STATUS OF THE iNFCIS IAEA PIE FACILITIES DATABASE

Håkon K. JENSSEN / IFE, Norway; Victor INOZEMTSEV, Mehmet CEYHAN / IAEA

Abstract

The number of hot cells in the world in which post irradiation examination (PIE) can be performed has diminished during last decades. This creates problems for countries that have nuclear power plants and require PIE for fuel development, surveillance and safety control. With this in mind, the IAEA initiated the issue of a catalogue within the framework of Coordinated Research Project (CRP) "Examination and Documentation Methodology for Water Reactor Fuel" compiling the PIE Facilities Catalogue, which was published as the IAEA Working Material in 1996 [1]. In 2002–2003, it was converted into a database and updated through questionnaires to the laboratories in the IAEA Member States. In 2005-2006, an interactive mode of the PIE Database was developed that allowed hot-lab managers to modify and amend its content in on-line internet regime at the IAEA Nuclear Fuel Cycle Information System web site http://www-nfcis.iaea.org/.

During 2007-2008 the IAEA PIE database and the European hot laboratory PIE database located at LHMA-SCK-CEN web site were merged into one PIE database managed from the IAEA. As a consequence of the merging process, 7 "new" European PIE laboratories were icluded into the IAEA PIE database. Also, a general transport cask overview first implemented at the SCK-CEN database, is now transfered to the IAEA PIE database. The specific casks utilised at the laboratories is also included under the actual PIE facilities.

The database consists of five main areas describing PIE facilities, i.e. acceptance criteria for irradiated components, cell characteristics, PIE techniques, refabrication/instrumentation capabilities and storage and conditioning capabilities. The content of the database represents the status of the participating laboratories and helps interested Member States to select PIE facilities most relevant to their particular needs. The database can also be used to compare the PIE capabilities worldwide with current and future requirements, as well as provide development incentives for laboratories with limited PIE techniques.

1. INTRODUCTION

The number of hot cells in the world in which post irradiation examination (PIE) can be performed has diminished during the last few decades. This creates problems for countries that have nuclear power plants and require PIE for surveillance, safety and fuel development. With this in mind and according to the recommendation given by the Technical Working Group on Water Reactor Fuel Performance and Technology (TWGFPT), the IAEA initiated the issue of a catalogue within the framework of a coordinated research program (CRP), started in 1992 and completed in 1995, under the title of "Examination and Documentation Methodology for Water Reactor Fuel (ED-WARF-II)". Within this program, a group of technical consultants prepared a questionnaire to be completed by relevant laboratories. From these questionnaires a catalogue was assembled that lists the hot laboratories and PIE possibilities worldwide in order to make it more convenient to arrange and perform contractual PIE on water reactor fuels and core components. The catalogue was published in 1996 as the IAEA Working Material [1].

The proposal to create an international database on PIE facilities/techniques was further discussed at the TM on advanced post-irradiation examination techniques for water reactor fuel held in Dimitrovgrad (2001), Russian Federation. The participants of this meeting agreed to convert the catalogue of PIE facilities into a database. PIE specialists from France, Germany, Norway and Russia volunteered to evaluate the possibility of creating an open database on the IAEA website. The group concluded that the scale of tasks and the number of PIE techniques have significantly increased since the initiation of the catalogue development. New materials and designs, including mixed oxide fuel, burnable absorber and other additive fuels, together with corrosion resistant claddings had become more prominent. PIE of lead test assemblies was completed with high burn-up test reactor experiments including re-fabricated fuel rods (made from irradiated commercial rods). Changes in composition, structure and properties of fuel and structural materials are to be investigated and understood in order to calculate, validate and forecast fuel operational margins and safety limits. Common approaches in PIE techniques allow comparison of results obtained in different countries and different laboratories that improve the trustworthiness of data used for fuel performance assessment and licensing. The group of PIE specialists agreed upon following basic principles of the database development: it should not interfere with commercial interests of participating organizations; the database should be regularly updated; all of the interested IAEA Member countries should have access to the database. All previous activities in the area (e.g. PIE facilities catalogue) should be taken into account and the PIE database should be seen in co-operation with other related programmers and databases on nuclear fuel examinations. During 2002 and 2003, the catalogue was converted into a database and updated through questionnaires to the laboratories in the IAEA Member States.

The PIE specialist group worked under the co-ordination of Mr. V. Onufriev, IAEA, Nuclear Energy Department, Section of Nuclear Fuel Cycle and Materials, until his retirement in 2005. His successor Mr. V. Inozemtsev is now the administrator of the IAEA PIE database.

Upon recommendations from the PIE group IAEA IT specialist, Mr. M. Ceyhan, implemented and finalized the PIE database for the IAEA Integrated Nuclear Fuel Cycle Information System (iNFCIS) early in 2004. Figure 1 gives the general description of the iNFCIS database system. The database was further developed and improved during 2005. The most important improvement was the organization of interactive on-line access for registered hot-lab managers or coordinators to edit facility data records. After the responsible person performs the data editing, the “submit for review” button must be utilized, e.g. first activate the admin page button and thereafter the facility operation buttons located under the opening page under the actual facility. This will generate an automatic e-mail with a message to the database reviewer aboat the facility changes. Thereafter, the database reviewer Mr. H. Jenssen, IFE, NORWAY, will check all the modifications and new entries, and only afterwards they can be visualized on the iNFCIS web site. The administrator, reviewer and facility coordinators have different roles and functions to be performed that enable the interactive database desired levels of flexibility and reliability.

A similar Internet cataloguet intended only for European PIE facilities was constructed in 2005 at the LHMA-SCK-CEN hot laboratory in Belgium under sponsorship of HOTLAB project of the European Sixth Framework Programme. The HOTLAB web site (www.sckcen.be/hotlab) also includes a report on European Hot Laboratories Research Capacities and Needs whithin the same project and a part on transportation issues, e.g. transportation gaskets, license issues, etc. In 2007 it was decided to merge the content of the European PIE database to the international IAEA PIE database. 7 new laboratories had to be included into the IAEA PIE database as a consequence of the merging process. The new facilities included were: CEA - LEFCA - Laboratory for Study & Experimental Manufacturing of Advanced Fuels, France. Ciemat, Spain. FZJ - Forschungszentrum Juelich Large Hot Cells (GHZ) and FZJ - Forschungszentrum Juelich Hot Materials Lab (HML), both facilities are located in Germany. SCK•CEN - Chemical and Radiochemical Measurements, Belgium. NCSR "Demokritos" - Radioisotopes and Radiopharmaceuticals laboratories and NCSR "Demokritos" - Radiochemical Studies and Quality Control laboratory, both facilities are located in Greece and KFKI-AEKI "Atomic Energy Research Institute", located in Hungary. The general information of transport casks utilised in Europe and specific casks utilised at some of the PIE laboratories were also transfered from the LHMA-SCK-CEN database into the IAEA PIE database.

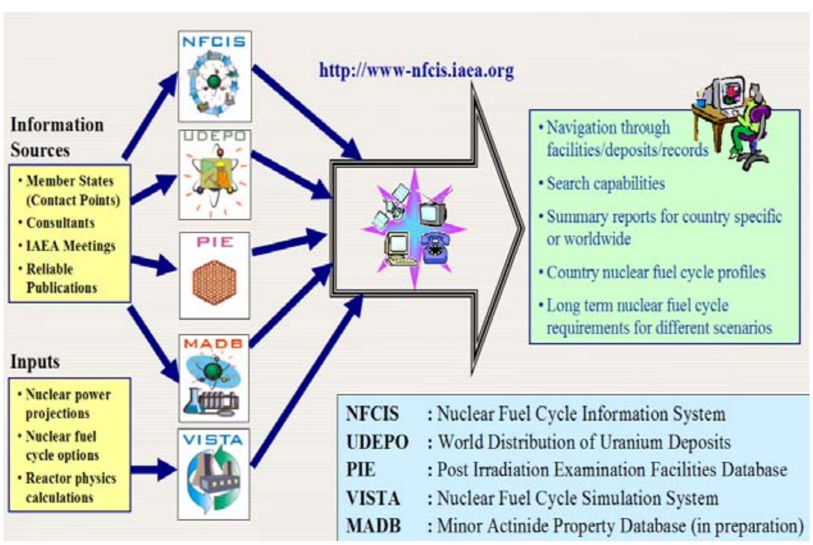

FIG. 1. *Integrated Nuclear Fuel Cycle Information System of the IAEA.*

2. BASIC FUNCTIONS AND MODULES OF THE IAEA PIE DATABASE

The IAEA operates a number of nuclear fuel cycle related databases and simulation systems for long-term projections of nuclear fuel cycle material and service requirements. Some of the databases and simulation systems are currently available online in iNFCIS web site at http://www-nfcis.iaea.org/ where the PIE database is located. Their purpose is to provide the IAEA Member States and public users with current, consistent, and readily accessible information for planning activities related to the nuclear fuel cycle. For the very first login to this database system you must register there in order to get a UserID and a password. Necessary information will then be sent to your e-mail address and you will get access to all iNFCIS databases including the Post Irradiation Examination (PIE) Facilities Database.

The transport casks and the facilities included in the database are listed in the opening page. Information aboat the cask is given under each cask, e.g. licensing, dimensions, etc. The selection of countries is linked to the various PIE techniques by the "technique" selection drop list. The general database user has the possibility to find out which of the laboratories that for instance perform neutron radiography or some of the other PIE techniques. If a search on a specific technique is performed, the names and the location of the laboratories performing the actual technique are listed. Listing of techniques linked to the specific laboratories is possible without extra navigations because the searching tools are always displayed at the database upper part. A user must only choose technique (e.g. all techniques) and country (e.g. all contries) from the searching tool to list this information. The home and help buttons can also be reached without extra navigations, i.e. these links or "hand tool" buttons are always displayed in the title bar at the upper part of the database interface.

The database consists of five main areas or topics related to the PIE facilities, i.e. general/cell characteristics, acceptance criteria for irradiated components, available PIE techniques, refabrication and instrumentation capabilities, and storage and conditioning capabilities. The general topic supplies facility name, the country where the facility is located, contact persons, phone and fax numbers, e-mail address, and link to the company/laboratory web page. The cell characteristics gives the main purpose of the facility, e.g. the specific materials that are examined in the laboratory, the number of cells and information of gamma activity limits for the concrete, steel and lead cells. The dimension of largest cell and the maximum fuel rod length that laboratory could receive are also important information given under this topic. Figure 2 gives an example of the general cell characteristics page of the Institute for Energy Technology/Halden Reactor Project facility.

FIG. 2. *An example of the General & Cell Characteristics page of the IAEA PIE Database*

The acceptance topic gives information about acceptance type and condition, e.g. fuel rods, assemblies or structural components that could be received at the hot lab facility. Transfer mode, maximum cask length and weight are given to support information in relation to external transportations to the facilities. Maximum fuel enrichment and fissile weight, failed rod acceptance, eventual protection packing and a general comment field are also included under this topic.

The main advantages of the present PIE database comparing to the PIE catalogue (1996) are its open Internet availability, simple interface, information volume and interactive on-line editing access for registered facility coordinators. Only actual PIE techniques were given in the catalogue, while essential technical PIE and transport cask details are implemented in the new database. There are several predefined fields for detailed descriptions of the different PIE methods. The field layouts are similar for all different PIE methods to ensure a uniform structure of the database. With the adoption of a uniform database format for all laboratories and details of techniques, it is hoped that the IAEA Member States will be able to use the database to select laboratories and transport casks most relevant to their particular needs. The database can also be used for comparison of PIE capabilities worldwide with current and future requirements. It is possible that the publishing of the database will provide an incentive for laboratories with limited PIE techniques to increase and improve their own capabilities.

The type of technique is given in the description, i.e. DT or NDT. There is also a field giving a short description of the techniques. One example of text in the description field under neutron radiography examination can be that neutron radiography is applied on irradiated and non-irradiated fuel rod internal components and material test samples. The “form of data presentation” field gives the format of the prepared data acquired under PIE, e.g. digital images and graphs. This is important information since it influences the dataflow between the facility and the customer, e.g. digital images are possible to exchange by e-mail immediately after data acquisition while analogue images must be sent by traditional post. There are additional fields for general comments, references, equipment, standards and test parameters. The content given under the “comment” field is up to the facility staff involved in the description of the techniques, e.g. the facility coordinator. The test parameters are normally related to the ambient conditions under which the PIE is executed, e.g. sample temperature, atmospheric pressure and amount and strength of HNO_3 + HCl acid. PIE details for type of specimen, measured and calculated parameters and features (e.g. measurement accuracy, microscope magnifications, etc.) are given in the respective fields of the various PIE techniques.

Refabrication and instrumentation possibilities of irradiated fuel rod are a separate topic. The information included hereunder is for instance fuel centre-line thermocouple, de-fuelling, welding of instrumented endplugs and pressurisation/leak testing, and other features. The last topic included in the PIE database is about storage & conditioning possibilities. Fields for description in relation to intermediate and long term storage and connection to reprocessing plants are implemented. There is a general reference field and also one for description of encapsulation purposes, e.g. in relation to reinsertion of fuel rod.

3. CONCLUSION

The PIE database was successfully implemented under the IAEA Integrated Nuclear Fuel Cycle Information System (iNFCIS) early in 2004. The iNFCIS database was given a new layout and it is also now possible for the facility coordinators to edit the PIE facilities data on the web page interactively. The number of visitors of the IAEA iNFCIS web site was 3350 and 4887 in 2004 and 2005 respectively. The number of visitors is nearly doubled in 2006, i.e. 6590 until 15th November. The number of visitors of the IAEA PIE iNFCIS database was 489, 916, 773 respectively for 2005, 2006, 2007 and 854 until 20th October for 2008.

The success of the database depends mainly on the quality of the data the IAEA receives from the hot laboratories and how frequent the editing and updating will be performed. The data transfer between the IAEA and the laboratories was in the beginning arranged by using Microsoft “Access” software. All relevant laboratories received an “Access” template with user instructions for filling out the PIE data and returning it to the IAEA. The “Access” template was not always easy to use according to the lack of feedback from some hot laboratories, which had problems with data input through the “Access” software. These problems are avoided in the new upgraded IAEA PIE database, i.e. the coordinators of the PIE facilities are now able to modify their information directly online through the web site. The implementation of the “interactive” data input mode ensures that the database should develop in a more flexible manner with minimum cost and efforts for both the IAEA and the PIE facilities. The updating of the IAEA PIE facility database with this new input mode started in 2005.

The database usage is verified and ready for utilization and it is hoped that the hot laboratory coordinators will play an active role in developing the information's contents of the database. The administrator and reviewer roles are to ensure that the coordinators maintain the facility data regularly.

The PIE database located under the LHMA-SCK-CEN web site will be shut down before the end of 2008 and it is not possible to edit PIE facility data from this web site, i.e. editing and updating must be performed through the IAEA PIE database.

The main benefit of merging the two PIE databases is that we now only need to edit, update and maintenance only one PIE databasen instead of two.

REFERENCES

[1] INTERNATIONAL ATOMIC ENERGY AGENCY, Catalogue of PIE which can examine LWR fuel and structural components, Working Material IAEA-IWGFPT/46, limited distribution, IAEA, Vienna (1996).