A STRATEGIC VIEW
ON NUCLEAR DATA NEEDS

Report by the NEA Secretariat

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Foreword

At its third meeting in October 1992, the NEA Nuclear Science Committee (NSC) discussed an interim report from a Working Party on scientific data requirements for the 1990s. Discussions covered:

- the need for more accurate or new scientific nuclear data,
- the continuing availability of data measurement facilities,
- the risk of losing expertise with the retirement of experienced scientists,
- the role of national and international data centres.

It was agreed to initiate a strategic review of these questions and to produce a synthesis document where the recommendations could be presented to Member countries as a proposal for action.

A small group of NSC members (Annex 1) was formed to draft a first version of such a report. The group met at the end of January 1993 to discuss the layout and content of the document and started to write the different chapters. A draft version of the report was then discussed at a NEA Think Tank meeting (Annex 1) at the end of May 1993, followed by an in-depth discussion at the Nuclear Science Committee meeting in early June 1993. The comments and suggestions from these meetings have been incorporated in the present report.

Executive Summary

This report examines the present and future needs for scientific nuclear data and discusses ways of meeting any such needs.

Different application areas have been covered and well founded requests for scientific data have been expressed both within the "traditional" fission reactor area and new areas, such as radioactive waste transmutation, medicine and fusion. Specific examples of cost savings to be made using improved data, or of potential penalties for current or future applications which may be incurred by relying on inadequate data are given.

The resources of qualified manpower are falling below a minimal level and the situation appears particularly alarming when the age structure of the staff presently working in the field is considered. If the present staff policy is not changed very soon, there is a clear danger that indispensable know-how in nuclear data will be lost.

Support from industrial users is needed, but the ultimate responsibility for financing nuclear data work must, in the long term, rest with governments. Better cooperation between data producers and users should be established.

Data centres play an important role in coordinating national efforts and in helping to avoid unnecessary duplication of work. A minimum of two international data centres is needed.

NEA proposes to undertake the following actions in the nuclear data field:

- Continued strong support for the NEA International Evaluation Cooperation, and, within the Data Bank Member countries, for the Joint Evaluated File project;
- Setting up a forum to facilitate the dialogue between users and producers of nuclear data;
- Promoting a framework for international collaboration in the field of nuclear data measurements.

It should be emphasised that any international cooperative effort undertaken by NEA would never replace national efforts, but would improve productivity from existing and future resources.

Contents

List of Figures

1 INTRODUCTION

1.1 Where is nuclear data used?

The present level of nuclear technology is to a large extent based on a massive accumulation of nuclear data. These scientific data are used throughout the development phase of any nuclear system. In the first stage of a project when the feasibility of a system is being investigated the data accuracy is not of prime importance, whereas much more accurate data are needed in the conceptual or R&D stage of a system, when safety and economical aspects are of prime importance. For example, when designing a shielding device around a nuclear system, more accurate knowledge of the nuclear data required for calculating the type and amount of material needed gives better confidence in the safety of the system and could result in large economic savings depending on the choice of materials, taking into account both the construction and decommissioning stages.

1.2 How do we obtain basic nuclear data?

Scientific nuclear data exists in many forms, from the basic experimental values to the processed data libraries used in specific applications. An attempt to describe in a simplified way the efforts involved in making the basic data usable in practical applications is shown in Figure 1. The different methods are described in more detail in Section 4.

1.2.1 Calculations

The aim of nuclear theory is to be able to describe accurately and globally model the processes involved when particles interact with different materials. Good results are being obtained in limited areas, but there is still no global model that would give accurate data predictions throughout all areas considered in nuclear physics. New theories developed have always to be verified against experimental data.

1.2.2 Experiments

Nuclear data experiments are being performed either to verify theoretical models or directly for special applied purposes. These measurements are normally performed at particle accelerators or research reactors. The results are published in scientific journals.

1.3 Accommodating nuclear data to user needs

1.3.1 Evaluations

The large amount of existing detailed experimental and theoretical data is difficult to use directly in nuclear applications. Furthermore, the basic data are not always consistent and have to be further critically analysed to obtain data values that can be used with confidence. This role of "condensing" the data base to so-called evaluated libraries is performed by evaluators, who are scientists with experience in both experimental physics and theoretical calculations.

1.3.2 Data processing and validation

The evaluated data libraries have to be properly tested and validated before being used in applications. The processing of the libraries is performed with very large and complex, thoroughly verified, computer programs preparing the data for the different kinds of application. The calculated results are compared with data from so-called integral experiments. These measurements are performed either in special research reactors or result from the analysis of data from power producing units.

1.3.3 Quality Assurance

An increasing number of nuclear data users request that the data to be utilised in applications should have undergone a minimum level of Quality Assurance, e.g. the procedures for maintaining and updating the evaluated data libraries, and that the computer codes used in the processing and validation of these data have followed certain criteria defined in common standards.

1.4 Distribution of data

A network of nuclear data centres exists to support the different steps in data development described above. The centres themselves compile bibliographic and experimental data and some of them play a central role in assembling and testing national or regional evaluated data libraries. These evaluation efforts are coordinated by the NEA Nuclear Science Committee, and the data libraries are available through most data centres. The centres also provide a service on all these scientific data, free of charge, to the nuclear community.

1.5 Time needed in up dating data libraries

Before estimating the time needed to improve the nuclear data base, the following information must be considered: planning and performing an experiment with the subsequent analysis of the data is a matter of some two to three years, a complete new evaluation for one isotope or element takes about one man-year, and processing and validating a complete evaluated library may need from ten to fifteen man-years. This is why it takes a minimum of about five years of well coordinated efforts to produce a fully tested and very accurate data library for the complete range of reactor applications. More limited or specific data needs could be fulfilled in a much shorter time, as long as the manpower and necessary equipment are available.

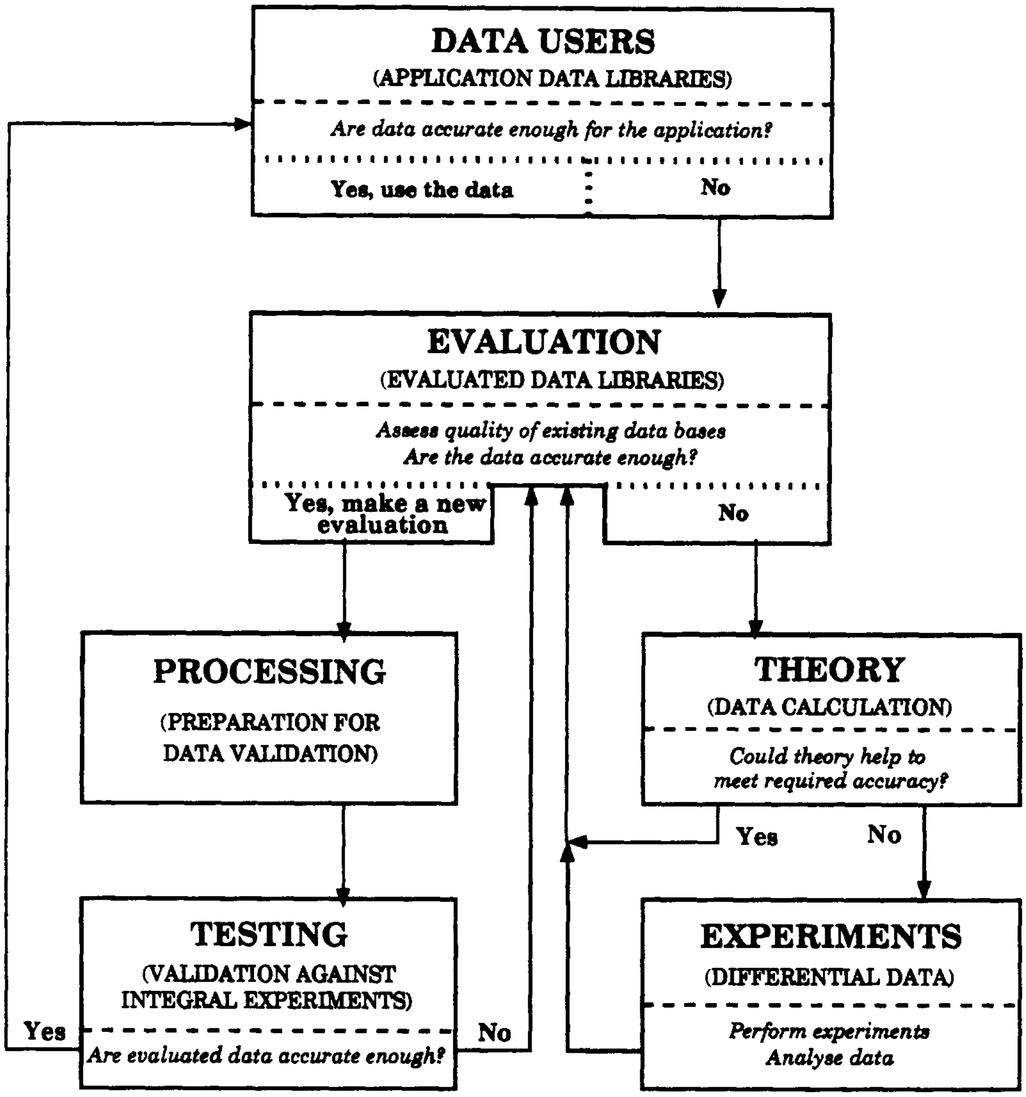

Figure 1 Schematic flow of scientific nuclear data

2 WHY DO WE NEED MORE NUCLEAR DATA?

2.1 Reactor power production

Fifty years after the first pile in Chicago, why are scientists still measuring and evaluating neutronics data?

During the early development of nuclear reactors, computer modelling was based on simplistic descriptions of the phenomena concerned and uncertainties in neutron reaction data were far too high to allow direct calculation within the required accuracy limits. The problems were solved by building simple integral experiments and more complex partial replicas of reactor designs, so that measurements could give representative information on basic nuclear data, which could be extrapolated to real operating reactors. These procedures were sound, but they lacked generality, so that new replicas and new data adjustments had in principle to be envisaged for every new core design significantly different from a previous one.

Nuclear scientists aim to produce a "universal" data library which can be used without adjustment. Integral experiments would then be needed for validation of the data files, but the degree of experimental validation required for lesser design changes would be sharply reduced, as would its cost. This aim has been partially achieved by the new generation of evaluated neutron data files in the NEA area: ENDF/B-VI (USA), JENDL-3 (Japan) and JEF-2 (NEA Data Bank countries) give comparable accuracy to adjusted data sets, when used to predict operating characteristics of thermal and fast reactors. For many minor changes to existing reactors, such as the re-design of fuel bundles, it has proved possible to calculate accurately the effect of the changes and to introduce them without need for further measurements. However, the validity of these files for more advanced applications is indeed limited.

Safety of reactors demands conservative design and operating procedures, which must be able to accommodate the least favourable assumptions about the effect of uncertainties in the various "fixed" parameters, including nuclear data. In future reactors, reduced uncertainties on operating parameters will allow components to be designed to uniform safety criteria, without the expense caused by "over-designing" to compensate for excessive uncertainties.

An interesting example, cited in a recent American report on Nuclear Data needs of the 1990s, concerns the fuel supplied for today's commercial nuclear power plants. An allowance of about 5 percent must be made in the expected endurance of the fuel, based on uncertainties in nuclear data for fission products and the trans-uranium isotopes. Advanced designs, with extended burnup, must allow even greater margins. Better nuclear data would improve estimation of the reactor fuel performance at the end of the fuel cycle, with following large economic benefits, while observing strict safety margins.

2.2 Other applications areas

The nuclear data programmes in Member countries have over the past several decades successfully provided data users, especially in the nuclear power industry, with data needed for the development of nuclear technology. Apart from the continued interest in nuclear data from these "traditional" users, new challenging areas, such as nuclear medicine and health, transmutation of nuclear waste, space and astrophysics applications and fusion energy, are developing with further nuclear data needs. Some examples from these new areas are given in the following section.

3 DATA NEEDS FOR SPECIFIC APPLICATIONS

The aim of this section is not to give a full and detailed list of data needs, but rather to indicate general requirements in each area of work. These requirements can be met by a combination of differential cross-section measurements, data evaluations, integral measurements and improvements in calculation methods.

3.1 Existing fission reactors and their fuel cycles

In the design of fission reactors, data uncertainties have from the beginning been compensated by conservative design. As data uncertainties were reduced and became better understood, through integral and differential measurements and evaluation, it has been possible to improve reactor performance while maintaining the required safety standards. Later versions of the evaluated data files will include correlated uncertainty information for all important materials; new versions of neutronics software will be developed up through the applications chain so as to exploit this knowledge on data uncertainties and thus to assign more rigorous uncertainty limits on practical operating parameters. New analysis of existing reactors using more accurate data would reveal explicitly the safety margins added by conservative design and demonstrate the possibility of economic gains through, for example, new fuel designs and increased burnup.

There remain a number of areas where there are known discrepancies between measurement and calculation. These include decay heat predictions, LWR moderator temperature coefficient predictions, structural material data relevant to reactor pressure vessel integrity, plutonium cross-sections relevant to LWR fuel cycles containing MOX fuel, and fission product data relevant to reactor operations, fuel storage, transport, reprocessing and disposal activities. Account can be taken of such discrepancies by applying bias factors to plant calculations and increasing operational margins. Some examples of data needs for fission reactors and their fuel cycles are given in Annex 2.

Whilst there may only be limited benefit in resolving some shortcomings for existing plants, others could have a significant impact on the economics of future operations (e.g. burn-up credit in criticality assessments). In addition, the resolution of the outstanding discrepancies is essential to further the aim of having an international basic nuclear data library that will allow the design of new reactor systems and associated fuel cycles with unadjusted, bias free application libraries.

An example of data improvement is the work being performed in the NEA's International Evaluation Cooperation to resolve long-standing discrepancies in data for the nuclides most strongly affecting reactor performance. Thus, one problem affecting the fission cross-section of ^{239}Pu has been resolved recently by measurements at Oak Ridge, USA and IRMM Geel, Belgium; further measurements are requested for inelastic scattering in ^{238}U, to resolve persistent discrepancies between the current generation evaluated neutron data files. Another international measurement programme concerns integral measurements of effective delayed neutron fractions for different fissile materials, as well as direct measurement of the delayed neutron yields for some of the major actinides.

3.2 Data needs for advanced reactors

Advanced reactors are intended to eliminate or alleviate the perceived possible shortcomings of existing designs in areas such as safety, environmental impact, simplicity of operation or economics. They still make use of current techniques and experience.

We may consider "evolutionary" designs, using proven core and fuel combinations in a new configuration, as a means of obtaining (for example) advanced safety features or very high fuel burn-up. In general, the data needs are very similar to those for current reactor designs, although (as in the example of high fuel burn-up followed by long-term storage of spent fuel) the economic benefits to be gained from improved data may be considerably greater.

A second group of concepts involves more radical changes to the physics of the core, to fuel construction or to the fuel cycle and may be described as "innovative". It includes light water reactors with different moderator-to-fuel ratios, reactors with plutonium fuel without uranium (for increased plutonium consumption), reactors devoted specifically to actinide burning. Reactors based on the thorium cycle should also be mentioned, even if not intensively studied to-day, as they are under consideration in different countries.

Whereas for the "evolutionary" designs, it may be possible to carry out data validation and adjustment using existing integral experiments and critical assemblies, radical innovations will necessitate both selected new integral and high quality differential experimental programmes and a corresponding evaluation activity, possibly under international coordination.

3.3 Transmutation and accelerator development

There has recently been renewed interest in a number of OECD countries in the concept of transmutation of actinides and long-lived fission products. This concept can contribute to solving the problems posed by the management of radioactive waste, by reducing the proportion of long-lived isotopes in need of deep geological disposal. The research in the field of transmutation is directed mainly along two alternative lines: actinide burner reactors or accelerator-based systems. In both cases there is a pronounced need for either more accurate or entirely new nuclear data.

The potential cost impact of the present large data uncertainties in the minor actinides (such as ^{237}Np, ^{241}Pu, ^{241}Am and ^{243}Am) considered for incineration in actinide burner reactors could be exemplified by the calculation performed for the design of the Integral Fast Reactor (IFR) at Argonne, USA. The data uncertainties, resulting in uncertainties relative to decay heat, Doppler control and safety margins, would necessitate a more conservative, and thus more expensive, design to accommodate these issues.

The nuclear data needs in accelerator-based transmutation depend strongly on the particular concept studied. In the case of direct spallation of the waste by the primary proton beam, high-energy fission cross sections for the actinides are important. For methods based on transmutation of nuclear waste by intense neutron fluxes, detailed knowledge of double-differential neutron production cross sections for the neutron producing target is essential. Nuclear data are also needed for the materials to be used in the construction and shielding of the accelerator and the target system, including neutron and gamma-ray emission data as well as activation and material damage calculations. In the Los Alamos ATW concept, for example, a total production of 10^{20} neutrons/second near the target area is foreseen, imposing special conditions on the materials used around this target.

3.4 Medical applications

The application of nuclear science and technology to medicine is of considerable importance to health care today. Techniques involving radio-nuclides and/or particle beams are central to the diagnosis, treatment and monitoring of cancer, brain and heart diseases and many other disorders. Nuclear data needs for medicine during the next decade will be of two types. The first involves the necessary refinement of existing data to better serve ongoing, relatively mature areas, such as radioisotope production, either by reactors or cyclotron accelerators, for diagnostic purposes. The second involves emerging methodologies, such as neutron based or heavy-charged-particle based radiotherapy, for which new data or extensions to existing data are required.

The emergence of Positron Emission Tomography (PET) as a physiological imaging method during recent years has led to the proliferation of hospital-based medical cyclotrons with proton beam energies in the range from 10 to 30 MeV. The primary purpose of these accelerators is to produce short-lived positron-emitting isotopes, such a ^{11}C, ^{13}N, ^{15}O and ^{18}F. Cross section data are available for most of the reactions which produce these isotopes, but there are many inconsistencies. Of more importance for the future is the fact that there are many other isotopes, for which reliable data are lacking and which may offer great potential advantages for diagnostic or therapeutic use.

An important developing area in the treatment of cancer involves the use of tumour-specific agents tagged with radionuclides in order to deliver very high radiation doses locally to tumour cells, while sparing healthy tissue. Such radiotherapy may have a major impact on cancer treatment in the immediate future. There are data available for most isotopes in use or suggested for future use, but with too large uncertainties, giving rise to widely discrepant results of calculations. Improvement of these data are important, especially with increasing concern about radiation doses.

3.5 Fusion data

Even though some of the nuclear data demands for fusion studies are covered by the existing evaluated data files, it is clear that the emphasis for fusion reactor applications is more on higher energies and, to some extent, on different materials, which is the case for tritium breeding and the necessary neutron multipliers to achieve it. Another difference is that photon production data are far more important in fusion reactors than in fission reactors, while there is more emphasis on nuclear heating (kerma) calculations and the evaluation of radiation damage (atomic displacement, gas production). For these reasons new evaluated data have to be used in fusion reactor calculations. The data requests cannot be fully met by nuclear model calculations, and would need an experimental effort: measurements of energy-angle distributions of emitted particles for light elements and for shielding materials in the range below 14 MeV are an important example.

For activation and decay heat calculations and for the development of low activation materials, a large number of data for the production of long-lived radio-isotopes are required. It is very important also here to include uncertainty data. A first attempt has recently been made to bring together virtually all these data in a single library, but much more work is required to improve its quality.

It is crucial to continue experimental and evaluation activities, because current data files lead to too large design margins which may cause erroneous forecasts. For this reason regional nuclear projects to update general purpose or special fusion files have been defined in the US (ENDF/B), Japan (JENDL), Russia (BROND) and Europe (EFF) and selected data sets from these files are included in a joint data compilation coordinated by the IAEA (FENDL project).

4 RESOURCES FOR SATISFYING DATA NEEDS

The resources (experimental facilities and qualified manpower) for meeting nuclear data needs have decreased and the situation has now arrived at a point where action must be taken before this trend becomes irreversible, with the loss of all expertise and premature closure of valuable unique facilities. International coordination of the remaining resources is probably the only remaining way of continuing operation in order to meet data needs expressed earlier in this paper. It should be noted that, at present levels of activity, unnecessary duplication has long been eliminated and international cooperation would not replace local activities, but could enable more productive use of existing resources in Member countries.

4.1 Experimental facilities

Integral measurements (measurements of neutron spectrum averaged data in representative reactor spectra) provide an accurate reference point for many macroscopic reactor properties, such as fuel enrichment required for criticality, the effect of absorber materials, and fission rate distributions (e.g. in MOX fuel). However, a knowledge of the differential data (detailed knowledge of the energy dependence of neutron interaction in different materials) is essential for a clear understanding of reactor behaviour and is particularly required for extrapolating to conditions outside the range covered by integral measurements, as well as for a wide range of non-reactor applications. The two types of experimental nuclear data are complementary and one cannot replace the other:

- *Integral facilities (research reactors)*

  Integral experimental facilities play a fundamental role in validating the calculation methods and data employed in a large number of different reactor applications. There exists today a range of plants with similar, but not identical, capabilities, where, in some cases, good cooperation has been established. As an example could be mentioned the AEA-CEA collaborative programme involving the UK DIMPLE and French EOLE/MINERVE facilities. The chief objectives of this programme are to validate the calculational methods and data used to predict fuel burn-up for efficient and safe reactor fuel management, assess the criticality safety aspects involving burn-up credit and to validate the JEF basic nuclear data prior to the adoption of the library as an industry standard for all reactor physics, inventory and criticality calculations. The use of complementary techniques and common standards provides vital quality assurance of the measurements and their analysis.

- *Differential facilities (accelerators)*

  Differential measurements of neutron nuclear data are the primary source on which any evaluation of data for energy applications has to be based. Generally speaking, a sound data base of differential cross sections exists today for most thermal reactor applications. However special problems remain, many of them related to questions of reactor safety; they require additional and particularly precise data, which can only be obtained by differential measurements. Also, the expected future development of new reactor types, such as reactors for burning of plutonium and minor actinides or reactors using the Thorium fuel cycle, will require new or improved data for different isotopes.

  A distinction should be made between mono-energetic and white neutron sources for differential measurements. Activation and often dosimetry data can best be measured at mono-energetic facilities, while white sources are by far superior in covering, for example, the energy regions of the resonances.

These neutron sources are in general complementary. Very few experimental facilities, especially white sources, are still largely engaged in differential neutron data measurements for energy applications.

4.2 Nuclear model calculation and development

Advances in nuclear theory and associated computer codes have increased the role of modelling in meeting data needs. A good example is the field of intermediate energy nuclear data for transmutation applications, where certain experiments are extremely difficult to perform or where large amounts of data for many different isotopes are needed. New theoretical models are being developed in this area and the calculational results are being compared to available experimental results.

While model calculations are very good for predicting the shape of data curves, they are less reliable for absolute values. Modelling will, however, always remain an fundamental complement to experiments, but certain types of data can only be obtained by differential measurements; obvious examples are resolved resonance data and data that require extremely high accuracy, such as standards data. Also modelling needs detailed and systematic knowledge of basic quantities such as level densities and fission barriers, which can only be provided by differential measurements.

4.3 Evaluation

Before being used in applications, the experimental and theoretical information must pass through an evaluation stage. Scientists, specialists in this field, collect all information available for an isotope or an element, perform a critical review of the available experimental and theoretical data and select the "best values". These data are then compiled in an evaluated file which is further processed in different ways, depending on the application.

Within OECD Member countries there are four major evaluation projects: ENDF (Evaluated Nuclear Data File) and JENDL (Japanese Evaluated Nuclear Data Library) projects are national efforts, whereas the JEF (Joint Evaluated File) is a collaboration on a voluntary basis of several laboratories in the NEA Data Bank Member countries and the EFF (European Fusion File) project is sponsored by the European Communities.

In the mid-1980s it became clear that the manpower allocated to evaluation had substantially decreased and the NEA reacted by organising an international cooperation (NEANSC Working Party on International Evaluation Cooperation) involving the above-mentioned projects. The cooperation is now well established and was recently opened to non-OECD countries through the IAEA. A long term goal of the cooperation is to achieve a convergence of the major evaluated files, thus providing a well-justified consensus on which nuclear data to recommend for different applications.

4.4 Manpower

In order to satisfy present and expected future data needs as discussed above, it is widely agreed that a basic set of facilities with a critical mass of experienced staff, for integral and differential nuclear data measurements covering all applications of importance, is indispensable. At present, this need is hardly fulfilled, especially in the field of differential measurements.

The manpower situation appears particularly alarming when the age structure is considered of the staff presently working in this field. For example, in the two most important centers for differential neutron data measurements, Geel and ORNL, about 70 percent of the active scientists are over 55 years of age and, with the present personnel policy, it is unlikely that they will be replaced when reaching retirement age. At other laboratories the situation is certainly no better. If the present staff policy is not changed very soon, there is the clear danger that indispensable know-how in experimental nuclear data measurements will not be able to be transferred and will be lost.

Concerning nuclear data evaluation, the manpower available is now at a minimum level throughout the OECD area and the need for involving younger scientists is as urgent as in the experimental area. Moreover, nearly all the present generation of evaluators have had long experience in making the kind of measurements they need to review. It is hard to see how evaluators can be trained independently of a high quality experimental programme.

5 THE NUCLEAR DATA CENTRES

The concept of a scientific data centre was at its origin very similar to that of a specialised library: it should collect and compile numerical and bibliographic data on the topic concerned, carry out relatively limited data verification and supply the information selectively in response to user requests. The same concept was followed, using computers, in building an international network of neutron data centres in the 1960s. This original network participated in the development of the Computer Index to Neutron Data (CINDA) and of a computerised compilation of numerical data from neutron cross-section measurements, now known as EXFOR. This combination of a specialised index and a linked collection of data, covering a high proportion of all unrestricted measurements and available on computer media to scientists worldwide, was unique at that time.

In the highly-developed but now much smaller nuclear research and development community of 1993, data centres no longer act simply as providers of data, but are themselves participants or act as focal points in the development and validation of the evaluated data sets which are used in nuclear calculations and of the corresponding software. In their service role, they ensure that their users receive the best information available, in a specified format and that they have access to information on the validation procedures used.

5.1 Existing data centres

The original four neutron data centres have cooperated since the beginning on fulfilling data needs for fission reactors. At present, each one continues to compile information on experimental data into the CINDA and EXFOR compilations and has an important role in the coordination of neutronics data evaluation, as well as the responsibility for making all these data available to users in their assigned geographical service area. The centres have specialised tasks in addition:

- US National Nuclear Data Center, Brookhaven (serves US and Canada)

  ENDF/B evaluation coordination;
  ENSDF coordination and evaluation (Evaluated Nuclear Structure Data File);
  NSR compilation (Nuclear Structure References).

- NEA Data Bank (serves the OECD area except US and Canada)

  JEF evaluation coordination;
  NSC International Evaluation Cooperation (coordination of all main evaluation efforts);
  Coordination of international program comparison exercises:
  Secretariat services to the Nuclear Science Committee;
  Computer program services to NEA and other countries on behalf of IAEA;

- IAEA Nuclear Data Section (serves non-OECD countries except CIS)

  FENDL compilation of evaluations for fusion applications;
  Formal coordination of the NRDC and ENSDF networks;
  Atomic and Molecular data compilation;
  Publication of CINDA and WRENDA (World REquest list for Nuclear DAta);
  Secretariat services to the International Nuclear Data Committee (INDC).

- CJD (Nuclear Structure and Nuclear Reactor Data Centre, Russia, serves CIS area)

  BROND evaluation coordination;
  Individual evaluations for BROND and ENSDF.

Other national or regional data centres have joined the original network: all centres have in common the EXFOR format for data exchange and are coordinated as the Nuclear Reaction Data Centres (NRDC) by IAEA. Many of the smaller data centres are research groups in national laboratories or universities. There are two neutron data centres whose chief task is coordinating national data evaluations (JAERI Nuclear Data Centre for JENDL and Chinese Nuclear Data Centre for CENDL), as well as five centres in Russia, Japan and Hungary compiling charged particle and photo-nuclear reaction data and contributing to the ENSDF file. These centres contribute their data to the network and draw from it the other data they need. While formal exchange is limited to specified compilations in EXFOR format, in practice many other data files are available to the users of all the centres.

Another matter of interest to data centres and their users is the availability of computer programs. There is a strong logical link as regards validation between the neutron data files and the codes in which these data are used to simulate reactor performances. Moreover, the next stage of development for both codes and data will be a coherent use of data uncertainties, with the ultimate aim of carrying uncertainty analysis right through into the prediction of reactor performance and safety margins.

Computer codes are distributed internationally by a network of three data centres:

- Energy, Science and Technology Software Centre (Oak Ridge, USA);

- Radiation Shielding Information Centre (Oak Ridge, USA);

- NEA Data Bank (also serves non-OECD countries on behalf of IAEA).

Countries providing copies of nuclear energy software prefer to retain control of their distribution: these three centres provide users with the assurance of a well-defined version of each program, and originators with the assurance that their wishes will be respected.

5.2 Coordination between the centres

The four original centres have followed the development of neutron data together since the 1960s, in a vast field of research where the construction of a world-wide data base of neutron data and references from the four geographical areas was an essential basis for the collaboration which has developed. At present, each centre devotes only a small part of its efforts to the common obligations of EXFOR / CINDA compilation and user service for its own service area; the different specialised projects have become their main work. Coordination between the centres is by regular annual meetings and frequent informal contacts.

Should the four centres be reduced to three or less? Their specialisations do not in general overlap and for NEA and IAEA they depend strongly on the character of the organisations in which they are based and the technical competence of the user community. Their compilation and service activities could in theory be transplanted and regrouped in fewer centres. However, **the nature of data compilation and user services is such that there are few economies of scale to be won by concentrating them in a single location**. Moreover, the efficiency of service, as well as scientists' willingness to prepare and submit data for compilation, depends on good contacts between centre staff and individual scientists. It appears preferable to continue these tasks on a regional basis.

However, there is scope for **improved coordination on medium energy data** (up to 1.5 GeV). Different centres have supported specific actions and meetings on this subject, while a Russian centre coordinates compilation work on charged particle data. Overall coordination has yet to be established.

In conclusion, regular coordination between the centres and strong pressures to rationalise their operation at a time when resources are strictly limited, have increased efficiency within the centres and minimised any overlap in their tasks. However, better coordination is needed as new work programmes are established on medium energy data for transmutation applications.

5.3 Coordination between evaluation projects

Should the national and regional evaluation efforts be merged? **The five national or regional evaluation projects, plus the European Fusion File (CEC, but linked to JEF) are all represented in a single NEA-coordinated International Evaluation Cooperation**. The continued development of individual evaluated files is a matter for the countries or regions concerned; NEA coordination will ensure that new evaluation work avoids any unnecessary duplication and that the best information and software is available to all participants. Work on resolving discrepancies between all these files will continue within this cooperation and it is expected that these evaluated files will converge; meanwhile the difference in data values between them and in the results obtained in predicting reactor behaviour, provide valuable pointers in identifying areas where data should be improved.

5.4 The specificity of NEA

For many years, national nuclear data measurement and evaluation programmes have been coordinated through the NEA's scientific committees. With the formation of the Nuclear Science Committee, the Agency's work programmes cover a broad scope of the science underlying nuclear power development and give a clear overview of data needs in this and associated fields. The Committee serves a relatively homogeneous group of Member countries, at a high technical level and with a direct or indirect interest in nuclear power; it brings together data users (reactor physicists) and all the groups involved in producing the nuclear data required.

The NEA Data Bank is very closely integrated with the work of the Nuclear Science Committee (see Annex 3 and 4). Examples from the JEF project (which is part of the International Evaluation Cooperation) are the testing and preparation of data libraries for reactor physics calculations. In connection with its computer program service, Data Bank staff coordinate many international program comparison exercises, as a contribution to code validation. It is expected that the most important data files and programs distributed by the Data Bank will in future require increased levels of validation and documentation, in response to the more formal Quality Assurance procedures which are gaining ground in user organisations.

6 CONCLUSIONS

Nuclear data is one aspect of the wider strategy of nuclear energy applications. Measurement and evaluation of basic nuclear data represent a long-term investment and should be evaluated in the wider context of nuclear development. It is important to show specific examples of cost savings to be made using improved data, or of potential penalties for current or future applications which may be incurred by relying on inadequate data. Some examples are give in Annex 2.

6.1 Needs for nuclear data

The needs are not confined to the nuclear power industry: areas such as medicine and nuclear-based industrial instrumentation should also be considered, as well as space and astrophysics. In some of these areas, new or improved data are necessary to advance technically, whereas in other areas, considerable data needs become apparent when exploring the feasibility of new concepts. Data needs for regulatory purposes may be given both industrial and governmental support. The essential role of evaluating and validating basic nuclear data before they are used in applications should also be well understood by funding bodies.

Data needs may be either short or long-term: these categories should be considered separately. Some **short-term needs should be supported by industry**. Industrial users of nuclear data must consider contributing to the cost of producing data for long-term needs, but **the ultimate responsibility for financing this work must rest with governments**.

6.2 Cooperation between users and producers

There is a general need to **strengthen contacts between data producers and users of all kinds**: nuclear industry, regulators, medical and public health, and science and technology outside the nuclear field (astrophysics, space etc.). It is very important that this dialogue should start on a country level, for example in national nuclear data committees. It could then be envisaged to establish an efficient international cooperation for discussing and prioritising common nuclear data needs (see the proposal below under "NEA Actions").

Users must be made aware of the negative consequences of using poor or outdated nuclear data, in particular the cost and safety aspects. In practice, the initiative lies with data producers to show what improvements in the data can be achieved, and to estimate in close collaboration with users the potential savings. An example would be the potential gains for current reactor types from application of the most recent validated data.

6.3 Resources

The small community of data producers is ageing, and increasingly restricted in its access to measurement facilities and the resources to use them. There is, for example, a real danger that important types of facilities (e.g. white neutron sources) may disappear world-wide. A minimum set of different facilities should be identified and Member countries strongly urged to continue operation of these facilities for national and international use.

Since the **resources in nearly all NEA Member countries are falling below the minimal level needed to carry out an independent measurement programme**, the ideal would be to agree on a common medium-term plan for measurement and evaluation, with shared access to experimental facilities (see "NEA Actions" below). **It should be emphasised that any international cooperative effort would never replace national efforts but would improve productivity from existing and future facilities**. Such international collaboration would help to foster a coherent worldwide approach to projects with significant manpower implications, and thus optimise scarce world resources. The overall level of equipment and manpower to be maintained will be a function of perceived data needs, and should allow for the independent verification of results which is basic to all science.

6.4 The network of data centres

Data centres are an integral part of the process of data production as well as data dissemination. A strong consensus have emerged from different discussions that these centres play an important role within the nuclear data community and that **the two international centres should continue to be strongly supported**. The national centres are very active in compilation and local dissemination of data, and their specialised contributions could not in practice be replaced; their maintenance is, however, a matter for the individual countries concerned. The network of data centres are well coordinated with yearly meetings. The centres should strengthen their specialisation on projects relevant to their user community, while data compiled and developed within the network should remain available to all the centres taking part.

6.5 NEA actions

It is NEA's specificity that it brings together in its Nuclear Science Committee the end users of nuclear data, as well as all the groups (experimenters, data centres, evaluators) who share the work in producing the data needed. It is proposed to work from this position in support of maintaining adequate data development facilities within the NEA membership area. Actions to be taken would include:

- Starting a pilot project on quality assurance procedures of nuclear data files and of the computer programs essential for data processing and neutronics calculations for data validation (Annex 3);
- Continued strong support for the NEA International Evaluation Cooperation, that coordinates all major evaluation efforts worldwide, and, within the Data Bank Member countries, for the Joint Evaluated File project (Annex 4);
- Setting up a forum to facilitate the dialogue between users and producers of nuclear data (Annex 5);
- Promoting a framework for international collaboration in the field of nuclear data measurements (Annex 6).

ANNEX 1

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ANNEX 2

SOME EXAMPLES OF DATA NEEDS FOR FISSION REACTORS AND THEIR FUEL CYCLES

A large number of examples of data needs for fission reactors and their fuel cycles were discussed at the meeting in January 1993 of the Working Group, responsible for the preparation of the document on 'A Strategic View on Nuclear Data Needs'. Some of these examples were further developed in the course of writing the document, but they were not included in the final version. The most significant examples are presented below.

1. Discrepancies in decay heat

The standard values used for licensing purposes are now considered to be too high, and new standards for ^{235}U and ^{239}Pu are proposed by different evaluators. The differences between these new evaluations are in some cooling time ranges greater than their estimated uncertainties, while the difference between the measured integral values of the decay heat and the summation of energy release from individual fission products is of the order of 10 percent in some time ranges.

This inability to reproduce the measured values by calculation on the basis of available nuclear data is worrying for safety assessment, and particularly so in the context of proposals for high burn-up fuel management strategies. The uncertainties affect emergency cooling needs, refuelling delays and storage of spent fuel.

New measurements are needed of yields and decay data for the fission products most strongly contributing to radiation in the discrepant time ranges, as well as verification of the effect of the varying reactor spectra on the fission yield, and of the different subsidiary contributions: fission from delayed neutrons, decay of higher actinides, fission product transmutation, and activation of structural materials. For fuel life extension towards 60 Gwd/ton, about 50 isotopes should be examined in this way.

2. *Avoiding positive void coefficients with MOX fuel in LWRs*

For recycling mixed oxide fuel in light water reactors, it is, in practice, necessary to increase the fissile enrichment to achieve adequate end-of-cycle reactivity. Maximum acceptable plutonium content is estimated at 10 ± 1.5 percent; the uncertainty is due to poorly known values for the fission and capture cross-sections of the Pu isotopes.

There is a requirement to know the fission and capture cross sections of the isotopes in light water reactor (LWR) spectra and the relative reactivity worths in spectra corresponding to different coolant fractions. Resonance shielding effects are important and an adequate knowledge of the resonance structure is required so that these effects can be calculated.

3. *Uncertainties in data for structural materials*

At neutron energies above 1 MeV the cross-section data for the major structural materials (Iron, Chromium and Nickel) are still unsatisfactory with up to 20 percent uncertainty in scattering from iron. Cross sections in the range 1-5 MeV will take on increasing importance in the "harder" neutron spectra of advanced reactors, both from the point of view of radiation damage to the structure and effects on reactivity. New measurements are needed, with a target accuracy of 5 percent for Iron, and 10 percent for Chromium and Nickel.

4. *The effect of moderator temperature on LWR reactivity*

There is a long-standing discrepancy of about 3 parts in 100,000 per °C (3 pcm/°C) between calculations and measurements of the moderator temperature coefficient. For typical operating values of -30 pcm/°C (BWR) and -15 pcm/°C (PWR), the discrepancy is an important one. Many experiments have been carried out to improve understanding of the separate parameters involved, and investigations are concentrated on improvements to nuclear data, in particular ^{238}U capture and ^{235}U h (h is the number of fission neutrons emitted per neutron absorbed); the results suggest that ^{235}U h is responsible, but further integral measurements, and high resolution measurements of ^{238}U resonance shapes for U in UO_2 at different temperatures, are needed to confirm it.

5. *"Taking credit for fuel burn-up"*

Present storage and transport regulations for nuclear fuel are based on reactivity values measured for un-irradiated fuel, and take no account of the loss of reactivity in used fuel. This effect is due to the reduced proportion of fissile material and the corresponding build-up of fission products, and if taken into account will allow closer packing of fuel elements with high burn-up, at a maintained safety level. For 10 to 15 percent extra fuel per container, shipping costs could be reduced by about $100,000 to $150,000 per shipment.

An international cooperative project working on this question aims at reducing errors to 10 percent on the fission and capture cross-sections of the actinides present in high burn-up fuel, and on capture cross-sections for fission products. In parallel, integral measurements on irradiated fuel and on the most important fission products will provide data for verifying the calculations for fuel reactivity.

6. *Predicting fuel performance for extended burn-up*

The data needed are similar to those in the section above, and are needed to predict the composition and reactivity worth of fuel as a function of burn-up. For fast reactors there are additional requirements for improved data on inelastic scattering for fission products. The economic benefits of high fuel burn-up spring from reduced fabrication costs per unit energy, and less frequent reactor outages for refuelling.

7. *Discrepancies in data for the primary isotopes*

The NEA's International Evaluation Cooperation, involving evaluators through the OECD area, is working to resolve long-standing discrepancies in data for the nuclides most strongly affecting reactor performance. Thus, one problem affecting the fission cross-section of ^{239}Pu has been resolved recently by measurements at IRMM, Geel and ORELA, Oak Ridge; further measurements are requested for inelastic scattering in ^{238}U, to resolve persistent discrepancies between the current generation evaluated neutron data files. Another international measurement programme concerns integral measurements of effective delayed neutron fractions for different fissile materials, as well as direct measurement of the delayed neutron yield.

ANNEX 3

POSSIBLE DEVELOPMENT OF THE NEA DATA BANK'S ROLE IN THE DATA CENTRES NETWORK

Since its creation in 1978, the Data Bank has gradually enlarged the scope of its work and services to users: the movement was confirmed in 1991 by the transfer of responsibility for the Data Bank to the new Nuclear Science Committee with its wider scope, extending in particular to chemistry and environmental questions relevant to nuclear applications. Data Bank working methods have been adapted in order to concentrate on projects giving higher added value, but remain based on the collection, verification or validation and distribution of data and computer programs. Thus, assembly and basic testing of evaluated data in the JEF file has taken the position of highest importance once occupied by the EXFOR compilation, and an evaluation project for chemical thermodynamics data, TDB, has taken its place alongside JEF.

Lower resources for work in Member countries on nuclear science have led to increasingly close coordination of national programmes within NSC, and correspondingly **close association of the Data Bank and the scientists involved in the validation of calculation methods and data**. It is time to draw the consequences of these changes, and to consider carefully the best use of the Data Bank's resources. Its work will be more effective by doing few things well.

Nuclear data

The Data Bank was from the beginning an active partner in the Joint Evaluated File project, and has more recently taken on the secretariat of the NSC Working Party on International Evaluation Cooperation (WPEC). This last activity will ensure that unnecessary duplication work is avoided and that the best information and software is available to all participants. Work on resolving discrepancies between evaluated files will continue. **It is proposed that NEA continue to strongly support this cooperative work in the field of data evaluation.**

However, if data for thermal reactors can be seen as broadly satisfactory except for specific discrepancies, there are already many more questions on data for fast reactors and actinide burning, while the field for fusion and transmutation studies can be considered as wide open. The importance of keeping operative a number of experimental facilities to be able to meet certain data needs has been strongly emphasised and **the recently formed subgroup on Experimental Activities under the NSC International Evaluation Cooperation will provide a means of coordinating experiments with evaluators' data needs**. The Data Bank will ensure that the results of such measurements are compiled and available to evaluators with minimum delay.

IAEA has a limited activity in coordinating evaluations; it is compiling and selecting evaluations for fusion applications in its FENDL data library. It is expected that development of new fusion evaluations, and benchmarking of these data, will continue in the frame of the International Evaluation Cooperation, where IAEA and the principal non-OECD evaluation projects are represented. A proposal for **NSC coordination of an "International Evaluated**

Intermediate Energy Nuclear Data File" for transmutation was discussed and conditionally approved at the Committee's meeting in June 1993.

While these projects all imply a high degree of participation by scientists in Member countries, they will nevertheless absorb nearly all the manpower available in the Data Bank for data work. NSC's programme on Transmutation should prove complementary to the wider data effort, and maximum coordination with other Nuclear Reaction Data Centres (NRDC) will be needed for the compilation of higher energy data.

Nuclear data services

The Nuclear Reaction Data Centres already cooperate closely in providing data services; data generated in one centre are normally available for distribution through the others, and formats are standardised. Customer service is an essential means of contact with users and producers of data, and the Data Bank should continue to supply its user community with the full range of data available within NRDC.

In order to economise on staff effort in answering requests, but also in order to increase the usefulness of its data collection by offering rapid access, the **Data Bank is further developing its on-line services via electronic network** .

It is hoped to enlarge the scope of its on-line services, to store and transmit information from all parts of NEA through different techniques such as bulletin boards and list servers.

Computer program services

In collaboration with code centres in the United States, the Data Bank provides a service to its Member countries, offering computer programs covering the full chain of computation needed for performance prediction and assessment of nuclear facilities. It also has service arrangements with IAEA.

There is a strong logical link between the validation of the different evaluated data files, and the codes through which these data are used to simulate different reactor applications. In particular, validation of data is inseparable from validation of the processing codes used to aggregate pointwise data into the multi-group cross section sets used as input to all further calculations. The Data Bank is specialised in providing data and program services together.

In parallel with the emphasis given to evaluation, the Data Bank should **expand its collection of integral data to cover many more critical aspects** of nuclear applications, and to be used for program and data validation. This combination of validation information and the program and data collections would form a long-term asset of great value to the nuclear community.

Quality assurance

The introduction of Quality Assurance (QA) procedures in the Data Bank's work has been discussed in the context of the JEF-2 evaluated file, and of selective in-depth program testing. Initial investigations suggest that for JEF the extra effort needed would concern first and foremost the documentation, while a proposal to carry out a pilot QA validation study for the data processing code NJOY has been adopted by NSC. Before embarking on a formal QA programme, careful estimates are needed of the help available from scientists in Member countries, and of the likely workload in the Data Bank.

ANNEX 4

NEA ACTIVITY IN THE FIELD OF NUCLEAR DATA EVALUATION

Joint evaluated file (JEF)

The Joint Evaluated File (JEF) project was started in 1981, as a means of coordinating evaluation work on nuclear data within the NEA Data Bank Member countries. The project is governed by a Scientific Coordination Group (SCG) comprising the leading reactor physicists and evaluators in the Member countries. The first version of the data library (JEF-1) was released and thoroughly validated against integral experiments in the middle of the 1980s. A second much improved version (JEF-2), building on the experience and feedback from the first version, was released for testing in the beginning of 1992. Many Western European countries have abandoned their local evaluation efforts and most of the countries have expressed their intention to use the latest JEF data in their present and future nuclear energy applications.

The NEA Data Bank has played, and is still playing, a central role as coordinator of this project. Even though the major part of the evaluation and testing activities are performed in Member countries, the Data Bank is responsible for the compilation, checking and maintenance of the JEF data libraries, which together contain more than 200 Megabytes of data. The Data Bank also organises twice yearly meetings of the different JEF working groups and maintains the documentation of these libraries.

International evaluation cooperation

Framework

A Working Party on International Evaluation Cooperation has been established under the sponsorship of the NEA Nuclear Science Committee (NSC). The collaboration includes all the different evaluation projects in the NEA Member Countries. These projects are at present: ENDF (United States), JEF/EFF (Western Europe), and JENDL (Japan). Cooperation with the evaluation projects of non-OECD countries is organised through the Nuclear Data Section of the International Atomic Energy Agency (IAEA).

The Working Party was established to promote the exchange of information concerning nuclear data evaluations, validation, and related topics, and to provide a framework for cooperative activities between the members of the different projects. This will include the possible exchange of scientists to promote the cooperation. Requests for experimental data resulting from this activity will be compiled, and measurements to provide the required data will be encouraged. The Working Party will determine common criteria for evaluated nuclear data files. The aim is to assess and to improve the quality and completeness of evaluated data.

The technical activities will be carried out by Subgroups established by the Working Party. The function of the Working Party will be to supervise this cooperation. This will be accomplished by identifying data needs and problems to solve, deciding priorities, and organising the effort to share the work within the cooperating projects.

Subgroup activities

Since the start of this activity in 1990, eleven subgroups have been established, working on the major, worldwide recognised, problem areas in nuclear data. Subjects covered are: resonance data for the major structural materials, the fission cross section of ^{239}Pu, capture and inelastic data of ^{238}U, thermal data for the major actinides. A few of the subgroups are of a long term nature (3-4 years of work), whereas the majority are shorter term activities trying to solve well defined problems.

The subgroups have mainly been working by correspondence, with occasional meetings in conjunction with major data conferences or specialists' meetings. There has been impressive progress in the work of many of the subgroups. Four of the eleven subgroups have completed or are just finishing their work and some of the others will complete their tasks later in 1993. Long standing discrepancies in, for example, the fission cross section of ^{239}Pu and the capture cross section of ^{238}U, have been resolved and the new data are being adopted in the different evaluated libraries.

Following the completion of several subgroups, a discussion on the launching of new subgroups was recently held. Five new subgroups were formed, of which could be mentioned: Nuclear Model Validation, Intermediate Energy Nuclear Data Evaluation, and Kerma and Radiation Damage Evaluation. Three long-term subgroups on Experimental Activities, Evaluated Data Formats and Processing for Application Libraries, and High Priority Nuclear Data Request List, were also formed.

ANNEX 5

COOPERATION BETWEEN USERS AND PRODUCERS OF NUCLEAR DATA

Identifying the needs of data users

Nuclear data is frequently provided to users in the field of nuclear energy, in answer to their requests. However, the impression remains that many users are not convinced that they will benefit by using more accurate (recent) data.

In practice, the initiative lies with nuclear data experts to show what improvements can be achieved in the short term by using better data for existing reactors and to make users aware of the negative consequences, particularly in terms of cost, of using older less accurate data in new applications.

Communication with funding authorities

The principal justification for new data measurements and evaluations lies in their importance for the continuing development which is essential if the nuclear option is to remain open. As a long-term investment, this work has so far been the concern of government, though more recently some major utilities have been looking into the possibility of supporting data development.

The present report is addressed also to national authorities who may not fully appreciate the need for continued improvement of nuclear data. It is important to improve communications between users and the funding authorities.

Contacts with new users

Nuclear data needs were in the past mainly confined to reactor design and some parts of the fuel cycle. Looking into the long-term, there are expectations for a more pronounced need of nuclear data in areas such as medicine, space, astrophysics and regulatory requirements. However, the communication between users in these fields and producers is very limited, while funding authorities have not always felt responsible for supplying data for non-energy needs. Moreover, users of nuclear data in fields such as medicine may lack familiarity with the form in which these data are presented, and with the effects of using poor-quality data. It is important to develop user-friendly systems to make modern nuclear data easily available to all kind of potential users.

Thus there is a need to extend the dialogue to include data users concerned with non-energy applications, and the funding bodies responsible for satisfying their needs.

How to facilitate good communication

Some countries have long-standing nuclear data committees, while others collect information on data needs on a less formal basis. It is intended that discussions should start on a national level, and also that they should take due account of the needs of non-energy data users. In order to integrate the requirements identified nationally, it may be necessary **for NEA to set up an international forum for discussion between producers and users of nuclear data.** The resulting consensus on data needs would be an essential input to an internationally coordinated program on nuclear data development.

ANNEX 6

A FRAMEWORK FOR INTERNATIONAL COLLABORATION IN NUCLEAR DATA MEASUREMENTS

Recent years have seen a steady decline in experimental activity on nuclear data in the OECD area, reductions in scientific manpower due to retirement of some very distinguished neutron physicists, and closure or mothballing of facilities internationally-known for the high quality of their output. No international agency can replace facilities closed, or scientists in early retirement due to the run-down of national programmes; however, it is proposed to promote international collaboration in making the most effective use of the facilities remaining, through the sharing of these resources and exchange of scientists.

In addition, as considered in a Study on Megascience at the OECD Directorate for Science, Technology and Industry (DSTI), there is an urgent need for a procedure for the exchange of information and for an open discussion between Member countries at an early formative stage on the planning and development of major facility projects and large-scale geographically distributed programmes. Such international collaboration would help to promote a coherent approach, on a world scale, to projects with significant financial and manpower implications, hence optimising scarce world resources.

In order to smooth the way for an increased level of exchange, it is proposed that NEA should provide a framework to include and complement the existing bilateral procedures.

The aims of the framework

Member countries would agree to promote the sharing of experimental facilities, such that scientists from one Member country could by different arrangements benefit from the facilities in another. NEA would provide a service to inform its users of measurement requests, of the availability of and requests for machine time, and of possibilities for collaboration. The NEA Nuclear Science Committee (NSC) would agree on guideline recommendations for the modalities of these exchanges on existing facilities, and also provide an opportunity for the exchange of information and for open substantive discussions at an early stage of large programmes in need of a major facility or world-wide coordination. Information would be supplied through national correspondents and spontaneously by users (information which would be cleared by the correspondent).

Information for Scientists

NEA Data Bank offers an interactive on-line service to accredited scientific users in Member countries, using international computer networks. This should be used to circulate information on:

Use of Experimental Facilities

- Countries would supply a clear technical description of the facilities they would be willing to open for shared use or collaboration by visiting scientists with local groups, including the target and measurement facilities available on-site. This would be accompanied by an experiment plan, showing measurements to be made within the future period by the local group, and periods of machine time which could be made available to visiting scientists.

- Where groups are willing to carry out measurements for third parties on a commercial basis, the types of measurements should be specified.

Exchange of Manpower

- Member countries and the EC already have frameworks for international exchange of scientific manpower, "Research Fellowship Systems", of their own. It would, therefore, be realistic to make the best use of arrangements already existing between Member countries in order to compensate for the shortage of manpower to measure nuclear data.

- The NEA would collect and compile on the NEA host computer information on existing fellowship systems and vacant fellowships in Member countries.

Request lists for nuclear data measurements

- Request lists for new or improved data are generated nationally and form the basis of a joint high-priority list generated within the NSC Working Party on International Evaluation Cooperation (WPEC). It is proposed to widen the basis of this list, and improve understanding and support by funding authorities through closer user-producer collaboration (Annex 5) and to correlate it with information on work in progress related to these requests.

Guidelines for exchanges

Many existing exchanges are carried out on a rather informal basis, with the conditions set in agreement with the host institute. It does not seem realistic to propose a standard contract to cover the multitude of possible exchanges and to suit all the different administrations which may be involved. However, the Committee may wish to study past exchanges and identify limited guidelines for good practice in the future.

Coordination of the framework

This exchange of information would be coordinated within NSC by the subgroup on Experimental Activities of WPEC; its members would nominate or act as correspondents for supplying information from their country to be included in the on-line service.

It is hoped that Member countries will wish to consult together before making further decisions relating to the potential for carrying out nuclear data measurements in the OECD area, concerning either existing installations or plans for new facilities.