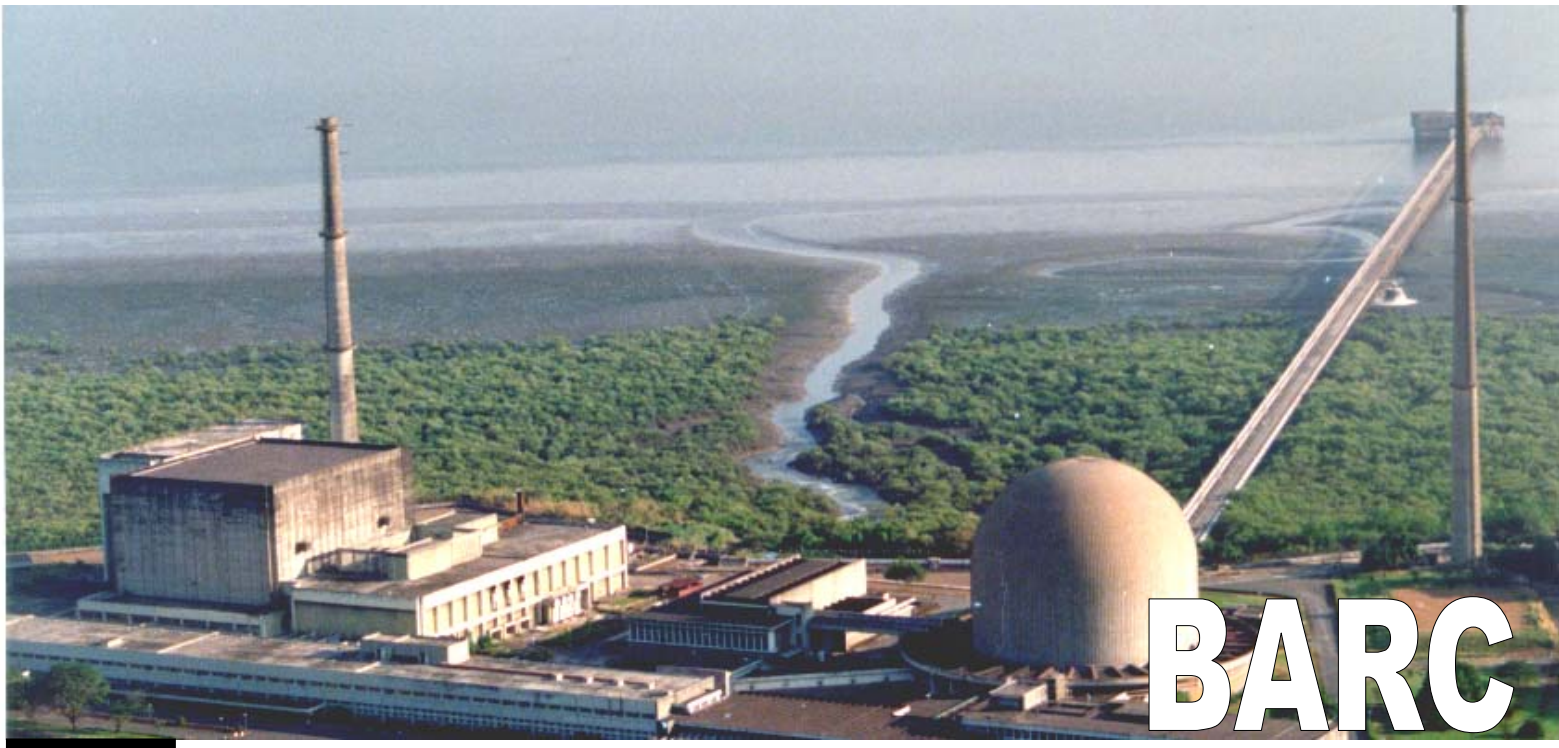

BARC NEWSLETTER

No. 227
December
2002

Message from Director, BARC

Dear colleagues,

At the outset, I would like to take this opportunity to wish a Very Happy and Exciting New Year 2003 to all of you. I must also take this opportunity to compliment each one of you for your exemplary cooperation and professional contributions during the last year in taking BARC a step forward in our goal of utilising nuclear science and technology for improving the quality of life in our society. I am particularly happy to observe the all-round progress made during the last year in our pursuit of excellence in both basic sciences as well as engineering sciences. Equally commendable have been the performances of our healthcare, security and fire services systems.

However, being members of BARC, we have the responsibility of continuously upgrading and expanding our R&D efforts that are much needed for building a strong Indian economy based on

Contents

sustained energy security, food security and health care. Accordingly, we have an ambitious programme in the 10th Plan, both in the power generation as well as non-power generation sectors. I am confident, with the sustained cooperation and commitment from each one of you, BARC will succeed to fulfill its commitment to the nation.

Finally, I also take this opportunity to send the Season's Greetings and Best Wishes for the New Year to all the family members of BARC colleagues at Trombay and other places in the country.

B.Bhattacharjee
Director

निदेशक, भाभा परमाणु अनुसंधान केंद्र, का संदेश

प्रिय साथियों,

सर्वप्रथम मैं आप सभी को नव वर्ष 2003 की हार्दिक शुभ कामनाएं देना चाहता हूँ । मैं समाज के जीवन स्तर को उत्कृष्ट बनाने में नाभिकीय विज्ञान एवं प्रौद्योगिकी के प्रयोग के लक्ष्य को प्राप्त करने में तथा केंद्र को इस क्षेत्र में आगे बढ़ाने के लिये गत वर्ष प्रत्येक व्यक्ति के द्वारा दिये गये अभूतपूर्व और व्यावसायिक योगदान के लिये बधाई देता हूँ । मैं गत वर्ष में मूल विज्ञान तथा अभियांत्रिकी विज्ञान दोनों ही विधाओं में किये गए उत्कृष्ट कार्य एवं प्रगति को देखते हुए अति प्रसन्न हूँ । मुझे प्रसन्नता है कि हमने इसके साथ ही साथ स्वास्थ्य, सुरक्षा एवं अग्नि शमन सेवा प्रणालियों के कार्य निष्पादन में भी समान रूप से दक्षता प्राप्त कर ली है ।

भा.प.अ. केंद्र के सदस्य होने के नाते हमारा उत्तरदायित्व है कि हम अनुसंधान एवं विकास के उन्नयन एवं विस्तार के लिये सतत् प्रयत्नशील रहें जो कि राष्ट्र की अर्थ व्यवस्था को सुदृढ़ बनाने के लिये अति आवश्यक है । देश की अर्थ व्यवस्था सतत् ऊर्जा सुरक्षा, खाद्य सुरक्षा और स्वास्थ्य संबंधी देखभाल पर आधारित है । तदनुसार, 10वीं योजना में विद्युत उत्पादन और गैर विद्युत उत्पादन दोनों ही क्षेत्रों के लिए महत्वपूर्ण कार्यक्रम शामिल किया गया है । मुझे विश्वास है कि आप के सहयोग एवं वचनबद्धता द्वारा भा.प.अ. केंद्र राष्ट्र के प्रति दिये गये वचन को पूरा करने में सफल होगा ।

अंत में, मैं पुनः एक बार ट्रांबे और देश के अन्य स्थानों में स्थित भापअ केंद्र के सभी सदस्यों और उनके परिवार के सदस्यों को हार्दिक शुभकामनाएं देता हूँ ।

बी. भट्टाचारजी
निदेशक

XnWIup2.0, A SOFTWARE TO GENERATE HANDBOOK OF MULTI-GROUP CROSS SECTIONS IN WIMS-D LIBRARIES FOR THERMAL REACTORS

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Introduction

Soon after the discovery of nuclear fission, several pioneers in nuclear energy dedicated their efforts to obtain estimates of basic nuclear cross section data of a number of actinides, moderators, structural elements and coolant materials both experimentally and theoretically. In the early sixties, the nuclear data were already significantly improved as compared to the status in the fifties but still the reactor design had to be based upon simplistic descriptions of nuclear power reactors. The simpler computer modeling in the sixties was complimented, as a mandatory requirement, by a number of one to one mock up of integral experiments for validation of nuclear data and methods for safe operation of the research and power reactors. The effective neutron-nuclear interaction cross sections of major fissile and fertile isotopes (U-235, U-238 and Pu-239) were then adjusted to fit the results of integral experiments. The nuclear reactors were successfully designed and operated by this approach. However, new designs again needed many new experiments and detailed integral validation. Further, not all the adjustments in basic data were justified when improved differential measurements were conducted and results of new basic data became available several years later. These procedures in sixties were sound and practical at that time and were applicable in a restricted way to only specific systems for the limited burnup and operating parameters that were studied. Today, after nearly 60 years since the first reactor pile, many of the experiments can be simulated without adjusting the cross section data of U-235, U-238 and Pu-239 as a result of greatly improved nuclear data and improved methods of calculations of neutron transport.

The WIMSD nuclear data library in 69 energy groups was made available by the UK in the late sixties. This old library is being successfully used in the design and safe operation of PHWRs in India. As the basic data changed in the last few decades and data of a number of isotopes have been added in the ENDF/B system, the need to get new WIMS libraries was strongly felt by the world reactor physics community that uses WIMS code. The generation of WIMSD library from first principles has been demonstrated by the experience in the IAEA WIMS-D Library Update Project. The details and outputs of this project are described at the web-site: http://www-nds.iaea.org/wimsd/. A strong need was felt by scientists using the non-commercial version of the WIMS code system or its equivalent to create a software with user-friendly graphical interfaces to enable quick visualization of the energy dependence of the multi-group cross sections of any nuclide of interest. Ideally, the reactor designer would like to have a convergence, universally, in the basic data and employ a single source of basic evaluated data file. In the field of nuclear energy, nuclear data files in different countries have been improving as a function of time and by addition of new isotopes and extension of data to higher energies. The interested reader can get more details at the IAEA website http://www-nds.iaea.org on basic evaluated nuclear data files that are available.

Designers of nuclear systems often demand, as an inescapable capability, to obtain as a first and

basic step, extensive visualization of nuclear data of each isotope for each specified energy region for the required partial reaction/parameter for each of the WIMS-D libraries. In a typical case of a WIMS-D library with, say 150 isotopes for the sake of illustration, with 30 of them as actinides as an example, with five reactions (total, transport, scattering, out-scattering, absorption), and, for actinides in addition with four quantities fission, nufission, nubar and eta would require in principle about 6000 graphs for a single library for six selected energy regions. For a system of, say, 7 different WIMS-D libraries that we have, this amounts to 42,000 histograms. The ratio plots for the same data again will number another 42,000. Thus 84,000 plots in all would be needed to complete the visualization requirements. This number will increase if the ratio plots are to be re-obtained with a different reference. To solve this complex and laborious problem with a high level of quality assurance, we successfully developed a computer program 'XnWlup' with graphical user interface to help the users of WIMS-D library. The features of this new software and some interesting experiences are presented in this article.

Applications and Use of XnWlup Software in Nuclear Data and Thermal Reactor Design Studies

The nuclear data centres in USA, Europe, Japan, Russia and China have been evolving computerized nuclear data files in ENDF/B format in the last 40 years to satisfy the nuclear data needs of nuclear energy development. The basic evaluated nuclear data files, known as "ENDF/B" system, contain the recommended values of nuclear data for application calculations. These data files cannot be directly used in application calculations. To use the best nuclear data in application calculations, it is an imperative engineering requirement to correctly process the basic evaluated nuclear data files into sable format. Thus, the recently released basic evaluated nuclear data files, such as ENDF/B-VI, JENDL-3.1, BROND-2 and CENDL-2, mentioned in Fig. 1 are <u>not</u> directly used as input to neutronics or other applied calculations but are first converted to pre-processed files which are post-processed into multi-group files which are then cast into specially formatted working libraries that are compatible with neutronic codes. The task of processing ENDF/B files is an inescapable part of any serious simulation study of nuclear systems. The IAEA WIMS-D library update project was conceived with the goal of providing updated working nuclear data libraries for the users of the WIMS-D5 or its earlier versions or compatible thermal reactor lattice-cell code. The WLUP is the vital link that will produce the working library for thermal reactor applications in the generic scheme shown in Fig. 1.

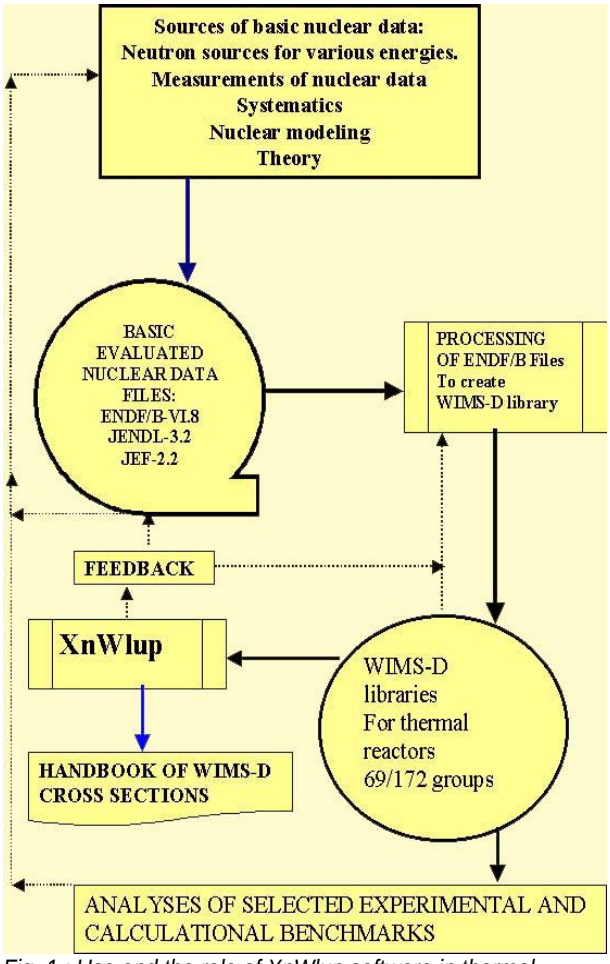

Fig. 1 : Use and the role of XnWlup software in thermal reactor studies

System's Requirement and Needed Input Files for XnWlup

The XnWlup software has been designed to help generate and view the histogram of 69/172 multi-group cross sections as a function of neutron energy. This program is developed for MS-WINDOWS and has been designed using Microsoft Visual C++ and Microsoft Foundation Classes Library (Refs. 1-2).

The XnWlup2.0 software package described in this article has been developed as the second and modified version of our previous (Ref. 3) software package 'XnWlup'. Histogram of multi-group cross sections as a function of neutron energy for a given nuclide is viewed by selecting a particular WIMS-D library. In addition to this, now this modified version helps the WIMS-D library users to compare the histograms of multi-group cross sections from different library.

In order to provide online help for this program, the help topics are made in HTML format and compiled with Microsoft HTML Help Workshop.

This process necessitates the requirement on the part of the user to have Microsoft Internet Explorer in order to view the online help topics.

This software package consists of the following files, all of which come in a single zipped file.

1. XnWlup2.exe
2. XnWlup2.chm (Online help file viewed through MS Internet Explorer)
3. material list files (endfb6.lst, endfb6gx.lst, jef22.lst, jendl32.lst, iaea.lst, iaeagx.lst, jendl3gx.lst, WIMS1971.lst)
4. BmpSave.dll
   Readme.txt

It is assumed that the WIMS-D cross-section data to be plotted are already available with the user of the XnWlup software. This software reads the WIMS-D library data in ASCII format from standard libraries such as "jendl32.lib", endfb6.lib, jef22.lib etc. (See http://www.rcp.ijs.si/~wlup/wimslib/index.html). The software assumes the standard WIMS-D format while retrieving the different cross sections like scattering, absorption, transport, fission, etc.

The required input files from the user machine are:

1. Library data files (ASCII) (For example: jendl32.lib or endfb6.lib or jef22.lib)
2. Material List files (ASCII) that contains NIN (Nuclear Identification Number), Symbol and Name for the respective element.
3. BmpSave.dll file to save the plotted histograms in a image file using 'Windows Bitmap' format.

There are at this time nine material list files included in this package. These files are meant for the currently available WIMS-D libraries jendl32.lib, endfb6.lib, jef22.lib and endfb6gx.lib, jendl3gx.lib, iaea.lib, iaeagx.lib, WIMS1986.lib and WIMS1971.lib. The file name of the material list file used for a given library and the file name given to that library are same except that the 'lst' extension is used for material list whereas 'lib' extension is used for library.

The material list file can be made by editing the 'matlst.txt' file available at http://www.rcp.ijs.si/~wlup/wimslib/matlst.txt. For example, the file 'matlist.lst' that is provided with our software package is made after the above-mentioned editing. Selection of these input files is performed by browsing while the program starts working.

Working with the Software

Due to the existence of graphical mode operating systems like MS-WINDOWS, many user programs are currently designed with user-friendly graphical interface. This graphical interface consists of a main window (a rectangular area allotted to the given program) that includes menus, tool bar buttons, dialog boxes, etc. This type of graphical user interface (Ref. 1 and Ref. 2) helps the users to execute the program in a way he wants without going through the manuals that explain the working procedure. Our software 'XnWlup' is developed with this graphical user interface in order to help those

users who frequently refer to the WIMS-D library cross section data of neutron-nuclear reactions to understand and interpret the interplay of different nuclear reaction data in reactor design calculations. The software also helps to produce handbook of WIMS-D cross sections. The typical working procedure of the ' XnWlup' program is

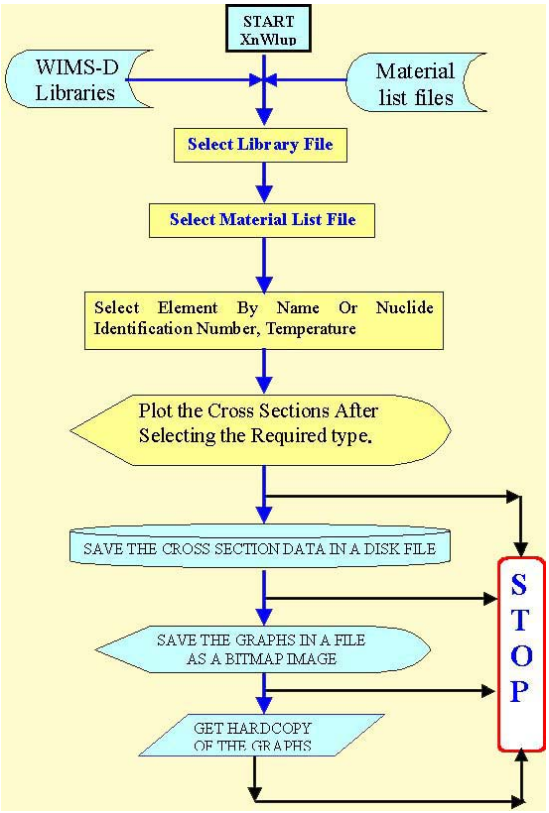

Fig. 2. Typical working procedure of 'XnWlup' program

explained in Fig. 2.

Opening the Input Files

Once the program is executed, the brief introduction window appears to direct the user to select the library file. After this introduction window, a 'File Open Dialog Boxe' is followed for selecting the input WIMS-D library files. By browsing through the various folders, the user can select a single or a multiple WIMS-D library files. Now, the user can select the required WIMS-D library file; and multiple selections of libraries are also allowed.

Note that XnWlup requires WIMS-D libraries in ASCII format. It is expected that the user has a material list file for each WIMS-D library file. The names of the material list file and library file are same except the extension '.lst' for material file whereas the WIMS-D library file has the '.lib' extension. The material list file should be stored in the same folder where the WIMS-D libraries are stored.

3. Type of data :

Interface Commands

If the user has properly selected the subdirectory in which the input files (WIMS-D libraries and the Material List files) reside, the main window of this software appears as given in Fig. 3. At this stage, by default, the program has selected the top most element listed in the library, generally Hydrogen bound in water. Now, the user can make out those tool bar buttons provided for interface commands. It is the convention followed while designing the Graphical User Interface that for each toolbar button there is a respective menu item. In XnWlup2.0 software, we have also provided the user with a menu item for each toolbar button that represents an interface command. Table 1 lists the function of each tool bar button that one can see in the main window. There are three types of interface commands implemented in this program as they are shown using separator in the tool bar of the Main Window (*see* Fig.3). For any WIMS-D library, the top-most cross section data is given for Hydrogen-bound in water and this program by default selects the first element listed in the library; and also by default total cross section is chosen. Therefore, initially, the XnWlup program displays the Hydrogen total cross section for Hydrogen bound in water in the main window.

In this program, the plotted cross section graph is parameterized by four parameters. These parameters are listed below.

1. Name of the Library,
2. Name of the Nuclide,

Neutron-nuclear reaction total, scattering, transport, absorption, fission or parameters
nufission, nubar and eta

4. Temperature.

Either by activating the tool bar button Ed or the respective menu command, the dialog boxes appearing on the screen help the user to select the required parameters for the graph. User can add new graphs, edit the plotted graphs by changing some of the parameters and can delete the unwanted graphs. The tool bar button can be used to change the color of the graphs, darkness of the gray background, number of data intervals between the symbols of the graph if symbol is added to the graph. An example is the comparison of eta values in the WIMS-D library derived from the Japanese evaluated nuclear data file, JENDL-3.2, for six different isotopes of uranium given in Fig. 4. The toolbar button Lin can be used to change the logarithmic scale of cross section to Linear scale. For instance, in the display presented in Fig. 5, the absorption cross section is plotted for U-238 from ENDF/B-VI, JENDL-3.2, JEF-2.2 and the older WIMS libraries on log scale. The plotted graphs in linear scale is shown in Fig. 6.

It is important to realise that the large discrepancy in some energy regions seen in the graph can mask smaller discrepancies in visualization and give an illusion of "good" agreement in other energy regions. This problem has to be addressed by zooming the energy region of interest. The option for zooming the graphs in different energy intervals is explained later in this article. If the cross section data happens to be zero for some energy groups, plotting with log scale is not possible and the plotting is done only with linear scale. Similarly, if maximum value of cross section exceeds 9000 barns, plotting is done only with log scale and linear scale plotting is not done.

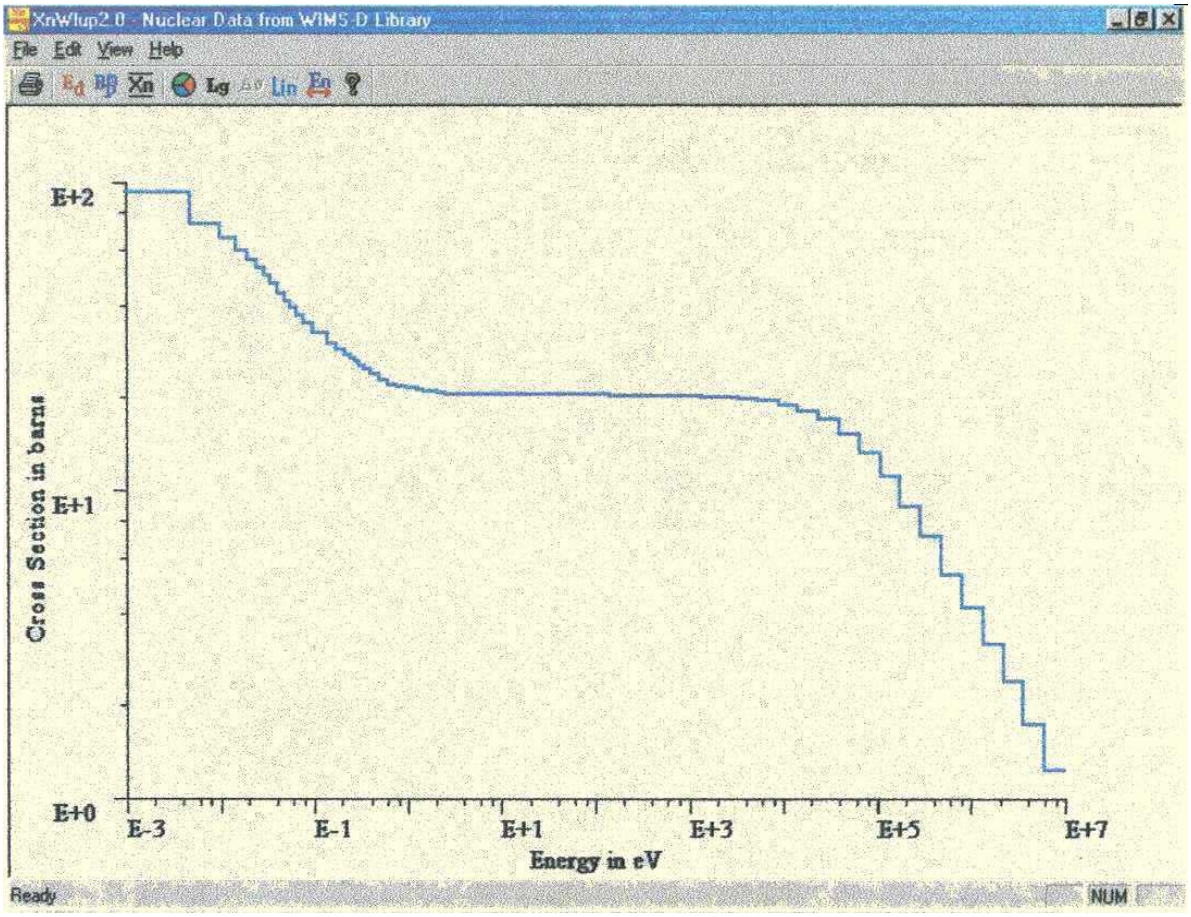

Fig. 3. Main window of 'XnWlup2.0' software with graphical user interface

Table 1: Function of each tool bar button in the main window

Button	Menu command	Function
	File | Print	To get the hard copy of the plotted graphs
Ed	Edit | Add/Remove/Edit Graphs	To add/remove graphs and edit the parameters for each graph like Library name, name of Nuclide, Reaction type, Temperature
Bp	File | Save as BITMAP	To save the plotted graphs as bitmap image in a hard disk file
Xn	File | Save Cross section	To save the cross section data in a ASCII file
	Edit | Graphs Colors	To change the color for each graph plotted and also to add the symbols
Lg	View | Legend	To display the Legend for each graph plotted
Δσ	View | Ratio	To view the ratio of cross section data between the reference graph and other graphs
Lin	View | Linear Scale	To plot the graphs with the linear scale for the cross section
En	Edit | Energy Range	To view the graphs in different energy groups like thermal, fast, resonance etc.

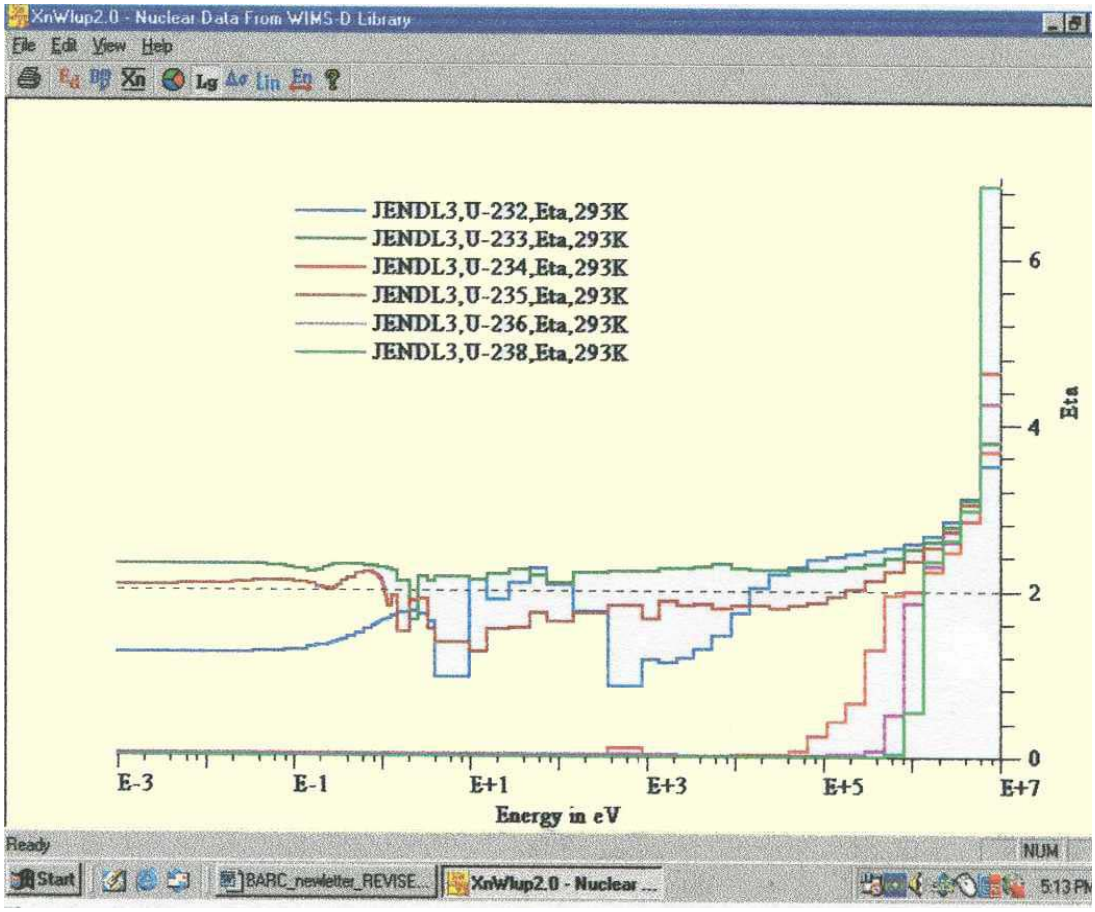

Fig. 4. A plot of the parameter "eta" for six different Uranium isotopes from JENDL-3.2 based WIMS-D library

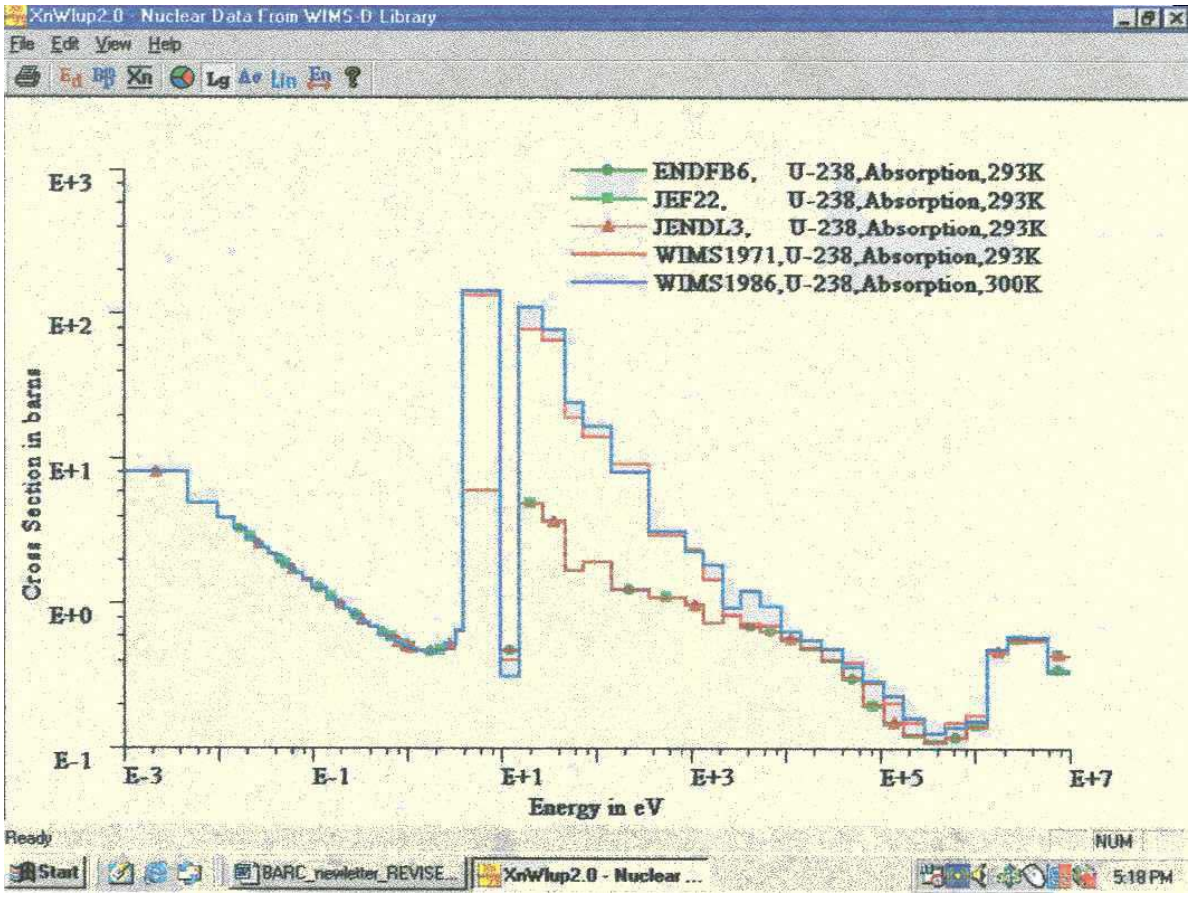

Fig. 5. Comparisons of absorption cross sections of U-238 on logarithmic scale

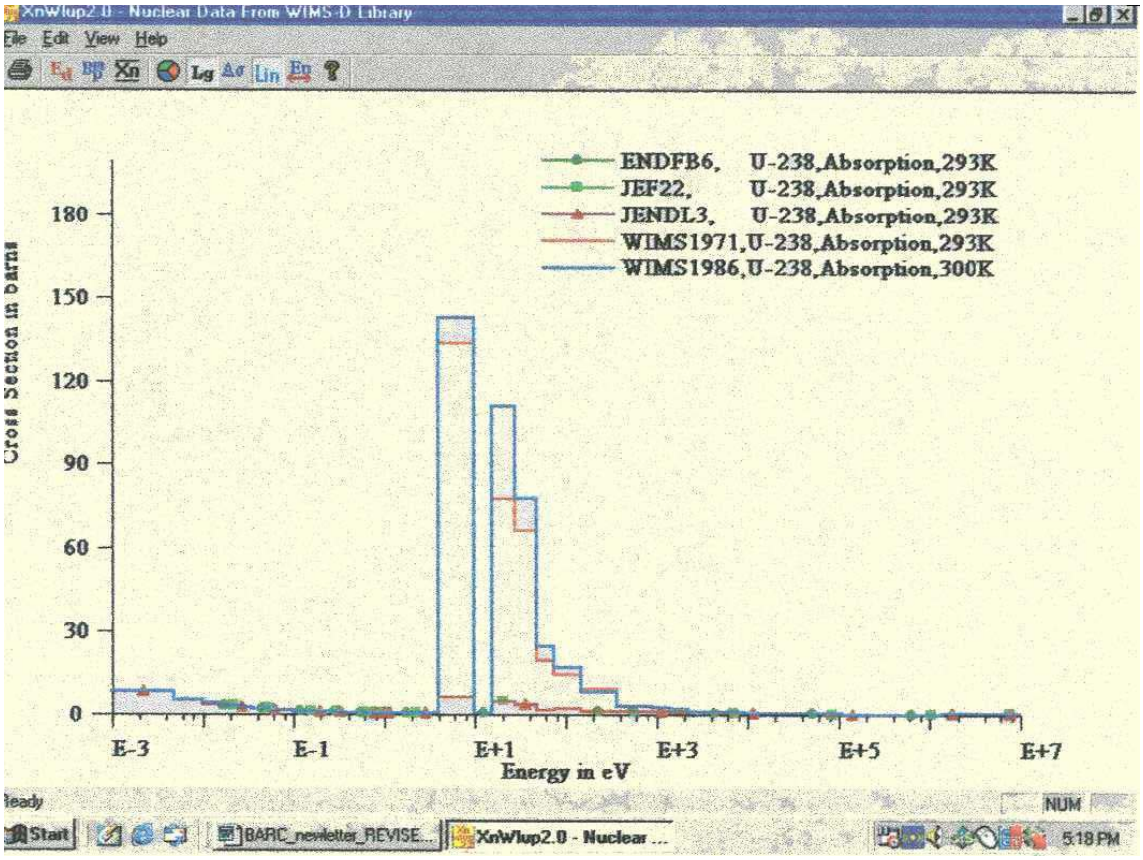

Fig. 6. Comparison of absorption cross section of U-238 on linear scale

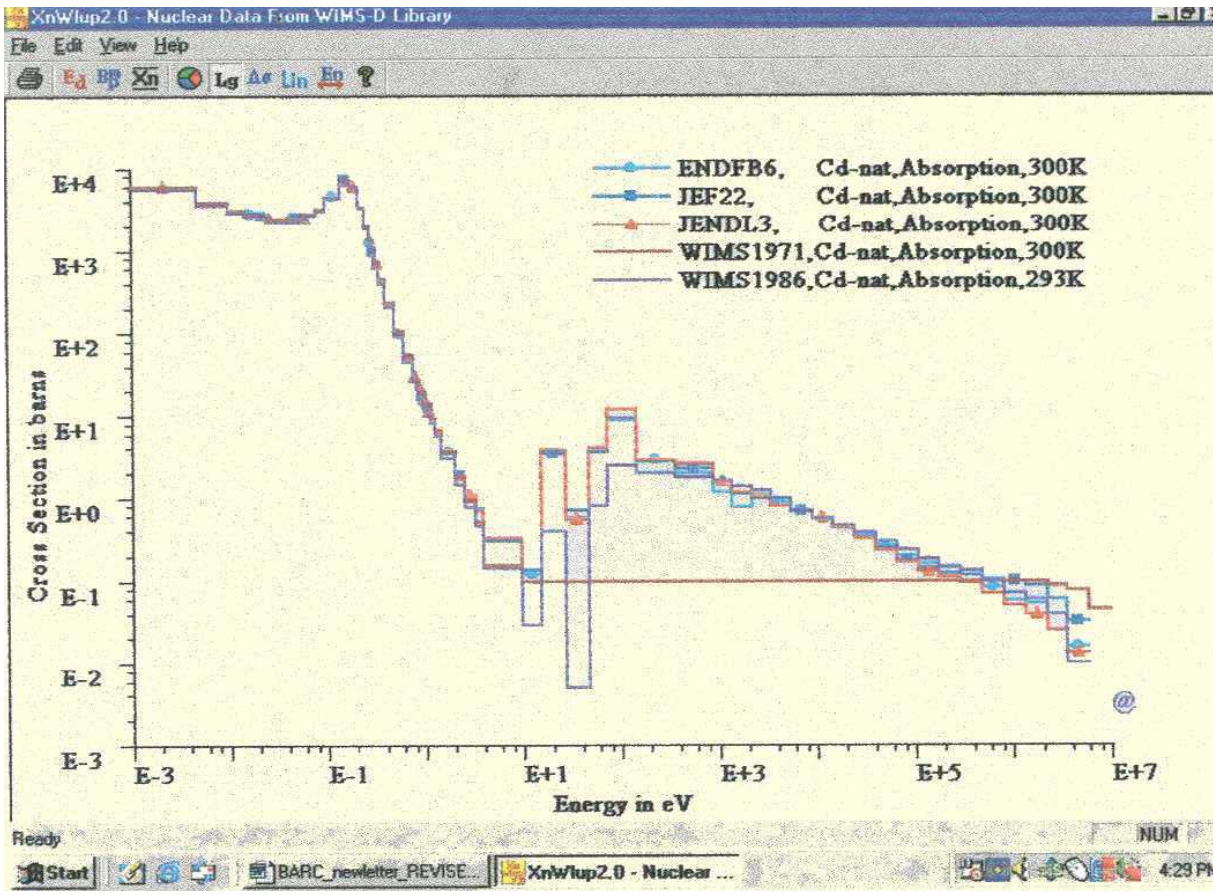

Fig. 7. Absorption cross section of Cadmium from five different libraries

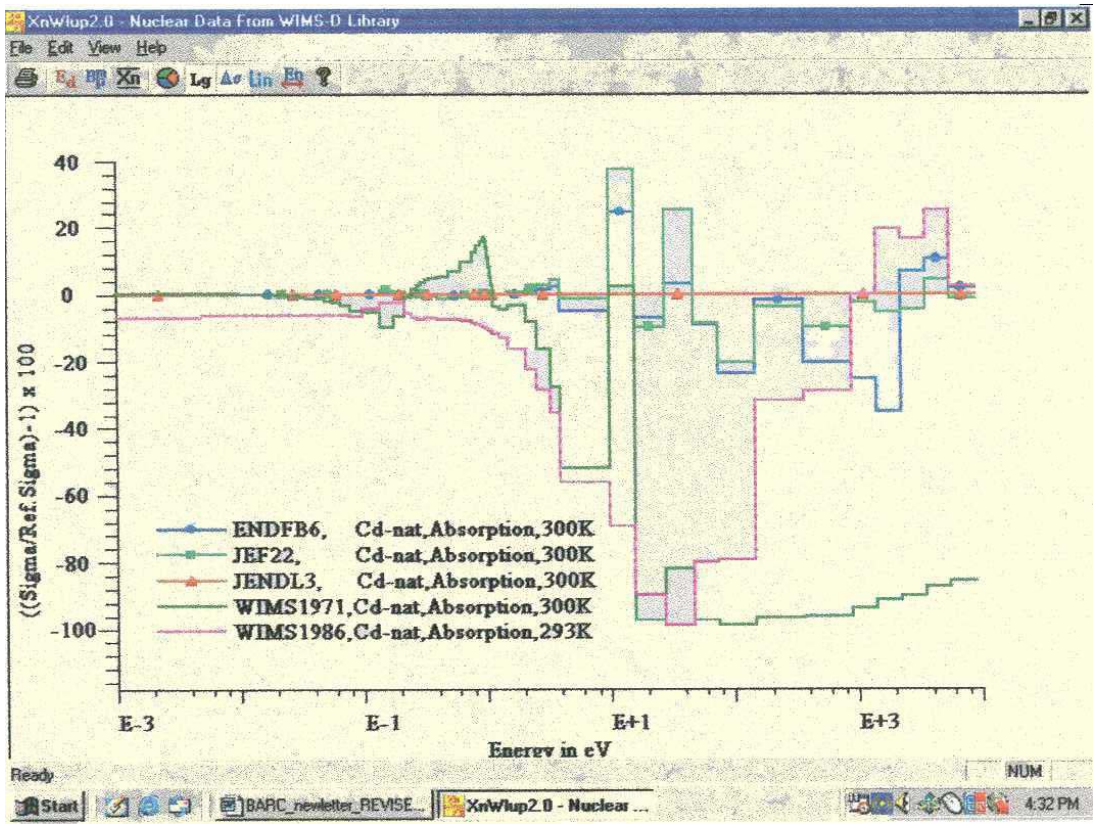

Fig. 8. Comparison of absorption cross section of Cadmium in thermal and resonance regions with respect to JENDL-3.2 based WIMS-D library

While plotting more than one graph, the user can get the histogram plot of ratio of cross section data as a function of energy. This ratio plot can be displayed either by activating the Δσ toolbar button or 'View|Ratio' menu command. While plotting this ratio of cross section, data of one graph is considered as reference, and the ratio of other graph's data for each group is calculated with respect to this reference data and the percentage deviation is plotted in the graph. The user selects reference data with the help of dialog boxes provided for this option. For instance, the display in Fig. 7 shows the graphs plotted for absorption cross section of cadmium from five different libraries ENDF/B-VI.8, JEF2.2, WIMS1971, WIMS1986 and JENDL3.2. The same data gives a ratio graph as shown in Fig. 8 when ENDF/B-VI is specified as the reference.

For plotting the ratio graphs, the XnWlup 2.0 requires by design that all graphs should have identical energy group structure.

The plotted graphs can be viewed in different energy windows by using the tool bar button En. This zooming option can be employed for both the actual plotted cross sections graphs and for the ratio graphs. It works both in the linear and in the logarithmic scale. As an example of this zooming option, we consider the case of absorption cross section of Th-232. The zoomed graphs in Fig. 9 were obtained for Th-232 by selecting the thermal energy region. The same data shown in Fig. 9 can be obtained as a ratio graph as shown in Fig. 10 by choosing ENDF/ B-VI library as reference.

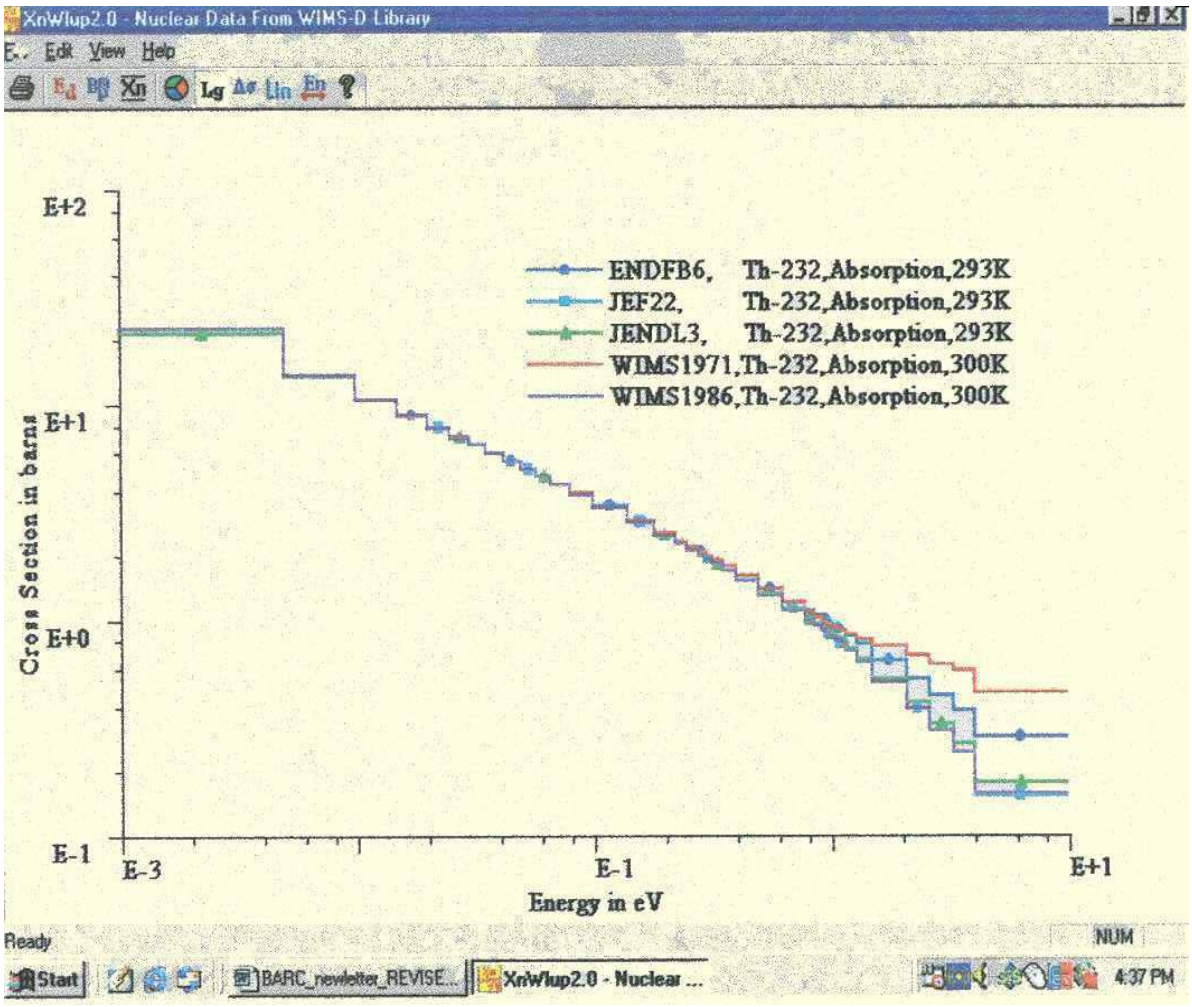

Fig. 9. Absorption cross sections of Th-232 in the thermal energy region

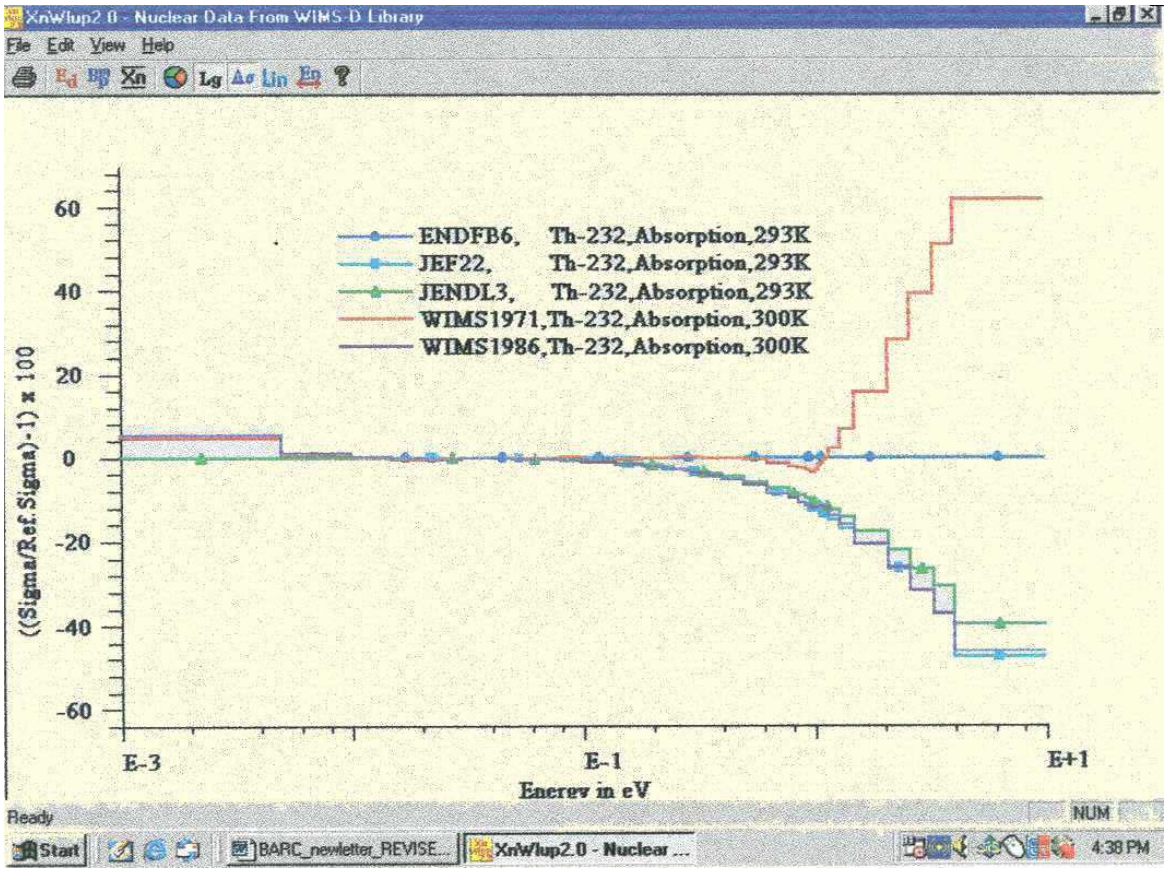

Fig. 10. Ratio of absorption cross section of Th-232 in the thermal energy region with ENDF/B-VI as the reference

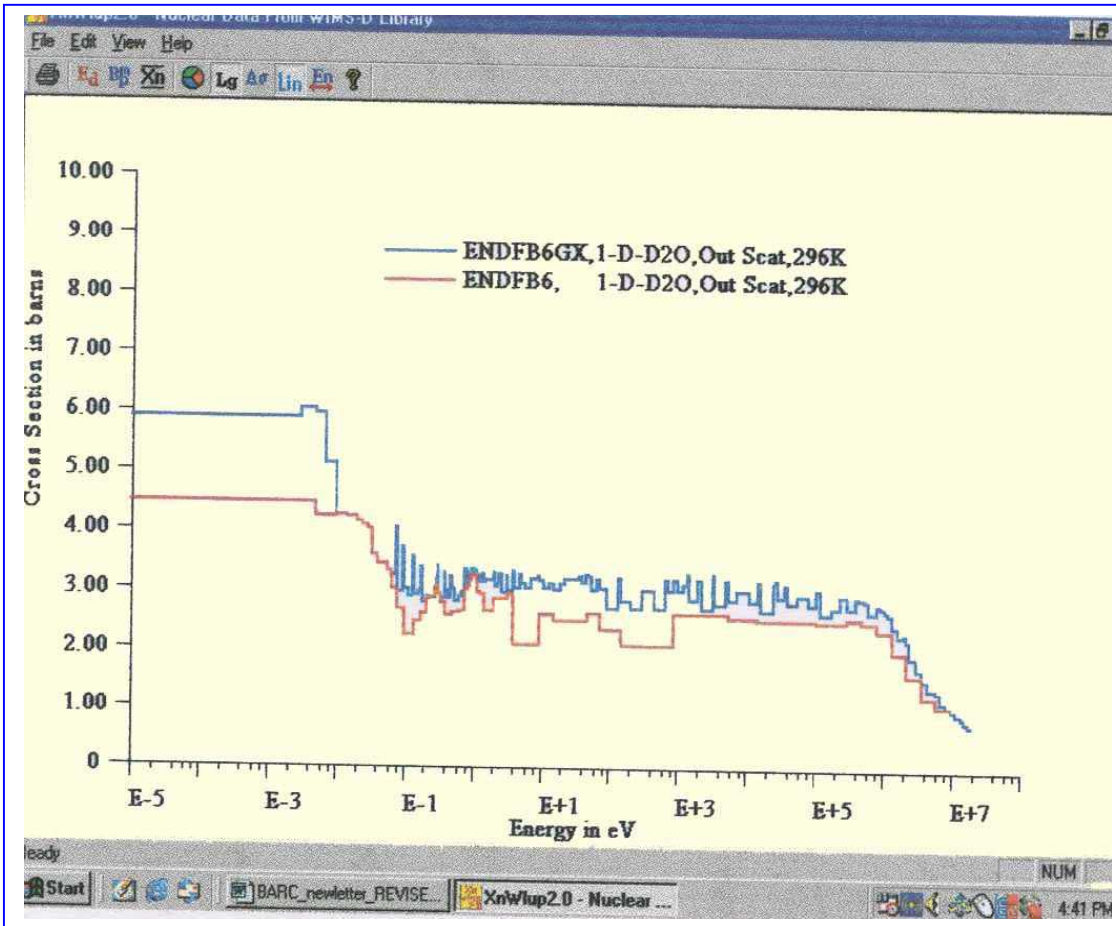

Fig. 11. Out-scattering cross section for Deuterium bound in heavy water

Scattering and Absorption Cross Sections

The scattering cross section for a given energy group plotted by the XnWlup2.0 is calculated by the software as the sum of self-scattering within the given energy group and out-scattering to all the other groups from the given energy group. The XnWlup2.0 software has the capability to plot the total scattering cross section and/or the out-scattering cross section. When the scattering cross section is selected, the user is prompted to specify the type of scattering cross section. The plots obtained in the case of out-scattering cross section for Deuterium bound in heavy water are presented in Fig. 11 for 69 and 172 group libraries. Figure 12 shows the comparison of out-scattering cross section data given in different 69 group libraries in thermal region(ENDF/B-VI is selected as the reference).

In WIMS-D library convention, the (n, 2n) and (n, 3n) cross sections are treated as negative absorption. Due to this approach, the absorption cross section in the first one to three energy groups (Mev range) becomes negative for some elements/isotopes. When the plot is made in logarithmic scale on Y-axis, the negative/zero cross sections are not plotted. The presence of negative absorption is indicated by the symbol @ in the graph. One can see this type of negative absorption cross section for Gd-157 as illustrated in Fig. 13. Figure 14 shows a plot in linear scale in the selected energy region 2 to 20MeV for the element, Gd-157, where the negative values are displayed.

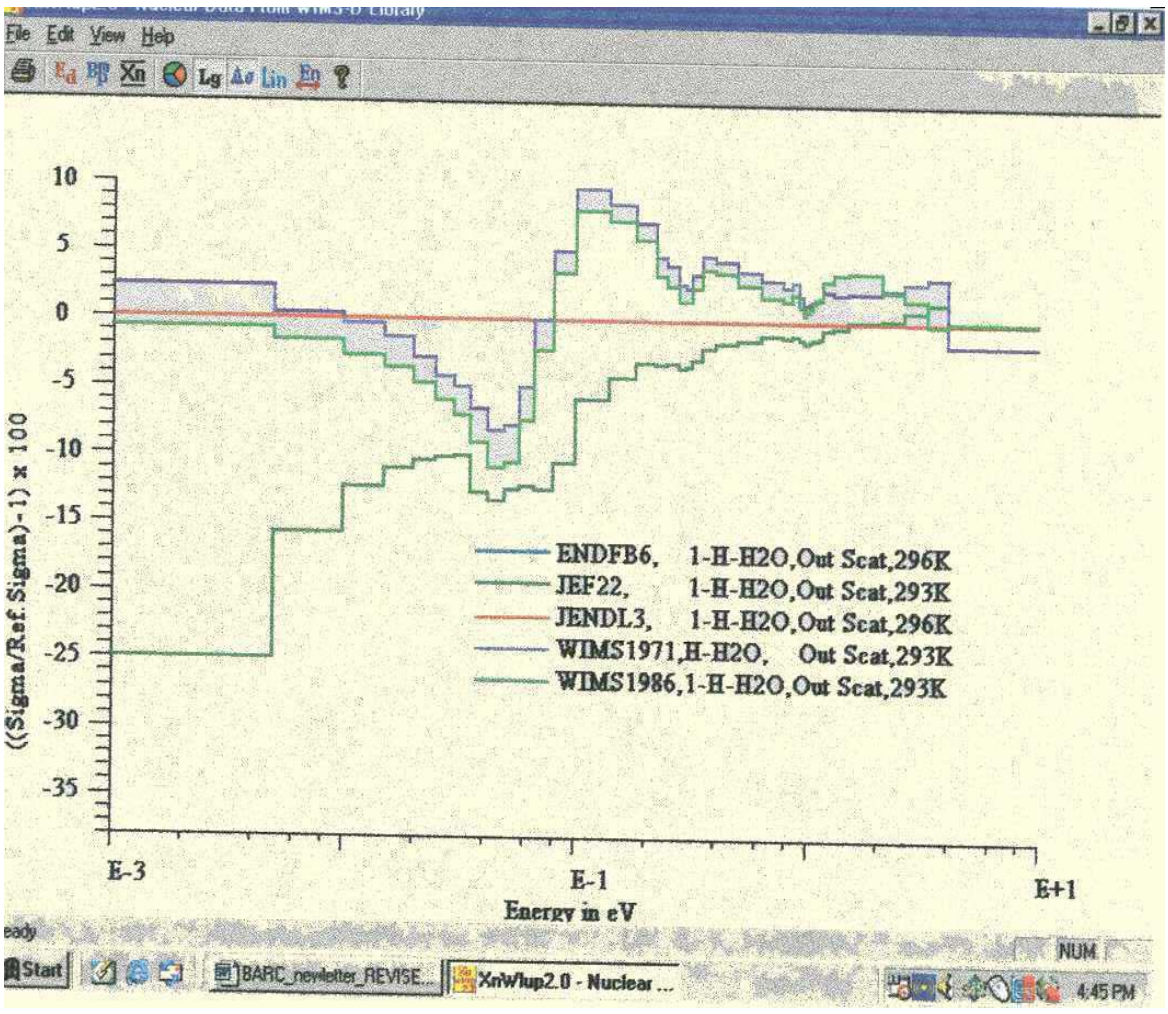

Fig. 12. Ratio of Out-scattering cross sections for Hydrogen bound in water from different WIMS-D Libraries by taking ENDF-B/VI as reference

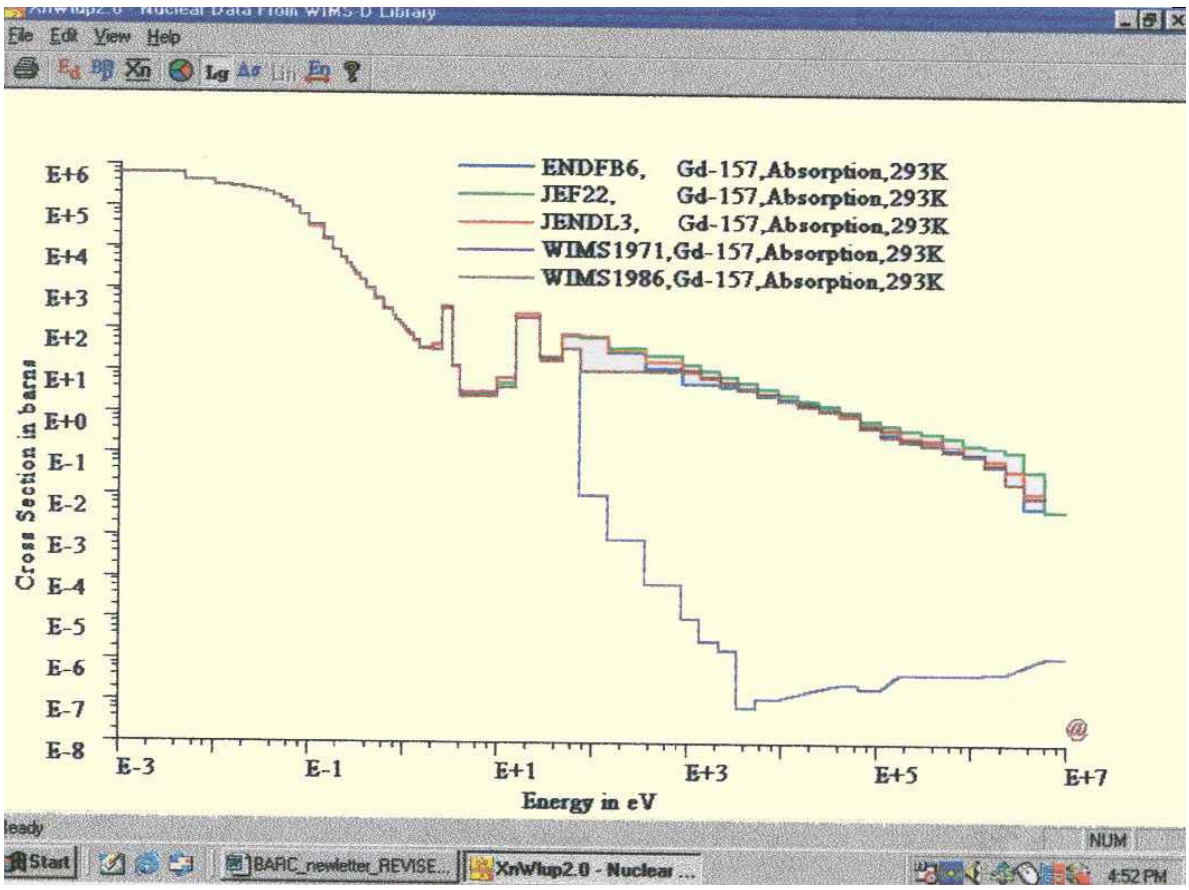

Fig. 13. Absorption cross sections of Gd-157

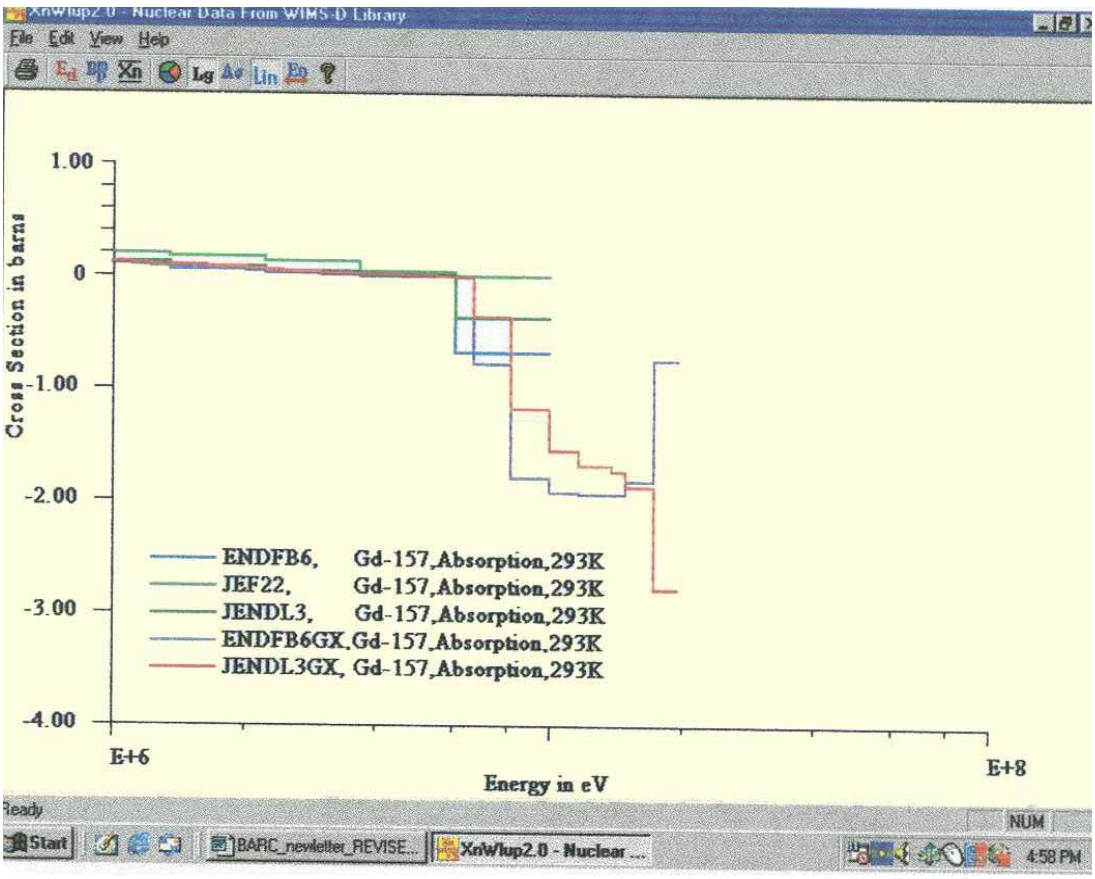

Fig. 14. Comparison of absorption cross sections for Gd-157 in the energy region where the negative values for absorption cross sections are seen in the WIMS-D libraries

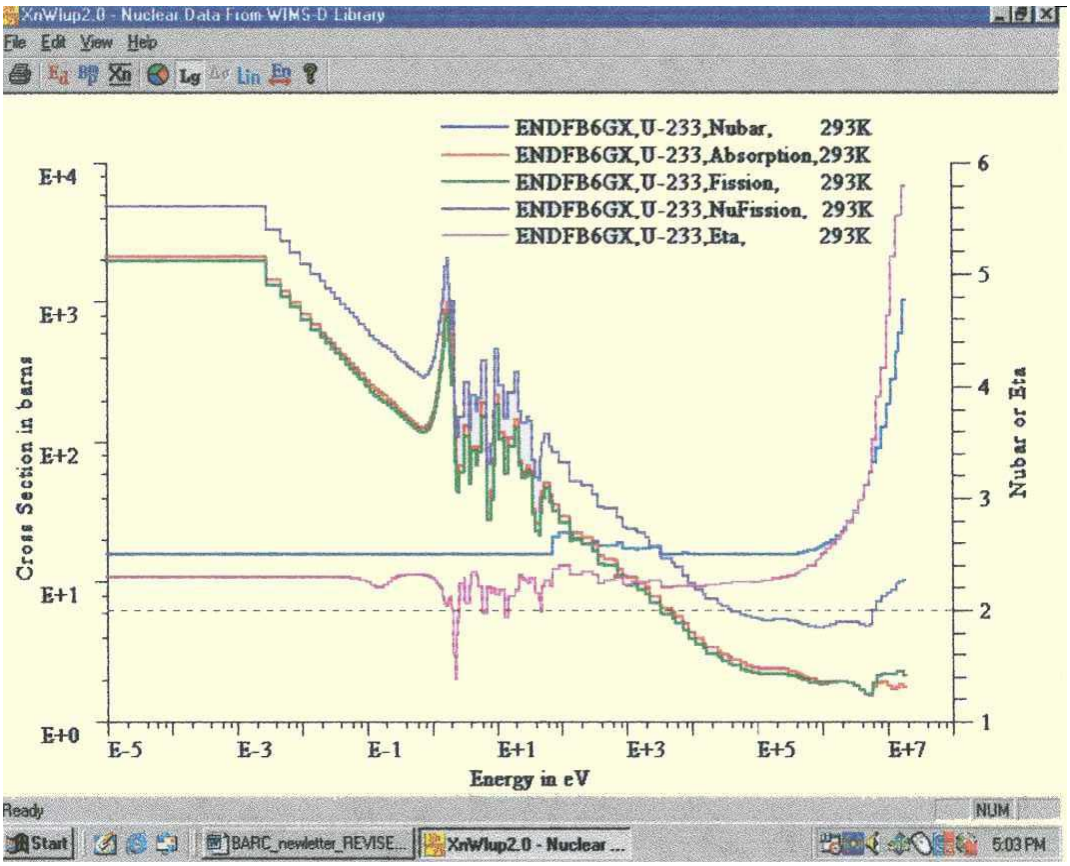

Fig. 15. Plots of 'ν', 'σ_a', 'σ_f', '$\nu\sigma_f$' and 'η' obtained for U-233 from the 172 group library of ENDF/B-VI.8

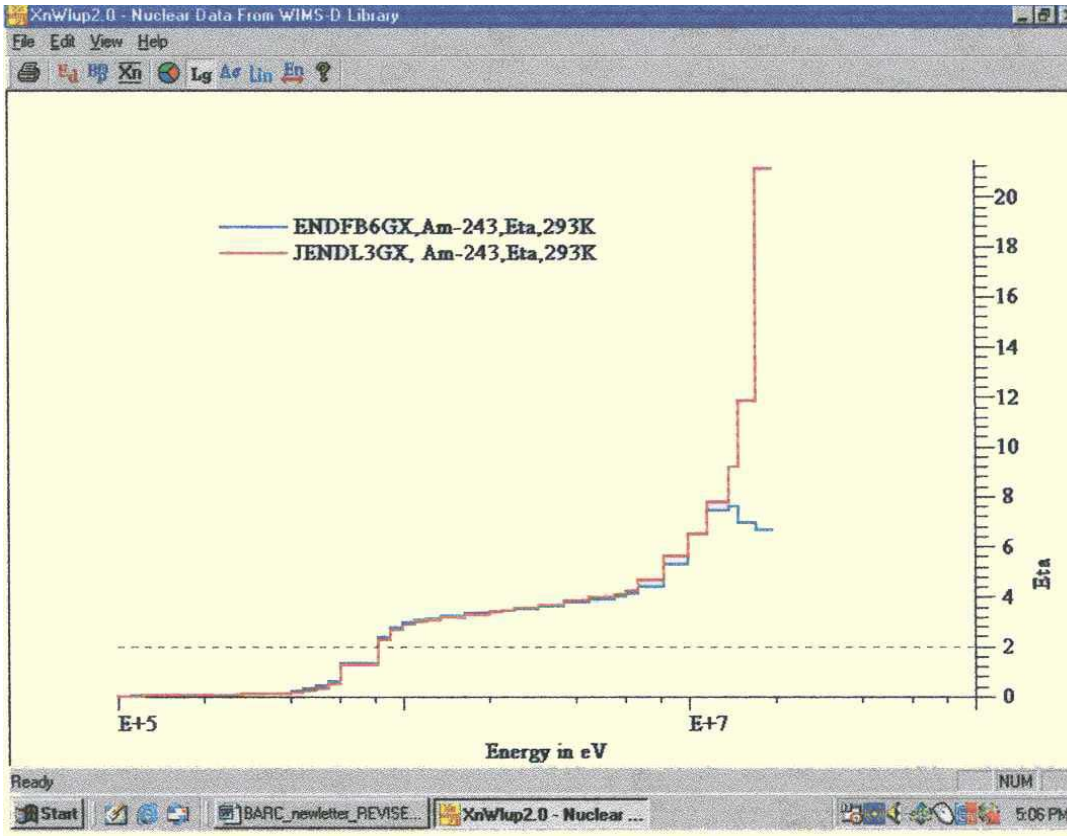

Fig. 16. Plot showing a comparison of eta of Am-243 in 172 group WIMS-D libraries obtained by processing ENDF/B-VI.8 and JENDL-3.2.

Plotting Fission Cross Section, NuFission, Eta and Nubar

If the selected nuclide is not fissile nuclide, choosing the option of fission or nufissionor eta or nubar makes a message "The selected nuclide is not fissile" appear on the screen. If only the selected nuclide is fissile, the 'σ_f', '$\nu\sigma_f$' and 'Eta' or 'ν' can be plotted. Fig. 15 shows the plots obtained for U-233 from the 172-group library of ENDF/B-VI.8.

Eta (η) is an important physics parameter used to characterize the fuel value. It is defined as the average number of neutrons produced per neutron absorbed in fuel. For a fuel composed of a single fissile isotope, the expression is (*see* Ref. 4) given by

$$\eta = \nu\sigma_f / \sigma_a$$

In the case of WIMS-D library since the denominator, by convention, also includes (n, 2n) as negative absorption cross sections, the plots generated by WIMS will match the real definition of eta only when the (n, 2n) cross sections are zero. The (n, 2n) cross sections occur in the first few groups of the 69/172-group library for the actinides. A plot for Americium-243 obtained using the XnWlup2.0 is given in Fig. 16 to illustrate the discrepancy in the eta of Am-243 between the 172 group libraries of ENDF/B-VI.8 and JENDL-3.2.

In the graph η-scale is given in the right side. It is well known in the field of reactor analysis that to produce more fissile material than one depletes in maintaining the fission chain reaction and parasitic absorption, one would have to operate with fissile isotopes and neutron energies for which $\eta(E)$ is greater than two. By keeping this in mind, a dashed line is drawn for $\eta = 2$.

Future Developments

We plan to extend the capability of the XnWlup2.0 software to cover several additional features that include the following:

1. Provide cursor initiated zooming capability to zoom specific energy regions in each of the above cases.
2. Include options to generate plots of other useful quantities, such as, fission neutron spectra, scattering matrices, P1 data, resonance integrals as a function of dilution cross section and temperature for each energy group and as a function of energy for each dilution and temperature.
3. Reconstruction of a material data (for example Zirconium alloy, Stainless Steel, UO_2 or PuO_2-UO_2) from its components and atomic densities given, and generate plots of macroscopic cross sections of the material and components and/or percentage of the contribution of each component to the total. This option can be useful for testing the importance of each isotope or partial contribution of a given element/isotope to a mixture.
4. Development of a client-server model of XnWlup to facilitate a web-server compatible version.

Concluding Remarks

Reactor design physics is the art or science of predicting integral quantities such as criticality, shielding, radiation safety related response functions etc., starting from a detailed description of basic nuclear data in simulation studies. Thus nuclear data is an inescapable and integral part of the design process of nuclear systems.

Several questions relating to basic reactor physics research and development involves critical examination and understanding of the appropriate nuclear data and discrepancies associated with the data. The version 2.0 of 'XnWlup' software described in this article facilitates the preparation of an extensive handbook of nuclear data such as total, absorption, transport, fission, total scattering cross section and out-scattering cross section data in the WIMS-D compatible libraries. It helps the user to efficiently obtain visualization of the energy dependent cross sections of nuclear reactions for the nuclides/isotopes listed in

69/172 groups in various available WIMS-D libraries. This program also plots the ‘eta’ or 'nubar' for fissile nuclides following the WIMS convention. The program provides the option of saving the graphs or numerical values of plotted data in a hard disk file. Using this software, the user can easily prepare his/her own handbook of cross sections selecting the reference file of his/her choice and energy regions to suit specific investigations.

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WORKSHOP ON LEGISLATION IN SAFETY, HEALTH AND ENVIRONMENT

A two-day Workshop on "Legislation pertaining to Conventional Safety, Health and Environment" was organised by the Industrial Hygiene and Safety Section of Radiation Safety Systems Division (RSSD), BARC, at Trombay during July 24-25, 2002. The members of BARC Safety Council (BSC), Operationg Plant Safety Review Committee (OPSRC), Conventional and Fire Safety Review Committee (CFSRC) and other Unit Safety Commmittees of BARC participated in the workshop. The faculty for the workshop consisted of experts from Atomic Energy Regulatory Board, Central Labour Institute, Office of Controller of Explosives, Indian Association of Occupational Health, National Safety Council, as well as BARC.

Inaugural function of the Workshop on "Legislation pertaining to Conventional Safety, Health and Environment"

While presenting the Welcome speech, Dr M.C. Abani, Head, RSSD, BARC, brought out the details of the Accident Prevention Programme and other activities undertaken at the Centre to prevent the conventional accidents.He mentioned that the conventional safety is at par with high standards of radiological safety at BARC which has a good safety record. Dr S. Banerjee, Director, Materials Group, BARC and Chairman, Conventional and Fire Safety Review Committee (CFSRC), appreciated the efforts put forth in organising this Workshop and expressed confidence that it would be very useful for all the members of the Safety Committees. In his Inaugural address, Dr V. Venkat Raj, Director, Health, Safety and Environment Group, BARC, insisted that safety should start with the users themselves rather than depending on any regulatory authority. While commenting on the new safety set-up at the Centre, he stressed on the self-regulatory approach with respect to safety matters. Mr S. Narayan, Head, Industrial Hygiene and Safety Section, RSSD, proposed the vote of thanks. The Workshop was well appreciated by the participants with the response that the topics included were very interesting and useful.

About 50 safety committee members attended this programme. The programme was repeated during August 27-28, 2002 for the second batch of members of the safety committees.

IAEA/RCA REGIONAL WOKSHOP

A workshop on "Application of Radioisotopes for Sediment Transport Studies" was organised by Isotope Applications Division, BARC, in association with the International Atomic Energy Agency (IAEA), Vienna, during May 20-25, 2002 at Hotel Parle International, Vile Parle (E), Mumbai. About 14 participants from 9 countries in the Region (namely, Bangladesh, China, Indonesia, Republic of Korea, Malaysia, Myanmar, Philippines, Thailand and Vietnam) and five Indian participants (one each from BARC; Kandla Port Trust (KPT), Gujarat; National Institute of Oceanography (NIO), Kerala; Central Water and Power Research Station (CWPRS), Pune, and Centre for Water Resources Development and Management (CWRDM), Kerala, attended the workshop. Dr Cath Hughes from Australian Nuclear Science and Technology Organization, Sydney, and Dr Mathew Chadwick from Water Research Laboratory (WRL), Sydney, Australia served as the IAEA experts.

The course was inaugurated by Dr L.K. Ghosh, Additional Director, CWPRS, Pune, on May 20, 2002. Dr S.V. Navada, Head, Isotope Hydrology Section of the Isotope Applications Division gave the welcome address. Dr Cath Hughes, the IAEA Expert, Dr C.A. Krishnan, RCA Liaison Officer in India, and Dr G.S. Rao, Hydraulic Engineer, KPT, gave remarks. Course Director, Dr. U. Saravana Kumar of the Isotope Applications Division, BARC, proposed the vote of thanks.

Dr L.K. Ghosh, Additional Director, CWPRS, Pune, delivering the Inaugural address. Others on the dais are (from left to right): Course Director, Dr. U. Saravana Kumar of IAD, BARC; Dr G.S. Rao, Hydraulic Engineer, Kandla Port, Kandla, Gujarat; Mr Matt Chadwick & Dr Cath Hughes, the IAEA Experts from Australia; Dr. S.V. Navada, Head, Isotope hydrology Section, IAD, BARC

The programme of the workshop focused on providing theoretical and practical knowledge on application of radioisotopes to study suspended and bed-load sediment transport in coastal environment and consisted of lectures, discussions, demonstrations and case studies.

A field visit to CWPRS, Pune, was arranged on May 22, 2002. Demonstration of physical & numerical models of a few important ports/ harbours in India were made to the participants. Also, a field demonstration on tracer monitoring, nucleonic suspended sediment concentration gauge, etc were carried out at Mumbai Coast on May 24, 2002. Hands-on experience was provided on some of the numerical sediment transport models developed by Water Research Laboratory, University of New South Wales, Sydney, Australia and CWPRS, Pune.

The participants of the IAEA/RCA Regional Workshop along with the faculty staff from BARC

On the last day, participants made presentations on the progress made in the workshop topic in their countries and their future planned activities. From the presentations, it was observed that a few countries like China, Myanmar, Vietnam, etc are fairly new to the workshop topic and expressed their eagerness to start the radiotracer

sediment transport activities in their countries very soon.

At the end of the workshop, a valedictory function was arranged. Dr. N. Ramamoorthy, Chief Executive, Board of Radiation and Isotope Technology & Associate Director, Isotope Group, BARC gave the valedictory address and distributed the course certificates to the participants. Mr Gursharan Singh, Head, Isotope Applications Division (IAD), BARC, Dr S.V. Navada, Head, Isotope Hydrology Section of IAD, BARC, and Dr. Cath Hughes, the IAEA Expert gave their remarks. Dr. U. Saravana Kumar, the Course Director, proposed the vote of thanks.

TRAINING COURSE IN BASIC RADIATION PROTECTION

The Radiation Safety Systems Division (RSSD), BARC, conducted the fourth three-day training course (August 21-23, 2002) in basic radiation protection for the benefit of the staff members working in the research reactor facilities of BARC. The course was conducted at the 'D' Block Auditorium, Modular Laboratories, BARC.

Dr K.L. Narasimharao, BARC Safety Secretariat, RSSD, welcomed the participants and said that the fourth training course was being conducted after seeing the overwhelming response for the three earlier courses conducted for the scientific and technical staff of Nuclear Fuels Group, Chemistry & Isotope Group and Board of Radiation and Isotope Technology at the Radiological Laboratories; Nuclear Recycle Group at the Waste Immobilisation Plant; and accelerator and irradiator facilities at the Modular Labs.

Dr M.C. Abani, Head, RSSD, BARC, in his opening remarks, said that the course has been specially designed keeping in view the safety requirements of the scientific and technical staff and users of the research reactor facilities. He also said that the International Commission on Radiological Protection (ICRP) has recommended the reduction of maximum permissible annual limit of exposure for occupational workers from 50 to 20 mSv. He added that in spite of lowering of the limit, there was no case of overexposure at BARC and the credit goes to all the employees.

Mr S.K. Sharma, Director, Reactor Group and Engineering Services Group, BARC, in his inaugural address, appreciated the efforts put in by RSSD in imparting the training in radiation protection and gave an overview of the various aspects of nuclear and radiological safety in the research reactors. He also said that India was the first country to adopt the new standards of annual limits proposed by the ICRP in 1990 and that all precautions are being taken to restrict the exposure to radiation well within safety limits. Dr Pushparaja, Head, Radiation Hazard Control Section, RSSD, presented the vote of thanks.

Mr S.K. Sharma, Director, Reactor Group and Engineering Services Group, BARC, inaugurating the training course.

Sitting on the dais are (left to right) Dr K.L. Narasimharao, Dr M.C. Abani and Dr Pushparaja

Thirty-six participants nominated by the Heads of Reactor Operations Division, Research Reactor Sevices Division (RRSD), Research Reactor Maintenance Division (RRMD), Solid State Physics Division (SSPD), Accelerator & Pulse Power Division, Analytical Chemistry Division, Radiochemistry Division, Laboratory Nuclear Medicine Section, Radiation Technology Development Section, Technology Transfer & Collaboration Division, and RSSD attended the course.

The faculty included M/s. K.T.P. Balakrishnan, T. Krishnamohanan, A. Seethapaty, A. Raju, S. Krishnaprasad, P. Ashok Kumar and Rajveer Singh, Drs P.C. Gupta, R.K. Gopalakrishnan and K.L. Narasimharao of RSSD; Dr B.S. Rao of Radiological Physics & Advisory Division; Dr R.K. Singhal of Health Physics Division and Ms Pramilla Sawant of Internal Dosimetry Division.

The course consisted of 14 lectures covering various subjects, namely, radiological safety in nuclear reactors, dose calculation, radiation biology, health physics instruments, dose limits, dose and contamination control, industrial hygiene & safety, environmental monitoring, radiation emergency response, internal dosimetry, reactor-specific Health Physics procedures, transport of radioactive materials, and unusual incidents in reactors.

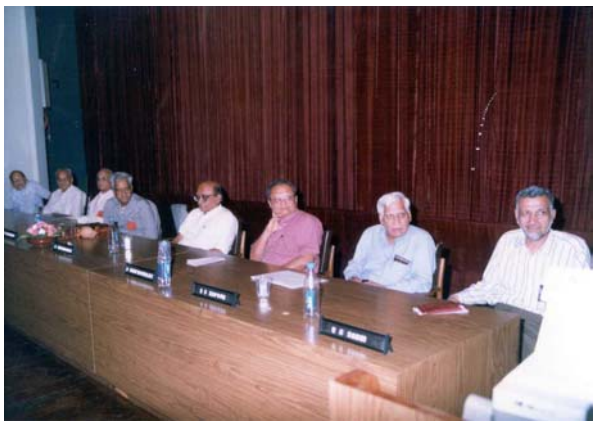
Dr M. Ramanadham, Head, SSPD, Mr R.C. Pant, Head, RRMD and Mr R.I. Gujarathi, RSSD, gave invited lectures on utilisation of research reactors, management overview, and design features of research reactors, respectively.

The course was organised by Dr K.L. Narasimharao, with the active help and co-operation of all the members of BSS. Dr V.C. Sahni, Director, Physics Group, BARC, in his concluding remarks, appreciated the efforts put in conducting the training course. He also said the safety record of BARC is enviable, that we should continue to learn, and that such training would increase our confidence and improve the safety standards.

SEMINAR ON ACCELERATOR BASED NUCLEAR PHYSICS RESEARCH

Over the past two decades, experimental nuclear physicists in the country have made commendable contributions and a large number of research papers have been published in high impact journals. Further rapid advances are expected as the superconducting LINACs at Mumbai and Delhi approach their final stages of commissioning, and ECR based ion sources at VEC routinely start providing a variety of beams for experiments. The superconducting cyclotron under construction at Kolkata will further enhance nuclear physics research in the country. Recently, DAE scientists and University researchers pooled their gamma detectors and other instruments to set up "a clover array" to carry out a number of front line experiments at the Mumbai Pelletron. More experiments are planned later this year at the Delhi Pelletron. International collaboration with SPS at CERN and RHIC facility at BNL enabled Indian scientists to contribute to new programmes, even as preparations to utilise LHC at CERN are surging ahead.

Inaugural session of the seminar



Keeping these developments in mind, a seminar on "Accelerator Based Nuclear Physics Research – Achievements and Emerging Scenario" was organised at BARC, to take stock of our achievements and chalk out plans for the coming years. Dr Anil Kakodkar, Chairman, Atomic Energy Commission, chaired the first session on Accelerator Technology. Dr R.K. Bhandari, VECC, and Dr A. Roy, NSC, covered in a comprehensive manner the significant developments in the field of accelerators and the technological base we have acquired over the years. In this session, Dr Kakodkar presented a bouquet to Prof. V. S. Ramamurthy, Secretary, DST, who completed 60 years in April, 2002.

Dr Anil Kakodkar, Chairman, AEC, felicitating Prof. V.S. Ramamurthy, Secretary, DST

The second session was related to Nuclear Fusion and Fission, a topic where BARC groups have made pioneering contributions. Prof. V. S. Ramamurthy gave a lucid presentation of the evolution in this field of research at Trombay and the significant achievements of nuclear fission activity at BARC. Dr. R. K. Choudhury, IOP, and Dr. S. Kailas, BARC, respectively gave a summary of the highlights of the heavy ion based fission and fusion programmes carried out using the Mumbai Pelletron accelerator. Dr B. C. Sinha, VECC/SINP, chaired this session. The third technical session was on nuclear physics at high energies using international facilities. Prof. G. K. Mehta, VC, Allahabad University, conducted this session. Dr T.K. Nayak, VECC, summarised the RHIC/CERN programmes using the indigenously developed PMD setup. Dr S.K. Kataria, BARC, gave an account of the excellent progress made in the development of silicon strip detector technology and the associated electronics to be used for experiments at LHC. Dr S.S. Kapoor, DAE - Homi Bhabha Chair Professor, gave the technical summary of this one day seminar. He also pointed out the emerging scenario in the broad area of accelerator based nuclear physics research.

As a part of this seminar, a special session was devoted to felicitation of Prof. V. S. Ramamurthy, Secretary, DST, who turned 60 recently. The speakers in this session included Dr V. C. Sahni, BARC, Dr B. A. Dasannacharya, IUC – DAEF, Prof. G. K. Mehta, Dr S.S. Kapoor, Mr B. Bhattacharjee, Director, BARC, Dr R. Chidambaram, Principal Scientific Advisor to Govt. of India and Dr P. K. Iyengar, former Chairman, Atomic Energy Commission. Director, BARC presented to Dr Ramamurthy a memento of BARC. While Dr Chidambaram presented to him two volumes containing his research publications, Dr Iyengar honoured him, in the traditional manner, with a shawl. Dr Ramamurthy, while accepting these felicitations, fondly remembered the excellent training he got in his formative years working at BARC. He also appreciated the BARC culture which has been all along very conducive for pursuing high quality R & D activities.

WORKSHOP ON RADIO-CHEMISTRY AND APPLICATIONS OF RADIOISOTOPES

Indian Association of Nuclear Chemists and Allied Scientists (IANCAS) conducted its 47th National Workshop on Radiochemistry and Applications of Radioisotopes at the Department of Physics, Jai Narain Vyas University, Jodhpur, during July 15-24, 2002.

The Workshop was inaugurated by Mr B. Bhattacharjee, Director, BARC in the function that was presided over by Prof. B.S. Paliwal, Dean, Faculty of Sciences, JNV University

Inauguration of 47th BRNS-IANCAS National Workshop at Jodhpur. Seated (left to right) are Dr R.R. Tripathi, Director of the Workshop, Dr K.D. Singh Mudher, Coordinator of the Workshop from IANCAS, Dr B.S. Paliwal, Dean, Faculty of Sciences, JNV University, Mr B. Bhattacharjee, Director, BARC, Dr V. Venugopal, Head, Fuel Chemistry Division, BARC, and Vice President, IANCAS and Dr S.R. Dhariwal, Head, Department of Physics, JNV University.

Jodhpur. Dr Dharival, Head of Physics Dept. thanked Dr M.C.Abani, Head, RSSD, BARC, an alumni of the university, for his initiative in organising the workshop in JNV University at Jodhpur and welcomed the participants. Dr V.Venugopal, Head, FCD, BARC and Vice-President, IANCAS, highlighted the role of

IANCAS in propagating the beneficial aspects of Radioactivity through National Workshops at various Universities/Institutes and bringing out literature as Thematic Bulletins. He said that the Workshops provide academicians with hands-on experience in handling radioactivity and the message about the peaceful uses of nuclear energy spreads by geometric progression through this medium. Dr K.D. Singh Mudher, Coordinator of the workshop explained the objective of the workshop, and the contents planned for this course.

Mr Bhattacharjee delivered the inaugural address on the aims of DAE to work for improving the quality of life through nuclear science with reliable, dependable, economic and eco-friendly power, application of radioisotopes in health care, food preservation and industry. He complimented the university and DRDO in organising this IANCAS workshop activity in Jodhpur. He also emphasised that for a sustained development of the country, a balanced linkage between energy and development is essential. He said that with the levels of fossil fuels in nature dwindling and limited technology available for tapping other sources, nuclear power is the only option available to tide over the increasing demand for power in the country. He also cited the need for creating a strong technological base to face the future challenges and hence India had opted for a 3-stage Nuclear Power Programme. India is one of the few countries to have developed its own resources such as personnel, reactors and technology to improve the condition of people through health care and increased yields in agricultural produce.

Mr B. Bhattacharjee, Director, BARC, being felicitated during the inauguration of the workshop by Dr B.S. Paliwal and Dr S.R. Dhariwal in the traditional Rajasthani style

While addressing the press, Mr Bhattacharjee, said that the process of developing selective crops in the desert areas had been initiated. He cited some hybrid varieties of moong, beans, pulses, blackgram and groundnut that were developed by BARC and these varieties, with large yields and less cultivation time, are very popular among farmers in Maharashtra. He denied reports of calves being born blind in some villages near Khetolai. He also denied reports that BARC was planning to dump the active waste in Thar desert.

Dr Paliwal, in his presidential address, lauded the role of IANCAS in eradicating the misconceptions and illusions about nuclear energy and bringing out the benefits of this subject through their workshops and literature. He felt that people in Rajasthan still have apprehensions about nuclear science in spite of enjoying its power from the nuclear power plants at Rawarbhata. He said this kind of workshops would help in allaying their fears.

Dr G.A. Rama Rao, Resource Person and Secretary, IANCAS, conducting the experiments for the participants

Dr R.P.Tripathi, Director of the Workshop, JNV University proposed a vote of thanks and the function was concluded.

Following the news item in the local newspapers like *Dainik Bhaskar* and *Rajasthan Patrika* about the workshop on Radioactivity, there were plenty of enquiries and requests from various schools and colleges inviting the resource persons to their institutions. The following schools/colleges were visited to give lectures and conduct experimental work on handling radioactivity.

1. Lachubai Memorial College of Science & Technology for 50 B.Sc. students.
2. Mr Badal Chand Sugan Kanwar Chordia Girls Senior Secondary School for 200 students from X to XII std.

3. St.Patrick's Vidya Bhavan Senior Higher Secondary School for 120 students from XI and XII std.
4. Department of Home Science, JNV University, for 50 girls from M.Sc., (home science)
5. 'Skylines' Science Institute for Easy Learning with Visual Teaching Aids (VTA), for 70 students of XI std.
6. A lecture on 'Application of radioisotopes in medicine' was given in the Pharmacy department, JNV University.
7. Ms Archana Mukerjee gave a special lecture to the students of Bio-technology, JNV University and arranged an experiment on 'Radioimmunoassay'.

Prof. L.S. Rathore, Vice-chancellor, JNV University presided over the valedictory function and Dr V.N. Vaidya, FCD, was the Chief guest. Dr G.A.Rama Rao, General Secretary, IANCAS responded to the comments and suggestions from the feed-back forms.

WORKSHOP ON PARALLEL PROCESSING

A five-day workshop on "Advanced Computer Architecture and Parellel Computing" was organised by M.Tech. Computer Science Programme of Utkal University and Orissa Information Technology Society at P.G. Department of Mathematics, Utkal Unversity, Vani Vihar, Bhubaneswar, from August 5 to 9, 2002. Scientists from the ANUPAM parallel processing group of Computer Division, BARC, were invited to conduct lectures and hands-on training programme for this workshop. Mr D.D. Sonvane and Mr Kislay Bhatt conducted this course on behalf of Computer Division, BARC. Prof. S. Padhy from P.G. Department of Mathematics, Utkal University, coordinated this course. The workshop was attended by 20 faculty members and 60 students from M.Tech., M.C.A. and B.E. programmes of various Universities and Engineering Colleges across Orissa.

The workshop was organised with the objective of exposing the participants to Advanced Computer Architecture, Parallel Processing Technology and the method of programming Clusters of PCs using MPI. The course consisted of 8 lectures on various topics related to Advanced Computer Architecture and parallel processing technology in general and the ANUPAM parallel computer, in particular.
The participants were exposed to parallel programming using MPI by setting up a cluster of PCs along with parallel software environment. They were given a set of sequential programs in C and were asked to parallelise them using MPI. In the limited time available, the participants were able to successfully parallelise a couple of programs and execute them on the system. This gave the participants a good insight to parallel processing and the confidence to parallelise large applications.

भाभा परमाणु अनुसंधान केंद्र के वैज्ञानिकों को सम्मान

BARC SCIENTISTS HONOURED

- डॉ जय पाल मित्तल, विशिष्ट वैज्ञानिक एवं निदेशक, रसायनिकी एवं आइसोटोप वर्ग, भापअ केंद्र को प्रतिष्ठित राष्ट्रीय विज्ञान अकादमी का वर्ष 2002 - 2003 के लिए अध्यक्ष पदनामित किया गया है ।

यह हमारे देश की प्राचीनतर वैज्ञानिक अकादमी है, जिसकी स्थापना मेगनन्द शाह द्वारा सन् 1930 में की

गई । प्रो.एम.जी.के. मेनन, प्रो.एस.के. जोशी, प्रो.एम.एस. स्वामीनाथन और सुश्री डॉ मंजु अकादमी के भूतपूर्व अध्यक्ष रह चुके हैं । डॉ मित्तल को यह सम्मान रसायन विज्ञान की विभिन्न विधाओं में महत्वपूर्ण योगदान देने तथा भाभा परमाणु अनुसंधान केंद्र में अपने सहयोगियों तथा प्रशिक्षणार्थियों के साथ विकिरण रसायनिकी तथा रसायन गतिकी क्षेत्र में किए गए खोज कार्य के लिए दिया गया है।

Dr Jai Pal Mittal, Distinguished Scientist and Director, Chemistry & Isotope Group, BARC, has been designated the President of the prestigious

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Meghnad Saha, and among its past presidents are Prof. M.G.K. Menon, Prof. S.K. Joshi, Prof. M.S. Swaminathan and Dr (Ms) Manju Sharma.

The honour comes to Dr Mittal for his seminal contributions to several disciplines of chemical sciences and for pioneering investigations in radiation chemistry and chemical dynamics he has conducted in BARC with his students and colleagues.

- श्री जी.बी. सुनील कुमार, नाभिकीय कृषि एवं जैव प्रौद्योगिकी प्रभाग, भापअ केंद्र को सर्वोकृष्ट पोस्टर पुरस्कार चेन्नाई के अन्ना विश्वविद्यालय में फरवरी 4-5,2002 के दौरान आयोजित संगोष्ठी बायोटेक्नालजी एट द टर्न ऑफ मिलेनियम में प्रदान किया गया । उक्त पुरस्कार में उन्हें रु.3001 की राशि नगद प्रदान की गई । उनके शोधपत्र का विषय एक्सप्रेस हेपेटाइटिस बी सरफेस एन्टीडान इन बनाना प्लान्टस एण्ड एन टी - 1 सैल लाइन ऑफ टुबेको था,जिसे भापअ केंद्र के सर्वश्री सुनील कुमार, टी.आर. गणपति, बी.एस. बापट तथा शांता बायोटेक्नीक्स प्राइवेट लिमिटेड हैदराबाद के सी.जे. रेवती एवं के.एन.एस.प्रसाद द्वारा लिखा गया था ।

Mr G.B. Sunil Kumar of Nuclear Agriculture & Bio-technology Division, BARC, was presented

the best poster award at the National symposium on 'Biotechnology at the turn of Millennium', held at Anna University, Chennai, during February 4 - 5, 2002. The award carries a cash prize of Rs 3001/-. The paper titled, "Expression of Hepataitis B Surface Antigen in Transgenic Banana Plants and NT-1 Cell Line of Tobacco", was authored by G.B. Sunil Kumar, T.R. Ganapathi, V.A. Bapat (BARC), and C.J. Revathi and K.S. N. Prasad (Shantha Biotechnics Pvt. Ltd., Hyderabad).