDL will be available in both formats.
- All new candidate files will be supplied to the NDS in FENDL/A format.
- O. Grudzevich will take responsibility for converting the starter file (compiled by NDS) from FENDL/A to ENDF-6 format.
- J. Kopecky will provide A. Pashchenko with a complete description of the FENDL/A (EAF) format. This will be available on the NDS open area so that it may be obtained by FTP.
- A. Pashchenko will provide a brief description of the type of ENDF-6 format used. This will probably be MF=3 for the total cross sections and MF=10 for reactions split into isomeric daughter states.
- If available for a particular reaction, covariance data will be supplied in ENDF-6 format.

## Deadlines

The following deadlines were agreed for the various tasks:

- 1/6/96 J. Kopecky to supply to NDS details of the FENDL/A (EAF) format
- 15/6/96 A. Pashchenko will supply whatever data are already available in the starter file to O. Grudzevich so that testing of the conversion procedure can be carried out. A. Pashchenko will provide a description of ENDF-6 format used.
- 15/7/96 Final version of master list of reactions produced (R.A. Forrest) and distributed (A. Pashchenko)
- 1/9/96 Camera ready versions of contributions for publication in Proceedings of 2nd RCM sent to NDS.
- 1/10/96 Candidates for inclusion in IRDL starter file available at NDS.
- 1/11/96 Complete starter file available in FENDL/A format (A. Pashchenko).
- 1/12/96 Complete starter file available in ENDF-6 format (O. Grudzevich).
- 10/97 Possible date for final meeting of CRP in Vienna. Informal meeting of CRP members will be organised in Trieste (May 1997) at the Nuclear Data



conference if possible.

## Selection procedure

The following procedure was agreed for selection of candidate data for the starter file.

- All reactions in the master list will have data in the starter file.
- By default all data will be extracted from the existing FENDL/A-2 library.
- If a new data source is agreed either at this meeting or in the future then it is the responsibility of the author to supply the new data to the NDS in the FENDL/A format.
- It was agreed that the author of a new candidate for inclusion in the starter file must give a justification for the replacement of the existing data by the new data.
- This justification will be circulated to the members of the CRP by A. Pashchenko and comments compiled. A. Pashchenko will be responsible for deciding (based on a majority decision) if the new data will be used in the starter file. E-Mail will be used for discussions wherever possible.

## File production

- The IRDL starter file will be available from NDS in both the FENDL/A and ENDF-6 formats. The file is a point-wise file, no processing to form group-wise libraries will be undertaken by NDS; it is the responsibility of users to prepare working libraries from IRDL.
- Files will be stored on the NDS open area so that they can be accessed by users via FTP. Only NDS (A. Pashchenko) will have permission to edit data; all others will only be able to view/copy the data.
- Maintenance of the IRDL will be the responsibility of NDS.
- NDS will publicise the availability of the IRDL starter file through the existing channels of the Data Centre Network.

## Candidate selection

Using the current master list of reactions it is possible to consider in details only those reactions not already discussed in detail by the FENDL/A selection panel.

Reaction	Source	Comments
B-10(n,a)	FENDL/A-2 (IRDF90.2)	
C-12(n,n')	Reaction removed	No isomeric state
C-12(n,2n)	FEI	
O-16(n,n'a)	JENDL/A-3.2	
O-16(n,n')	Reaction removed	No isomeric state
Si-29(n,d)	FENDL/A-2 (ADL-3)	
Si-29(n,n'p)	FENDL/A-2 (ADL-3)	
Si-30(n,a)	FEI	Need for new experimental work at 11 MeV. Also the

Reaction	Source	Comments
		slope of cross section function at 14 MeV is required to decide between evaluations.
P-31(n,p)	FENDL/A-2 (IRDF90.2)	
Cl-35(n,2n)	ADL-3	
Ti-46(n,p)	FEI	Better evaluation is available since the FENDL selection procedure.
Ti-47(n,d)	FEI	Properly split by K. Zolotarev.
Ti-47(n,n'p)	FEI	Properly split by K. Zolotarev.
Ti-48(n,d)	FEI	Better evaluation is available since the FENDL selection procedure.
Ti-48(n, n'p)	FEI	Better evaluation is available since the FENDL selection procedure.
Ti-48(n,p)	FEI	Better evaluation is available since the FENDL selection procedure.
Ti-48(n,a)	FEI	Better evaluation is available since the FENDL selection procedure.
Ti-49(n,d)	Reaction removed	Accuracy of available data not adequate for dosimetry applications.
Ti-49(n,n'p)	Reaction removed	Accuracy of available data not adequate for dosimetry applications.
Ti-49(n,t)	Reaction removed	Accuracy of available data not adequate for dosimetry applications.
Cr-52(n,n')	Reaction removed	No isomeric state
Cr-52(n,2n)	FENDL/A-2 (EFF-2.4)	
Cr-53(n,d)	FENDL/A-2 (EFF-2.4)	
Cr-53(n,n'p)	FENDL/A-2 (EFF-2.4)	
Cr-54(n,a)	FEI	
Mn-55(n,a)	FEI	New experimental data required. Recent measurements at 14 MeV suggest cross section much lower (23 mb) than current values.
Fe-54(n,2n)	FEI	Properly split (isomers) by K. Zolotarev.
Co-59(n,a)	FENDL/A-2 (IRDF90.2)	Add dosimetry as an application.
Ni-58(n,n')	Reaction removed	No isomeric state
Ni-58(n,p)	FEI	Result of collaboration between FEI and IRK Vienna.
Cu-63(n,n')	Reaction removed	No isomeric state
Ga-69(n,a)	JENDL/A-3.2	New measurements at 14 MeV (22mb) suggest that JENDL/A-3.2 better than ADL-3.
Nb-93(n,n')	FEI	

Reaction	Source	Comments
In-115(n,n')	IRDF90.2	
In-115(n,g)	IRDF90.2	Add dosimetry as an application, O. Grudzevich will supply correctly split data.
Ba-138(n,a)	FENDL/A-2 (EFF-2.4)	
La-139(n,g)		Add dosimetry as an application. The source of data may be changed to RDF, and A. Ignatyuk and K. Zolotarev will investigate.
Os-190(n,a)	ADL-3	
Au-197(n,n')	FENDL/A-2 (ADL-3)	
Au-197(n,g)		Add dosimetry as an application
Dy-158(n,p)	FENDL/A-2 (?)	
Ir-193(n,2n)	FENDL/A-2 (?)	

### Other matters

It was agreed that a summary of progress in the CRP will be presented at the Trieste Nuclear Data Conference. A. Pashchenko, A. Ignatyuk and R.A. Forrest will be responsible for preparation of a paper.

It was recognised that the current CRP had encouraged several collaborations between groups, especially for data measurements. These collaborations are vital to ensure efficient use of the very restricted manpower and facilities available for work in the area of activation cross section measurements.

The members of the CRP greatly appreciate the presence of K. Zolotarev as a consultant at the meeting. His contribution on candidates for dosimetry reactions is considered vital for ensuring that IRDL is of the greatest use for the dosimetry community.

Thanks to hosts.