

Status of the Joint IAEA-HOTLAB Post Irradiation Examination Facilities Database (PIEDB)

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Abstract. While the number of states with nuclear power programmes are growing, the number of hot cells decreased during the last decades, creating problems with post irradiation examination (PIE) for fuel surveillance, safety control and nuclear materials studies, including the development of new radiation resistant materials for advanced and innovative nuclear applications. Therefore, there is a permanent need for wider international exchange of information about existing PIE facilities to enable increased efficiency in their use. The Joint IAEA HOTLAB Post Irradiation Examination Facilities Database (PIEDB) attempts to fill this requirement. In 2007–08, following an agreement with the international HOTLAB Working Group (<http://www.sckcen.be/hotlab>), the IAEA PIE Database integrated the HOTLAB PIE Catalogue, including transport casks information. The merged data is available at the Integrated Nuclear Fuel Cycle Information Systems (iNFCIS) website (<http://www-nfcis.iaea.org/PIE/PIEMain.asp>) and jointly managed by the IAEA and HOTLAB, representing the only publicly accessible world-wide source of information on the subject. The database consists of six main areas describing PIE facilities (i.e. acceptance criteria for irradiated components, cell characteristics, PIE techniques, re-fabrication/instrumentation capabilities, storage and conditioning capabilities, and references) as well as major technical and licensing data of casks. The database can also be used to compare the PIE capabilities with current and future requirements, as well as to provide development incentives for laboratories with limited PIE techniques. An important advantage of the PIEDB is the procedure of the professional reviewing of all new inputs made on-line. The PIEDB is experiencing a growth in popularity, with an increasing number of users, which indicates its practical usefulness. Hence it is important to continuously update the information, to promote and advertise individual hot lab capabilities. The paper contains a portrayal of the history of the PIEDB, and presents a description of its content, the web form and its current status and development.

1. INTRODUCTION

The number of hot cells in the world in which post irradiation examination (PIE) can be performed has decreased 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 made by the IAEA's Technical Working Group on Fuel Performance and Technology (TWGFPT) (formerly Technical Working Group on Water Reactor Fuel Performance and Technology), the IAEA initiated the issue of a catalogue within the framework of a Coordinated Research Program (CRP) (1992–1995), under the title of “Examination and Documentation Methodology for Water Reactor Fuel (ED-WARF-II)”.

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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 listed 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 an IAEA Working Material [1].

The proposal to create an international database on PIE facilities/techniques was further discussed at the Technical Meeting (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. It was stated, that 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 from the Dimitrovgrad TM 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 States 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.

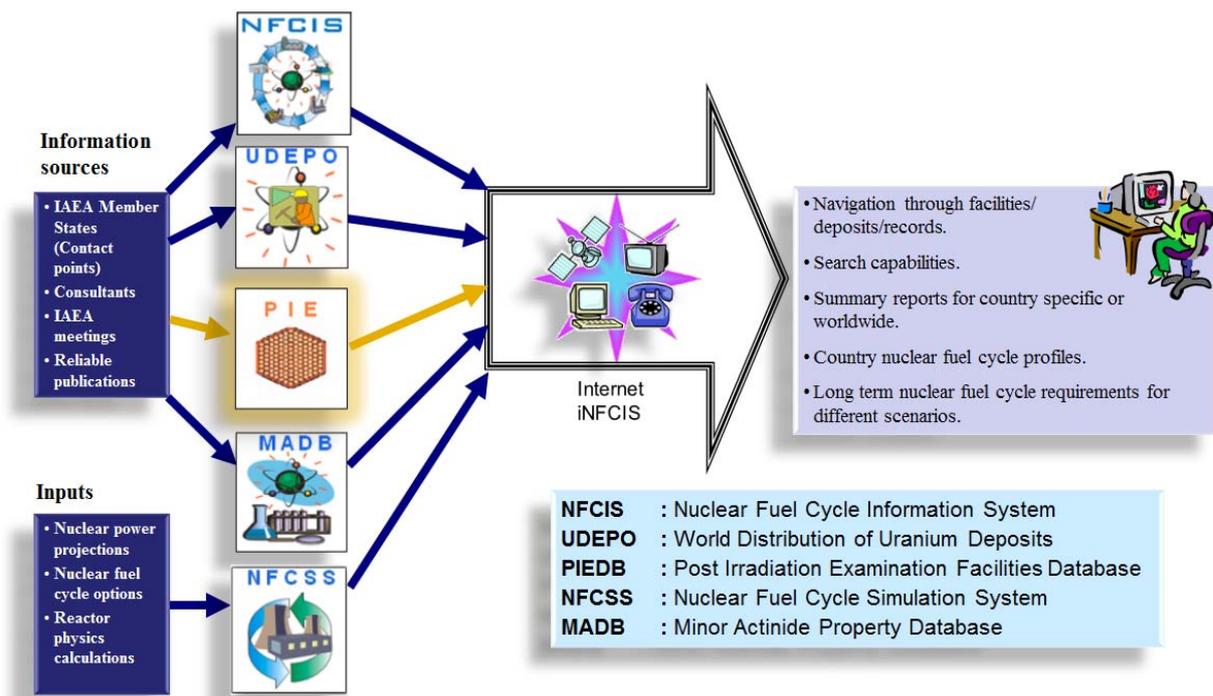


FIG. 1.1. Integrated Nuclear Fuel Cycle Information System (iNFCIS) of the IAEA.

In early 2004, the IAEA's Integrated Nuclear Fuel Cycle Information System (iNFCIS) became the home of the PIE database [2]. Fig. 1.1 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 to edit facility data

records. New entries are checked by reviewers and only before being published in iNFCIS website. The administrators, reviewers and facility coordinators have different roles and functions to perform, that enable the desired interactive database levels of flexibility and reliability.

The 6th Framework Programme of the European Commission funded a “HOTLAB” project in 2004 and 2005. HOTLAB included 19 organizations from 13 countries and was concentrated around three tasks [3]:

- A public web catalogue to present capabilities of European hot laboratory facilities,
- their post irradiation examination techniques,
- and to provide contact points.

In 2007–2008 the IAEA and the European Commission (EC) ‘HOTLAB’ project collaborated, by integrating the EC HOTLAB catalogue into the IAEA PIE database, creating the Joint IAEA HOTLAB PIE Facilities Database (PIEDB). This merger also added the HOTLAB catalogue’s casks information.

Since then, the PIEDB has been jointly managed by the IAEA and HOTLAB, making it the only publicly accessible world-wide source of the subject information. This demands an up-to-date picture of PIE capabilities of the individual facilities, so in 2010–2011 the PIEDB has undergone a large update process of its facility data, including a modification of its capabilities.

2. CONTENT OF THE PIEDB

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 at the 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 accessing this database system the user must register in order to get a user-ID and a password. Necessary login information will be then sent to the user’s e-mail address and with that access to all iNFCIS databases will be possible, including the Joint IAEA HOTLAB Post Irradiation Examination Facilities Database (PIEDB).

The currently 45 facilities included in the database are listed in the opening page by country. The selection of facilities can also be sorted by an individual PIE technique or a technique topic. The general database user has the possibility to check the laboratories that perform for instance neutron radiography. The actual laboratories are listed if a search is performed on a specific technique. Listing of techniques linked to the specific laboratories is possible without extra navigations because the searching tools are always displayed in the upper part of the web page. 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 web interface.

The database consists of six 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, storage and conditioning capabilities and reference documents.

The general topic supplies facility name, the country where the facility is located, contact persons (1st and 2nd), phone and fax numbers, e-mail address, and link to the company/laboratory web page. The cell characteristics give 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 the largest cell and the maximum fuel rod length that the according

laboratory can receive are also important information given under this topic. Fig. 2.1 gives an example of the general cell characteristics page for the KINR (Ukraine) facility.

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 transportation. Maximum fuel enrichment and fissile weight, failed rod acceptance, eventual protection packing and a general comment field are also included under this topic.

The techniques topic, gives the type of technique (destructive (DT) or non-destructive (NDT)). The technique is then described by several fields, giving a detailed description of the technical capability of the according facility, see Fig. 2.2. 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 of the "Comment" field is decided by the facility staff involved in the description of the techniques. 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 HNO₃ + 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. Software tools and codes can be filled in mentioning "Software Tool" in the "Technique" field.

PIE Facility Report

Facility Name : KINR Hot Cell Laboratory

Export to PDF

General & Cell Charac. | Acceptance Info. | Techniques | Refabrication & Instrumentation | Storage & Conditioning | Reference Documents

General			
Facility Name	KINR Hot Cell Laboratory	IAEA Ref #	14-PIE
Country	Ukraine	Last Update	Sep 2010
Address	Institute for Nuclear Research Radiation Materials Science Department 47 Nauki Avenue, Kiev, 03028, Ukraine		
Contact Person	Mrs. Ludmila Chyrko, Ph.D., Head of Department		
Second Contact Person	Mr. Vladimir Revka, Ph.D., Senior Researcher		
Phone	+380 44 5254820 // +380 44 5254781	Fax	+380 44 5254463 //
Email	chyrko@kinr.kiev.ua ; revkav@leco.cz		
Web Address	http://www.kinr.kiev.ua (Please notify us if you can not reach this web address!)		
Additional Information			
Cell Characteristics			
Purpose	Mechanical testing of NPP structural materials; recharge of closed radioactive sources and temporary storage of solid wastes		
Gamma Activity Limit (Concrete) (TBq)	0	# of Concrete Cells	0
Gamma Activity Limit (Steel) (TBq)	920	# of Steel Cells	8
Gamma Activity Limit (Lead) (TBq)	0	# of Lead Cells	0
Cell Atmosphere	air	Maximum Length of Rods (m)	2
Largest Cell Width (m)	2	Scheduled Maintenance	Yes
Largest Cell Length (m)	2.5		
Largest Cell Height (m)	2.5		

FIG. 2.2. An example (KINR, Ukraine) of the 'General & Cell Characteristics' page of the PIE DB. The selection of other topics, such as 'Acceptance Info.', 'Techniques', 'Refabrication & Instrumentation', 'Storage & Conditioning' and 'Reference Documents', is located on top of the page.

Refabrication and instrumentation possibilities of irradiated fuel rods are a separate topic. The information included hereunder is for instance fuel centre-line thermocouple, de-fuelling, welding of instrumented end plugs and pressurization/leak testing, and other features.

The next topic included in the PIEDB 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.

The last topic, “Reference Documents”, gives the facility co-ordinator the possibility to include further reference material that can be easily uploaded and made available to the interested user.

The screenshot shows the INFCIS website interface. At the top, there is a navigation bar with links for Home, Logout, Feedback, Disclaimer, and a list of facilities: NECIS, UDEPO, ThDEPO, PIE, NECSS, MADB, and Projects. Below this is a header for 'PIE Post Irradiation Examination Facilities' with a user profile for 'User Alan Aqrawi'. A menu bar includes Background, Facilities, Casks, Help, and Admin Page. The main content area is titled 'PIE Technique Report' and shows the facility as 'IFE, Nuclear Safety and Reliability, Nuclear Materials Technology Dep.'. Below this is a table with technical information for Neutron Radiography.

Technical Information	
Technique	Neutron Radiography
Type	NDE
Technique Topics	;
Short Description	Radiography images of irradiated/non-irradiated fuel rod internal components and material test samples.
Form of Data Presentation	Digital neutron radiographic images
Comment	Spatial resolution is approximately 50 micron
References	Håkon K. Jenssen, B. C. Oberlander. Improvements in PIE-techniques at the IFE hot-laboratory "Neutron radiography, three dimensional profilometry and image compilation of PIE data for visualization in an image based user-interface", Advanced post-irradiation examination techniques for water reactor fuel, page 49 - 99. Proceedings of a Technical Committee meeting held in Dimitrovgrad, Russian Federation, 14 - 18 May 2001, IAEA-TECDOC-1277.
Equipment	JEEP2 reactor, neutron radiography cell and film/foil materials.
Standards	It is possible to produce test standards with different hydride content for hydrogen determination in cladding materials.
Test Parameters	Specimen orientation, neutron irradiation dose (exposure time of test sample in neutron beam).
Type of Specimen	Non-irradiated and irradiated experimental fuel rods, material test samples and control rods.
Measured Parameters	Transmission of the collimated neutron beam is measured as a function of position and orientation of the test object.
Calculated Parameters	Dimensions and material densities in test samples, i.e. fuel rods and reactor components. Hydrogen contents in Zry-cladding materials.
Features	Stitching of individual neutron radiography images, i.e. whole fuel rod digital images. Visualisation of hydrides (moisture), fuel relocations, instrumentation details, etc.
Technique Documents	

FIG. 2.2. An example of the technical information on neutron radiography capabilities (IFE, Norway).

The casks section of the PIEDB includes 19 casks, with detailed casks reports, including specifications on cask type, provider, purpose, classification, type of loads, licensing, accessories, packaging characteristics, content characteristics, specific characteristics, transportation mode, loading mode, technical support, reference and contact data (see Fig. 2.3).

3. ON-LINE ENTRY, REVIEW PROCESS AND REGISTRY WITH THE DB

The main advantage of the PIEDB is its open internet availability, simple interface, information volume, interactive on-line editing access for registered facility coordinators and the professional review and verification process. The data entered by the according facility coordinator of the facility, is then verified by DB reviewers, before it is released and integrated.

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 assured that

the IAEA Member States are able to use the database to select laboratories most relevant to their particular needs.

Registering a new facility, hence registering as a facility coordinator, requires registering with the database and requesting an administrator log-in for the according new facility. In addition to this, an official letter of nomination by the Head, or Director of the facility nominating an official 1st and 2nd facility coordinator is required (an example letter can be found in the Appendix "Example Letter 'Official Nomination of Contact Persons'"). Table 3.1 gives a detailed description of the procedure.

General	
Cask Type	AGNES Cask
Provider	LA CALHENE
Purpose	Transport of contaminated, irradiated and non-irradiated targets.
Classification	- Type B(U) IAEA-96- Criticality safety index : 0
Type of Loads	N°1: Targets enriched up to 93,5% U 235
Licensing	- F/389/B(U)-96(Bb)
Accessories	- Cask lifting fork - Auxiliary transport means: * transport shell * stowage equipemnt (turnbuckles)
Packaging Characteristics	- External dimensions of the shielded cask: D: 776 mm H: 983 mm Gross weight: 4350 kg - External dimensions of the transport shell: D: 1650 mm H: 1705 mm Weight 5404 kg (max. loaded) - Useful dimensions: 3 cavities D: 22,7 mm H: 250 mm - Shielding thickness: 250mm lead equivalent
Content Characteristics	- Maximal weight of the content: 1 kg - Maximal power: 600 W - Maximal activity: 2100 TBq - Non fissible
Specific Characteristics	- Internal cask equipment: leak-tight container connected through the cask to the containment cell - Docking equipment on the hot cell - Transfer into or out of an alpha, beta, gamma containment without breaking the containment and with full protection against irradiation
Transportation Mode	- On site : dry - On public means of conveyance: dry
Loading Mode	- Dry horizontal loading/unloading by docking against hot cell wall - Vertical loading under water
Technical Support	No
References	Belgium: IRE
Contact	LA CALHENE, 1 Rue du Compté de Donegal, 41102 Vendôme Cedex, France M. Alain COLLET - Phone : +33 2 54 73 47 39 Fax : +33 2 54 73 47 10 E-Mail : ACollet@lacalhene.fr
Documents	

FIG. 2.3. An example of the technical report and contact details for a cask (AGNES cask, LA CALHENE, Belgium).

4. RECENT UPDATES AND MODIFICATIONS

The high importance of an up-to-date picture of PIE capabilities is a main goal of the PIEDB. In 2009 it was decided that the PIEDB should undergo a general update of its data, as some parts of it had been updated in 2003 for the last time. In addition to this, alongside with the update process, the PIEDB would undergo a modification process, as there were necessary improvements to its stability and innovations to be included. For example, did the PIEDB experience instabilities, due to data entries with unconformable symbols – these led to data loss.

In early 2010 facilities were requested to update their data. During this process, it became obvious that many facility contact points were outdated, and in some cases some effort was needed to establish the correct contact. The renewal phase of the technical and contact data in the PIEDB was successfully

completed with very positive results by late 2010 (see Fig. 4.1). Through 2010 the DB was constantly reviewed, tested to run stable, and further new requests from facilities were integrated. The admin manual for facility admins has been updated. After the update process, 9 new facilities have been included, leading to an overall number of 45 facilities from 23 different countries and 19 casks.

New modifications, such as improved stability of the PIEDB during operation, the possibility to export the full content of an individual facility as a PDF file have been accomplished.

By mid 2011, it is planned to begin with the migration of the PIEDB to the IAEA Nucleus platform (<http://nucleus.iaea.org>), IAEA's common access to scientific, technical and regulatory information resources. Subsequently it will be a target, to adopt a common Nucleus 'look and feel'.

TABLE 3.1. PIEDB REGISTRATION PROCEDURE

Registration procedure
1. Appoint someone from your organization to be the 1 st and 2 nd facility coordinator for the PIEDB.
2. Send an e-mail to Mr Viktor Inozemtsev (DB Custodian) (V.Inozemtsev@iaea.org , cc: A.Aqrawi@iaea.org ; piedb.contact-point@iaea.org) requesting registration as the official facility coordinator and contact person for the PIEDB. A corresponding facility page will be created in the database by the IAEA.
3. Next in the process, please provide an official letter of nomination for the 1 st and 2 nd official contact persons for the facility signed by your Head of Division, Department, or Director or equivalent and send it to Mr Viktor Inozemtsev (V.Inozemtsev@iaea.org , cc: A.Aqrawi@iaea.org ; piedb.contact-point@iaea.org). An example letter can be found in the Appendix of this paper.
4. In the meantime you should register with the database and send your newly generated user-ID to Mr Viktor Inozemtsev (V.Inozemtsev@iaea.org , cc: A.Aqrawi@iaea.org ; piedb.contact-point@iaea.org), in return your account will be activated as the admin for the facility page.
5. Fill in the database with the facility's infrastructure. An admin handbook is located in the PIEDB admin section for your convenience.

5. RECEPTION AND GROWING COLLABORATION

The PIEDB is experiencing a year-by-year growth in popularity and reception. The numbers of visits to the PIEDB were 10810 in 2010, in comparison the whole IAEA iNFCIS website was visited 3350, 4887, 7680 times in 2004, 2005 and 2006 respectively.

The excellent collaboration between the IAEA and HOTLAB (<http://hotlab.sckcen.be/>) regarding the PIEDB is on-going and growing. Another good example of the close collaboration was the organization of the Technical Meeting on 'Hot Cell Post-Irradiation Examination and Pool-Side Inspection of Nuclear Fuel' in May 2011 in Smolenice.

In 2010, involvement of the European NULIFE research network for plant life management (launched under the EURATOM framework programme) was established. Instead of developing a new DB, the existing PIEDB is being used and NULIFE facilities are being included (<http://www.vtt.fi/proj/nulife/index.jsp>). A separate admin manual for NULIFE hot lab managers was written and provided.

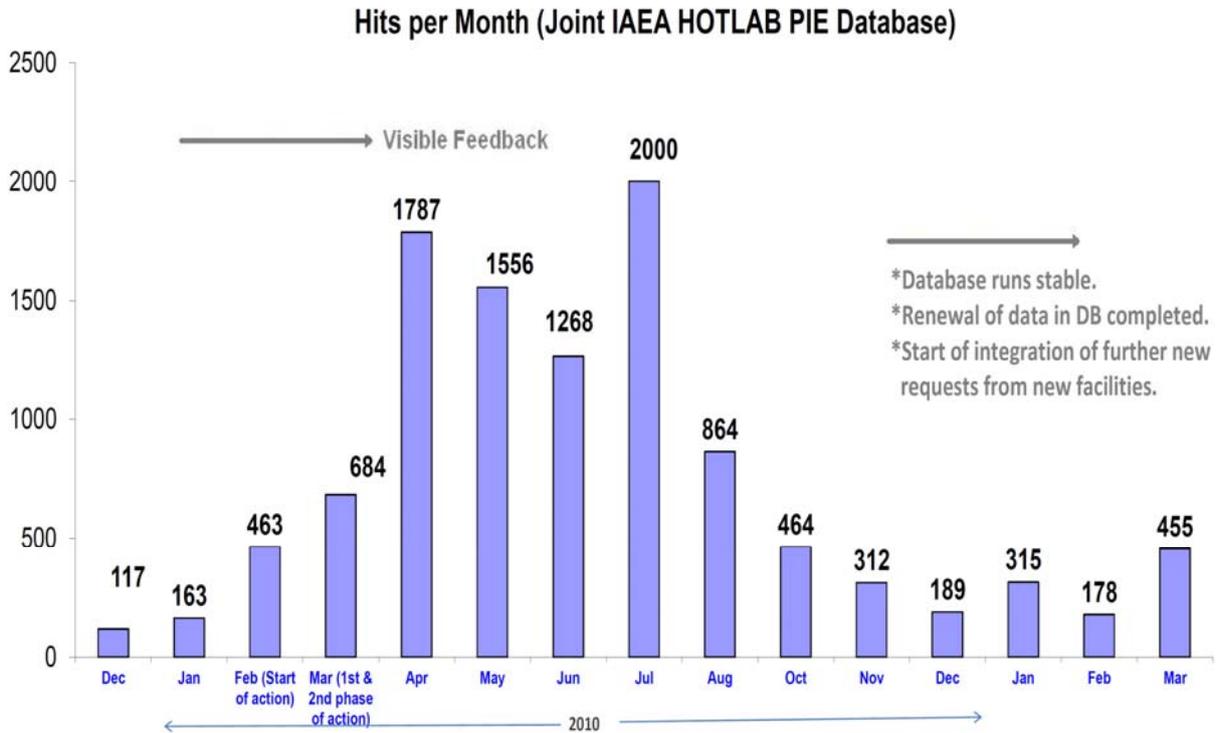


FIG. 4.1. Visible feedback during the renewal and update phase of the PIE DB, based on the ‘hits per month’. The hits per month after the update process remain higher on average than previous months, due to a growth in advertency.

6. CONCLUSION

The PIE DB is used as an authoritative source of information about PIE facilities worldwide and for comparison of their capabilities with current and future requirements. It presents a special opportunity for facilities to promote their services. The DB plays an important role in giving an incentive for laboratories with limited PIE techniques to increase and improve their own capabilities, and it provides interested users with a tool to select the most appropriate facilities, casks and examination techniques.

The keyword in this regard is ‘proactive’. The possibility for the facility coordinators to edit their PIE data on the webpage interactively is a well-received advantage, but it requires being proactive about it. The success of the database depends mainly on the quality of the data that the IAEA receives from the hot laboratories, and on how frequent the updating is being performed. Therefore the data being up-to-date is crucial to the main goal of the database. This strongly depends on the individual facility coordinators being aware of this, and on regular initiatives by the IAEA and HOTLAB to uphold focus on up-to-date information. As it showed during the update process, facility coordinators might change, therefore timely informing the IAEA or HOTLAB is important for keeping the process going.

The recent update process has been successful and the feedback is positive. This revitalization of the database and its growing advertency lead to six new facilities being included, making it an overall number of 45 facilities from 23 different countries, and 19 casks.

Regarding the near future of the PIE DB it is planned to extend the number of included PIE facilities. As the database is growing, the role of the administrators and reviewers is to ensure, that the review process continues to be effective and timely. In case of difficulties or problems, the IAEA and HOTLAB have and will provide an efficient and competent support.

REFERENCES

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- [2] INTERNATIONAL ATOMIC ENERGY AGENCY, Status of the iNFCIS IAEA PIE facilities database, Post-Irradiation Examination and In-Pile Measurement Techniques for Water Reactor Fuels, IAEA-TECDOC-CD-1635, Vienna (2009) 176–179.
- [3] INTERNATIONAL ATOMIC ENERGY AGENCY, The European HOTLAB project and its future, with emphasis on its internet catalogue, Post-Irradiation Examination and In-Pile Measurement Techniques for Water Reactor Fuels, IAEA-TECDOC-CD-1635, Vienna (2009) 163–175.

APPENDIX: EXAMPLE LETTER 'OFFICIAL NOMINATION OF CONTACT PERSONS'

To be sent as email attachment to:

V.Inozemtsev@iaea.org

DB Custodian

Division of Nuclear Fuel Cycle and

Waste Technology

IAEA

<p>Direction de l'énergie nucléaire Département d'études des combustibles</p> <p></p> <p>NE-NFCMS IAEA <i>To the attention of Mr Alan AQRAWI</i></p> <p>Cadarache, le 2 mars 2010</p> <p>Hot lab or facility name</p> <p>Subject: IAEA HOTLAB database – LEFCA chapter</p> <p>Dear Sir,</p> <p>I designate Mr [REDACTED] as our first contact person for all activities related to the IAEA database regarding the LEFCA Facility.</p> <p>Mrs [REDACTED] will act as a second contact person.</p> <p>Best regards</p> <p> Head of the Fuel Department of CEA</p> <p>Commissariat à l'énergie atomique Centre de Cadarache - DEC/DIR - Bat. 352 - 13108 Saint-Paul-Lez-Durance Cedex Tel. : 04.42.25.25.20 - Fax : 04.42.25.73.01</p> <p>Etablissement public de recherche à caractère scientifique, technique et industriel R.C.S. PARIS B 775 685 019</p> <p></p>	<p></p> <p>[REDACTED] Head Service of Plutonium Uranium and Minor Actinides Fuel Studies Department CEA/CADARACHE - Build. 717 – F 13108 Saint Paul Lez Durance Cedex Tel : [REDACTED] Fax : [REDACTED] E-mail : [REDACTED]</p> <p>[REDACTED] Head Fuel Elaboration Technology Laboratory Service of Plutonium Uranium and Minor Actinides Fuel Studies Department CEA/CADARACHE - Build. 717 – F 13108 Saint Paul Lez Durance Cedex Tel : [REDACTED] Fax : [REDACTED] E-mail : [REDACTED]</p> <p>First and second contact person details</p> <p>Commissariat à l'énergie atomique Centre de Cadarache - DEC/DIR - Bat. 352 - 13108 Saint-Paul-Lez-Durance Cedex Tel. : 04.42.25.25.20 - Fax : 04.42.25.73.01</p> <p>Etablissement public de recherche à caractère scientifique, technique et industriel R.C.S. PARIS B 775 685 019</p> <p></p>
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