ANNEX I

A LIST OF ADDITIONAL IAEA PUBLICATIONS ON NUCLEAR KNOWLEDGE MANAGEMENT THAT PROVIDE USEFUL GUIDANCE IN SPECIFIC AREAS OF KNOWLEDGE MANAGEMENT.

The first comprehensive publication on this subject was published by the IAEA in 2006:

INTERNATIONAL ATOMIC ENERGY AGENCY, Knowledge Management for Nuclear Industry Operating Organizations, IAEA TECDOC-1510, IAEA, Vienna (2006).

Knowledge Preservation:

INTERNATIONAL ATOMIC ENERGY AGENCY, Web Harvesting for Nuclear Knowledge Preservation, Nuclear Energy Series No. NG-T-6.6, IAEA, Vienna (2008).

INTERNATIONAL ATOMIC ENERGY AGENCY, Comparative Analysis of Methods and Tools for Nuclear Knowledge Preservation, Nuclear Energy Series No. NG-T-6.7, IAEA,Vienna (2011)

Research and Development:

INTERNATIONAL ATOMIC ENERGY AGENCY, Knowledge Management for Nuclear Research and Development Organization, IAEA TECDOC-1675, IAEA, Vienna (2012)

Knowledge Management in General:

INTERNATIONAL ATOMIC ENERGY AGENCY, The Impact of Knowledge Management Practices on NPP Organizational Performance – Results of a Global Survey, IAEA TECDOC-1711, IAEA, Vienna (2013).

INTERNATIONAL ATOMIC ENERGY AGENCY, Managing Nuclear Design Knowledge over the Life Cycle – Stakeholder Perspectives, Challenges, and Approaches (in preparation).

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INTERNATIONAL ATOMIC ENERGY AGENCY, Development of Knowledge Portals for Nuclear Power Plants, Nuclear Energy Series No. NG-T-6.2, IAEA, Vienna (2009).

INTERNATIONAL ATOMIC ENERGY AGENCY, Nuclear Accident Knowledge Taxonomy, Nuclear Energy Series No. NG-T-6.8, IAEA,Vienna (2016).

INTERNATIONAL ATOMIC ENERGY AGENCY, Fast Reactor Knowledge Preservation System: Taxonomy and Basic Requirements, Nuclear Energy Series No. NG-T-6.3, IAEA, Vienna (2008).

Education and Training:

INTERNATIONAL ATOMIC ENERGY AGENCY, Nuclear Power Plant Personnel Training and its Evaluation: A Guidebook, Technical Report Series No. 380, IAEA, Vienna (1996).

INTERNATIONAL ATOMIC ENERGY AGENCY, Training the Staff of the Regulatory Body for Nuclear Facilities: A Competency Framework, IAEA TECDOC-1254, IAEA, Vienna (2001).

INTERNATIONAL ATOMIC ENERGY AGENCY, Establishing the Infrastructure for Radiation Safety, IAEA Safety Standards Series No. SSG-44, IAEA, Vienna (2018)

INTERNATIONAL ATOMIC ENERGY AGENCY, Means of Evaluating and Improving the Effectiveness of Training of Nuclear Power Plant Personnel, IAEA TECDOC-1358, IAEA, Vienna (2003).

INTERNATIONAL ATOMIC ENERGY AGENCY, Nuclear Engineering Education: A Competence Based Approach to Curricula Development, Nuclear Energy Series No. NG-T-6.4, IAEA, Vienna (2014).

ANNEX II

PRESENTATIONS MADE BY MEMBER STATES DURING TECHNICAL MEETING ON MANAGING NUCLEAR SAFETY KNOWLEDGE–EXPERIENCES AND NATIONAL APPROACHES, 17-22 JULY, 2016, VIENNA, AUSTRIA

KNOWLEDGE MANAGEMENT AND ORGANIZATIONAL LEARNING AT NUCLEAR AND RADIATION SAFETY CENTER

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Abstract
Establishment of the knowledge management system at the Nuclear and Radiation Safety Center, which is a technical support organization of the Armenian Nuclear Regulatory Authority, is a continuous process that was initiated in parallel to the company establishment and improved based on the company needs and experience. It has a purpose to create, collect and share the knowledge with the employees who need it. The knowledge management system is integrated into the company Quality Management System. The objective of this paper is to describe the knowledge management model applied in the Nuclear and Radiation Safety Center, which covers all the aspects related to knowledge creation, obtaining, maintaining, retaining and transfer.
Keywords: knowledge management, need for knowledge, knowledge creation, knowledge share, knowledge storage, knowledge management model

1. INTRODUCTION

Knowledge is one of the most valuable assets for an organization. The effective management of knowledge is recognized as an important element for sustaining competitive advantage and improving performance.

In any organization knowledge is constantly being created and shared. Unfortunately, this relevant knowledge could be often lost as it was not properly documented in due time. The worse situation is when the employees leave the company, and all the knowledge and information they have contributed leaves with them. This is crucial for the companies and the sector in general suffering from the lack of qualified specialists.

Knowledge management is an important part of organizational learning. It is a systemic effort to decide what the organization needs to know, how to develop this knowledge and thus maintain the competitiveness in the market.

The necessity to apply the elements of knowledge management at the Nuclear and Radiation Safety Center (NRSC) has been already recognized at the stage of company establishment. After shutdown of both units of the Armenian Nuclear Power Plant (ANPP) in 1989 and collapse of the Soviet Union in 1991, the scientific institutions providing technical support to ANPP were closed down and most of specialists left Armenia in search of work, taking with them all accumulated knowledge. In 1993 the Government of the Republic of Armenia made a decision to restart ANPP. Armenian Nuclear Regulatory Authority (ANRA), which was established the same year, faced difficulties with implementing regulatory oversight during ANPP restart due to limited staff and knowledge, and lack of local technical support. Some technical assistance received from the International Atomic Energy Agency (IAEA), United States Nuclear Regulatory Commission (U.S. NRC) and European Commission (EC) was not enough to cover the gaps. The best, but risky solution to get out of this situation was to establish the local technical support organization. The idea was supported by the Government of the Republic of Armenia and in 2001 NRSC was established.

Initially only five specialists worked for NRSC. Many specialists simply rejected invitation to join the company as nobody believed that the company will survive and effectively operate. However, NRSC not only survived but also expanded the scope of its activities, developed capabilities and nowadays this is the leading expert organization in the field of nuclear and radiation safety in the local market and the most reliable partner for international organizations.

The most important factor in this success was the approach to the knowledge management adopted by the company since its establishment. In conditions of lack of qualified specialists, the only possible solution was to attract students and new graduates, and to organize their training and learning in place, with support from international organizations, thus forming a team of professionals and developing company capabilities.

This paper describes the knowledge management model and the elements of organizational learning applied at NRSC.

2. KNOWLEDGE MANAGEMENT SYSTEM

Knowledge management (KM) is an integrated approach to identify, create, classify, store, share and apply knowledge to enhance the organizational productivity, quality, profitability and growth. KM is a process through which NRSC generates value from its intellectual and knowledge-based assets.

KM system of NRSC is focused on both individuals and teams. Increased knowledge and skills of individuals enhance the entire team's capability, which, in its turn influences organizational capabilities and brings to development of core competencies.

The most important objectives of KM process within NRSC [1, 2] are to maintain and further develop the company technical competence with regards to:

- Status of science and technology;
- Knowledge-oriented planning and implementation of projects;
- Distribution and sharing knowledge;
- Utilization of knowledge;
- Making knowledge and knowledge processes more explicit;
- Introduction of more systematic methods to the management of knowledge.

KM is an element of NRSC Quality Management System (QMS) and is included in the system as a supporting process. Description of KM related processes is provided in the QMS handbooks.

3. KNOWLEDGE MANAGEMENT MODEL

KM model used at NRSC covers the following main processes (see Figure 3.1):

- Identification of need for knowledge;
- Knowledge creation;
- Knowledge share;
- Knowledge storage.

KM PROCESS

- Knowledge need identification

- Knowledge creation
- Knowledge share
- Knowledge storage

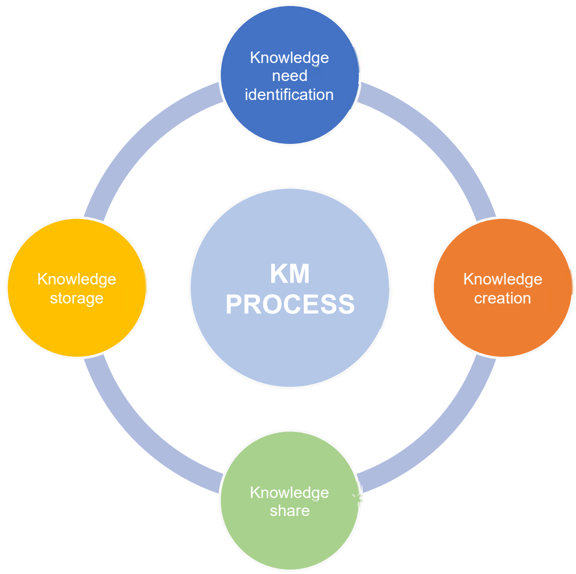

Figure 3.1. NRSC KM process model

3.1 Identification of need for knowledge

Figure 3.1. NRSC KM process model

Detailed description of each of the processes is presented in the sections below.
Before knowledge can be shared or created, the need for knowledge has to be identified. Further requirements to it have to be determined to allow finding the right knowledge in case of sharing and to enable creation of right knowledge in case of creation [2].

The need for knowledge is identified through:

- Analysis of working processes to identify shortcomings that lead to need for additional knowledge;
- Starting activities in new areas;
- Investigation of development trends and changes in scientific environment (new methods, tools, approaches, etc.);
- Analysis of completed projects (i.e. lessons learned);
- Annual performance evaluation of company staff.

The need for knowledge is identified at:

- Individual level;
- Team level;
- Organizational level.

Knowledge needs identified at individual level are reflected in Personal development plans, prepared for each NRSC employee based on the results of annual performance evaluation [3] and/or are included as topics in the Individual training programs (see Section 3.2).

Knowledge needs identified at a team level are included in the Group passports [4-8]. These are the documents developed for all technical directions (groups) of NRSC activities which describe in details:

- Group purpose;
- Scope of group activities;
- Group structure and distribution of responsibilities among group members;
- Software tools used by the group;
- Special equipment used by the group;
- Group capabilities;
- Group development program (identification of needs for knowledge) with defined priorities;
- Regulations, literature, training materials, manuals, any other documents defined by the group, which are used in daily work.

Group passports are living documents which are periodically updated. The needs for knowledge identified in the group development programs are becoming a part of NRSC development program and transferred into knowledge through knowledge creating possibilities identified in Section 3.2. Knowledge needs at the company level are general strategic goals described in NRSC Business plan, which is prepared annually.

A good example of a timely identified need for knowledge is starting application of Computational Fluid Dynamics (CFD) codes and establishment of Multiphysics Simulation Group within NRSC organizational chart. CFD applications are currently widely used for safety justification of NPP specific safety issues and are the most up-to-date methods. These issues are often related to situations where the 3D aspects of flow and geometrical effects have a significant influence on the safety criteria. Turbulent mixing is a common feature of these flows and the degree of mixing controls the result which directly affects safety. CFD tools are able to model small scale mixing phenomena with a fine space resolution and could be a very powerful tool for better understanding of physical behavior.

The CFD repertoire of NRSC currently consists of ANSYS software package which was provided to NRSC under the United States Agency for International Development (USAID) assistance program, including corresponding training. Currently ANSYS-CFX is in wide use by NRSC in its technical support activities to ANRA with regard to safety assessment of ANPP.

NRSC experience, passed trainings and accumulated knowledge in application of CFD codes are described in details in “ANSYS Application Methodology” handbook [14], which is an element of knowledge sharing (see Section 3.3) and a training material for newcomers (see Section 3.2).

Another good example for evaluating NRSC knowledge status and identifying needs for knowledge is regular participation in the recognized international topical meetings, like CAMP (U.S. NRC Code Applications and Maintenance Program), PSAM (Probabilistic Safety Assessment and Management Conference), PHYSOR (The Physics of Reactors Conference), NURETH (International

Topical Meeting on Nuclear Reactor Thermal Hydraulics), and others. Participation in these meetings contributes not only to the process of identifying NRSC needs for knowledge, but also to the other elements of KM process, such are knowledge creation (see Section 3.2) and knowledge sharing (see Section 3.3). Familiarization with the experience of other countries/companies is on one hand a good learning possibility, and on another hand right place to determine NRSC knowledge status, evaluate applicability of the other countries' experience to NRSC and generate ideas for further development. NRSC knowledge/experience is in its turn shared with other participants. 5

3.2 Knowledge creation

New knowledge is created in cases when no existing knowledge matches the requirements of identified need for knowledge. This process could be combined with the elements of so called "Knowledge pull" [2], which covers searching for existing knowledge with the purpose to re-use it.

An examples of "Knowledge pull" are:

- Feeding knowledge to NRSC experts (through participation in trainings, workshops);
- Involvement of specialists possessing required knowledge (practiced in cases when the knowledge is required for single or short-term use);
- Buying knowledge itself (software, method, etc.).

New knowledge is created through:

- Research and development projects;
- Internal projects;
- Participation in international benchmarks;
- Expert support;
- Individual training programs;
- Participation in trainings, workshops, recognized topical meetings, etc.

The distinctive feature of knowledge creation is that in most cases this does not immediately brings a value and is even costly, however this is a good investment for further benefits if the need for knowledge was identified in time and the requirements were set correctly.

As the main company value is its staff, and actually this is the staff who contributes to the development of team's and company's capabilities, at NRSC the main emphasis is done on knowledge creation at individual level (training of staff), moreover that the main problem existing in the field is a lack of qualified specialists.

Training of NRSC newcomers is conducted according to the training programs developed for all main categories of NRSC technical staff. These are typical templates, which are adjusted in each particular case to the needs of trainees depending on their experience and the level of basic knowledge (educational knowledge). Training programs cover both theoretical and practical parts, and include:

- Introductory course;
- Specialized course.

Training courses are formulated as internal projects. Training is conducted by a team of NRSC experts. If necessary, external experts could be involved. Each trainee has an immediate supervisor, who is taking responsibility for preparation, processing and review of training program, and organizing all the aspects related to organization of effective training for trainee.

The main advantage of NRSC approach to training is that from the moment of joining the company trainees become equal right NRSC staff members and have the opportunity to participate in projects, workshops, training courses and other educational activities, like other staff has. In training activities the main emphasis is done on on-the-job type of training. An average duration of training course is three years. It is assumed that after completing the full course trainees should be able to independently carry out their duties.

Trainging program is a living document and could be revised at any tim depending on the company and individual needs. Training performance and progress is continuously monitored through presentations during NRSC weekly seminars ad during performance evaluation.

NRSC is preparing new specialists not only for its needs but also for ANRA. This activity is a task within annual contract with the Regulatory body. Besides it, NRSC experts are actively involved in preparation of specialists with specialization in the field of nuclear and radiation safety in the Republic of Armenia as a whole, through teaching the courses in reactor physics at the Yerevan State University and State Engineering University, as well as providing trainings in the field of nuclear and radiation safety to other organizations on a contract basis.

Training of staff is a continuous process and includes not only training of newcomers but also retraining (advanced training) of existing staff. This activity is organized through:

- Initiation of research and development activities;
- Conducting internal projects;
- Participation in international benchmarks;
- Expert support;
- Participating in trainings, workshops, recognized topical meetings, etc.

3.3 Knowledge sharing

The general purpose of KM is to make knowledge usable for more than one individual, e.g. for an organization as a whole; that is, to share it. This process could be combined with the elements of so called “Knowledge push” [2], which covers “feeding” knowledge to the recipients who are known to be in need of it. This is important because people will not search for specific topics concerning their everyday work over and over again. Knowledge sharing is done by regular or event triggered knowledge sharing occasions.

Good example of regularly organized knowledge sharing event is NRSC weekly meetings (seminars). These are organized twice per week with the main purpose to inform the staff on the progress in NRSC activities, new endeavors, to discuss the project related topics and lessons learned, as well as to share with the rest staff new knowledge/ideas received through participation in different knowledge creating events, such are trainings, workshops, topical meetings.

3.4 Knowledge Storage

The general purpose of KM is to make knowledge usable for more than one individual, e.g. for an organization as a whole; that is, to share it.

This process could be combined with the elements of so called “Knowledge push” [2], which covers “feeding” knowledge to the recipients who are known to be in need of it. This is important because people will not search for specific topics concerning their everyday work over and over again.

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Currently, information and knowledge are stored at NRSC in the following formats:

- Electronic documentation;
- Paper documentation;
- Electronic knowledge (implicit and explicit knowledge);
- Employee’s brains (tacit knowledge).

The main purpose is to increase the share of electronic documentation (to make transition from paper to electronic office) and to transfer tacit knowledge to explicit knowledge thus preserving the knowledge from lost.

The main repositories for knowledge storage at NRSC, which are accessible for whole NRSC staff, are: 7

- Library;
- TECHLAB (electronic library);
- Intranet;
- QMS documents (handbooks). *3.4.1 TECHLAB*

TECHLAB is a database of regulartory documents, tachincal reports, publications, training materials, etc. The materials can be regtistered as:

- Hard copy;
- Electronic copy;
- Any kind of information carrier (CD, USB flash drive, etc.).

For each document registered at TECHLAB the following main characteristics are defined:

- Document ID;
- Category;
- Title;
- Description;
- Issued Country;
- Author;
- Place of storage;
- Keywords.

TECHLAB gives search possibility by the same characteristics (see Figure 3.4.1.1).

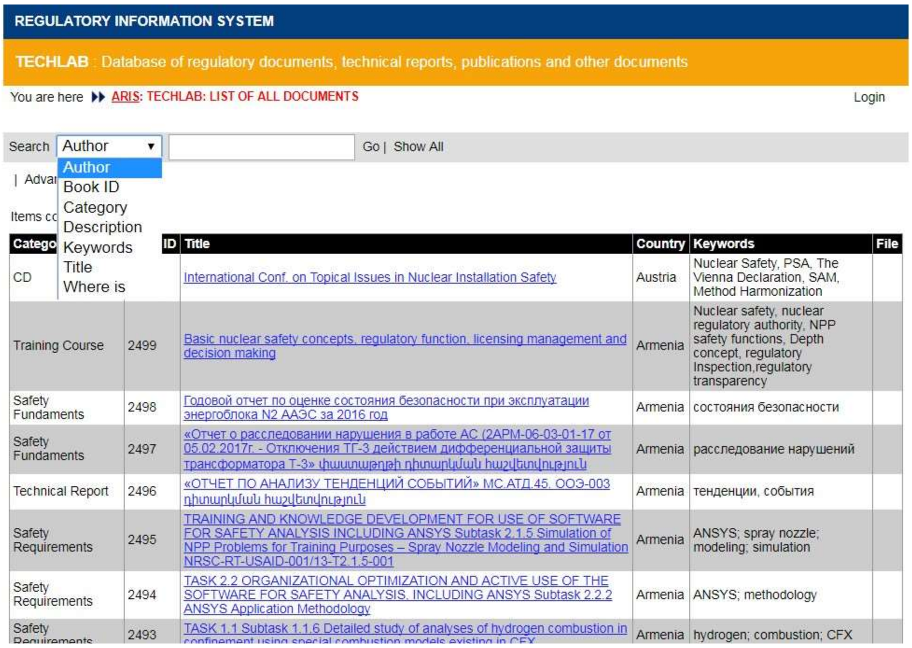

Figure 3.4.1.1. TECHLAB

The categories of documents registered at TECHLAB are:

- Literature;
- Regulatory documents;
- QMS documents;
- Project files;
- Software tools;
- Workshop proceedings;
- Other materials.

TECHLAB is accessible to all NRSC staff and any type of required information/knowledge could be easily retrieved from this database.

3.4.2 Intranet

Information which has to be accessible to whole NRSC staff or a part of it is shared via Intranet (local network) (see Figure 3.4.2.1). This is the main storage repository for project related documentation and QMS documents. Access to information is defined by the granted access permissions.

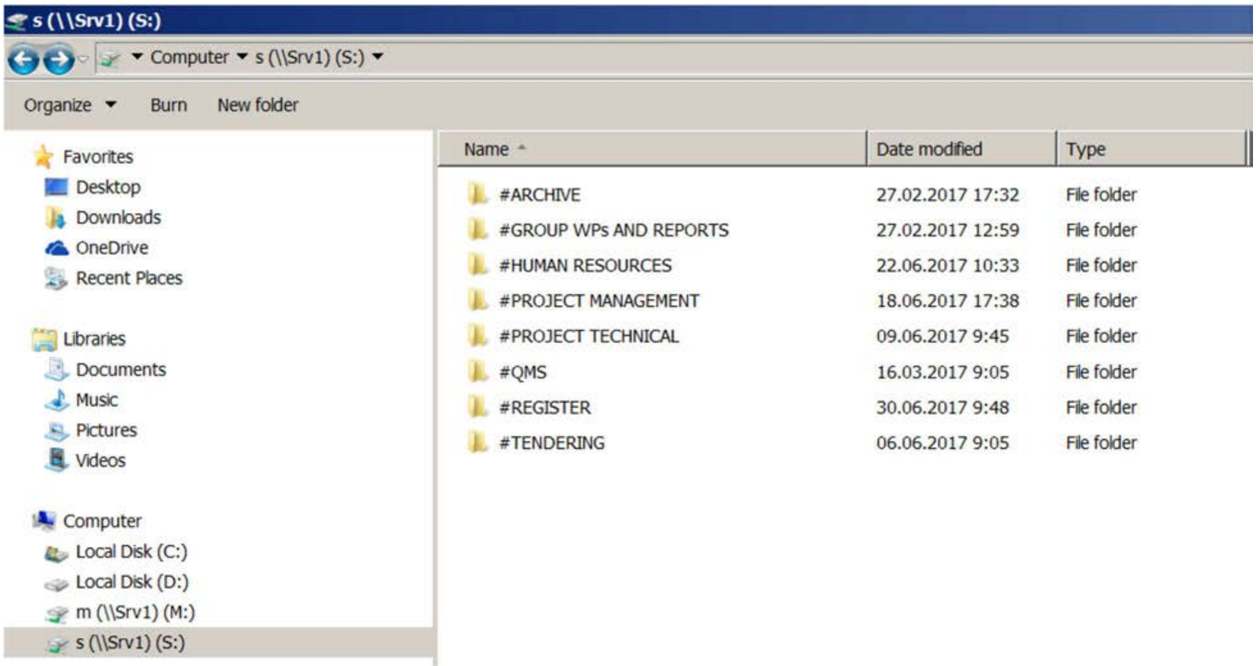

Figure 3.4.2.1. NRSC local network

3.4.3 QMS documents

Created knowledge is described in NRSC internal documents, called “Expertise Handbooks”, which are constituent part of NRSC QMS [9-13]. Separate documents are developed for nuclear and radiation safety areas of NRSC activities, including:

- **Expertise handbook for nuclear safety:**

  - Part 1: Core and nuclear fuel;
  - Part 2: ANPP technological system;
  - Part 3: Probabilistic assessment of risk;
  - Part 4: Thermal hydraulic analyses.

- **Expertise handbook for radiation safety:**

Expertise handbooks are explanatory documents (manuals) describing in details how expertise/review activities are implemented by NRSC in different areas of nuclear and radiation safety. The explanations are supported by examples. The documents cover regulatory requirements as well but the main emphasis is done on description of activities coming from NRSC experience. Expertise handbooks are living documents and are periodically updated with gained experience. 9

The purpose to establish such document is to tacit knowledge into explicit knowledge, and to prepare training materials for newcomers. Another example of knowledge sharing documents developed by NRSC is an “ANSYS Application Meth-odology” handbook described in Section 3.1 [14].

4. CONCLUSIONS

KM system has to be working for the company to benefit from it. Working KM system enhances individual, team and organizational capability thus increasing overall productivity and quality of company activities and is becoming an important element for sustaining company competitive advantage.

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SIX YEAR ENTIRE HIGHER EDUCATION PROGRAMME IN NUCLEAR AND RADIATION TECHNOLOGIES

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Abstract

Belarus is the embarking country in nuclear energy now. The appropriate national human resources programme was stated by the Council of Ministers of the Republic of Belarus in 2008. During the last almost 10 years it was found that the entire six year higher education programme in nuclear and radiation technologies to train directly to the level of Master of Science may be fitted to highest extent to contradictive terms and conditions arisen in Belarus. There are many reasons for that requiring a broad diversity of topics to be studied within one specialty. The main of them are: 1) safety of nuclear and radiation technologies is becoming the ultimate goal of any education and training in the field; 2) growing number of radiation units in different branches, especially, in medicine; 3) restricted number of nuclear facilities including installing nuclear power plant in Belarus; 4) the training resources accumulated during last years in Belarus in the field should be effectively used for long future (dozens of years); 5) the effective education and training system requires appropriate dimension of student groups studying at different specialties and experienced training and auxiliary staff. The number of specialties for entire education and training in nuclear and radiation area in case of Belarus should not be very big but each of them should be uniform in its educational content as much as possible to provide gaining consistent knowledge and skills. Three specialties for the six year entire programme are under consideration now: "Nuclear physics and technologies", "Nuclear and radiation safety" and "Medical physics". In all the specialties the topics of nuclear and radiation safety must be placed in specific focus related to aspects of technologies studied. At the same time, the national education programme should contain the core material being equal to all the specialties. The reasons to introduce the six year programme for some of specialties existing in Belarus and their standing nuclear and radiation safety content are discussed in the report. The proposed syllabus will cause the appropriate changes in the structure and content of the system of re-training and professional updating in the field. The possible scheme of roadmaps to train specialists within such renewed system to meet national and, possibly, regional education and training needs, is also discussed. The proposing system despite of the national peculiarities for Belarus may be useful for many of countries rapidly developing nuclear and radiation technologies.

1. INTRODUCTION: KINDS OF STRATEGIES IN EDUCATION AND TRAINING

Education and training on nuclear safety is one of the most important features of any education and training programme on nuclear technologies and applications. The volume and deepness of the study of nuclear safety, tools for preserving nuclear safety culture at a national level depends on a national strategy of education and training chosen by a country.

There can be considered three strategies of the organising the education and training system (E&TS) for the countries which has started the nuclear power (named hereinafter the Strategy 1, or Strategy 2, or Strategy 3):

1. to bear totally on a E&TS of a country – provider of the nuclear power technology;
2. to organise E&TS fully at the national basis;
3. to implement the blended approach of two aforementioned ones.

To enroll from these three options a country should take into account the following considerations:

- long term vision of nuclear power use in the country;
- possible providers of nuclear power technology;
- development of other nuclear and radiation technologies in the country;
- capacity of the existing national education and training programmes and human resources development at the moment od taking decision;
- estimated cost of different programmes within that listed above.

The Strategy 1 can be considered as the easiest way for a country having enough financial resources. But in this case the nuclear safety education and training is fully carried out by external providers that impedes to fulfill a national control from relevant regulatory authorities.

The Strategy 2 implies the establishment of the entire education and training programme including all aspects of nuclear safety and its relationships with radiation safety and nuclear security at national level in a country. This Strategy is relevant to the countries with developed nuclear industry and appropriate education and training system. But the Strategy 2 seems to be almost unreal for a country embarking nuclear power. It can be developed from the Strategy 3 with time.

The Strategy 3 is seemed as the most sustainable approach to build a national education and training programme in co-operation with other countries on bilateral and/or multilateral basis. The nuclear safety aspects in this case can be, at the beginning, in the focus of external providers of education and training programmes transferring into the national education and training programmes with time while appropriate human capacity will being accumulated at a national level.

Belarus had started to develop the Strategy 3 almost 10 years ago. It was not clear at that moment that our country had started to follow exactly such approach. Not all considerations listed above were fully analysed because of the lack of data at that moment and multiplicity of assumptions and uncertainties at that time. Not all the problems are solved even for now. But we must take into account that the main problem will arise soon, that the demand of specialists for Belarusian NPP and for related organisations will be satisfied in few forthcoming years. The E&TS developed up to now should not be focused only on their needs but has to be expanded on education and training of much more broad pool of specialists involved in operation and management with nuclear materials and radiation sources at all.

2. WAYS OF ORGANISATION OF THE NATIONAL EDUCATION AND TRAINING PRORAMMES

The main content of education and training can be split between formal university education and appropriate industrial/institutional on job training and experience. The shares of each part in the total time of education and training of a competent researcher or engineer can be different and depends on experience of a country, There are three scenarios of the development of education and training programme for nuclear technologies to gain the appropriate engineering competence that were consolidated in the document [1], prepared under the IAEA initiative and support (Fig. 1).

In Scenario 1 the main part of education and training is concentrated in academic institutions. The industry focus the training on specific issued related to a job. In Scenario 2 the academic education is more general but there are some main specific points for industry. In the Scenario 3 the academic education is quite general and all specific professional education is implemented by the nuclear industry.

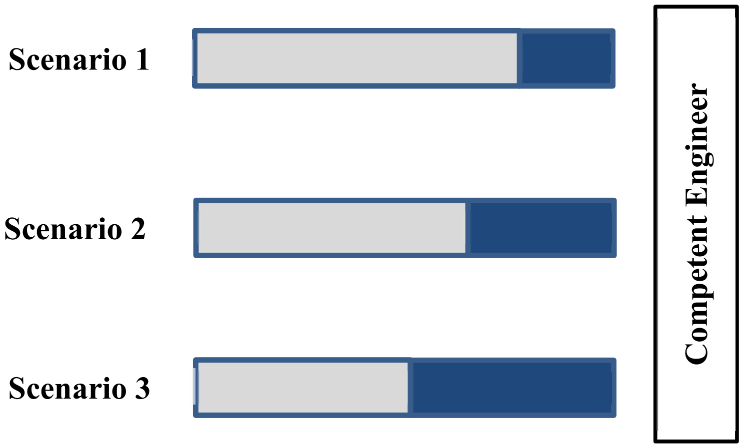

Fig. 1. Various approaches for producing a competent nuclear engineer [1].

To reach the appropriate level of knowledge and competence in nuclear safety within any education and training programme one is to allocate appropriate time to education and training. In Scenario 1 all general and many of specific aspects of nuclear safety are studied in universities or academic institutions. It requires the appropriate training of the university/institute staff. The nuclear safety issues may be only generally delivered within an academic curriculum in the Scenario 2. And, they may be only indicated in an academic curriculum within the Scenario 3 while the main training in nuclear safety becomes the responsibility of the industry.

There is no recipe how to calculate the appropriate share in time to be allocated for nuclear safety for any programme and any Scenario. Therefore, on practice, the time for education and training in nuclear safety, as a rule, is provided depending on the rest of hours forming after planning the conventional scientific and engineering subjects needed to be learnt by a researcher or an engineer. But there is the minimal duration of education and training for each aspect of nuclear safety despite of the using form of education and training.

The real duration depends on job responsibilities and professional duties to be performed. For example, the nuclear safety engineer having the basic 6 year university education on nuclear physics and technologies needs to gain, at least, one year experience on a particular nuclear power plant. In case of other Scenarios there is the risk to miss the opportunity to provide relevant general scientific and engineering education without missing time on that at specific training courses. Thus, in case of Scenario 3 the Fourier analysis and special functions are studied only at master level (see [1]) that leads, from one hand, to unavoidable repetitions at the master level, and from the other hand, restricts the capacity of bachelors to perform modeling and to apply appropriate calculating tools and software consciously.

All the scenarios are independent on kinds of Strategies of building E&TS and can be realized within each of them. Their enrollment is up to a country. But one should take into account all the threats and weaknesses habitual to any Scenario and any Strategy. There is no room now for general comprehensive analysis of them in this short paper. So, let us focus only on considerations and feelings following from the particular experience of Belarusian State University (BSU).

3. THE REASONS TO INTRODUCE THE ENTIRE SIX YEAR PROGRAMME. ADVANTAGES AND RESTRICTIONS OF ITS APPLICATION

For the purposes of this paper we call the “entire programme” the education and training programme in the field of nuclear physics and technologies that is intended for graduates of secondary school that comprises the undergraduate professional education and master course in the field. According to the classification described above the entire programme can be referred to the Scenario 1. The inner, inherent reason to introduce the entire 6 year programme in the field of nuclear physics and technologies is the diversity of knowledge and skills to be gained by a trainee related to the following parts of syllabi:

- applied nuclear physics including reactor physics and radiation measurements;
- applied mechanics;
- heat and mass transfer with application to nuclear units;
- basic chemistry and material science to proper assessment of the radiation impact on materials used in nuclear technologies and for
- radioactive waste management and nuclear materials management, studying the ways arisen at the stage of
- decommission of nuclear and radiation units;
- electrotechnics for understanding the operation of power units;
- electronics with studying its up to date elemental base and applications of it to automation of measurements and control of nuclear and radiation units;
- standardisation and metrology with focus on the nuclear and radiation applications;
- applied mathematical methods and tools used in nuclear engineering calculations;
- programming and software to manage with engineering calculations and safety assessment;
- basic biological, medical and environmental science to train appropriately in radiation protection;
- principles and tools of radiation protection and shielding calculations;
- principles of nuclear safety and provisions for it;
- accounting nuclear material and control;
- basic nuclear security and physical protection;
- design of nuclear and radiation facilities;
- basic emergency preparedness and response;
- economical aspects of nuclear industry;
- environmental impact assessment for application of nuclear and radiation technologies;
- legal and regulatory basis of nuclear and radiation applications;
- social impact of use of nuclear and radiation technologies;
- safety and security culture;
- professional ethics.

One may add to this list some other specific points to be important for some jobs in nuclear and radiation applications.

During almost 10 years BSU is carrying out the 5,5 academic undergraduate programmes named after "Nuclear physics and technologies" (Physics Faculty) and "Nuclear and radiation safety" (International Sakharov Environmental Institute of BSU – ISEI of BSU). Our experience has demonstrated that even in the conditions of hard auditorium part of theoretical education (32 -30 academic hours a week during 5 years) not all the aspects listed above can be studied in sufficient and comprehensive way.

For the specialty "Nuclear physics and technologies" it is related, first of all, to applied mechanics, basic chemistry, biological, medical and environmental science, electrotechnics, dosimetry and radiation protection, basic emergency preparedness and response, environmental impact assessment for application of nuclear and radiation technologies; accounting nuclear material and control; legal and regulatory basis of nuclear and radiation applications; social impact of use of nuclear and radiation technologies; safety and security culture; professional ethics.

For the specialty "Nuclear and radiation safety" the training of following topics can be improved only by expanding the duration of academic process: applied nuclear physics with reactor physics; heat and mass transfer with application to nuclear units; design of nuclear and radiation facilities.

Other applied topics may also be delivered better and deeper having appropriate time. It is true for both specialties.

It is also related to the 5 year programme of undergraduate training on "Medical physics" realised by the ISEI of BSU. The focus of medical physics programme is laid in the medical use of nuclear and radiation technologies. Therefore, it requires to pay much more attention to biological and medical studies. It also leads to the necessity to expand the academic programme to six years to harmonise all parts of their professional education.

There are also other more general reasons to introduce entire six year programmes in the field:

- safety of nuclear and radiation technologies is becoming the ultimate goal of any education and training on nuclear and radiation technologies;
- growing number of radiation units in different branches, especially, in medicine;
- restricted number of nuclear facilities including installing nuclear power plant in Belarus;
- training resources accumulated during last years in Belarus in the field should be effectively used for long future (dozens of years);
- effective education and training system requires appropriate dimension of student groups studying at different specialties and experienced training and auxiliary staff.

At least, the graduates from all specialties considered above get the diploma on higher education that higher than the Bachelor degree but is below to Master degree. Such intermediate position of the trained specialists causes misunderstandings while the graduates try to get a gob out of Belarus.

Because of these and some other reasons BSU recently initiated to introduce the entire six year programmes for specialties "Nuclear physics and technologies" and "Nuclear and radiation safety" with awarding by Master Degree. The advantages of such a programmes are:

- integrity of fundamental education in which the core knowledge and skills can be developed systematically without lacks and gaps to form the broad spectrum of competences;
- opportunity to organise the academic process with optimal combination of theoretical education and practical training allocated the appropriate tie for each component;
- opportunity to train deeply in the application of fundamental knowledge to the solution of engineering problems;
- correspondence of the duration of university education to the real physiological time necessary to become really mature person psychologically capable to solve complex professional tasks including the nuclear safety.

In difference to other forms of educational programmes the entire programme provides the flexibility for trainees to change easily their job profile and to adapt to any changes in technologies during their professional life.

The possible restrictions of such long term academic programmes are followed mostly from economical and legal issues. From economical point of view this is the long term investment that can be returned on approximately after the 12 – 15 years. There is only a government that can take a decision to establish such programme. I case of that the majority of nuclear and radiation installation owners are private and in case of non-governmental educational institutions involved in education and training such academic programmes can be considered as economically non-effective. In this case the Scenario 3 can be used (Fig. 1). The Scenario 2 is more habitual to the 'blended' national economy with rather big participation of the governmental capital in nuclear industry and in higher education as well.

The other economical restriction has happened from that in case of small number of nuclear installations in a country the nuclear industry will be rapidly 'saturated' by specialists and the demand for them will drop down after some time. This restriction is not applicable to the Scenario 3 in which professional training policy is forming by enterprises. It can be strong restriction for the Scenario 2 but in case of extended academic education in Scenario 1 this restriction can be overcome by flexibility of graduates to apply their knowledge and skills to any branch in which nuclear and radiation technologies are in use and/or safety issues are in focus.

The legal restriction can be arisen from a point that only an operator possesses all the necessary practical knowledge related to its facility including the nuclear safety issues. That is why practical training at the long term university level can not include particular things related to a definite nuclear enterprise. It may be considered as some kind of wasting expensive training time but the investment into general education and training can be returned on later because of flexibility of graduates in their job application without much additional re-qualification. Unfortunately, these considerations can not be supported by appropriate figures, because to get it one needs to make 'experiments' trying to implement different schemes of education and training. It is impossible for many reasons beginning from the decision makers doubts and ending by the variations of economical conditions in which different educational schemes will be tested.

4. POSSIBLE STRUCTURE OF THE SYSTEM OF EDUCATION AND TRAINING IN FAVOR OF NUCLEAR AND RADIATION TECHNOLOGIES IN BELARUS

The entire educational and training programme that roughly described above is not the only way of education and training in favor of nuclear and radiation technologies in Belarus. First of all, there are other specialties directly connected to the State programme of human development for nuclear power in Belarus: "High energy chemistry" (provided by the Chemical Faculty of BSU), "Steam turbine units for atomic power plants" (Belarusian National Technical University) and "Electronics of physical units" (Belarusian State University of Informatics and Electronics). There is also Post-Graduate Course on Radiation Protection and Safety of Radiation Sources (PGEC) realised in Belarus as the re-training course mostly to cover international training needs under the IAEA umbrella. The possible scheme of roadmaps to train specialists within such renewed system to meet national and, possibly, regional education and training needs, is presented on the Fig. 2.

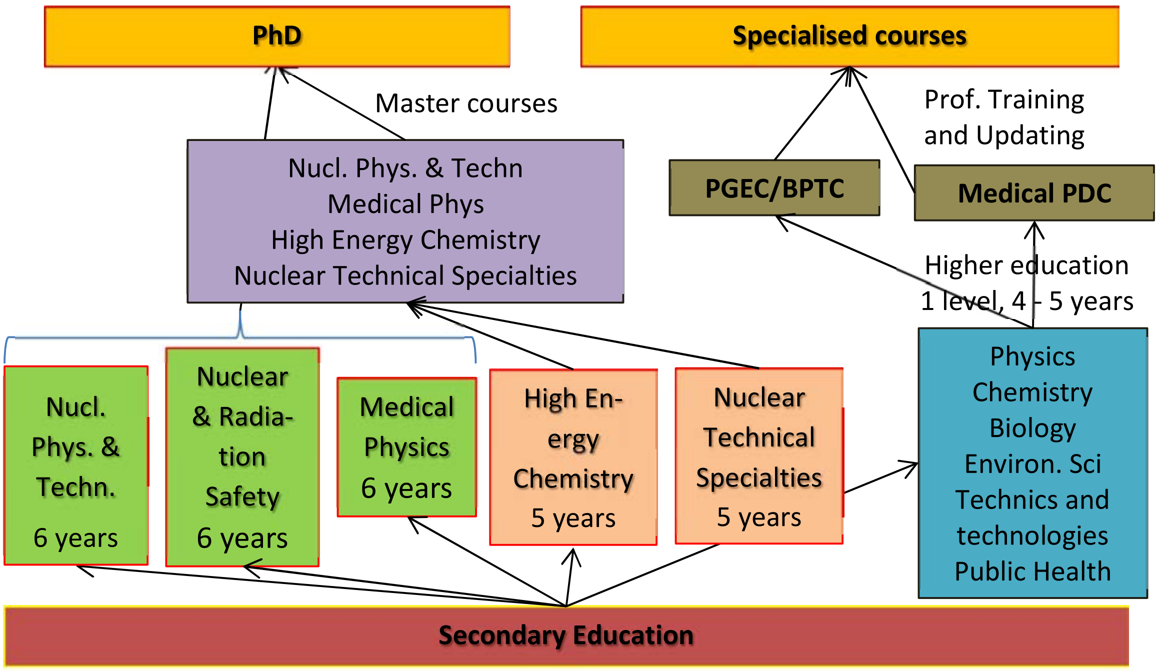

Fig. 2. Provisional chart for the Belarusian System of Higher Education and Training in the field of safety of nuclear and radiation technologies

It is seen the graduates from other scientific, technical or even medical specialties should have an opportunity to enter the field of nuclear and radiation technologies and their safety passing the appropriate re-training courses like PGEC and/or Basic Professional Training Course (BPTC) on nuclear safety, or professional development courses for the medical applications of nuclear and radiation technologies.

5. CONCLUSIONS

From our point of view, the estimated duration for forming comprehensive competences in nuclear technologies and their safety can be from 7 to 10 years independent on the Scenario chosen by a country for education and training Strategy in the nuclear field. This estimation is not related, for example, to the training of managers for nuclear industry that requires more time and development of the specific skills and knowledge not directly related to nuclear technologies.

To get indicators of that the entire programme is correspondent to the minimum requirements to the education and training system to be consistent with required competences one can use the collecting and analysing feedback from participants of the training programmes considered above and organisations where they work about how the training has influenced on their competence in nuclear safety. This is the separate task and it is worth to be supported by a particular IAEA technical document. This document should also include the template questionnaire for collecting feedback from participants and industry specified to reveal the lacks of each part of professional education programme.

Thus, the entire six year professional education programme can be considered as a most alive programme for countries with the predomination of the governmental investments to the economy. The adoption of such programmes does not prevent specialists from other brunches to enter the nuclear and radiation safety area.

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CANADIAN APPROACH TO MANAGING NUCLEAR SAFETY KNOWLEDGE

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ABSTRACT

The Canadian approach to managing nuclear safety knowledge integrates building workforce capacity and capability, capturing existing knowledge from research and development to regulatory decisions, and sharing knowledge with national and international partners. Knowledge management strategies and activities are an integral part of the industry and regulatory body's mature management systems. This paper aims to provide an update on the evolution of Canada's knowledge management activities within our current context. A continuing theme in the Canadian environment is the urgency of succession planning for scientists and engineers as experienced operators, regulators and researchers retire and potentially take with them a wealth of tacit knowledge. Thus training, development and knowledge transfer become ever more important to ensure a sufficient supply and high calibre of next-generation nuclear professionals. In 2002, a group of Canadian universities formed an alliance with nuclear power utilities, research organizations and federal government agencies through the University Network of Excellence in Nuclear Engineering (known as UNENE). Now, over a decade since its creation, UNENE is a well-established and fully functional framework with programs focusing mainly on education and research serving the industry at large. The lengthy time scales inherent in the nuclear lifecycle span decades and create additional challenges. For this reason, it is important to capture nuclear safety knowledge, create robust information repositories and effectively manage archives. An example of one such repository is CANTEACH, which provides high-quality technical documentation relating to the CANDU nuclear energy technology. In today's digital age, these repositories are evolving from static libraries to interactive online forums that facilitate the connection between people and information, as well as the connection between people. Capturing and sharing information are now intertwined activities that have shared responsibilities among individuals, organizations and national entities. A national knowledge-sharing culture fosters effective coordination and collaboration between various nuclear safety knowledge stakeholders. The Canadian Nuclear Society promotes the exchange of information on all aspects of nuclear science and technology, whereas the Canadian Nuclear Association provides a forum for discussion and encourages cooperation among various nuclear stakeholders. Through these types of networks, the sharing of lessons learned, best practices and expertise strengthens our collective nuclear safety knowledge. Canada has built a solid foundation of knowledge management practices within the nuclear industry, and with continued focus and dedication to continuous improvement, it will continue to be ready for the demands of the future.

1. INTRODUCTION

1.1. HISTORICAL BACKGROUND

Canada's contributions to emerging nuclear knowledge in the early twentieth century, a period shadowed by war and military might, are noteworthy. Canada's pioneer work on atomic theory, the discovery of uranium deposits and the development of modern nuclear technology underlined innovations in nuclear science and engineering applications [1]. In particular, Atomic Energy Canada Limited (AECL), now Canadian Nuclear Laboratories (CNL), invested significantly in the development of the CANDU (CANada Deuterium Uranium) reactor and next-generation designs [2]. In addition to nuclear energy technology, Canada also invested in research on isotope production and its use in nuclear medicine, uranium mining and milling methods, radioactive waste management, as well as safeguards and transportation of nuclear substances [1].

1.2. CURRENT CONTEXT

Canada continues to push the boundaries of knowledge in the area of nuclear batteries, nuclear fission and small modular reactors, such as molten salt, high-temperature gas and pebble-bed reactors [3, 4]. Canada has a well-established nuclear knowledge base, which is shared among the various stakeholders.

Figure 1. National stakeholders

Over 31,000 jobs in Canada are directly or indirectly attributed to the nuclear sector [5]. However, the looming departure of large segments of the workforce due to retirement could outpace replacement. This poses a dual risk: loss of nuclear safety knowledge and lack of qualified personnel to continue the work. Therefore, it is paramount to ensure there are enough new entrants (people who enter the labour force after completing their education), migration (people who move into a new geographic location) and mobility (people who change occupations or re-enter the workforce) to allow knowledge transfer and meet future workforce demands. National strategies aimed at building capacity, such as the new Canadian Express Entry program which helps streamline international migration of engineers, will support a strong inflow of talent [6].

2. BUILDING CAPACITY AND CAPABILITY

2.1. CANADIAN-BASED ALLIANCE

Nuclear workers receive foundational knowledge through undergraduate, graduate and doctoral programs. There is a wide variety of programs available. These range from nuclear medicine to nuclear safety, licensing and regulatory affairs. In 2002, a Canadian-based alliance of universities, industry partners and federal government agencies was established. The University Network of Excellence in Nuclear Engineering, known as UNENE, is now a mature framework that supplies high-quality graduates, supports nuclear research and creates respected university-based independent experts [7]. This important partnership identifies what capabilities are required, develops relevant curricula and yields graduate students who are in high demand within the nuclear industry.

In addition, UNENE plays a role in fostering knowledge networking through professional exchanges (e.g., conferences, committees and technical panels) and international exposure from research collaborations and publications.

Figure 2. UNENE objectives

3. CAPTURING KNOWLEDGE

The ability to build capacity and capability, at a national level, rests on the quality and availability of knowledge for transfer to individuals and organizations. Nuclear safety knowledge in Canada is captured and transmitted in many rich formats, from documents in repositories to storytelling by mentor to mentee. Below are just three examples of Canadian nuclear safety knowledge content available in the public domain.

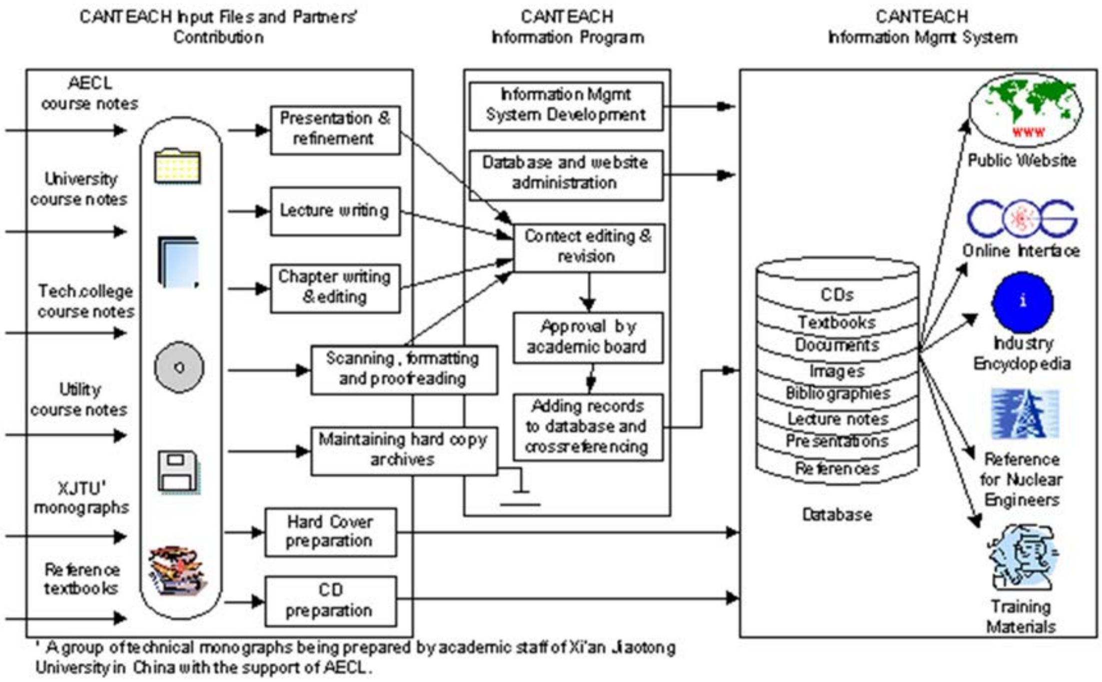
3.1. THE ESSENTIAL CANDU

The Essential CANDU, initially released in 2014 and last revised in 2017, is a brilliant example of national cooperation to capture nuclear knowledge with an educational focus. Initiated by UNENE, this textbook is administered by the CANDU Owners Group (COG), funded by CANDU utilities and developed with technical content from industry, the federal regulator and national nuclear networks. This peer-reviewed textbook serves as a living document that embodies the CANDU storyline. Such a tool helps new workers learn about CANDU technology and seasoned professionals pursue specialized topics, aiding the agility of deployment and redeployment throughout the industry [8].

3.2. CANTEACH

CANTEACH is also an educational reference pertaining to CANDU technology. This online library contains legacy publications and images that are easily retrievable by categories like reactor system, lifecycle phase, and science and engineering discipline. The project was initiated in 2002, with key contributions from COG and AECL (now CNL). Since then, the site has expanded and evolved to become a trusted source of nuclear information [9].

Figure 3. CANTEACH project model



3.3. REGULATORY DECISIONS

The Canadian Nuclear Safety Commission (CNSC), an independent administrative tribunal set up at arm's length from government, makes decisions on the licensing of major nuclear facilities through a public hearing process. All evidence from the industry applicant, CNSC staff technical briefings and intervenor submissions are heard and reviewed by the Commission. Decisions, hearing transcripts, webcast archives and other documentation are made available to interested parties and members of the public. As a result of this transparency, there is a comprehensive archive of important nuclear safety knowledge relating to regulatory decisions and the technical basis for those decisions.

4. SHARING THROUGH NETWORKS

4.1. CANADIAN NUCLEAR SOCIETY (CNS)

The objectives of the Canadian Nuclear Society (CNS) align to enhance Canada's nuclear safety knowledge. The CNS acts as a forum for information exchange, encourages education in and knowledge of nuclear science and technology, as well as builds professional and technical capabilities of those in the nuclear sector. The society is a not-for-profit organization with wonderful resources for nuclear workers and the public alike. Its "Ask an Expert!" tool puts students, journalists and interested members of the general public in contact with Canadian nuclear scientists and educators [10]. This and similar types of informal outreach make nuclear information accessible and may even serve as an early recruitment tool, capturing the attention of young would-be nuclear scientists and engineers. For their nuclear professional members, the CNS hosts annual conferences, lunch-and-learns, nights out and lecture series with nationally recognized experts. These opportunities to discuss technical issues and network among professionals build capability and promote sharing of nuclear safety knowledge nationally.

4.2. CANADIAN NUCLEAR ASSOCIATION (CNA)

The Canadian Nuclear Association (CNA) is also a non-profit organization that represents the nuclear industry in Canada [11]. From its "Talk Nuclear" blog where the association discusses nuclear's role in our communities, to its TeachNuclear website which brings to life all things nuclear, the CNA is a one-stop shop for instructional media on nuclear in Canada. The CNA has over 100 members, including power utilities, labour unions, manufacturers, uranium mining and fuel processing companies, engineering firms, universities and like-minded associations [12]. The CNA actively engages young Canadians by providing specific information about careers in nuclear. It casts a broad net, highlighting the need for those who are interested in continuous growth as engineers, professionals, and skilled workers and technicians. This association and those like it provide venues for those entering the workforce to build their professional networks in nuclear and begin the cross-generational knowledge transfer required, in particular for nuclear power plants that have a cradle-to-grave lifecycle in excess of 100 years.

4.3. CANDU OWNERS GROUP INC. (COG)

Although COG is an international corporation, CANDU technology was invented in Canada; therefore Canadian nuclear stakeholders, such as the industry and the federal regulator, have a vested interest in leveraging this network. The COG vision statement, "achieving excellence through collaboration" speaks volumes. Members participate in technical discussions aimed at solving challenging issues, share operating experiences and enhance safety through a collective regulatory understanding [13]. COG also publishes *COGnizant* quarterly; the spring 2017 issue provided industry news from members in Canada and internationally, as well as information on COG research, activities and projects [14]. This network has demonstrated its commitment to nuclear safety knowledge management and is an integral part of the national strategy.

4.4. WIN-CANADA

WiN (Women in Nuclear) is a world-wide association of women working in nuclear. WiN-Canada was formed in 2004 and shares its global parents' principal objectives to: 1) promote public awareness of positive contributions of nuclear to people and society, 2) provide opportunities to share knowledge and experience through exchange, and 3) promote nuclear career interests of women and young people [15]. This association uses knowledge-sharing strategies, such as networking events and mentoring, to help close the gender gap of entrants into the nuclear field. It also focuses on building readiness of young professionals to take on new challenges, in roles where women have been historically underrepresented.

Although this paper briefly describes recent and relevant examples of nuclear knowledge management in Canada, many others exist. Knowledge management in organizational environments is recognized as a priority for achieving greater efficiency today and attaining the strategic business objectives of tomorrow. The nuclear stakeholders in Canada, through their collective efforts, are helping to ensure that we will succeed in building a competent and agile workforce of the future.

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HUMAN RESOURCES DEVELOPMENT IN THE STATE OFFICE FOR RADIOLOGICAL AND NUCLEAR SAFETY, CROATIA

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Abstract

Human Resources Management is present in today's organizations as well as in public administrations. At the same time it is a mechanism for the creation of an efficient, effective, transparent and quality public administration and state administration. Managing human resources in the administration is rounded up with the legal framework but it allows much greater possibilities than it is applied in practice. State Office for Radiological and Nuclear Safety is the nuclear regulatory body in Croatia. Therefore all our activities related to Nuclear Safety Knowledge Management are within Civil Service Act and its regulations. To move from given situation which limits the further development of nuclear knowledge management and human resources development in general in the state administration, State Office for Radiological and Nuclear Safety, has taken some steps.

1. INTRODUCTION

Human resources management is present in today's organizations as well as in public administrations.

Human Resources Management is one of the fundamental determinants of public management and better public management. At the same time is a mechanism for the creation of an efficient, effective, transparent and quality public administration and state administration. The successful functioning of the public system and the implementation of necessary reforms increasingly depends on human resources in the public and state administration. "Strategy of development of human resources in the state administration" was valid until the end of 2013. In mid 2015 Croatia has brought a new strategic document called „Development strategy of public administration for the period 2015 – 2020" which contains a part/section on Human Resources in Public Administration. For state administration in particular no valid strategy on human resources management is present.

Human resources development in the administration is rounded up with the legal framework but it allows much greater possibilities than it is applied in practice. Significance of human resources development and the Nuclear Safety Knowledge Management in Croatian regulatory system is growing but slowly.

2. KNOWLEDGE MANAGEMENT IN CROATIA AND THE STATE OFFICE FOR RADIOLOGICAL AND NUCLEAR SAFETY

Today in Croatia we are facing significant efforts to implement civil service reform measures (including human resource management and therefore knowledge management) especially after joining the European Union. Awareness of the importance of human resources and the need for their continuous development is growing in the Croatian state administration in order to fully implement the reforms of the legal and institutional framework. For the moment state administration and public administration are separated as they do not have the same regulatory framework. State Office for Radiological and Nuclear Safety is the nuclear regulatory body as a part of state administration, therefore, we will talk about state administration in this paper.

The Civil Service Act and regulations made under the same Act prescribe conditions and employment procedures of civil servants, their transfer, the civil service completion and salary system. There are definitions of rights, obligations and responsibilities.

The current system of development and management of human resources in the civil service includes the recruitment planning, implementation of recruitment procedures and introduction into the service,

analysis and job descriptions, ongoing training, evaluation of performance and efficiency, rewarding and progression officials.

Deep analysis in the "Development strategy of public administration for the period 2015 – 2020" (further more: Strategy) and monitoring of human resources management determined that the system is too complex, burdened with unnecessary processes and, in certain cases, even inapplicable.

System functions of human resource management are not standardized (recruitment, training, performance appraisal, promotion, remuneration, termination of service) and do not apply across the public administration.

Mentioned objectives and measures set in that new Strategy are to be reached until 2020. In the meantime, Croatian regulatory system has to work on valid framework.

As it is mentioned already the current system of human resource management in the civil service in Croatia encompasses recruitment planning, implementation process of employment, promotion, performance appraisal of civil servants, analysis and job descriptions, education and rewarding. Basically all the activities are carried out on the basis of pre-prescribed procedures and do not allow progress if you do not change specific regulatory framework.

State Office for Radiological and Nuclear Safety is an effectively independent regulatory body empowered by the Act on Radiological and Nuclear Safety fully depending on State Budget with no income on their own. The number of civil servants and essential knowledge, skills and abilities for them to perform all the regulatory functions are predetermined in the Ordinance on Internal Organization of the State Office for Radiological and Nuclear Safety. The number of civil servants according to that Ordinance on Internal Organization is 49, but the current number is 23 with Director General. This number is constantly falling.

Therefore all our activities related to Management of Nuclear Safety Knowledge are set within mentioned Civil Service Act and their regulations.

As we are rather small regulatory body in non-nuclear country, we are facing some problems in Managing Nuclear Knowledge in general because our regulatory framework imposes its own rules which must be followed.

Firstly, it is difficult to find an experienced civil servant in nuclear field as for young graduated students it is not challenging to work in a state administration such as our State Office (salary issue). As it is specific branch of knowledge in Croatia, usually they are rather interested to work in private sector. So, we have to invest in development of trained civil servants - from junior into senior civil servant. In Croatia it is hard to find specific nuclear trainings. Also, because of economic crisis in Croatia and therefore insufficient financial support to educate them, we are facing significant problems in the development of nuclear knowledge and preservation of that knowledge, too. As there is no systematic training programme in civil service any more (it is not mandatory like few years ago) we are using all other possible resources to organize education in neighbouring countries or elsewhere with significant assistance of the IAEA and regional technical cooperation projects. Some of the basic trainings for junior civil servants are organized by State School for Public Administration and are usually for free but are often insufficient in specific topics. State School of Public Administration is the central organization for the co-development of employees in the public sector (and state sector, too). Its training programs, projects and collaboration with numerous partners, trainers and coaches, seek to provide a high quality of performance of public administration organizations.

Further, we have a large outflow (turnover) of civil servants in the last few years in State Office due to the fact that we are EU member state since 2013 and therefore working forces from Croatia are known on European labour market. Currently, it is forbidden to employ a new civil servants in state administration (only possibility is 2 for 1) and therefore we have a lot of empty working places in the State Office now. One civil servant is mostly doing multiple job and there is no replacement for them in any case. In that sense it is hard to manage human resources as there is no sufficient civil servants.

Great loss of nuclear safety knowledge occurs when senior civil servants are retired as there is no tool for keeping their knowledge and mostly no time to do so. There is no formal preservation of their knowledge.

Several times we tried to point out problems we have in the management of human resources (Ministry of Public Administration, which is responsible for human resource in the public administration in Croatia and the Ministry of Finance) but to no avail due to economic crisis in Croatia and general restriction of employment in the state administration.

It is also difficult to find proper education for young and new civil servant especially in nuclear and radiological filed. Luckily, we are using all our resources and efforts in finding proper education and training via IAEA, OECD, EU and bilateral agreements with neighbouring countries.

To move from given situation which limits further development of nuclear safety knowledge management in the state administration, State Office has taken some steps. One step forward is e-learning on implementation of radiological safety measures, available on our web site for all users http://e-ucenje.dzrns.hr/. It is mostly for end users but also applicable for civil servants in our State Office.

In 2015 we conducted an Integrated Regulatory Review Service mission under TC project (CRO/9/011 Supporting an IRRS Mission) in order to review the Croatian regulatory framework for radiation and nuclear safety and to exchange knowledge and experience on regulatory issues. The IRRS team identified areas for Croatian Government and State Office where significant efforts for improvements are needed to comply with International Standards. Great work is in front of us all in State Office to improve areas indicated in the IRRS Mission Report.

The State Office is working on Personal Training Plan of each civil servant which is set by Civil Service Act but not mandatory as there is no annual catalogue of available trainings for civil servants as before. Only State School of Public Administration (since 2010) is running trainings for civil servants with several categories – public management (such as training on public procurement, public appearances), EU programs (Europe in brief: European and national policies), public policy (E-consulting), special programs (State Aid), train the trainer (basic and advanced) and in-house training (on demand). No trainings on nuclear or radiological matters in that school.

Promoting usage of INIS during conferences, workshops or similar occasions in Croatia is also one of the aspects for managing nuclear safety knowledge. We do not have proper INIS centre but only two appointed civil servants in State Office in charge for promotion and preparation of inputs for INIS base (along with other duties in the State Office).

In 2017, the State Office issued internal Training plan for its civil servants to move forward. It consists of a mentioned personal training plan with the list of educations during years 2017 and 2018. Personal training plans are planned by senior civil servants along with civil servant itself. The personal training plan may contain maximum 40 days of training per year due to the current large staff shortage in the State Office. After returning from training, each employee is obliged to publish educational material on the internal portal of the State Office and to arrange a brief presentation of the same training for interested officials in the house. This ensures the flow of information and sharing of knowledge.

3. FUTURE AHEAD

We have no valid national civil service human resources development strategy but only "Development strategy of public administration for the period 2015 – 2020" containing part on Management of Human Resources in public administration. Therefore no particular guidance ahead but only regulatory framework and certain objectives until 2020 without particular action plans for implementation yet.

The overall objective of the reform of the human resources in the public administration is to improve administrative capacity of public bodies which includes state administration as a part of public administration.

The specific objectives of the new reform of the human resources in Croatian public administration and measures for their implementation set in a/m Strategy are:

1. Develop a competence framework for employees in the public administration
2. To strengthen the competency of all employees in the public administration
3. Strengthen the capacity for good governance
4. Development and implementation of new and continuous improvement of existing methodologies and mechanisms in the system of training in public administration
5. Establish a centrally-coordinated system of employment in public administration
6. Establish uniform criteria for a new job classification
7. Establish a rating system based on measurable criteria work efficiency
8. Establish and implement a system of promotion based on merit principle
9. To establish a unified system of wages and remuneration for all employees in public bodies
10. Adapt the number of employees with simplified and streamlined processes
11. Establish a system of ethics in public administration
12. To improve the mechanisms of prevention and fight against corruption in public administration
13. To develop the system of education and training for work in public administration
14. Strengthen cooperation and include the results of public research organizations in policy and the development of efficient public administration.

As this new Strategy is valid since 2015 (until 2020) we are eager to see next moves of the new government. Hoping we will have soon action plans for that Strategy. It's time to do something in human resources management as a whole.

While Croatia and its state administration do not move from this position, the State Office should continuously work on managing nuclear safety knowledge on their own. It means with own resources, financial and human, working on attracting young scientists into civil service, find all possible training resources, find the way to stimulate them to stay in state administration, to share their knowledge, to preserve that special knowledge and to keep knowledge before retirement (or leaving state office).

4. CONCLUSION

It should be planned to improve human resource management in the civil service in Croatia but it is unlikely to happen until we strategically reform the system of public administration in general as a good foundation for systematic and strategic development of human resources management in the state administration in a whole. Most civil servants consider that the management of human resources in public administration is formal. Activities of human resource management in the civil service are carried out only for the purpose of meeting the legal form.

While some things do not change the State Office for Radiological and Nuclear Safety in Croatia has to manage on their own on Knowledge management in general and Nuclear Safety Knowledge management but in accordance with the legal framework in Croatia.

A STRATEGIC APPROACH TO THE NUCLEAR KNOWLEDGE MANAGEMENT-ORIENTED TO RADIATION SAFETY

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Abstract

International experience and organizational practice in Cuba, in the field of Competence Management, allows recognizing certain weaknesses to achieve a strategic approach to labor competence and to guarantee radiological safety and sustainability of development, which constitutes a scientific problem to solve that, requires research that must move from the theoretical-conceptual to the practical- operational.

The guarantee of radiation safety is an aspect that claims two fundamental components: technology and human resources. One can consider that these two components are driven by human competence, which are the key element to guarantee the safety development of technological and operational aspects. In this regard, knowledge management is imperative. On the other hand, the design of a safer technology cannot be separated from its operation, and therefore it requires the development of new competence.

Cuba has made significant efforts to develop a national strategy to create competence in radiation safety based on a methodology that was applied as a management tool.

The main objective of this methodology is to promote the creation and development of a sustainable training system to develop competence in radiation protection and safety using existing capacities, synergies of national institutions concerned and international cooperation.

This methodological proposal is based on a systemic approach, which allows the equivalence between Knowledge Management and Competence Management oriented towards the Strategic Objectives of the organization that correspond to the lines identified within the National Programmatic Framework, which defined development lines on Cuba from 2017 to 2021.

Partial applications have been developed in three institutions linked to the nuclear activity in the country to precise, the strategic needs and with the aim to contribute to the consolidation, sustainability, and guarantee radiation safety.

The analysis started with the identification of the key development lines in each organization, the characteristics of the human resources associated with them and the form of guaranteeing their sustainability.

1. INTRODUCTION

To make effective the management of the competence aimed at achieving sustainable development it is necessary to elaborate a strategy that starts with the identification of the knowledge needs associated with that purpose.

When analyzing the guarantee in radiological safety, it is a need to take into account two fundamental components: technology and human resources. In both components, one can identify the presence of people and their competences.

Cuba has made an effort to ensure a safe operation of the applications of nuclear technologies. In this regard, a strategy has been designed with the aim to create, as is defined, the *radiological competence*.

There is a methodology [1], which has become a management tool to guarantee the nuclear safety in such applications. This methodological proposal is based on a system approach aimed at integrating the management of knowledge and competence, which are oriented to fulfill the strategic objectives of the organizations that are in correspondence with the lines of development identified in the National Programmatic Framework.

With the proposed of contributing to the consolidation of the sustainability and guarantee of radiological safety, a partial application was developed in the institutions of the Cuban Nuclear Energy and Advanced Technologies Agency (AENTA) to determine the strategic training needs. In that work, four areas of study are considered:

- Analyze the state of the competences in the institutions.
- Assess the situation regarding the mobility of personnel where the Regulatory Authority (Regulatory Body) was included.
- The projection of the training capacity of professionals of the nuclear profile at the national level.
- A summary of actions aimed at specialized training in the institutions studied.

Partial conclusions were elaborated in each one of the developed aspects, and finally, the general conclusions are established.

2. THE METHODOLOGICAL PROPOSAL.

The strategy for the development of the present work is outlined in Figure 1. It includes the fundamental elements that will be studied and, in particular, it is specified that the strategic needs must be included within the actions identified in the National Programmatic Framework.

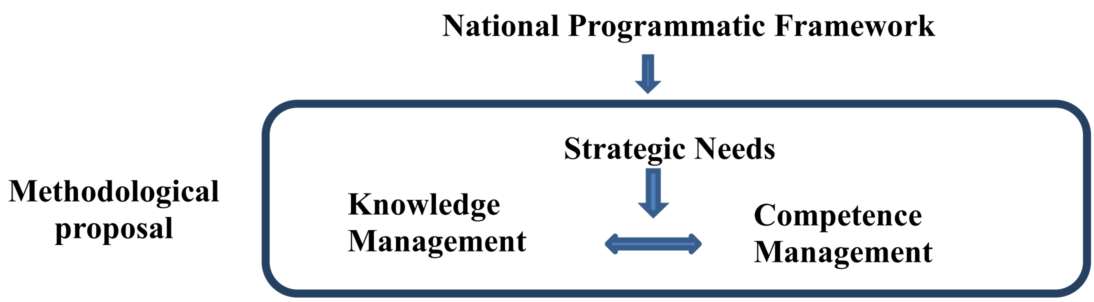

Figure 1. Work development strategy.

The AENTA is an organization dedicated to the management and development of the application of nuclear technologies and other advanced technologies, establishes the National Program Framework and ensures its compliance. It also coordinates the implementation of projects and supports the international cooperation, in particular with the International Atomic Energy Agency, with the Russian Federation (ROSATOM), Viet Nam, among other countries.

In the National Programmatic Framework [2], the following key areas of planned development have been identified in the medium term:

- Radiological safety
- Agriculture and food.
- Human health and nutrition.
- Water and the environment.
- Energy and industry.

Within the System of Institutions of the AENTA are selected for the present study:

- Isotopes Center (CENTIS).
- Radiation Protection and Hygiene Center (CPHR).
- Center for Technological Applications and Nuclear Development (CEADEN).
- Center for Information Management and Energy Development (CUBAENERGIA).
- Center for Environmental Engineering of Camagüey (CIAC).

These institutions are specialized in a certain area of nuclear development in the country and complement each other so that the project work is done by the integration among them.

In Cuba, there is the Higher Institute of Technologies and Applied Sciences, which constitutes the Cuban University dedicated to the training of undergraduate and postgraduate in the specialties of Nuclear Physics, Radiochemistry, Engineering in Nuclear and Energy Technologies and Meteorology. It has MSc and Ph.D. programs in the all the specialties. It is also included, programs in Science and Innovation Management and Environmental Management. Other academic activities of training are also carried out as, postgraduate courses and specialties.

At any University, at InSTEC are undertaken research-development activities, scientific-technical service, and software development and has close relations with Universities and Research Centers of Latin America and abroad.

3. SOME RESULTS OBTAINED IN THE APPLICATION OF THE METHODOLOGICAL PROPOSAL.

The application of the **methodological** proposal was developed in the five institutions of the AENTA. The variables analyzed were: the preparation of existing staff, the mobility of staff, the capacity to train the qualified workforce to respond to the demand for personnel and training specific actions in the country.

3.1 Status of the training capabilities of the staff in the institutions.

The preparation of and the skill gaps of the technical staff were analyzed in all the institutions belonging to the AENTA. The first step was the identification of the key areas of development of each institution and the training needs.

For example, the results obtained in the work area "Nuclear instrumentation for diagnosis in medicine, quality control and dosimetry" belonging to CEADEN and linked to different prioritized projects included in the National Program Framework was showed in Fig 2. The first step was the study of the necessary and existence competences in the area [3], [4] and after that; we can identify the competences gaps of each worker.

Because of this analysis, it was possible to identify the competences gaps and establish training plans for each specialists.

It also permits to propose the succession plans of the staff currently working on this line as well as the projection of successions due to potential migrations

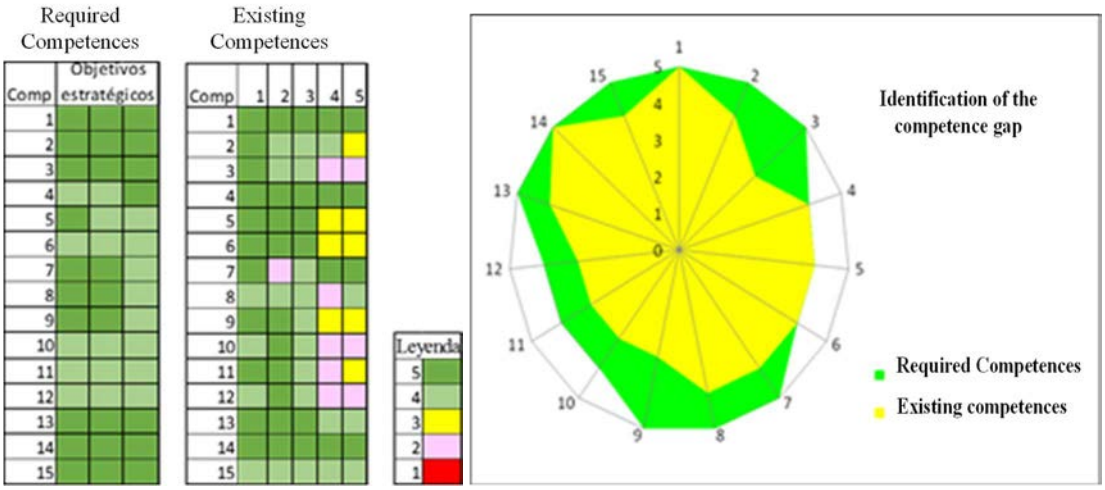

Figure 2. Identification of necessary and existing competences for the fulfillment of the strategic objectives designed for the work area.

3.2 Analysis of the mobility of personnel in the institutions of the AENTA and the Regulatory Authority (Regulatory Body).

To ensure the safe operation of nuclear facilities, within the framework established by nuclear safety standards, an indispensable ingredient is to ensure the existence of a qualified workforce.

This situation demands a strategy that must be approached with a margin of 10 years of forecasting. It is clear that the professional training institutions play an essential role. In the case of Cuba, as already mentioned, there is only one university institution dedicated to the preparation of professionals in the nuclear activity, which is the Higher Institute of Technologies and Applied Sciences, so that this activity has a national scope.

Within the study, the National Center for Nuclear Safety (Regulatory Body) was included because of its role in enforcing radiation safety through the granting of licenses and control of nuclear applications in the country.

To reduce uncertainty in recruitment we consider the potential migration (including pensions and the labor market) and the analysis of new developments.

A key factor to take into account is the current uncertainty associated with the process that goes from recruiting the students entering in the university till the formation of a genuine and well educated professional. This uncertain creates the prerequisite to calculate the initial demand that satisfies the most real needs and that should be increased to prevent a strong fluctuation of the stability of professionals. Of course, this situation would generate some chaos in guaranteeing the nuclear safety. To achieve this objective were identified coefficients that affect the initial demand to reach planned demand.

These coefficients have been calculated by statistical data with trend studies that incorporate intervening variables and that include the analysis of the dynamics of the environment.

Table 1 shows a summary of the results of the analysis of the retirements related to the planned demand in the period between 2015 and 2024, which is updated annually.

Table 1. Summary of potential retirements and projected demand (2015-2024)

Projection of Demand																							
Specilities	2015		2016		2017		2018		2019		2020		2021		2022		2023		2024		Total		
	R	D	R	D	R	D	R	D	R	D	R	D	R	D	R	D	R	D	R	D	R	D	Ce
Bacheler in Nuclear Fisic. (*)	3	6	1	3	2	5	5	9	0	2	2	5	1	3	2	5	1	3	0	2	17	42	1,6
Engeners in Nuclear and Power Technologies. (*)	0	3	6	20	0	3	0	3	1	6	2	9	1	6	2	9	4	14	2	9	12	79	2,8
Bacheler in Radiochemestry. (*)	5	8	7	10	0	1	3	5	2	4	0	1	0	1	2	4	11	15	0	1	12	52	1,3
Total	8	17	23	33	2	9	8	17	3	11	4	15	2	10	6	17	16	33	2	11	41	173	

(*) University Careers for five years of study.
R – Retired
D – Demand

In the period 2015-2024 in the centers considered, 40 specialists arrive at the retirement age. The distribution by fields of activities is: 16 are Nuclear Physicist, 12 are Radiochemists, and 12 are Engineer in Energy and Nuclear Installations.

In the same period, the initial demand for these specialties in the Centers of the AENTA is around 78 graduates (23 in Nuclear Physicist, 34 Engineer in Nuclear and Energy Technologies and 21 in Radiochemist).

However, the demand to be planned must be higher, by including other indicators that the University institution takes into account, to calculate the potential graduations and the needs of other Organizations that demand nuclear specialists and have not been considered in the study.

3.3 Projection of the capacity to train professionals to respond to the needs.

Another interesting fact is to assess the dynamics of graduations of professionals with a nuclear profile. The information provided includes the actual results for the years 2015 and 2016 and the projection until 2021 in correspondence with the enrollment per year of each one of the specialties. Starting from 2017, Table 2 shows only a forecast since it can fluctuate depending on the quality of the students recruited. As can be seen, there are no difficulties in meeting the needs of specialists in the AENTA institutions, leaving a surplus that can guarantee the demands of institutions not considered in the study.

Table 2. Projection of the new graduates and satisfaction of the demand until 2021

Graduation projection vs. Demand																
	2015		2016		2017		2018		2019		2020		2021		Total	
	D	G	D	G	D	S	D	S	D	S	D	S	D	S	D	S
Bacheler in Nuclear Fisic. (*)	6	16	3	13	5	10	9	12	2	8	5	15	3	28	33	86
Engeners in Nuclear and Power Technologies. (*)	3	18	20	19	3	13	3	10	6	13	9	14	6	38	48	107
Bacheler in Radiochemestry. (*)	8	12	10	8	1	8	5	10	4	7	1	15	1	23	31	71
Total	17	46	33	40	9	31	17	32	11	28	15	44	10	89	112	264

(*) University Careers for five years of study

G - Graduates
D - Demand
S - Students

3.4 The design of specialized training courses.

Is known that if one wishes to complement the training of university graduates, it is necessary to have continuous training that contributes to achieving the specialization of this workforce.

Previously, the potential offered by the InSTEC related to the scientific activity where the doctorates and master's degree were distinguished. There is also the possibility, depending on the needs of the employers, of planning other training activities which include an alliance with the specialized units.

An example of this is the "Medical Physics Diploma" which is carried out in cooperation with institutions of the Health sector (such as INOR) and as a collaborator the CPHR.

The need for a certification issued by the Regulating Entity [5] for the exposed occupational personnel has a "Radiological Protection Course," developed by the CPHR and recognized by the National Regulatory Body.

Training is also carried out by employers' own institutions, which design courses that are aimed at ensuring radiological safety. These have two components: the assimilation of the technology itself and the associated regulations.

Among them we can highlight some of those that organized and implement by the Center of Isotopes [6]:

- Update on radiological safety issues for exposed occupational personnel.
- Radiological safety update course for personnel related to radioactive material.
- Radiological safety update course for personnel involved in the import and export of radioactive material.
- Safety Culture Workshop (directed to all personnel working at the Isotope Center).

As you can see, a continuous training process is designed that goes from the acquisition of the student in secondary education to training as specialists, which is aimed at ensuring the radiological safety in institutions linked to nuclear technologies.

4. CONCLUSIONS.

The implementation of the methodological proposal has enabled a strategy aimed at ensuring the preparation of personnel linked to the application of nuclear technologies so that it can contribute to ensure radiation safety.

As results, the methodology allowed to:

- Identify the training needs to ensure the development in the application of nuclear techniques in the country ensuring radiation safety; and its periodical improvement.
- Determine the recruitment needs of personnel to respond to the potential mobility of specialists and new developments.
- Create the conditions for the development of scientific activity in the nuclear field in the country.
- Ensure an adequate satisfaction of the demand of specialized personnel.
- Provide training courses designed to achieve specialization in the operation of nuclear technologies for a reliable performance and for ensuring the radiation safety.

All this work must be in constant revision and improvement.

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IMPLEMENTING KNOWLEDGE MANAGEMENT PROGRAM AS A PART OF EFFECTIVE INTEGRATED MANAGEMENT SYSTEM FOR THE ETRR2 COMPLEX

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Abstract

In the IAEA documentations focus on management, for example the recently issued IAEA Safety Requirements publication Leadership and Management for Safety (IAEA Safety Standards Series No. GSR Part 2), it is understood that the organization information and knowledge (both tacit and explicit) should be managed as a resource for effective implementation of the management system. Also, lack of a knowledge management program is one of the warning signs of a decline in safety culture. This paper focuses on enhancing the Knowledge Management performance as a main step to achieve the goal of applying the Integrated Management System to improve safety, operation efficiency and performance.

ETRR2 Complex contains three nuclear installations (ETRR2 Reactor, Fuel Manufacturing Pilot Plant-FMPP and Radioisotopes Production Facility-RPF) and Administrative and engineering building (headquarter of the complex), which have a fairly adequate knowledge base. The paper introduces a proposal of Knowledge Management design for the ETRR2 complex. The objective of the proposed plan is first to evaluate the existing Knowledge base and then implement effective Knowledge Management (KM) program in order to avoid risks to overall operations such as 'Risk of Knowledge Loss' and lower safety and productivity.

1. INTRODUCTION

The lifetime of nuclear installations is very long, and through it a lot of modifications, modernizations or changes are happened due to different reasons such as:

a) production changes,
b) plant growth and expansions,
c) replacement and renewal,
d) deterioration of primary equipment,
e) modifications to applicable laws, regulations, standards and codes,
f) etc.

These aspects should be continually monitored and kept through effective knowledge management system to ensure that plant data and information for components and operation, also explicit and tacit knowledge for staff are adequately maintained overtime. Those circumstances, occurring individually or in combination, suggest that a knowledge management system is important to conduct necessary analysis and evaluation that may be required each time to ensure continued safe and reliable plant operation.

The Egyptian Atomic Energy Authority (EAEA) is a governmental research Authority that owns the Egypt Second Research Reactor (ETRR 2) complex. This Complex includes the following main installations at the Nuclear Research Centre of the (EAEA) in Inshas site:

1. A nuclear reactor (Egypt Second Research Reactor-ETRR2): used mainly for the generation and utilization of neutron flux and ionizing radiation for research and other purposes, including experimental facilities associated with the reactor,
2. A fuel manufacturing facility (Fuel Manufacturing Pilot Plant-FMPP): erected to assemble the fresh fuel elements that used for ETRR-2 core refueling,
3. A facility for producing radioisotopes (Radioisotopes Production Facility-RPF): erected to provide therapeutic and diagnosis isotopes to meet the requirements of Egyptian medical professionals and industrial radioisotopes to meet agricultural and industrial needs, and
4. An administrative and engineering building (headquarter of the complex) contains: administrative offices, engineering laboratories, technical offices, stores, library and documents archives.

The paper focuses on enhancing the operating organization performance of the complex by introducing a proposal of Knowledge Management design as a main step to achieve the goal of applying the IMS for the complex to improve its safety, operation efficiency and performance.

2. KNOWLEDGE MANAGEMENT AND ITS RELATION WITH INTERNATIONAL MANAGEMENT STANDARDS

The following clauses shows how the new international standards speak about management require that the organization information and knowledge (both tacit and explicit) should be managed as a resource for effective implementation of the management system.

2.1 ISO 9001 - fifth edition 2015-9-15

This new version of ISO standards pays more attention to information and knowledge. It contains an individual clause (no. 7.1.6) titled by *Organizational Knowledge* as one of the support resources. It defines the Organizational Knowledge as the knowledge specific to the organization; which is generally gained by experience and it is information that is used and shared to achieve the organization's objectives. Also, as part of the alignment with other management system standards, a common clause on "documented information" has been adopted without significant change or addition (no. 7.5).

2.1.1. Organizational Knowledge

The new ISO standard addresses the need to determine and manage the knowledge maintained by the organization, to ensure the operation of its processes and that it can achieve conformity of products and services. Where, this knowledge is required to be maintained and be made available to the extent necessary. Also, when addressing changing needs and trends, the organization is required to consider its current knowledge and determine how to acquire or access any necessary additional knowledge and required updates.

Requirements regarding organizational knowledge were introduced for the purpose of: a) safeguarding the organization from loss of knowledge, (e.g. through staff turnover; failure to capture and share information; b) encouraging the organization to acquire knowledge, (e.g. learning from experience; mentoring; benchmarking).

2.1.2. Documented Information

As shown in figure 1, one of the major differences in terminology between ISO 9001:2008 and ISO 9001:2015 was exchanging the term documentations by the new term documented information.

Table A.1 — Major differences in terminology between ISO 9001:2008 and ISO 9001:2015

ISO 9001:2008	ISO 9001:2015
Products	Products and services
Exclusions	Not used (See Clause A.5 for clarification of applicability)
Management representative	Not used (Similar responsibilities and authorities are assigned but no requirement for a single management representative)
Documentation, quality manual, documented procedures, records	Documented information
Work environment	Environment for the operation of processes
Monitoring and measuring equipment	Monitoring and measuring resources
Purchased product	Externally provided products and services
Supplier	External provider

Figure 1: A snap from ISO9001 - fifth edition 2015-9-15

Where ISO 9001:2008 used specific terminology such as "document" or "documented procedures", "quality manual" or "quality plan", this edition of this International Standard defines requirements to "maintain documented information".

Where ISO 9001:2008 used the term "records" to denote documents needed to provide evidence of conformity with requirements, this is now expressed as a requirement to "retain documented information". The organization is responsible for determining what documented information needs to be retained, the period of time for which it is to be retained and the media to be used for its retention.

2.2 IAEA Safety Requirements No. GS-R-3 and GSR Part 2

The Safety Requirements publication titled "The Management System for Facilities and Activities" (IAEA Safety Standards Series No. GS-R-3, Vienna, 2006) shows in clause number 4 titled Resource Management that *'Resources' includes individuals, infrastructure, the working environment, information and knowledge, and suppliers, as well as material and financial resource*. The recently issued General Safety Requirement titled "Leadership and Management for Safety" (IAEA Safety Standards Series No. GS-R-3, Vienna, 2016) supports the same definition of resources and in clause 2.27. it emphasizes that organization information and knowledge should be managed as a resource.

2.3 IAEA Safety Guide No. GS-G-3.1

The safety guide publication titled "Application of the Management System for Facilities and Activities", IAEA Safety Standards Series No. GS-G-3.1, IAEA, Vienna (2006) mentioned in clause no. 4.2 that using of information management, knowledge management and the corresponding technology is one of the ways that improve the performance of the organization. Also, clause 5.6 shows that the organization should consider knowledge management to develop the processes necessary for the effective implementation of the management system.

2.4 IAEA Safety Guide No. GS-G-3.5

The safety guide publication titled "The Management System for Nuclear Installations", IAEA Safety Standards Series No. GS-G-3.5, IAEA, Vienna (2009) lists typical symptoms of a decline in safety culture in clause 2.29 and two of them are related to Knowledge management: (point m) Failure of corporate memory — a lack of historical data and lack of a knowledge management program to manage staff turnover. Disproportionate number of experienced individuals leaving the organization, e.g. when reorganizing and/or downsizing, and (point s) Lack of learning — unwillingness to share knowledge and experience with others, or to use the experience of others to improve safety at the installation. Organizations become complacent and focus on the successes of the past, and are reluctant to invest in acquiring new knowledge and skills for the future.

3. CONCEPT OF KNOWLEDGE MANAGEMENT

Knowledge management (KM) is defined as the process of: capturing, developing, sharing, and effectively using organizational knowledge. It refers to a multi-disciplined approach to achieving organizational objectives by making the best use of knowledge.

Knowledge management is a structured cooperation between members of the organization, technology, structure and operations of the business organization in order to add value through the reuse of knowledge or its innovative outputs, and then participation and implementation by providing the Organization with valuable lessons and the best applications learned, which can be described as the memory of the organization which enables it to continue organizational learning.

Knowledge management focuses:

- on individuals and organizational culture to: stimulate and nurture the sharing and use of knowledge;
- on processes or methods to: find, create, capture and share knowledge; and
- on technology to: store knowledge and make it accessible and to allow individuals to work together without needing to be in the same place.

Individuals are the most important of these components, because managing knowledge depends on the willingness of individuals to share and reuse knowledge.

4. INTEGRATING KNOWLEDGE MANAGEMENT INTO EXISTING MANAGEMENT SYSTEM

Since a lack of nuclear safety knowledge can have significant implications much beyond an undesirable lack of efficient use of knowledge as a commercial resource, effective knowledge management informs and supports the whole integrated management system process by ensuring that the right knowledge is available on the right time for the right person in order to take the right decision.

One question that is often asked is ***"how does the organization integrate knowledge management strategies, processes and systems into the existing management system?".*** IAEA-TECDOC-1675 titled "Knowledge Management for Nuclear Research and Development Organizations" has answered this question in clauses (8.1 to 8.3) as follows:

4.1 Creating a standard for KM

There is currently no ISO standard for KM. One useful strategy is to 'invent' a standard for KM based on the ISO philosophy. On this basis a KM standard would be expected to address aspects such as:

— Policy;
— Objectives and targets;
— Resources;
— Training and awareness;
— Communication;
— Controls;
— Monitoring and measurement;
— Audits and management review.

By addressing the above requirements a systematic structure will emerge that will enable an organization's KM activities to be readily assimilated into the existing management system.

4.2 High level integration options

One approach for KM integration into the management system involves defining KM as a core process and including this as a top-level management process. This is illustrated by Fig. 3 below.

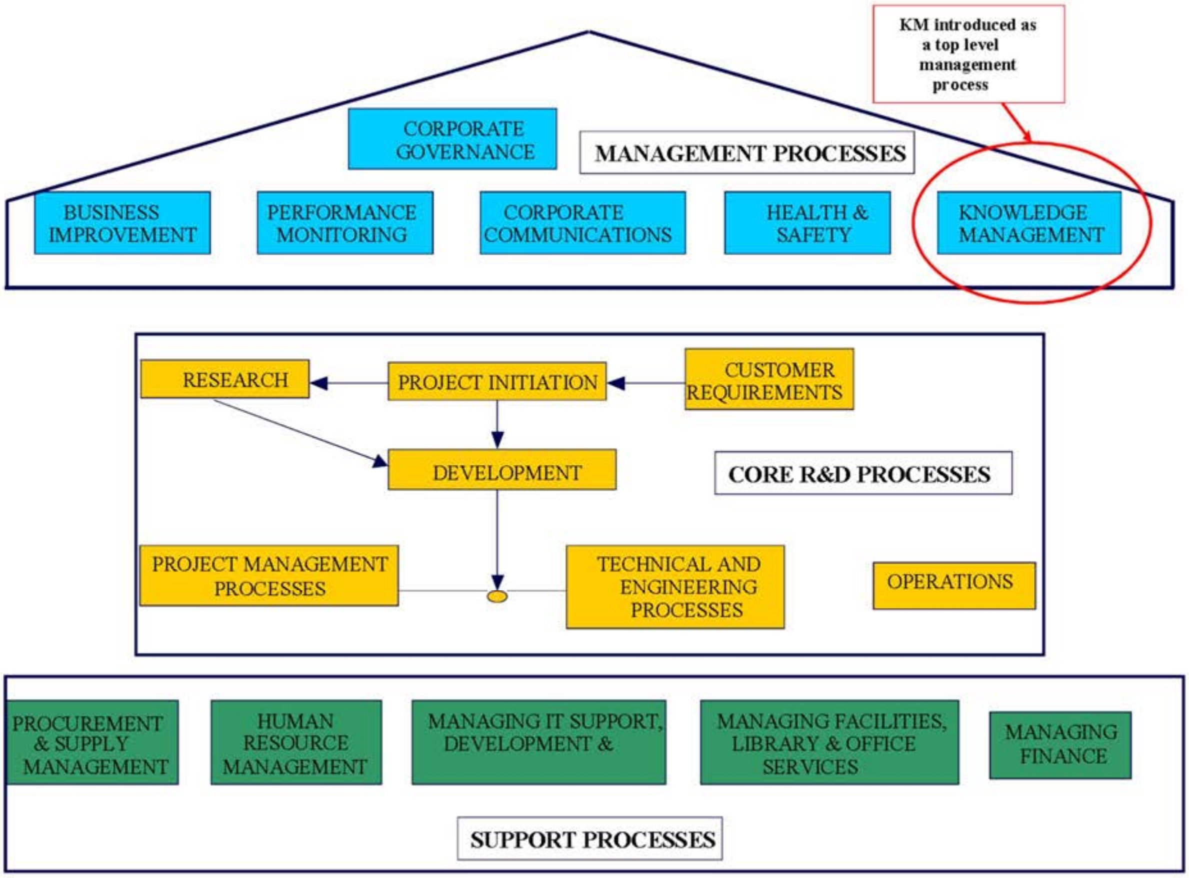

Figure 9. Introducing KM as a major component of the management system.

The main advantage of this approach is that KM is immediately elevated to a core business activity. As a central element of the management system, KM will receive attention, review and audit both internally and externally. This in turn will automatically lead to top-level management attention needed for success and further improvement.

4.3 Integration at the working level

This approach recognizes that the organization is already carrying out KM activities as part of its normal function but not necessarily labelling these as KM. Such activities may include knowledge transfer aspects e.g. coaching, mentoring, learning from experience, training, succession planning etc. The methodology adopted recognizes these activities form part of the organization's KM strategy but leaves them unaltered with the same ownership. The KM strategy would identify new initiatives and try to integrate these into the existing system but not at the top management level. With the ease of implementation, the transition from existing to new KM initiatives is less demanding on people's time and the resources needed.

ETRR2 Complex contains three nuclear installations (ETRR2 Reactor, Fuel Manufacturing Pilot Plant-FMPP and Radioisotopes Production Facility-RPF) and Administrative and engineering building (headquarter of the complex), which have a fairly adequate knowledge base. This knowledge base has been preserved in the complex through the following:

- Its acquisition began from the design stage of the reactor as participants from EAEA were involved in the design.
- Also participants were involved in construction and commission stages.
- During construction and commission stages, whatever possible, major tasks were photographed and video recorded.
- All basic, details, as build documents were acquired either by soft or hard copy.
- After the plant was fully operated, all work orders and working procedures were kept either in soft or hard copies.
- Major tasks were photographed and video recorded and sometimes combined with interviewing the people involved in those tasks.
- New faults and problems were have to be written down in a log books, discussed and converted to new working procedures.
- The softcopies and video recording films were kept in a fileserver in the intranet of the complex.
- Recently, the EAEA began to send attendees to joint ICTP/IAEA NKM schools.

The following will introduce a proposal of Knowledge Management design for the ETRR2 complex.

The scope is to determine the performance of the KM system of the three plants (ETRR2, FMPP and RPF) and improving their function in order to avoid risks to overall operations such as ‘Risk of Knowledge Loss’ and lower safety and productivity. The proposal will deal with the three nuclear installations as individual projects; each project has its own team and team leader. The following steps describe the general work plan:

1- Evaluating the existing Knowledge base
2- implementation of KM program containing different projects
3- building the suitable team for each KM project
4- defining the KM activities and best practices
5- designing Knowledge Performance Indicators (KPI)
6- making comparative analysis with Pilot similar KM projects

5.1 Evaluating the existing Knowledge base

Assessing the existing knowledge base by evaluating and numerating documented data, information, as well as knowledge and skills of individuals based on knowledge. This will be in order to give a clear indication about the usefulness of the existing knowledge base.

5.1.1 Sources of Knowledge

The proposed program is based on the principle that the complex now has a "knowledge reservoir" of its own. This knowledge base is much more than the sum of individual knowledge of employees, and it is capitalized, more or less over time, through information products (documents, databases, software etc.) or by knowledge exchanges/transfers, individual or collective.

The knowledge is created by the research actors (which are the principal “knowledge workers” of each plant), most of time by in interaction with the various information systems available in the complex (databases, search engines, document management systems, software etc.), some knowledge is exchanged in an informal or semi-formal way (discussions, communities, seminars etc.), it produces tacit knowledge. Some knowledge is codified in new records (publications, reports, documents etc.), it is explicit knowledge. It accumulates in the firm during its history, and forms what is called a "Knowledge reservoir”. Commonly, organizational knowledge is based on:

a) internal sources (e.g. intellectual property; knowledge gained from experience; lessons learned from failures and successful projects; capturing and sharing undocumented knowledge and experience; the results of improvements in processes, products and services);
b) external sources (e.g. standards; academia; conferences; gathering knowledge from customers or external providers).

The task will be determining and numerating all these sources and collecting and classifying the available and existing data, information or knowledge.

5.1.2 Used techniques to collect data

In our approach, we used the following to document the current state:

- Interviews: with key and knowledgeable persons such as: expertise leaders, innovation managers, senior supervisors, plant manager, etc.
  A questionnaire and an interview plan shall be established, a targeted group of chosen people shall be formed, according to appropriate criteria, and the analysis of the entire knowledge domain will be realized.
- Written materials: collecting, analyzing and summarizing information and documents, etc.
  Considering any digital asset we can treat as a structured member of a digital data base content:
  1. Scanned paper document
  2. PDF electronics file document
  3. Microsoft Office file - DOC, PPT, XLS, etc.
  4. Image file - jpg, TIFF, GIF, Windows Bitmap, etc.
  5. Multimedia - AVI, MPEG, Flash
  6. Other
- Creating and updating: When it is necessary to create and update documented information, the following should be considered:
  1. ensure appropriate identification and description (e.g. a title, date, author, or reference number);
  2. ensure appropriate format (e.g. language, software version, graphics) and media (e.g. paper, electronic);
  3. ensure appropriate review and approval for suitability and adequacy.

- Revising and updating data of ‘Resources’ which includes: individuals (e.g. the number of individuals and their competences by collecting updated CVs), infrastructure, the working environment, knowledge and information, and suppliers, as well as material and financial resources.

5.2 Implementation of KM program containing different projects

The objective of the proposal is to enhance the existing Knowledge Base of the ETRR2 complex through the following:

1. Establishing a set of standard principles,
2. Integration at high and working levels,
3. Experience drawn from others

Our references in this case are: IAEA standards, Our working experience, Leading management development theorists and Design principles for each plant. In addition to this, there is necessary reference documentation that consists of:

- The documents on organisation (missions, organisational charts, descriptions of activity, portfolio of activities etc.);
- Strategic documents (mid-term plans, summaries of previous mid-term plans);
- Quality documents.
- Other Documents (publications, studies, activity statements, etc.).

The purpose or business need for this program is to digitize knowledge base and infrastructures for all buildings at the same computerized data base to make a unified computerized system using servers workstation and storage station for backing up in order to reach the ideality of the KM system and make it a stable system. Then, make a single hole storage workstation simple to access and simple to save and also to check all procedure and transfer it to multi users access template simple to print and simple to save at the same workstation which will be the main one located in the Reactor Engineering Building.

5.2.1 Project Prerequisites

For sustained benefit, cultural issues need to be addressed:

- Is knowledge sharing encouraged?
- Is knowledge regarded as critical to individual and organizational success?
- Is innovation encouraged?
- Is self/organizational learning and development the norm?

If the above are not in place, the project may also need to be treated as part of a cultural change initiative. It is thought that this culture is integrated with safety culture.

5.2.2 Detailed work plan

For each project team the following detailed plan is proposed:

- assessing the existing Knowledge base: evaluate and numerate documented knowledge and skills of individuals based on knowledge
- implementation of KM program containing different projects: one KM project for implementing improved KM system for each plant

- building a team for each KM project: assigning the suitable personnel with adequate skills and experience
- defining the KM activities and best practices such as: training, knowledge sharing, Community of Practice CoP, Forum, etc.

The project team hierarchy is shown in figure 3 and the schedule time plan and milestones is shown in figure 4. The project deliver products or services will be infrastructure for completely computerized system and to train all who will track the system to be aware how to handle it also to be aware how to keep it secured and stable system.

The idea is to follow each document in the three building (documents tracking) to make digital library for the complex. Also, to complete all document's templates (forms, checklists, …) at the same digital stock with quality assurance procedure. This will be done using four servers one in each building of the three nuclear installations and the fourth will be the workstation for the three servers. This KM program will be flexible to accept any change to the management system infrastructure

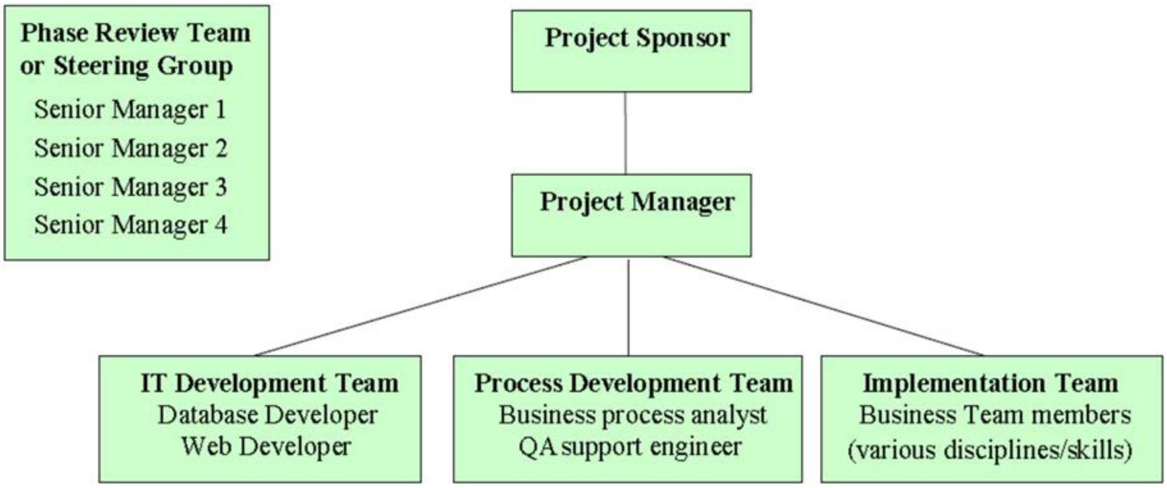

Figure 3 Project team organizational chart

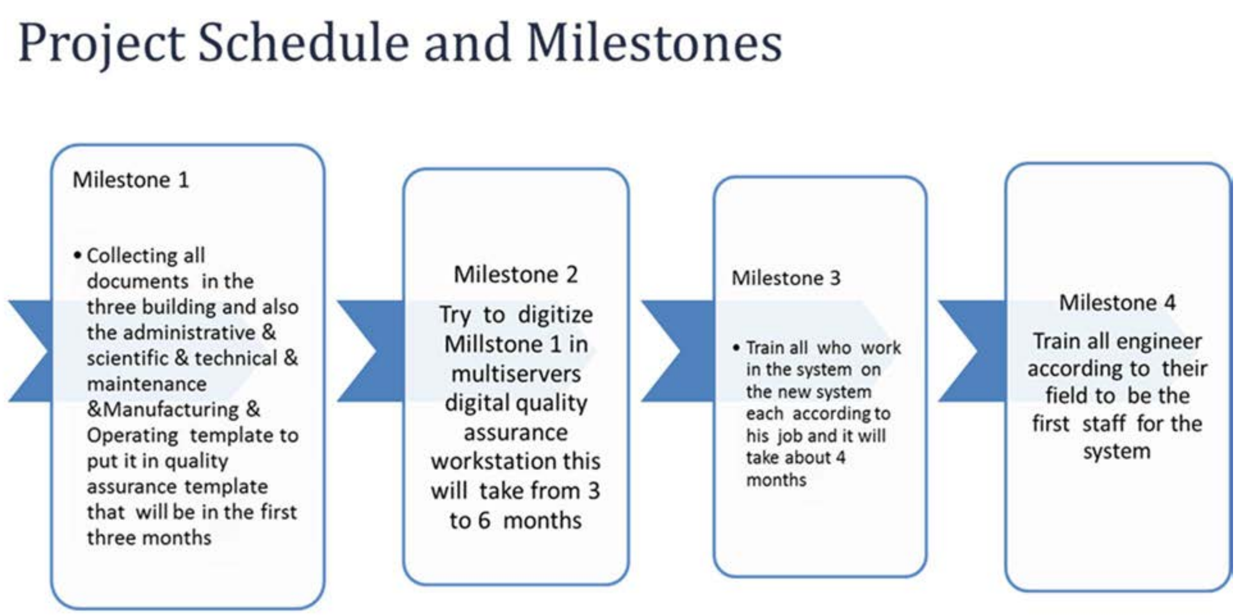

Figure 4 project schedule and milestone

5.2.3 Success Factors

Elements that are key to the success of the project may be:

- to get a stable computerized KM system
- to reach satisfaction for all stakeholders
- Make all administrative, scientific and technical infrastructure for all computerized system follow the same quality assurance templates that will be handled in the system
- Delivered on time

5.2.4 Review of KM Projects

Project Reviews are examinations at the end of a project to determine if:

- the objectives of the project were achieved
- the intended benefits were realized
- lessons can be learned for future projects

Assessment Techniques

- Objective checklist
- Questionnaires to determine perception of project success
- Pre and post project KPIs

5.3 Issues and challenges related to KM establishment and how to overcome them

- Cyber Security.
- IT Difficulties.

- Laws and Regulations.
- Security Clearance.
- Lake of resources (5 Ms):
    1. Money (Funds and Budget).
    2. Man (personnel and expertise)
    3. Machine (necessary SSCs)
    4. Material (Knowledge)
    5. Management (commitment and attitude)

There are some ideas to overcome those challenges, such as:

- Just by integrating the KM system within the IMS would already help
- More informal ways of improvement actions: Observations – Witnessing
- Small rewards (not even €, but any kind of reward)
- Follow-up actions, reviews, reporting to find out if recommendations have been fulfilled
- If actions are not fulfilled find out why, find root causes and work on them
- KPI's on "action-efficiency" to top management
- Practical regional training workshop KM
- Practical examples, success stories about integrating KM within management systems
- Fellowship on practical issues of the improvement cycle like self-assessment, observations, … – technical cooperation adapted to the size and power of the installation
- Web Forum – Platform – good practices on KM for nuclear installations.
- New laws and regulations should be issued.
- More I.T. staff should be provided to the complex to support KM.

6. MAIN ADVANTAGES GAINED

- To give a clear indication about the usefulness of the existing knowledge base.
- Making available increased knowledge content in the development and provision of high levels of performance.
- Improving the human resources and technology management
- achieving organisational objectives by making the best use of knowledge
- achieving greater Shear human and other resources among ETRR2 facilities
- Encourage teamwork to improve performance
- Aid in achieving the production and safety potentials of the complex
- Functions are sheared between several senior experts
- Very important step in the process of applying the IMS.

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MANAGING NUCLEAR KNOWLEDGE IN THE HUNGARIAN ATOMIC ENERGY AUTHORITY

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Abstract

The paper describes the background and status of the Knowledge Management System (KMS) of the Hungarian Atomic Energy Authority (HAEA). The missions of the HAEA are the supervision of the peaceful application of the nuclear energy for purposes of a safe environment and protect the people. Tasks are: licensing, inspection and assessment of nuclear facilities in Hungary. There are many definitions of the knowledge management (KM). The definition in the HAEA is: Knowledge management includes all methods, instruments, tools and activities that contribute to identify, attain, develop, transfer, and preserve knowledge. A KMS is an essential tool for maintain the state of the art knowledge in our authority. The medium-term objective of the strategic plan of the HAEA is to keep human resources and knowledge base at a high level. To optimize the internal efficiency of the HAEA it is essential to improve the organizational culture, organizational knowledge. A KMS provides a relevant accessible tool for these. During the last years, several knowledge management elements have been established and used in the HAEA, but it was recognized that a higher level of maturity for knowledge management is needed because of the dynamic nuclear industry environment. A fully functioning KMS makes it easier individual and organizational knowledge transfer, preservation aimed efficiency of official work.
A KM program was launched in 2015 in the HAEA with management commitment. The reason to start this program was that the HAEA faced new challenges caused by the life time extension of Paks NPP, building a new NPP, the extension of the official tasks, doubling the number of the regulatory body, generational changing, and retirements in the HAEA.

The KMS of the HAEA is continuously developing. Elements were developed, plans and project is ready to organize them to a well operated system. KM is not only the responsibility of an organization information technology, human resources, or training department. To be effective, a KMS should be organization-wide. The long term goal is to develop an intranet portal that provides further tool to develop and expand the knowledge management in the HAEA.

This paper presents what tasks were done in relation to the establishment of the KMS, what tasks await us in the future, what are the positive and negative experiences with the program. This summary is based on the results achieved by us.

1. INTRODUCTION

The medium-term objective of the strategic plan of the HAEA related to knowledge management in the period 2015-2017 is to keep human resources and knowledge base of the nuclear authority at high level with:

- Organize systematic and practical trainings and further trainings;

- Organize training for new entrants inspectors;
- Application and further development of the Hungarian Nuclear Knowledge Base;
- More effective utilization of results of research and development support HAEA;
- The maintenance and improvement of organizational knowledge;
- Create Knowledge Management System of the HAEA.

During the last years, several knowledge management elements have been established and used in the HAEA, but it was recognized that a higher level of maturity for knowledge management is needed because of the dynamic nuclear industry environment.

In order to achieve the above mentioned goals, the following elements of the KM have been done and the following improvements are needed in order to meet the others.

2. KNOWLEDGE MANAGEMENT SYSTEM

2.1 Knowledge identification

The purpose of the identification of the knowledge is to get an accurate picture about the available and the missing individual knowledge of the HAEA. Several years ago a Knowledge Profile Database was developed which shows knowledge elements and its holders. The aim was to create a kind of catalogue, which shows where the knowledge is reachable. The Knowledge Profile Database is filled in with personal data (name, degree and education data) and the measure of specialization knowledge. The Knowledge Profile Database currently shows the individuals, the measure of their knowledge in areas of expertise and the importance of the knowledge. Knowledge is divided into the above main areas of expertise:

- Control
- Quality management
- The structure of nuclear installations
- Life cycle of nuclear installations
- Operation of nuclear installations
- Technical scientific background information
- Safety analysis
- Radiation protection
- Management of nuclear and radioactive materials
- Safety culture and human and organizational factor
- Control, event reviews
- Nuclear accident prevention

The levels of knowledge and the importance of it displayed in the knowledge profile database can be 1-5. Each employee of the staff can be characterised in all areas by these metric. The metrics have the following content:

1- Basic knowledge in the area;
2- Knowledge easy to learn, replacement of the knowledge holder is easy from the internal resources of the area;
3- Knowledge is systematic, documented in the area;
4- Essential knowledge, some employee have, it needs several years learning, the necessary internal resources limited;

5- Expert-level knowledge, critical, essential, unique, special knowledge.

The Knowledge Profile Database is filled by all employees. After analyzing data the lack of knowledge and the area to improve can be determined. The missing knowledge can be determined by compare of existing and importance of knowledge.

2.2 Knowledge attainment

2.2.1 Internal knowledge attainment-Human Resource

The HAEA should ensure that all of its personnel have the competencies needed to perform their assigned tasks. Recruiting and selecting suitable candidates are the first important steps for ensuring competence and attain knowledge. [1] HAEA is facing human resource and capacity building challenges regarding the new construction plans at Paks NPP site, the extension of the official tasks, generational changing, and retirements. The preparation for new units licensing is one of the most significant task at the HAEA. According to Government Decree 1850/2014. (XII. 30.) the Hungarian Government agreed to increase the number of employees at HAEA in two steps. From the 1st of January 2015 HAEA was entitled to hire 76 new employees, then from the 1 st of July 2015 additional 10 newcomers joined. Original number of experienced staff was 80, now with newly applied employees it is 160 and HAEA hopes to grow its employee base further. This process will cause significant changes in the organization. The job interviews are still continuous and the professional training program is in progress for the selected newcomers. The recruitment procedure has been transformed in recent years, the inclusion is more complex than previous years: screening resumes, written and oral interviews in Hungarian and in English language recruitment instead of only one Hungarian language interview. Most of the newcomers are engineers or physicists, about half of them have some work experience, and also half of them have nuclear education or experience. [2]

2.2.2 External knowledge attainment-Technical support activities

The international agreements on nuclear safety specify requirements for the technical background. The Act on Atomic Energy also orders that the safe use of atomic energy and the solution of the corresponding technical support tasks shall be facilitated by scientific and technical development, coordinated organization of research activities and practical use of the results of international and domestic scientific research. The coordination and financing of technical background activities in relation to safety and security of the peaceful use of atomic energy in Hungary meant to support the regulatory oversight is the task of the HAEA. Various background programs support the regulatory oversight activity regarding the peaceful use of atomic energy. Since 1996 the programs have been being developed in multi-annual task plans. The implementation of the tasks takes place according to annual support contracts according to a negotiation process including a tendering system. In the field of regulatory activities related to nuclear safety it is a requirement to incorporate the Technical Support Organizations (TSOs) in order to support of the regulatory work. During the technical support programs of recent years a network of technical support organizations assisting the regulatory activity of the HAEA has been formed. It provides the necessary independent background for the HAEA with qualified professionals. The independence of expertise support is guaranteed by high level quality management systems introduced at the TSOs. The HAEA organizes regular seminars for its TSOs to feed back their results of the different regulatory technical issues and R&D activities. These seminars offer good opportunity for HAEA to meet the experts of the TSOs face to face and for the TSOs to get direct contact with the experts of the authority. [3]

2.3 Knowledge development - SAT training program

Training programs can be divided into three groups in the HAEA: training for new entries, training, advanced training. In any case, the HAEA training programs follow the principles of the Systematic Approach to Training (SAT).

The following basic principles are kept in mind in the training system of the HAEA:

- The HAEA expects and supports the attainment and the maintenance of the required knowledge;
- The HAEA maintains training system to ensure high-quality official functions;
- To develop training programmes competence requirements and skills of the staff are take into account;
- The development of training programmes the HAEA highlights the followings:
    - follow the scientific developments and professional development results in the areas of official activity;
    - experience feedback in the official activities;
    - the effectiveness of training programmes, skills;
    - application of modern training methods.
- Lifelong learning.

In order to achieve the principles the HAEA:

- Maintains training system based on approved internal processes.
- Takes into account systematic approaches in the training system. The systematic training method of international atomic energy agency (systematic approach to training-sat) was implemented and applied as follows:
    - Analyze the evolution of the institutional knowledge and training needs;
    - Plan the longer and shorter term training objectives and programs;
    - Develop training systems;
    - Implement the agreed training programs, and
    - Assess the training programs carried out.
- Assesses and evaluates the knowledge level of the employees of the staff, to prepare the required individual training needs.
- Ensures the conditions for the implementation of the mandatory public service training programs, training requirements.
- Prepares long term training strategy and medium-term training plan.
- The training system as part of annual training plan, taking into account national and international training programmes, including the regular and mandatory training formats.
- Assesses the implementation of the training programmes and experiences and develops training system based on experiences related to them.
- Take into account the career opportunities of the staff in the development of the training programme.

- Constantly assesses and supports the objectives of the organization, in accordance with their individual learning needs.

The annual training plan of the HAEA is prepared in each January. The HAEA provides a wide variety of training programs for the staff. The annual training plan takes into account the comments and proposals obtained in the self assessment of the HAEA training system. Classroom training, on-line training and practical exercises are distinguished in the plan. Online training is used mainly to refresh how to apply software tools. The advantages of the online training are that it can be performed when the participant can find suitable time for it, and also the mentor can check how the participant has solved the given task. Classroom training is a traditional training form where the audience is in contact with the lecturer. Lecturer can be a staff member of the HAEA or an external expert. The training plan includes various exercises: alerts, methodical, table top and full scope exercises for the Emergency Response Organization of HAEA.

2.4 Knowledge transfer

2.4.1 Mentor program

The goal of the mentor program is to ensure the effectiveness of the new entries, transfer the accumulated professional knowledge and experience to the new generation. A mentor is a person who provides guidance to a less-experienced employee, the mentee. The mentor program is an innovative special form of the internal training system of the HAEA in which the more experienced inspectors transfer their knowledge to the mentees, so it is a very important tool of the Knowledge Management System of the HAEA. The scope of the professional mentor program is determined by the education of new entries, professional background, and the current tasks of the HAEA.

2.4.2 Identification of risk of knowledge loss

The process of identification of risk of knowledge loss is currently in implementing phase. The process is governed in an internal regulation which has been completed, but has not yet entered into force. HAEA has internal regulation to identify persons with critical knowledge and areas where critical knowledge transfer is necessary.

According to the internal regulation at the beginning of each year persons who are expected to be 3 years out of the HAEA are determine and assess those fields where knowledge transfer is necessary.

An action plan will be done to transfer knowledge. The basis of the identification of the critical knowledge is the further developed Knowledge Profile Database described above. The identification of the critical knowledge of the HAEA is based on the method of IAEA Risk Management of Knowledge Loss in Nuclear Industry Organizations [5]. After the identification of the possibility of loss of the knowledge the task recipient employees and personalized knowledge transfer technique may be selected. Knowledge transfer techniques can be: descriptions, professional summary, practical knowledge transfer, mentoring, interviews.

2.5 Knowledge preservation

The goal of maintain the HNKB is to preserve and maintain the common knowledge gained during the years of the utilization of nuclear energy. The HAEA has prepared a national level knowledge management strategy for the further and future nuclear power generation, and for the related regulatory activities. The first phase was the establishment of a knowledge basis related to the regulatory activities, based on a computer aided experience feedback system. The second phase was the establishment of the HNKB with the wide participation of the interested utilities, engineering companies, research institutes, institutions and authorities. In 2012 the Hungarian Government invited the International Regulatory Review Service mission to compare the country's regulatory system and practices with relevant IAEA Safety Standards. The full scope review was executed from 11 to 22 May 2015. The IRRS team identified 6 good practices including: HAEA has developed an effective database for knowledge and experience gained during the use of nuclear energy in Hungary.

2.5.1 Computer aided experience feedback system

In addition to the official task related information knowledge can come from numerous other sources, on a regular basis in the work of the HAEA. For example from reports of international organizations and regulations, experiences of some countries, information on events of foreign nuclear power plants, results of research and development activities, results of HAEA staff activities. In the experience feedback process, the goal is managing all information, experience in a single system. The computer aided experience feedback database facilitates this information retention process. This mechanism was regulated in an internal procedure record categorized information received from different sources.

The process of experience feedback is:

- Monitoring of information sources, collecting experience;
- Assessment of the information, proposal for the recovery of information;
- Evaluation of the proposal;
- Setting of tasks;
- Execution of the tasks;
- Assessment of the results and the utilisation rate;
- Feedback.

2.5.2 Hungarian Nuclear Knowledge Basis (HNKB)

The information sources of the HNKB consist of four groups. *The first group* is the personal experience of the HAEA senior staff, which is to be collected by preparation of personal memories about reactor events, assessment activities, inspection reports, evaluated documents, and the personal annotations and comments. The personal memories will be transformed into common knowledge by systematic organization and structuring the individually gathered information pieces and by introducing it into a computerized database application. *The second group* consists of the international level event reporting systems, such as the Incident Reporting System (IRS, IAEA-NEA), the Incident Reporting System for Research Reactors (IRSRR), International Nuclear and Radiological Event Scale (INES) and the domestic system of event investigations, such as the database of the Hungarian events. *The third group* of information sources includes the policy making documents, standards and recommendations coming from the IAEA, NEA, organizations of EU, or VVER Forum, etc. *The fourth group* is the knowledge gained from the reports of the research and development projects supporting the sustainability of nuclear operations or assisting the regulatory activities. Computerized database applications empower the human intelligence with the data organizing, seeking, searching and visualizing functions. The results of the above listed information and knowledge collecting efforts are promoting the effectiveness of the regulatory activities, and the well grounded decision making. [4]

3. OUTLOOK ON THE FUTURE USE OF THE KMS

The KMS of the HAEA is in its development phase. During the last years, several knowledge management elements have been established and used in the HAEA, but it was recognized that a higher level of maturity for knowledge management is needed because of the dynamic nuclear industry environment. KM is not only the responsibility of an organizations information technology, human resources, or training departments. To be effective, a KMS should be organization-wide. The IT and KM strategies of the HAEA is not aligned. The KMS operated by the HAEA requires advanced computer-based tools. The long term goal can be to develop the KMS further and develop an intranet portal that provides further tool to develop and expand the knowledge management in the HAEA.

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NUCLEAR SAFETY KNOWLEDGE MANAGEMENT

THROUGH PERSPECTIVE OF STRUCTURING REGULATIONS

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Abstract

Conducive conditions that are expected for maintaining and improving the human resources capacity and obtaining the effective results during regulation making process generally rely on expertize and experience of individual/personnel. There will be some considerations to create and use a information system to help for solving the limitation of human ability to memorize, to persuade the stakeholders for more involving to give feedback, in that so the structure of regulation would be more quality and harmonize with the related regulation. More comprehensive and harmonize the regulation on nuclear safety, more effective the nuclear safety knowledge management.

1. INTRODUCTION

One of the innovation areas in nuclear safety knowledge management of laws and regulations is the structuring of legislation by reducing the overlapping and disharmony of regulatory, will be or have been published, and the increasing effectiveness of the management of published legislation by mapping out the issues.

The scope to be carried out includes the following aspects of innovation:

1. regulatory of nuclear power plant (NPP);
2. information system for supporting;
3. community relating regulation of nuclear power plants in Indonesia, regional, and international; and
4. quality of human resources.

Conducive conditions that are expected to include: (1) NPP regulatory activity will be more combination of prescriptive & performance based, in line with the availability of regulation and acceleration of capacity building and quality of human resources; (2) The formulation, preparation, and implementation of regulations have utilized an integrated system based on up-to-date information; (3) Stakeholders are informed on the concept of integrated adaptive regulatory system; (4) Simplification of NPP due to reduced disharmonize; and (5) Feedback mechanisms are established among the nuclear regulatory community because awareness and interest are formed.

The regulatory characteristics in the field of nuclear power are identified as follows:

- Requires special knowledge and expertise in both technical and legal-drafting aspects;
- The nuclear regulatory reference is obtained from international nuclear safety standard documents, both from the International Atomic Energy Agency as well as the best-practice of nuclear industrial countries;
- Specifically for the regulation of the nuclear site's safety aspect, local wisdom (unique Indonesian territory in the ring of fire) provides significant additional contribution to the safety data and parameters set for Indonesian reference; and
- In the process of stipulating regulations in the nuclear field, generally done by adaptive process (adjust the content/substance arranged) with the condition of the state of Indonesia and its national legislation `

Currently, the business process undertaken by the technical working unit of the Directorate for Regulation Development of the Nuclear Installation and Material (NIM) - BAPETEN is still done in a simple and manual method, and rely on the expertise and knowledge of human resources in accommodating the implementation of policy formulation to the process of harmonization and enactment involving the Ministry of Justice and Human Rights, As well as the State Secretary Ministry for higher regulatory hierarchies.

On the other hand, the demands of applicants/license holders in the field of nuclear, public, and related stakeholders on improving the quality of nuclear regulations that need to be facilitated by the Directorate for Regulation Development of the NIM - BAPETEN is higher. Therefore, it is necessary to have improvement strategy and improvement of performance both from the aspect of making of information system and mechanism, working mechanism, human resource quality and also supporting facilities is needed to reduce the risks and/or negative impact in nuclear activities in the future.

This innovation or change project seeks to obtain more effective and efficient mechanisms to support the process of drafting more applicative regulations in promoting efforts to improve the quality of public services and improving the performance of the drafting of legislation in Indonesia.

To be more easily known and remembered, this information system is called E-ARNEST (Electronic-Adaptive Regulation on Nuclear Energy System and Technology.

Furthermore, the implementation of this change project will continue through a system-wide testing and implementation process supported by an adequate internal human resources capacity improvement as well as an overall monitoring and evaluation process. Hopefully the scope of stakeholders will be broader, apart from outside the work unit is also outside BAPETEN.

Expectations to be achieved in the long term is to add, complete, and refine data and information on a continuous basis in the form of input the contents of the laws and regulations in the field of nuclear, exercise (testing), and gradual evaluation until the processing of the latest data and information), As well as maintenance information, so that can be utilized by stakeholders.

The desired condition for long-term stages is that it can be nationally useful in that the product of supervision and quality of human resources is increasing to regional, even international level. In addition the public will be more empowered and awakened motivation and participation to become part of nuclear regulatory community.

Regarding nuclear regulations, the Government of Indonesia has signed the Nuclear Safety Convention and ratified it by Presidential Decree No. 106/2001 on the Ratification of the Convention on Nuclear Safety. As a consequence and implementation of the ratification of the convention, Indonesia as a party to the Convention is obliged to increase the safety level in the field of nuclear power at a high level.

2. DISCUSSION AND CONCLUSION

Based on the writer's observation, there are several strategic issues related to the arrangement of nuclear regulation, which are relatively basic enough, they are:

(a) The public demand and international recommendation as well as other stakeholders to obtain a regulation in the field of installation and nuclear material, comprehensive but simple (easy to understand), and not overlapping, does not appear duplication, especially potentially conflicting with each other;

(b) The complexity of the technical load to be regulated in relation to regulatory objects (nuclear power reactors, research reactors, fuel cycle facilities, nuclear materials and related installations, and international agreements), not all stakeholders can easily digest and explain to other parties/the general public regarding the meaning of the regulated charge. As a consequence, it is possible that the spread of the benefits of this regulation is not immediately felt. Therefore, we need strategy and engineering effort, as well as a sense of art/creativity to increase stakeholders interest to improve their knowledge in nuclear power regulatory field through re-creation service such as simulation, quiz, etc.

(c) The willingness of the BAPETEN to provide excellent service to the stakeholders, especially the general public and students, in the form of interesting and accessible data and information concerning aspects of regulation of NIM, understanding of user friendly technical regulations to fulfill the mandate of the intellectual life of the nation;

(d) Beyond the Directorate for Regulation Development of NIM, there are still other technical units in BAPETEN that have similar tasks and functions but for different regulatory objects. In addition there is a legal work unit but for non-technical ones. Ideally there is a process of harmonization and internalization of all the rules that are prepared, especially with the related definitions, technical content, norms, etc. However with the rapid development of technology and international regulations and standards in the field of safety, nuclear security, and changes in national legislation which in fact is very difficult to collect, synchronize, synergize, and harmonize all legislative products comprehensively, especially against regulations that have not been revoked after publication more than 20 years ago, while there are new regulations that are considered representative but contradictory, it is not possible to directly revise it, and potentially cause legal problems.

(e) The need for increasing product effectiveness and efficiency in the drafting of regulations;

(f) The flow of rotation of staff in the Directorate for Regulation Development of NIM is high enough, one new staff or from another work unit join in each year, so it is necessary to increase the capacity of human resources to adapt quickly in improving the quality and work productivity, especially for technical staff in drafting regulations.

(g) There is still gap between the data and information required as basic data formulation and preparation of regulation on NIM area with the availability of arranged materials that have been prepared;

(h) There is lack of understanding related to the formulation of regulation of field of NIM either for applicant/permit holder, related sector, related ministry/agency, and public.

The above problems can be reduced by attempting to avoid potential duplication, definition differences, repetition of regulated items, considers dis-harmonization, nonconformity, inconsistency, through information systems capable of detecting and informing those potentials, where until now it is carried out manually, and highly dependent on the capabilities, memory, and knowledge of individuals who have shortcomings and limitations,

On the other hand to carry out such performance improvement needs to be supported by the availability of information and technology (IT) systems that supported the completeness of facilities and adequate human resources to produce data and information valid, useful and accountable. Current conditions, initial data and information as a basis for technical analysis of the formulation and preparation of regulations on NIM itself is generally still relatively minimal and needs to be improved quality. Information received often still needs to be deepened.

The process of formulation, review/evaluation of regulation on NIM currently running on technical units, is still conducted manually. The implication is that there are often problems in the process of designing regulations on NIM so that the quality of the arrangement becomes less than optimal.

This indicates the need for data and information support to improve the quality of the system and the process of formulation and regulation of NIM better in the work unit of Directorate of Regulation Development of NIM so that the follow up step that need to be done is the need of easy process of formulation and compilation of regulation on NIM done through application or implementation of online information system automation is integrated with the E-ARNEST portal. The information tracking mechanism or the regulatory evaluation of is still manual, not yet part of an integrated application between the arranged rules. The minimum information required for rapid identification is not yet available on the database, so in general the data and information required to support the formulation and preparation of regulations of NIM in the still require deepening of the return that may be at risk of the slow process of regulation formulation of NIM.

Of course, to improve the performance of regulatory oversight of NIM in Indonesia also needs to be supported by the presence of other supporting devices. For example, with the availability of an question book (FAQ), and information leaflet/brochure on NIM. In addition, there is also the need for support facilities and infrastructure information technology, as well as the quality and quantity of human resources is adequate, so it can be one factor that can accelerate the changes and improvements regulatory performance. In addition, the existence of communication channels through reporting and consultation on "on line". Where, reports or information as well as consultations regarding regulation arrangements can be submitted on line, so that interested parties can be responded immediately by the BAPETEN.

The process for input of initial data of the information system can be enriched with knowledge base, for example, as shown in the table.

KNOWLEDGE BASE

NO	PROBLEM IN CONTENT OF REGULATIONS (EXAMPLES FOR INDONESIA CONDITION)	CATEGORY OF PROBLEM	DECISION MAKING RECOMMENDATION
1.	Definition: Radioactive is an action taken to protect workers, public, and the environment from the hazard of radiation during radioactive material transportation. Transport of radioactive material is the transfer of radioactive material that meet the technical requirements of radiation safety in the transport of radioactive materials and the technical requirements of security in the transport of radioactive material, from one place to another through public traffic networks, by means of land, water or air transport.	Confusion/ unclear/ incomplete	(a) Clarification (b) Redefinition (c) Revision (d) … (other)
2.	Transportation of radioactive source is the transfer of radioactive source from one place to another through public traffic network by means of land, water or air transportation.	Disharmonize	(a) Clarification (b) Redefinition (c) The newest is used (d) Revision (e) … (other)
3.	Clearance level is the value determined by BAPETEN and expressed in concentrations of activity, at or below that value, radioactive unsealed source, radioactive waste, or contaminated or activated materials may be exempt from control Clearance level is the concentration value of the total activity and/or total activity of a single radionuclide or mixture determined by BAPETEN, which when the concentration of total radionuclide activity and/or activity is below that value, the radionuclides can be exempted from control Clearance level is the value established by the regulatory body and is expressed in concentrations of surface activity or contamination, and/or total activity where, if the value is less than or equal to that value, the source of radiation is exempt from supervision.	Disharmonize	(a) Clarification (b) Redefinition in more general (c) The newest is used (d) The sanctions are the lightest when the violation is related (e) Revision (f) The most applicable is used (g) … (other)
4.	The release limit value of the radioactivity to environment, which is planned and controlled, and determined by BAPETEN The discharge limit value of the radioactivity to environment, which is planned and controlled, and determined by BAPETEN	Over definition	(a) Clarification (b) Redefinition (c) Simplification (d) Revision (e) … (other)
5.	Safety of ionizing radiation, hereinafter referred to as radiation safety, is an action taken to protect	Multi-definition	(a) Clarification (b) Redefinition

	workers, public, and the environment from the hazard of radiation.			
	Safety of ionizing radiation in the medical section, hereinafter referred to as radiation safety, is an action taken to protect patients, workers, public, and the environment from radiation hazards		(c) (d)	Dissemination Revision
	Safety of ionizing radiation, hereinafter referred to as radiation safety, is an action taken to protect patients, workers, public, and the environment from the hazard of radiation.		(e)	… (other)
6.	A licensee is a person or legal entity that has received a permit for the utilization of nuclear energy from BAPETEN	Over lex specialis Dubious/ In dubio pro reo	(a)	Clarification
	License Holder is National Nuclear Energy Agency, state owned enterprise, cooperative or business entity in the form of a legal entity having development license, operating permit, decommissioning license of nuclear installation; and /or utilization permits of nuclear material from the BAPETEN		(b) (c) (d)	Redefinition The newest is used The most applicable is used
	License Holder is a legal entity that has a build license, a operating license, a decommissioning license for a nuclear installation; and/or utilization permits of nuclear material from the BAPETEN.		(e) (f)	Revision …… (other)
7.	Radiation Worker is any person who works in nuclear installations or ionizing radiation installations that are estimated to receive annual doses over doses for the general public	Multi-definition	(a) (b)	Clarification Redefinition
	Radiation Worker is everyone who works in nuclear medicine installations that are estimated to receive annual doses of radiation exceeding the dose for the general public		(c) (d) (e)	Dissemination Revision … (other)
8.	Radiation Accident is unplanned events including operating errors, malfunctions, or malfunctions of tools, or other events that have an impact or potential impact that can not be ignored from the aspect of radiation protection and safety	Multi-definition	(a) (b)	Clarification Redefinition
	Radiation Accident is an unplanned event including an operating error, malfunction, or failure of a tool function, or any other event leading to the impact of radiation, radiation exposure and/or contamination conditions that exceed the limits set out in the provisions of laws and regulations		(c) (d) (e)	Dissemination Revision … (other)
9.	Management System is a system used to direct and control an organization to achieve the desired goals	Multi-definition	(a) (b)	Clarification Redefinition
	Management System is a set of interrelated or interacting elements to define policies and objectives, and enables those goals effectively and efficiently, by integrating all organizational elements		(c) (d) (e)	Dissemination Revision ….

	including structures, resources, and processes to achieve all organizational goals.			
10.	Site is a location on land which is used for construction, commissioning, operation and decommissioning, one or more nuclear installations and related systems (Govt. Reg. No. 54/2012)	Definition Limitations (Not accommodate Floating NPP)	(a)	Clarification
			(b)	Extended definition
	Site is a location on land which is used for building, operation and decommissioning of 1 (one) or more Nuclear Installation and other related systems (Govt. Reg. No. 2/2014)		(c)	Revision
			(d)	… (other)

In general, there are no significant obstacles identified, but if the E-ARNEST information system is integrated in the process system flow of nuclear regulation and drafting process, also if there are supporting facilities, then the obstacle that must be anticipated is the need for the human resources/Data that should always be updated regularly and continuously, as well as to 'preserve' the data. In other words, it is necessary to calculate 'man-hour' every year.

The strategy for the problem is to propose a budget allocated for the facilitation of IT facilities and inputs. Because the nature of the activity does not require skill and high educational background, it is planned to use field worker or outsourced or outsourced personnel.

On the other hand, the potential for automation will lead to loss of human resources or hidden unemployment needs, but so far the concern is insignificant, since the simplified system of business processes is focused on optimizing the ability of the system to overcome human limitations, especially memory capacity and the possibility of un-optimal management of knowledge.

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Strategies to Facilitate Knowledge Codification through Integrated Management System (IMS)

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Managing nuclear safety knowledge is challenging due to the uniqueness of the knowledge itself. It requires specific strategies to ensure it becomes an integral part of all nuclear activities. In general, safety knowledge that need to be managed includes both explicit (documented knowledge) and tacit (subjective knowledge) knowledge. Explicit knowledge is in the form of a formal, easily documented, systematic, and easily communicated within organization. While tacit knowledge is knowledge held by an employees in accordance with the understanding, skills (expertise), and their experience. Therefore, tacit knowledge need to be managed differently to ensure it can be properly captured, preserved and transferred to successors. This is the most difficult steps in the implementation of nuclear safety knowledge management. Tacit knowledge need to go through codification process so that it can be systematically documented and accessible in the organization. One of the strategies to facilitate tacit knowledge codification is through the implementation of Integrated Management System (IMS). IMS for safety and security is established in Malaysian Nuclear Agency (Nuclear Malaysia) to ensure nuclear safety and security matters are incorporated in managing nuclear facilities and activities. This paper looks at the role played by the IMS process in contributing to the knowledge codification within the organization.
Keywords: nuclear safety knowledge, tacit knowledge, Integrated Management System (IMS)

1. INTRODUCTION

Nuclear R&D organization like Nuclear Malaysia is facing critical challenge to maintain efficient and effective management of nuclear facilities. TRIGA PUSPATI Reactor known as RTP is the only nuclear research reactor in Malaysia and fully owned by Malaysian Government. RTP has been safely operated and maintained since 1982. The reactor was designed to provide research and training capabilities in the area of science and nuclear technology. It incorporates facilities for advanced neutron and gamma radiation studies as well as for application, including Neutron Activation Analysis (NAA), Delayed Neutron Activation Analysis (DNA), radioisotope production for medical, industrial and agricultural purposes, Neutron Radiography and Small Angle Neutron Scattering (SANS). Highly skilled and knowledgeable employees are required to ensure RTP is operated safely and securely, comply with licensing and legal requirements and deliver efficient and effective performance. It is obvious that Nuclear Malaysia rely mostly on competent employees who are specialist in their fields. Despite of having competent employees, nuclear R&D facilities also dependent on knowledge to develop new technologies and at the same time to enhance the existing technologies.

In K-economy era, knowledge become the most valuable asset to highly technical agency like Nuclear Malaysia [1] [2]. Managing the knowledge possessed by skilled employees is challenging and requires appropriate methods and strategies. This tacit knowledge can be described as “things that we know but cannot tell” [12] and thus can only be transferred through interaction. Tacit knowledge is not easily articulated or formalized and difficult to deliver using words, text, drawings or other symbolic forms. It is considered to be more valuable than explicit knowledge and requires more cognitive effort to be transferred [13]. This paper will discuss on role played by quality sys-tem to facilitate tacit knowledge conversion.

2. INTEGRATED MANAGEMENT SYSTEM

2.1 Integrated Management System for Nuclear Organization

In general, Integrated Management System (IMS) refers to the combination all related system of management practices into one comprehensive management system for easier administration and operations. The related systems such as quality, environmental, safety, security, economy and health [8]. It provide a single framework and form one integral part of organization's management system to address all the goals of the organization. According to IAEA, management system is defined as integration of all elements of the organization into one coherent system in order to achieve objectives of the organization efficiently and effectively. These elements include the structure, resources and processes within the organization [9].

The implementation of the Integrated Management System (IMS) was first introduced in IAEA Safety Standards Series No GS-R-3: The Management System For Facilities And Activities (Safety Requirements) in 2006. It aimed to integrate safety, health, environmental, security, quality and economic elements into a management system that focuses on safety as fundamental principle. These requirements must be met to ensure the protection of people and the environment and they are governed by the objectives, concepts and principles of the IAEA Safety Fundamentals publication. The objective of IMS is to define the requirements for establishing, implementing, assessing and continually improving a management system that integrates safety, health, environmental, security, quality and economic elements. This management system is designed in such a way that safety is not compromised and properly taken into account in all the activities of an organization.

Why IMS is so important to be implemented in nuclear organization? Basically, there are two main reasons. The first reason is nuclear organization has to give high priority to safety and security aspects in their operation compared to other organizations. The smallest error or accident that occurred during its operation may have catastrophic effects [7]. Secondly, the operation of nuclear organization also has to be complied with variety of regulation including legal and reinforcement of international and national acts. Due to these reasons, establishment of effective and efficient integrated management system is required to ensure that nuclear safety and security matters are not dealt separately, standardization in operation, persistent regulatory compliance and continual improvement for overall nuclear facilities operation.

4.4 IMS History in RTP

The history of the IMS implementation in Reaktor TRIGA PUSPATI (RTP) started way back as early as during construction period of RTP. During the period in 1979 - 1982, the manual used for the management system at that particular time was QA Program established by General Atomics (GA) of USA. The manual was corresponding to the IAEA Guideline which focused on safety management. During the early operation period of RTP in 1982 – 2004, first manual quality program was introduced in RTP called Safety Procedure Manual under the purview of Safety, Health and Environment (SHE) Committee and IAEA through its safety missions. This manual includes the safety assurance procedures & mechanisms related to the operation of the reactor. The dynamic of management system in RTP was shifted in 2004 when the Atomic Energy Licensing Board (AELB) had started to take in charge of licensing activity of RTP. The board had conducted regular inspections to RTP in order to ensure the compliances of licensing requirements. Under the new requirements set by the AELB, a new QA program was developed in RTP in accordance with the general requirements of the IAEA Safety of Research Reactor, Safety Series

No. NS-R-4 (2005). The QA Program manual was developed and fully implemented in RTP before it was capped for a new safety series by IAEA in 2008. Post 2008 to 2012, a new QAP Manual was established based on two main documents of international guidelines and local regulations. The manual describes the guidelines from the IAEA Safety Series No. SS-50-C/SGQ – Quality Assurance for Safety in Nuclear Power Plants and Other Nuclear Installations and the specific requirement by the relevant act, regulation and standards followed such as Act 304, OHSAS 18001 and ISO 9001:2000. It also includes the design, construction and acceptance criteria for various activities involved in the RTP operation.

The Integrated Management System (IMS) for RTP was introduced in 2012, mostly focused on hu-man capital development. It was fully established for implementation in 2014 based on IAEA Safe-ty Standard GS-R-3– The management system for facilities and activities. It was approved by SHE Committee in 2013 and among other activities were IAEA Expert mission, representative from LE-NA, Italy, fellowship through IAEA TC program, pre-Internal audit at RTP based on IMS manual, introduction of IMS to RTP members and preparation IMS program for RTP new control system called ReDICS.

The establishment of IMS programme for RTP is to ensure that all operation is adequately planned, correctly performed, can be assessed continually and improved accordingly. The program provides a systematic and integrated quality system approach in safety, health, and environment, security, financial and quality for accomplishing work with the ultimate goal of a safe, efficient and effec-tive manner of the operation of RTP. IMS was developed in accordance to the recommendations in IAEA Safety Standards Series No.GS-R-3 (2006) and subsequently modified based on the new requirement adopted in General Safety Requirements No. GSR Part 2 (2016). It provides the main framework for the arrangements and processes necessary to address the mission, vision and goals of the organization and is considered in a coherent manner. It is developed in accordance with the following criteria:

i. Identification of processes and their application
ii. Definition of the sequence and interactions between processes

iii. Establish criteria and methods needed to ensure the effective operation and effective process control

iv. Provision of resources and information needed to support the operation and process monitoring

v. Monitoring, measurement and analysis of the processes themselves

vi. Implementation of actions necessary to achieve planned results and continuous improvement

The IMS provides outline of the policies, standards and procedures which have been developed and will be adopted and it comply with the safety guidelines established by IAEA, Malaysian laws and related applicable Malaysian regulations as illustrated in Figure 1.

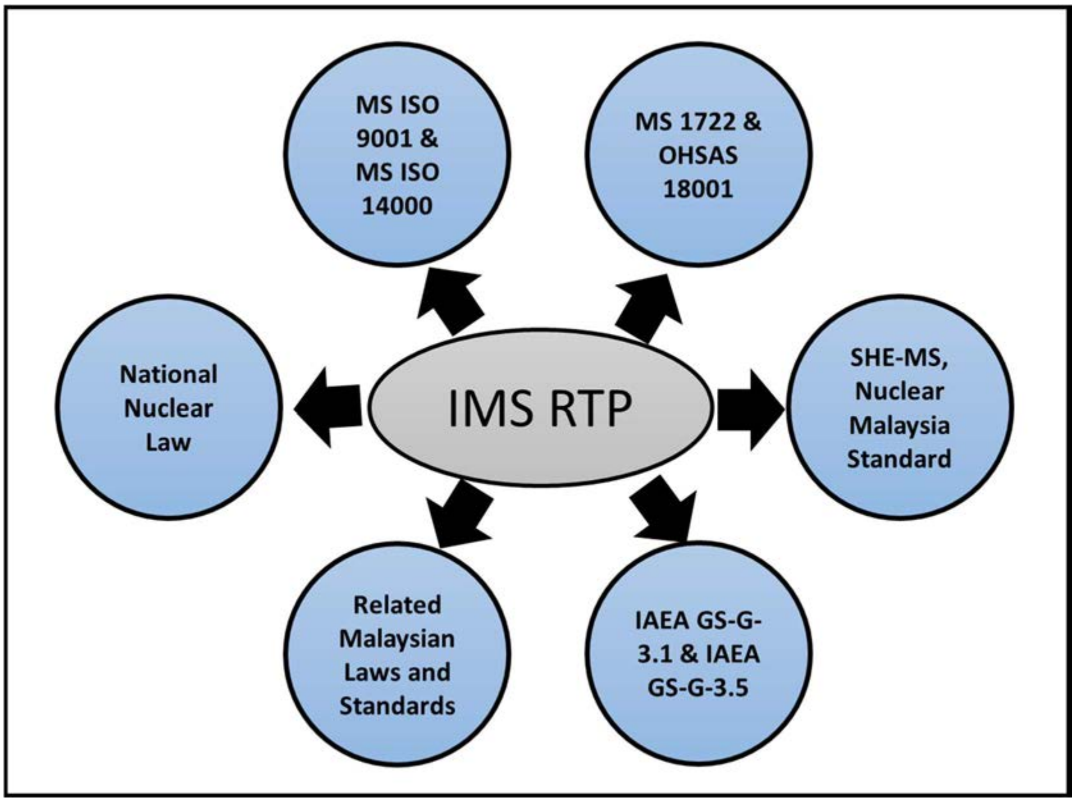

Figure 1: IMS of TRIGA Reactor [10]

One of the key elements that needs to be managed throughout IMS implementation is to manage the accumulated information from integrated system management activities. RTP developed IMS documentation system which consists set of documents that describe the overall measures established by RTP to achieve management goals and objectives. Therefore, RTP is able to organize information effectively and efficiently and at the same time manage to avoid repetition of information. The details of each document are cross-references between certain documents at the different level. A typical level of document structure at RTP is shown in figure 2.

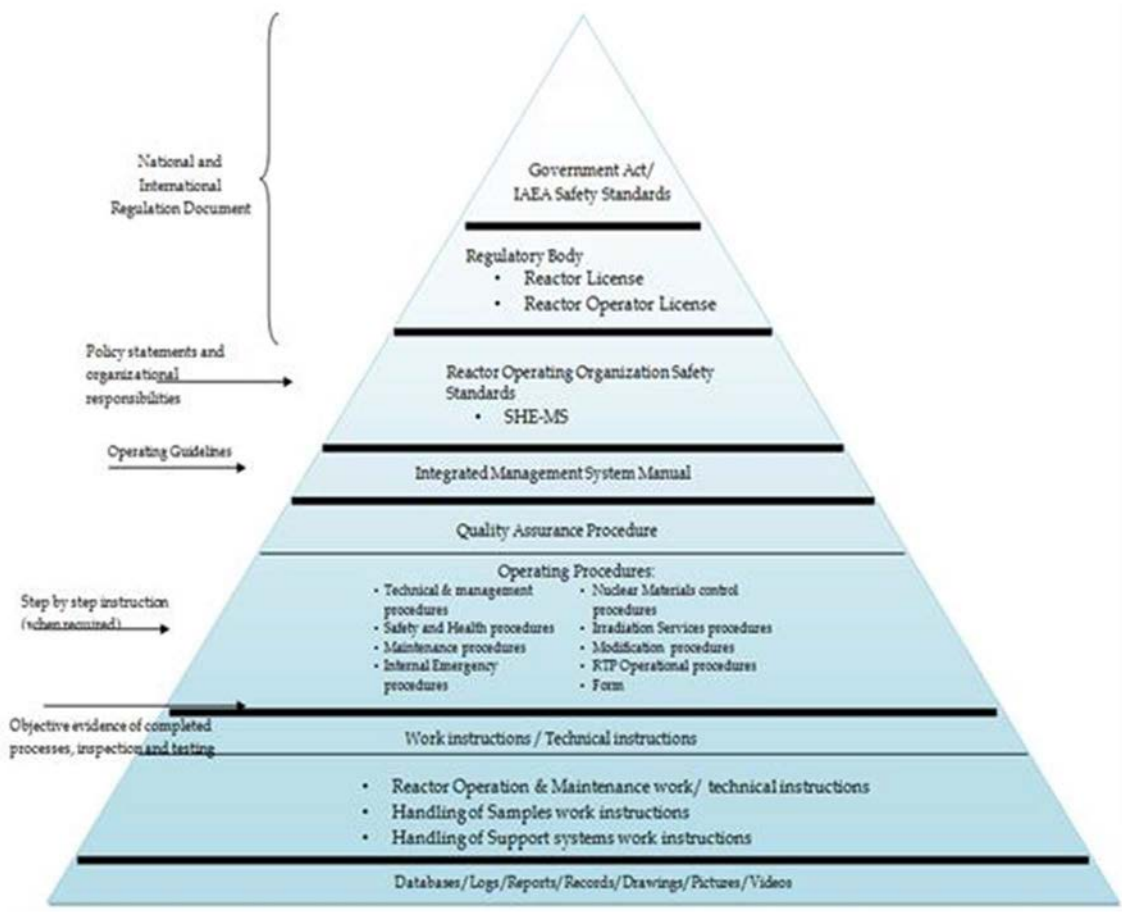

Figure 2: Structure of Quality Assurances document at RTP

5 KNOWLEDGE CODIFICATION PROCESS THROUGH IMS IMPLEMENTATION

There are many definitions of knowledge management given by scholars. In nuclear safety knowledge context, knowledge management is enabler to improve effectiveness and efficiency of nuclear facilities, activities and materials, to ultimately enhance nuclear safety. It also aimed to promote smooth flow of knowledge from where it resides, to where it is required and sharing of knowledge relevant to organization. There are two forms of knowledge namely explicit knowledge and tacit knowledge [11]. Explicit knowledge is in the form of a formal, easily documented, systematic, and easily communicated within organization. While tacit knowledge is knowledge held by an employees in accordance with the understanding, skills (expertise), and their experience. Based on literatures, tacit knowledge has to be codified into a common representation so that it can be systematically documented and accessible in the organization. Before the codification process is implemented, the organization has to consider following principles:

i. What organizational goals will codified knowledge serve?

ii. What knowledge exists in the organization that addresses these goals?

iii. How useful is existing knowledge for codification?

iv. What is the appropriate medium for codification and distribution?

Based on Nonaka & Takeuchi 1996 [11] Knowledge Transformation Model (Figure 3), there are four mode of knowledge conversion, which can provide us with the direction of knowledge codification process.

	Tacit	Explicit
Tacit	Socialization	Externalization
Explicit	Internalization	Combination

Figure 3: Four Modes of Knowledge Conversion

TABLE 1: DESCRIPTION OF KNOWLEDGE CONVERSION

Mode	Description
Tacit to Tacit	Socialization: Creating tacit knowledge through shared direct experience.
Tacit to Explicit	Externalization: Articulating tacit knowledge through dialog and reflection
Explicit to Tacit	Internalization: Learning and acquiring new tacit knowledge by practice and simulation
Explicit to Explicit	Combination: Systematizing (collecting, reviewing, editing, connecting) explicit knowledge and information

In RTP situation, IMS implementation process is aligned with knowledge codification principles. RTP goal for IMS implementation is in line with knowledge codification requirement. RTP also has identified process, procedures, and work instruction that need to be documented to fulfil IMS requirement and RTP final goals. By using appropriate knowledge transformation mode, tacit knowledge that embedded in employee can be codified and more knowledge sharing can be captured. The IMS documentation platform can serve as knowledge repository so that knowledge can be shared and utilised within organization. The IMS implementation relate to codification process in two ways. Firstly, IMS are used as a codification tool to formalise the codified knowledge within the RTP. This is done by applying combination of knowledge transform. IMS act as enabler to codify tacit knowledge embedded in employees (externalization) and at the same time facilitate knowledge sharing through discussion about the process functioning (socialization). Secondly, the output of IMS implementation (IMS documentation) is ready to be accessed and utilized within the RTP. This will contribute to organizational learning (socialization).

4. CONCLUSION

Over the last decade, the quality system or integrated management system implementation have increased their impact on organization by increasing organization performance and contribute to continual improvement. As IMS implementation include documentation requirement, these standard also contribute to knowledge accumulation within the organization. They promote knowledge codification and formalization. The integrated management system provides guideline to establish efficient standardization and to provide learning effect in the organization.

The completion of the codification depends on several factors. One of the factor is the nature of the organization. The characteristic of nuclear facilities process and activities affect the nature of the knowledge to codify. The complexity of the codification based on the way the organization interpret and adopt the IMS requirement. The completion of codification also depends on active interpretation of the requirement within the organization. All systems involved need to have the same interpretation so that the information and knowledge required to achieve IMS goals can be mapped properly. Commitment and cooperation from other systems also give impact in identifying critical knowledge that needs to be codified to address IMS goals and at the same time to fulfil knowledge codification principle.

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THE EXISTING SITUATION OF THE KMS AT THE CNSNS

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Abstract

CNSNS (National Commission for Nuclear Safety and Safeguards), the Mexican Regulatory Authority has identified as one of its general strategic objectives to develop and strengthen a sustainable level of competence by the improvement of personal resources and knowledge management. CNSNS considers its staff as its most important asset, so that the development of competence is an investment for the future. This objective cannot be fully achievable without the implementation of an integrated Knowledge Management System (KMS). Accordingly, in 2012-2014, a collaboration agreement between the European Commission and the CNSNS allowed to develop the Strategy and Action Plan for the implementation of the Knowledge Management System (KMS). The Secretariat of Public Function (National Comptroller), in Mexico, has also issued the *Guide to promote innovation processes, the transfer of knowledge and best practices in the Federal Public Administration* to identify, to preserve and transfer the institutional knowledge to contribute to the achievement of the institutional goals and to fulfil the strategic objectives of the federal government. In a similar way, other measures coming out from internal initiatives, like the implementation of the Quality Management System, certified in ISO 9001, or from external directions, like the new Federal Law of Transparency, have become to strengthen the documental base of the institutional knowledge. Thought, one thing is having visualized an organizational model and action plan to implement a new programme, like the KMS, and another thing is to embrace the change, to overcome the resistances and to start walking. The purpose of this paper is to give an overview of the existing situation of KM in the CNSNS and how the regulatory framework for the Federal Public Administration contributes in the configuration of a KMS.

1. INTRODUCTION

In the past, traditional knowledge identification, capturing, storage and transferring, have been practiced in the National Commission for Nuclear Safety and Safeguards (CNSNS): The more experienced people in the working groups have been in charge of the on-the-job training for the newcomers. This process has been complemented with dedicated training sessions, some of them lectured by our own staff, where the trainees use training manuals containing explicit knowledge. And operational procedures and guides try to preserve part of the knowledge necessary to fulfil the objectives of the CNSNS. However, the concept *knowledge management* is still too abstract, difficult to understand and carry on.

In 2012-2014 CNSNS integrated a small team from different areas to collaborate with European Commission experts in the development of a Strategy and Action Plan for the implementation of the Knowledge Management System. These two documents are an excellent beginning in the development of a Knowledge Management Programme.

2. The CNSNS Knowledge Management Strategy

The goal of the KM strategy is the implementation of the Knowledge Management System (KMS). In doing this, next three elements must be considered: the knowledge management culture, consisting of the attitude and behaviour of the personnel of CNSNS; the knowledge management organization, including processes, procedures, practices and tools; and the information technologies system for KM. One KM strategic objective is oriented to the development of every element.

The KM strategy describes the CNSNS in terms of areas, staff distribution, functions and general tasks. Afterwards, describes the status of the KM in the CNSNS, where six priority areas are identified as urgent in the development of the KM programme:

a) Stablish appropriate KM policies and strategies
b) Implement knowledge capture / transfer methods and techniques
c) Improve Human Resource Management
d) Implement methods for effective learning from regulatory experience
e) Implement work control methods to facilitate KM
f) Implement IT solutions supporting management

Finally, the KM strategy provides an initial list of needed actions in order to achieve the strategic objectives associated to the three KM elements.

3. The CNSNS Action Plan for the Implementation of the Knowledge Management System

The KM strategy is complemented by an action plan, which consists of next three general phases:

A. Preparatory phase. Includes the appointment of the responsible KM team
B. Development and enhancement of KM culture. Includes training, the development of a communication strategy and the performance of the KM risk assessment. Due dates are appointed to fulfil every task.
C. Design and development of IT systems for KM. The preparation, design, development and upgrading phases of IT systems are described and associated to a proposed calendar.

4. The Knowledge Management in the Federal Public Administration (FPA)

After having issued the Federal Law on Budget and Treasury Responsibility [1], the FPA developed the Program for a Close and Modern Government 2013-2018 (PCMG) [2], aimed to enhance the efficiency and effectiveness of the public administration; all of this in the frame of the National Development Plan 2013-2018 [3]. The PCMG included an action line to “promote the innovation processes, the knowledge transfer and the best practices among institutions, to increase government efficiency and effectiveness” and a Guide was developed and issued to ease the institutions achieving the goals of the PCMG.

4.1 Maturity model for the innovation and knowledge transfer in the Federal Public Administration

Among other contributions, the Guide to promote the innovation, the knowledge transfer, and best practices, in the entities of the Federal Public Administration (Guide) [4] presents a maturity model to promote the innovation and knowledge transfer in the FPA.

Maturity model on innovation and knowledge transfer

Maturity Stage	Description
1. Innovation and knowledge transfer are not for public institutions.	Innovation in the FPA is considered as being a fantasy, and any resource dedicated in this direction is considered thrown away. Innovation is associated with private companies and businesses. Traditional public institutions use data and information in making decisions, but do not create knowledge.
2. Innovation and knowledge transfer might exceptionally occur in public institutions.	Some public institution identify the value of innovation and knowledge transfer and develop specific projects to help in the solution of a specific problem or to take advantage of an opportunity.
3. Innovation and knowledge transfer are present in public institutions and there is an associated investment in resources.	Some institutions identify innovation and knowledge transfer as competitive advantages; in consequence, they allocate budget and human resources to ensure the planned results.
4. Innovation and knowledge management are present in the everyday life of public institutions.	Public institutions develop innovation and knowledge transfer activities on a regular basis. They see these activities as central to achieving their goals in efficiency and effectiveness.
5. Innovation and knowledge management are present in institutions in a collaborative way.	Public institutions enhance their innovation and knowledge transfer processes based on the interaction among their internal structures and their interaction with other public institutions.
6. Innovation is embedded in the public organizational culture.	All public institutions add value to their operation through the innovation and the transfer of knowledge and continuously receive feedback from society.
7. An innovation-country ecosystem.	All the stakeholders (government, private sector, academy, civil organizations, etc.) collaborate in the promotion of innovation and knowledge management as sources of prosperity and economic growth.

4.2 Obstacles to innovation and knowledge transfer

Innovation is not in the nature of traditional public institutions, dedicated to guarantee citizen rights and demonstrate reliability and predictability in their actions. The performance of public servants is stablished in the laws and any act away from them must be punished.

Therefore, innovation in the FPA institutions faces, among others:

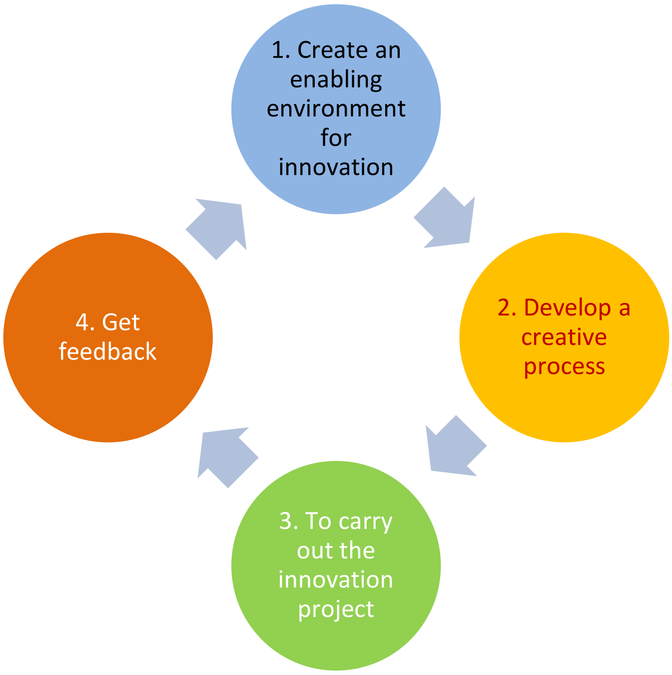
1. The bureaucracy is subject to too many rules that prevent innovation
2. There is a culture of risk aversion and resistance to change
3. Most of senior managers lack time to devote to the activities of innovation
4. There are no budgets tagged for innovation activities
5. There is a poor culture for the acquisition and use of new technologies
6. There are not incentives to innovate
7. Public servants lack sufficient skills and competencies to manage innovation
8. A poor communication between departments, agencies and professions, makes it difficult to support innovations among different areas
9. Lack of mechanisms and structures to improve organizational learning and lack of culture of innovation

On the other hand, the knowledge transfer is affected by next barriers:

1. Organizations do not identify what they do well or do not give it enough value, so do not consider that it can be useful for some other internal area or for an external organization
2. Individuals or areas feel "owner" of knowledge and choose not to share it or "partially share it" in order not to lose control or recognition
3. There is no custom or there is no a specific procedure for documenting specific knowledge or best practice
4. There is fear of criticism and resistance to feedback for improvement
5. There is an excess of selfishness to realize the transfer of knowledge and lack of humility to receive it
6. Lack of recognition and dissemination of what is done well, and that is susceptible of transfer

Some of the barriers to innovation and knowledge transfer come out from the structure and rules in the institutions of the FPA in the origin of the problem, but what really prevents the public institutions from innovation is the institutional culture. An environment survey could show details of the institutional culture.

4.3 The innovation cycle



The Innovation Cycle

The Guide of the FPA is mostly oriented to the innovation process, and sometimes includes the 'knowledge transfer' or 'knowledge management' without distinguish or define any of them. However, the analysis for the innovation process (knowledge creation) is valid for the knowledge manknowled

In previous section, several barriers for innovation and knowledge transfer have been identified. It is evident that some improvements are needed in the structure and rules of FPA, but culture is revealed also as an important factor to change, and this is the first step in the innovation cycle.

Step 1. Create an enabling environment for innovation.

Indicates the proposed activities to develop minimum conditions for the innovation and knowledge transfer:

a) Ensure the commitment of the high management
b) Carry on a diagnostic of the status on innovation and knowledge transfer
c) Identification of internal allies. Virtual Internal Network for Innovation (VINI)
d) Identification of external allies

Step 2. Develop a creative process.

Indicate the minimum activities proposed to facilitate creative thinking and the generation of ideas:

a) Innovation routines creation
b) Process optimization

c) Initial preparation
d) Challenges identification
e) Challenges selection
f) Ideas generation
g) Ideas selection
h) Solution design

Step 3. To carry on innovation projects

Activities to present the projects and get the authorization of the decision-makers to implement the innovation and knowledge transfer process:

a) Submit project proposals to strategic committees or decision-makers
b) Carry on the institutional project for innovation and knowledge transfer
c) Follow up of the project

Step 4. Get feedback

The results of the institutional project must be documented and disseminated. And finally, innovation efforts must be rewarded to reinforce the organizational culture of knowledge:

a) Document knowledge in lessons learned or best practices
b) Dissemination of innovation efforts
c) Identification of external knowledge and trends
d) Reward innovation and knowledge transfer

5. Conclusions

The IAEA TECDOC, in preparation, on knowledge management for safety regulators [5], provides a quick guide for the implementation of a KMS. According to this guide, the CNSNS has covered the first two steps: the strategy development and programme planning. Step 3, Implementing activities, and Step 4, Reviewing activities, are still waiting are still waiting for the reintegration of the KM organization.

In this process of integration, the Knowledge Management System will have to be coordinated also with the CNSNS Quality Management System (QMS), already set up, in an Integrated Management System. A successful implementation of the KMS, integrated with the QMS and the training plan will help in improving both, the effectiveness and efficiency of the regulatory process, to fulfil the goals of the Secretariat of Public Function, and the own objectives of the CNSNS.

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MANAGING NUCLEAR SAFETY KNOWLEDGE IN SMALL, NON-NUCLEAR COUNTRIES: CHALLENGES AND PITFALLS – *EXPERIENCE OF MONTENEGRO*

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Abstract

Addressing safe utilization of radiation sources in small countries is quite a specific issue in many ways – given modest (but only seemingly not demanding!) scope of activities/facilities, from one side, and limited resources/capabilities of the state, from the other. Starting from the premise that safety must be paramount, thus not compromised by any means at any moment, country's limited resources (institutional, human, financial, technical) should be used in the most meaningful (focused, efficient and effective) way towards achieving that aim. This is a reasonable and responsible attitude towards both the well-being of country's own citizens and to complying with international norms and obligations in the field. Two categories/principles emerge crucial in this respect: commensurateness and competence. Montenegro is a small, developing and "non-nuclear" country, the use of radiation sources being modest and limited to ordinary medical and industrial applications. Even though, there is (or will be in the foreseeable future) a considerable need for nuclear knowledge in many fields, safety-related one way or another. The multi-facet role of a state university in providing the required nuclear knowledge, competence, expertise and technical services is discussed in light of the above. Education, training and scientific/technical excellence are emphasized. The support of IAEA and European Union in generating adequate capabilities and creating a sustainable system in the country (through networking, e-learning, equipment and expertise provision, project frameworks, HRD schemes, etc.) is essential. While education basically stands for knowledge, training contributes to its practical applicability – both being fundamental constituents of competence. Importantly, training cannot replace education – attempting so, one falls into a typical competence pitfall. Training is thus meaningful only when superposed onto an adequate education. Messing up these terms will lead to a false perception of knowledge and competence (quasi-knowledge and quasi-competence); eventually, safety will inevitably be compromised. Some particular experience of Montenegro is outlined, concerning the establishment, goals and *modus operandi* of the University Centre for Nuclear Competence and Knowledge Management (UCNC).

1. INTRODUCTION

Nuclear safety knowledge and based-on-it nuclear safety competence represent a broad range of both theoretical and practical achievements of research and experience accumulated in more than hundred years of extensive developments in nuclear field. It goes from fundamental physical laws of the universe to widespread medical applications for diagnostic and therapy purposes, from nuclear power plants or nuclear weapons to common analytical techniques, from huge internationally operated accelerators to plain household smoke detectors…

However, the need for nuclear knowledge (safety-related in particular) in a society/country may vary substantially, depending primarily on two factors: its level of general development and whether the society/country utilizes (or intends to utilize) nuclear energy for power production or not.

Finding itself in a triangle between

- narrow scope of radiation activities/facilities (seemingly/deceptively not demanding);
- limited resources available in the country and
- domestic responsibility and international norms/obligations in the domain of nuclear/radiation safety,

a small country will likely recognize two principles to be followed in order to meet its goals in a realistic (focused, effective and efficient) way: *commensurateness* and *competence*. Being competent and finding the right measure ("not less, not more") is thus imperative for all: users and facilities, regulators and legislators, technical support organizations and educational institutions, and others.

2. SITUATION IN MONTENEGRO

Montenegro is a small, developing and "non-nuclear" country (population 625.000, no nuclear installations or fuel cycle elements whatsoever). The use of radiation sources is modest and limited to a few ordinary applications – primarily in health care and sporadically in some other fields.

Even though and strange enough, there is (or will be in the near and mid-term future) a significant need in nuclear knowledge, competence and expertize – directly or indirectly related to proper (safe and effective) utilization of radiation sources. It goes about the following, the list being far from exhaustive [1,2]:

- medical applications (diagnostics, radiotherapy, palliation, sterilization of equipment, consumables, blood products, etc.);
- radiation protection, incl. various dosimetry services and QC/QA of radiation sources;
- environmental protection (radioecology, analytical and monitoring services, etc.);
- low and medium activity radioactive waste management;
- industrial, geological, hydrological, agricultural, biochemical and archaeological applications (non-destructive testing, various gauges, radioisotope labelling, harmful insects sterilization, etc.);
- scientific research, higher education and training;

- legislative and regulatory aspects, including both the development of domestic legal/regulatory infrastructure for the safe and secure utilization of radiation sources and complying to international safety norms and joining international conventions in he field;
- preparedness and response to radiological and nuclear emergency situations;
- combating nuclear terrorism and illicit trafficking of nuclear and other radioactive materials;
- nuclear forensics;
- security systems based on X-rays and other nuclear methods;
- introduction of some future topics (e.g. nuclear power for electricity generation and sea water desalination);
- public information and communication with media, etc.

Given that, it should be taken into account that Montenegro, even a non-nuclear country, used to be part of ex-Yugoslavia, which was a pretty advanced nuclear country. There is hence a certain germ/tradition in nuclear knowledge – especially in the system of higher education – which permeates favourably the local professional nuclear/radiation society.

Finally, one should note the above list is pertinent/applicable to many countries with similar nuclear/radiation profile. As a matter of fact, these countries make the vast majority (by number, at least) and the world and the IAEA system.

It goes without saying that the topics listed are relevant for all countries, thus nuclear ones as well. However, it is understandable that the approach to, and the treatment of nuclear safety knowledge are basically different in nuclear and non-nuclear countries – hence the point of the present paper.

3. KNOWLEDGE AND COMPETENCE – FUNDAMENTAL PREREQUISITES FOR THE PURPOSEFUL AND SAFE UTILIZATION OF RADIATION SOURCES

Successful implementation of international norms on the utilization of radiation sources – largely and in much detail addressing safety issues – requires a number of prerequisites at the State level. This primarily means the provision of adequate resources: legal, institutional, material (financial, technical, logistical) and, of course, human. Among the latter, it is often taken for granted that necessary knowledge and competence do exist *per se*. However, this is not always the case, just the contrary – time, efforts and material resources (both from the country itself and from international cooperation) are frequently wasted because these fundaments are not built solid at first.

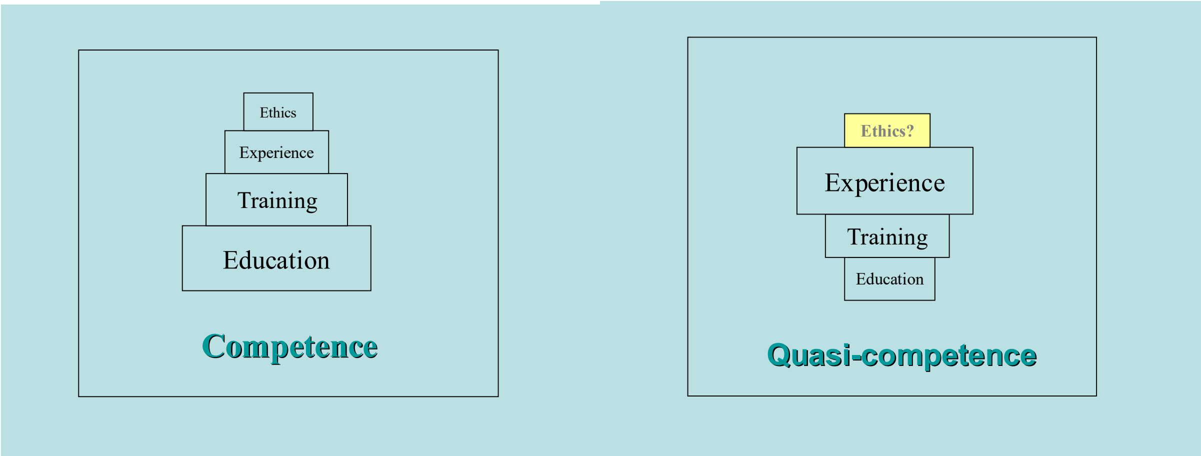

Figure 1. Education as the fundament of competence and competence vs. quasi-competence

Provision of adequate knowledge, competence and expertize represents consequently a major concern in small countries – if inadequate (e.g. like in Fig. 1, right), safety will eventually be jeopardized. The above are thus the fundamental prerequisites not only for the meaningful and purposeful utilization of radiation sources, but also for their safe and secure employment at all

Universities, state ones in particular, are the logical and regular points of creation, dissemination and preservation of nuclear (including safety) knowledge, competence and expertize in small countries. Let us mention hereby the fundamental difference between state and private universities: the former are meant for meeting the country needs in various aspects of fundamental and applied knowledge, while the latter are meant for profit.

Furthermore, while education basically stands for knowledge, training contributes to its practical applicability – both being fundamental constituents of competence. Importantly, training cannot replace education – attempting so, one falls into a typical competence pitfall. Training is thus meaningful only when superposed onto an adequate education. The same holds for experience. All of them (education, training, experience) are necessary constituents of competence, but messing them up will lead to a false perception of knowledge and competence (quasi-knowledge and quasi-competence); eventually, safety inevitably will be compromised (Fig. 1).

A similar dangerous pitfall is the misperception (unfortunately, not so uncommon in small non-nuclear countries) that competence stems from the position the person holds. It should be *vice versa*, of course.

Quasi-knowledge and quasi-competence are more perilous for nuclear safety than plain ignorance and incompetence (i.e. clear lack of knowledge and competence), as the latter are more explicit and easier to recognize/prevent/rectify.

It is important to note that quasi-knowledge and quasi-competence can be traced behind most of nuclear mishaps – from minor/benign incidents (like just poor, clumsy communication with public/media), to major accidents with grave consequences.

Figure 2. University of Montenegro campus (left); IAEA NKM Mission in 2009 (right)

In this context, the importance of formal education at universities is crucial and should be particularly pointed out. In its complexity, it includes the ensemble of i.a. educational programmes accreditation and regulatory overview, teaching staff qualification and permanent development, selection and enrolment of students, international inter-university cooperation with student exchange/ mobility schemes, etc.

4. UNIVERSITY OF MONTENEGRO

University of Montenegro (UM) is the only state university in the country (Fig. 2) and the only one providing higher education, scientific research and expertise in natural and technical sciences, including nuclear/radiation-related ones – it is the statutory duty of UM to do so, and to do it in a manner commensurate to the country needs [3]. By far the most relevant expertise in the country is either concentrated at UM or is deriving out of it. Therefore, it goes without saying that UM has fundamental role in meeting nuclear knowledge management (NKM) goals in Montenegro, including the safe and purposeful utilization sources [4].

5. IAEA AND EU ASSISTANCE

Small issues in big countries are often big issues in small countries. IAEA offers the unique and equal opportunity for all Member States (MS) to come up with their problems and seek for cooperation/assistance in order to cope with them; given the impetus/interest from MS, there are numerous modalities IAEA offers in pursuing these goals.

Montenegro became an independent country and IAEA member state in 2006. It has since successfully participated in various IAEA activities, including several cycles of technical cooperation (TC) projects. In the beginning the focus was on developing regulatory infrastructure (legal and institutional) and upgrading capabilities in medical application of radiation sources (diagnostics and therapy). Given the country is an "ecological state" – as defined by the first article of its constitution – emphasis was put on environmental protection as well (radioecology and application of nuclear techniques in environmental monitoring). Safety and security were addressed through participation in dedicated activities organized by the IAEA – e.g. projects on drafting national radiation regulations on radiation safety, or combating illicit trafficking of nuclear and other radioactive materials (whereby border police capabilities were upgraded towards meeting international norms).

Being in the negotiations/accession process with the European Union (EU), Montenegro is also in position to benefit from various mechanisms existing in the EU to strengthen capacities in non-power applications of nuclear energy, including safety of radiation sources. In this sense, our positive experience with IAEA cooperation was affirmatively reflected/ accepted during negotiations on Chapter 25 – Science (the chapter being much about cooperation with EURATOM). This chapter which was the first chapter to be opened in the negotiations and was successfully closed (preliminarily, awaiting finalization of negotiations/ accession).

It is the policy of the country (institution in charge is Ministry of Science) to approach cooperation with the two (IAEA and EU) in the way that the activities complement and resonance with each other, rather than overlap or excess – fortunately/helpfully, it is already in the mechanisms of IAEA and EU for the most part. This is reflected *inter alia* in the latest Country Program Framework (CPF), specifying priorities in technical cooperation for the period 2014-2020, with human resource development (HRD) among the first priorities [5]. Note that the CPF period coincides with the supposedly final stage of Montenegro accession to the EU.

6. NETWORKING

Networking is becoming increasingly important for managing (building, preserving, sustaining, disseminating) a national body of knowledge, competence and expertise (NKM). This is particularly valid for those countries whose domestic resources are limited and/or where no critical mass of the above three constituents exists, which could sustain the system on its own. For instance, IAEA-based international networks for nuclear security education (INSEN) [6] and training/support (NSSC) [7], even relatively recent, proved pivotal/fundamental in this respect. There are also very useful dedicated networking schemes hosted by the European Union.

Networking is highly permeable and successful within university communities. It is easy to join/participate for all interested in a topic, regardless of academic titles, positions, etc.

At UM (Department of Physics) we have launched several targeted educational courses at post-graduate level, following the IAEA-INSEN guidelines [8]; the pioneering educational materials developed within the network represent the basic literature for both students' and lecturers' use [9]. We also participate in nuclear knowledge management (NKM) activities and use their information system (INIS) when sourcing relevant data. UM is also national contact point for INES (International Nuclear and Radiological Event Scale) and has trained staff for properly reporting in case of incident/accident. UM participates in IAEA-supported Nuclear Instrumentation Laboratory Network (NILNET).

Selected laboratory services are offered as well, primarily for educational/training purposes, but also for routine measurements, monitoring of radioactivity and radiation parameters in the living, working or outdoor environment. Laboratory for nuclear spectrometry has classic NaI and HPGe detector systems, very high sensitivity anti-coincident spectrometer, etc., while environmental laboratory offers atomic absorption spectrometer, medical QC/QA control devices, radon equipment, etc. [10]. These are all at students' permanent disposal for educational purposes at various levels (B.Sc., M.Sc., Ph.D.) and within various educational programmes (radiation protection, safety and security of radiation sources, radioecology and environmental protection, etc.).

7. CONCLUSION: WAY FORWARD

In concluding, let it be emphasized that Montenegro is determined to continue with its efforts in improving nuclear safety knowledge and the way it is managed. In particular, the pivotal institution, State University of Montenegro, through its Centre for Nuclear Competence and Knowledge Management (UCNC), is on the way towards [11]:

- becoming national centre of competence and expertise in nuclear/radiation related issues;
- assessing, creating, preserving and transferring nuclear knowledge (NK), commensurate to Montenegro needs (nuclear knowledge management – NKM);
- offering consultancies and technical support services to all relevant stakeholders;
- being advisory body to the government for nuclear/radiation related issues and
- focal point for dissemination and exchange of NK, in particular with IAEA and EU;
- promoting nuclear/radiation applications for peaceful purposes, in particular medicine and environmental protection;
- being national radiation protection centre;
- developing curricula for nuclear/radiation related studies at all levels;
- supporting young students and scientists in nuclear/radiation related field and facilitate their exchange with reputed institutions abroad and
- giving proper and timely information and comments to the public and media on relevant topics/subjects.

An IAEA NKM expert mission to UCNC in 2009, including representatives from NKM centres in the region, affirmatively reviewed the above goals and encouraged both IAEA and Government of Montenegro to continue supporting its realization [1]. Ever since, UCNC stays on the above course. Our new visions – following Montenegro EU accession process – extend to EU perspectives, Horizon 2020 Framework Programme in particular [12].

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CONTRIBUTION OF THE TRAINING CENTRE- REGIONAL DESIGNATED CENTRE ON EDUCATION AND TRAINING (RDC) ON RADIATION PROTECTION OF NATIONAL CENTRE FOR NUCLEAR ENERGY, SCIENCE AND TECHNOLOGY, CNESTEN ON BUILDING COMPETENCIES IN RADIOLOGICAL SAFETY AT NATIONAL AND REGIONAL LEVEL

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Under its law of creation, Law No. 17-83, the National Centre for Nuclear Energy, Science and Technology (CNESTEN) "contributes to education and training of specialists needed for national nuclear power program, and other areas using nuclear techniques." During the thirty years of its existence, the CNESTEN Build competencies of its humans resources. Now it has a pool of about one hundred and half experts in several peaceful utilisations of Nuclear Techniques on socio economic areas (Health, Energy, Environment, Industry, Agriculture, Water, Management of the radioactive waste, Radiation protection, the Nuclear Safety and Nuclear Security, etc.). Thanks to the importance of the education and training in building and strengthening competencies to ensure a safe use of ionizing radiation in peaceful application and according to the national and regional needs, CNESTEN makes a strategy on developing Training Centre on Nuclear fields. Since 2012 CNESTEN is recognized by AFRA / IAEA as a "Regional Designated Centre" (RDC) in "Education and Training in Radiation protection and Safety of Waste Management".
In this paper, we propose to present our experience on the contribution of our centre in building competencies on Radiation protection and Safety of Waste Management in Morocco and in the Region such as the benefit of the networking for this success story with focus on our experience feedback on raining the IAEA Postgraduate Regional Education Course in Radiation protection and Safety of ionising radiation sources (PGEC).

1. Introduction

Recognizing the importance of education and training in building and strengthening radiation protection, and considering national and regional needs, CNESTEN made a strategic decision to establish a regional training centre for training in radiation protection.
In collaboration with IAEA and in association with several national partners, CNESTEN have organized the IAEA Postgraduate Regional Education Course in Radiation protection and Safety of ionising radiation sources (PGEC) on nine occasions, training some 197 participants from 20 nationalities of French-speaking African countries.
In 2012 CNESTEN was recognized by the AFRA / IAEA system as a "Regional Designated Centre" (RDC) in "Education and Training in Radiation protection and Safety of Waste Management".
Experience of running the IAEA PGEC has led to the development of other specific training courses and has built a fruitful network in the region.

2. National Centre for Nuclear Energy, Science and Technology (CNESTEN)

CNESTEN is a Public Institution founded in 1986 under the supervision of the Ministry of Energy, Mines. Water and Environment it has Legal and financial autonomy, Controlled by Administration Council.
Its missions are:

 Promoting nuclear applications (Research and services),
 Technical Support of the national Authorities (safety
Radioprotection, radioactive waste...),
 Preparing the technological base of Nuclear Power Option.
Its human resources are 253 individuals mainly:
 About 1/3 Doctors and Engineers,
 About 1/3 Technicians,
 About 1/3 Administrative and Support.

3. CNESTEN Training Centre

Under its law of creation, Law No. 17-83, the CNESTEN "contribute to education and training of specialists needed for national nuclear power program, and other areas using nuclear techniques". During its thirty years of its existence, CNESTEN have significantly contributed to building competencies in radiation protection in Morocco and in the Africa region. . In CNESTEN, there is a pool of about one hundred and fifty experts in radiation protection, nuclear safety, nuclear security and various nuclear techniques spread across a wide range of applications that include the health sector, energy production, environment, industry, agriculture, water resources, and management of radioactive waste.

3.1. Three levels of intervention:

• National level: For setting a national infrastructure for Education, Training and Research in nuclear fields over various socio-economic areas,
• Regional level: For contributing to develop regional capabilities for safe use of radioactive sources,
• International level: For sharing experience and developing networking.
In the field of education and training CNESTEN developed a local, regional and international partnership. A thousand of professionals and students are trained per year totalling about 20 000 man-days
of training per year, of which more than 30% are from foreign countries.
CNESTEN is recognized by the AFRA / IAEA system as "Regional Recognised Centre" (RDC) in four areas: "Education and Training in Radioprotection and Safety of Waste Management"; "Isotopic Hydrology" and "Nutrition" and Non Destructive Testing (NDT). CNESTEN host and cordon the "Nuclear Security Support Centre" (NSSC).
CNESTEN has set a long term vision for all its E&T activities by establishing an overall strategy to ensure sustainability, efficiency and effectiveness. As a result, a dedicated International Training Centre (ITC) for nuclear science and technology is under construction, and is expected to become operational during 2018. This ITC is open to national, regional and international collaboration.

3.2. Infrastructure supporting Education and Training activities:

 CNESTEN's Maamora Nuclear Studies Centre (CENM) including mainly the TRIGA MARK II Reactor and associated Laboratories in different nuclear applications and techniques
3
(Health, NDT, EPR, Radiation Protection, Nuclear Security, Isotope Hydrology, Environment, Material Science, Agriculture, …);
 CNESTEN's Rabat Al-Irfane Training Facilities including a Visio-conference facility and rooms equipped with didactic material;
 CNESTEN's International Training Centre (ITC) for nuclear science and technology which is under construction, and is expected to become operational during 2018.

 Specific Facilities of CNESTEN partners. (Universities, Hospitals, Regulatory, ...)

4. Regional Training Centre (RTC) and Regional Designated Centre on Education and Training (RDC) on Radiation protection: IAEA and AFRA approach

In 2000, the 44th General Conference mandated the Secretariat (resolution GC (44)/RES/13) to intensify Post Graduate Educational Course (PGEC) activities and to develop syllabuses and training material for specific target groups and specific uses of radiation sources and radioactive materials. The Secretariat was also urged to strengthen, within existing resources, the role of Regional Training Centres **(RTCs)** and to develop national training centre and to facilitate cooperation between such centres', on the one hand, and national and regional authorities and professional bodies on the other. Over the years RTCs have been established with the Agency's support. The RTCs offer training in Arabic, English, French, Russian, Spanish and Portuguese; and they represent strong regional resources with respect to the implementation of the strategy.
The inter-governmental African Regional Cooperative Agreement for Research, Development and Training related to Nuclear Science and Technology (AFRA) is one of the regional agreements under the IAEA. AFRA entered into effect in 1990. The AFRA Member States have been carrying out cooperative projects in various fields of nuclear science and technology for socio-economic development. As an intergovernmental agreement AFRA translates the political commitment of Member States into regional cooperation and mutual assistance under the umbrella of Technical Cooperation among Developing Countries (TCDC). AFRA focuses on Capacity Building and networking among its member states. AFRA is fostering sustainable regional self-reliance and mutual assistance in Africa. This aim can be consolidated through the recognition of regional institutions in high priority fields (AFRA Regional Designated Centres (RDCs).
The RDCs and RTCs on education and training in radiation protection are considered equivalents. Both procedures for the recognition of RDC/RTC include IAEA Education and Training Appraisal (EDUTA) mission and then conclusion of Memorandum of understanding for RDC and Long Term Agreement for RDC.
The RDCs/RTCs can act as a resource for building competence in radiation, transport and waste safety within the regions and play a useful and cost-effective role by complementing and supporting the activities of national institutions operating in similar fields.
One of The criteria set by IAEA/AFRA to the selection of RTCs/RDCs is "Regional centres should be established only in countries with adequate radiation protection infrastructure and national capability for training at the PGEC level".
In 2011 the AFRA committee recognized the following institutions as RDCs for Education and Training in Radiation protection:
- Nuclear Research Centre of Algeria (CRNA),
- School of Nuclear and allied Sciences of the University of Ghana (SNAS),
- National Centre for Nuclear Energy, Science and Technology (CNESTEN) Morocco.

5. Postgraduate Educational Course in Radiation Protection and the Safety of Radiation Sources – PGEC

The aim of the Postgraduate Educational Course in Radiation Protection and the Safety of Radiation Sources is to meet the needs of professionals at graduate level, or the equivalent, for initial training to acquire a sound basis in radiation protection and the safety of radiation sources. The course also aims to provide the necessary basic tools for those who will be recognized as qualified expert in radiation protection in the later years and be involved in education and training in radiation protection and Safety of Radiation Sources in their home countries. It is designed to provide both theoretical and practical training in the multidisciplinary scientific and/or technical bases of international recommendations and standards on radiation protection and their implementation. The participants should have had a formal education to a level equivalent to a university degree in the physical, chemical or life sciences or engineering and should have been selected to work in the field of radiation protection and the safe use of radiation sources in their countries.

- The PGEC is based on the IAEA syllabus.
- The original version of the standards syllabus of PGEC was published in 1995.
- The first revised version has been published in 2002. TRAINING COURSES SERIES No. 18. (Official publication).

The Standard Syllabus of the Postgraduate Educational Course in Radiation Protection and the Safety of Radiation Sources is divided into eleven parts. The total minimum suggested duration is 18 weeks

The second revised version in 2008 has been approved by the steering committee on education and training in radioprotection and waste safety (SC).

The third revision in 2010, approved by the SC, is under processes of Publication

The revision takes into account the requirements of the IAEA Revision of Safety Series and related Safety Guides, and recommendations of the Steering Committee as well as experience gained from the conduct of the Postgraduate Educational Course in Radiation Protection.

The PGEC is regularly conducted in several regional training centres in recent years in Algeria, Argentina, Brazil, Belarus, Ghana, Greece, Malaysia, Morocco and the Syrian Arab Republic.

6. Moroccan experience on conduction of the PGEC

6.1. Background

Recognizing the importance of education and training in building and strengthening radiation protection, and considering national and regional needs, CNESTEN made a strategic decision to establish a regional training centre for training in radiation protection.

In the first stage, a tripartite partnership between CNESTEN-IAEA-INSTN France has been done.

In 1998 CNESTEN, on collaboration with IAEA, and INSTN France organized, in association with national partners, organized a pilot session at Morocco. The duration of this session was 09 weeks.

In 2001 CNESTEN was considered by the IAEA as a Regional Centre for African French speaking countries in Radiation Protection and the Safety of Radiation Sources.

The first session of PGEC-Morocco was conducted in 2002 with 20 weeks duration.

Since CNESTEN conducts regularly PGEC-Morocco with 21 weeks duration. In collaboration with IAEA, CNESTEN organized, in association with national partners, seven editions of the Postgraduate Regional Education Course (PGEC) in Radioprotection and Safety of ionising radiation sources.157 participants from 19 nationalities of French-speaking African has been trained

In 2007 CNESTEN received IAEA EduTa mission.

In 2010 it received AFRA/IAEA EduTa mission.

In 2012 CNESTEN was recognized by the AFRA / IAEA system as a "Regional Designated Centre" (RDC) in "Education and Training in Radiation protection and Safety of Waste Management".

6.2. Context

The principals' points of Moroccan PGEC context are:

- Collaboration between IAEA and Government of Morocco through the CNESTEN,
- Host agreement between IAEA and Government of Morocco under projects RAF/9/028; RAF/9/035, RAF/9/048 and RAF/9/056,
- Agreement between CNESTEN and School Mohammadia of Engineers (EMI). EMI give a certificate to the participants who succeed on final exam,
- Partnership between CNESTEN and national Institutions,
- National Partners: School Mohammadia of Engineers, National Centre of Radiation protection (CNRP), the new National Agency for Nuclear Safety and Security(AMSNOUR), Scientific University, Medical and Pharmacy University; National Institute of Oncology (INO), Military hospital Mohammed V, National Institute of Agronomic Research (INRA).

6.3. Organization

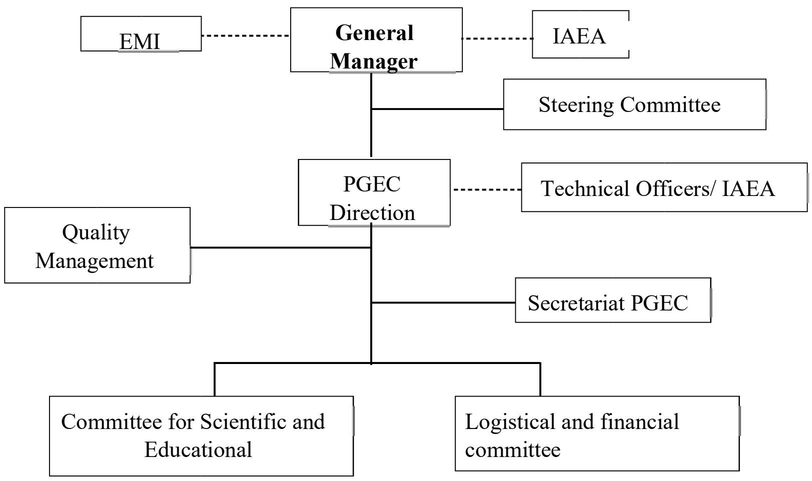


Fig.1: Organization of the PGEC.

According to this organization the role and responsibilities of the actors in PGEC teem are clearly define on document of organisation. This team is the work force for success and continual improvement of the PGEC.

6.4. Program

- The program of the Course is based on the IAEA Standard Syllabus and articulated around 11 modules;
- The duration of the course is 21 weeks; Content :
  - 242 Lecture sessions;
  - 86 Exercises sessions;
  - 62 of Practical Exercises sessions;

- 27 Tutored sessions;
- 41 Sessions of Examination, 1 Final Exam;
- 11 Technical Visits,
- 30 Sessions Project assignments.

- Lectures' Institutions:
  - CNESTEN;
  - Moroccan Institutions;
  - IAEA.

- Program:

Module	Title	Duration (week)
I	Review of fundamentals	2
II	Quantities Measurements	2
III	Biological effects of Ionizing Radiation	1
IV	Principles of radiation protection and Regulatory control	2
V	Assessment of external and internal exposure	2
VI	Protection against occupational exposure	4
VII	Medical exposure	1,5
VIII	Public exposure	2
IX	Accidental exposure	2
X	Training the trainers	1
XI	Project assignment	
	Global evaluation	1,5
Total		**21**

Table 1: Program of Moroccan PGEC

 Technical visits :

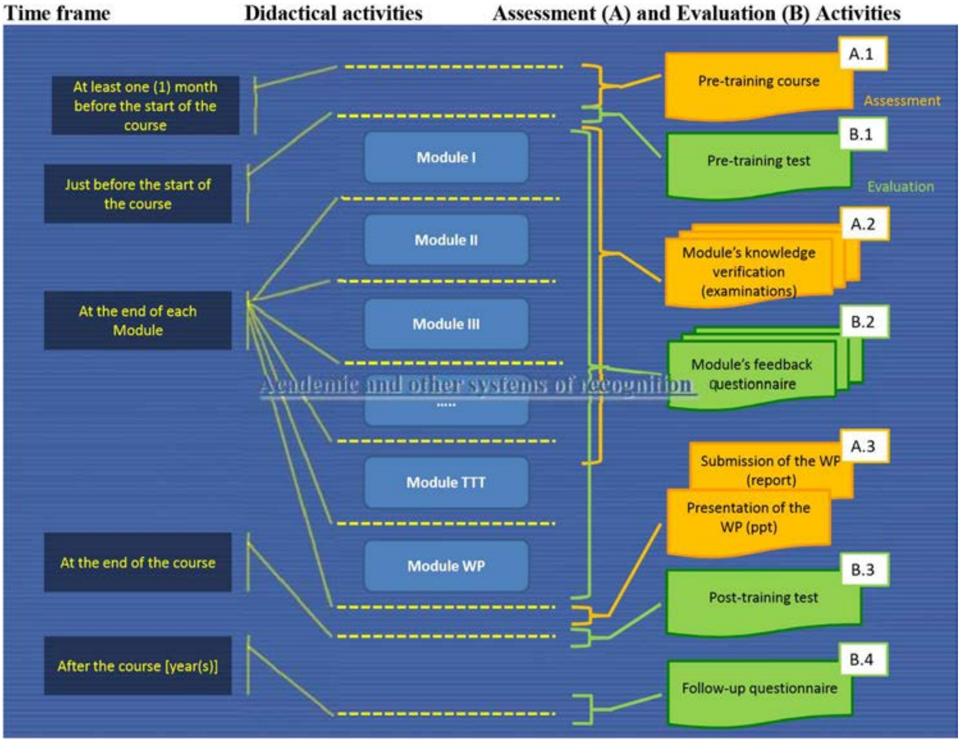
- Technical visits TRIGA MARK II reactor;
- Technical visits to radioisotopes production lab;
- Technical visit to Environment monitoring Unit;
- Technical visit to Dosimeter lab
- Technical visit to an irradiator facility;
- Technical visits to private and public hospitals;
- Technical visit to an industrial radiography facility;
- Technical visit to an SSDL facility;
- Technical visit to National Centre of Radiation protection (CNRP) **Social**

Program

- Visits
  - to Rabat;
  - to Casablanca;
  - to Tangier;
  - to Fes ; • to Marrakech.
- Others special social events: (Aïd Al Adha, Chrismes, Achoura, etc.)

6.5. Mechanisms of Assessment and Evaluation

Time frame **Didactical activities** **Assessment (A) and Evaluation (B) Activities**



1.1. FIG.2: PGEC ASSESSMENT AND EVALUATION MECHANISM

The Assessment and evaluation of the PGEC consists on Assessment of knowledge acquisition and Evaluation of the course.

- **Assessment of knowledge acquisition :**

- Pre-training course
- Knowledge Assessment for each module,

- Finale exam,
- Project assignment.

- **Evaluation of the course:**

- Pre-training and post-training test
- Intermediate evaluations
  - Questionnaire/module (feedback students),
  - Oral Intermediates evaluations (students, pedagogical and logistic committees),
  - Feedback lecture.
- Global evaluation
  - IAEA questionnaire (students),
  - Oral evaluation (students, represented of IAEA, steering committee, pedagogical and logistic committees),
  - Modules coordinators feedback (Module report).
- Follow up questionnaires

- ***Key Indicators:***

- **Evolution of % Local Lecturers / Total: 70% to 90%**

Edition	non local lecturers	local lecturers	% of local lecturers
2002-2003	19	45	70 %
2003-2004	11	49	80 %
2004-2005	8	49	85 %
2005-2006	8	49	85 %
2006-2007	5	49	90 %
2008-2017	3-5	50	>90%

Table 2: Evolution of % Local Lecturers / Total: 70% to 90%

- **Evaluation of the course by the participants:**

1	2	3	4	5

To be stongly im-proved	To be improu-ved	Well	Very well	Excellent

Table 3: Scale of IAEA Questionnaire (Evaluation of the course by the partici-pants)

- Knowledge Improvement:

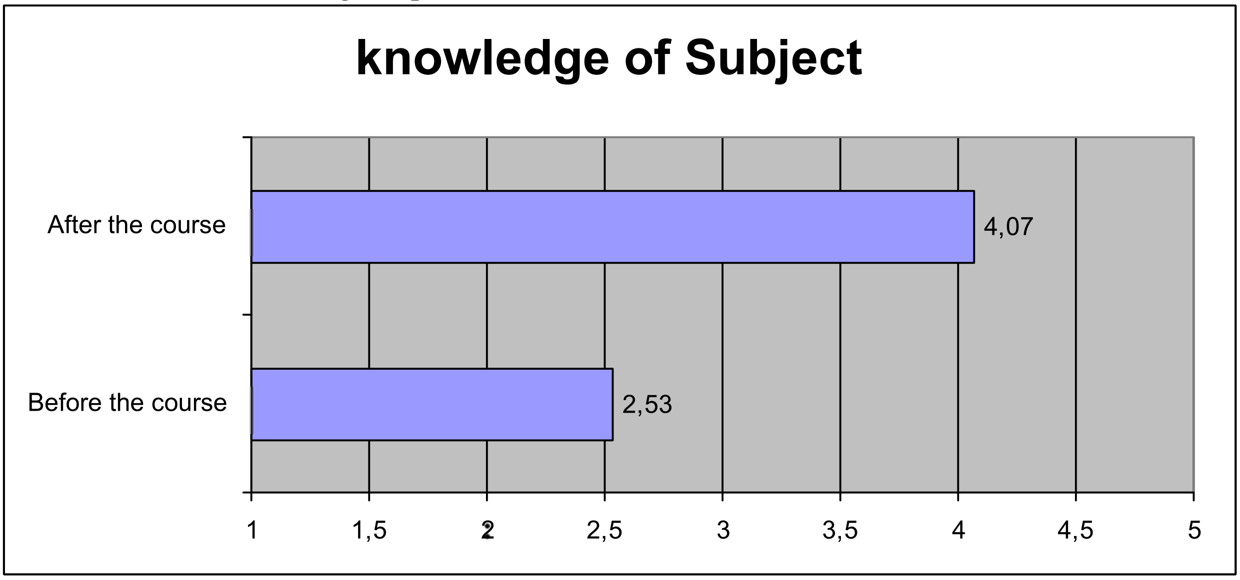


Fig 3: Knowledge Improvement

- Participants' Course evaluation

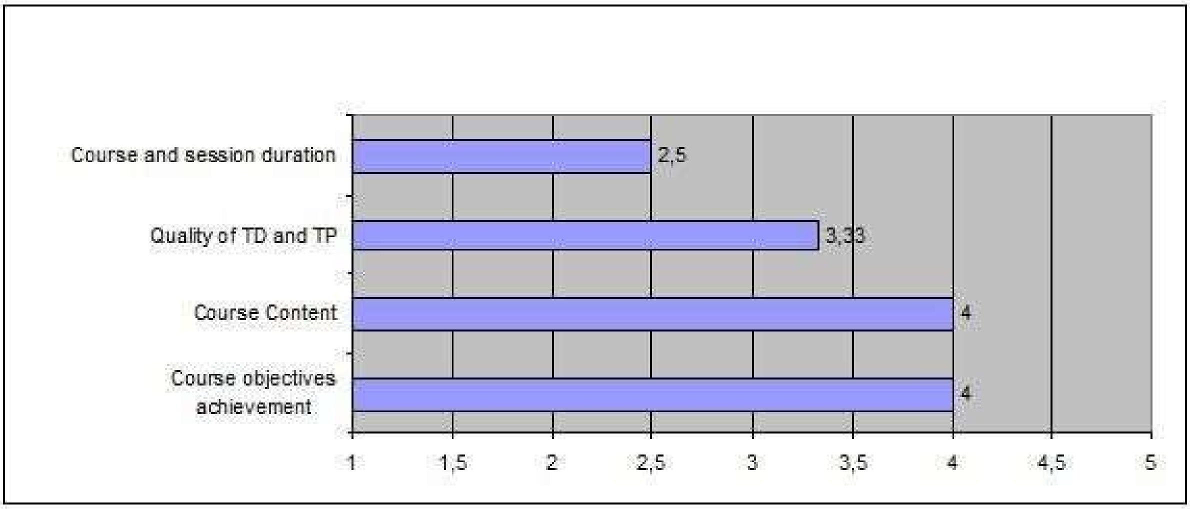


Fig4: Participants' Course evaluation

- Number of trained:

    - Trained, total number : 197 ▪ Country : 20 nationalities ▪ Profiles :
        - Exploitation and regulation
        - Regulatory body;
        - Medical sector;
        - Mining Sector; • Students;
        - Industries, Environment, Emergency response, Research.

1.1.1. 6.6. Academic and other systems of recognition

- EMI (Mohammedia Engineering School) gives certificate to the participants who success the exams.
- EMI fellow all the process of running PGEC. It has to be compatible with The EMI system (prerequisites, conditions of Knowledge evaluation of the participants, experience of lecturers, etc.).

1.1.2. 6.7. Quality management system

According to the commitment of the Top Management for continue improvement of the PGEC and Recommendations of the EduTa Mission, CNESTEN mad decision to go through PGEC Quality management system. The quality approach could be summarized as billow:

➢ **Quality Approach :**

- Design of Quality Committee;
- Call for 02 experts for evaluation and implementation of quality system;
- Quality Action Plan based on the process approach according to the following standards :
    - ISO 9001:2008 QMS;
    - ISO 10015:1999 Guidelines for Training;
    - IWA 2: 2007 Guidelines for the Application of ISO 9001:2000 in education;
- Definition and mapping of Process;
- Drafting documents and definition of the organization and responsibilities;
- Drafting and approval the first version of the Quality Manual;
- Overall assessment of the previous session PGEC;
- Review of Quality Manual;
- Drafting processes, procedures and record;
- improvement and locking management training system;
- Certification ISO 9001;
- Use this experience to bring the system to the training centre;

➢ **Mapping process**

The following figure 2 illustrates the mapping process of the PGEC training course.

Mapping Process

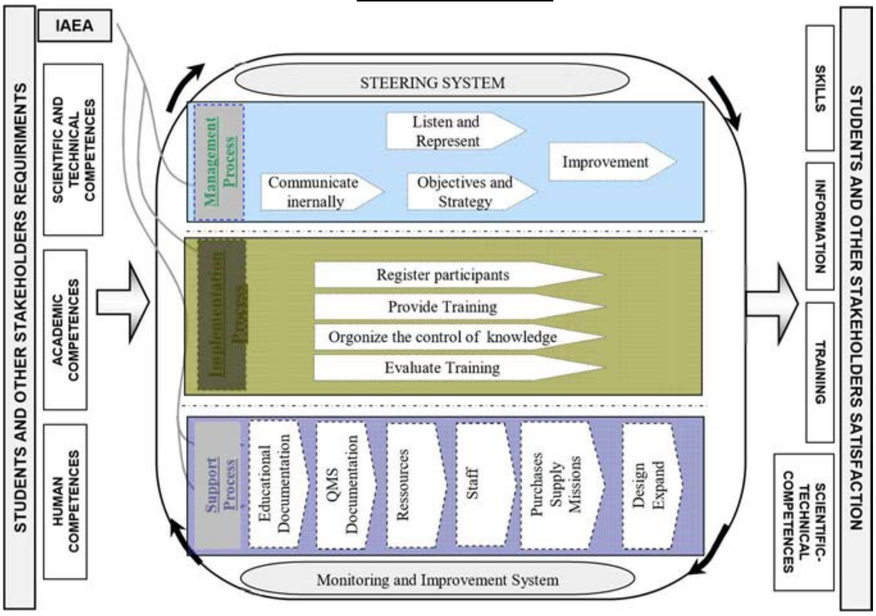


Fig.5: Mapping process of the PGEC

1.2. 7. CONCLUSIONS

- Sustainability of the Training;
- Enriching experience feedback;
- Our objective is to continually improve radiation protection in a sustainable manner, both nationally and regionally, through education & training;
- Experience of running the IAEA PGEC has led to the development of other specific training courses and has built a fruitful network in the region.

8. References:

1. Postgraduate Educational Course in Radiation Protection and the Safety of Radiation Sources (PGEC) standard Syllabus. IAEA Training Course Series 18, Vienna 2002
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14. Moroccan PGEC Quality manual
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18. ETRAP conference 2013-2017 doc

IAEA Technical Meeting on Managing Nuclear Safety Knowledge – Approaches and Experiences of ANVS on LTO NPP Borssele

Abstract

In 2006 the Dutch government signed an agreement (Covenant) with the owners of the Borssele NPP, which allows for operation until the end of 2033, if requirements of the operating licence and the Covenant keep being met. Before 2013 the Safety Report (Summary of Safety Analysis Report or SAR) contained a statement that the design of the plant is based on an operating period of 40 calendar years starting from 1973. Therefore the licence holder had to apply for a licence approving Long Term Operation (LTO) supported by sound evidence that the plant can be safely operated for a longer period of 60 instead of 40 calendar years. The licence holder completed a project to demonstrate that the plant and its organisation are capable of safe operation during its anticipated operating life. This project was amongst others based on guidance provided by IAEA Safety Report Series No. 57 'Guidance for Safe Long Term Operation'. The regulatory body initiated a set of SALTO missions (2009-2014), to support its assessments and to make sure the LTO-programme was according to international standards.

In this paper the following Nuclear Safety Knowledge Management challenges for the Regulatory Body are discussed:

- Maintaining an in depth knowledge of the LTO assessment and the background of the LTO licence requirements until 2034;
- Monitoring and evaluation of the progressing state of the art in science and technology for ageing management, plant programmes, organisation, management system, human factors and other LTO related area's;
- Equipment qualification after the phaseout in 2022 of other Siemens/KWU NPPs in Germany;
- Maintaining a coherent multidisciplinary oversight on ageing management, plant programmes, organisation, management system, human factors and other LTO related area's;
- Knowledge loss by retirement of experts;

In response to the Knowledge Management challenges for LTO and other aspects the Dutch regulator has taken the initiative to start a "KWU regulator group" (KWUREG), bringing together regulators from all countries (Brazil, Germany, the Netherlands, Spain, and Switzerland) where Siemens/KWU NPPs are in operation. The Dutch regulator aims to further enhance knowledge creation, preservation and transfer by means of starting a 'virtual' Community of Practice (CoP) for Aging Management and LTO with regular online meetings with experts from the regulators in the KWU regulator group.

1. Description of the Regulatory Body (ANVS)

The Regulatory Body (regulator) is the authority designated by the government as having legal authority for conducting the regulatory processes, including issuing authorizations, supervision and enforcement. In 2015 the various entities that formerly constituted the Regulatory Body, have largely merged into the one entity, the Authority for Nuclear Safety and Radiation Protection, Dutch acronym ANVS. The ANVS is organised in three departments: (1) Nuclear Safety & Security ('Nucleaire Veiligheid en Beveiliging', NVB), (2) Radiation Potection & Emergency Preparedness ('Stralingsbescherming en Crisismanagement', SBC) and (3) Control, Communication & Support ('Sturing, Communicatie en Ondersteuning', SCO). The latter supports the other units in their operation and provides central coordination of the core activities of the ANVS. It also manages the public information and communication tasks of the ANVS. Since 2016 SCO is staffed with a Knowledge Management Coordinator, whose role is (1) an *expert* in knowledge management, providing advice to identify, develop and implement effective knowledge management practices, and (2) a *coordinator* of knowledge management-related practices and activities within the ANVS. There is general awareness across senior managers of the need and value of a knowledge management and of the relationship between knowledge management and learning processes such as training, learning from experience and continual improvement. A high degree of knowledge sharing can be identified within the Regulatory Body. And also an attitude that supports an open, no blame culture and the uninhibited reporting of incidents when they occur.

Existing only for two years, there are still challenges ahead in the field of Knowledge Management at the newly formed Regulatory Body. For example:

- First efforts have been made to introduce a documented knowledge management policy and strategy, and to integrate these within the wider management system.
- Human resource planning and processes, such as strategic workforce planning, recruitment, training and employment development, succession planning and retention initiatives are in place for some, but not for all types of expertise.
- Competence evaluation is carried out on a frequent basis, although a robust competency framework is not used.
- Work activities, findings and lessons learned are not systematically documented and communicated.
- There is no adoption and integration of IT solutions in support of knowledge management.

2. Knowledge Management Case: Long Term Operation (LTO) of Borssele NPP

The Borssele NPP has been in operation for over 40 years. According to the licence the licence-holder had to issue a third 10-yearly safety review at the end of 2013. At the time the Safety Report contained a statement that the design of the plant is based on an operating period of 40 years starting from 1973. Therefore the licence-holder had to apply for a licence approving Long Term Operation (LTO) supported by sound evidence that the plant can be safely operated for a longer period. It was decided between the Regulatory Body and the licence-holder not to combine the two subjects but to execute two complementary projects, each having its own time frame. The LTO project resulted in a licence application that was submitted for regulatory review in 2012.

The LTO project covered among others:

- The so called preconditions referenced in IAEA Safety Report Series 57 [1], like adequate programs for maintenance, in-service inspection, surveillance, chemistry and equipment qualification;
- The assessment of design calculations and safety analyses containing time related (40 years) assumptions;
- The ageing assessments and ageing management programs;
- A number of non-technical issues in the area of organisation, administration and human factors.

When assessing the application to extend the design lifetime to sixty calendar years the Regulatory Body was advised by the German Gesellschaft für Anlagen- und Reaktorsicherheit (GRS). Conditions have been attached to the licence based on the findings and recommendations of GRS, the IAEA SALTO peer reviews [2] and the Regulatory Body's assessment of the application. The conditions attached by the Regulatory Body to the licence are a.o. in the area of additional In-Service Inspections, Ageing Management, RPV embrittlement, Fatigue, 'Leak before break', Qualification of Accident-Resistant Electrical Equipment and Active Components A large number of documents describe the background for these conditions.

3. Nuclear Safety Knowledge Management challenges and responses in the field of LTO

The Regulatory Body identified the following Knowledge Management challenges specifically for LTO:

- Maintaining an in depth knowledge of the LTO assessment and the background of the LTO licence requirements until 2034;
- Monitoring and evaluation of the progressing state of the art in science and technology for ageing management, plant programmes, organisation, management system, human factors and other LTO related area's;
- Equipment qualification after the phaseout in 2022 of other Siemens/KWU NPPs in Germany;
- Maintaining a coherent multidisciplinary oversight on ageing management, plant programmes, organisation, management system, human factors and other LTO related area's;
- Knowledge loss by retirement of experts;

In response to these challenges the Regulatory Body has taken measures in the area of human resource planning and training. This addresses workforce planning, succession planning, employee development plans, coaching and mentoring and the use of a systematic approach to training. The implicit knowledge held in a person's mind is more difficult to articulate or write down and so it has to be shared between people through discussion, stories and personal interactions. It includes skills, experiences, insight, intuition and judgment. The Regulatory Body has developed a programme for succession planning for the senior positions involved in the further activities involving licensing and and supervision of LTO. The aim of the programme is to identify and develop employees to ensure that key organizational positions can be filled with qualified internal candidates, in advance of actual need. Training and coaching and mentoring techniques are used to help transfer knowledge. A great challenge that the Regulatory Body is facing right now is the recruitment of qualified personnel.

The Regulatory Body has also taken measures in the area of external collaboration. This addresses the collaboration with the Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) and participation in a.o. the Western European Nuclear Regulators Association (WENRA) and the "KWU regulator group" (KWUREG). The Regulatory Body and GRS have an agreement by means of a so-called 'call-off-contract'. The general aim of the work is to provide technical support to Regulatory Body in the field of nuclear safety of the Borssele NPP (KCB) and other nuclear facilities operated in the Netherlands. Further activities will deal with the new build of nuclear installations, support in the area of emergency preparedness and support in the build up of knowledge of the ANVS. The aim of the work for the long-term operation of KCB is to support ANVS, amongst others, in a yearly survey of international experience with LTO in NPPs and RRs.

The Regulatory Body is a member of WENRA. WENRA has regular discussions about the safety aspects of continued operation of nuclear power plants.

4. Planned improvements

To strengthen the knowledge of LTO related subjects, the Regulatory Body will take the initiative to start a 'virtual' Community of Practice for LTO and to enhance the knowledge transfer from a Dutch R&D organization.

The Dutch regulator has taken the initiative to start a "KWU regulator group" (KWUREG), bringing together regulators from all countries (Brazil, Germany, the Netherlands, Spain, and Switzerland) where Siemens/KWU NPPs are in operation. KWUREG shall promote closer cooperation of those countries and is expected to lead to an increase of information on operating and regulatory experience of Siemens/KWU NPPs. The Dutch regulator aims to further enhance knowledge creation, preservation and transfer by means of starting a 'virtual' Community of Practice (CoP) for Aging Management and LTO with regular online meetings with experts from the regulators in the KWU regulator group.

Countries with a nuclear programme, like the Netherlands, perform research in order to update and improve their nuclear knowledge. On behalf of the Dutch government, the Nuclear Research and consultancy Group (NRG) carries out a nuclear research programme. This research programme is funded by the Ministry of Economic Affairs, the Regulatory Body participates in an advisory board. The Dutch government has defined four priorities for the research programme:

- Securing and continuous improvement of nuclear safety
- Reducing the impact of radiation
- Optimising solutions for radioactive waste
- Contributing to a low CO2 economy

NRG's research can roughly be categorised as follows:

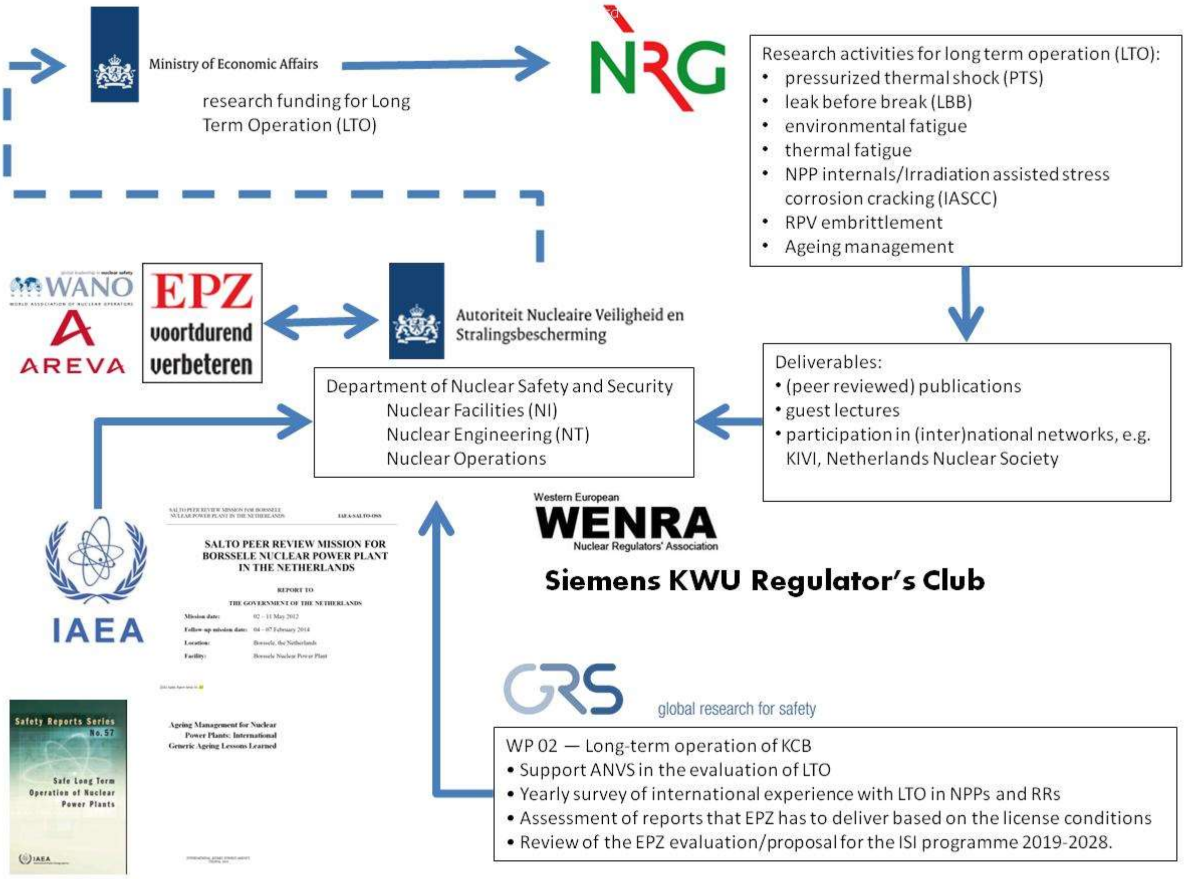
- Desk studies: modelling, simulating, calculating, advising, etc.
- Experimental research in the High Flux Reactor (irradiation) and laboratories: qualifications and tests

For example, one research project which will provide more knowledge about the ageing of reactor vessels. In the coming years, NRG will irradiate various steel samples in the HFR with deliberately applied contaminations in differing concentrations. By bombarding the steel with these contaminations with neutrons, better insight is obtained into the behaviour of reactor vessel steel in the future. NRG performs research on the following 'time limited ageing analysis' (TLAA) and ageing mechanisms:

- pressurized thermal shock (PTS),
- leak before break (LBB),
- environmental fatigue,
- thermal fatigue,
- NPP internals/Irradiation assisted stress corrosion cracking (IASCC),
- RPV embrittlement.

5. Conclusion

To acquire, preserve and use deep, rich knowledge of long term operation of nuclear installations the Regulatory Body has taken measures in the areas of human resource planning, training and external collaboration. Further strengthening is pursued by starting a ‘virtual’ Community of Practice and by systematic knowledge transfer from a R&D organization. The figure below shows the related activities of Regulatory Body in Knowledge Management for LTO.



Ministry of Economic Affairs
research funding for Long Term Operation (LTO)
NRG
Research activities for long term operation (LTO):
• pressurized thermal shock (PTS)
• leak before break (LBB)
• environmental fatigue
• thermal fatigue
• NPP internals/Irradiation assisted stress corrosion cracking (IASCC)
• RPV embrittlement
• Ageing management
WANO
AREVA
EPZ voortdurend verbeteren
Autoriteit Nucleaire Veiligheid en Stralingsbescherming
Department of Nuclear Safety and Security
Nuclear Facilities (NI)
Nuclear Engineering (NT)
Nuclear Operations
Deliverables:
• (peer reviewed) publications
• guest lectures
• participation in (inter)national networks, e.g. KIVI, Netherlands Nuclear Society
IAEA
SALTO PEER REVIEW MISSION FOR BORSSELE NUCLEAR POWER PLANT IN THE NETHERLANDS
REPORT TO
THE GOVERNMENT OF THE NETHERLANDS
Western European
WENRA
Nuclear Regulators' Association
Siemens KWU Regulator's Club
Safety Reports Series No. 57
Safe Long Term Operation of Nuclear Power Plants
Ageing Management for Nuclear Power Plants: International Generic Ageing Lessons Learned
GRS global research for safety
WP 02 — Long-term operation of KCB
• Support ANVS in the evaluation of LTO
• Yearly survey of international experience with LTO in NPPs and RRs
• Assessment of reports that EPZ has to deliver based on the license conditions
• Review of the EPZ evaluation/proposal for the ISI programme 2019-2028.

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Management of Nuclear Safety Knowledge in Romania –

Current Status and Strategies for Development

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[1] National Commission for Nuclear Activities Control (CNCAN), Bucharest, Romania

Abstract

The paper presents the current status and the strategies for further development of the nuclear safety knowledge management in Romania, both with regard to regulatory specific and industry specific competences.

In 2014, a National Strategy for Nuclear Safety and Security, approved by Government Decision, was enacted, establishing as a strategic objective "the continuous improvement of the national competences for nuclear safety and security". The actions for the fulfilment of this objective include nuclear safety knowledge management in all relevant industry and regulatory organizations. A model for a National System of Competencies in Nuclear Safety and associated guidelines have been developed in the framework of the Regional Excellence Project on Regulatory Capacity Building in Nuclear and Radiological Safety, Emergency Preparedness and Response in Romania. The model and guidelines apply to all the nuclear installations and activities and to all the organizations in the nuclear sector that have mandates, roles and responsibilities relevant for nuclear safety. The methodology for the development of the model consists of the application of the 4 - Quadrant Model developed by the IAEA at the Safety Report Series 79 (Managing Regulatory Body Competence). Although this model was initially intended and used only for the nuclear regulatory authority, it is applicable to any organization in the nuclear sector. The model was designed to represent a method of visualizing and thinking about a complex issue, not as a prescription to be rigorously adhered to. It is expected that each organization establishes its own sets of competences, criteria for levels of competences, and standards for evaluation. The paper presents information on the status of the use and implementation of this model together with planned actions. Challenges in managing nuclear safety knowledge effectively at national level are analyzed and presented in the paper.

The paper also presents the knowledge management process and the knowledge management portal developed by CNCAN, highlighting the artifacts, espoused values and basic assumptions that characterize an effective knowledge management culture.

1. Development of a National System of Competencies in Nuclear Safety

1.1. Strategic Objectives

In 2014, a National Strategy for Nuclear Safety and Security, approved by Government Decision, was enacted, establishing as a strategic objective "the continuous improvement of the national competences for nuclear safety and security". The actions for the fulfilment of this objective include nuclear safety knowledge management in all relevant industry and regulatory organizations. A model for a National System of Competencies in Nuclear Safety and associated guidelines have been developed by the National Commission for Nuclear Activities Control (CNCAN), the nuclear regulatory authority of Romania, in the framework of the Regional Excellence Project on Regulatory Capacity Building in Nuclear and Radiological Safety, Emergency Preparedness and Response in Romania, supported by the Norway Grants 2009-2014.

This work, presented briefly in this paper, will be used for issuing a regulatory guide to detail the expectations regarding the implementation of regulatory requirements on the management of competences important for nuclear safety.

The benefits of this system include:

- the clear definition of the competences required in the various areas of activity of the nuclear sector, including for its regulation, leading to improved educational curricula and more focused training and qualification programs;
- the improvement of safety and safety culture in the nuclear sector through better understanding of the complexity and diversity of the necessary competences;
- the provision of a basis for assessing the inventory of available expertise and for implementing strategies for knowledge management.

Challenges in managing nuclear safety knowledge effectively at national level related mainly to the complexity of the competences required for all the nuclear safety related activities of all the different relevant organizations, from nuclear regulatory authority to license holders.

1.2. Structure of the model

The model applies to all the nuclear installations and activities and to all the organizations in the nuclear sector that have mandates, roles and responsibilities relevant for nuclear safety.

The methodology for the development of the model consists of the application of the 4 - Quadrant Model developed by the IAEA at the Safety Report Series 79 (Managing Regulatory Body Competence). Although this model was initially intended and used only for the nuclear regulatory authority, it is applicable to any organization in the nuclear sector.

The model applies the SARCON methodology for each relevant combination of General Area of Competence / Nuclear Installation & Activity / Functions. Details are outlined for each general area of competence for: requirements (legal, regulatory, standards, etc.); technical disciplines, and other specific competences.

The structure of the model is presented in Table 1.

In **Quadrant 1** are those competences related to the legal, regulatory and organizational basis. They are mainly specific to the individual organization. They relate to the knowledge of, and skills needed to comprehend and comply with the legal framework for regulatory control of facilities and activities, the specific regulations and guides, codes and standards (internal and external) and the organisation's management system. It should be acknowledged that the level of comprehension of the laws and regulations required for the various organizations differs in accordance with their mandate, roles and responsibilities. For example, the nuclear regulatory authority should have the highest level competences in this area, necessary for the development and maintenance of the legal and regulatory framework to support nuclear safety.

Quadrant 2 is the knowledge of, and skills needed to comprehend and apply science and/or engineering fundamentals in a particular field. This is divided into basic knowledge in science and engineering fields; more advanced technology specific to nuclear installations and related areas; and more specialized technology, engineering and science such as that needed by experts in technical fields (e.g. safety assessment methodologies and specialized areas like electrical systems and analogue and digital instrumentation and control systems).

Table 1 – The 4-Quadrant model of competences

1. Competences related to the legal, regulatory and organizational basis 1.1 Legal basis 1.2 Regulatory policies and approaches 1.3 Regulations and regulatory guides 1.4 Management system ***Note: The management systems are different for the various organizations***	**2. Competences related to technical disciplines** 2.1 Basic Science & Technology 2.2 Advanced Science & Technology 2.3 Specialized Science & Technology ***Note: These may vary for the different organizations, according with their responsibilities and specific work***
3. Competences related to each organization's processes and practices ***Note: The processes and practices are different for the various organizations; these are based on the responsibilities assigned in legal documents and reflect the nature of the specific work performed by the organizations (e.g. regulation, research, operation of nuclear installations, emergency response, investigations, etc.)*** ***These competencies will have to be identified and defined by each organization.***	**4. Competences related to personal and interpersonal effectiveness** 4.1 Analytical thinking and problem solving 4.2 Personal effectiveness and Self-Management 4.3 Communication 4.4 Team work 4.5 Management and Leadership 4.6 Safety Culture ***Note: These may be generally the same for all the organizations; in specific cases they could be tailored to better suit their responsibilities and specific work***

Quadrant 3 comprises those competences related to organisation's practices. They are those skills required to implement the nuclear safety-related processes of the organization. The processes and practices are different for the various organizations; these are based on the responsibilities assigned in legal documents and reflect the nature of the specific work performed by

the organizations (e.g. regulation, law enforcement, research, operation of nuclear installations, emergency response, investigations, etc.)

Quadrant 4 relates to those personal and behavioural competences needed to: approach problems objectively, gather and integrate information and develop a comprehensive understanding to reach conclusions whilst maintaining consistency, transparency, independence and equality.

The model outlines **only** the competences relevant for nuclear safety. It is not the purpose of the model to list all the competences needed for the functioning of the organizations in the nuclear sector and for the performance of their work. It is the responsibility of each organization to identify, document and secure all the competences it needs in order to perform its work and fulfill its responsibilities.

The competences outlined in the model should be available in each organization to the extent they are necessary for the performance of the work and for meeting the nuclear safety requirements, in accordance with their respective mandate and responsibilities. For example, it is expected that competences for the legal and regulatory framework are available in the regulatory authority to a greater extent than in the industry, because the regulators issue the requirements and the licensees apply them. In the same manner, technical competences for the design and operation of nuclear installations are available in the industry to a greater extent than in the regulatory authority, because the prime responsibility in these areas is with the licensees, who perform the work, while the regulator reviews and inspects this work to determine compliance with regulations and license conditions.

The model is a method of visualizing and thinking about a complex issue, it is not a prescription to be rigorously adhered to. Each organization should establish its own sets of competences, criteria for levels of competences, and standards for evaluation.

1.3. Guidelines for the use of the model

Each organization should perform a competence needs assessment using the model, in order to:

- identify the competences that are both relevant and necessary for its work;
- determine the depth / extent to which the identified competences should be available within the organization, either in-house or outsourced;
- identify the gaps between the necessary competences and the available competences;
- plan for acquiring the necessary competences.

Competence needs can be evaluated using the basic principles of the internationally recognised Systematic Approach to Training (SAT) – but applying this to the analysis of all competence needs – not just the training needs of the organisation. This requires the functions of the organisation (and the organisational subdivisions) to be specified closely and the strategic plans, goals and objectives of the organisation interrogated to ascertain the future competence needs of the organisation at the strategic level.

The competence needs assessment should cover the following steps:

1) Job and Task analysis: each organization should identify, describe and perform an analysis of the jobs and tasks necessary for the performance of its work and for the fulfilment of its legal and statutory responsibilities.

2) Competence needs assessment: for each family / category of jobs, the competences should be defined, including the knowledge, skills and attitudes required; the levels of the necessary competences should also be identified

3) Competence gap analysis: a gap analysis between existing and needed competences should be made for the short term and long term

4) A plan for securing the required competences, for the long term, should be prepared by each organization. The provisions of this document apply also to the personnel of contractors used for performing the subcontracted-work, for the situations in which the required competences are not available within the organization and need to be outsourced.

The Levels of knowledge required will be defined in a generic manner, e.g.:

(a) Basic: General competence in the area concerned;

(b) Medium: A competence level sufficient in routine cases;

(c) High: A competence level required for more sophisticated cases or at the strategic level within organization.

In particular cases, to the extent practicable, the levels of knowledge may be further detailed, e.g.:

- Basic: Basic knowledge of a field of science or engineering such as would be typical of a university graduate with a major in the field, but without practical experience.
- Medium: Advanced knowledge of a field of science or engineering such as would be typical of a holder of an advanced degree in the field or of an experienced practitioner, preferably with some experience in nuclear applications.
- High: Comprehensive knowledge of a field of science or engineering such as would be typical of a holder of an advanced degree with extensive practical experience, preferably with extensive experience in nuclear applications.

If practical or relevant, competence levels may have associated information on the years of practical experience that would typically be needed to acquire such expertise, e.g.:

Basic: <5 years of experience;

Medium: 5-10 years;

High: >10 years

Such an approach, although with inherent subjectivity, may prove relevant / useful for skills and workforce planning.

1.4. Current status of the relevant regulatory requirements and guidance

In June 2017, CNCAN issued two new regulations, NSN-21 – Fundamental Nuclear Safety Requirements for Nuclear Installations and NSN-23 - Training, qualification and authorization of nuclear installations personnel with nuclear safety related jobs, which include requirements on the management of competences important for nuclear safety.

A regulatory guide providing the model for a National System of Competencies in Nuclear Safety and associated guidelines is being prepared based on the work described above. The publication of this guide is planned for 2018.

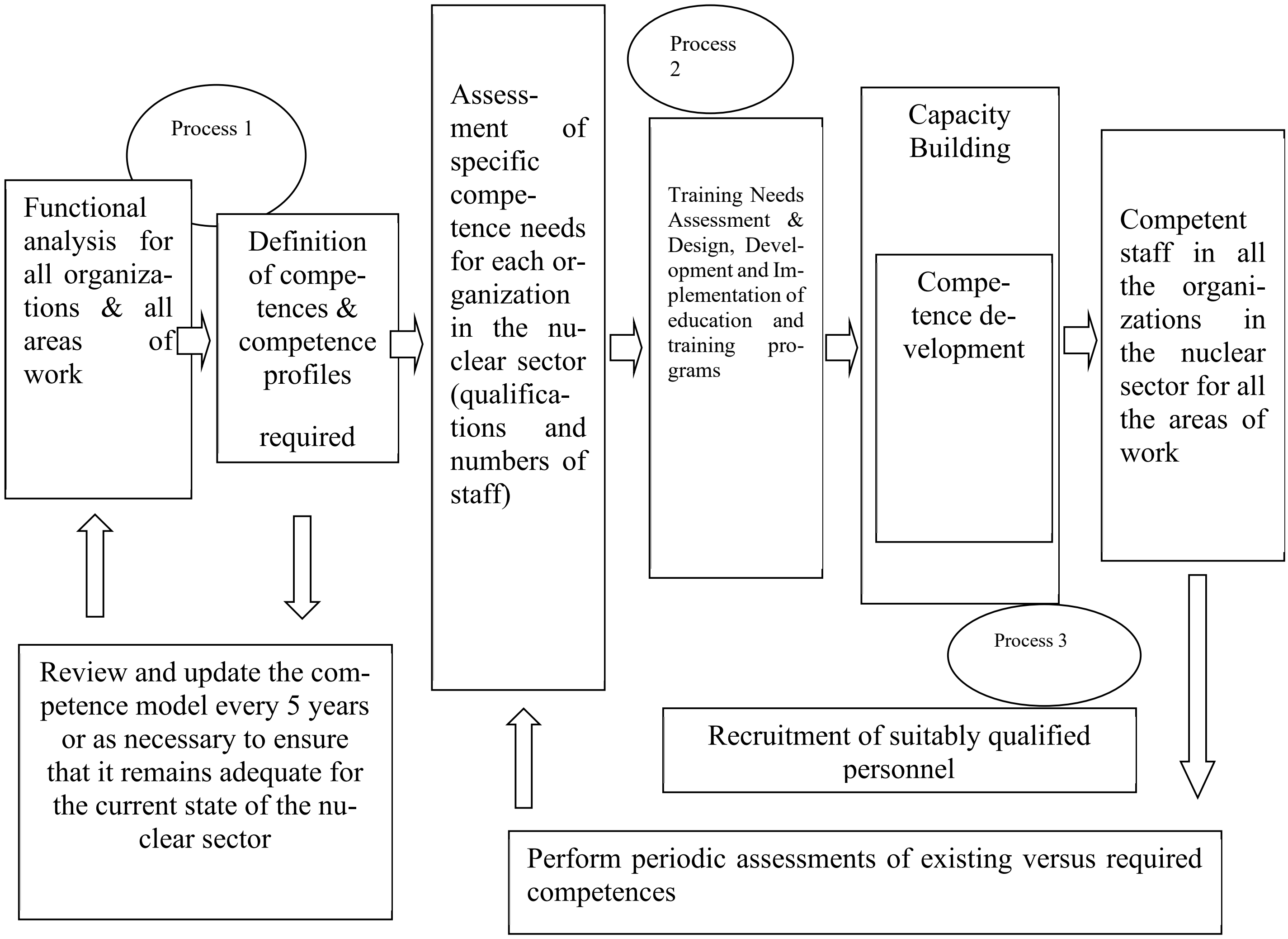

Figure 1 – Strategy for performing competence assessments and for securing the required competences in all organizations

2. The knowledge management process and the knowledge management portal developed by CNCAN

2.1. Organizational context

CNCAN is the nuclear safety and security regulatory authority of Romania, responsible for the regulation, licensing and control of nuclear activities, ensuring the peaceful use of nuclear energy and the protection of public and workers from the harmful effects of ionizing radiation. CNCAN elaborates the strategy and the policies for regulation, licensing and control with regard to nuclear safety, radiological safety, non-proliferation of nuclear weapons, physical protection of nuclear installations and materials, transport of radioactive materials and safe management of radioactive waste and spent fuel. CNCAN reports to the Prime Minister, through the General Secretariat of the Government. CNCAN is completely separated and independent from all the organisations concerned with the promotion or utilization of nuclear energy. The responsibilities assigned to CNCAN by the Law are concerning solely the regulation, licensing and control of nuclear activities.

CNCAN started to develop its knowledge management process and associated procedure and tools in the framework of a Regional Excellence Project on Regulatory Capacity Building in Nuclear and Radiological Safety, Emergency Preparedness and Response in Romania, supported by the Norway Grants 2009-2014. One of the subprojects of the excellence project was dedicated to the development and implementation of the integrated management system and knowledge management (KM) of CNCAN. The activities of this project started in 2014.

The drivers for establishing a KM process in CNCAN were related to the complexity of the regulatory activities, mainly in the area of nuclear safety, as well as to the relatively high staff turnover, challenge in recruiting highly experienced staff and need for ensuring long term availability of the specific regulatory competences. Before the start of the above mentioned project, the KM process in CNCAN was not thoroughly formalized. Mechanisms for knowledge capture, sharing and transfer have always been in place, in a semi-formalized manner.

The challenges associated with the establishment and implementation of the KM process are related primarily to the high workload on the experienced staff, who have as their main tasks the implementation of the core regulatory processes, i.e. development of regulations and guides, performance of reviews and assessments, conduct of inspections, licensing, including license renewal, and enforcement. While it is recognized that a formalized KM process will ensure or at least contribute significantly to long-term sustainability of regulatory competences, its implementation competes for resources, on the short-term, with the more urgent or even the routine tasks of a regulatory authority. Therefore, until the KM process is established and implemented and shows its effectiveness, it needs an initial investment consisting of qualified and experienced regulatory staff.

Another challenge in the definition of the KM process and in the development of an associated procedure was that, although several reports have been issued by the IAEA on this topic, there was no model of a KM process and / or KM procedure for a regulatory body and almost no information publicly available on regulatory KM portals and on their structure and content. Last but not least, the amount of relevant knowledge, important for nuclear safety related regulatory activities, represents a challenge in itself, both in terms of knowledge capture as well as in terms of structuring the information and making it easily retrievable when needed.

The definition, establishment and implementation of the KM process, associated procedure and KM portal for CNCAN started in the Nuclear Fuel Cycle Division, in charge of the regulation, licensing and control of nuclear installations. This division has currently 31 staff members and is composed of the following units:

- Nuclear Safety Assessment Unit;
- Nuclear Regulations and Standards Unit;
- Cernavoda NPP Residents Inspectors Unit;
- Management Systems Oversight Unit;
- Radiological Protection, Radioactive Waste Safety and Transport Unit;
- Radiological Emergencies Unit;
- Mining, Safeguards and Physical Protection Unit.

2.2. Objectives of the KM Initiative

The objective of the KM initiative are to formalize the KM process to ensure a sound basis for the long-term sustainability of the regulatory competences. For this purpose, a KM process procedure has been elaborated and is under implementation, together with a KM portal which is under continuous development.

The KM process under implementation has the following objectives:

a) Improve effectiveness and efficiency by reducing the need to (re)discover knowledge;

b) Make sure the right knowledge is available at the right time and right place for those who need it;

c) Create a knowledge repository for ensuring retention of critical knowledge;

d) Support timely acquisition of new knowledge that is relevant for the organization (e.g. research results, operating experience feedback, new codes and standards, etc.);

e) Establish and improve knowledge assets;

f) Enhance the knowledge sharing environment;

g) Manage knowledge as an asset;

h) Reduce the risk of losing knowledge due to staff turnover.

The expected results of the implementation of the KM process are:

a) Minimize the risk of knowledge loss through the application of mitigation measures;

b) Ensure availability recordable/retrievable nuclear knowledge throughout CNCAN;

c) Effective use of knowledge;

d) Support living/adaptable training programs for the CNCAN core functions;

e) Prevent information streams duplication and personnel information overload in CNCAN

f) Support a clear, coherent, traceable and adaptable/flexible competence system, including clear profiles of job positions;

g) Enhancing the processes for strategic planning and decision-making.

2.3. Description of the KM Initiative

The work on the actual development of the KM process procedure and portal has started in 2014, although previous KM work has been performed in 2009-2011, also in a framework of a regional excellence project. The previous work referred to a KM health check and support in development of a knowledge management and capacity building policy and infrastructure for the regulatory authority.

The main tasks of the KM initiative involved the definition of the KM process, including its steps, the elaboration of a KM procedure outlining the responsibilities of regulatory management and staff at all levels, the description of the activities for each step / sub-process of the general KM process, the flowchart of the process, the indicators of KM process effectiveness and the requirements / specifications for the KM portal, as well as the development and implementation of the KM portal. The KM portal has been developed using free open-source content management software and web-based application builder.

The participants in this project consisted of cca. 10 CNCAN staff involved in the development of the KM process procedure and portal, plus another 10 staff involved in the pilot testing of the use of the KM portal and in the upload of information into the portal. On the overall, at least 20 people have been involved in the initial phase of this KM initiative.

2.4. Major challenges and achievements

The main challenges, as already presented in section 2, are related to the additional workload on the experienced staff, to the unavailability of or lack of access to regulatory models to follow for the development of the KM process procedure and KM portal, and to the large amount of information that needs to be processed and made available as knowledge to those who need it.

The main achievements are the formalization of the KM process and the development of the KM process. Both are still under development and implementation and improvements may be performed after the initial trial period (2015 - 2016).

In terms of impact, the work on this KM project has increased the workload for some of the staff but presents the benefit of improving knowledge and information sharing, mainly by means of the KM portal.

2.5. Lessons learned

The main lessons learned from the initial phase of this KM initiative are that the consultation of the end users is essential for ensuring the success of any KM initiative and that it would be useful to have a database of models used by regulatory authorities for KM processes, procedures and portals, to avoid re-inventing the wheel. Another obvious but important lesson is that the culture of the regulatory body is essential for the success of any KM initiative, especially in what regards the shared basic assumptions about knowledge sharing.

2.6. Additional information

The general KM process developed by CNCAN includes the following steps:

1. Identification of the necessary knowledge;

2. Identification of the risk of knowledge loss;

3. Acquisition and / or creation of knowledge;

4. Knowledge retention (capture, collect, store and organize knowledge);

5. Knowledge utilization;

6. Review of the effectiveness of the knowledge management process;

7. Identification of opportunities for improving the knowledge management process.

The following indicators have been identified as useful for monitoring and measuring the effectiveness of the knowledge management process:

1) percentage of staff contributing to the sharing of knowledge by means of the portal (target: >10% of the technical staff in the first year after the launch of the portal; final target: > 80% of the technical staff);

2) available knowledge inside the organization versus necessary knowledge – measured as number of people with the required KSAs (Knowledge, Skills and Attitudes) available in the organization / number of people with the required KSAs needed (this latter number is determined based on the competence needs analysis);

3) number of KM initiatives (e.g. portal, exit interviews, meetings/discussions organized for sharing knowledge) implemented vs. initiatives planned;

4) use of past experience and knowledge to improve regulations and guidance, process procedures and work instructions;

5) use of (documented) experience to solve a current problem;

6) percentage of documents digitized from those requiring digitization (this means that first it has to be decided which documents have to be available in electronic format from those that are normally send in hard copy – letters to and from licensees; licensing basis documentation; licenses / authorizations / permits; inspection reports; assessment reports; etc.);

7) portal usability (determined based on surveys of users' satisfaction);

8) relevance and quality of information available through the knowledge portal (determined based on surveys of users' satisfaction);

9) number of self-assessments on knowledge management (implemented vs. planned);

10) rate of implementation of opportunities for improvement resulting from the various forms of assessments;

11) number of days spent by staff participating in training events, workshops, technical meetings and expert missions;

12) conformance of the knowledge management process to the requirements in this procedure (assessed through audits);

13) updates to the training and qualification programs based on feedback from knowledge;

14) results of surveys aimed at measuring attitudes towards knowledge sharing.

The following artifacts, espoused values and basic assumptions supporting an effective KM process have been identified (examples):

Artifacts:

- KM process description procedure;

- KM portal;
- KM slogans and posters; policy;
- Rewards for KM involvement

Espoused values:

- Knowledge management is essential for an effective regulatory regime;
- Everybody is responsible for the success of knowledge management;
- Knowledge is a resource of the organization;

Basic assumptions (only the positive ones, supportive of the KM process implementation):

- All relevant knowledge should be made available to all those who may benefit from it;
- I/We have a responsibility to share what I/We know so others may find and use it;
- The better informed people are, the more effective is their work;
- Knowledge transfer contributes, in the long-term, to the reduction of workload on the (senior) staff;
- Continuous learning is key for maintaining the required competences.

Note: It is also important to identify and discourage basic assumptions that undermine the success of the KM process (e.g. "if I teach somebody else what I know, I would be no longer needed"; "Knowledge is power").

3. Conclusions

There are several initiatives being implemented for the management of nuclear safety knowledge in Romania, both at the national level and in the various organizations in the nuclear sector, including the nuclear regulatory authority. These are in line with the trends at international level and contribute also to the implementation of the Romanian National Strategy for Nuclear Safety and Security.

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NUCLEAR SAFETY KNOWLEDGE PRESERVATION AND TRANSFER. EXPERIENCE OF RUSSIAN REGULATORY BODY ROSTECHNADZOR AND ITS TSO "VO "SAFETY".

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Paper

1. INTRODUCTION.

Effective knowledge management is of great value for nuclear power industry due to high risks of nuclear energy, critical role of safety culture and human factor for ensuring safety of nuclear facilities. Knowledge on Nuclear Safety Regulation is the most important and unique capital due to specific functions of a regulatory authority.

Experts of regulatory authorities as Safety Knowledge owners completely correspond to definition of knowledge workers: professionals, whose work has intellectual character and is focused on the manipulation of knowledge (preservation, use, distribution, development etc). Such persons represent intellectual capital (intellectual assets) of a regulatory authority.
Therefore, Safety Knowledge shall be carefully preserved in order to ensure safety and knowledge transfer to young generation shall be arranged in an efficient and timely manner.

Rostechnadzor as Russian Nuclear Authority has appropriate organizational structure: Headquarters – 1 Deputy Chairman for Nuclear Supervision, 3 Departments for nuclear and radiation safety regulation; 6 Interregional Territorial Departments for Nuclear and Radiation Safety; 2 TSOs including "VO "Safety". The following facilities are among those under supervision: 35 operating units of NPPs in operation, 7 units under construction; 17 nuclear fuel cycle facilities, 13 industrial reactors; 66 nuclear research installations, 790 storage facilities for nuclear materials and radioactive waste; 22 facilities of the nuclear fleet, and much more.

Effective safety regulation as an "intelligent customer" of such number of nuclear facilities requires appropriate intellectual assets to be available as well as appropriate scope of safety knowledge. Rostechnadzor and its scientific and technical support organization "VO "Safety" have positive experience in preservation and transfer of knowledge on all groups of regulatory competencies according to the IAEA approaches (under the document SR-79).

2. NUCLEAR SAFETY KNOWLEDGE PRESERVATION AND TRANSFER. EXPERIENCE OF ROSTECHNADZOR AND "VO "SAFETY".

2.1. Nuclear safety knowledge preservation. Comprehensive Modular Program of Rostechnadzor "Nuclear Safety regulation in atomic energy use".
To reduce the risk of critical knowledge loss and under an assignment of Rostechnadzor, specialists of JSC "VO "Safety" developed a Comprehensive Modular Program for personnel training "Safety Regulation in atomic energy use" (further – Program), containing base knowledge on all groups of regulatory competencies.

Program's objective is to preserve knowledge in the area of nuclear safety regulation.
The target audience of the Program comprises the Regulatory Body staff, the specialists from embarking countries focusing on the Russian peaceful nuclear technologies as well as a broad scope of nuclear employees who professionally cooperate with the nuclear regulatory authority.

The Program is based on a modular principle and consists of conceptual units (modules) that collectively contain knowledge of all groups of regulatory competences according to the IAEA approaches (under the document SR-79):

Module 1. Global nuclear safety regime. International approaches and practice of safety regulation in atomic energy use.
Module 2. System of state safety regulation in atomic energy use in the Russian Federation.
Module 3. Technological processes and VVER NPP design. General information.
Module 4. Safety regulation at NPP life-cycle stages.
Module 5. Safety regulation of nuclear facilities (except for NPPs).
Module 6. Safety regulation of separate types of activities in the field of atomic energy use.
Module 7. Assessment of nuclear installation safety.
Module 8. Technical visits.

The modular principle enables developing of a specific training program upon request on the basis of Program topics according to the specialization of a trainee group in a scope agreed upon.
The Program topics cover relevant types of activities at all life cycle stages of different nuclear facilities.
Each topic of the Program is provided with the relevant training material (lectures, presentations, textbooks, study guides etc) for full-time and distance learning. All training materials are developed by highly qualified experts in nuclear safety regulation. This safety knowledge array is regularly updated and supplemented; it is a reliable framework both for professional development of young employees in Rostechnadzor and its technical support organizations and for international cooperation when promoting Russian VVER technologies abroad.

2.2. Nuclear safety knowledge transfer. Experience of "VO "Safety".
"VO "Safety" as a Scientific and Technical Support Organization of Rostechnadzor is authorized to conduct the Program based training in regulatory competences. The grounds for the educational activity are the Statute, the license for educational activity and the Program within the topics of thereof all the training programs are developed. "VO "Safety" has a positive experience in training on regulatory competences provided for representatives of a number of embarking countries: Belarus, Bangladesh, Viet Nam, Egypt, Islamic Republic of Iran, Turkey, etc., including training provided under the technical cooperation programs of the IAEA.

"VO "Safety" continuously improves its training programs and applies different forms of knowledge transfer: distance and full-time learning with lectures, workshops, technical visits, training inspections, etc.; they contribute to the most efficient training of each group of trainees as per specific topics.

Establishment of the Centre for Nuclear Safety and Security in South Africa: Project Progress and Lessons Learnt

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Abstract

In order to address existing regulatory challenges and to conform to international best practice the National Nuclear Regulator (NNR) embarked on a multi-phased project to establish a Centre for Nuclear Safety and Security (CNSS) in July 2014. The CNSS was subsequently launched in September 2016 to mark the completion of the first phase of the project. The CNSS project is the first of its kind to be undertaken by the NNR and is also the first application of a process to establish a nuclear safety centre for a nuclear regulatory body in South Africa and in Africa. As such the CNSS project provides an opportunity to learn new lessons regarding the implementation of the process for establishing a nuclear safety centre for a nuclear regulatory organization. The aim of this paper is to disseminate information on the process followed by the NNR to establish the CNSS and the operational model chosen for the CNSS, present a summary of the project close-out report in order to formalize acceptance and closure of the first phase, highlight lessons learnt, outline the vision, mission and values for the operational phase of the project. The organization of the operational phase of the project, key deliverables and major risks for mitigation are also outlined to ensure that subsequent phases of the project remain on track. The successful completion of the establishment phase of the CNSS project, despite some few logistical challenges, serves as an important demonstration that similar projects can be planned and completed with products that have direct use by other regulatory bodies in Africa and internationally.

1. Introduction: Organizational Context and Project Background

The National Nuclear Regulator (NNR) of South Africa is an Agency of government that is empowered through the NNR Act (No 47 of 1999) [1] to protect the public, property and the environment against nuclear damage through the establishment of safety standards and regulatory practices. Like most nuclear regulatory bodies, the NNR proactively undertakes and participates in relevant initiatives to assess the safety performance of the country's nuclear infrastructure and identify challenges and opportunities for improvement. References [2&4] discuss challenges faced by the NNR which led to the initiative to establish the CNSS. The latter will serve as a dedicated nuclear safety centre to support the NNR. The establishment of a dedicated nuclear safety centre as part of nuclear industry infrastructure is a common practice among nuclear countries that is also recognized and recommended by the International Atomic Energy Agency (IAEA) [3]. The proposed Centre will implement the following key programmes:

- Education & training (E&T) programmes in nuclear safety, radiation protection and nuclear security;
- Regulatory Research and development (RR&D) programmes in nuclear safety, radiation protection and nuclear security;
- Technical support service (TSS) programmes in nuclear safety, radiation protection and nuclear security.

The objectives and benefits of implementing these programmes are discussed in detailed in References [2&4]. The CNSS project is the first of its kind to be undertaken by the NNR and is also the first application of a process to establish a nuclear safety centre for a nuclear regulatory body in South Africa and in Africa. As such the CNSS project provides an opportunity to learn new lessons regarding the implementation of the process for establishing a nuclear safety centre for a regulatory organization. The aim of this paper is to disseminate information on the process followed by the NNR to establish the CNSS and the operational model chosen for the CNSS (Section 2), present a summary the project close-out report in order to formalize acceptance and closure of the first phase of the project (Section 3), highlight lessons learnt from the completion of the first phase of the project (Section 4). Section 5 outlines the vision, mission and values for the next phase of the project, i.e. the operational phase of the CNSS. The organization of the operational phases of the project, key deliverables and major risks for mitigation are also outlined in Sections 6&7 to ensure that subsequent phases of the project remain on track. Section 8 provides a summary of conclusions.

2. Process for establishing a nuclear safety centre and operational model

The sub-sections below present the process followed by the NNR to establish the CNSS and the operational model chosen for the CNSS.

2.1 Process for establishing a nuclear safety centre

The process for establishing the CNSS started with the identification of challenges facing the Regulator as summarized in References [2&4]. Following this, a number of alternatives were explored in order to address the identified challenges taking into account desired outcomes and the approach or process suitable for addressing each challenge. For example, for challenges on nuclear education and training, the Education Capability Assessment and Planning (ECAP) Framework approach was adopted and integrated into the project through participation in the SAN-NEST (South African Network Nuclear Education Science and Technology) project. The ECAP Framework provides a process for developing countries to establish sustainable nuclear education, including a framework for planning and assessing the potential of higher education's contribution to the promotion and development of nuclear science and technology to meet development priorities. Project Cycle Management (PCM) and Logical Framework Approach (LFA) were used as methodologies for designing, monitoring, and evaluating the project. Project management tools utilized to guide the project include PRINCE2® and PMBOK® Guide. A web application platform (SharePoint®) was used to implement project management processes, as recommended in these guidelines, as well as store, track, and manage project documents, including project cost and schedule. The project was overseen by a Steering Committee consisting of representatives from various divisions of the NNR and monitored by the NNR project management office (PMO) for compliance with NNR internal business processes, including quality, cost and schedule requirements. At the end of the establishment phase of the CNSS, a project phase close out report was compiled to record lessons learnt from this first phase of the project, disseminate information necessary to formalize acceptance and closure of the first phase, and to outline the vision and mission for the next phase of the project, i.e. the operational phase of the CNSS. Key deliverables and major risks for mitigation were also outlined to ensure the project remains on track.

2.2 Operational model

In order to leverage on existing resources, South Africa's National Skills Development Strategy [5] calls for the promotion of Partnerships between employers, public education institutions (Further education and training colleges, universities, universities of technology), private training providers and SETAs (Sector Education and Training Authorities) so that the integration of education and training becomes a reality experienced by all South Africans. This requirement formed part of the Strategy for the establishment of the CNSS. Consequently, a call for proposals was issued to academic institutions, including other relevant institutions for partnering with the NNR in addressing the challenges faced by the NNR. A number of institutions submitted proposals for partnering with the NNR on the CNSS project. The proposals were evaluated by the NNR according to the eligibility criteria which were specified in the call for proposals issued to the institutions. All institutions that met the eligibility criteria were chosen as CNSS partner institutions.

The various institutions are allocated funding and assigned areas of focus and responsibility (i.e. by the program sponsor or sponsors) within the broader defined focus area, preferably within their individual areas of pre-existing competencies, capacities, expertise and specialisation in accordance with the Hub and spokes model (Figure 1). The Hub and Spokes model is recognized by the South African national research system and has been successfully used by the National Research Foundation (NRF) as a model for collaboration among academic institutions in the country. The first hub-and-spokes cluster in the energy sector has been established to contribute to the key strategic area of Energy Security with the Centre for Renewable and Sustainable Energy Studies at the University of Stellenbosch serving as the hub with three spokes focussing on wind, Solar thermal and solar photo-voltaic renewable energy respectively, located at five paired universities which includes Nelson Mandela Metropolitan University, University of Cape Town, Stellenbosch University, Fort Hare and University of Pretoria. According to this model, one institution is selected as the coordinating point (the Hub) and the rest are the Spokes. These hub-and-spokes are mainly expected to focus on applied research with a goal of ensuring that South Africa stays abreast with regard to the latest technologies and research in a specific focus area. A hub-and-spokes cluster may have any number of spokes and these may be added as the need arises, for example if new sub-focus areas not yet catered for are realized. The hub and spokes model selected for the operation of the CNSS was modified accordingly to take into account circumstances that are unique to the NNR and the nuclear industry. For example, in the modified model, the NNR retains responsibility, through a graded approach, for co-ordination of CNSS activities (for nuclear safety and security reasons), instead of delegating the co-ordination of CNSS entirely to the coordinating institution. Furthermore, the primary focus of CNSS activities is the safety and security of nuclear technologies rather than their operational efficiency.

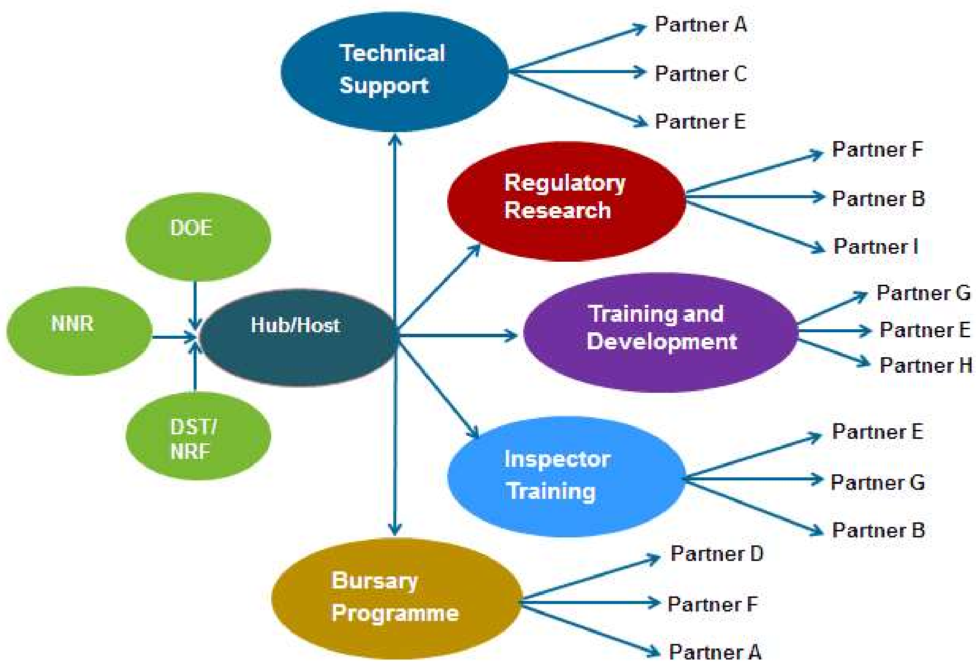

Figure 1: Hub and Spokes Model

3. Summary of project close-out report

Overall the project was executed successfully despite significant challenges which were encountered during the course of implementing the project as highlighted in the subsections below.

3.1 Evaluation of Scope Management

A Scope Management Plan which formed part of the CNSS Project Plan was used to manage the scope of the project and to mitigate against scope creep. Overall management of the scope was successful with only one significant change of scope during the entire project, i.e. the NNR initially held discussions with a single institution interested in partnering with the NNR regarding the possible funding of the construction of facilities for purposes of hosting the CNSS. However, after undertaking a cost benefit analysis, several other institutions were invited to participate through a formal competitive bidding process. This lowered the overall cost of implementing the project.

3.2 Evaluation of Time Management and Project Schedule

A Project Schedule was developed as part of the Project Plan to monitor the project progress. However, the schedule failed to take into account other risks and external factors beyond the control of the project team which would later have a negative impact on the project schedule. For example, during October 2015, the project went behind schedule due to a nationwide strike action which affected universities which were meant to participate in a formal competitive bidding process for the provision of hosting facilities for the CNSS. This had a domino effect on subsequent deliverables and resulted in a net delay in the delivery of the project of about three months.

3.4 Evaluation of Cost Management

Project cost management formed part of the overall Project Plan. Costs for various activities and the overall budget for the project was determined at project planning stage to provide baseline estimates against which to monitor project costs. As the project was executed by mainly utilizing internal human resource capital, and due to the matrix structure of the NNR, it is not possible to accurately determine the total human resource costs that supported the delivery of the project. Nevertheless, the project was completed within budget.

3.5 Evaluation of Quality Management

A Quality Management Plan which formed part of the CNSS Project Plan was used to ensure high quality of project outputs. As part of the plan the project team involved at least one international consultant with extensive experience in the nuclear industry and the application of project management standards in order to execute the project in accordance with international project management practices and to meet global standards. Working with the Project Management Office, the consultant assisted the project management team to adhere to the correct application of standard project management practices in all aspects of the project, including contracting, organization of work and workshops, Quality and Safety Assurance. The Guide called the Project Management Body of Knowledge (PMBOK®Guide) was used as a project management standard to ensure quality management throughout the project.

3.6 Evaluation of Human Resources Management

A Human Resource Plan which formed part of the CNSS Project Plan was used to guide the assignment of personnel to the project. As part of the plan, the NNR appointed an internal team whose membership was drawn from various divisions of the NNR to work with the international consultant. The team possessed the necessary knowledge and provided essential input to the project. However, there were some challenges that needed to be overcome during the course of the project. For example, the international consultant was only available for two weeks a month. This meant that some activities had to be synchronized with his availability. At some point during the project one member who had sufficient knowledge of the project resigned. The matrix organizational structure of the NNR posed its own challenges as the staff dedicated to the project had other responsibilities. Nevertheless, suitable measures were put in place to mitigate against all these challenges leading to overall success of the project.

3.7 Evaluation of Communication Management

A Communication Plan which formed part of the CNSS Project Plan was used to guide project execution, project control, and to facilitate communication among stakeholders. A Project Dashboard tool (a Microsoft Excel application tool) was designed and made available by PMO to communicate general and specific details related to project progress. Steering committee meetings were also held at least once a month or as necessary in order to communicate project progress and to resolve key issues. Internal tools such as the Intranet, SharePoint and Outlook were also used to facilitate communication. The Chief Executive Officer (CEO) of the NNR also gave regular feedback on project progress as part of the CEO's feedback staff meetings.

3.8 Evaluation of Risk and Issue Management

A risk matrix was developed as part of the CNSS Project Plan to mitigate against foreseeable risks likely to be encountered during project execution. Although this exercise was useful, as already highlighted in sub-section 3.2, the risk matrix developed failed to take into account other external factors beyond the control of the project team which would later have a negative impact on the project schedule.

3.9 Evaluation of Procurement Management

NNR internal policies and processes were adhered during procurement of all services related to the project. Working with Supply Chain Management (SCM), the Project Team prepared bids documents, request for proposals documents, undertook bid evaluations and submitted evaluation reports for approval by various bid adjudication committees, in accordance with SCM processes. All important documents were signed-off and filed according the NNR's Document Control system requirements.

4. Lessons Learnt

Key lessons learnt from the project are highlighted in the subsections below.

4.1 Project Organization

The project was executed by an internal team whose membership was drawn from various divisions of the NNR. This approach ensured that there was direct ownership of project inputs, processes and outcomes by staff. It also facilitated dialogue between NNR staff and the project team. The project team also consisted of one international consultant with extensive experience in the nuclear industry and the application of project management standards. This ensured that the project was executed in accordance with international project management practices and met global standards.

4.2 Project Schedule

The Project was completed slightly over schedule by approximately three months, with a duration of just over two years from the kick-off meeting of the project to the launch ceremony of the CNSS. As the project was executed by mainly utilizing internal resources it was also completed on budget.

4.3 Collaboration and networking

The NNR did not have the entire infrastructure, including skilled and trained human resources, necessary for the implementation of the project. However, the potential of the project to support the mandates of several government departments, including academic and research institutions, made it possible for the NNR to seek opportunities of cooperation in order to optimise the use of resources. Participation in the ECAP initiative; as well as the SAN-NEST Project provided the NNR with the right platform to identify key institutions to partner with as part of cooperative agreements and the correct tools to use for this project. The use of appropriate project management tools facilitated the development of the Strategy; as well as the management of knowledge generated during the project.

4.4 Funding

The CNSS project, once completed, will lead to diversification of the NNR's organizational structure into further programmes and sub-programmes that are not currently provided for in the NNR budget. The cost of programmes and activities that cannot be accommodated within the current NNR budget will have to be funded/co-funded by alternative mechanisms. Since the NNR had never engaged in a similar project, developing a funding model for implementation of the project proved to be a challenge. As a result the project team conducted research and undertook two study tours to gather lessons learnt from other regulators.

5. Vision, Mission and Values for Operational Phase

The vision of the CNSS is to be a world-class Centre for Nuclear Safety and Security on the African continent. The CNSS mission is to establish capabilities and pursue excellence in offering Education and Training, Research and Development, Technical Support and Expertise related to Nuclear Safety and Security in order to improve regulatory practices in South Africa, including the African region. The CNSS is an NNR owned Centre which is positioned within the Faculty of Engineering & Information Technology and the larger community of the University of Pretoria. Its operational model is based on a collaboration or partnership model (referred as the hub and spokes model) with other local and international academic institutions, as well as other relevant organizations. Due to this the CNSS embraces the values enshrined in the strategic plans of all its partner organizations. Furthermore, being a nuclear technical centre which is founded on the application of engineering and scientific principles from many disciplines, the CNSS values a symbiotic relationship and collaboration across multiple disciplines, as well as between Academic Institutions and Industry.

6. Plan and Strategic Focus Areas for Operational Phase

The focus of CNSS is on sharing and gaining access to global good practice, experience and information about nuclear safety and security by undertaking various activities which has an impact on the following:

6.1 Establish capabilities in Nuclear Regulatory Research and Development

This involves establishing capabilities for CNSS to undertake research in nuclear safety and security by creating collaborations with existing and accredited research institutions involved in similar initiatives, extending the boundaries of knowledge, venturing into new frontiers of knowledge, innovation and scholarship.

6.2 Establish capabilities in Nuclear Education and Training

This deals with establishing capabilities for CNSS to undertake education and training activities in nuclear safety and security by creating collaborations with existing and accredited education and training institutions, maintaining and strengthening existing education and training programs as well as developing new programs. This activity addresses both the production of graduates who are international scholars and capable of addressing national imperatives of infrastructure development and reduction of social inequalities, as well as continuous professional development of nuclear industry employees through short term courses.

6.3 Establish capabilities in providing Nuclear Technical Support and Expertise

This deals with establishing capabilities for CNSS to provide technical services and expertise in nuclear safety and security by entering into short term and ad-hoc contract agreements with existing and accredited professional service providers, relevant institutions as well as external technical support organizations. The ultimate objective is for the CNSS to contribute to the creation and development of small medium enterprises such that the CNSS has a symbiotic and win-win partnership with the nuclear Industry in South Africa and internationally.

7. Project Organization and Risks

The implementation of the operational phase of the project is led by the CNSS Director who report directly to the CEO. In order to accomplish activities planned for the operational phase, the matrix organisational system at the NNR will be used and resources will be drawn from the various divisions to be complemented by resources from external service providers and short term appointments.

All risks identified for this project are recorded in the risk management register for the CNSS Project. The register is updated as and when new issues emerge. The initiative to establish the CNSS stemmed from the need to address existing capacity issues at the NNR and other national challenges, however there is a risk that the project may be construed as providing an indication of the scale of activities being undertaken to support the country's nuclear expansion plans.

8. Conclusions

This paper has presented valuable lessons learnt from the completion of the establishment phase of the CNSS project, disseminated information regarding the process followed for establishing the Centre, presented a summary the project close-out report in order to formalize acceptance and closure of this phase of the project, and outlined the vision, mission and values for the operational phase of the CNSS. Project organization for the operational phase of the project, key deliverables and major risks for mitigation were also outlined to ensure that subsequent phases of the project remain on track. The collective will, efforts and cooperation of NNR staff (both at operational and management levels) guarantee the realization of the operational phase of the CNSS project.

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KNOWLEDGE MANAGEMENT IN A REGULATORY BODY IN THAILAND: INITIATING & ENHANCEMENT

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Abstract
Thailand is one of countries that has been adopted the use of nuclear technology in various application such as medically, agricultural, industrial and research applications for many decades. Recognizing this enormous potential in many applications, the Office of Atoms for Peace (OAP) as a regulatory body under the Ministry of Science and Technology, carries out a variety of activities to disseminate and promote youth, entrepreneurs and public awareness of the atomic energy in Thailand. In recent years, "Knowledge Management" (KM) is one of the key factors that contribute and enhancing the organization's capability to safe, secure and efficient operation of nuclear activities and facilities and also for the regulatory processes as well. In this regards, the OAP is aware and recognize of the importance of studying and initiating nuclear knowledge management program in the regulatory body. This paper describes the initiating and enhancement of nuclear knowledge management project in OAP.

1. Organizational Background

Thailand is one of countries that has been adopted the use of nuclear technology, thus the need for a governmental body to control and regulate safe uses of it. This is the main responsibility of The Office of Atoms for Peace (OAP), a regulatory body, which is under the Ministry of Science and Technology. It is founded in 1961 as the Office of Atomic Energy for Peace (OAEP) before changing its name to the OAP on October 3, 2002 according to the act amending ministry, sub – ministry and department B.E. 2545 [3]. The OAP are responsible for licensing the use or possession of nuclear material, radioactive material as well as the utilization of atomic energy. In addition, the OAP is in charge of monitoring, assessing and inspecting the licensees to ensure that all operators are safely performed. There is a 24/7 network on radiation surveillance and emergency notification, all is for the usage of atomic energy in the safe and efficient manner. This is a place where all scientists, academic partners and staff work together under the same mission which is to regulate the use of atomic energy, the safe and to create public awareness on nuclear science and technology. This place is also a center for collaborations relating to nuclear energy both domestically and internationally [4].

2. History of Knowledge Management in Thailand

The world in the twenty-first century is moving towards a more complex and dynamic environment so the way that an organization successful practiced in the past may not be applicable in the future [6]. To improve public sector organizations to be high performance organizations, in past several years, public sector organizations in Thailand has been introduced to variously management concepts and tools which were initiated and developed in order to increase more effectiveness and efficient improvement in the public sector. "Knowledge Management" is one of the management applications that were introduced to the public sector in Thailand in very large scale.
"Knowledge Management" was first addressed in the Thai public sector formally in part III "Result-Based Management" section 11 of the Royal Decree on Criteria and Procedures for Good Governance, B.E. 2546 (2003) as follow;
"The government agency, for result-based management under this Royal Decree, shall make itself to be global learning organization. For this purpose, the government agency shall acknowledge and analyze information in all aspects and shall then apply analytical result to its administration for correct, quick,

and suitable service. The Government agency shall also promote and develop capability, vision, attitude and co-learning of its official" [5]

Knowledge management is also inserted as one criterion in other mandatory management tools, e.g., quality assurance of universities, the National Economic and Social Development Plan, and the Public Sector Management Quality Award (PMQA)1. Presently, most government agencies are initiating and implementing knowledge management in their organizations, especially in hospitals, universities, other government agencies in the central administrative system, and state enterprise [2].

3. Initiating of Knowledge Management Project in a Regulatory Body in Thailand

Since 2005, the OAP is aware and recognize of the important of studying and initiating knowledge management in the organization regarding to the introduction and suggestion about the knowledge management application and action plan initiation in Thai public section by the Office of the Public Sector Development Commission (OPDC). In 2006, the OAP has been initiating a knowledge management project that called "Nuclear Science and Technology Knowledge-Base Development". The project was an activity plan during 2006–2016 which aim to promote and disseminate about nuclear knowledge such as nuclear application, safety, regulation, inspection to people all around Thailand such as schoolchildren, teacher, local people, community leaders, media, entrepreneurs, through various form of activities such as nuclear exhibitions, nuclear youth camp, nuclear knowledge caravan, local seminar, nuclear knowledge corners. In this regard, the target population in every activity can learn directly from the OAP's scientists. Since the project initiation, the activities have been conducted in more than 40 provinces all around Thailand as shown in Figure 1.

In parallel, 2012 – 2013, the high level executives of the OAP has been considered to improve the knowledge management project by established a knowledge management committee in order to develop an internal knowledge management plan and system. But because of the severally and rapidly changing of internal environment included the limitations of the traditional characteristics of the organization [2] such as cultural, structural, technological and human resource aspect [6] cause the project still remain in primarily and pending stage of the initiating.

4. Enhancement of Knowledge Management Project in a Regulatory Body in Thailand

During 2016 to 2017, OAP's KM project specifies its maintaining knowledge goals, particularly of retiring experts and transferring this knowledge to the next generation [1]. The committee has been improved and updated the functional details and responsibilities and appointed in attempt to manage internal knowledge both tacit and explicit knowledge, systematically [1]. Several meetings were conducted and the committee identified by using 7 steps of OAP knowledge management process [1] as follows;

1PMQA is a quality award in the Thai public sector, using the same criteria as the Malcolm Baldridge Award [2]

- **Knowledge Identification -** *To make the OAP's knowledge assets visible, it is necessary to explore knowledge within the organization.*
- **Knowledge Creation and Acquisition** - *Knowledge creation is the knowledge created within the organization for example; new skills, ideas which can improve organizational processes. Knowledge acquisition is the required knowledge that obtained from external sources.*
- **Knowledge Organization -** *An organizational knowledge structure shall be mapped as a part of knowledge identification. Knowledge structure can be updated or extended as necessary. Knowledge organization based on knowledge structure is needed for a systematic knowledge retention in the future.*
- **Knowledge Refinement -** *It is the processes and mechanisms to select, filter, purify and optimize knowledge included in various storage media. It is the process required for continuous quality improvement of explicit knowledge management with ISO standards in document storage.*

- **Knowledge Access** - *The knowledge and experiences should be readily accessible to others and replicated if desired. This is to allow users to access to the knowledge desired easily and conveniently by using information technology management through web board.*
- **Knowledge Sharing** - *Knowledge can be shared by the organization with its staffs, between staffs of the organization as well as with people outside of the organization. Implicit and tacit knowledge transfer can be done by various means for example; formal classroom, on-the-job training, informal Communities of Practice, and mentoring.*
- **Learning** - *Organizations and staffs need to learn and internalize relevant knowledge experiences and actions through personal and group interactions within the organization.*

Desired State of KM	**Result**
Work Process Improvement	• Work Instruction
Knowledge Staff	• Learning and Training
Knowledge-based Development	• Knowledge Asset

Desired State of KM	Result
Work Process Improvement	• Work Instruction
Knowledge Staff	• Learning and Training
Knowledge-based Development	• Knowledge Asset

Table 1. Expectation of desired state and result of the OAP's KM project in the future [1]

2. CONCLUSION

Initiating knowledge management system in an organization might be difficult but initiating the management in a nuclear and radiation regulatory body organization in order to ensure the future effectiveness and competitiveness might be more difficult due to several major obstacles within the organization such as rapidly changing of the internal environment, cultural, structural, technological and human resource aspect. But because of awareness and recognition of the importance of knowledge management, the OAP will continually precipitate the organization into knowledge-based organization as soon as possible. The project is not only be useful for developing of enhancing organization capability and better work process but also including benefit for nuclear technicians and staff working in the core and secondary function of regulatory body [1] Moreover, the result of this project will be a very important part that can lead OAP to develop its own human resource management and development plan and formulate internal training programs for knowledge transfer and exchange between staffs so as to keep organizational knowledge developed and sustainable [1].

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SE NNEGC “ENERGOATOM” EXPERIENCE AND CONCEPTS OF NUCLEAR KNOWLEDGE MANAGEMENT PROGRAMS

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Abstract
Managing nuclear knowledge is the very important task for the operating organization, especially now, in a time of change, both worldwide and in individual country and in particular in nuclear industry. Development, formalization and functioning of the nuclear knowledge management system plays a special role for our Company, especially lately in the context of personnel ageing, retirement, dismissal because of change of place of employment (a large number of qualified and experienced personnel left the Ukrainian NPPs and work now in the Russian Federation, Belarus, China, Islamic Republic of Iran and other countries).

Surge of activity relating to development and implemetation of NKM system was observed in our Company during the period 2010-2013, when this has been done within the framework of the IAEA TC projects. We have developed the Company's Standard SOU NAEK 008:2013 “Personnel qualification management. SE NNEGC Energoatom knowledge management system. Basic provisions” and procedures for knowledge loss risk assessment, knowledge management self-assessment; have introduced the appropriate changes in our HR policy; have developed and put into operation the Corporate Knowledge Portal; have trained the personnel too.

Our major achievements and benefits in managing nuclear knowledge are:

- time required for searching and obtaining necessary information, including failure analysis and operating experience, has reduced:
- possibility for on-line information and knowledge exchange on particular subject is supported;
- possibility for collaborative work (e.g. within a particular project) of personnel from different geographically remote sites is assured;
- expert’s critical knowledge have been retrieved, analyzed and systemized in data bases;
- knowledge continuity has been achieved by implementing the “tutor-successor” knowledge transfer model;
- quality and completeness of training materials has been improved;
- decision-making process has been improved, including engineering and technical decisions, based on objective knowledge rather than on subjective concepts.

1. INTRODUCTION

In this Paper the following sections will be considered:

- Place and tasks of Knowledge Management in the integrated management system of NNEGC “Energoatom”;

- Prerequisites and objectives for KM system implementation;
- Details and approaches on NNEGC “Energoatom” KM system implementation within the framework of IAEA TC Projects;
- KM processes and tools using by NNEGC “Energoatom” KM system;
- SE NNEGC “Energoatom” lessons learned, achievements and benefits after implementing KM system.

2. PLACE AND TASKS OF KNOWLEDGE MANAGEMENT IN THE INTEGRATED MANAGEMENT SYSTEM OF NNEGC “ENERGOATOM”

2.1 Knowledge management is integrated in the SE NNEGC Energoatom management system and assures fulfillment of the following tasks:

- knowledge transfer between generations of nuclear industry employees – in the framework of Quality Assurance subsystem of the integrated management system;
- workforce optimization during construction of new nuclear facilities, maintaining long-term operation and NPP decommissioning – in the framework of Quality Assurance subsystem of the integrated management system;
- improvement of management decisions, introduction of innovation approaches – in the framework of Quality Assurance subsystem of the integrated management system
- ensuring of nuclear facility safe operation and maintenance by applying operating experience – in the framework of Safety Ensuring subsystem of the integrated management system;
- development of corporate culture, provisions for developing of safety culture – in the framework of Safety Ensuring subsystem of the integrated management system;
- enhancing of operating and economic indicators due to effective management of knowledge as a resource – in the framework of Product release subsystem of the integrated management system.

2.2 Management of knowledge is performed at SE NNEGC Energoatom in compliance with requirements of ISO 9001:2015 [1], Section 7.1.6 “Organizational knowledge” and regulations of the State Nuclear and Radiation Safety Regulatory Authority of Ukraine NP 306.1.190-2012 “General requirements for management system in the nuclear energy utilization field” [2], Section VI “Management of Resources”:

“6.2 Information and knowledge of the organization, including knowledge of its personnel, are the resource that to be managed based on documented procedures.”

3. PREREQUISITES AND OBJECTIVES FOR KM SYSTEM IMPLEMENTATION

3.1 The necessity of implementing knowledge management system within the SE NNEGC Energoatom is caused by following needs:

- to reduce the risk of loosing critical knowledge in case of retirement, professional advancement and staff turnover;

– to support of NPP long-term operation and their decommissioning in the future;
– to improve personnel and organization performance (less errors and better quality);
– to transfer knowledge to new generations;
– to increase competitiveness of the company;
– to attract and develop skilled individuals;
– to improve company's management system;
– to facilitate access to information for personnel and managers;
– to improve the decision-making process.

3.2 Knowledge management is aimed to achievement of basic goals of the SE NNEGC Energoatom:

– supporting nuclear and radiation safety level according to requirements of applicable standards, regulations and rules;
– generating of electrical and thermal power by the most safe and the effective way;
– enhancing NPP power units reliability and efficiency, decreasing number of failures and incidents during NPPs operation.

3. DETAILS AND APPROACHES ON NNEGC "ENERGOATOM" KM SYSTEM IMPLEMENTATION WITHIN THE FRAMEWORK OF IAEA TC PROJECTS

4.1 Systematic activity on KM implementation at Ukrainian NPPs and Operating Organization`s Headquarter was carried out within the framework of three IAEA TC Projects:

IAEA TC Project UKR/0/009 "Improvement of NPP Maintenance Personnel Training System", task 3 "Realization of systematic Knowledge Management"

IAEA TC Project UKR/0/010 "Strengthening Knowledge management in Nuclear Industry", tasks 1 to 4.

IAEA TC Project UKR/0/011 "Improving the Knowledge management System in Nuclear Industry of Ukraine".

4.2 Activities carried out within the framework of the IAEA TC Project UKR/0/009 (UKR/4/012) at the Zaporizhzhya NPP

4.2.1. Task 3. Realization of systematic Knowledge Management

3.2.1.1 Four expert visits were conducted at the NPP site.
3.2.1.2 Two groups from NPP Training Centre visited United States (TVA Company) and Canada (Bruce Power)

4.2.2. After that

4.2.2.1. We changed some NPP documentation:

– We supplemented the NPP Statement on manpower policy with the chapter on KM policy.

4.2.2.2. We worked with NPP staff:

- We captured and preserved tacit knowledge of selected experts;
- We made changes based on this knowledge in operational documentation and issued new album of diagrams;
- We conducted the self-assessment on KM according to procedure provided by IAEA experts.
- We trained personnel responsible for knowledge and experience preservation activity on subject “A structured interview aimed to determination of critical knowledge of personnel”;
- We performed an analysis of effectiveness and efficiency of advanced training of NPP managers and specialists conducted by third-party educational organizations.

4.2.2.3. We developed an interface between KM and IT:

- We developed multimedia modules for training courses (for maintenance personnel);
- We developed the β –version of Information System of Knowledge Management (for personnel department staff, knowledge officers).

4.3 Activities carried out within the framework of the IAEA TC Project UKR/0/010

4.3.1. Task 1. Development of Strategy and Action Plan on Managing Nuclear Knowledge in Ukraine

Ministry of Energy and Coal Industry of Ukraine in cooperation with operating organization developed the draft document “Knowledge Management Strategy in Nuclear Industry of Ukraine” (not implemented). Supposed it should be a document of a national level so the draft describes the KMS in terms of nuclear-energy organization in totality (that is not only NPP, but nuclear-fuel organizations, R&D organizations, Universities).

According to draft Strategy, activities on KMS realization are divided in two groups:

- National (or ministerial) level;
- Corporate level

4.3.2. Task 2. Development of guidance documents on managing nuclear knowledge of the IAEA TC Project UKR/0/010.

To describe development, implementation and functioning of the SE NNEGC Energoatom knowledge management system, as well as to define responsibility for the system functioning, to determine of the applied knowledge management processes and instruments, the Company's Standard SOU NAEK 008:2013 “Personnel qualification management. SE NNEGC Energoatom knowledge management system. Basic provisions” has been developed. IAEA recommendations documented in GS-R-3 [3], NG-T-6.2 [4], NG-T-6.6 [5], NG-T-6.7 [6], TECDOC-1510 [7], TECDOC-1586 [8], INSAG-16 [9], IAEA publication “Management of risks related to loss of knowledge in nuclear industry organizations” [10] were assumed as a basis for this standard.

4.3.3. Task 3. Transfer of KM technology and KM assessment (KM assist visits at Ukrainian NPPs)

From 2009 to 2011 the following missions were undertaken:

- Two KM workshops at ZNPP and Sevastopol National University on Nuclear Energy and Industry;
- Two KMAV at SUNPP;
- One KMAV at RNPP.

4.3.4. Task 4. Development of knowledge portal for NNEGC Energoatom

- During the period of 2009-2010 the Technical Specification for Portal was developed by IAEA experts and adopted by NNEGC Energoatom.
- We selected SharePoint as a platform software for the Portal and described the modules needed to be developed/included in Portal software.
- We held a tender for procurement of needed hardware (multifunction scanning/printing device, server, PCs).

4.4 Activities carried out within the framework of the IAEA TC Project UKR/0/011

4.4.1. Task 2. Development of knowledge portal for NNEGC Energoatom

4.4.1.1 Expert mission to support portal development. ENERGOATOM Headquarter

On the basis of experts` recommendations the Schedule on primary measures for increase of effectiveness and acceleration of implementation of the CKP was developed

4.4.1.2. Scientific visit on Benchmarking of existing practice on portal development and implementation. GRS (Germany, Munich)

During the scientific visit the training was provided on the following topics:

- Portals
- Content Management
- Enterprise Search
- Process-oriented KM
- Collaboration and (internal) Communication
- Human Resources
- Personal KM
- Knowledge Representation, Taxonomies, Ontologies
- Knowledge Acquisition and Preservation
- Assessing KM
- IT-Structure, Hardware, Software

4.4.1.3. Workshop on development of knowledge base related to lifetime extension. ENERGOATOM Headquarter

The stages and dates of tasks implementation were defined (such as development of taxonomy on lifetime extension, development of knowledge base module on lifetime extension etc.)

4.4.2. Task 3. Implementation of IAEA Cyber Learning Platform for Nuclear education and training

4.4.2.1. Working meeting to identify basic requirements for Russian version of IAEA Cyber Learning Platform for Nuclear education and training. ENERGOATOM Headquarter

NNEGC Energoatom` needs were identified and background information for "INPUTS AND BASIC REQUIREMENTS FOR NNEGC ENERGOATOM" developing was collected.

4.4.2.2. Expert mission to support implementation of Cyber Learning Platform (CLP4NET). ENERGOATOM Headquarter

State of realization of "INPUTS AND BASIC REQUIREMENTS FOR NNEGC ENERGOATOM" was assessed; measures for preparation to the CLP4NET implementation were developed.

4.4.2.3. Expert mission to install the CLP4NET. ENERGOATOM Headquarter

CLP4NET was installed, initial training was performed, order about CLP4NET pilot operation was issued.

4.4.2.4. Development of manuals for the CLP4NET. ENERGOATOM Headquarter

Manuals were provided during the mission on items 3.3 and 3.4. After that Manuals were corrected and use when working with CLP4NET.

4.4.2.5. Expert mission (meeting) for practical training of the system administrators, instructors and trainees on the CLP4NET use and applications at KhNPP (with participation of RNPP personnel) and ZNPP (with participation of SUNPP personnel) Training Centers

Personnel training was performed, raised issues were discussed.

5. KM PROCESSES AND TOOLS USING BY NNEGC "ENERGOATOM" KM SYSTEM

5.1 To support knowledge management, the following processes are applied within the SE NNEGC Energoatom (corresponding to phases of the knowledge life cycle):

5.1.1. Acquisition of knowledge

5.1.1.1. The process input data are as follows:

- norms and regulations;
- operational and working documents;
- training and methodological materials;
- operating experience materials;
- reports related to results of internal and external audits;
- design documentation;
- documentation provided by goods and services suppliers;
- Internet (IAEA, WANO portals);

- training provided by third-party organizations;
- reports on results of business trips;
- experience exchange.
-

5.1.1.2. To transform the process input data to systematic acquired knowledge, the following forms of work are used:

  - professional development courses;
  - workshops and trainings;
  - subject conferences;
  - participation in working groups;
  - participation in new projects;
  - self-education.
  -

5.1.2. Creation and attraction of knowledge

Critical knowledge of experts is considered as process input data. Transformation of input data to explicit knowledge is going on by applying such methods as questionnaires, interviewing. Obtained data are documented and introduced to corresponding databases.

5.1.3. Knowledge transfer

Input data for the process are knowledge (both explicit and implicit) of the qualified and experienced personnel. Knowledge transfer is performed by applying the following methods:

- tutoring;
- rotation of skilled professionals;
- workshops and trainings;
- fire safety and emergency response trainings;
- experience exchange and trainee job programs;
- organization of working groups, communities of practice;
- staff meetings;
- development of documented methodologies, procedures, instructions.

5.1.4. Preservation of knowledge

The acquired, retrieved and documented knowledge are the input data for the knowledge maintenance process. The following forms are used for knowledge maintenance:

- organization of information exchange between subdivisions;
- regular training for managers;
- stimulation of employees for enhancing their level of competency;
- development of coaching practices;
- identification of competence and specific skills, knowledge and abilities to introduce into the personnel data base;
- development of intranet and functioning of corporate knowledge portal;
- automation of operating processes.

Systematic mentally stored knowledge (implicit) and objectively stored explicit knowledge (represented by documents, files, data bases) are resulting from the process.

5.1.5. Application of knowledge

Acquired and systematic knowledge formalized in documents or databases is the input data for the process. To assure the effective knowledge application, knowledge recording and implementation into industrial practice is undertaken. Activities are also undertaken related to improvement of information technologies, which assure data maintenance and personnel access to knowledge for their effective application. This process results in effective, safe and cost-effective NPP operation.

5.2 When introducing the knowledge management system and in the course of its functioning, the following KM tools are applied:

5.2.1. First group (technology):

- knowledge bases;
- databases (corporate information systems);
- automated personnel training management systems (for every NPPs);
- automated HR management systems;
- multimedia training courses;
- operating experience automated systems;
- corporate knowledge portal;
- cyber-platform CLP4NET for distance learning;
- forums within the portal or cyber-platform.

5.2.2. Second group (organization):

- incentive compensation and non-financial recognition for knowledge sharing;
- storytelling;
- identifying of employees with implicit knowledge;
- knowledge mapping;
- cross-disciplinal corporate training;
- activities in communities of practice and experts groups;
- involvement of experienced specialists as instructors in the personnel training system;
- best practices exchange;
- self-assessment on KM;
- tutoring.

6. SE NNEGC “ENERGOATOM” LESSONS LEARNED, ACHIEVEMENTS AND BENEFITS AFTER IMPLEMENTING KM SYSTEM

6.1 Positive results have been obtained following implementation and during functioning of the knowledge management system in SE NNEGC Energoatom, in particular:

- we have now really useful, functional, comprehensive IT tool – Corporate Knowledge Portal, consists of 12 libraries, 10 classifiers, 2 glossaries, sites of 29 NNEGC “Energoatom” departments, sites for 2 working groups, informational modules about Company`s licenses and permits, suppliers, external and internal audits; and all Company`s staff as users;
- time required for searching and obtaining necessary information, including failure analysis and operating experience, has reduced:
- possibility for on-line information and knowledge exchange on particular subject is supported;
- possibility for collaborative work (e.g. within a particular project) of personnel from different geographically remote sites is assured;
- expert’s critical knowledge have been retrieved, analyzed and systemized in data bases;
- knowledge continuity has been achieved by implementing the “tutor-successor” knowledge transfer model;
- quality and completeness of training materials has been improved;
- decision-making process has been improved, including engineering and technical decisions, based on objective knowledge rather than on subjective concepts.

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6.2 Lessons learned and problem areas

To enhance effectiveness of the knowledge management system functioning, it would be reasonable to create a subdivision (appoint an official) within the organizational structure of the Headquarter to bear KM activities coordination functions and to be “the center of responsibilities” for this subject.

To enhance effectiveness of the knowledge management system functioning, it would be reasonable to create a subdivision (appoint an official) within the organizational structure of the Headquarter to bear KM activities coordination functions and to be “the center of responsibilities” for this subject.

Prior to introducing the knowledge management system, personnel responsible for KM functions should be duly trained by a competitive organization.

From the very beginning, KM system has to be implemented within the whole organization, rather than at individual NPPs. This would provide for uniformity of actions and extend scope of personnel accessible information.

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1. UNDERSTAND BUSINESS OBJECTIVES

The first thing to do is to understand the business objectives. This means understanding the issue that the business is trying to resolve. For example, is the business trying to increase sales, are they trying to improve marketing campaign results, are they trying to improve communication, is there a collaboration problem that needs to be corrected? Just what is the problem that is being addressed and how does it align with the overall organizational strategy? Understanding the objective(s) underpins not only the selection of the right kind of technology but the determination of success criteria and metrics for the initiative.

2. UNDERSTAND USER REQUIREMENTS

Another activity in aligning the business and IT is understanding the user requirements from a business pers

pective. This means asking the users what functionality they currently have in any existing tools that they may be using and asking them what additional functionality they want. This is not as easy as it may seem as the users may not understand the functionality that is available or know what they want. In this case, it is incumbent upon the person collecting the requirements to know the functionalities that are available and discuss them with the users. In some cases this may involve showing users' technology options; however, this should be avoided if possible, as jumping to possible solutions too soon can spell disaster for the project through misaligned expectations.

Part of understanding user requirements is understanding how people do their work. When do they work, how do they work, who do they work with, what tools do they use, and what expectations do they have about the availability of technology and information. These are all important questions to ask in determining the technology requirements. The technology requirements do not just mean the software but also mean the hardware requirement, for example, what is its availability level, where geographically should it be located, what kinds of bandwidth and redundancy are required.

In understanding user requirements it is important to identify groups of users based on the types of activities they will be doing using the technology. For example, Community of Practice leaders is one type of user group or profile. They will expect to be able to create a community, add members, send messages, and do other administrative and facilitative activities for their Community using the technology platform.

4. EMBED KM IN PROCESSES

Once the strategic and process driven requirements are understood it is important to determine how Knowledge Management will be embedded in these processes. Do the processes need to change, does the software need to be configured to accommodate existing processes, what needs to happen in order to enable the business processes with Knowledge Management.

5. TRAINING AND COMMUNICATIONS

Part of this alignment with business processes includes the training and communication plan. It is important to train staff in the new technology. Whether that training takes place in a classroom or through CBT (computer-based training), or through some other means is up to see the management alignment and support, they are more likely to support it themselves.

1. CROSS-FUNCTIONAL PARTICIPATION

Implementing KM technology goes across functions in the organization, as such, it is a necessary part of the project to reach out into the whole organization by creating a virtual team. While at first glance this may seem cumbersome and time-consuming, the investment in involving all stakeholders in the initial planning stages is critical to the success of the project. Soliciting user requirements from all areas of the organization helps to ensure that nothing is missed; it also helps in change management, communication, implementation, rollout support, on-going maintenance, improvement, and governance activities. Without this kind of involvement across the organization, technology may very well be rolled out, but it will be perceived as something that IT or another organizational department is doing to the rest of the organization and it will not be adopted and used, resulting in sub-optimal ROI (Return on Investment) and productivity improvements.

Having implementation leads from across the business helps to ensure that as the technology and KM activities are rolled out and that they align with the users and their processes. This allows for minor modifications in configuration if necessary. As previously mentioned, this distributed model helps ensure buy-in and support from all stakeholders.

Tied into these previous two points is the need for the KM initiative to have relationships with key knowledge network points within the organization. Understanding who these people are and the role that they play is critical to the successful adoption of the KM technology and programme as a whole. These people are thought leaders, gateways, to the legions of people in their network that they may work with regularly, or only on an occasional basis. Having the support of these individuals makes roll-out that much easier.

2. TECHNOLOGY IS A MEANS TO AN END

It must be remembered that technology is a means to an end, not the end itself. If stakeholders and business processes are not involved and considered as part of the process of determining what technology to purchase or create, the best software in the world can be rolled-out to the organization, but no one will use it.

3. DEQUATE BUDGET

The last thing to consider in aligning business and IT around the Knowledge Management technology is that an adequate budget must exist. Users will provide lots of requirements and functionality requests that will make their jobs easier. All of this functionality does not need to be available at the initial roll-out, but the functionality does need to be prioritized and a set of "must-have" functionality must be incorporated into the initial technology release. If that core technology functionality is not present users will rebel against the implementation and will continue to do their jobs the way that they have always done them. The investment in planning, technology selection, and development will have been for nothing.

4. THE ALIGNMENT PROCESS

The alignment process is made up of 8 steps, starting with collecting the requirements, moving through selecting and implementing the technology and processes, and ending with using and evolving the KM technology and processes (see Figure 1).

Throughout the execution of the alignment process a change management plan is executed. The plan will evolve during the process to account for future phases/activities of the KM initiative. The plan will include training and communication activities to help inform and engage staff throughout the organization. Part of the change management activities will be to assign roles and responsibilities as they were envisioned in the KM Strategic Plan that is developed as part of the alignment process.

11.1 Step 1: Collect

First analyse the organization's existing Knowledge Management practices, starting with current information and knowledge processes or flows, business processes, and organizational culture. This analysis is crucial to understanding the current state of the People, Process, and Technology components that are part of the Knowledge Management activities.

Information collected through the use of interviews, questionnaires, and workshops is incorporated into a KM strategic plan document that becomes the basis for the next steps in the KM initiative. It only in understands the current state that a plan can be developed to the desired future state.

11.2 Step 2: Analyse

The goal of the Step 2 is to review/interpret the information gathered in the Step 1and to create a framework of processes, knowledge, and information flows. These are then associated with KM methods and best practices, as well as the technology or technologies that will support them. Throughout this phase, the organization must work to understand how its processes can be evolved to create stability and flexibility to advance the maturity of the KM activities within the organization.

11.3 Step 3: Resolve

The analysis from Step 2 is summarized in a strategic plan document that forms the basis for future phases in the KM initiative. Key to this is to rationalize existing and desired processes and information flows, identifying dependencies, and defining metrics and key success factors. The finalization of the plan typically includes a maximum of two iterations/review sessions with identified stakeholders; more than two iterations results in loss of momentum and loss of interest/buy-in by the stakeholders. Reviewing the strategic plan with the stakeholders and getting input helps with buy in and support, but also ensures that nothing was misunderstood or overlooked.

11.4 Step 4: Select software application

Once the strategic plan is created, the organization can take the requirements developed and specified in the Collect-Analyse-Resolve steps and start looking at specific technologies. The organization may want to consider creating their own application rather than buying an application off-the-shelf, especially if they have needs that are not met by the marketplace. However, in most cases, the benefits of buying off-the-shelf software far outweigh the benefits of a custom development initiative. This make versus buy decision will be further discussed in a later chapter.

When selecting an application, it is important to compare the same features and functions against each technology being considered. The easiest way to do this is to create a scoring methodology and record scores for each application. Adding up the totals will give each application a score. Once each application is scored, appointments with the desired vendors can be made to review their product or depending on the organizational rules, an RFP (Request for Proposal) can be issued to the desired vendors.

In making a final decision, each of the finalists must be rated and ranked on the same criteria, therefore the initial scoring system may need to be modified based on the results of the functionality review, e.g. some functionality may be available out-of-the-box from one vendor, while another requires it to be a customization, price is not the only criteria. Other factors that may influence the decision-making process are guidelines put forth by the IT department and / or any existing vendor relationships.

11.5 Step 5: Design/develop/test

Design, develop, and test, are a fairly standard set of IT activities. Design is creating and documenting the customization and configuration information in the case where software has been purchased off-the-shelf. In the case where the organization has decided to create a customized application, the design phase is quite detailed as users will be involved in detailed design sessions so that the application development team has the information they need to design and develop the application.

A critical part of the design/develop/test step is determining the high-level taxonomy and meta-data as planned in the over-all KM strategic plan. Detail level taxonomy and meta-data are created as needed as part of the implementation and evolution of the KM initiative. The taxonomy and meta-data may need to be revised as the application and processes are tested, this is expected and will help ensure the acceptance of the KM technology and processes once they are implemented.

Performing adequate testing is critical to the success of the implementation. There are many types and levels of testing that must be performed. Two of the key sets of tests are: functional testing, which ensures the application works the way users expect it to work; and stability testing, which makes sure the application consistently performs at or above an acceptable level; this is often called load testing.

It is important to include users in the functional testing as the users are able to easily identify functions that do not work as they should. Catching these types of errors before the system goes live helps to ensure its success once it is operational.

11.6 Step 6: Implementation

The implementation step involves organization staff as much as possible, so that the organization feels that it is part of the process and will be able to continue with KM on their own once the project is completed and the KM activities are completely implemented. This approach maximizes buy-in and acceptance among staff, helping to ensure the ultimate success of KM within the organization.

Implementation activities also include a roll-out of KM processes, workflows, and governance as defined in the KM strategic plan and capture base-line metrics. Additionally, an evaluation of the need to select/develop further metrics is included in this step.

11.7 Step 7: Use

At this step of the KM programme, the organization is using the application in its everyday activities. Governance policies and programmes are being executed and monitored by the governance committee and future projects are being planned. Feedback and suggestions for improvements are being collected and implemented where possible and prioritized where they may require budget, longer-term planning, or additional resources not otherwise available as part of regular operational activity.

11.8 Step 8: Evolve

In the evolve step, the feedback and suggestions for improvement received during the Use step, are evaluated along with improvements based on new releases in the application from the vendor as well as changes made necessary by the maturation of the organization. As the organization matures in its use of the technology and KM processes, staff often become capable of using more complex functionality and features, and of generally performing more sophisticated tasks with the technology implemented to support their KM activities. This evolution is desired and necessary.

The other part of the Evolve stage is the continued implementation of the strategic plan that was developed earlier as part of the road map process. As the strategic plan is implemented, it continues to evolve to meet the needs of the organization as they currently exist and as they are anticipated to change over a rolling 3 to 5-year time horizon.

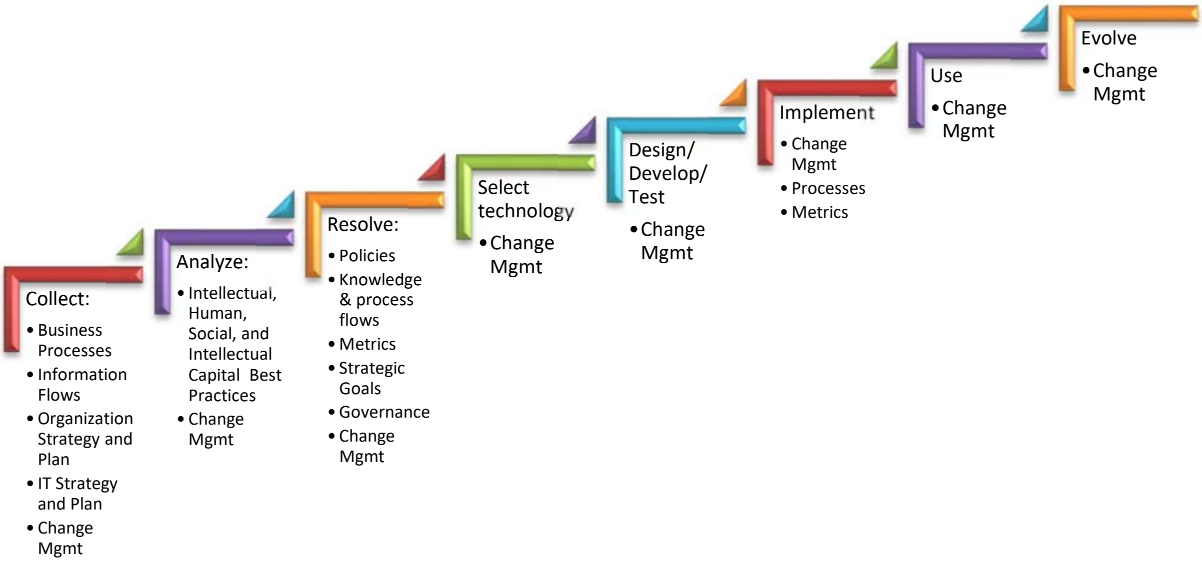

FIG 1 Alignment process

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INTRODUCING KNOWLEDGE MANAGEMENT INTO THE INTEGRATED MANAGEMENT SYSTEM OF NUCLEAR ORGANIZATIONS

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Abstract

The analysis for introducing knowledge management into an integrated management system in nuclear organizations, conducted by NKMI, and discussed in a number of meetings in IAEA and other organizations has shown that currently there is no full and comprehensive implementation of KM in IMS. NKMI has suggested and developed a common, systematic approach for introducing Knowledge Management in the IMS of a nuclear regulatory organization, based on the concept of competence, graded approach and continuous improvement. The approach is based on the concept of integrating an initial review of all knowledge and competence needed for effective and efficient process implementation including a gap analysis and provision of compensatory measures. Knowledge resources are represented as a knowledge resource matrix, which are necessary to complete a given process successfully. The "performance" of the available knowledge resources contribute to an efficient regulatory process is also reviewed at the end of process implementation where relevant decision for enhancement of knowledge and competence are taken, including capturing, preserving, sharing and reuse of new knowledge, gained through the process implementation. The "knowledge resource matrix" approach is fully based on IAEA recommendation and has already been applied in a number of regulatory processes.

1. MANAGEMENT SYSTEMS IN NUCLEAR ORGANIZATIONS

Nuclear regulatory organizations around the world are increasingly adapting to meet the changing expectations of governments, society, and external stakeholders. By employing integrated management systems nuclear regulators can work effectively and efficiently to fully comply with local and national requirements while also meeting IAEA Safety Requirements and Standards (e.g. GS-R-3 the Management Systems for Facilities and Activities, GS-G-3.1 Application of the Management System for Facilities and Activities, and GS-G-3.5 the Management System for Nuclear Installation). The recently completed revision of the most popular quality standard ISO 9001/2008[1], which entered into force in October 2015 also sets a number of new requirements for competence and sustainability which constitute a new challenge to organizations.

The standard requires organization to determine the knowledge necessary for the operation of its processes and to achieve conformity of products and services:

"This knowledge shall be maintained and made available to the extent necessary. When addressing changing needs and trends, the organization shall consider its current knowledge and determine how to acquire or access any necessary additional knowledge and required updates." Organizational knowledge being the knowledge specific to the organization which is generally gained by experience. It includes also the information that is used and shared to achieve the organization's objectives.Organizational knowledge in this context can be based on: a) Internal Sources (e.g., intellectual property, knowledge gained from experience, lessons learned from failures and successful projects, capturing and sharing undocumented knowledge and experience; the results of improvements in processes, products and services); b) External Sources (e.g., standards, academia, conferences, gathering knowledge from customers or external providers)".

Thus for the first time, knowledge and its management had become a core part of one of the principal International Quality Standards, against which different businesses around the globe will be audited. In nuclear industry or regulatory organizations this has a direct impact on the safety, which brings knowledge management to be the critical process in safe and successful operation of the nuclear industry in general.

1. KNOWLEDGE MANAGEMENT IN MATURE NUCLEAR ORGANIZATIONS

Nuclear regulatory organizations in mature nuclear countries need to find new ways of being smarter, taking advantage of the experience and knowledge of their people and innovations, and apply new technologies to achieve higher and higher levels of organizational performance effectiveness and safety. This type of continuous improvement at a systemic, organizational level is best addressed in many of the organizational performance excellence models used in many different types of organizations around the world.[2].

Most organizations using such models share a common goal, to excel in challenging times. The model incorporates modern management techniques and relates most directly to knowledge-based organizations. The key principle is that managers and employees in a nuclear regulator are knowledge-workers and therefore need to be managed as such. To achieve a high level of effectiveness, then, the management systems must incorporate approaches and means to fully leverage the knowledge, experience and insight of all staff, in other words, incorporate Knowledge Management (KM) principles and objectives.

2. KNOWLEDGE MANAGEMENT FOR REGULATORY ORGANIZATIONS IN "NEWCOMER" COUNTRIES

While nuclear power plants or other operational nuclear organizations have a longer period of growing capacity and knowledge transfer from the vendor (supplier) of the technology (could be more than 5 years or more until operations are to be initiated) the nuclear regulatory authority should be fully competent and knowledgeable from day one of the project start. The introduction of knowledge management into the IMS of the NEPIO, the Regulatory Authority and later in the operating organization at the earliest stage of their activity becomes a critical element of the nuclear power program development.

Management systems have become the fundamental management approach in nuclear organizations and the IAEA [1] alongside other organizations like ISO [2], INPO [3] and others have provided systematic and detailed guidance of establishing and implementing an integrated approach to manage the organization with safety as overriding priority [1]. Following are the expected benefits from introducing KM at an early stage of its establishment:

- Faster problem identification; Broader knowledge across the organization of early warning signs of potential trouble through practices such as regular team debriefs and knowledge exchange;
- Consistent use of best practices in problem-resolution techniques across the organization through activities such as After Action Reviews, and knowledge sharing sessions;

— More timely corrective actions taken thanks to better supporting and problem reporting documentation (whether at the process level or as part of on-site maintenance and inspections) through better knowledge capture & dissemination practices using a document management solution;
— Quicker response to problems by employing the most knowledgeable and expert individuals thanks to an experience/knowledge-based 'yellow pages' or employee directory.' and
— More comprehensive and robust safety management programs because critical knowledge from early stages of design, construction, etc is captured in the knowledge-base.

Possible organizational performance benefits and examples of possible KM practices that could be employed to achieve them are:

— Reduced costs from process improvements based on increased participation by employees and strong collaboration on innovation and improvement opportunities;
— Better and faster trained employees from using process experts in refining process documentation and training materials;
— Less dependence (reduced costs) on external training programs, by employing internal coaching networks and Communities of Practice; and
— Reduced time spent on cyclic maintenance downtime through better planning and documentation.

The last four benefits should be seriously considered by “young” organizations as the transfer of knowledge and achieving a sustainable competence is the key strategic objective of the organization.

3. MANAGING THE KNOWLEDGE RISKS

The IAEA developed several publications on Risk Assessment and Risk Management that deal directly or indirectly with Knowledge Management issues in operating organizations, beginning with IAEA-TECDOC-1209 Risk management: A tool for improving nuclear power plant performance [5]. Indeed, the IAEA issued its landmark publication The Nuclear Power Industry's Ageing Workforce: Transfer of Knowledge to the Next Generation (TECDOC-1399) in 2004, followed shortly thereafter with TECDOC-1510 and STI/PUB/1248 in 2006. These publications specifically address one critical issue, the loss of knowledge through attrition. This issue was recognized globally as a critical issue in the 1990s and early part of this century due to demographic changes in the workforce specifically, and aging populations generally. What many organizations fail to realize is that Knowledge Management addresses much more than just knowledge loss through attrition.

With a growing number of new countries interested to develop a nuclear power program the risk of losing knowledge has shifted in a different domain. The risk environment has been reformulated from risk of losing valuable knowledge through attrition, mainly retirement to risk due to rotation of experts and TSO, irrelevant transfer of knowledge from international experts to national expert community and lack of continuity in the process of acquiring expertise and experience form the young generation of professionals. The later being a problem not only for newcomers but also for mature nuclear countries where recent young generation tends to change profession and areas of interest early enough before they really gain the knowledge and experience needed for addressing nuclear safety issues.

Knowledge Management practices contribute directly to the effectiveness and efficiency of an organization in its daily operations and what it needs to be successful in its future, in addition to safety. The IAEA publications that speak to the issue of risk in nuclear organizations are enhanced by including Knowledge Management practices as enablers to address identified risks. It is an important factor in achieving safety and both an operational improvement but also in nuclear regulation and a strategic enabler for future success. Knowledge Management today has matured from the initial stage of philosophical discussions and has moved into a strategic management tool and a critical enabler for Organizational Excellence.

4. INTRODUCING KNOWLEDGE MANAGEMENT INTO THE IMS

The Nuclear Knowledge Management Institute (NKMI) has been working to develop a simple and easy to understand approach for implementing Knowledge Management in the Management System of nuclear regulatory organizations. As the current standards provided by the IAEA and other international organizations do not give a clear guidance how to apply knowledge management approaches, methodology and tools into IMS processes, a simple but practical approach has been developed and implemented. The approach (Fig. 1) is based on the concept of integrating an initial review of all knowledge and competence needed for effective and efficient process implementation including a gap analysis and provision of compensatory measures.

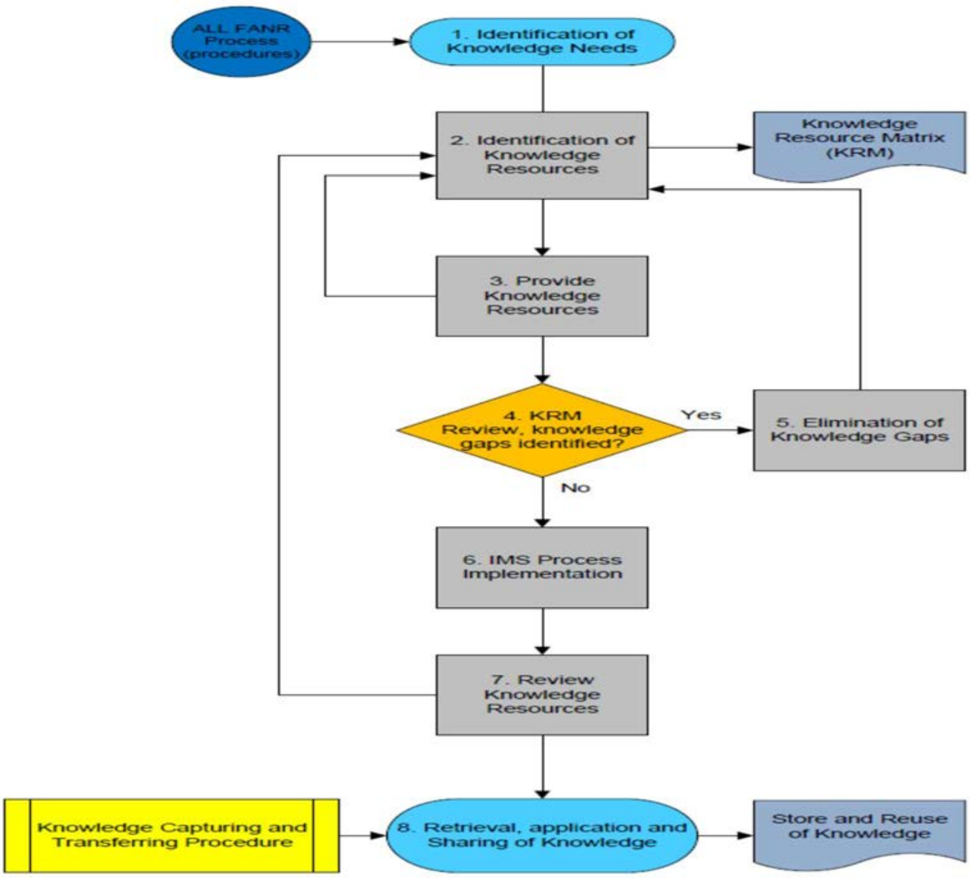

FIG.1 Introducing Knowledge management into processes of IMS.

The "performance" of the available knowledge resources is also reviewed at the end of process implementation where relevant decision for enhancement of knowledge and competence are taken, including capturing, sharing and reuse of new knowledge, gained through the process implementation.

The suggested approach is not meant to replace current IAEA requirements and guidance for Integrated Management System. Its purpose is to complement the IAEA guidance and to provide an efficient model of managing knowledge and competence in the different IMS processes. The suggested approach for implementing Knowledge Management in the IMS establishes a sustainable knowledge base for core processes implementation but also serves as a good model to support all other management and supporting processes in a nuclear organization.

5. KNOWLEDGE RESOURCE MATRIX INTEGRATION MODEL

Integrating a knowledge management approach into the IMS process is suggested, based on the IAEA recommendations for assuring competence [4]. This approach requires that in order to implement its principal function the respective organization needs a set of competencies in different areas. The IAEA recommends that these competences be compiled in 4 major areas: legal, technical, organizational and cultural.

TABLE 1. GENERIC KNOWLEDGE RESOURCE MATRIX FOR IMPLEMENTING IMS PROCESSES.

	Human Resources	Structural Resources	Relationship Resources
Legal, regulatory, organisational knowledge	The legal and statutory competencies of experts needed to meet the requirements and activities of the respective IMS Process.	The requirements, codes and regulations to be utilized and met for the Process, as appropriate, including where necessary IT solutions support Process.	External regulatory/legal resources and legal knowledge gained from external organizations, communities of practice, experts, etc.
Knowledge of technical disciplines	The technical and scientific competencies of experts required to understand and apply knowledge to meet the requirements of the Process.	Technical documents, reports, R&D data and other resources utilized for meeting required outputs of the process, and IT support as needed for process.	External technical resources and technical knowledge gained from external organizations, TSO, Communities of practice, etc.
Knowledge of organization's Practices	Specific rules, requirements and practices for staff in meeting Process requirements.	Internal guidelines, procedures, records and reports of activities, review, audits, lessons learned, etc. to guide and regulate the process implementation and measure effectiveness of meeting Process requirements.	External sources of experience and feedback, including vendor proposals, NGO's, and external or new staff members who import knowledge into the Process.
Personal and behavioural competences	Culture and interpersonal skills, including organizing, communication and transfer of technical competence and knowledge.	Documents, training material, assessments and other resources produced and shared to achieve personal and behavioural competences, relevant to meet Process requirements and to interface with other affected organizations.	Utilizing international conferences, NGO's and cooperation to gain and develop personal and behavioural competences needed in the Process.

The so called "competences quadrant" [5] thus becomes a principle necessity for implementing any of the IMS processes in the nuclear organization. The NKMI has further developed this concept using the modern management approaches to competence [6], which can be vested in humans, in laws, standards, documents and any other explicit formats as well as in working relationships, networks, and external co-operations, including outsourcing and knowledge sharing activities. Thus the "competence quadrant" as recommended by the IAEA converts into a knowledge resource inventory as a matrix having three main components: human based knowledge resource, structural or codified knowledge resource and relationship knowledge resource.

All of these are absolutely necessary and should be carefully considered in the implementation of the IMS processes. The suggested generic knowledge resource matrix is presented in Table 1. The knowledge resource matrix approach creates an opportunity for the process owner to maintain a realistic inventory of available knowledge resources within the organization as well as in other related organizations; TSOs, external consultants, R&D organizations and individual experts. At the same time the process knowledge matrix provides the background and rationale for senior management decisions aimed at planning and acquiring knowledge resources for implementing the core function of the organization.

The development of a knowledge resource matrix for each IMS process and procedure creates a horizontal cooperation between experts, units, sections and divisions and makes the most efficient use of available knowledge resources in the organization. In many cases such cohesion is blocked by administrative barriers and lack of real accounting of the existing organizational capacity. An open minded and transparent process of developing a "knowledge resource matrix" for each process and procedure in the IMS is necessary to achieve effective and efficient use of all organizational knowledge resources and correctly plan and introduce external support.

At the initiation of each process the knowledge resource matrix of needs to be developed and validated. The knowledge acquisition procedure (Figure 2) provides for conducting a knowledge gap analysis and developing compensatory measures.

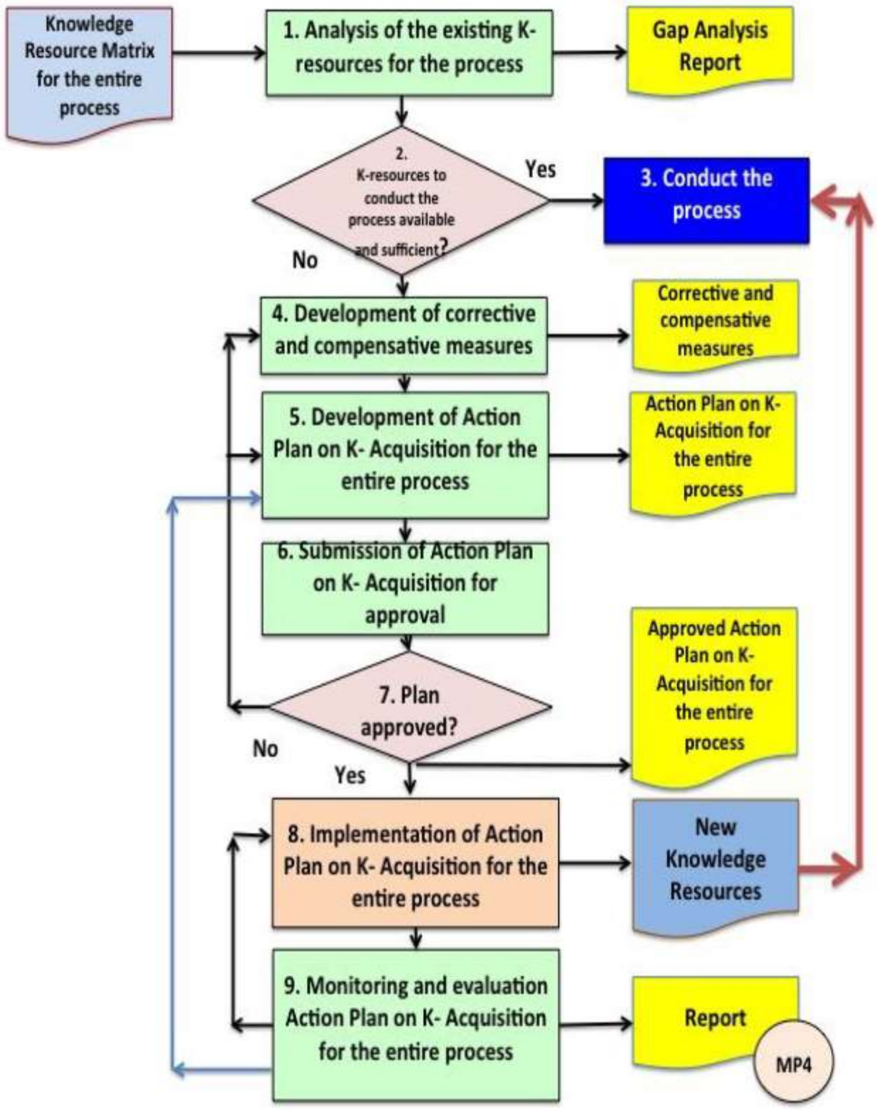

FIG.2 Knowledge acquisition procedure

Once the main IMS process is completed than the knowledge management component is activated and provides for review and analysis of knowledge resources and their performance during the process as well as for critical knowledge capturing and transfer and reuse through sharing, training, etc., through a knowledge capture and transfer procedure (Fig.3). Important element of the KM implementation is capturing new knowledge and its validation.

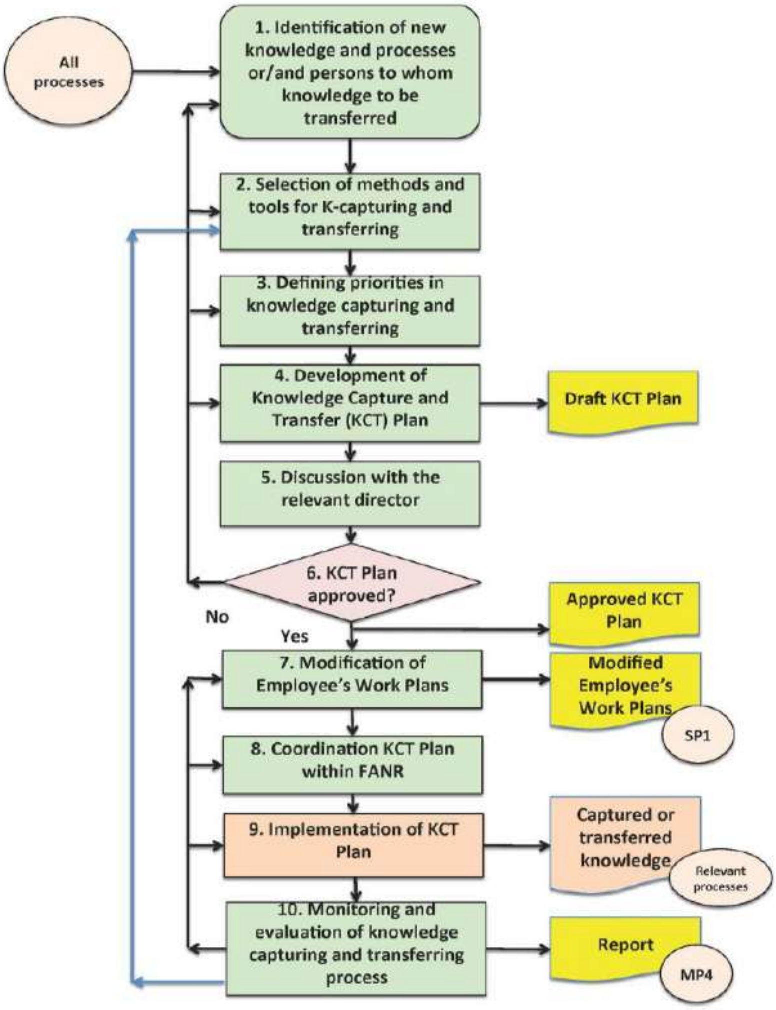

FIG. 3. Knowledge capturing and transfer procedure

6. CONCLUSIONS

The suggested approach for introducing KM in the IMS of a nuclear organization, both regulatory and operational, is entirely based on IAEA recommendation for developing and maintaining competence in nuclear activities. This is of critical importance for a regulatory organization in a newcomer country where national competence is insufficient and external assistance at the beginning of the nuclear program is almost obligatory. The knowledge resource matrix for each process of the Integrated Management System provides the knowledge base for maintaining an overriding priority of safety in developing and implementing nuclear activities. Last but not least the knowledge resource matrix is a simple and transparent overview of the capacity of the organization and can serve as basis for decision making in HR management, Education and Training activities, Leaving Experts Debriefings, Experts Onboarding and of course attracting and linking to different areas of international nuclear expertise.

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THE ROLE OF THE RADIATION SAFETY INFORMATION COMPUTATIONAL CENTER (RSICC) IN KNOWLEDGE MANAGEMENT

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Abstract

The Radiation Safety Information Computational Center (RSICC) is an information analysis center that collects, archives, evaluates, synthesizes and distributes information, data and codes that are used in various nuclear technology applications. RSICC retains more than 2,000 packages that have been provided by contributors from various agencies. RSICC's customers obtain access to such computing codes (source and/or executable versions) and processed nuclear data files to promote on-going research, to help ensure nuclear and radiological safety, and to advance nuclear technology. The role of such information analysis centers is critical for supporting and sustaining nuclear education and training programs both domestically and internationally, as the majority of RSICC's customers are students attending U.S. universities. RSICC also supports and promotes workshops and seminars in nuclear science and technology to further the use and/or development of computational tools and data. Additionally, RSICC operates a secure CLOUD computing system to provide access to sensitive export-controlled modeling and simulation (M&S) tools that support both domestic and international activities. This presentation will provide a general review of RSICC's activities, services, and systems that support knowledge management and education and training in the nuclear field.

1. INTRODUCTION

For the past five decades, the Radiation Safety Information Computational Center (RSICC) has served as the official repository for nuclear modeling and simulation (M&S) and data for the Department of Energy (DOE) and its predecessors and has collected and disseminated related information worldwide under specific distribution restrictions and guidelines set forth by the US government. RSICC maintains collaborations with other similar international organizations to foster cooperation and exchange of M&S tools and data to benefit to our customers. RSICC houses nearly 2,000 software packages provided by code developers supported from various research institutes and universities in the US, as well as international agencies and research centers. Many of these codes have a broad range of applications and uses.

One revolutionary challenge that RSICC has faced is the ever-expanding capability of computing technology accompanied by growing reliance on the need for M&S tools. In some part, the demand and reliance on M&S tools is a consequence of the increasing cost associated with operation of experimental nuclear facilities and the reduced availability of such facilities. Therefore, being able to provide quality-controlled software and data that can be utilized across a diverse set of computing technologies is of growing importance, yet it is no easy task. Fortunately, RSICC has had the support of sponsors and code and data developers, along with access to a variety of computing resources to ensure that the packages that we supply to the user community span the breadth of computing resources available to our customers and address the range of the applications for which such software is needed.

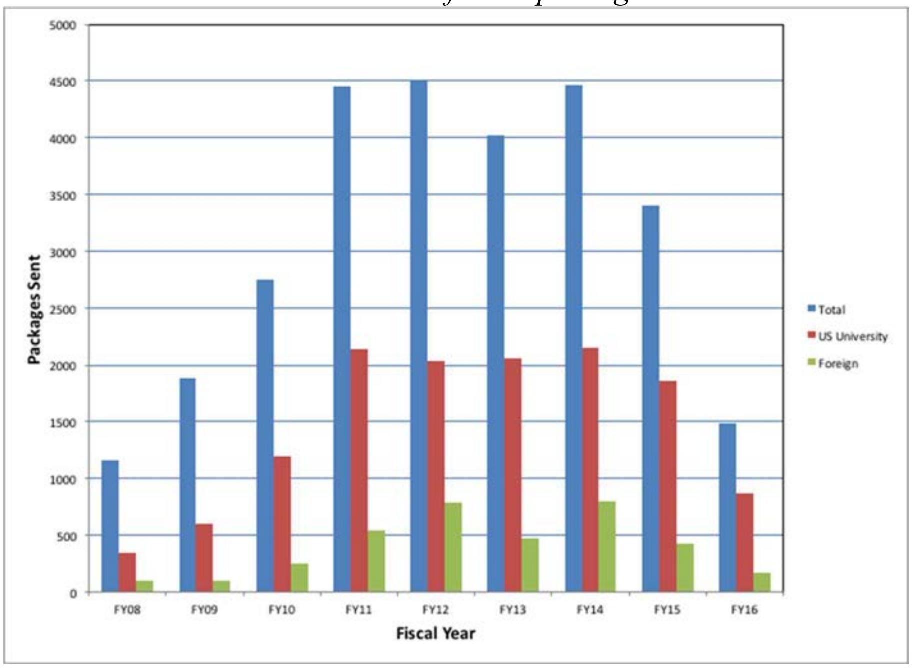
RSICC's distribution of M&S tools and data helps to promote international cooperation in nuclear safety, ensures the safe development and deployment of nuclear technology, and provides those countries possessing or pursuing nuclear technology access to state-of-the-art software. All of these activities are an integral part of the knowledge management mission of RSICC. In fact, RSICC has over 16,000 active customers. Students, researchers, and faculty at U.S. universities represent the fastest growing segment of RSICC's customers. The growth in the number of RSICC's foreign customers has presented some challenges in providing access to M&S tools that have deemed "sensitive" by the U.S. Federal government because these pose a greater risk of diversion from their intended purposes or could be utilized for nefarious activities. To help to resolve the dilemma between the open sharing of nuclear technology and the need to minimize the potential use of nuclear technology for nefarious purposes, RSICC developed, deployed, and implemented a system to provide access to modern software and data for which access would otherwise be limited or restricted. The deployment of this system also has additional benefit because some users may lack access to sufficient computing infrastructure to effectively utilize modern M&S tools. This secure access provides an important avenue for knowledge sharing. This paper provides a general overview of RSICC's activities, services, and systems that support knowledge management activities in the nuclear field.

2. Software Demand

Blue >750; Red 350-749; Green 150-349; Yellow 50-149; Light Blue

The demand for state-of-the-art M&S tools has nearly doubled over the past 5 years, as shown in Figure 1. Over the past 5 years, RSICC has distributed approximately 4,000 software and data packages annually to customers and has seen a substantial growth in the number of packages delivered to customers who are not US citizens (shown in the figure as "foreign"). At the same time, RSICC has seen substantial growth in the number of requests from US universities.

FIG. 1. RSICC's annual software package distribution.



Along with the growth in the demand for M&S tools and data, RSICC's customer base has expanded to include over 100 countries (Figure 2) and over 20,000 registered individuals. The greatest number of our customers is in the US, but RSICC has seen additional growth over the past 5 years in countries pursuing development and deployment of nuclear technology. Over 16,000 active customers from throughout the have requested or received software from RSICC since 2005. Outside the US, most of RSICC's clients reside in Canada, France, the United Kingdom, China, Republic of Korea, and Germany. As reliance on advanced M&S tools and data grows, RSICC anticipates further growth in the demand for its services. The provision of these services is critical to the preservation and promulgation of knowledge in the nuclear field.

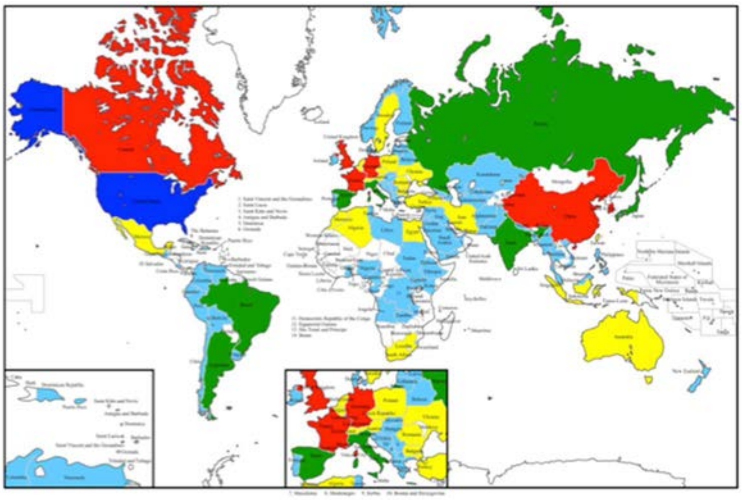


FIG. 2. RSICC's customer demographics.

3. KNOWLEDGE MANAGEMENT OF MODELING AND SIMULATION TOOLS AND DATA

RSICC's primary mission is centered on the archival, preservation and distribution of software, data and experimental databases. The M&S software and data distributed by RSICC are being used for many applications including but not limited to developing advanced reactor concepts, computing radiation source terms, designing and developing fusion devices, ensuring nuclear criticality safety, designing accelerators, nuclear medicine studies, and nuclear security applications. Of the 2,000 packages maintained by RSICC, the Los Alamos Monte Carlo code MCNP [1] and the Oak Ridge National Laboratory SCALE system [2] and are in the most demand by our customers, as shown in Figure 3, because these codes can be applied across many application areas. Accordingly, RSICC also co-sponsors various training workshops and seminars to enhance the knowledge of our customers in the use of these codes.

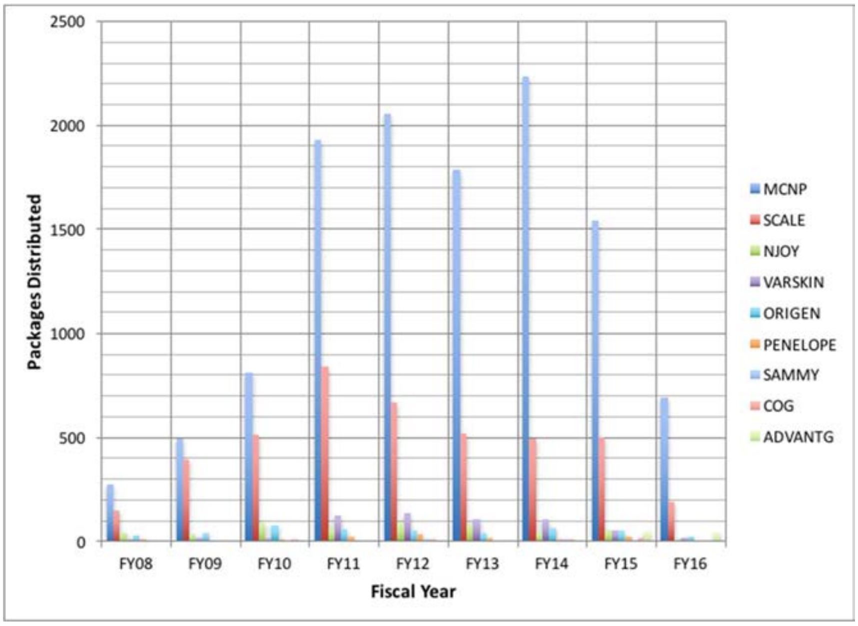


FIG. 3. High-demand package distributions by RSICC's.

In addition to the M&S software and data, RSICC also archives, maintains and distributes databases and information from legacy experiments related to nuclear criticality safety, reactor physics and nuclear shielding. These databases are maintained in electronic format and provided to our customers to support on-going research and education activities. Some of these databases are jointly maintained by RSICC and the Data Bank of the Nuclear Energy Agency.

As previously stated, some individuals who otherwise could not be provided access to certain M&S software are now be able to use state-of-the art M&S software through RSICC's secure cloud computing system. These individuals are mainly foreign nationals collaborating with or working at US national laboratories, universities, or companies. Access to RSICC's secure cloud server has been provided to over 50 individuals involved in various research and development activities. One example of a significant international collaboration is with ITER [3], the international nuclear fusion megaproject under construction in the south of France. Access to the secure cloud has been provided to allow ITER contributors to use the MCNP Monte Carlo code for the design of shielding and safety systems without which it would be difficult for them to meet their obligations to this international project.

4. SUMMARY

Knowledge management is an integral part of RISCC's core mission. RSICC's acquisition, preservation and dissemination of M&S tools, data and legacy experimental data along with the operation of secure cloud server contribute significantly to the promulgation of knowledge in the use of state-of-the-art M&S tools. Additionally, RSICC's support of conferences, training workshops, and seminars that are related to M&S tools is vital to enhancing the knowledge base of the users of M&S tools. Centers such as RSICC play a pivotal role in knowledge management and are a valuable service to nuclear community. In light of the growing dependency on M&S, such centers are likely to have an even greater role in knowledge management in the future.

5. ACKNOWLEDGEMENTS

The author would like to acknowledge the support of the US Department of Energy Office of Nuclear Energy, the National Nuclear Security Administration, and the Office of Nonproliferation and Arms Control for development and deployment of the secure cloud computing system. The author would like to thank Mark Baird, Matt Disney, Ken Barker, and Brian Zachary of ORNL for their efforts to install, test, and validate the system's operation, as well as for their development of the network security protocols that enabled the system to be deployed.

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OECD/NEA DATA BANK ACTIVITIES ON NUCLEAR KNOWLEDGE PRESERVATION AND MANAGEMENT

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Abstract

The Nuclear Energy Agency (NEA) operates as a special agency of the Organisation for Economic Co-operation and Development (OECD), an intergovernmental body based in Paris. The main objective of the NEA is to assist its member countries in maintaining and further developing, through international co-operation, the scientific, technological and legal bases required for a safe, environmentally friendly and economical use of nuclear energy for peaceful purposes.

The NEA Data Bank, created in 1978 by the fusion of the Neutron Data Compilation Centre and the Computer Program Library, deals more specifically with nuclear data and computer programs covering the whole nuclear fuel cycle and some non-energy applications. The objectives of the Data Bank are to "act as an international centre of reference for its Member countries with respect to basic nuclear tools, such as computer codes and nuclear data, used for the analysis and prediction of phenomena in the nuclear field, and to provide a direct service to its users by developing, improving and validating these tools and making them available as requested".

1. NUCLEAR ENERGY AGENCY DATA BANK

Over the years, the Data Bank has built up outstanding scientific assets since it concentrates nearly all available information relating to reactor physics in one place. This sum of knowledge is at the disposal of Member countries through direct services to users, supplying nuclear data and computer programs covering most research and development work in the nuclear sector. Based at Boulogne-Billancourt (France), the Data Bank services are used by scientific users that have been granted authorisation by Member countries and that belong to over 800 organisations: national laboratories, universities, safety authorities, etc. The main objective of the data preservation and transferring activity is to minimize the risk of losing highly valued knowledge contributed by the member countries, and to prevent additional costs to future generations should they start searching again on the development of similar nuclear systems. The Data Bank's advanced computer facilities allow a large number of data and computer programs to be sent out each year.

NEA Data Bank services are financed by contributions from its 25 Member countries, and no direct services charge is made to users.

The NEA Data Bank has a special exchange arrangement with the US DOE and also provides services to non-OECD member countries, according to a specific cooperation with the IAEA.

2. NUCLEAR DATA SERVICES

The NEA Data Bank acts as a centre of excellence for scientific nuclear data used in all areas of nuclear energy application. It is an essential link between the producers and users of nuclear data by providing scientists, who are using bibliographic, experimental and evaluated nuclear data in their work, with reliable data in a convenient and readily-available form.

The Data Bank services also consist in advising scientists on the data that is best suited for the required applications. The advice is frequently based on feedback from the NEA Nuclear Science programme, where the performance of many data sets is tested in different international benchmark exercises.

In order to offer an extensive and useful service, the Data Bank has built up a number of very large databases containing different types of scientific nuclear data. Most of these databases are maintained and updated within international networks and are directly accessible through the NEA Internet pages. All data reside in the on-line databases and are provided by free access in the following categories:

— EXFOR: Experimental nuclear reaction data, covering neutron and charged particle induced reactions as well as photonuclear data. EXFOR, started in 1969, has always been coordinated through the international Network of Nuclear Reaction Data Centres (NRDC), where the other three main nuclear data centres are, besides the OECD/NEA Data Bank, the National Nuclear Data Center (NNDC) at Brookhaven National Laboratory (USA), the Nuclear Data Services (NDS) at the IAEA and the Russian Nuclear Data Center (CJD) at the Institute of Physics and Power Engineering (IPPE). In addition to storing the experimental numerical data points and their bibliographic information, experimental information including detail descriptions of uncertainties is also compiled. EXFOR is complete with respect to neutron reaction data, and it is intended to cover also all charged particle data up to 12C with incident energies up to about 1 GeV. Selected photon-induced and exotic reaction data are also included. EXFOR contains at present about 21,108 experiments from 1935, divided in 163,425 different data sets collected from 8,130 scanned literature dating since 1960's;
— CINDA: Bibliographical information on experimental, theoretical and evaluated nuclear data for neutron and charged particle induced reactions. CINDA contains an almost complete bibliography of all neutron data published since 1932, as well as an index to corresponding EXFOR entries and evaluated data. Besides neutron data, CINDA also covers charge-particle induced data, photo-neutron, photo-fission and spontaneous fission data. CINDA is available upon web retrieval, through the JANIS program and as an archive book that can be requested from the NEA;
— EVA: Evaluated nuclear data libraries (JEFF-3.2, ENDF/B-VII.1, JENDL-4.0, TENDL-2014 and many more) in a common format of ENDF -6 describing reaction data, decay data, fission yields etc.;
— JEFF: The Joint Evaluated Fission and Fusion (JEFF) Nuclear Data Library Project is a collaboration between NEA Data Bank participating members. The JEFF library comprises sets of evaluated nuclear data, mainly for fission and fusion applications; it contains a number of different data types, including neutron and proton interaction data, radioactive decay data, fission yield data, thermal scattering law data and photo-atomic interaction data. The JEFF-3.2 Nuclear Data Library is the latest version of the neutron file, released by the NEA in March 2014. JEFF-3.2 is available in ENDF-6 and ACE formats from the web and covers 472 nuclides. It contains data evaluations compiled at the NEA Data Bank in co-operation with several laboratories in the Data Bank member countries. An update of the decay data and fission-yield libraries is also in preparation and is scheduled for the next release of JEFF, under the JEFF-3.3 library series.

The NSC Working Party on international nuclear data Evaluation Cooperation (WPEC) provides a worldwide framework for co-operative activities between the major nuclear data evaluation projects. The goal of the WPEC is to improve the quality and completeness of evaluated nuclear data available for use in science and technology and to promote the efficient use of available resources through international collaboration. The Working Party will assess needs for nuclear data improvements and address those needs by initiating joint data evaluation and/or measurement efforts. The WPEC has so far produced 31 reports and is currently working on a number of different issues. The Working Party is also maintaining a list of the most important nuclear data requirements, the High Priority Request List (HPRL). The purpose of this list is to provide a guide for those planning measurement, nuclear theory and evaluation programmes.

The NEA Data Bank is also providing assistance to nuclear data users by developing tools to facilitate the handling of the data. One of those tools is the computer display program JANIS designed to facilitate the visualisation and manipulation of nuclear data. Its objective is to allow the user of nuclear data without prior knowledge of the storage format to easily access numerical values and graphical representations. It offers maximum flexibility for the comparison of different nuclear data sets. JANIS comprises a number of functionalities and contains the latest evaluated data libraries. The search function for experimental data information in EXFOR and CINDA has been set up. A variety of output formats exist in JANIS. For the graphical display, the PS/EPS and PNG formats are possible, and tabular data can be stored in CSV format for further use in other types of software (e.g. MS Excel).

The JANIS software has become very popular and the latest version of the software was distributed to more than 500 users. The code can also be run directly from the NEA Internet pages, allowing users to always launch the most up-to-date version, JANIS-4.0 (September 2013). Access to nuclear data by JANIS exceeds 120,000 requests per month; therefore JANIS has gained the status of real user-interface to our users of nuclear data. The program continues to be improved and, for example, work is currently under way to display uncertainty (covariance) data.

The recent development of the NDEC (Nuclear Data Evaluation Cycle) platform is at the center of the initiative undertaken by the Data Bank to strengthen its role as a reference centre in verification, benchmarking and validation of nuclear data. These efforts aim at providing better nuclear data services to the Data Bank's member countries in general and to serve the Joint Evaluated Fission and Fusion (JEFF) Nuclear Data Library project in particular.

3. COMPUTER PROGRAM SERVICE

The Computer Program Service (CPS) maintains a collection of about 2 000 computer codes covering all NEA's fields of interest. Computer programs acquisition is done through contributions from member countries, or exchanges with other centres (mainly RSICC in the USA). Prior to their inclusion in the CPS collection, programs are tested. These "computer program packages" are distributed upon request to scientists in Data Bank member countries and, on a case y case basis, to non-OECD member countries through the cooperative arrangement with the IAEA.

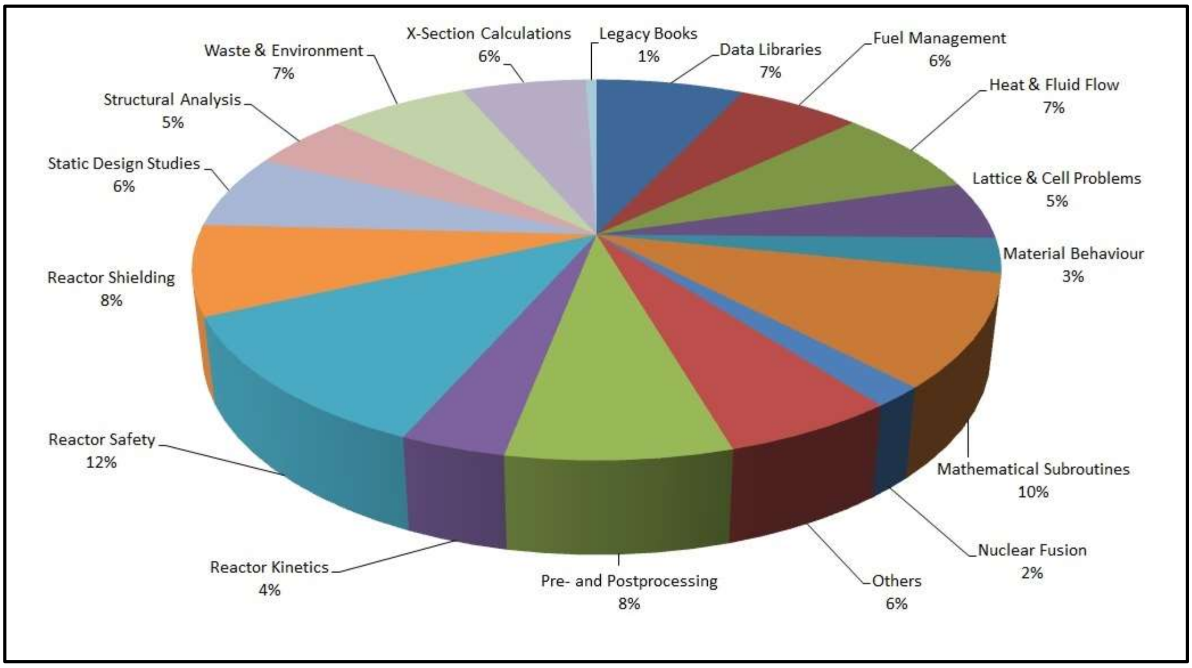

FIG. 1. Computer programs by topic.

The CPS collection covers a wide range of nuclear science and technology fields, including disciplines from physics to chemistry and applied mathematics and, to a minor extent, geology and biology insofar as the impact of nuclear activities on the environment is concerned. Figure 1 shows the subdivision of computer codes available from the NEA Data Bank by application field.

The computer codes used in most nuclear applications have the role of bridging the gap between the underlying microscopic phenomena and the macroscopic effects. Using a mathematical and algorithmic language, they accumulate, in a readily usable, concise way, the wealth of physics knowledge that science and technology have acquired over the last half-century. In many cases these computer codes can have a relatively complex structure; in addition to several modules, they also contain associated data libraries (for generic or project-oriented applications), application-dependent code/data sequences, test problems, documentation including validation reports, etc. This represents an extensive knowledge base managed at an international level.

Generally, a program package contains the source files, its related documentation (including a description of the physical problem, the mathematical method used to solve it, information on input and output data and instructions to run the program), a test case including sample input and output data and associated data libraries if needed. A regularly updated list of all the computer programs abstracts is available on the CPS web pages.

It is well known that the best computer code can produce wrong results if used by inexperienced users. When computer codes are small, used by experts only, no specific training was required. With the increased use of computer codes for modelling practically every aspect of science and engineering a large number of users needs to be trained to ensure a correct and effective use of them. It is with this in mind that such courses have started to be organised by the Data Bank on the most popular computer programs. Each course is attended by between 10 and 25 participants and is financially self-supporting through the fees paid by them. The classes are taught by the authors of the computer codes. Participants gain hands on-experience and acquire competence in the use of the codes for problem solving. The training courses are an essential component for knowledge preservation and transfer.

4. INTEGRAL EXPERIMENTS

The Data Bank co-operates closely with the NSC on the preservation of information and data from well-documented integral experiments in the areas of reactor physics (IRPhE), criticality safety (ICSBEP), fuel performance (IFPE) and radiation shielding (SINBAD). The NSC provides scientific guidance on which experiments to preserve and is also responsible for the verification and evaluation of the data. The Data Bank assists in the compilation of the data and in the dissemination of the final product in the form of qualified benchmark databases (DICE - Database for the International Criticality Safety Benchmark Evaluation Project, IDAT - International Reactor Physics Handbook Database and Analysis Tool).

The Data Bank is also assisting the CSNI in preserving data and information from different joint research projects in the nuclear safety area, such as the CSNI Code Validation Matrix (CCVM), the Cabri Water Loop Project, the Material Scaling Project (MASCA) and the International Steam Explosion Database (STEX).

There is no common distribution policy for the integral experiments, as different data sets have different restrictions depending on the origin of the data. A few databases are available only to the contributors or participants to a specific project.

Since its foundation in 1964, the Computer Program Library, which became the Computer Program Service in 1978, has distributed about 110,000 packages of computer programs and integral experiments to more than 800 nominated establishments around the world.

5. THERMODYNAMIC DATA

In addition to computer program and nuclear data services, the Data Bank is also coordinating a separately funded project that aims to produce a comprehensive, internally consistent and quality assured chemical thermodynamic database of selected chemical elements used in the safety assessment of deep geological nuclear waste repositories. The project, called the Thermochemical DataBase (TDB) project, is a joint undertaking of the Data Bank and the NEA Radioactive Waste Management Committee.

The TDB project has published 13 major reviews so far, covering chemical thermodynamic data of inorganic and organic species of uranium, thorium, neptunium, plutonium, americium, technetium, nickel, selenium, tin, iron, and zirconium as well as a state-of-the-art report on solid solutions.

6. CONCLUSIONS

The legacy of very large sets of data, algorithms and competent knowledge included in the reports on studies covering the interplay and performance of the different tools represents a highly valuable resource and investment for the member countries. This legacy needs to be preserved and maintained, in a format suitable for the new generation and its new technologies.

DIGITAL REPOSITORIES OF LEARNING MATERIAL AS A SUPPORT TOOL FOR KNOWLEDGE MANAGEMENT AND CAPACITY BUILDING

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Abstract

For some years, digital repositories are emerging as a de facto standard service for storing,preserving and disseminate knowledge: academic, scientific information and, morerecently, primary research data of institutions. Some of the digital repositories host alsocollections of material classified as learning objects; some others are created to manageonly learning objects (LO), as the Learning Objects Digital Repositories, or were built tofunction as learning objects aggregators. The term “learning object” itself is involvingdifferent types of structures, organization and complexity. This paper will show how digitalrepositories, metadata standards and semantic web technologies can be valuable tools formanaging educational content, which can contribute to build a learning and knowledgedriven organization.

IT–ENABLED KNOWLEDGE MANAGEMENT SYSTEM FOR NUCLEAR RESEARCH AND DEVELOPMENT ORGANIZATION

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Abstract

A knowledge management (KM) system for codification, preservation and utilization ofall multi-disciplinary knowledge assets accumulated over several decades of nuclear research,development and operation is essential for improved organizational productivity,new insights and high-levels of innovation. IGCAR's Nuclear Knowledge ManagementSystem deployed with IT-as-enabler addresses various challenges related to people, process,technology and resources and provides a technology platform to leverage the collectiveknowledge of the organization. This paper describes the strategic action plan and structuredapproach followed for building IT-enabled knowledge management system to acquire, store,share and utilize the organizational knowledge assets in the explicit form of publications,technical reports, presentations, projects, activities, facilities etc., along with the tacit knowledgemulti-media modules. It highlights the salient features of the in-house-developedadvanced KM portal deployed for facilitating the creation, archival, retrieval, sharing anddissemination of knowledge assets originating from diverse domains, in an organized andsecured way. The paper also underlines the application of semantic technologies, toolsand standards in implementing a robust KM technology infrastructure with enhancedfunctionalities.

OECD/NEA (NUCLEAR ENERGY AGENCY) REPMET (RADIOACTIVE WASTE REPOSITORY METADATA MANAGEMENT) INITIATIVE

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Abstract

National radioactive waste repository programmes require large amounts of data to demonstrate safety that increase in number, type and quality as these programmes proceed through the successive stages of final repository development, i.e. siting, characterization, construction, operations and closure. As a repository takes decades to develop, long-term data management is a critical aspect for guaranteeing that future generations will be able to understand the decisions carried out today. Metadata, "data about data", are a fundamental tool of modern data management. They are used to search information in data records; to store the context with data; and to support their archiving and preservation. The OECD/NEA RepMet is an initiative devoted to bringing about a better understanding of the identification and administration of metadata to support national programmes in managing their radioactive waste repository data in a way that is both harmonized internationally and suitable for long-term management and use. After exploring several metadata concepts and their application in non-nuclear fields (e.g. geospatial, records management), the RepMet group started developing data and metadata libraries for topics relevant to radioactive waste repositories. RepMet is currently working on a library for waste packages ready for disposal in repository.

1.INTRODUCTION TO REPMET

RepMet is an initiative under the IGSC (Integration Group for the Safety Case) of the OECD/NEA RWMC (Radioactive Waste Management Committee). The initiative was launched by the IGSC in 2013 due to their need of preserving important safety data. The project is currently in its Phase-I. Several worldwide Waste Management Organizations (WMOs) and research laboratories from OECD/NEA countries are involved in the RepMet initiative: ANDRA (France), ENRESA (Spain), JAEA (Japan), NAGRA (Switzerland), NDA (UK), NWMO (Canada), ONDRAF/NIRAS (Belgium), POSIVA (Finland), PURAM (Hungary), Sandia National Laboratories (USA), SKB (Swedish), SURAO (Czech Republic). The RepMet group meets twice yearly; working groups, composed of RepMet members, carry on the project work in the intervening periods.

2.BACKGROUND. WHY METADATA. WHY REPMET

National radioactive waste repository programmes require a large amount of data across multiple disciplines (e.g. geoscience, engineering, waste management, context aspects) for a variety of purposes including site selection and characterization, numerical modelling, repository design and construction, repository operation, repository licensing, waste packaging, safety case production, environmental impact assessment, etc. The collected data increase in number, type and quality as national programmes progress toward a final repository. A critical challenge is to manage this large amount of data for the overall repository life cycle: pre-siting, siting, characterization, construction, operation and finally closure. Metadata, "data about data", are a key tool of the long-term data management. The main aim of RepMet is to investigate metadata and to bring about a better understanding of their application within the radioactive waste repository field in support of national programmes. By carrying out this work at the OECD/NEA level, involved organizations will benefit from an internationally harmonized approach which benefits from the experience and learning acquired by sister organizations.

Error! Reference source not found. shows a possible scheme for classifying metadata, and includes potential applications for radioactive waste management (see last paragraph of Section 3 for specific examples).

TABLE 1. A CLASSIFICATION SCHEME FOR METADATA WITH POTENTIAL APPLICATIONS FOR THE RADIOACTIVE WASTE MANAGEMENT

<table>
<tr><th colspan="3">Metadata Types</th><th>Potential applications</th></tr>
<tr><td>Discovery metadata</td><td colspan="2">Helps a user to find the data objects that they are looking for.</td><td>Subject area of a dataset, dates of creation or update, geographical coverage.</td></tr>
<tr><td rowspan="3">Preservation metadata</td><td colspan="2">Representation information and preservation description information needed to ensure long-term understandability and confidence in the data objects.</td><td>-</td></tr>
<tr><td>Contextual metadata</td><td>Put the data objects into a wider context, allowing objects to be related and compared, and to provide understanding of their provenance.</td><td>Details of organisation that produced or modify a dataset, original format of dataset.</td></tr>
<tr><td>Detailed metadata</td><td>Detailed metadata represent additional information about the data or object in a structured and detailed way.</td><td>Source, ID, how waste inventory is derived from the radionuclide inventories.</td></tr>
</table>

Future generations have to be able to understand the collected data and be able to trace the decisions made today. The core idea of long-term data management is that “data are being collected and managed for the others to use”. The current generation of scientists and research teams, as well as communication specialists, have to keep in mind this idea and document their work accordingly. How to preserve repository data beyond its closure, in other words the very long-term management data, lies outside the scope of RepMet initiative. This is one of the scope of a different OECD/NEA RWMC activity: the Preservation of Records, Knowledge and Memory across Generation (RK&M) initiative. However, RepMet has a strong connection to RK&M, because the set of information handled by RK&M initiative is also derived from data and metadata handled by RepMet initiative.

3.LILW WASTE PACKAGE LIBRARY

After analyzing metadata and their application in several non-nuclear fields (e.g. INSPIRE for geospatial data, Dublin Core Schema for records management), the RepMet initiative is focusing its Phase-I on a particular topic of relevance to radioactive waste repository programmes: low and intermediate level waste (LILW) packages that are ready for final disposal.

As a first step, RepMet has produced two exploratory questionnaires to develop an overview of the data and metadata currently collected by RepMet members about LILW waste packages ready for final disposal. The questionnaires were organized around a number of high-level categories (e.g. “wasteform”, “container”, “overpack”), each of which lists potentially relevant data and metadata that might be collected. Respondents were asked to identify whether they collect each piece of information, and to explain the reasons for its collection (storage, transport, or final disposal), pointing to relevant documentation and adding further information as necessary. Eleven organizations responded to the questionnaire: they added 206 items to the initial 90 that the NEA Secretariat selected initially as starting point. A second revised version was developed in order to organize information in more structured and complete way (e.g. new arrangement of high-level categories, deletion of overlapping items, merging of redundant items): after this revision, the new questionnaire contained 157 items. Thirteen organizations responded to the second questionnaire (two more than for the first questionnaire): they added only 30 items. New respondents added the half these new items; the other half are due to the addition of increased detail for generic items or the inclusion of additional topic as items concerning spent sources. The analysis of the second questionnaire lends confidence to comprehensive nature of the current data list.

Starting from the data list obtained after the second questionnaire, the RepMet group has set a goal of creating a unified data and metadata library for LILW waste packages ready for final disposal. Metadata are connected to data and vice-versa, thus before identifying metadata for waste packages, and more generally for the library, RepMet needs to structure and organize the data. To describe the relationships between different pieces of data and metadata, the RepMet group adopted a number of concepts and tools from the software engineering field of data modelling, namely the "Data Model" (DM) 0 and "Entity-Relationship Diagram" (ERD) 0. From a general point of view, a DM is a description of a number of logical entities, together with their properties (attributes) and the logical relationships between each entity. Entities are typically "real world" objects such as, in the radioactive waste management field, a wasteform, container or overpack; they may also composites of other entities such as a waste package. A logical relationship, for example, between wasteform and waste package express the minimum and the maximum number of occurrences of wasteform that may be related to a single occurrence of the waste package (and vice-versa since a relationship is bidirectional). In our current DM, for example, one or more wasteforms may be within one waste package, as well as a one waste package may contain one or more wasteforms. Attributes are then the data (e.g. waste activity) or metadata (e.g. assaying method) which make the entity well defined. These software engineering tools are also used to ensure that the library is well defined and could subsequently be customized and implemented within a data storage system if desired. The choice of such a system or provider lies outside the scope of RepMet. In carrying out this work, RepMet has developed a high-level methodology to create a data and metadata library for LILW waste packages ready for disposal. This methodology consists of the following steps:

1. Define a set of entities related to the waste package (e.g.: container, waste, wasteform);
2. Define relationships (cardinalities) between each entity (e.g.: how many different types of waste may be associated with each container);
3. Develop, as far as possible, a comprehensive and mutually exclusive set of well-defined data attributes to describe the properties of each entity (e.g.: the activity or density of the waste);
4. Develop, as far as possible, a comprehensive and mutually exclusive set of well-defined metadata attributes to underpin each data item (e.g. how the waste activity was assayed) and support long-term management and use.

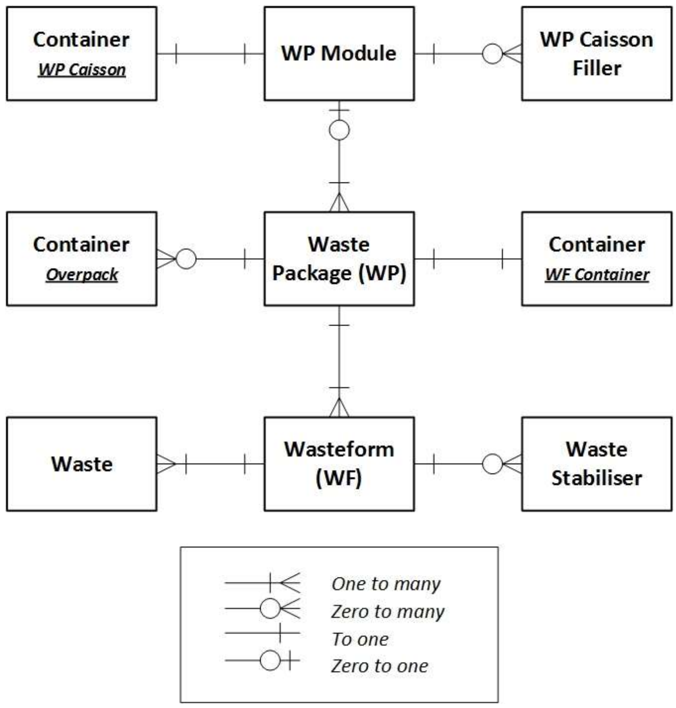

FIG. 1. DM 0 entities and relationships for LILW waste package library according ERD 0.

Suitable definitions are required for each entity and data or metadata attribute to ensure that each user understands the item in the same way. An official glossary of the RepMet initiative will be used to collate all of these definitions: where possible existing controlled vocabularies by OECD/NEA and IAEA have provided these. The group has achieved the first three points of the methodology above for LILW waste packages and is now working on final point, the core of the project. The group presented its preliminary data model at the RepMet meeting in October 2015 where the entities and relationships were discussed, following which a number of changes were made. Error! Reference source not found. illustrates the current set of entities and their relationships using an ERD representation.

The data attribute list for each entity will be presented at the RepMet meeting in April 2016. These data attributes have been sourced from the second questionnaire and associated with the defined set of entities: the questionnaire items have been reviewed, sometimes changed, and hierarchically organized in mind-maps (diagrams for structuring information in an effective visual way). It is anticipated that the waste package library will become a useful instrument for WMOs when defining future information requirements for waste packages in view of their final disposal.

To complete the library, sets of metadata need to be associated with the data attributes to fulfil the roles of discovery or preservation identified in TABLE 1. Discovery metadata may include the subject area (e.g. waste package inventory taking into account the current library) or the dates of creation and update of certain data attributes in order to facilitate their automatic search. Contextual preservation metadata may include the organization that provide the data or its original format. For example, the data attributes of overpack entity may be associated with metadata reporting the name of manufacturing company or the original data format as paper reports. Detailed preservation metadata may include useful and additional information. For example, the data attributes concerning radiological inventory (e.g. gamma activity, single radionuclide activity) may be associated with metadata attributes reporting if they are from direct measurement and observation (e.g. 137Cs), and/or statistical estimation (e.g.: HTMR radionuclides). In the first case, metadata may contain information about the instrumentation used for measuring and its calibration; in the second case, other metadata may contain information about the statistical estimation process. However, it is worth observing that one person's data may be another's metadata: the boundary between what is considered "data" and "metadata" is highly dependent on the context and mode of use. Metadata standards in non-nuclear fields are a possible source for the metadata attributes of the library. The recommendation of useful existing metadata standards, as an alternative to the creation of a new one, is a key aspect of RepMet current investigation on metadata for radioactive waste repository programmes. In addition to the metadata library, the RepMet initiative is developing a guidance document on metadata policy to aid Waste Management Organizations in the production of effective policies to manage the creation and maintenance of metadata.

4.MAJOR ACHIEVEMENTS

Data modelling techniques have proven to be a fundamental tool for RepMet and allowed the initiative to come to a better, common, understanding of waste package data. The working group had initially discovered that members from different countries understand and interpret individual waste package terms differently: the group was able to come to a common agreement through data modelling. As a matter of fact, the relationships shown within Error! Reference source not found. depend strictly on the definition of each entity, and RepMet has therefore started developing a controlled vocabulary via a glossary. The starting point for the RepMet group glossary was the "IAEA Safety Glossary" 0. However, some definitions have been modified in order to ensure self-consistency within the DM and to add flexibility to the DM to ensure that it can represent a diverse range of waste packaging solutions. Moreover, the use of concepts from the field of data modelling allows RepMet to be consistent with existing methods and terminology, while also producing a DM that can more readily be adapted and implemented by waste management organizations if desired.

5.CONCLUSIONS AND NEXT CHALLENGES

The RepMet, by exploiting tools and terms from the field of data modelling, has developed a high-level methodology to produce data and metadata libraries for topics related to radioactive waste repository programmes. The first library has focused on LILW waste packages that are ready for disposal. Questionnaires have been issued to get an overview of the information currently collected by WMOs for LILW waste packages. The RepMet has already organized and structured the collected information in a DM 0 which consists of entities, relationships among entities (as Error! Reference source not found. shows according to ERD 0), and data attribute lists for each entity. Currently, in order to finalize the library, the group is working on selection of discovery and preservation metadata (TABLE 1) to underpin the data attributes. In addition to the investigation of metadata in view of the long-term management and use, it is expected that this library will be useful to WMOs also for defining future information requirements for waste packages. Following the same methodology, future libraries are expected to cover other relevant topics, such as HLW (High Level Waste) and spent fuel waste packages ready for disposal, and repository site characterization.

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RECORD MANAGEMENT AUDIT: NUCLEAR MALAYSIA'S EXPERIENCE

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Abstract

Malaysian Nuclear Agency (Nuclear Malaysia) is heavily reliant on information in order to accomplish its strategic research & development, and commercialization (R&D&C) outcomes. Since its beginning in 1972, the activity of Information Management (IM) – Records Management (RM) is always integrated in the process of knowledge repository. Division of Information Management (DIM) is the custodian for the agency's knowledge repository and also responsible to ensure its compliance with the National Archive of Malaysian Act 2003 (Act 629), as well as to address the needs of 3s - Safety, Security and Safeguards outlined by IAEA.

In 2013, Nuclear Malaysia has launched KM Nuclear Policy which includes KM audit committee, to oversee and provide checks and balances for KM initiative programmes. The first KM audit conducted was the Record Management Audit (RMA), started in 2014. The journey faced some challenges from people, process and technology and later completed in 2015 with accumulation of new knowledge derived for the KM improvement. RMA is a unique process which needs to be shared with others because it offers example and experience from the perspective of nuclear R&D agency.

1.ORGANIZATIONAL CONTEXT

1.1 Malaysian Nuclear Agency: government R&D for nuclear technology

Malaysian Nuclear Agency (Nuclear Malaysia) was established on September 19, 1972 with the responsibilities to introduce and promote the use of nuclear science and technology in national development. As a R&D organization, Nuclear Malaysia is heavily reliant on information in order to accomplish its strategic research, development and commercialization (R&D&C) outcomes. From time to time, new products, services, and breakthrough on nuclear and related technologies were introduced to the public and market.

Nuclear Malaysia always emphasized the activity of record management as part of the Knowledge Management (KM) process. As a government agency, records are both an important business asset and the cornerstone of truly accountable government. It is compulsory for Nuclear Malaysia to comply with primary legislation governing agencies' record management responsibilities; National Archive of Malaysian Act 2003 (Act 629). The Act stated that "Public records" means any papers, documents, records, registers, printed materials, books, maps, plans, drawings, photographs, microfilms, cinematograph films and sounds recording of any kind whatever, officially received or produced by any public office for the conduct of its affairs or by any officer or employee of a public office in the conduct of his official duties". In addition, Nuclear Malaysia also needs to comply with the 3s; Safety, Security and Safeguards outlined by IAEA.

1.2 Division of information management: KM custodian

Records management took place in Nuclear Malaysia in a much conventional way until 2015. It is managed by the Division of Information Management (DIM), a section that acts as agency's repository and one-stop knowledge centre (library, gallery, publication, nuclear education outreach and public awareness activities). For other divisions it is compulsory to submit copies of their publication to DIM, which later will be reported in the Nuclear Malaysia's Key Performance Index (KPI) annually. This reporting process is mandated by the agency's Documentation Policy.

Records are managed by DIM in various formats, including paper, microfiche (given by IAEA), negative films (pictures), drawings and videos. Most records are kept until now, except microfiche which were approved by INIS to be disposed permanently. The decision was made after INIS announced the migration of knowledge in IAEA; this was successfully conducted and an online version is now readily available at the INIS website. For other formats, DIM has not set up the retention timeframes, has left the decision to each division for final disposal. It is also not necessary to surrender records to DIM, but these can be stored at the respective division and for varying periods of time. For instance, reactor log books and drawings are permanently at onsite locations and managed by the nuclear operator.

1.3 KM Initiative Programme: Drives for Record Management Audit

In 2014, DIM has initiated a KM programme called Record Management Audit (RMA). There are three drivers (reasons) which led to this programme. The first driver was because audit is part of Nuclear Malaysia KM Policy. A dedicated committee was set under the KM policy to conduct a check and ensure the balance of KM implementation in Nuclear Malaysia. To start the ball rolling, the committee chose to audit the record management, since this program has never been done before.

The second driver for RMA, is to implement the recommendation of the IAEA Assist Mission (Jan 21-25, 2013). The mission assessed Nuclear Malaysia's KM maturity and offered some recommendations to strengthen the effort for its implementation. One of the recommendations was to review the strategy for the information management system. This action should consider record auditing and technology adaptation to strengthen KM repository.

The last driver for RMA, is to migrate the KM repository from conventional to digitized, a longstanding plan for Nuclear Malaysia, but difficult to implement because the technology is very costly. Hence, to convince the government for possible budgetary support towards the NKM program, a sound justification and solid statistical reasoning had to be presented. Therefore, through RMA, Nuclear Malaysia was able to show the importance of knowledge migration and technology as enabler for KM repository.

2. OBJECTIVES OF THE RECORD MANAGEMENT AUDIT

The objective of RMA was to provide assurance on the adequacy and effectiveness of the implementation of DIM's records management framework, in terms of collection numbers, documentation process, security classification; and to provide an interim progress check on the availability of the documents recorded in the repository.

3. DESCRIPTION OF THE KM INITIATIVE

DIM has initiated the RMA internally as part of KM initiatives. To meet the objective, DIM developed an action plan with a people-centric approach. The Division has communicated with Nuclear Malaysia's top management for their support and endorsement, and to the researcher group for their cooperation, as the respondent of this audit.

Initially, DIM estimated the project would be completed in a year because the respondent was among the researcher of Nuclear Malaysia. The total number of researchers is 323, but only 49% or 160 responded to the audit. Unfortunately it took longer to get feedback from the researchers, and the assessment process was tedious. Figure 1 shows the steps of the RMA initiative.

A variety of techniques was used to identify the key elements and processes necessary for a RMA. Benchmarking was used to determine what had been done in Malaysia, particularly from the R&D institutions perspective. A KM technical visit was conducted to MARDI, MPOB, Central Bank of Malaysia, PETRONAS. This was followed by the identification of the national requirement outlined by National Archive and the practice of international standard by IAEA. A literature search assisted in the assembly of background information to perform RMA through IAEA publication series.

The scope of the record keeping requirements was also established. It was determined that it would be necessary to maintain certain record series on the site, while others would be surrendered to DIM repository. A revised set of document categories was established that provides a basis for the types of information and record to be stored in the system. Determining the record classification requirements was also necessary, as it is important to save critical records and discard others that are inconsequential.

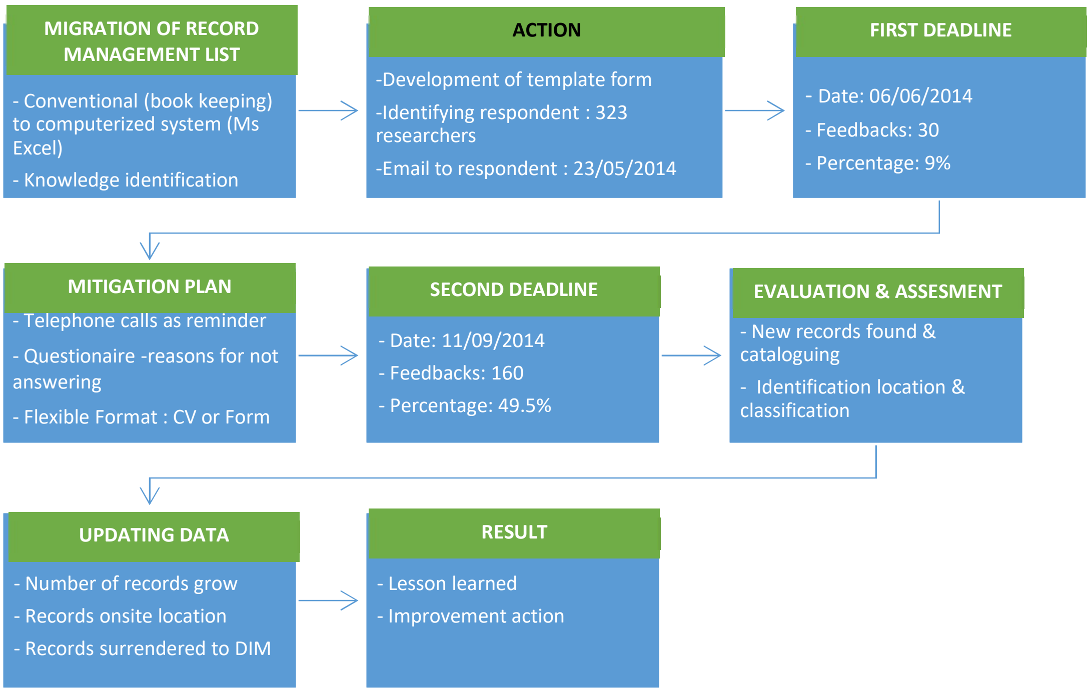

FIG. 1. Record management audit process.

3. MAJOR CHALLENGES

In the process to complete RMA, DIM faced several major challenges from the three aspects of KM: people, process and technology.

4.1 People

Divided into two groups:

- Respondent: Some respondents failed to see the importance of RMA. They had difficulties to respond within the time frame because of reasons such as: they were busy with other jobs responsibilities (meetings, research), they were not in the office (fellowships, trainings), they misunderstood the format or did not received the mail at all.
- DIM's officer: Difficulties to choose the best practice, lack of staff, no background in record management and proper training for KM Repository.

4.2 Process

The documentation process is part of the KM policy, which explains the respondent their responsibility and their role in protecting knowledge assets. The aim of the RMA process is also to ensure the continuity of agency operations and the preservation of nuclear technology in Malaysia. Major findings for the process of RMA are:

- The systems used were conventional or manually recorded into a log book. The classification was too simple and the issue of document security was not properly addressed.
- There are numbers of old documents that were not recorded in the log book. This is based on the respondents' feedback.
- The record keeping activity was not properly monitored. Some documents were not in the repository. Borrowed documents were not returned, they were misplaced or maybe in onsite locations.
- Some respondent claimed that documents were no longer available, due to malfunction of their desktop computer. Therefore they could not surrender those documents.

4.3 Technology

DMI's Officer only use Microsoft excel to record the list of documents that have been audited. The process is quite difficult and searching the list where documents have been recorded can be confusing. Old documents in hardcopy were recalled and recorded in a more systematic way. This process requires tools of modern scanning technology to ensure a smoother scanning process and to save time.

4. LESSON LEARNED

RMA has been very important and it should be considered by any R&D organizations as part of their KM initiatives. After performing RMA, there were a few lesson learned that DIM would like to share with other agencies, which have not perform RMA yet or are planning to do so. The lessons learned are summarized below.

5.1 Strengthening record management system

All agencies should start with benchmarking or identifying the national key requirements (e.g. archive act), and comply with international standards (if any). To ensure a successful RMA, this must have endorsement by the top management of the agency and be supported by policies & procedures. The RMA plan must identify what is a 'record', and describe the process for ensuring that records are appropriately received, created, controlled, archived or destroyed.

5.2 Documenting key decisions

During the process of RMA, try to track a sample of key business decisions or processes through agency's records. Documentation for these processes was relevant for future operational decisions. For example the chronology to embark on new nuclear facilities; government decisions, legal aspect, procurement, commissioning, operational and decommissioning.

5.3 Ensuring adequate security over records

Agency should assess the risks associated with their records and develop business continuity plans. Document placement (onsite or offsite), format (digital or printed), classification and knowledge retention need to be reflected when drafting a disaster recovery plan. In addition, the agency should have secure access to the records management system by restricting the administration to only a few staff. This is to avoid that a person with unnecessary administrator access could inappropriately change or delete electronic records.

5.4 Training staff in records management

Training has to be perceived as an investment, and not as additional expenses. Record Management has a lot of processes. It includes the work with explicit, implicit and tacit knowledge and experience. Agencies need to provide some training to the staff on record management; this must be comprehensive and undertaken by all required staff. Adequate staff training is essential to ensuring that records are created and retained as needed.

5. CONCLUSIONS

Good record management underpins Nuclear Malaysia's R&D&C activities and processes. It supports agency accountability, permits effective flow of information within and between agencies, and assists agency efficiency by ensuring information is readily identifiable and available. RMA will be considered as a yearly activity with different scope and objectives.

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THE STORAGE OF THERMAL REACTOR SAFETY ANALYSIS DATA (STRESA)

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Abstract

The Storage of Thermal Reactor Safety Analysis data (STRESA) is an online information system that contains three technical databases:

— European Nuclear Research Facilities, open to all online visitors.
— Nuclear Experiments, available only to registered users.
— Results Data, being the core content of the information system, its availability depends on the role and organization of each user.

Its main purpose is to facilitate the exchange of experimental data produced by large Euratom funded scientific projects addressing severe accidents, providing at the same time a secure repository for this information. Due to its purpose and architecture, it has become an important asset for networks of excellence as SARNET or NUGENIA. The Severe Accident Research NETwork of Excellence (SARNET) was set up in 2004 under the aegis of the research Euratom Framework Programmes to study severe accidents in water-cooled nuclear power plants. Coordinated by the IRSN, SARNET unites 43 organizations involved in research on nuclear reactor safety in 18 European countries plus the USA, Canada, Republic of Korea and India. In 2013, SARNET became fully integrated in the Technical Area N°2 (TA2), named “Severe accidents” of the NUGENIA association, devoted to R&D on fission technology of Generation II and III.

1.ORGANIZATIONAL CONTEXT

The European Union (EU) is a unique economic and political partnership between 28 European countries that together cover much of the continent. The European Commission is the EU's politically independent executive arm. It is alone responsible for drawing up proposals for new European legislation, and it implements the decisions of the European Parliament and the Council of the EU.

At the EU level, a wide range of nuclear-related activities such as health protection, safeguarding against proliferation of nuclear weapons, supply of nuclear fuel and nuclear research fall under the scope of the Treaty Establishing the European Atomic Energy Community (Euratom), one of the original Treaties of Rome in 1957 and signed by all EU Member States.

Nuclear research is funded by the European Commission through multi-annual Euratom Framework Programmes. These programmes provide support for research under two Specific Programmes, one for 'direct actions' carried out by the European Commission's own Joint Research Centre (JRC) and the other for 'indirect actions' -i.e. research carried out by consortia of key EU research organisations and industrial partners and managed by the Commission's Directorate-General for Research and Innovation.

The Joint Research Centre (JRC) is the European Commission's in-house science service which employs scientists to carry out research in order to provide independent scientific advice and support to EU policy. The range of work carried out at the JRC also includes the compilation of a large number of databases in addition to the development of software and modelling tools.

These resources are either available to all members of the public or to specific research groups, providing assistance to scientists in carrying out their work.

2.OBJECTIVES OF THE KM INITIATIVE

The STRESA information system was developed by the JRC in the year 2000 with the objective of storing and disseminating experimental results produced by unique and large JRC experimental programmes such as LOBI, FARO, KROTOS or STORM.

The specific requirements stablished at that time were to be accessible through Internet and to allow full control over the visibility of the experimental data performed directly by the experiment responsible and not by an external coordinating institution.

Due to the convenience of these requirements, STRESA was later on also used extensively by SARNET to exchange among its members results from severe accidents experiments developed in their own nuclear research facilities.

The JRC launched in 2015 a new updated version of STRESA with the objective of becoming the reference scientific repository for nuclear severe accidents research in Europe, contributing this way to the development and consolidation of the European Research Area (ERA).

ERA is a unified research area open to the world based on the internal market, in which researchers, scientific knowledge and technology circulate freely. Through ERA, the Union and its Member States will strengthen their scientific and technological bases, their competitiveness and their capacity to collectively address grand challenges.

3.DESCRIPTION OF THE KM INITIATIVE

STRESA is an online information system that contains three technical databases (European Nuclear Research Facilities, Nuclear Experiments and Results Data) and has incorporated capabilities for information management, targeted search and communication among users in order to cover the needs of at least two main groups of users:

a. JRC colleagues working in Severe Accident Modelling in support to Emergency Plan Preparedness for European NPPs:

    i. Using the database and its search features as source of information for the assessment and improvement of analytical models and system codes.

    ii. Using the database as data management framework for guaranteeing the confidentiality, integrity and availability of the research results.

    iii. Using the communication features of the database allowing sharing data with researchers from other organisations and discussing about the experiment results.

b. Scientists from other European research organisations:

    i. Using the database as their own experimental data repository, keeping full control over the confidentiality of their content and its availability to different groups of users.

ii. Using the database and its search features as source of information for their research activities, being able to request data sets and research documentation directly to the intellectual owner.

iii. Use the communication features of the database allowing sharing data with researchers from other organisations and discussing about the experiment results.

4. MAJOR CHALLENGES AND ACHIEVEMENTS

The biggest challenge has been the need to face evolving risks requiring very different fields of expertise. We had to involve ICT experts for dealing with information security and legal experts for handling data protection and intellectual property.

Thanks to the trust built up during the already 15 years of operation, European research institutions such as the Kungliga Tekniska Högskolan (KTH), the Magyar Tudományos Akadémia Energiatudományi Kutatóközpont (MTA-EK) or the Institutul de Cercetări Nucleare – Piteşti (ICN-Pitesti) decided during the last years to hand over to the JRC an important amount of results data for its secure storage and administration under the new STRESA.

5. LESSONS LEARNED / KNOWLEDGE DERIVED

The risks, requirements or opportunities that online information systems had in 2000 had little to do with the ones they have today. During the long term operation of these systems it is not always easy to identify the ideal moment in time in which their related processes, features, technical solutions or even architecture should be reassessed and finally modified. An interesting lesson related to this particular fact may be learned by looking at the development of the operation of STRESA through all these years.

The first version of STRESA consisted in a distributed network of independent but equal information systems installed in different servers managed by different organisations. This guaranteed an important priority for the involved organisations: absolute full control over the distribution of the owned scientific data.

Through the time, the different maintenance approaches and the possibility to fine tune each version according to particular needs or interests, caused that the development of the different STRESA versions started to diverge. When new challenges requiring the investment of new resources arose, not all organisations were equally prepared to guarantee the confidentiality, integrity and availability of the data stored in their own STRESA version.

Having the resources and the mandate to address this situation, the JRC reformulated the STRESA architecture launching a new version in which the European Commission assumes all responsibility over the service regarding information security, data protection and intellectual property.

Even with all scientific data siting in a single server that is being managed by the JRC, absolute full control over the distribution of the owned scientific data is still guaranteed by using a legal framework: a Licence Agreement between the European Union (the Licensor) and the partner organisation (the Licensee) stablishing the terms of use of the information system according to the needs of the data owner; allowing them to focus in their core business: research.

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ROLE OF TRAINING REACTOR VR-1 IN NUCLEAR TRAINING IN NATIONAL AND INTERNATIONAL CONTEXT

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Abstract

The VR-1 reactor is the key facility in the field of nuclear educational and training in the Czech Republic. The reactor is equipped with several specific educational and training experimental devices and four training laboratories belonging to the reactor - laboratory for neutron interactions studies, laboratory for neutron activation analysis, radiation protection & environmental studies laboratory, and I&C laboratory. Educational and training activities at the reactor were step-by-step extended from domestic activities through the national and international levels up to regional multilateral activities. Future reactor operators and reactor physicists of Czech nuclear power plants have been trained at the reactor since 1992, also reactor physicists from nuclear power plants in Slovakia have been trained since 2002, and trainees from various nuclear developing countries have been also trained at the reactor since 2006. An effective procedure for implementing new experiments and new experimental devices has been developed during more than 25 years of the VR-1 reactor operation. Over 25 experiments can be carried out at the reactor at three levels: demonstration, standard, and advanced.

1. TRAINING AT RESEARCH REACTORS

Numerous research and experimental reactors were built during the first rapid phase of nuclear power development. These reactors were utilised to analyse various aspects of the reactor physics and operation. Nowadays, these reactors can be transformed into nuclear facilities providing education and training of students, personnel from nuclear power plants and experts from a regulatory body.

Training of professionals covers wide range of trainees from young professionals coming for their initial training to experienced workers participating in gradual lifelong learning. Preparation of these courses must take into account both initial training and regular refreshing courses [1], [2]. Training at a research reactor is a very specific discipline compared to other activities at the reactor. There is much less focus on the scientific background in contrast to R&D. Also offering the reactor for training is much more expensive than utilisation of any laboratory at a university, therefore, the training must be as effective as possible. The initial level of knowledge must be respected. As a result, adaptation of the education and training methodology to the initial participants' background level is the key to an effective training. The training at a research reactor is an interactive process, which must use several tools and approaches in order to be efficient and productive. The trainees must be confronted directly with the lecturer - face-to-face approach. In order to visualise the analysed problem, simulators can be utilised. These offer a readily available tool for the simplest transition from the theoretical education towards solution of practical problems. The trainees can learn a practical impact of the subject. The even more advanced approach builds upon direct interaction of the trainees with a real life device or facility. This hands-on training provides imminent experience for the trainees from a certain field of study. It can be argued that these approaches including face-to-face training, simulators and hands-on training are all complementary types of training, which are all necessary for an effective training of any group of trainees.

Users coming for a training at any research reactor have some common general expectations. They are expecting, in the first place high quality of the training. This must come together with wide range of knowledge of the tutors shared with the trainees. This knowledge must well surpass the course requirements. The overall impression from such a course can be further improved by an offer of complex supporting services [3]. It must be considered that the trainees are participating in a course organised at an experimental facility located with the highest probability outside from their homes and work places. They have to travel in a different city or perhaps also country. Every help is therefore a most welcomed to facilitate necessary arrangements.

Complex services offered to the participants should include arrangement of accommodation for the trainees [3]. It is also convenient for the nuclear facility to maintain contacts with nearby hotels and these can offer more favourable rates for the accommodation. Having a really close hotel to the location of the course also reduces necessary time consumed for transportation of the trainees. The course organiser can also arrange transportation from the airport to the hotel and they can help with arrangement of the local transportation. Participants coming from abroad might need assistance with obtaining visas and health insurance. The overall impression from the training can only be improved by providing the attendees with a readily available internet connection at the training facility and/or at the place of accommodation. A special attention must be paid to different cultural and social habits of the participants. All these arrangement are made not only to provide better feeling about the course for the attendees, but it is also beneficial for the final outcome of the training [3]. It helps participants to fully concentrate on the training itself and maximise the training outcome. Budget savings can result in an increased number of trainings, or longer training courses.

2. TRAINING AT THE VR-1 REACTOR

The VR-1 reactor is a pool type reactor with light water moderator and low enriched uranium in form of UO_2 [3]. Its nominal thermal power is 1 kW and it allows maximum power of 5 kW for a short period. It was designed and constructed in the late 1980s, and has been in operation since 1990. The reactor is equipped with two horizontal channels (radial and tangential) and with approximately 10 vertical channels, of varying diameters, which can be loaded into various core positions, and one pneumatic transfer system. The reactor is also equipped with several specifically designed educational instrumentation systems (for delayed neutron studies, void and temperature reactivity coefficients studies, for reactor kinetics studies, etc.) [3]. The reactor is operated by the Czech Technical University in Prague. The reactor operates on a day-shift basis, on working days. The reactor is used for educating of students from Czech and abroad universities, training of experts of the Czech and Slovak nuclear programmes, for R&D work, and for promotional activities related to nuclear energy use (public relations).

TABLE 1. TYPICAL 5-DAYS COURSE FOR FUTURE NPP OPERATORS DURING INITIAL TRAINING AT THE VR-1 REACTOR

Monday 8.30 – 11.30 12.30 – 15.30	Welcome meeting, visit of the reactor Neutron detection
Tuesday 8.30 – 11.30 12.30 – 15.30	Measurement of delayed neutrons Study of the reactor kinetics

Wednesday 8.30 – 11.30 12.30 – 15.30	Reactivity measurement Study of the reactor dynamics
Thursday 8.30 – 11.30 12.30 – 15.30	Control rod calibration Critical experiment – approaching critical state
Friday 8.30 – 12.30 13.30 – 15.00	Digital control and safety systems the reactor, hands- on experience of reactor control by trainees Discussion and evaluation of the course

Training at the VR-1 reactor is based on educational/training units. Standard duration of one unit is 3 hours (i.e. 180 min.) and each unit may consist of one or more experiments [3]. Training course at the VR-1 reactor consists of several units and depends on the customer's request, initial knowledge level of the trainees or curricula. Preparing an effective training course at the VR-1 reactor for a new stakeholder is a long and time consuming process which includes discussing the content and level of the course, course methodology, and terminology used during the course, course material, an evaluation of the course and all logistics issues [3]. An example of a typical 5-day course for future operators of a nuclear power plant (NPP) during initial training is shown in Table 1.

Training at the VR-1 reactor is provided for both national and international customers such as CEZ Group (Czech Republic), State office for nuclear safety (Czech Republic), Research centre Rez (Czech Republic), ENEL-Slovenske elektrarne power company (Slovakia), International Atomic Energy Agency (Austria) or Kuwait Institute for Scientific Research (Kuwait).

3. TRAINING OF NUCLEAR POWER PLANTS' STAFF

Training of operators of Czech nuclear power plants was one of the main reasons for the VR-1 reactor construction [4]. The first contact with NPPs was realised almost four years prior the reactor commissioning in December 1990. After one year of trial operation, the first training of NPP's operators was conducted in February 1992. In the years 1992-2015, more than 90 training courses were completed. Length of each course was three to five days. Together more than 500 future operators passed the training (typically there were 4-8 attendants per a single course). Given the typical number of two experiments per training days, over 600 experiments were performed.

CEZ Group as the owner of Czech NPPs has been the main customer for training at VR-1 reactor (approx. 80 % share on the courses). Further training was provided for company Slovenske Elektrarne- ENEL, which operates Slovak NPPs (share ca. 13 %). Finally, there were professionals from UJV Rez - operates two Czech research reactors - and Skoda company - nuclear manufacturer. It is possible to conduct training for companies from two Central European countries - Czech Republic and Slovakia, as there is no language barrier.

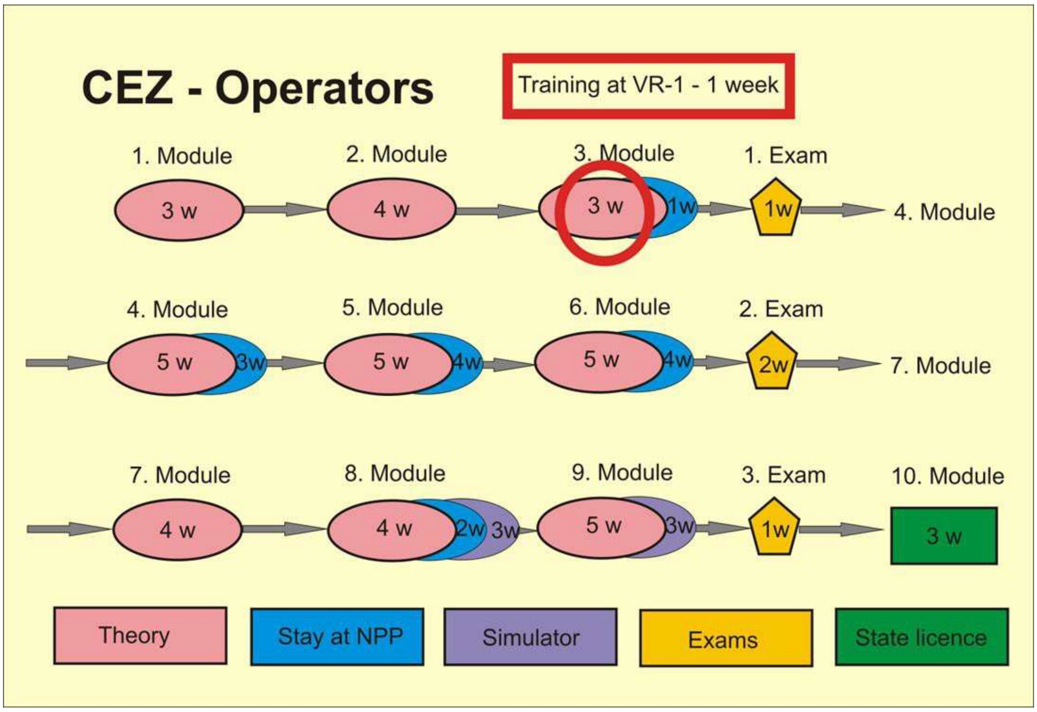

FIG. 1. Integration of training at the VR-1 reactor to NPP operator training programme [4]

Tailoring the training course to special needs of a customer can be illustrated in example of CEZ Group. These courses started as 5-day courses, later it was changed to 3-days length, and recently, it was again prolonged to 5-days courses (typical programme of the course is showed in Table 1.). The training at VR-1 reactor represents typical initial training for CEZ Group operators and reactor physicists and it is included early in the course of preparation of these specialists. Figure 1. shows, how the training at VR-1 reactor is integrated into the training schedule of the CEZ Group NPP's operators [4].

There is also tradition of training of nuclear physicists from Slovak NPPs [4]. It is organised in cooperation with Slovak University of Technology in Bratislava. This course is a typical refreshing course and the Slovak professionals are coming at the reactor every three years. This programme is similar to the training for CEZ Group, but it is usually more flexible and focuses on one certain subject, which is analysed in more detail. Typical topics of this training are critical experiments, reactor kinetics and dynamics, linearity of neutron detection lines, etc. Interesting is that due to similarity of the Czech and Slovak language, the training can be conducted in Czech and there is no need to use English.

4. GROUP FELLOWSHIP TRAINING PROGRAMME ON RESEARCH REACTORS

Another example of a successful training which is carried out at the VR-1 reactor is Group Fellowship Training Programme on Research Reactors (GFTP) [5]. The course has been organised by Eastern European Research Reactor Initiative (EERRI) for IAEA fellows since 2009. The six-week GFTP course is focused on participants from non-nuclear countries, who wish to develop nuclear competence and infrastructure as the first step to development of a national nuclear power programme [5]. The course is aimed at young technical professionals with little or no nuclear experience who can work in the future research reactor operating organization or in the respective national regulatory body.

The GFTP is a typical example of wide range course, which is extremely difficult to organise by a single reactor or a single university [5]. Therefore the GFTP course is organised by several EERRI members at several research reactors in the Czech Republic (VR-1, LVR-15, and LR-0 reactors), Austria (ATI TRIGA reactor), Slovenia (IJS TRIGA reactor), and Hungary (BME and BRR reactors).

The VR-1 reactor plays an active role in educational and training activities of the EERRI coalition and 7 from the total 11 courses were carried out at the VR-1 reactor where 56 participants from 24 countries (Algeria, Australia, Azerbaijan, Brazil, DRC, Egypt, Ghana, Iraq, Jamaica, Jordan, Lebanon, Libya, Malaysia, Mexico, Myanmar, Nigeria, Oman, Pakistan, Philippines, Saudi Arabia, Sudan, Syrian Arab Republic, United Republic of Tanzania, Tunisia & Yemen) have been trained since 2010.

5. CONCLUSIONS

All means of nuclear education and training – face-to-face training, simulators, hands-on training – are complementary types of training. All are necessary for an effective utilisation of a research reactor in training. Utilisation of research and dedicated training reactors for improvement of knowledge of nuclear professionals is important and cannot be replaced by other theoretical types of training. Neither the use of advanced simulators can compensate the close contact with a real facility offering direct manipulations with the equipment.

Several rules for providing successful and cost-effective training were discussed. The most important is adaptation of the training to the specific needs of the participants. Different background knowledge must be reflected. But there are still other ways how the organization of the training can improve the experience for the participants. Some possible ways were provided.

The good practices were demonstrated at the example of the VR-1 reactor. This reactor provides effective and professional training at national and international level and demonstrates a way to integrate a research reactor into programme of training of professionals.

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APPLIED NUCLEAR KNOWLEDGE MANAGEMENT IN AUSTRIA

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1. INTRODUCTION

The Technical University Vienna operates one 250 kW TRIGA research reactor at the Atominstitut for academic education and research. Although Austria is basically an anti-nuclear country this research reactor is well supported by the respective authorities in order to keep nuclear knowledge alive. As an example in 2012 the Atominstitut managed to return after 50 years of reactor operation all HEU and LEU fuel to the US and received in exchange almost fresh fuel elements to continue operation at least up to 2025. In 2015 more than 5 M€ were invested to renew the I&C system, the primary- and secondary coolant system and the ventilation system of the TRIGA reactor.

The Technical University Vienna considers therefore the Atominstitut including its recently upgraded TRIGA reactor as an important asset for keeping the nuclear knowledge alive and to continue knowledge transfer to the next generation of young engineers. In view of making full use of the recent investment and the available technical and academic infrastructure, this facility is also offered to non- academic organisations as a potential centre of knowledge transfer as will be shown below in more detail.

As education and training is the prime utilization of the TRIGA reactor Vienna the following topics are covered in all the following educational and training courses:

- reactor physics and kinetics
- reactor instrumentation and control
- radiation protection
- dosimetry
- safeguards
- nuclear security

These specialized courses are attended not only by national and international students during their academic curriculum but there is also high interest from international customers to send their trainees to those courses on a commercial basis. In addition this reactor has the privilege to be the closest nuclear facility to the International Atomic Energy Agency which results in close cooperation in many of the above mentioned topics.

The courses are carried out in small groups of maximum eight participants and are composed of a combination of theoretical lectures and hands-on training in the areas mentioned above and can be offered both in German and English language. As the courses are structured in individual modules the content of the courses can easily be adapted to the particular needs and interests of the target groups.

The present paper describes the experience through 40 years of nuclear knowledge management and gives four examples of different approaches to nuclear knowledge management for:

- potential nuclear newcomer countries
- NPP countries without any research reactor
- a country objecting nuclear power
- international organizations

2. Courses for potential newcomer countries (Africa, Asia, South America)

Several emerging- or newcomer countries approached the IAEA as they have no or only very limited access to adequate nuclear facilities for human resources development or nuclear knowledge management. Therefore about ten years ago the IAEA coordinated and supported the establishment of a coalition of six research reactors in the following countries: Austria, Czech Republic, Hungary and Slovenia. The aim of this coalition was to offer easy access to several research reactor facilities experienced in education and training. This coalition established a six weeks intensive course where the participants are confronted with different nuclear aspects. The area of topics offered within such a course are listed below.

- Administrative and organisational topics: regulatory and site requirements, nuclear project planning and implementation and decommissioning,
- Reactor related topics: reactor physics, instrumentation and control systems, thermo- hydraulics, maintenance and inspection programs,
- Radiation monitoring: radiation protection, personnel and environmental monitoring,
- Practical courses on reactor physics and kinetics, instrumentation and control systems, radiation protection, dosimetry and on fuel management.

The standard course program starts always at the IAEA Vienna, followed by 1 to 3 weeks at the TRIGA reactor Vienna and then the group travels either to Prague, Budapest or Ljubljana where the participants are further trained at other types of educational reactors . These courses have been carried out very successfully twelve times since 2009 with the financial and logistic support of the IAEA with more than 80 participants from nuclear emerging countries from Africa, Asia and South America.

3. COURSES FOR NUCLEAR POWER COUNTRIES WITHOUT ANY UNIVERSITY RESEARCH REACTORS (UK, SLOVAK REPUBLIC)

Although UK operates a number of nuclear power plants but due to political decision UK has closed down all its civilian research reactors. UK has a dedicated nuclear educational program but no possibility to offer practical hands-on education, training and practical nuclear educational program at a research reactor facility. Responsible for an educational program is the Nuclear Technological Educational Consortium (NTEC) located at Manchester University. In view of this situation NTEC signed an agreement with the Atominstitut to host two groups of up to eight students each per year for practical education and training in reactor physics topics. The curriculum of this course and the credits are accepted by the home university of the students and is now a regular part of the academic curriculum. Again this courses are a combination between theory and practice and cover a full range of practical reactor experiments. /4/.

Another country is Slovak Republic which operates four WWER 440/213 nuclear power plants at the sites of Bohunice and Mochovce. However since the political separation from the Czech

Republic no national research reactor is available in Slovakia, the closest research reactor to Bratislava is the TRIGA reactor Vienna about 60 km from Bratislava. Since many years the Atominstitut cooperates with the Technical University Bratislava in various academic and scientific topics. As the TU Bratislava is the main organizer of the retraining program of Slovak NPP staff it contacted the Atominstitut to participate in this retraining program. Therefore since many years the Atominstitut host Slovak NPP staff for practical courses for retraining and knowledge conservation.

4. COURSES FOR COUNTRIES OBJECTING NUCLEAR POWER (AUSTRIA)

Austria started the nuclear era in the mid-fifties by building three research reactors followed by the construction of 730 MWe boiling water reactor.

As in the mid-seventies a strong anti-nuclear movement swept throughout Europe construction of this almost finished nuclear power plant was stopped and the operation licence was denied after a public referendum. The only remaining nuclear facility is the TRIGA reactor at the Atominstitut which continues nuclear knowledge management throughout the decades. The graduates in BS, MS and PhD physics level are hired by public- and governmental organisations, international organisations and nuclear medical centres. More than 50 highly specialized theoretical lectures and practical courses are offered at the TU Vienna to keep nuclear knowledge alive even in an anti-nuclear environment.

5. COURSES FOR INTERNATIONAL ORGANISATION (IAEA, CTBTO)

Within the IAEA Safeguards Traineeship Program the IAEA offers a ten month training course for young trainees from nuclear emerging countries. After passing this course the trainees have the qualification to apply to the IAEA for a junior safeguards inspector position. This course is offered every two years and starts usually every second year in February at the headquarters of the IAEA followed by four weeks basic education at the Atominstitut on subjects listed above. After this introductory course the trainees attend a follow-up course in Karlsruhe/Germany and are then attached to senior safeguards inspectors for on the spot-training in a NPP. Since 1984 about 125 safeguards inspectors have therefore spent their initial hands-on training at the Atominstitut, many of them are now Senior Safeguards Inspectors

Besides these safeguards directed courses the Atominstitut has offered its facility to IAEA fellows and received more than 150 fellows from all over the world to be trained in very particular nuclear subjects within the IAEA Technical Cooperation program. These fellows are attached to one of the research groups at the Atominstitut and follow their particular academic education as requested in the IAEA fellowship application form.

The CTBTO uses the experts from the Atominstitut to contribute to international symposia and the TRIGA reactor is frequently used for scientific visits of specialist which also include young international diplomats and non-technical personnel.

6. SUMMARY

All described courses have been carried through several decades and the practical experiments are well proven. After explaining the theory behind the experiments the participants have the possibility to work during their experiments right at the reactor top or in the control room which in many facilities today is possible due to administrative and regulatory restrictions. These courses contribute added value both to newcomer countries where access to such facilities is limited due to various reasons and to established nuclear countries for reasons described above.

In this contribution it is shown that even a very small nuclear facility such as the Atominstitut Vienna with a low power research reactor can make a valuable contribution to human resourced development and nuclear knowledge management.

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STAGED INTRODUCTION OF NON-POWER AND POWER NUCLEAR TECHNOLOGIES TO NEWCOMER COUNTRIES

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Abstract

Staged introduction of non-power and power nuclear technologies to new comer countries and related knowledge management are presented. Contribution and benefit of radiation technology to medicine and society are very important before nuclear power plants are introduced. Recently, not only new nuclear power technologies but also compact and high-performance accelerators for medicine and industrial/social infrastructure maintenance have been developed and used. Such staged introduction with respect to technology, education and economy contributes to enhancement of PA (Public Acceptance). Organized education, knowledge management and network should be associated.

1. INTRODUCTION

Staged introduction of non-power and power nuclear technologies is very effective to breed PA in the society. We hope that the introduction and safe operation of nuclear power supply could be the destination. For the purpose, non-power nuclear technology can have a powerful role to enhance educational and safety levels and PA of the society. Although the nuclear power plant is a rather large issue, there are several levels of the non-power nuclear technologies, such as compact and portable electron linear accelerator (linac) for industrial/societal infrastructure maintenance, X-ray cancer therapy linac, compact linac for medical radioisotope (RI) production, particle beam cancer therapy system by proton cyclotron and proton/carbon synchrotron. Safety standards and knowledge management can be supplied by international collaboration led by IAEA. The whole image is depicted in Fig.1.

2. UPDATED NON-POWER NUCLEAR TECHNOLOGIES AND KNOWLEDGE MANAGEMENT

About 10,000 gantry type X-ray therapy system including Tomotherapy are operating in the world. They use S-band (microwave frequency:2.856 GHz, wavelength:105 mm) electron linac. As the frequency becomes higher, in another word, as the wavelength becomes shorter, the linac structure becomes smaller. Mitsubishi Heavy Industry has developed VERO system for X-ray inspection and stereotactic therapy using 6 MeV X-band (9.3 GHz, 32 mm) linac. Pinpoint X-ray therapy system of Accuthera Inc. got the FDA (Food and Drug Administration) approval in USA in 2015. 30 MeV X-band linac γ-ray source for ^{99}Mo/^{99m}Tc production is recently considered. Since a few aged nuclear reactors are still mainly used for the RI production, the worldwide supply of RI is not sustainable. We are proposing distributed production and delivery of RIs for medicine and science/technology by adopting such a compact production system. Particle beam cancer therapy is very popular in Japan. A variety of proton cyclotron and proton/carbon synchrotron are available.

Moreover, portable X-band (9.3GHz) 950 keV linac X-ray source has been developed and applied for on-site inspection of industrial infrastructure. Inner structures of chemical reaction chambers, pipes, large machines etc. are inspected by hard X-ray transmission imaging. Even dynamic imaging of moving liquid surface in a chemical reaction chamber can be observed. Synchronized inner imaging between X-band linac X-ray source and pump gives stationary imaging of rotor during working. Commercial industrial inspection has started. 3.95 MeV linac X-ray source has been developed and applied for on-site inspection of societal infrastructure such as bridge. Many bridges were constructed more than 40 years so that those maintenance becomes more important for public safety in the world. Among several inspection methodologies, hard X-ray imaging is most effective to get direct imaging of degraded reinforced iron wires and rods. Further, we add Be target to 3.95 MeV linac X-ray source in order to generate neutrons and use them for detection of water which induces corrosion of iron wires and rods.

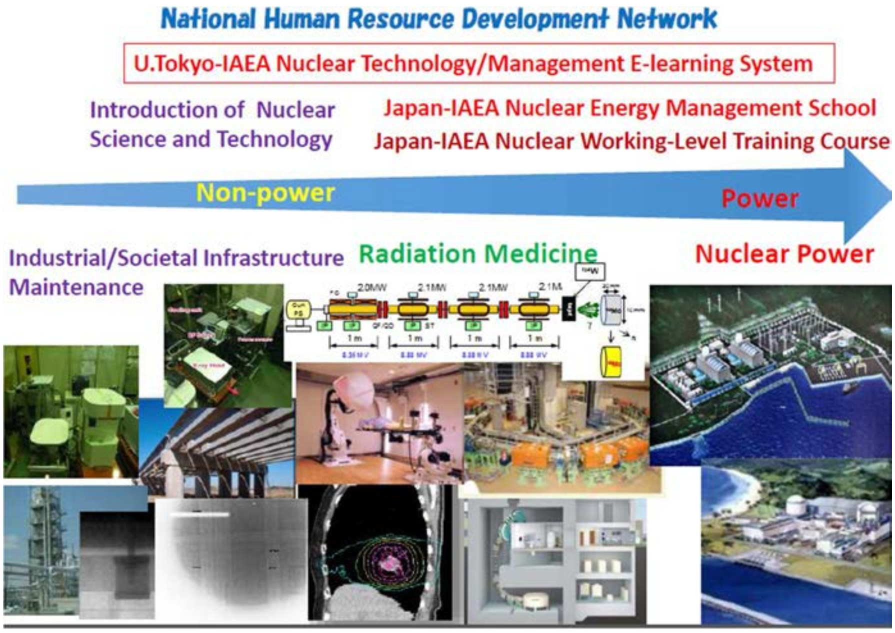

FIG.1. Staged introduction of non-power and power nuclear technologies associated with education programs and human resource development network

For the purpose of safe introduction and operation of such non-power nuclear technologies, radiation education and regulation are crucial. IAEA are providing several education contents and knowledge management for them. One of them is “Supporting Sustainability and Networking of National Nuclear Institutions in Asia and the pacific Region”. It provides and operates many textbooks, short term training modules, e-learning system and so on. Such safe operation and contribution to the public must become the basis of PA for near future introduction of nuclear power.

3. HUMAN RESOURCE DEVELOPMENT PROGRAM AND NETWORK FOR NUCLEAR KNOWLEDGE MANAGEMENT

IAEA supplies and operates a plenty of nuclear knowledge management in the world. Here Japan-related activities are summarized here.

We have formed the roadmap of HRD for coming ten years. We opened and presented it, especially at the IAEA general conference in 2015. Each activity has its own and specialized mission/role. Among them, we have operated the Japan-IAEA Nuclear Energy Management School for three times so far and are going to host the 5th school this July in Tokyo and Fukui.

IAEA knowledge management section of the energy department is leading INMA (IAEA Nuclear Management Academy) to form master courses on the nuclear management in the world. Japan and IAEA are developing the e-learning system in order to contribute to this task. Moreover, we plan to start the Japan-IAEA Working-Level Training Course for Foreign Countries with the nuclear power plant simulators and site training for six weeks from November in 2016. We are integrating and forming the practical education contents such as the 19 textbook series, in both Japanese and English, e-learning materials on 15 subjects, and DVD textbooks on Nuclear Structural Engineering and Nuclear Thermal Hydraulics with comprehensive videos/animations following Nuclear Reactor Engineering by Dr.J.Dies (Spanish Nuclear Safety Council) and IAEA. The e-learning contents are going to be linked to the IAEA's Cyber Learning Platform for Nuclear Education and Training (CLP4NET) in 2016.

Those national knowledge management programs and network for both non-power and power nuclear technologies are working well in Japan and expected to be introduced to newcomer countries.

NKM PERSPECTIVES OF NUCLEAR EDUCATION IN PAKISTAN

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Abstract

Pakistan Institute of Engineering and Applied Sciences (PIEAS), Karachi Institute of Power Engineering (KINPOE) and CHASNUPP Centre for Nuclear Training (CHASCENT) are the main institutes providing for the nuclear skilled man power demands of the country's nuclear technology program. The PIEAS is a public sector university and offers M.Sc. and Ph.D. programs in nuclear science and technology. The CHASCENT is the training institute which focuses on the training programs for nuclear power, while the KINPOE offers Master program in nuclear power engineering, post graduate training program (PGTP) and Post Diploma Training Program (PDTP) related to nuclear power engineering and technology. The nuclear education programs and other relevant NKM activities at PIEAS, KINPOE and CHASCENT play a key role in the information management, human resource and competence management. This paper presents the NKM perspective of nuclear education in Pakistan, its continuation and enhancement for the expanding nuclear power program to meet the country's energy demands.

1.INTRODUCTION

Pakistan enjoys the useful applications of nuclear technology in medical, power, agriculture & biotechnology and research & development sectors. The country intends to further enhance the utilization of nuclear science and technology in its development. For example, Pakistan is facing an acute shortage of electricity for more than a decade that affects public life, consequently the country's development. In comparison to other power technologies, nuclear power is safe, clean and reliable energy source and capable to provide base-load electricity. Utilization of nuclear power minimizes the oil, gas and coal imports. Therefore, national policy of Pakistan is set to increase its current nuclear share from 800 MWe to 8800 MWe by 2030. The implementation of national policy leads to the demand of skilled and qualified man power. The country has developed nuclear education and training system to satisfy its current skilled man-power requirements. There are four institutes providing nuclear education and training programs in the country.

1.1 Nuclear education and Training System

The nuclear education and training system of the country is comprised of following four institutes to provide the sustainable nuclear education and training to exploit the useful application of nuclear technology;

- Pakistan Institute of Engineering and Applied Sciences (PIEAS) www.pieas.edu.pk
- CHAShma CEntre for Nuclear Training (CHASCENT) www.paec.gov.pk/chascent
- Karachi INstitute of POwer Engineering (KINPOE) www.kinpoe.edu.pk
- National Institute for Biotechnology and Genetic Engineering (NIBGE) www.nibge.org

1.2 Pakistan Institute of Engineering and Applied Sciences (PIEAS)

Pakistan Institute of Engineering and Applied Sciences (PIEAS) has travelled around 50 years distance since its birth as Reactor school to a country's leading public sector university. It is the main Human Resource Development center of PAEC since 1967. PIEAS has established the following nuclear education programs.

- MS/PhD Nuclear Engineering
- MS/PhD Radiation Physics
- MS/PhD. Medical Physics
- MS Radiation & Med. Oncology
- MS/PhD Process Engineering
- MS Electrical Nuclear Power

PIEAS is the only institute of the country who offers MS Nuclear Engineering degree. Most of the nuclear engineering graduates join country's nuclear power program. The MS radiation physics program is training based program. During MS Radiation Physics degree, one complete semester is dedicated to pure training in radiation protection. For this semester, the students are attached to radiation protection/ Health Physics program of the nuclear power plant to get real hands-on experience in different disciplines of radiation protection.

TABLE 1: DIFFERENT NUCLEAR EDUCATION PROGRAMS AND ITS GRADUATES IN 2012

Degree program	Starting years	Graduates in 2012
MS Nuclear Engineering	1969	1219
MS Nuclear Medicine	1989	147
MS Medical Physics	2001	114
MS Radiation and Medical Oncology	2008	12
PhD in various fields	2000	56

The department of Physics of PIEAS has started MS Medical Physics program with the technical assistance of IAEA and local Hospitals to satisfy the radiation skilled manpower demand of Pakistan Atomic Energy Commission (PAEC). The MS Radiation and Medical Oncology (RMO) is designed to provide knowledge and clinical skills to the medical doctors required to manage cancer patients. Table 1 reflects the magnitude of different nuclear education programs at PIEAS.

1.3 Chashma Centre for Nuclear Training (CHASCENT)

CHASNUPP Centre of Nuclear Training (CHASCENT) offers comprehensive training and retraining programs to create and maintain a competent and professional work force for nuclear power program. It helps continuous learning, professional and personal growth to enhance organizational effectiveness. Followings are the key training activities at CHASCENT.

1.4 Basic Training program

CHASCENT runs the following basic training programs;

- Post Graduate Training Program (PGTP)
- Post Diploma training program (PDTP)

The PGTP program is developed to nuclearize the non-nuclear engineers while PDTP is designed for non-nuclear technicians to familiarize them with nuclear power. Figure no. 1 presents the behavior of the pass-out trainees for last 12 years. The Figure also shows the increasing trend of the trainee due to enhancement of nuclear power program. Other training programs are given below.

- General Employee Training Program
- Operation/Simulator Training
- Management Training Program

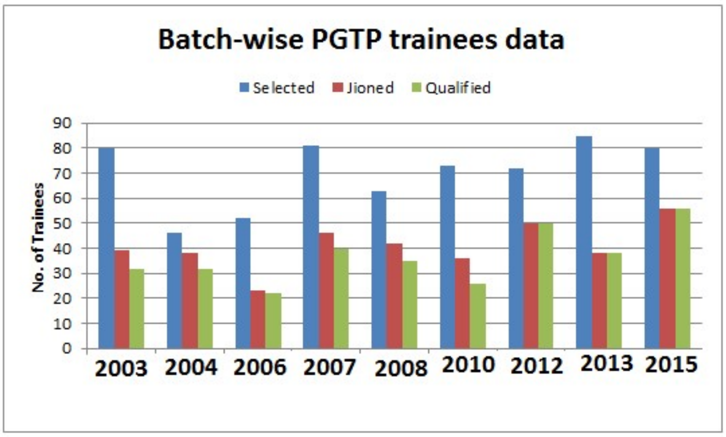

FIG.1.Nuclear manpower trend at CHASCENT.

1.5 Karachi Institute of Power Engineering (KINPOE)

The institute began in 1974 with two one year training programs named as Post Diploma Training Program (PDTP) for the training of newly appointed technicians and Post Graduate Diploma (PGD) for engineers. The one year training program for engineers was enhanced to a degree program in 1993 under which a degree of Master of Engineering in Nuclear Power Engineering. Keeping the expansion of nuclear power program of the country, institute is running four different educations and training program. Figure-2 represents the increasing trend in enrolments and number of nuclear education and training programs at KINPOE since its birth till 2012.

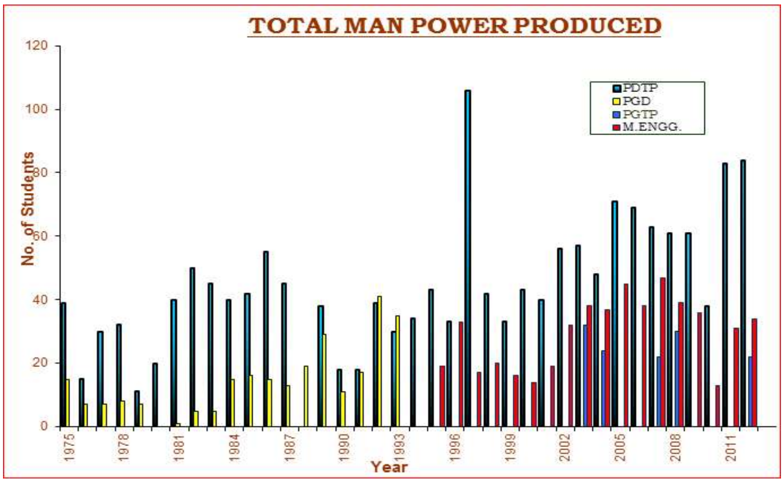

FIG. 2.Nuclear manpower trend at KINPOE.

1.6 National Institute for Biotechnology and Genetic Engineering (NIBGE)

NIBGE is one of the main biotechnology institutes operated by Pakistan Atomic Energy Commission (PAEC) in Faisalabad. It is affiliated to PIEAS Islamabad, for awarding MPhil & PhD degrees in biotechnology.

1.7 Nuclear Knowledge Management Perspectives

During each education and training activity at different institutes, the created nuclear knowledge at the industry/universities is transferred to the students and trainees by the experts with their solid theoretical practical background. The nuclear knowledge is also preserved at the institutes in the hard (reports, proceedings and books) and soft (Cd's, electronic data storage banks and audio/video lectures) formats. Parallel to nuclear knowledge creation, dissemination and preservation, these NKM actives augment the nuclear Human Resource Development program of the country to meet the skilled man power demands of nuclear power, medical and agriculture sectors. The increasing trend of enrolments at nuclear education and training institutes also confirm the positive and strong public support for nuclear energy in the country.

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AN E-LEARNING TOOL AS LIVING BOOK FOR KNOWLEDGE PRESERVATION IN NEUTRON ACTIVATION ANALYSIS

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Abstract

Neutron activation analysis (NAA) is one of the most common activities in research reactors, irrespective of their power size. Although being a well-established technique, it has been observed that retirement and/or departure of experienced staff often results in gaps in knowledge of methodological principles and metrological aspects of the NAA technique employed, both within the remaining NAA team and for new recruits. Existing books are apparently not sufficient to timely transfer the knowledge on the practice of NAA. As such, the IAEA has launched a project resulting in an E-learning tool for NAA, consisting of lecture noes, animations, practical exercises and self-assessments. The tool includes more than 30 modules and has been reviewed and tested during an IAEA workshop by experienced and new coming practitioners. It is expected that the tool will be developed as a 'living book' which can be permanently updated and extended and serve as an archive, fostering unpublished experimental experiences.

1. ORGANIZATIONAL CONTEXT

Enhancement of low and medium power research reactor utilization is often pursued by increasing the neutron activation analysis (NAA) activities, and this analytical technique in principle is available in more than half of the 246 operational reactors worldwide. NAA has been confirmed as one of the most suited opportunity for the commercialization of research reactor (RR) services [1]. Moreover, national metrology institutes have increased interest in using NAA for their metrology network given its demonstrated ability to satisfy the requirements of the primary ratio method [2]. However, lack of automation has been identified as a bottleneck in the capacity of NAA to meet client needs [3]. The IAEA has implemented a co-coordinated research project Development of an Integrated Approach to Routine Automation of Neutron Activation Analysis (2012-2015). During this project, participants realized that, once the increased capacity is results into an increase in requests for samples to be analyzed, resulting in a growth in the number of gamma-ray spectra to be analyzed; and with it the potential number of conflicts in the interpretation of the results. Finding the root cause of such non-conformities and resolving them to prevent reoccurrence may be a time consuming task which could diminish the advantage of automation in NAA.

Several books and other guidance documents exist on the concepts and execution of NAA [4-9], but a dedicated part is often missing on (sources of) errors and troubleshooting once results are not trusted or unacceptable. This knowledge is typically obtained by hands-on experiments or transfer of knowledge by experienced scientists over relatively long period of time. Worldwide experienced practioners are retiring and a new generation is trained to continue the neutron activation analysis facilities. However, there is often overlap time between leaving expertise and newcomers. Such cases have already been clearly observed and reported as a result of the IAEA activities supporting the NAA laboratories in assessing their analytical performance through inter-laboratory proficiency exercises (2010-2015).

These are few of the considerations for the research plan of developing a modern e-learning tool on practical aspects of NAA, the associated sources of errors and approaches for monitoring, identifying and compensation for them by trouble shooting.

2. OBJECTIVES OF THE E-LEARNING TOOL

The overall objective of the e-learning tool in NAA is to realize a 'living book', summarizing the basic concepts of NAA and providing practical information on the conduct of NAA. The tool will inform the user on (potential) errors made during e.g. the input of data, spectrum analysis and –interpretation and reporting and to some extent take over the educational role of the NAA supervisor. The tool will contribute to foster experience in NAA on the conduct of the technique, on sources of error and ways to overcome them in a pragmatic way. Eventually, e-learning will contribute even to reduce the threshold for laymen for using NAA, and thus may provide an outlook for increased utilization of facilities and research reactors.

3.DESCRIPTION OF THE TOOL

The e-learning tool for NAA has a modular structure to which, if relevant, continuously new or better information can be added as new modules or as animations or movie clips. The tool is complementary to existing textbooks since it comprises information on the practice of NAA that either never has been published or which may be not universally available (anymore). For pedagogical reasons, each module has a self-evaluation test. The tool can be expanded with examples of practical cases that occurred in various NAA facilities and which usually are not suitable for documenting in scientific publications. These can easily be compiled and preserved so that the tool comprises not just the success stories of the practice but also the (daily) pitfalls.

The e-learning tool is currently available on an IAEA platform as a series of PowerPoint slides with a multitude of diagrams. Ideally, these should be narrated with a voice-over.

4. MAJOR CHALLENGES AND ACHIEVEMENTS

One of the challenges of the e-learning tool was to present material in compact modules, each with its own teaching objectives; and to present in such a way that the information is self-explanatory. As mentioned in the above, narration of the slides would be ideal but has not yet been accomplished.

For each module both terminal training objectives and enabling training objectives have been identified.

In addition, for each module a short introducing text was written. Different self-evaluations have been integrated in the modules based on the multiple choice, short/one line reply, true/false or corresponding response principle.

Presently (2016), the IAEA E-learning tool on NAA contains the following training modules (Table 1).

The International Committee on Activation Analysis (ICAA) has confirmed its willingness to patronize the e-learning tool pending some questions on legal responsibility following the use of the tool. Patronizing by the ICAA provides an outlook for permanent maintenance and expansion of the tool.

TABLE 1. MODULES OF THE IAEA E-LEARNING TOOL ON NAA

Module #	Module title
Module 1	Introduction
Module 2	Radioactivity and radiation
Module 3	Decay schemes and interpretation
Module 4	Neutrons and neutron sources
Module 5	Nuclear reactions and activation
Module 6	Decay process
Module 7	Germanium detectors
Module 8	Gamma-ray spectrometer electronics
Module 9	Dead time and pile-up corrections
Module 10	Shapes of gamma-ray spectra
Module 11	Gamma-ray spectrometry
Module 12	Basic calibration
Module 13	Advanced calibration
Module 14	Uncertainty of measurement
Module 15	Practical NAA
Module 16	Pre-analysis quality assurance
Module 17	Performing analysis quality assurance
Module 18	Quality control
Module 19	External quality control
Module 20	Quality management

Module 21	Analytical characteristics
Module 22	Cyclic NAA
Module 23	Epithermal NAA
Module 24	Large sample NAA
Module 25	Automation in irradiation
Module 26	Automation in counting
Module 27	Automation in data processing
Module 28	Delayed neutron counting
Module 29	Basic principles of prompt gamma NAA and applications
Module 30	Neutron depth profiling
Module 31	Radiation protection in the NAA laboratory
Module 32	Low level gamma ray counting
Module 33	Gamma ray self-attenuation
Annex	Practical NAA: principles, sources of error and QA/QC; input and output parameters, including troubleshooting

5.LESSONS LEARNED/KNOWLEDGE DERIVED

The tool has been reviewed and tested during an IAEA workshop on October 2016 by both experienced and new coming practitioners in NAA. The concept of the tool, an overview of its contents and the outcome of the workshop will be presented during the conference.

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ROLE OF MNRC TO DEVELOP KNOWLEDGE AND SKILLS IN NUCLEAR APPLICATIONS

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Abstract

Since 2003, CNESTEN is operating Maamora Nuclear Research Center MNRC which is including a 2 MW nuclear reactor and a dozen of specialized nuclear techniques laboratories dedicated to earth sciences, human health, industry, safety and security, radioactive waste management, etc. Preparing the required qualified human resources needed investment in terms of identification of necessary competencies, training and expertise development. Human Resources and Communication Department established a strategy to lead with the CNESTEN overall vision and strategic objectives. As a result, modern HR tools were established such as: competencies repository, systematic approach for training SAT, multi-annual training program, evaluation system, etc. This paper will present all the HR projects identified and developed targeting the CNESTEN scientific and technical staff. The objective is to sustain the CNESTEN activities by qualifying its human resources, developing knowledge and expertise at both the individual and collective levels. Furthermore, CNESTEN is playing a major role in the transfer of nuclear techniques applications knowledge to several African countries. This experience will be presented in this paper as well.

1.CNESTEN EVOLUTION AND CONTEXT

Since its creation in 1986, CNESTEN is engaged in promoting and developing nuclear science and technology in different socioeconomic sectors where the atom can provide a solution to the problems encountered.

With this regards, several programs of nuclear techniques applications covering the areas of health, water, environment, agriculture, industry, safety and security have been implemented at MNRC involving the end users and stakeholders.

During these last decades, CNESTEN invested in the development of its human capability through recruitment of young engineers, searchers, and technicians who were trained in nuclear science and technology in connection with the IAEA and in some similar centers in France, United States of America, Belgium, South-Africa and other countries.

This workforce contributed to the realization of the Maamora Nuclear Research Centre MNRC, operated since 2003, including a research reactor of 2 MW power and a dozen laboratories dedicated to sectorial applications of nuclear techniques. The NRC is located at 25 km in the north of Rabat.

Started with a dozen of persons in the end of 1986, the CNESTEN staff was stabilized during the last years around 260 persons (FIG.1).

The stagnation of CNESTEN staff is due to departure mostly for retirement (10 persons per year), and the limited number of new jobs (8 persons per year). In this context, CNESTEN is confronted to enhance the staff performance in order to continue the development of its programs in terms of scientific production and commercial.

2.CNESTEN KM DEVELOPMENT AND TRANSFER

In 2016, the CNESTEN population could be described as follows: Average age is 42 years, Average seniority is 14 years, and females represent 30 % while researchers, engineers and technicians staff represents more than 72 %. Twenty engineers and researchers have developed an international expertise and competence used by the IAEA in the context of sharing nuclear knowledge in Africa.

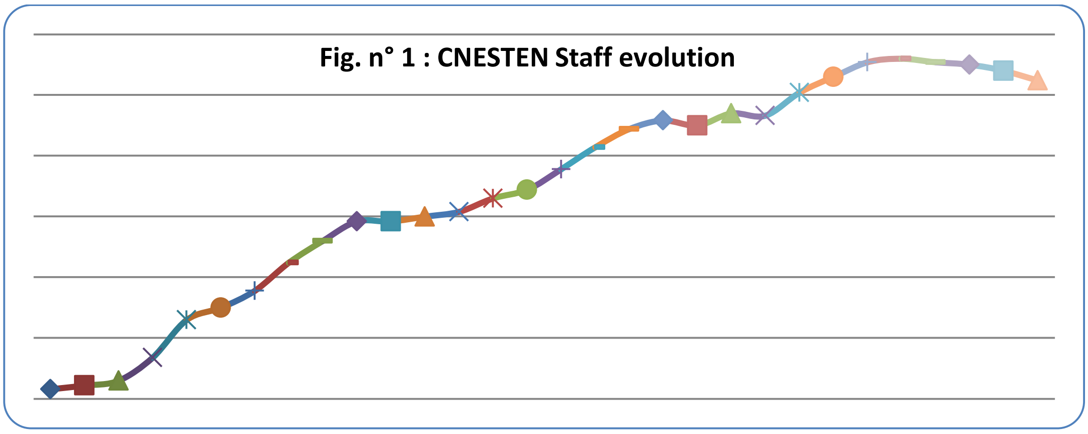

FIG. 1. CNESTEN staff evolution.

These seniors with many years of experience are playing an important role in knowledge transfer within the CNESTEN generations and also at national and international level.

According to its missions leading with the promotion and development of knowledge and expertise in the field of nuclear applications at the national level, CNESTEN established with several universities partnership concerning creation of joint research units dedicated to nutrition and the management of radioactive waste.

CNESTEN is also involved in the academic training in several masters on the nuclear technology and engineering, nuclear safety and medical physics. In this framework, more than 130 students are received annually in training at the MNRC including 30 PhDs degree.

The effort of dissemination of nuclear information is also done towards educational system, more than 1,500 students and scholars are received at the MNRC each year for visiting where explanations about the nuclear sciences and technology are given to them.

In cooperation with the IAEA, CNESTEN is actively contributing to the development of knowledge in the field of nuclear applications as a designated center in the fields of isotope hydrology, radiation protection, and nutrition.

3.CNESTEN KM CHALLENGES

In its 2020 vision, CNESTEN has the ambition to further align its plans according to the national priorities in terms of climate changes, innovative research and national capacity building for nuclear and radiological safety and security.

In this framework, CNESTEN is looking for strengthening its regional role in Africa through research, training and expertise in nuclear science and technology.

However, these challenges combined with the stagnation of the CNESTEN workforce, imposed by the general context, are forcing further maintenance and development of the human and knowledge capital.

4.CNESTEN KM STRATEGY AND ACTIONS

Being the unique NRC in Morocco, CNESTEN has a specificity to manage specialized and rare expertise whose replacement cost, in case of departure, is very high in terms of delays or loss of expertise.

In this way, CNESTEN established, in 2013, a strategy to implement talent and expertise management in order to maintain a high level of performance at national and international level especially in terms of research programs, training and expertise.

4.1 Organization

In this strategy, a new organization has been set up based on four pillars respectively dedicated to the research studies, the optimization of nuclear facilities, the nuclear safety aspects and the support activities (FIG. 2).

Autonomy was encouraged in parallel to the audit and control which were also strengthened.

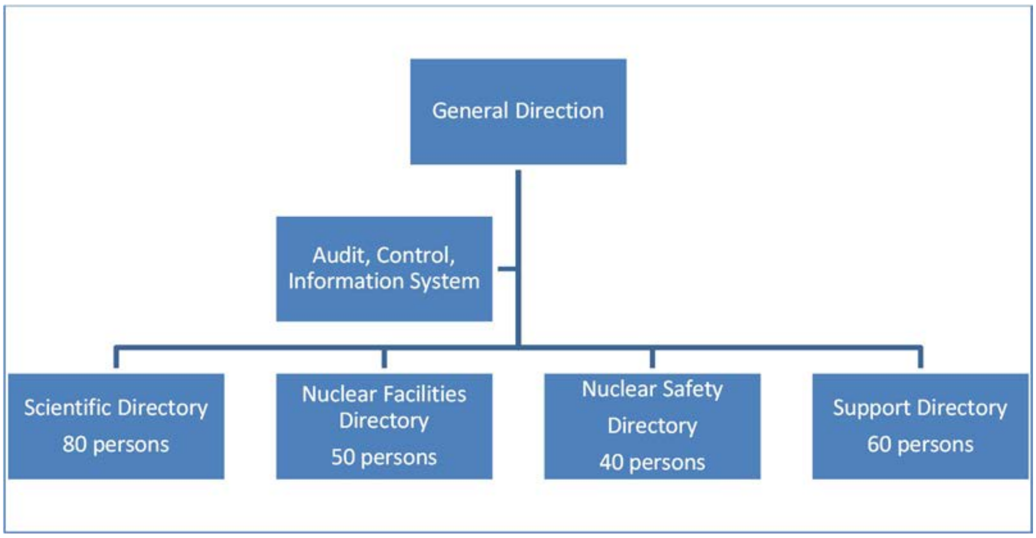

FIG. 2. CNESTEN organization.

4.2 Repository of jobs and skills

Furthermore, a repository of jobs and skills was established which allowed the CNESTEN:

(1) To have a better visibility of employment and its evolution,
(2) To be provided with a performance assessment tool adapted to its specific activities,
(3) To optimize organizational adjustments, enjoying a tool of decision support in recruitment, promotion, training and internal mobility, control staffing, jobs and skills;
(4) And to prepare for the implementation of a proactive management system especially according to the identification of new jobs, qualification and skills (nuclear energy power, fuel cycle, material sciences, computing).

4.3 Systematic Approach for Training

In 2013, a Systematic Approach for Training SAT was performed which lead to the identification of training needs in core business, support, quality, management and personal development (Table 1).
The identified training needs concerned more than 120 persons and the total duration was evaluated to 220 weeks each year. The annual estimated cost is 2 Million Dirhams (Equivalent to 200 000 Euros).
Regarding these needs, we have executed in 2014 and 2015 training plans focused on the quality management system (ISO 9001 and ISO 17025), good manufacturing practices for radiopharmaceuticals, management by objectives and projects, communication skills, leadership, business plan, sales force, coaching and public procurement. These initiatives concerned more than one hundred employees and covered an average of over 400 man-days.

Training actions focused on core business are generally carried out under the cooperation of CNESTEN with the IAEA and some of its counterparts in Europe, America and Asia. Thus, over five hundred days of training were conducted by forty employees each year.

4.4 HR information system

To manage the data capturing the new skills acquisition through training and their impacton raising individual and collective performance, CNESTEN is deploying an information system that enables it to monitor, evaluate and replace its human resources in alignment with new projects and requests from its national and international environments.

TABLE 1. TRAINING EVALUATED NEEDS

Training fields	Training Domains	Triennial needs (in man-days) 2014-2016	% per domain	% per field
Core business	Nuclear safety and security	1 128	31,5%	45,7%
	Management of the nuclear facilities	14	0,4%	
	Applied Mathematics	255	7,1%	

	Analytical Chemistry	44	1,2%	
	Nuclear and Isotopic Analyses	68	1,9%	
	Material Sciences	14	0,4%	
	Nuclear Instrumentation	4	0,1%	
	NDT	30	0,8%	
	RIA	13	0,4%	
	Radioactive waste management	65	1,8%	
Support	Computing	71	2,0%	6,9%
	Finance, Accountability	76	2,1%	
	Marketing and Communication	40	1,1%	
	Maintenance	60	1,7%	
Quality	Quality Management System	699	19,5%	19,5%
Human development	Personal development	100	2,8%	27,9%
	Langue (English, Spanish, …)	417	11,7%	
	Management	480	13,4%	
		3 578	100,0%	100%

4.5 Other projects

In addition, other projects are initiated and concern the establishment of a proactive HR management system dedicated to identify jobs and skills also the evaluation individual and collective performance.

5.CONCLUSIONS

Through this paper, we showed the interest to develop human resources management activities which prerequisites to build a comprehensive system of knowledge and expertise management.

In fact, this system is required to perform CNESTEN national and international positioning and is integrated in its global strategy and vision.

This experience could be shared with other institutions in Morocco and IAEA Member States in Africa and Middle East countries.

A NEW APPROACH FOR EDUCATION AND TRAINING OF MEDICAL PHYSICISTS IN CUBA: FROM UNIVERSITY TO CLINICAL TRAINING

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Abstract

According to the international recommendations of IAEA and the International Organization for Medical Physics (IOMP), the education and training of clinically qualified medical physicists (CQMP) should include three main academic and professional elements: a university level education, a postgraduate education specific in medical physics (MP) and a supervised clinical training. In Cuba, most of the medical physicists working in radiation oncology (RO) or nuclear medicine (NM) services have graduated from nuclear related programmes of the High Institute on Applied Technologies and Sciences (InSTEC), who further perform a postgraduate study in medical physics (MP), at the level of a so-called Diploma course or a Master in Sciences. Nevertheless, the third level of education, namely the supervised clinical training has not yet been established, due to the lack of official recognition of the profession of MP by the health authorities. A new approach for comprehensive training of CQMP is presented, where, by maintaining the three elements of education, the process is optimized so that a medical physicist is prepared with the highest level of theoretical and clinical training, in agreement with the current demand of the advanced technologies put in service in Cuban hospitals.

1.INTRODUCTION

According to international recommendations of IAEA and IOMP, the education and training of clinically qualified medical physicists (CQMP) should include three main academic/professional elements: a university level education, a postgraduate education specific in MP and a supervised clinical training. The IAEA published a report devoted specifically to the situation of the MP profession in Latin America, with recommendation regarding the possible structure of education and training of CQMP in this particular region, the contents of academic programs and the figures for estimating the staffing requirements in MP.

Education and training of medical physicists has been of the highest priority in the IAEA Technical Cooperation (TC) Programme since late 90´s. A regional TC project was approved and implemented in 1999 ,that promoted the creation of a regional Master in Sciences degree program in Medical Physics (MSMP), which produce more than 20 graduates in 4 years. This program was the seed for other similar programs in the region, including the Cuban MSMP, which was accredited by the Ministry of High Education in 2000. This program was structured in accordance with recommendations made by the IAEA Syllabus for Radiotherapy Physics, and expanded to other areas of MP, such as Nuclear Medicine, Diagnostic Radiology (DR) and Radiation Protection (RP), so the Cuban MSMP program cover the 4 main field of competences in MP: RO, NM, DR and RP.

In parallel to the MSMP program, other academic training modalities in MP were accredited by the Ministry of Health, taking into account the guidelines recommended by the IAEA and also the Cuban Nuclear Regulatory body (CNSN) for licensing CQMP in RO and in NM. These were postgraduate programs, so called "Diploma", which is a modality below the MSMP, containing only one of the 4 field of MP; in this case, both Diploma programs in RO Physics and NM Physics existed.

However, the figure of CQMP has not been officially recognized by the health authorities, reason why in the country does not exist yet a system of professional certification of the CQMP.

Their clinical training is still conducted in a heterogeneous way, without following guidelines duly authorized or accredited by professional bodies programs. Moreover, the on-the-job time required by the CNSN in RO and NM practices to provide individual medical physicist license is much lower than recommendations of relevant international organizations.

On the other hand, as the health system in Cuba is all public, since early 80's all the RO and NM departments had the Ministry of Health mandate of hiring medical physicists as part of their staff. This measure implied that the amount of physicists working in RO and NM services increased significantly, in comparison with other Latin American countries. In Cuba, the main source of professionals entering the position of medical physicist in hospitals have been graduated of nuclear related university programs: bachelor in Nuclear Physics or Nuclear Engineering, mainly from the High Institute on Applied Technologies and Sciences (InSTEC), so they had a very strong background in Radiation Physics and Dosimetry. These conditions allowed the establishment of a critical mass of teachers and trainers that conducted to setting up the above mentioned academic programs in Medical Physics.

The main purpose of this study was to design and establish a comprehensive training schedule of CQMP, that combines the current existing strength of the first level of education, the on-the-job training and a new approach for the postgraduate specific education.

2.MATERIALS AND METHODS

The needs for optimizing the process of comprehensive training of CQMP was based on three main facts that were present in the existing approach:

Firstly, most of the candidates entering the MSMP or Diploma programs were graduated of 5 year full time equivalent (FTE) bachelor in Nuclear Physics or Nuclear Engineering, so they have a very strong background in Physics and Math. As shown by an IAEA/EFOMP survey , this is in general a basic education schedule one or more year longer than the average in many countries.

Secondly, the junior medical physicists are recruited by RO and NM departments just finishing their basic university education, so when they are admitted in a postgraduate MP programme, they must share the academic education with their jobs in the hospital. This means that the modality of delivering the MP courses need to be adapted to this condition, so they are organized in concentrated modules, with mandatory subjects and optional subjects.

Thirdly, most of the recruited junior MPs perform their bachelor or engineering thesis is topics related to MP, so they usually have an additional preparation in some of the contents they are expected to face during their professional development.

In order to take advantage of the existing academic and clinical infrastructure for training CQMP, and the facts mentioned before, a comprehensive, scaling approach was designed, considering the following premises:

Premise 1. As the basic university education in InSTEC university programs are relatively long and nuclear related subjects are deeply covered, a mention in MP can be established in the final years (4th and 5th), covering mandatory subjects that must be part of any postgraduate program.

The current structure of the study plan conceives 6 optional subjects, with a total of about 16 academic credits (1 academic credit= 16 lecturing hours). The planned subjects are:

- Fundamentals of Radiation Dosimetry;
- Radiation Detection and Measurements in Medicine;
- Digital Medical Image Processing;
- Fundamentals of Radiotherapy Physics;
- Fundamentals of Diagnostic Imaging Physics;
- Radiation Protection in Medicine.

Premise 2. A professional MSMP program (pMSMP) has been designed, covering the 3 main areas of competences of a CQMP: RO, NM and DR. Consequently, the program has a mandatory module (26 credits), that include most of the subjects described above, 3 optional modules of subjects for each specific area (7 credits each) and 3 internships in each of those areas (16 professional credits each, where one professional credit is equivalent to 40 hours FTE competence based training), based on the IAEA recommendations [4, 5 9].

Premise C. Three updated Diploma courses are being developed by the Ministry of Health in the corresponding main areas of MP, in coordination with the pMSMP, so that crossed recognition of credits be possible.

Premise D. A Diploma course on Radiation Protection, based on the IAEA Standard Syllabus has been already implemented by InSTEC in coordination with the Cuban Nuclear Regulatory Body and other Radiation Protection entities (Centre for Radiation Protection and Health, CPHR). This program covers those subjects related to radiation safety issues in Medicine, and is in close cooperation with premises A, B and C.

Premise E. Doctoral research projects are in progress, where senior CQMP are involved, in order to strengthen the academic qualification of the teaching staff participating in the education of MPs.

3.RESULTS AND DISCUSSION

A new Diploma program has been initiated for junior MPs working in hospitals, that covers the mandatory subjects included in the pMSMP as described in previous chapter. The program has finished its first edition, and a second edition is in progress. The intention is to move most of its subjects to the undergraduate programs of Nuclear Physics and Engineering of InSTEC, so that the pMSMP could be shortened in at least one academic semester.

The designed pMSMP has been approved by university authorities. Further approval by health and high education authorities is pending. The structure of subjects and internships included in the proposed pMSMP program is shown in table 1.

An IAEA TC project is in progress (CUB/6/025: Improving the quality of cancer patient's diagnosis and treatment introducing advanced technologies in radiotherapy and nuclear medicine), which objectives are in close agreement with a national project (NUOLU-1-5-2-2014), regarding the necessity of upgrading and strengthening the programs for education and training of MPs in Cuba. These projects consider the establishment of the pMSMP program, the support for a MP laboratory that should help in developing practical skills of students in using informatics and computational tools in MP, without affecting the work regime of clinical departments.

The combination of a more MP oriented basic university programs, a MSMP with a stronger practical component closely linked to in-hospital training programs, and a high academic level doctoral program for reinforcement of teaching human resources, will contribute to a optimal and safer introduction of newer technologies in Radiation Medicine.

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DEVELOPING COMPETENT WORKERS THROUGH EDUCATION AND TRAINING: CASE STUDY OF THE LEBANESE ATOMIC ENERGY COMMISSION (LAEC)

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Abstract

Education and Training is at the center of interest of the Lebanese Atomic Energy Commission (LAEC) to spread safety and security culture and to enhance and help facilities to use nuclear and related analytical techniques in key socioeconomic development areas. It is an essential component to combat the decline in expertise and to ensure the continuation of the high level of radiation protection knowledge in Lebanon. Education is a key component of knowledge management. Education and training with experience is used to develop competence. This paper will present the educational programmes launched by LAEC in collaboration with scientific universities, training programmes provided to staff and users, methods of training at LAEC, EduTA mission conducted by IAEA experts and the recommendations.

1.INTRODUCTION

The National Council for Scientific Research established the Lebanese Atomic Energy Commission (LAEC) in 1996 with the full support of the International Atomic Energy Agency (IAEA) for preparing the national legal and technical infrastructures allowing an effective implementation of a comprehensive radiation safety scheme in the country.

After its establishment, the LAEC, in cooperation with the IAEA through its technical cooperation programmes, started to put in shape analytical laboratories. It started to develop technical competence of its staff in order to make the use of radiation sources by the users in medicine, industry and research complies to the IAEA Safety Publications and to enhance the nuclear and related analytical techniques in different important areas like environment, human health, food safety, preservation of cultural heritage, and industrial development.

The LAEC task is regulating and controlling practices dealing with ionizing radiation (radiation safety, nuclear security and safeguards). The LAEC is composed of six departments, Scientific Research Development, Environmental Radiation Control, Assurance of Radiation Safety, Nuclear Security and Emergency, Inspection –Authorization- Regulation, Border Radiation Control.

The LAEC has about 70 staff member of which 13 are PhD. holders, 41 are engineers and regulators, inspectors, laboratory assistants, technicians and 15 are support staff.

The large progress of the use of radiation sources in industries, research centers and particularly in medical sector as well as the continuous national need for testing and certification laboratories, pressed the LAEC to develop its workers' skills in regulatory issues and radiation safety services.

For developing the competence of its workers and the users, the LAEC launched Educational Programmes in collaboration with scientific universities, it organized training programmes. The EduTA mission evaluates these programmes and sets its recommendations.

2.EDUCATIONAL PROGRAMS BETWEEN LAEC AND SCIENTIFIC UNIVERSITIES

- In 2008, The LAEC established in cooperation with the Beirut Arab University a one year diploma in Radiation protection and Safety and Security of Radioactive sources based on Post Graduate Educational Course (PGEC) syllabus developed by the IAEA. This diploma gives the chance for the students to get a Master in Physics- Major Radiation Protection if it is followed by one academic year and practical work for a MSc. thesis preparation. The diploma is open for chemistry, public health and;
- physics BSc. holder. The graduates of such a diploma can be potential Radiation Protection Officer candidates in licensed facilities and can integrate research institution dealing with radioactive sources and the regulatory body as junior inspectors and regulators. The practical sessions of this course are implemented at LAEC laboratories. This post graduate course is the main academic and professional training in radiation protection in Lebanon. It is under academic and administrative supervision of the Beirut Arab University and is supported by the specialized infrastructure of the LAEC;
- In 2015 the Lebanese University – faculty of Sciences issued in collaboration with the LAEC the Master Degree entitled “Lasers and Ionizing Radiations Safety and Protection”. The master is open for BSc. (biology, physics, medicine..) or BSc in radiation technology (faculty of Health). The program based on the PGEC plus a program for laser safety. The graduate of this master will serve as radiation protection officer in medical field (hospitals and clinical centers) and can complete his/her PHD.

The LAEC requires that the educational level of RPO be relevant to the activities and radiation risks presents in the practice.

3.TRAINING PROGRAMMES AT LAEC

The LAEC’s staff is trained and continuously updating its knowledge and skills through the IAEA technical cooperation program and via its cooperation with Arab Atomic Energy Agency (AAEA) and European Union (EU).

The IAEA projects pertaining to developing competent workers at LAEC are:

- Human Resource Development and Nuclear technology Support: to upgrade the competence of the staff at the Lebanese Atomic Energy Commission;
- Training and capacity building for the development of applications using nuclear and related analytical techniques in environment and material science.

This project aims at further upgrading and extending the analytical capabilities at the LAEC, training staff in nuclear analytical and related technique and developing skills in repairing and maintenance of nuclear instruments used in services and research laboratories;

- Strengthening medical physics through education and clinical training programmes in ARASIA States Parties.

Moreover, the LAEC is a participant in Asian network for education in Nuclear technology (ANENT) which assists the member countries in building capacity and develop human and scientific infrastructure through cooperation in education, nuclear knowledge, and related research and training in nuclear technology in the Asian region.

In addition, the LAEC is contributing to the training of technical staff from public and private sectors, dealing with ionizing radiation (safety, security and radiological emergency) and coming from different medical, industrial, and research institutions by organizing specialized and commensurate training sessions and by facilitating their participation to regional and international training and workshops.

LAEC has the national requirements to assure that persons involved with activities involving ionizing radiation have the appropriate training on a basic schedule.

TABLE 1. LIST OF TRAINING ACTIVITIES EVENTS PROVIDED BY LAEC FOR USERS

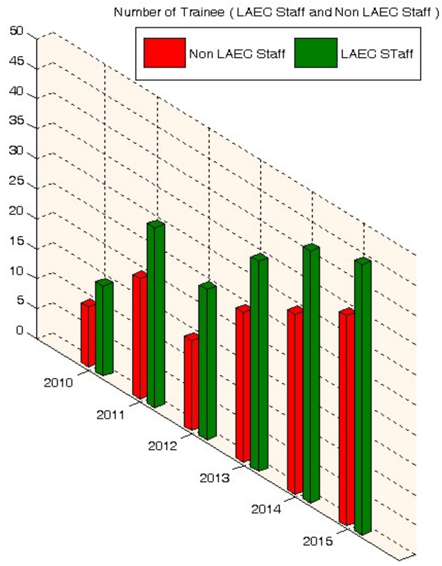
Title	audience	duration
Radiation Protection in the medical field	Radiology technician, Phy-	1 day (level 1)
Radiation Protection in radiology	Radiology technician, Phy-	1 day (level 2)
Radiation Protection in Nuclear medicine	technician, Physician	1 day (level 2)
Radiation Protection in radiotherapy	technician, Physician	1 day (level 2)
Basic course in radiation protection for industrial Sector	Technician	1 day
Radiation Protection and the safety of radiation sources in industrial applications(Advance)	Technician in industrial sector	2 days
Awareness course in radiation Protection for First Responders	Civil Defense and LAEC staff	30 hrs course
Presentation of the role of the radiation protection officers by LAEC officers	RPO in all sector	1 day

More than 300 participations to IAEA and other training programs have been recorded till now.

FIG. 1a and FIG. 1b show the number of LAEC Staff and non LAEC Staff participated in training courses: 192 participants to IAEA training and 136 participants to other training.

The LAEC is also hosting and co-organizing with the IAEA, AAEA and others, specialized training courses, workshops and seminars. The LAEC is also hosting Ph.D and MSc students in cooperation with national and foreign universities and research centers.

Fig.2a and Fig.2b show PHD, masters and diploma students hosted by LAEC with the coordination of scientific institutions. 28 PHD students and 21 Diploma and Master students.



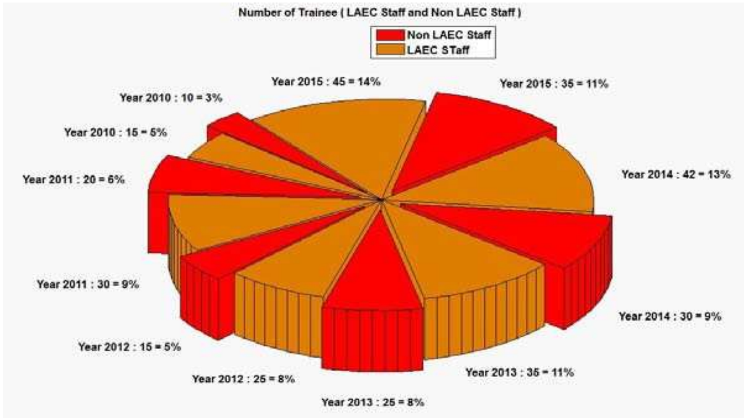
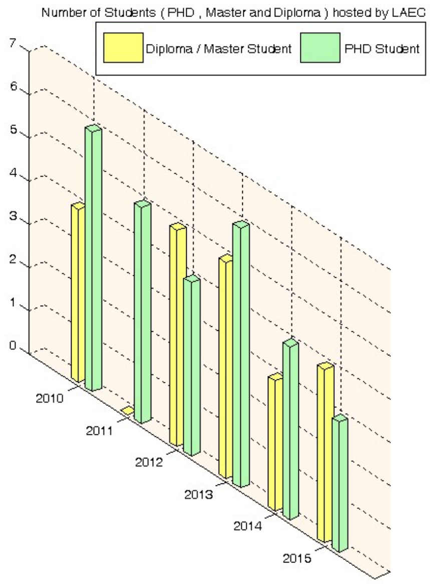


FIG.1a. Number of LAEC Staff and non LAEC Staff. *FIG.1b. Number of LAEC Staff and non LAEC Staff.*



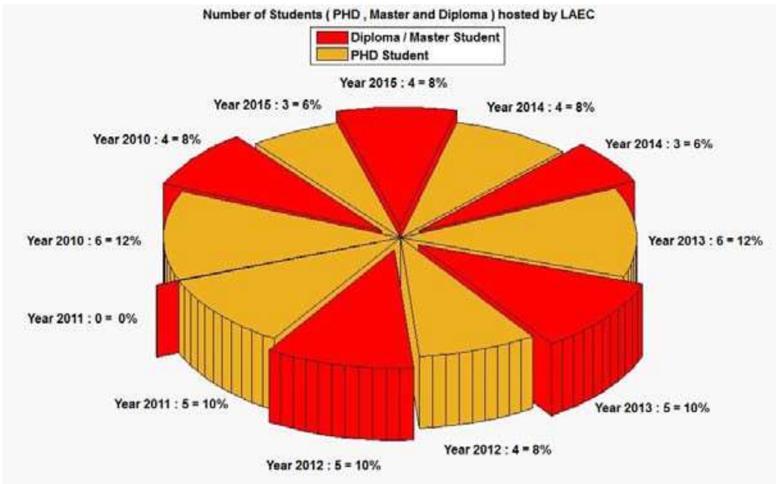


FIG.2a. Number of students (PHD, Master, Diploma) hosted by LAEC. *FIG.2b.Number of students (PHD, Master, Diploma) hosted by LAEC.*

3.1 Tools of training at LAEC

The tools of training at LAEC are:

- Classroom programs (lectures, case discussions, interactive activities), the classroom is equipped with LCD projector and microphones. The practical sessions are implemented at the specialized laboratories at LAEC, the participants are divided into working groups every 3 or 4 students. At the end of the training course, the participants are provided with CDs included the presentations. The instructors are from LAEC and experts specialized in certain fields;
- On the Job training such as the training dedicated for radionuclide analysis which enables new staff at the Environmental Radiation Control Department- LAEC to gain experience and to become familiar with applied and new methods. After this training, the staff will be able to manipulate and analyze samples with familiarity. He/she can improve the applied methods and techniques. Any missing information and expertise could be gained from this training.

3.2 EduTA Mission

Upon the request of the Lebanese Atomic Energy Commission (LAEC) an Education and Training Appraisal (EduTA) was conducted by IAEA experts on January 2014 to carry out a detailed appraisal of the status of the provisions for education and training in radiation protection and the safety of radiation sources.

4.RECOMMENDATIONS OF EDUTA RELATED TO HUMAN COMPETENCE

- It is recommended to develop a human resource plan for the staff of the regulatory authority with a specific training and retraining programme based on the analysis of the necessary skills and competence;
- It is recommended to establish a national policy and strategy for education and training in radiation, transport and waste safety, according to the IAEA methodology, including:
  - Analysis of the education and training needs;
  - Design of the national education and training programme;
  - Development and implementation of the national education and training programme Evaluation and feedback.

Based on the recommendation, a scientific visit was undertaken to Malaysia and France by two national coordinators of training programmes from LAEC. The aim of the visit is to develop the practical sessions of the programmes. Consequently, the LAEC developed its training programmes practically more than theoretically.

5.CONCLUSIONS

The LAEC is looking forward to maintain and develop its cooperation with relevant ministries, public institutions, research centers and universities. The LAEC is committed to continue serving the community with high competency, transparency and openness and is dedicated to deliver high quality and reliable results, assured by its skilled staff, by using state of the art techniques through an integrated quality system. The LAEC believes that knowledgeable and skilled workforce is an essential element in the implementation and safe operation of all nuclear facilities as well as nuclear technology research and development. The LAEC develops the competent of its staff through educational programmes, scheduled trainings, workshops, scientific visits or fellowships in defined subjects cover radiation safety issues or analytical techniques in different fields. Education is a key component of knowledge management. Any national nuclear energy programme depends on the successful development of a competent workforce, through a sustainable academic or university education and industry training.

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DEVELOPMENT OF AN EDUCATIONAL NETWORK TO STRENGTHEN EDUCATION, TRAINING AND OUTREACH IN LATIN AMERICA: LANENT-LATIN AMERICAN NETWORK FOR EDUCATION IN NUCLEAR TECHNOLOGY

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Abstract

In the current century, networks have played an important role in the dissemination ofexperiences, information exchange and training of human resources for different area ofexpertise. The IAEA has encouraged in regions, through its member states, the creationof educational networks to meet rapidly and efficiently the dissemination and exchange ofknowledge between professionals and students in the nuclear area. With this vision, theLatin American Network for Education in Nuclear Technology (LANENT) was establishedto contribute to preserving, promoting and sharing nuclear knowledge as well as fosteringnuclear knowledge transfer in the Latin American region. LANENT seeks to increasetechnical and scientific cooperation among its members in so far as to promote the benefitsof nuclear technology and foster the progress and development of nuclear technologyin areas such as education, health, the industry, the government, the environment, themining industry, among others. By means of LANENT, the participating institutions of thisnetwork, devoted to education and training of professionals and technicians in the LatinAmerican region, may have access to major information on nuclear technology so as to maketheir human resources broaden their nuclear knowledge. Moreover, this network seeksto communicate the benefits of nuclear technology to the public with the aim of arousinginterest in nuclear technology of the younger generations. This paper will present andanalyze results and initiatives developed by LANENT in Latin America

THE EUROPEAN NUCLEAR EDUCATION NETWORK: TOWARDS HARMONISATION OF EDUCATION, TRAINING, AND TRANSFER OF KNOWLEDGE

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Abstract

The European Nuclear Education Network (ENEN) Association strives to develop a more harmonized approach for education in the nuclear sciences and nuclear engineering in Europe and to integrate European education and training in nuclear safety and radiation protection. Improved co-operation and sharing of academic resources and capabilities at the national and international level is an important long-term objective. With respect to stakeholders, such as nuclear industries, research centers, regulatory bodies and other nuclear infrastructures, the primary objectives of ENEN are to create a secure basis of skills and knowledge of value to the EU, and to maintain a high-quality supply of qualified human resources for design, construction, operation and maintenance of nuclear infrastructures, industries and power plants. ENEN supports activities aimed at maintaining the necessary competence and expertise for the continued safe use of nuclear energy and applications of radiation and nuclear techniques in agriculture, industry and medicine. In this technical brief we describe selected activities pursued to reach these goals.

1.INTRODUCTION AND BACKGROUND

The development of knowledge and technologies related to nuclear fission and fusion has been one of the major achievements of mankind. Nuclear fission provides for about 30% of the electricity generated in the European Union. It is the most abundant zero carbon energy source, and provides for almost half of the European zero carbon electricity. Many significant contributions to science and technologies beyond nuclear power are known and widely applied today. Examples include diagnostics through imaging and variety of therapies in medicine, sterilization in food processing, and diagnostics in industry, forensics, archeology and geology, among others.

The expected lifespan of nuclear power plants, including commissioning and decommissioning, extends over more than a century. Disposal of radioactive waste from power and non-power applications extends this commitment even further. Safe, competitive and sustainable use of nuclear technologies is therefore based on a long-term commitment of all stakeholders to vigorously participate in the quest for new and management of existing knowledge. Securing further developments in education, training, skills, competences, attitudes and cultures of personnel involved in industry, academia and regulatory organizations, is at the core of the values and efforts that the European Nuclear Education Network (ENEN) Association stands for.

The ENEN Association is a non-profit organization established by the consortium of the EU 5th Framework Programme (FP) “ENEN” project in 2003 [1]. It started as a network of universities and research centres in EU countries involved in education in nuclear engineering at Master and PhD level and is presently involved in the challenging role of coordinating E&T in the nuclear fields in Europe. The main objective of ENEN is in fact the preservation and further development of expertise in the nuclear fields by higher education and training. Its members are now universities, research centers and industrial bodies established in European Countries; in addition, MoUs have been signed with several institutions and networks beyond the borders of European Union, *e.g.*, in Japan and the Russian Federation, thus reaching a number of nearly 70 members.

During the first 10 years of operation, the ENEN Association has laid the foundations for harmonization of E&T activities. The establishment of the European Master of Science in Nuclear Engineering (EMSNE) certification, assigned to engineers who with a complete curriculum in the field and with significant educational experience abroad in an ENEN institution is a prime example. In order to stimulate young researchers and to encourage highest-quality work, ENEN organizes a yearly PhD event in relation with an international conference, where PhD students compete for a prize. ENEN coordinates and participates in several EU projects that have represented important milestones in the activities of the Association. This has allowed a strong commitment of ENEN Members in favour of common missions. The active involvement in many activities in tight interaction with European institutions in the field has led to the recognition of the value of the ENEN Association by the European Council in 2008[1] and to the participation in a hearing of a European Parliament Commission related to the new "safety directive" in 2014. In this technical brief, we discuss selected on-going endeavours aimed at further coordination and harmonization of activities in nuclear E&T on the European level.

2.EMSNE CERTIFICATION

The European Master of Science in Nuclear Engineering (EMSNE) is a Certificate delivered by the ENEN Association, with the endorsement of all its Members, in order to certify the highest quality standards of Nuclear Engineering Education and the European dimension pursued achieved by the EMSNE laureate, combining the joint state-of-the-art know-how of the European universities. This goal is achieved through full use of the unique nuclear research and industrial facilities throughout Europe, pushing towards analytic, resourceful and inventive nuclear engineering. This fostering of international exchanges creates a network of nuclear engineers and scientists of different nationalities. It promotes the contact and collaboration between students from several countries with different educational views, different nuclear reactor technologies, and different nuclear policies, and encourages and helps to develop a common Nuclear Safety Culture throughout Europe.

[1]"The Council welcomes the existence within the European Union of coordinated teaching and training leading to qualifications in the nuclear field, provided notably by the ENEN. The Council hopes that, with the help of the EU, ENEN and its members will continue to develop the coordination of nuclear education and training in Europe. The Council insists that the appropriate conditions must be created for mutual recognition of nuclear professional qualifications throughout the European Union. The Council encourages the Member States and the Commission to establish a "review of professional qualifications and skills" in the nuclear field for the European Union, which would give an overall picture of the current situation and enable appropriate solutions to be identified and implemented." (EU Council conclusions on the need for skills in the nuclear field, December 1-2, 2008)

The basic requirements for the certification are: (*i*) at least 5 years university education (3+2, 4+1, or 5), (*ii*) at least 60 ECTS "purely nuclear", (*iii*) 20 ECTS must be obtained from a "foreign" (different country) institution, member of the ENEN Association, and (iv) Master's thesis on a nuclear topic. The "purely nuclear" topics are broadly defined as Nuclear Power Plant Technology & Reactor Engineering, Reactor Physics, Nuclear Thermal Hydraulics, Safety and Reliability of Nuclear Facilities, Reactor Engineering Materials, Radiology and Radiation Protection, and Nuclear Fuel Cycle and applied radiochemistry. Each year the laureates (26 in 2015) receive the EMSNE Certification diplomas in a relevant ceremony. The last years this ceremony has been held, with the support of the IAEA Nuclear Knowledge Management section, as a side event of the IAEA General Conference, in Vienna, Austria.

3.ENEN PHD EVENT AND PRIZE

The ENEN PhD Event & Prize is an action of the ENEN Association to support the research and science in the nuclear fields promoting the work of young scientists and researchers who start their career finishing their PhD. It is 1–2 days session where 10-12 PhD Finalists, nominated by ENEN Members and selected by the ENEN PhD Prize Jury, present their research in an competitive but friendly environment. The ENEN PhD Prize is awarded to the best (3) three presentations. The event is organized on a yearly basis in the framework of an international congress in the field of nuclear sciences – for example, in 2015 The 9th ENEN PhD Prize & Event took place in the framework of the International Congress on Advances in Nuclear Power Plants (ICAPP) 2015 in Nice, France, 5-6 May 2015. More than 100 young researchers have presented their research in the context of these events.

4.EUROPEAN PROJECTS

The ENEN Association is strongly engaged in providing long term sustainability to past and ongoing European projects aiming at improving, consolidating and harmonizing cross-European education, training and knowledge transfer efforts in the nuclear sector. TRASNUSAFE [3] and NUSHARE [4] are projects in the field of nuclear safety culture, but with different perspectives. TRASNUSAFE is funded through the EURATOM Research and Training programme, and its grand objective is to design, develop and test two relevant training schemes on Nuclear Safety Culture with a European environment, based on a specific evaluation of the training needs. Importantly, the target audience for these training schemes on nuclear safety culture are professionals operating at a high level of managerial responsibility in the industrial and the medical sectors. On the other hand, NUSHARE is a project implementing a European Education, Training and Information initiative proposed after the Great East Japan Earthquake and Tsunami (Fukushima 2011). Its main objective is to develop and implement education, training and information programmes strengthening competences required for achieving excellence in nuclear safety culture. Particular attention is being paid to lessons learned from stress tests conducted on all EU nuclear Power Plants in response to the Fukushima accident and to sharing best practices at the European level. The NUSHARE project addresses the specific needs of different stakeholders in nuclear safety by the development and EU-wide dissemination of programmes for three target groups: (*i*) policy makers and opinion leaders in governments, parliaments, international organisations, scientific communities, and press, (*ii*) staff members of Nuclear Regulatory Authorities and Technical Safety Organisations (TSOs), and (*iii*) electric utilities, systems suppliers, and providers of nuclear services at the level of responsible personnel, in particular managers.

PETRUS-III [5] and CORONA-II [6] are examples of European Fission Training Scheme (EFTS) projects targeting a specific scientific-technological community. The main objective of PETRUS-III is to promote Education and Training (E&T) in the field of geological disposal of radioactive waste. The project brings together the community that since 2005 coordinates universities, radioactive waste management organizations, training providers and research institutes efforts to develop cooperative approach to E&T in these fields through the "PETRUS" initiative. CORONA-II on the other hand focuses on the enhancement of the safety of nuclear installations through further improvement of the training capabilities aimed at building up the necessary personnel competencies. A specific objective of the CORONA-II project is to proceed with the development of state-of-the-art regional training center for VVER competence (to be called CORONA Academy), a viable solution for supporting transnational mobility and lifelong learning amongst VVER operating countries [7].

The most recent EURATOM Research and Training programme project is ANNETTE [8]. This project aims at enhancing the Europe-wide efforts initiated in the past decades by different organisations belonging to academia, research centres and industry to maintain and develop education and training in the different nuclear areas. The main aim of this action is to consolidate and better exploit the achievements already reached in the past and to tackle the present challenges in preparing the European workforce in the different nuclear areas, with special attention to continuous professional development, life-long learning, cross border mobility and e-learning. The ENEN Association, as coordinator of the project, together with the other participants, is committed to perform coordination and support actions coherent with the SET Plan Roadmap for Education and Training for the nuclear sector, tightening the links between the areas of nuclear safety/engineering, radiation protection, waste management and geological disposal at the same time, by better coordinating their contributions in the E&T fields. The transition from science to technology occurring in the fusion research environment justifies an additional effort to tighten the links to the E&T effort on the fission side with common actions related to fusion.

In all the above mentioned examples, the Association will host the courses and the structures set up by the projects, in order to assure that after their completion they will maintain a long term impact.

5.INTERNATIONAL COOPERATION

The Practical Arrangements agreed between the ENEN Association and the Nuclear Knowledge Management Section at the International Atomic Energy Agency (IAEA) improve the cooperation in the area of regional networking for research, education, training, and outreach in nuclear science and technology. The Cooperation Agreements with the IAEA Regional Networks for Latin America (LANENT), Asia (ANENT) and Africa (AFRA-NEST) further promote the collaboration and secure the efficient and fertile utilization of the integrated database.

The ENEN Association is also coordinating projects having as main outcome to set up joint Education and Training courses with Russian institutions such as ENEN-RU II [8]. The main objective of this project to define and develop a common basis to allow effective cooperation between the European and Russian networks for nuclear E&T. In particular, conducting pilot items for E&T and listing and promoting further use of E&T facilities, laboratories and equipments is an important measure. On the other hand, The Post-Fukushima European

Japanese Exchange Project in Nuclear Education and Training (EUJEP 2) [9] is aiming to enhance the quality of nuclear higher education and training by stimulating exchanges and internships at Master level between higher education and training institutions from EU and from Japan. The project includes the mutual exchange of students, and faculty members and hence improves current practice to prepare students for work in an international context. In the long term, the impact of this young generation is expected to benefit to the safe design, construction and operation of nuclear power plants and to the implementation of nuclear and radiation technologies with respect to their sustainability, their reliability and their safety aspects.

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ENS AND FORATOM EDUCATION, TRAINING AND KNOWLEDGE MANAGEMENT ACTIVITIES

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Abstract

The European Atomic Forum (FORATOM) and the European Nuclear Society (ENS) established in 2013 a joint Task Force dedicated to education, training and knowledge management (ETKM) issues in nuclear. The main purpose of the Task Force is to strengthen the link between the industry, research institutes and education and training stakeholders on the European level. Further to inform the European political institutions about the nuclear education and training activities undertaken by various stakeholders. The aim of this paper is to present number of activities done in the framework of FORATOM and ENS Task Force (TF) and present the recommendations given by the E&T experts. The TF combines the expertise of Human Resources, Training and Education provided by the industry as well as universities and research institutes. The Task Force aims to play a role of a gateway for collaboration between different key players of the nuclear education, training and knowledge management field. Further TF is aiming to inform the European institutions about the actions and roles undertaken by ENS and FORATOM members in the area of education and training.

1.INTRODUCTION

Education is essentially a knowledge creation process, involving academic institutions as suppliers and students as customers; on the other hand training is a competence building process, involving employers and other training providers as suppliers, and on-the-job professionals as customers. Education and training in the nuclear industry across the full fuel cycle and including research is crucial in ensuring safety. Investing in nuclear education and training is also one of the important keys for the future of the industry in Europe. Ensuring sufficient skilled graduates emerge from European nuclear education and training institutions into the industry is vital to maintain the share of nuclear energy in the mix and the industry's global technological leadership. The industry also promotes a high degree of nuclear professionalism. Likewise, attracting young people to study disciplines related to nuclear energy at university level is a challenge the industry must continue to address. Not only is the need for bringing in new recruits to the industry important, but the competences of the current workforce need to be developed; preserved and transferred to the next generation.

The FORATOM and European Nuclear Society (ENS) work side-by-side in the ETKM TF addressing these important issues.

2.ETKM CHALLENGES

Education, training and knowledge management in the nuclear field is of key importance for the safe operation of reactors and the safe disposal of nuclear waste, two of the most important issues related to the nuclear sector. Both the nuclear industry and the scientific and research communities are aware of the need for well-educated young professionals with thorough knowledge of and skills in nuclear science and technology, and the difficulties the higher education institutions are facing to provide practical experience and hands-on training to students.

The exchange of experience and expertise, the sharing of capabilities and resources and networking between stakeholders are crucial for the development of efficient education and

training programmes geared to provide the highly-skilled workforce that a dynamic and fast-evolving sector demands. The role of this paper is to draw attention to a number of activities done in the framework of Education, Training and Knowledge Management Task Force (ETKM TF) jointly established by organisations, FORATOM and ENS.
Different stakeholders provide several nuclear courses, trainings and on-hand workshops. On one hand universities offer Bachelor and Master programmes in nuclear related subjects. On the other hand companies try to attract postgraduates to specific trainings of nuclear safety, radioprotection, operation or waste management. The range of offered courses is very wide and very often difficult to navigate through. Therefore the European Nuclear Society together with its Young Generation Network established the open Education and Training (E&T) Platform [1]. This provides an overview of available university courses, as well as training and education programmes offered by industry and other institutions. The Platform is closely linked to ENS' bi-annual conference on Education and Training, NESTet, and continues to evolve thanks to the input received throughthe conference. Another significant contribution to the Platform is made by ENS' members in 22 countries and by its 50-strong corporate memberships but also by the members of the ETKM TF. Moreover the cooperation with the IAEA Nuclear Knowledge Management (NKM) Division and European Nuclear Education Network (ENEN) allow adding new information to the ENS Platform. The ENS E&T Platform is one of its flagship projects in nuclear knowledge management domain.

In the process of collecting the information for the E&T Platform several partnerships were created [2]:

- With ENEN on exchange information on the universities nuclear programmes;
- With European Human Resources Observatory in Nuclear (EHRO-N) on training opportunities offered by the industry;
- With IAEA NKM section on European-wide NKM activities.

ENS and FORATOM work closely with each of the partners and hold regular meetings over the year. The representatives of the listed groups became members of the ETKM TF. One of the main concerns of the FORATOM/ENS working group is how to secure a sufficient number of the nuclear workforce in the future.

Two aspects are here defined: the importance of the Science, Technology, Engineering and Math education (STEM) among the secondary school pupils and close collaboration between the universities and industry.

According to the EHRO-N report published 2012 [3]: "Putting into perspective the supply of and demand for nuclear experts by 2020 within the EU-27 nuclear energy sector" the nuclear industry will face a lack of qualified employees. It states that around 40.000 nuclear experts will be needed by 2020 for new posts and in order to replace retired personnel. The lack of engineers and young qualified workers is also a problem facing other energy technologies. In order to respond to the HR needs of the nuclear industry it is important to encourage young people to study engineering, physics, chemistry or mathematics. The statistics show that less and less graduates are coming out of the STEM disciplines. A majority of European countries together with the European Commission have different initiatives to attract young people to STEM subjects. The aim is to increase young people's interest in technical studies already at the primary and secondary school level. The ENS Young Generation Network (YGN) undertakes a wide range of activities in different European countries in order to raise more interest for STEM studies among pupils. The ENS YGN visits schools, cooperate with teachers or organize scientific events in order to explain the basics of nuclear. There is a need to support the YGN in their activities by seniors and nuclear companies.

Another aspect contributing to the lack of nuclear employees is the weak interaction between the universities and industry. Universities should "produce" qualifications according to the industry needs and vice versa and industry needs to communicate and support the universities programme to receive adequate skills. In some European countries the link between university and companies is very strong and graduates leaving the schools have already a clear perspective of their career path. Some companies offer intensive internship programmes but we have to keep in mind that 75% [4] of the nuclear employees do not require a university degree but more hands-on skills. Therefore, to fill in the nuclear workforce gap in the European nuclear power plants, it is also important to create broad apprenticeships offers in Europe. ETKM members who represent interest of both sides, universities and industry, wrote a paper about best examples of cooperation among various stakeholders as an answer to nuclear HR situation [5]. This paper offers a starting point for discussions with the ETKM TF partners and European Institutions on what kind of efforts should be undertaken regarding critical jobs needed in the sector, up until 2050.

3.CONCLUSIONS

In summary, the European Nuclear Society together with FORATOM recognized a need to create a gateway for industry input to the EU institutions and various EU initiatives in the area of education, training, and knowledge management. The ETKM Task Force in particular provides a forum in which, with common goals, ENS an FORATOM cooperate to strengthen the link between industry-research institutes and education and training stakeholders. As a result of ambition to facilitate young generation the navigation of nuclear programmes and trainings available in Europe, the Education, Training and Career Platform was created. Furthermore the ENS NESTet conference dedicated to nuclear education and training, allows the exchange of information on ongoing nuclear E&T projects in Europe and to create new collaborations among the E&T stakeholders. In order to attract more persons to a career in nuclear, it is important to start the process in secondary schools to create strong links between industry and academia.

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ANENT ACTIVITIES FOR KNOWLEDGE SHARING AND DISSEMINATION

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Abstract

This paper describes the main activities and achievement of the Asian Network for Education in Nuclear Technology (ANENT) related to knowledge sharing and dissemination in the Asia and Pacific region, and how it has strengthened its networks. Since the establishment of ANENT in 2004, the basic framework and infrastructure of collaboration among universities, R&D organizations, and training institutes have been established and improved. The ANENT web-portal was opened in 2004 to share, exchange, and disseminate information and experiences of interest for the educational communities in the region. A regional learning management system (LMS) was installed in the Korean server as an innovative tool for facilitating and promoting e-Learning. Using this LMS, six e-Training courses and five Train the Trainer (TTT) courses were implemented. In 2016, a newly launched four-year IAEA Technical Cooperation project will facilitate ANENT activities to strengthen the nuclear knowledge management (NKM), develop the human resources and enhance young nuclear scientists' and public understanding of nuclear science and technology. Internet technology will help implement these activities by providing effective and efficient methods and tools and use the regional scientific infrastructures such as research reactors for nuclear education and training through regional LMS.

1.INTRODUCTION

Many countries in the Asia Pacific region have needs for qualified nuclear human resources necessary to support ongoing as well as future activities. After the Fukushima accident, nuclear science and technology education in the region has experienced a decline in the number of students. At this rate, it will be difficult to sustain the nuclear science and technology programmes in all areas. In this light, there are regional needs to share technology and knowledge available within the region, to follow up on the work done within ANENT, and to promote the utilization of existing regional tools, such as the ANENT regional LMS.

The Asian Network for Education in Nuclear Technology (ANENT) is a regional partnership, supported by the IAEA, aiming at cooperation toward capacity building, human resource development, and knowledge management in nuclear science and technology. The ANENT was established in 2004 and has 19 member countries in the Asia and Pacific region, and eight collaborating member organizations. The objective of ANENT is to promote, manage, and preserve nuclear knowledge and to ensure the continued availability of qualified HR in the Asian region for the sustainability of nuclear technology and to prepare newcomer countries to commence nuclear power programmes. The ANENT strategy rests upon the principles of cooperation, sharing of information and knowledge for capacity building, and better use of available resources by integrating available educational resources, promoting the utilization of the ANENT e-Learning, and facilitating exchange of experienced nuclear professionals[1].

In accordance with these ANENT concepts, ANENT activities have been focused on the sharing and dissemination of nuclear knowledge through education and training in the Asia and Pacific countries [2,3]. This paper presents the ANENT main activities focused on knowledge sharing and dissemination carried out to date. In addition, future ANENT projects for strengthening networks are presented.

2.MAIN ANENT ACTIVITIES FOR KNOWLEDGE SHARING AND DISSEMINATION FROM 2004 TO 2015

2.1 ANENT Web-Portal (WP) and Cyber Learning Platform (CLP)

The first product and asset of the ANENT was the ANENT web-portal (WP) in Figure 1. The portal including concept and design was developed by the Korea Atomic Energy Research Institute (KAERI). Then, the KAERI has undertaken the launching and the operation of the WP in their server at *www.anent-iaea.org* since April 2005. It provides basic information on the ANENT management and activities, promoting external and internal communication. ‘About ANENT’ and ‘Activities’ have a lot of information about ANENT objectives, members, structure, and activities, and ‘Links’ show a number of useful websites on nuclear knowledge and science and technology. The registered members can login the ‘Nuclear Education and Training Database’ which contains more than 900 inputs of data about existing lectures and training courses at each institution. ‘Related Events’ provides a list of related events in the past, present and foreseeable future including archival information.

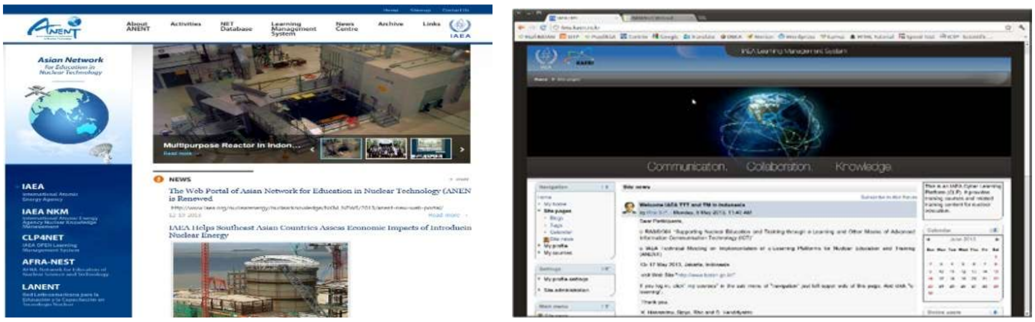

FIG. 1 ANENT Web-Portal (left) and ANENT Cyber Learning Platform (CLP; right) renewed in 2014

The cyber learning platform (CLP) was designed and developed by KAERI with the assistance of the IAEA as shown in Figure 1. The CLP was added to the WP in August 2006 to support users to access various types of educational information and training course materials. Registered users can log in to the CLP and play four roles: learner, lecturer, course manager, and general manager. Each mode has several menus depending on the roles and functions. The CLP contains a learning management system to allow teachers to register, enrol, monitor, and evaluate students’ learning. The significance of the CLP and e-Learning activities has been increasingly recognized. Due to the limited accessibility to the already existing CLP system, the IAEA has developed a new learning management system (LMS), named ‘CLP4NET’, using open source, MOODLE software. Like the ANENT CLP, the LMS has an automatic system to allow teachers to enrol, monitor, and evaluate students’ learning in each course. Various functions have made it easier and simpler for users to create course content and navigate the system.

To facilitate the use of LMS by ANENT members countries, the MOODLE-based LMS was installed at the KAERI, as the new ANENT Regional LMS in December 2011. The KAERI serves as the Site Administrator to manage the registration and oversee the whole operation, and the ANENT members play roles as the course creators to enrol students and create courses.

Through the vulnerability test and localization, the ANENT regional LMS was accessible and usable by all participants in the regional course in March 2013. In addition, the ANENT regional LMS was used by the participants in the Train the Trainers (TTT) course to conduct e-Learning courses on energy planning, which was hosted by National Nuclear Energy Agency (BATAN) of Indonesia in May 2013.

2.2 E-learning activities through the ANENT LMS

ANENT activities are usually carried out through implementation of the IAEA regional TC project. In 2007, a four-year regional TC project entitled 'Supporting web-based nuclear education and training through regional networking' started. The project strived to address the increasing needs of nuclear education and training opportunities, resources and new strategies through the ANENT CLP for the national and regional capacity building in the region. A wide range of activities includes e-training, TTT courses on the CLP as the tool of e-learning, the contents development by expert missions, procurements and fellowship programmes. Within the scheduled activities of ANENT, KAERI hosted five e-training courses on energy planning using the ANENT CLP in cooperation with the IAEA's Planning and Economic Studies Section (PESS) during 2007-2014. KAERI staff served as the site administrator and video conference organizer, and PESS experts provided the training package and the online tutoring.

The TTT courses on ANENT LMS were organized in Vienna in 2008, in Manila in 2009, and in Abu Dhabi in 2009. The objective of the TTT was to provide the participants with opportunities to build capacity to get familiarized with the CLP, and to make it sustainable for any users in learning, organizing, and operating e-training courses. Total 80 participants learned various processes from lecture preparation, course establishment, course registration and learning, to post-learning, which was played by four modes as Learner, Lecturer, Course Manager, and General Manager. Several countries such as Indonesia and the Syrian Arab Republic conducted the national seminars on the CLP.

2.3 Partnerships within ANENT members and beyond Asia

The Practical Arrangements with the European Nuclear Education Network Association (ENEN) in June 2009 was concluded to implement training courses and disseminate a variety of information, curricula and materials in the field of nuclear energy and applications. ENEN is a well-known international organization for its unique and pioneering objectives and activities to develop the expertise in the nuclear field by higher education and training. ENEN has been a collaborating member of the ANENT providing advice and guidance on the ANENT activities at the planning, implementation and review processes.

When the sixth Coordination Meeting was held by the Khalifa University of Science, Technology and Research (KUSTAR) in UAE, the intention was expressed to establish a regional hub for web-based education and training. Based on the experience and lessons learned of the ANENT CLP, the new e-Learning Portal was developed and installed at the KUSTAR. In parallel, Practical Arrangements were concluded between the IAEA and KUSTAR to enhance cooperation in education, training and research in nuclear science and technology in September 2010.

Building on the positive results of the ANENT, similar regional educational networks were established, i.e. Latin-American Network for Education in Nuclear Technology (LANENT) in the Latin American and Caribbean Region, and the AFRA-Network for Education in Nuclear Science and Technology (AFRA-NEST) in the African Region, both with the support of the

IAEA. During the 57th IAEA General Conference in September 2013, the new Practical Arrangements were concluded with the ENEN to expand partnership and cooperation in these three regions. Additionally the Cooperation Agreements were signed between the three regional networks.

These educational networks have been working actively together and with other regional and national educational networks in the world. The educational networks hold joint meetings periodically, to identify and discuss common needs, synergies, and solutions.

3.NEW ANENT PROJECT ON NETWORKING FOR NUCLEAR EDUCATION AND OUTREACH PROGRAMS

A new four-year ANENT project was launched in 2016 under the title 'Networking for nuclear education, training, and outreach programmes in nuclear science and technology in the framework of ANENT'. This project will facilitate ANENT activities to strengthen the nuclear knowledge management, develop the human resources and enhance young nuclear scientists' and public understanding and appreciation of nuclear science and technology and its value to the society. Internet technology will help implement these activities by providing effective and efficient methods and tools and use the regional scientific infrastructures such as research reactors for nuclear education and training through regional LMS.

In this new phase it is required to take further actions to consolidate and enlarge the efforts of each participating members from universities, R&D organizations and training institutes into a regional stage in order to achieve the bottom-up of the regional HR capability under the existing cooperation framework, ANENT. The main activities consist of utilization of ANENT regional LMS, collaboration and sharing of information for outreach activities, and internet research reactor laboratory project.

3.1 Utilization of ANENT regional LMS

The ANENT member countries have had many practical experience in e-Learning through the cooperative network of ANENT since 2004. Learning materials, e-Learning contents, best practices and virtual tools for nuclear E&T and outreach are available for sharing and disseminating with member countries. It is important to develop and deliver well organized and systematic e-Training courses through the LMS so that the benefit of the e-learning will be efficiently and widely spread in the region and beyond. The main activities are as follows:

- To analyse and collect efficient e-Learning materials and methodology;
- To utilize the ANENT regional LMS among the Members in the region;
- To train how to manage the e-Learning contents;
- To distribute materials available to the Members in the region;
- To implement e-Learning courses using ANENT regional LMS.

3.2 Collaboration and sharing of information for outreach activities

Promotion of nuclear science and technology to young scientists and the public is necessary to create better understanding and appreciation of its value. There are many best-practices, outreach materials and activities that have been developed in the ANENT Member countries.

These should be effectively shared among the Member countries. Once the ANENT establishes the tools and mechanism with the support of IAEA, the best practise of outreach materials and activities can be developed, collected, and disseminated among the ANENT countries via the ANENT web portal and the ANENT regional LMS. The main activities are as follows:

- To analysis the existing outreach material available in the region;
- To share the outreach materials and methodology through the networks;
- To deliver knowledge and skill to young scientist about e-Learning activities;
- To develop e-Learning course based on outreach and materials.
- To organize outreach conference

3.3 Internet research reactor laboratory in the region

Research reactors (RRs) could be used more efficiently as a tool to support education and training to understand the principles of the NPP, for example, to learn about reactor physics, neutronic and thermal-hydraulics aspects, safety culture, etc. However, there is very few RRs that have appropriate capability to be utilized for teaching or training purposes because they are operated on a more continuous basis to support other utilization programmes. In most cases the available RRs do not belong to universities or training institutes and are located far away from the students who need the experimental facilities. With the assistance of the IAEA Internet Reactor Laboratory (IRL) project, the region could use these RRs capability with flexible operation for education and training purposes. A long-distance research reactor experiment will be broadcasted via a web-based application device and will be more efficiently conducted by utilizing the ANENT regional LMS in the future. The main activities are as follows:

- To select a suitable research reactor in the region as the host;
- To prepare the necessary hardware for the purpose;
- To develop standard experiment procedure for internet reactor laboratory operation;
- To implement the research reactor experiments through internet under IRL project.

4.CONCLUSIONS

Since the establishment of ANENT in 2004, the basic framework and infrastructure of collaboration among universities, R&D organizations, and training institutes have been established and improved in the Asia and Pacific region. The main activities were the development of a web-portal and cyber learning platform, implementation of e-Learning courses, and partnerships within ANENT members and beyond Asia.

In order to achieve successful implementation of the ANENT activities, it should attain participation with corresponding responsibility from each member country of ANENT. Furthermore, to ensure sustainable sharing and dissemination of knowledge and experiences acquired through the established ANENT collaboration framework, the ANENT would take full advantages of its web-portal and regional LMS and strengthen its network in an effective way.

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CENTERS OF EXCELLENCE CONTRIBUTION TO KNOWLEDGE AUGMENTATION

O. Mignone

Abstract

Knowledge Management is a key need of the nuclear industry to cope with the knowledge limited augmentation and the risks of knowledge loss due to a number of reasons, such as: staff attrition, organizational changes, upgraded technologies, new projects implementation, and the nuclear power evolution in recent years (i.e. post-Fukushima upgrades).

This document describes the contribution of Nuclear Centers of Excellence to the Knowledge Augmentation. The effective implementation of Nuclear Centers of Excellence is a key success factor for Knowledge Management programme of the Nuclear Organization. This document, is based on a real example of Operating Organization approach in launching such initiative for staff knowledge augmentation and performance improvement. Eventually, any type of Organizations in the nuclear sector could apply the proposed technique to reach better Knowledge usage.

The Nuclear Centers of Excellence are a key Knowledge Management initiative for the learning organizations that are caring about organizational intellectual capital and striving for performance improvement. The Nuclear Centers of Excellence can be realized as a forum for exchanging of ideas, knowledge, information, experiences; to collect lessons learned; and to identify areas for improvement where further organizational competence building is needed. Usual realization of this initiative is going through an active staff involvement in knowledge sharing in a form of different Technical Communities of Practice focusing on specific knowledge domains.

1.PURPOSE

This document purpose is to present elements about the Nuclear Centers of Excellence (NCoE) as contributors to Knowledge Augmentation in the nuclear Energy field, and these elements are represent case study related to the Company's processes and procedures. This document considers that the Company could be an operator of nuclear power plants, or be embarked in nuclear new build projects.

2.BACKGROUND

Knowledge Management (KM) is an essential management area for keeping a sustained safe, reliable and economic performance during nuclear plant operation and maintenance, upgrades, emergency response, life extension, and decommissioning.

IAEA: Knowledge is the nuclear energy industry's most valuable asset and resource, without which the industry cannot operate safely and economically.

Due to the natural ageing process, nuclear expert staff is retiring and leaving positions that need to be filled with younger professional, technicians and workers. Several IAEA documents describe the techniques for capturing, storing, and disseminating explicit and implicit knowledge, in such a way to fill the knowledge gaps of newer employees. Besides, knowledge management is essential for implementing performance improvement processes, for implementing plant refurbishing and modernization due to technology upgrades, for making plant uprates, for developing organizational changes, and for considering the nuclear power evolution in recent years (i.e. post-Fukushima upgrades).

Consequently, several business lines are developed within the Knowledge Management frame. This document highlights the contribution that NCoE can make to achieve Nuclear Knowledge Augmentation.

3.DEFINITIONS

European Forum of Quality Management

Excellent organizations achieve and sustain superior levels of performance that meet or exceed expectations of all their stakeholders.

Business Excellence

A self assessment process for selecting the right strategies to achieve optimum business performance with the minimum of energy and cost.

A strategy that makes quality an integral part of the way business is designed.

Industry Use of Centers of Excellence

Industry's approach to building workforce capacity and capability systematically and effectively is based on sharing and leveraging resources across multiple worldwide locations to support facilities safety, security, operability and performance. These approaches and their deployment are aligned with values of agility and performance in order to scale up rapidly in support of stakeholders and customer opportunities.

For the Industry, excellence is achieved by:

- performing at high quality at sustained pace – the ability to reach a performance level that becomes a superior level and an internal benchmark
- sustaining that performance for an extended period with no discontinuities.

4.COMPANY EXPECTATIONS

Internal Working Teams

Company expectations on NCoE are the creation of internal working teams composed by Company experts for achieving superior knowledge and capabilities in specific technical and management areas, which can be of use by each Company group or department for:

- interchanging information,
- transferring knowledge from experts to less experienced persons,
- equalizing information among professional and technical staff in different departments / locations,

- disseminating knowledge and experience among the Company departments to facilitate issues resolution and decision making processes,
- capturing international and national information on operational experience, and/or on construction experience to augment the Company staff knowledge,
- creating libraries of useful information and lessons learned,
- resolving problems and/or anticipating negative issues, and
- mitigating / neutralizing safety and operational risks.

Goals Nuclear Centers of Excellence

Expectations are that the NCoE may achieve the following goals

- Allowing the Company experts and the staff in general to augment their knowledge counting with experience base to perform their job with increased performance and satisfactory results,
- Allowing prompt elaboration of resolutions, and/or contributions to the problem solving process will increase the Company performance and agility, allowing savings, producing solutions, and eliminating waiting times,
- Producing focused outputs for improving processes and procedures and for improving staff training and upgrading programs
- Creating a performance environment consistent with the Company vision [as an example being Number 1 in a particular business segment], and developing and implementing performance improvement programs
- Maximizing the staff job satisfaction to provide the foundation for building excellence in the respective knowledge and expertise area, creating the experts “pride” on their knowledge and the motivation to share it
- Making possible that experts transfer their implicit knowledge to other people, (reluctance from experts to share implicit knowledge has been observed in the past as a limitation for knowledge dissemination and augmentation).

5.BROAD EXCELLENCE FRAME

The broad frame of the NCoE may be as follows:

- Areas of interest for Operations, Maintenance, Technical Support, Engineering, Procurement, Construction, Safety, and Plant Upgrades for which it is desirable to augment and consolidate knowledge and expertise of individuals in charge of nuclear activities
- Areas for which the interchange of information among the nuclear experts in the Company could create synergies
    - ✓ to make easier the identification and resolution of problems in each group or department, and
    - ✓ consequently to augment knowledge and decision making capabilities of different Company departments
- Areas in which there is a strong dependence on suppliers, and for which the Company needs to acquire knowledge and capabilities for improving the management of those suppliers and/or performing effectively in-house activities.

6. TYPICAL KNOWLEDGE AREAS

Typical organizational competence areas or knowledge domains that can be found in technical and management topics may allow creation and implementation of centers of excellence. These are related with the Technical Communities of Practice (TCoP) implemented worldwide.

The competence areas are related to nuclear plant operation, maintenance, technical support, engineering, modernization and upgrades, administrative systems, life extension, and decommissioning, covering a wide spectrum. These go from Nuclear Reactor Internals to Components in the Balance of Plant in the technical areas. In the management areas, from Human Resources Management to Enterprise Management, including also Nuclear Safety Culture.

An illustrative list of competence areas is included in Annex 1.

The Company may select topics that better suit to their safety, performance, and business needs. It is advisable to start the Centers of Excellence initiative with a limited number of topics.

Knowledge Areas or Areas of Competences are many times called “Centers of Excellence”. Thus, this document calls these areas as “Centers of Excellence”.

7.IMPLEMENTATION

The NCoE implementation may be based on the steps described below:

Initiating

- Defining a communication matrix for each NCoE, including groups and departments of the Company
- Assigning Experts and mid-level junior staff from each Department to each NCoE, number depending on Company, usually from 10 to 15 persons
- Identifying an Expert as Center Leader (with high and recognized expertise on the subject) and Experts from other Companies as Contact Points

A typical NCoE Matrix could be as follows:

Center	**Department1**	**Department2**	**Department3**	**Department4**
Center 1	**Center Leader** Contact Point	Contact Points	Contact Points	Contact Points
Center 2	Contact Points	**Center Leader** Contact Point	Contact Points	Contact Points
Center 3	Contact Points	Contact Points	**Center Leader** Contact Point	Contact Points
Center 4	Contact Points	Contact Points	Contact Points	**Center Leader** Contact Point

Executing

- Encouraging Company Experts to interchange information for the subject area on as applicable basis, i.e. by e-mail, by interchanging reports, by communicating achievements,
- Encouraging the Center Leader to call meetings or conference calls on regular basis (i.e. every two or three months) for exchanging ideas, opinions, and information, talking about problems, solutions, achievements,
- Elaborating Minutes of Meeting of the conference calls or meetings
- Keep a dynamic flow of communication to coordinate attendance at International or National conferences, symposiums, and work-shops in the subject areas
- Encouraging the interaction with Universities and Research Institutes in the subject of interest
- Creating a library of information on the subject areas, incorporating lessons learned, identifying standards applicable internationally or nationally, and assessing the impacts of changes of the new versions of the standards
- Define the convenience to train young engineers in the subject area, and interchanging opinions on the training plans adequacy
- Reporting
- Elaborating NCoE Reports to the Center members, to other NCoE, and to the Company Direction
- Organizing presentations (i.e. once per year, every two years) to illustrate other nuclear engineers in the main aspects of the NCoE
- Controlling

- Applying key performance indicators to evaluate the NCoE effectiveness
- Presenting results to the Company Direction in dedicated review meetings

8.LESSONS LEARNED

The Learning Organizations should strive to increase Knowledge through different Learning techniques. Very effective educational and training programs are based on documented records of lessons learned from previous activities. In successful organizations, every activity or project leader are requested to prepare documented lessons learned of what went well, or went short of expectations.

In this regard, Nuclear Lessons Learned are a substantial element for the Company staff knowledge augmentation, improvement of processes and procedures, equalization of experiences, and increased capability for decision making..

An effective Lessons Learned system is a key platform for interchanging information, increasing awareness, and improving performance, in the same plant or project or in other plants or projects under Company responsibility.

A Lesson Learned is a collection of experiences structured systematically, which allow communication to other plant and/or project participants to improve working processes and performance.

The Lessons Learned must add value to the organization, augment knowledge, increase decision making capabilities, improve plant and/or project performance and when implemented, make Company systems and procedures more efficient and effective.

In other terms, Lessons Learned represent a knowledge augmentation gained through experience or practice that, if shared, will be of benefit to others.

Within the context of a plant department or project the lesson learned will be:

- something that we did differently on this particular activity or project - or
- something that if we were to do the activity or project again, we would do it differently

Lessons Learned contribute to Knowledge Augmentation, which in turn contributes to consistent performance improvement for achieving full Stakeholder/Customer Satisfaction consolidating the Nuclear Safety Culture.

The Lessons Learned should be available to all Company staff and the NCoE are exceptional forums and vehicles to disseminate information, experiences, problem solutions and “why-how to do” as gathered in the Lessons Learned.

The process should be designed to capture Lessons and to action, circulate and reuse them to ensure achievement of effective Knowledge Augmentation Goals.

It is essential that both positive and negative lessons are captured in such a way that the outcome is a positive action going forward. The lessons learned process should primarily be focused to reuse good practices developed on activities and/or projects rather and to avoid recurrence of negative issues.

Focus should be on how we can do things better in the future.

9.PERFORMANCE EVALUATION

In order to keep a growing knowledge base derived from the NCoE, their performance and effectiveness should be evaluated periodically. This evaluation may be made, as an example, by assessing the interactions among experts in scope and frequency, information interchanged, personnel involved in interactions, and number of issues resolved.

To this effect, the NCoE Leader assisted by the Contact points should prepare an Report summarizing information on achievements, contributions, interchanges (conference calls, meetings) and problems solved.

This Report could be half-a-year or annual, and should comprise a section indicating the convenience for continuing operation of the NCoE, or eventually, its discontinuation.

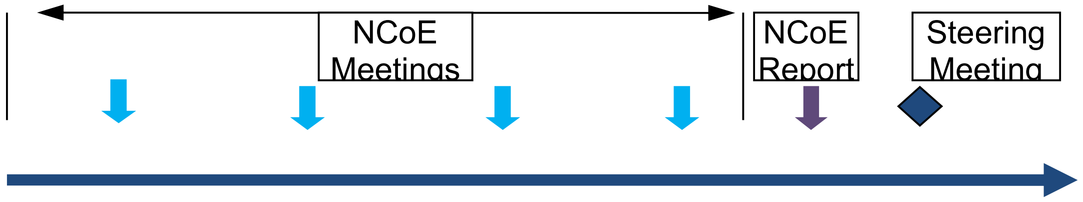
Illustrative key performance indicators to measure NCoE effectiveness on annual basis could be as follows (for further thinking before application):

- Number of global conference calls / meetings held on the year (i.e. >4)
- Issues presented to the Center and resolved effectively (i.e. >3)
- Internal Presentations to the NCoE members (i.e. >3)
- Number of internal reports prepared by the NCoE members (i.e. >3)
- Participation to International Symposiums on the subject (i.e. >1)
- Number of Lessons Learned registered and embedded in the business processes (i.e. >3)

10.DIRECTION OVERVIEW

The global overview of the NCoE may be made by an upper level Management Directing Board or Steering Committee composed by Company Directors:

The Steering Committee may meet on half-a-year or yearly basis, and it will review the NCoE reports, to evaluate the soundness of the achievements and progress towards Knowledge Augmentation by the NCoE. The evaluation should confirm the convenience for continuing the operation of each NCoE and eventual modifications to improve effectiveness.



11.CONCLUSIVE REMARKS

Knowledge Management is a key need of the nuclear industry to cope with the knowledge limited augmentation due to the risks of knowledge loss because of a number of reasons, such as: staff attrition, organizational changes, upgraded technologies, new projects implementation, and the nuclear power evolution in recent years (i.e. post-Fukushima upgrades).

The Nuclear Centers of Excellence effective implementation is a key success factor for Knowledge Management programme of the Nuclear Organization. This document, is based on real case example of Operating Organization approach in launching such initiative for staff knowledge augmentation and performance improvement. Eventually, any type of Nuclear Organization sector can apply the proposed technique to reach better Knowledge usage.

The Nuclear Centers of Excellence are a key Knowledge Management initiative for the learning organizations that are caring about organizational intellectual capital and striving for performance improvement.

The Nuclear Centers of Excellence can be realized as a forum for exchanging of ideas, knowledge, information, experiences; to collect lessons learned; and to identify areas for improvement where further organizational competence building is needed. Usual realization of this initiative is going through an active staff involvement in knowledge sharing in a form of different Technical Communities of Practice focusing on specific knowledge domains.

Typical organizational competence areas or knowledge domains that can be found in technical and management topics, related to nuclear plant operation, maintenance, technical support, engineering, modernization and upgrades, administrative systems, life extension, and decommissioning, may allow creation and implementation of centers of excellence.

The Company may select topics that better suit to their safety, performance, and business needs. It is advisable to start the Centers of Excellence initiative with a limited number of topics.

The Centers of Excellence, or Technical Communities of Practices, are usually composed by experts, mid-level, and junior staff, and this composition creates an environment in which the experts can interchange ideas and experiences with less experienced staff, allowing sound platforms for knowledge dissemination and augmentation, including lessons learned from valuable experiences in different domains.

However, the effective implementation of Centers of Excellence needs to count with motivated staff, willing to share their knowledge with other experts and with the mid/young staff, in order to accelerate the filling of large expertise gaps. Sharing tacit knowledge has been observed as an obstacle in knowledge augmentation due to experts reluctance to give away their own expertise.

Centers of Excellence need some operative rules, to ensure that an effective interchange forum is created and is working properly, as proposed by this document.

The information exchange allowing the resolution of similar problems in other Company departments, avoiding recurrence of past problems, creating libraries of documents and reports that are available to all Company staff, and the use and dissemination of lessons learned are tangible results that usually justify the Nuclear Centers of Excellence implementation.

The Learning Organizations should strive for applying all learning techniques to increase staff Knowledge. The Lessons Learned system has been a proven technique to this goal, and the Lessons Learned should be effective to gather information of activities that may need future improvement, and also of positive results that may be disseminated to other Company departments for performance improvement. Centers of Excellence proved to be exceptional vehicles for effective lessons learned management and consequent Knowledge Augmentation.

Some performance indicators are needed to measure the effectiveness of the Centers of Excellence, and these are described in this document. The Company Management should be involved in overviewing and controlling the Centers of Excellence results and achievements, and this overview should encourage the experts to be diligent in sharing their knowledge.

GLOSSARY OF ABBREVIATIONS

IAEA: International Atomic Energy Agency

KM: Knowledge Management

NCoE: Nuclear Center of Excellence

TCoP: Technical Communities of Practice

ANNEX 1 – TYPICAL KNOWLEDGE AREAS

For illustrative purposes only, other Areas may be of interest

➢ **Technical**

- Nuclear Physics and Reactor Core Calculations
- Nuclear Fuel Performance and Management
- Safety Analyses
  - ✓ Thermal Hydraulic Analyses
  - ✓ Seismic Analysis and External Events Analyses
  - ✓ Probabilistic Safety Assessments
- Nuclear Reactor Internals
- Primary Circuit System and Components
- Reactivity Mechanisms
- Nuclear Components, Pumps, Vessels, Valves
- I&C Digital Control Systems
- Radiation Monitoring Systems
- Radioactive Waste Management
- Maintenance Techniques
- Steam Turbine and Secondary Cycle (Steam, Feedwater, Condensate)
- Chemical Laboratories
- Water Treatment
- Plant Decommissioning

➢ **Management**

- Nuclear Safety, Security, and Safeguards, Nuclear Safety Culture
- Training and Indoctrination Programs
- Knowledge Management, Lessons Learned
- Human Resources Management
- Operation, Maintenance, Technical Support management
- Enterprise Management Systems
- Configuration Management
- Document Management
- Spare Parts Strategy and Inventory Control
- Emergency Preparedness and Response
- Communication to the Public and to the Media
- Plant Life Management / Extension

TRIANGLE OF KNOWLEDGE IN THE NUCLEAR ENERGY

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Abstract

The methodology of the knowledge triangle in nuclear energy is the subject of discussion. The necessity of creation of the nuclear knowledge triangle is proved; an abstract scheme, approaches to implementation, the basic problems and generalized requirements for the functioning of the nuclear knowledge triangle are presented.

1.ANALYSIS: TRIANGLE OF KNOWLEDGE IN NUCLEAR ENERGY

Accumulation, preservation and use of nuclear knowledge are expensive and long-term processes, which have a complex and complicated form [1]. Various types of nuclear knowledge possessed by many actors at different levels and stages of nuclear facility lifecycle (developers and suppliers of specialized equipment, security services for operation of facilities, research and development organizations, educational institutions, regulatory state bodies, international organizations, etc.). Knowledge transfer between the phases of the life cycle of nuclear power plants is carried out on the research, development, [2] and for the operation [3] including modernization, to the decommissioning [4]. Some of the components of nuclear knowledge are successfully developing on the basis of the free exchange of knowledge between experts of different organizations, while others - are in a frozen state, or are not used due to poor knowledge transfer between stakeholders [5]. Consequently, the development of a methodology and approaches for the establishment of cooperation between the subjects of nuclear knowledge for Capacity Building is an urgent task. At the macro level of nuclear knowledge management existing nuclear knowledge entities can be attributed to the Research [2], Innovation [6] and Education [7] areas of activity.

The main problem in many countries is still a lack of integration of the “three corners of the nuclear knowledge triangle": education, research and innovation. Higher education and research are still more or less strictly separated spheres. And most innovation processes have got their origins not in systematic cooperation between research institutions and enterprises. Efficiency will be augmented by making the information available worldwide and fostering cooperation. Sustainable development of nuclear power is directly related to the formation of nuclear knowledge triangle (NKT): the synergy of education, research and innovation areas.

2.AN ABSTRACT SCHEME FOR THE KNOWLEDGE TRIANGLE

The ideal knowledge triangle (Figure 1) consists of three main components: education (universities, training centers), innovation (public sector enterprises, private enterprises), research (the organization of the Academy of Sciences, research departments at universities, research and development organizations) and provides for their deep interconnection and integration.

Higher education: the development and modernization of educational standards take into account the requirements of enterprises and research institutions, requirements for skills, knowledge and competencies of graduates. Teachers undergo training and advanced training in research institutions and enterprises.

Scientific organizations: develop requirements for educational standards. Leading research workers engaged for lectures, tutorials, diploma projects, undergraduates and graduate students in the universities; organize practical training and employment of graduates in their own organizations. Actively involve students and undergraduates in the research.

Enterprises: develop requirements for educational standards; organize practical training and recruitment of graduates at the enterprises. The leading experts of the enterprises are involved in teaching at universities, with the leadership of diploma projects; participating in the creation and operation of joint ventures with universities, educational, scientific and industrial laboratories, branches and centers.

Three components of knowledge triangle interact on the following formulas (see Figure 1):
University + Company = joint laboratory
University + Enterprise = branch of the department
University + Enterprise = education center
University + Research institution = branch of the department
University + Research institution = joint laboratory

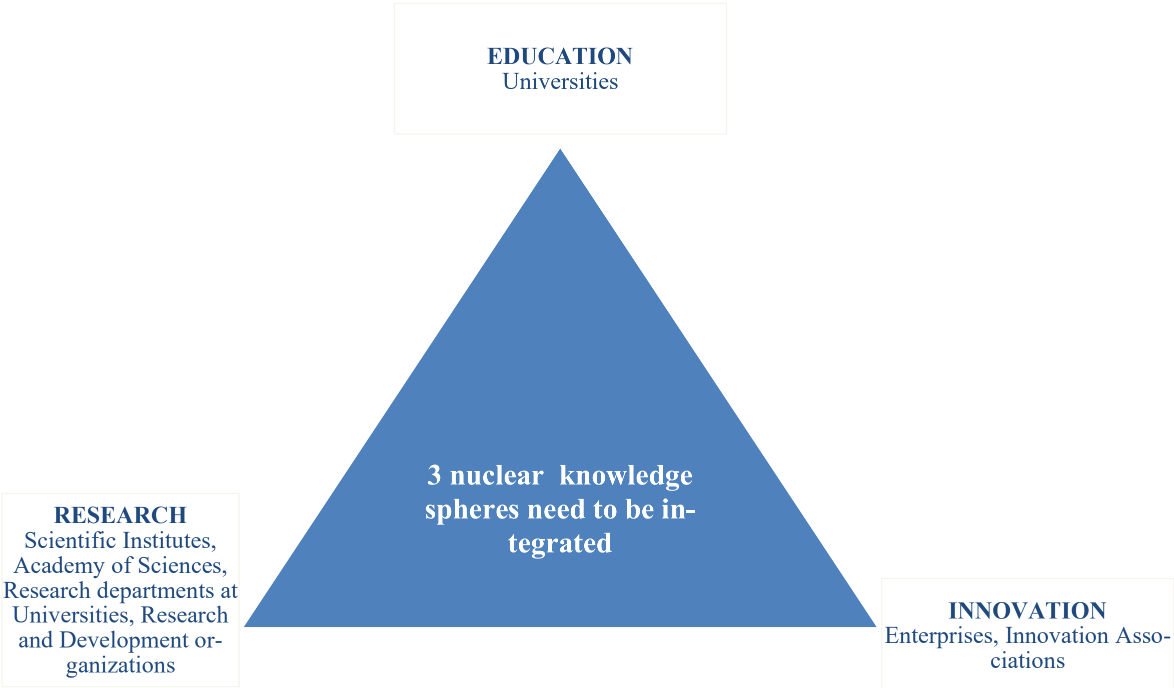

FIG 1. Ideal nuclear knowledge triangle

3.NKT CHALLENGES

The main NKT objectives are:
(1) Increasing the operating reliability and safety of nuclear power plants by accelerating the transfer of knowledge and experience in NKT;

(2) Sustainable development of innovation on the basis of the effective transfer of knowledge, generating new knowledge, preservation and restoration of existing knowledge and use of knowledge for NKT entities;
(3) Reducing the risk of loss of knowledge in the nuclear industry organizations;
(4) Increase the level of responsibility and control, based on the rapid development of approaches to identify sources of dual-use and limit their use in the military sphere;
(5) Support the modernization of the education system;
(6) Support for improving the quality of higher education;
(7) Increased educational opportunities for universities, the ability to modernize;
(8) Support for human resources development;
(9) Improving the efficiency of human resources based on accelerating the exchange of new ideas and ways to solve problems, generate new ideas and provide an opportunity to solve problems in the shortest possible time;
(10) Creation and development of contacts between educational and research institutions;
(11) Creation and development of contacts between educational institutions and industrial organizations;
(12) Support promotion of nuclear knowledge;
(13) Sharing the benefits of peaceful applications of nuclear science and technology.

4.REQUIREMENTS FOR THE FUNCTIONING OF THE KNOWLEDGE TRIANGLE

Today, the reality is that we can't, bat talk about increasing the effectiveness of the nuclear industry without the integration and interaction of science and education, education and industry and, science and industry. At the same time higher education in this interaction plays a key role as a major supplier of human resources for science and business.

The field of nuclear technology lags in adaptation of curriculum for the requirements of the nuclear companies to graduates of higher education institutions. Therefore, education sets the task to give fundamental knowledge on a number of basic disciplines and together with innovative companies NKT provides opportunities to explore current technologies.

For the harmonic functioning of the knowledge triangle in an existing partnership environment necessary to develop mutual requirements for the integration of the three components: Education + Innovation + Research; identify the factors (organizational, legal) that prevent the functioning of the triangle; develop an information environment (common internet portal, a computer network, combining entities NKT in real time).

5.CONCLUSIONS

Result of NKT is the formation of a new mechanism of social partnership - real participation NKT entities in mutually beneficial exchange of resources (material, technical, human, intellectual, educational, informational, etc.). Operation of NKT will ensure sustainable innovative development of the nuclear industry.

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ATOMIC ENERGY COMMISSIONS AS FULCRUMS FOR THE DEVELOPMENT OF NATIONAL FRAMEWORKS FOR THE BUILDING OF PERTINENT NUCLEAR TECHNOLOGY EDUCATION AND TRAINING PROGRAMMES: THE NIGERIAN EXAMPLE

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Abstract

Nuclear technology development is human capital intensive. Consequently, the successfuland effective deployment of nuclear technology for multifarious applications to benefithuman society in a sustainable, safe and secure manner is critically hinged on the availabilityof a competent, robust and experienced human resource base. Many countries use nuclearand isotopic techniques to promote sustainable development objectives in energy and power, food and agriculture, human health and water resource management, as well as in themarine environment and industrial applications, amongst others. For many developingcountries with limited educational training infrastructure in nuclear science and engineering, building the requisite manpower and national capacity, aswell as management and retentionof knowledge, to optimally reap the benefits of nuclear technology in the various sectorsmay be challenging. While the responsibility for growing the critical sectoral manpower inthe areas of applications may rest with the mandated national institutions, the respectivenational atomic energy commissions (AECs) could play a catalytic role. This paper highlightsthe central coordinating role, that an AEC, as the national focal agency for atomic energydevelopment, as in the case of Nigeria, could play in setting out the national agenda andstrategy, and laying the foundation for the building of the critical human resource base forsuccessful and sustainable programme implementation.and effective deployment of nuclear technology for multifarious applications to benefit.

Human society in a sustainable, safe and secure manner is critically hinged on the availabilityof a competent, robust and experienced human resource base. Many countries use nuclearand isotopic techniques to promote sustainable development objectives in energy and power, food and agriculture, human health and water resource management, as well as in themarine environment and industrial applications, amongst others. For many developingcountries with limited educational training infrastructure in nuclear science and engineering, building the requisite manpower and national capacity, aswell as management and retentionof knowledge, to optimally reap the benefits of nuclear technology in the various sectorsmay be challenging. While the responsibility for growing the critical sectoral manpower inthe areas of applications may rest with the mandated national institutions, the respectivenational atomic energy commissions (AECs) could play a catalytic role. This paper highlightsthe central coordinating role, that an AEC, as the national focal agency for atomic energydevelopment, as in the case of Nigeria, could play in setting out the national agenda andstrategy, and laying the foundation for the building of the critical human resource base forsuccessful and sustainable programme implementation.

INTERGENERATIONAL KNOWLEDGE TRANSFER

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Abstract

Institutions of higher education and universities have been at the forefront of intergenerational knowledge transfer. Their role has gone through evolution and several ideas of the university co-exist. Factors like the squeeze on public funding of higher education across nations, exhortation by governments to value work-based learning as a part of higher education and demand for graduates ready to start working immediately on joining a workplace, are making it necessary to further evolve the classical approach towards intergenerational knowledge transfer. The paper presents a framework that has been evolved in India to meet the requirements of intergenerational knowledge transfer. It essentially integrates a workplace and a university in a single entity similar to the practice in medical education.

1.INTRODUCTION

Human civilization has come to its present level of sophistication based on intergenerational knowledge transfer. Methods adopted for knowledge transfer vary, and determine the efficiency with which transfer takes place. Universities and other institutions of higher education have been the centres for intergenerational knowledge transfer for the past several centuries and have accomplished and continue to accomplish their task efficiently. While universities have been in existence for a long time, many workplaces including large corporations, research centres, other organizations, both national and international have come on the scene comparatively recently, and have emerged as users of knowledge as well as contributors to knowledge generation. In fact, many workplaces are store-houses of knowledge that needs to be preserved and transferred. As a result, knowledge now exists at multiple places and in diverse formats, a feature that shall ensure that knowledge will not be lost. One, of course, has to continue to look for any gaps and do all that is necessary to preserve knowledge.

Conventional wisdom tells us that for intergenerational knowledge transfer, coexistence of the young and the old is a necessary pre-condition. Whenever an activity is expanding, fresh talent is drawn towards that activity on a regular basis to meet requirements of growth and to replace aging workforce. Regular induction of fresh talent keeps the organization pursuing the activity vibrant, and knowledge from seniors to juniors is transferred by a variety of formal and informal processes. Details of formal processes are determined by the type of organization. In a university or an institute of higher education, such processes include attending lectures, study of text books, practice in a laboratory, and regular interactions between a research supervisor and students. In corporations, formal processes would take the form of structured training of an employee at the time of induction and periodic up-gradation, documentation of practices in the form of manuals and reports, and making them available for reading by employees, recording of exit interviews of employees at the time of superannuation or resignation etc. Trends during the past couple of decades point towards workplaces or corporate world encouraging academic credentials and one comes across close partnership between corporate and higher educational institutions [1]. A recent initiative launched in many organizations called as 'oral history projects' involves interviewing individuals who have made seminal contributions and recording such interviews. Informal processes would include information exchanged between the young and the old through word of mouth during personal interactions at workplaces, in cafeteria or outside of workplaces.

When an activity is at a steady state or near steady state, one needs young manpower to replace aging workforce, and for efficient knowledge transfer an overlap between the incoming and outgoing workforce has to be planned. While this can be done, there is a reluctance among the young to take up such an activity as it is difficult for newcomers to reach leadership position in an organization that is not growing. When an activity is declining, it is still more difficult to attract fresh talent to replace outgoing manpower and the conventional model of knowledge transfer which pre-supposes co-existence of the young and the old breaks down.

However, the conventional wisdom presupposing co-existence of the young and the old is under challenge due to a variety of reasons including explosion of knowledge. Self-study by students based on reading printed material as well as material available online requires that knowledge should be preserved so that it can be used by knowledge seekers as and when they need it. In certain cases such as management of emergency one needs information that can be retrieved fast and this has to be planned using technology to store information and development of appropriate taxonomy for retrieval. This is the issue which the International Atomic Energy Agency is trying to address through its nuclear knowledge management initiative [2].

This talk concentrates on what is being done in India for intergenerational transfer in the crucial area of nuclear knowledge. The Government of India is trying to expand the role of nuclear energy in India's electricity generation mix and therefore, we have a situation where the young and the old co-exist in the nuclear establishment. All nuclear facilities are owned and operated either by the Central Government or by companies that are owned by the Central Government. While the higher education system in India is quite vibrant, the employment opportunities are only in the Government sector. Given this scenario, we have established a unique framework for intergenerational knowledge transfer as described in the following paragraphs.

2.THE FRAMEWORK

Before postulating a new framework, one has to examine the existing approach towards higher education. The classical approach separates workplaces (that is professional organizations) making use of knowledge in a given discipline from universities which transfer knowledge to students. This separation is, however, not universal. In the field of medicine, schools and hospitals are integrated into a single institution or are co-located. Medical professionals teach students as well as practice their profession. I always wonder as to why this model has not been extended to other disciplines.

Considering the squeeze on public funding of higher education across nations, exhortation by governments to value work-based learning as a part of higher education and demand for graduates ready to start working immediately on joining a workplace, it is necessary to rethink and tweak the classical approach towards imparting higher education. Extending the model of medical education to other disciplines will increase vocationalism, which has always been contested by academicians who subscribe to the belief that most important mission of higher education is the "pursuit of truth". In spite of such contestation, vocationalism has taken place and to paraphrase Narisada Kaoru [3], throughout the long history of the higher education, to adapt to circumstances and to fulfil various functions, several ideas of the university co-exist.

The IAEA has been concerned with aging and retiring of the nuclear workforce, and consequent decline in the number of qualified and experienced staff and the loss of knowledge possessed by them [4]. This feature is not unique to the nuclear industry. The concern arises from the fact that as the program in many countries is not expanding and universities do not find it attractive to run academic programs in nuclear science and engineering. Therefore, it is no longer possible to attract young graduates to take up a career in nuclear science and engineering.

Indian scene has similarities as well differences: the nuclear program is thriving, young graduates have interest in taking up a career in nuclear science and engineering, but vibrant educational programs on the subject in institutions of higher education are at sub-critical level. Such academic programs are not in a position to support the needs of the nuclear establishment. This situation has persisted for a long time. However, to address the problem a Training School was established in late nineteen fifties in Bhabha Atomic Research Centre (BARC) to provide training in nuclear science and engineering to young graduates prior to their induction in the nuclear establishment. The program was not accredited to any university, though the training was fully academic. Faculty is drawn from among the practicing professionals working in the nuclear establishment. In this regard, one can see a similarity with medical profession. The program, first started as a part of BARC, was extended to other units of the Department of Atomic Energy to meet increasing requirements of manpower.

A young person always has attraction for a higher degree as it increases both social status and professional mobility. Around the turn of the century, it was realized that for continued success, it is necessary to get accreditation for the pre-induction training program. From the point of view of management, a pre-condition for any such accreditation by a university was that there should be no loss of autonomy in decision making, that is in the formulation of syllabi, selection of faculty, pattern of examination, and evaluation of student performance. The management realized that this level of autonomy would be possible only if the Department of Atomic Energy has full control of the university accrediting the program. As a result, a university level institution, having accreditation in accordance with the system of higher education in India, was set up in 2005. As described in the next section, it is an institution providing a unique framework for intergenerational knowledge transfer.

3.THE HOMI BHABHA NATIONAL INSTITUTE

Concerns related to knowledge management can be easily addressed, if a framework for higher education that enables practicing professionals to teach is created. This is what has been done by setting up of the Homi Bhabha National Institute (HBNI) in India. Set up in the year 2005, it integrates academic programs being run in the following 11 institutions, all fully funded by the Department of Atomic Energy:

1. Bhabha Atomic Research Centre (BARC), Mumbai established in 1957[2] and having campuses at other places in the country;
2. Indira Gandhi Centre for Atomic Research (IGCAR), Kalpakkam set up in 1969;
3. Raja Ramanna Centre for Advanced Technology (RRCAT), Indore set up in 1984;
4. Variable Energy Cyclotron Centre (VECC), Kolkata, which became operational in 1977;
5. Institute for Plasma Research (IPR), Gandhinagar set up in 1986;

[2] Although it started in 1954, as the Atomic Energy Establishment, it was formally inaugurated on January 20, 1957.

6. Saha Institute of Nuclear Physics (SINP), Kolkata set up in 1950;
7. Institute of Physics (IoP), Bhubaneswar, set up in 1972;
8. Harish-Chandra Research Institute (HRI), Allahabad set up in 1966;
9. Tata Memorial Centre (TMC), Mumbai set up in 1941; and
10. Institute of Mathematical Science (IMSc.), Chennai set up in 1962; and
11. National Institute for Science Education and Research (NISER)[3], Bhubaneswar set up in 2006.

The Institute, thus, has a distributed structure. Its Constituent Institutions have been carrying out advanced research and development for several decades. HBNI is a leading[4] research university and educates students at the doctoral and masters level. Distinctive characteristic of the Institute is to advance indigenous nuclear technological capability. The first five institutions listed above are engaged in technology development and are at the forefront of developing new nuclear knowledge, which is now being passed on to the next generation of students through the framework established by the setting up of HBNI.

HBNI has now completed eleven years. During this period, following an approach based on prudent gradualism, the HBNI has come a long way to establish itself as a leading research university. Prudent gradualism had to be followed on two fronts. In interaction with academics and officials from accrediting agencies outside of the HBNI, one had to explain the unique architecture of HBNI as a further evolution of the 'idea of a university' [3]. In dealing with stakeholders inside the HBNI, one had to work to superimpose a 'university culture' over the existing culture and this involved several facets: one was to explain the role and responsibilities of the faculty towards students to practicing professionals; the other was to explain the difference between doctoral research that has to be completed by a student in a certain time frame versus working on large research problems which may be done by individuals or teams of researchers over a longer time period.

Results of all these efforts are now visible. The program being run in the BARC Training Schools on a non-formal basis since 1957 has been converted into a formal program thereby giving the students an opportunity to get a post-graduate diploma or an M.Tech.[5] (with the addition of a one-year project to one year of course work) from HBNI. While the Training Schools are functioning like Graduate Schools, the name Training School has so far been retained as it re flects history. Doctoral programs predominantly concentrate on problems related to nuclear science and engineering and intake to doctoral programs is being

[3] The NISER was set up with education and research as its mission, while all other institutions were set up with research and development as their mission.

[4] The HBNI has been accredited by the National Assessment and Accreditation Council (NAAC) with a CGPA of 3.53 on a four-point scale at 'A' Grade valid until 10 May 2020. NAAC is an autonomous agency set up by the Government of India and the grade 'A' is the highest grade. HBNI has been ranked at 17th position in the University category in India's Rankings 2016, released on 4th April 2016 by the Ministry of Human Resource Development.

[5] As per nomenclature of degrees followed in India, M.Tech. stands for Master of Technology and consists of one year of course work and one year of project work leading to a thesis. M.Sc. stands for Master of Science, B.Sc. for Bachelor of Science and MD for Doctor of Medicine.

progressively increased. M.Tech. in fusion science and engineering has been started at the Institute for Plasma Research. Postgraduate and super-specialty medical programs in the area of oncology at Tata Memorial Centre have been significantly expanded. MD in nuclear medicine has been started in Bhabha Atomic Research Centre. Other important programs being offered are a post-M.Sc. Diploma in Radiation Protection and a post-B.Sc. Diploma in Medical Radio-Isotope Technology, both at BARC, and a post-B.Sc. Diploma in Fusion Imaging Technology at the Tata memorial Centre. Further details can be seen on HBNI website [5].

4.CLOSING REMARKS

By establishing a university having unique architecture, it has been possible to achieve several objectives including nuclear knowledge management. The HBNI has also made vast research infrastructure in the institutions of the Department of Atomic Energy for human resource development. Every year more than 150 students complete M.Tech. or post-graduate diploma with specialization in nuclear science and engineering, and get employment in the nuclear establishment as they are selected by the nuclear establishment prior to their joining the academic program. Annual doctoral output is about 200 and is expected to cross 300 in near future. More than 100 students complete post-graduate or super-specialty programs in specializations related to oncology.

Squeeze in public funding for higher education has led to concepts like cooperation and partnership between universities and workplaces. The model of HBNI takes this forward by integrating a ‘workplace’ and a ‘university’ in a single entity. It is a step in the process of further evolution of the concept or ‘idea of a university’. While implementing the concept, it has been ensured that the academic rigour is not lost.

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NUCLEAR KNOWLEDGE MANAGEMENT AS AN ESSENTIAL ENABLER FOR REGULATORY EFFECTIVENESS AND EFFICIENCY

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Abstract

Regulatory bodies must maintain the highest levels of competence to provide regulatory oversight to the operating organizations. In building up that competency, regulators amongst others develop safety regulations and authorization processes, review and assess the safety and design documentation provided by the operating organization and inspect the facility, the vendors and manufacturers of safety related components. Over the years, regulators have seen an exodus of skills due to several reasons such as natural attrition, poaching by industry due to new nuclear build opportunities, etc. Regulatory knowledge and experience loss becomes the biggest risk to many regulators. Intervention strategies must be devised to mitigate this risk, and knowledge management is one of them. The presentation will highlight and conjecture ways and means by which nuclear knowledge management can enable a regulator to be both effective and efficient.

CHALLENGES IN IMPLEMENTING IAEA NATIONAL NUCLEAR SAFETY KNOWLEDGE PLATFORMS

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Abstract

Integrated Management Systems and human resource development of nuclear knowledge have always been a challenge for developing countries. National Radiation Protection Agency (NRPA) staff when trained by International Atomic Energy Agency (IAEA), return and restitute with all colleagues the themes acquired in nuclear knowledge. NRPA became a member of Forum for Nuclear Regulatory Bodies in Africa (FNRBA) in 2009. FNRBA organized with IAEA a workshop, from 14 to 18 October 2013, in Nairobi, Kenya on the Knowledge Safety Network. NRPA of Cameroon created the first National Nuclear Portal under FNRBA. This was linked to other national websites. During the IAEA review missions, most counterparts took the opportunity from the thermatic site to share information and develop advanced reference materials. The IAEA Integrated Regulatory Review Service (IRRS) team also shared materials that could not be transferred through email with national counterparts using the Global Nuclear Safety and Security Network (GNSSN) SharePoint website due to large file sizes. The regulatory documents have been uploaded on the platform and can be accessed through FNRBA and NRPA website (www.anrp.cm). UN organizations implementing projects in Cameroon are also linked to the platform. The action plans and progress reports for IAEA/AFRA projects are also available. Moreover, NRPA regulatory activities and licensing sources are available on this platform.

1.INTRODUCTION

The Integrated Nuclear Security Advisory Services (INSServ) took place in Cameroon from 21st to 25th April 2014 and the Integrated Regulatory Review Service (IRRS) from 12th to 21st October 2014. This was after the government requested the Director General of International Atomic Energy Agency (IAEA) through an official correspondence on 11th June 2013, for these missions. The main objective was to further improve the effectiveness of the Cameroon governmental, legal and regulatory framework for safety and security. Triggered by the expansion of national economic and social sectors, the demand for nuclear science and technology applications in Cameroon is marking an ever-growing trend in scale and scope. Consequently, there is an increasing use of radioactive sources in various socio-economic developmental activities and the above development calls for organized and coherent measures to regulate and control the applications of radioactive sources from a safety and security perspective without impeding on the beneficial application thereof.

As of February 2016, 162 radioactive sources have been identified to be extensively used for beneficial purposes in Cameroon in medical, industrial, agricultural, research and educational applications. Ensuring their safety and security has been done for the past three years by the National Radiation Protection Agency (NRPA) and significant improvements have been made in this respect. However, proper legislative framework and adequate resources remain major concerns. Many efforts are being put in place to review the current situation and to identify the means of maintaining the highest possible level of safety and security of radioactive sources throughout their lifecycle and everywhere in Cameroon.

The primary foundations through which valuable regulatory exercise could be ensured is by developing and sustaining sound national regulatory infrastructures which is equipped to effectively and efficiently implement regulatory control over the application of nuclear technology and practices involving the use of radiation sources at a national level and by promoting regional cooperation among Regulatory Bodies. In the context of the above development, NRPA has been part of the Forum of Nuclear Regulatory Bodies in Africa (FNRBA) since 2009 and the AFRA Projects on Self-Assessment of Regulatory Infrastructure for Safety and Networking of Regulatory Bodies (RAF 9038) and Sustaining the Regulatory Infrastructure for the Control of Radiation Sources (RAF 9042 and RAF9049).

2.PROGRESS MADE, NEEDS AND PRIORITIZED AREAS IDENTIFIED [2]

- Legislative Framework, Regulations and Codes of Practice;
- Regulatory Body Functions: Inventory of Radiation Sources, Authorization, Inspection;
- Safety and Security of Radiation Sources;
- Regulatory Control on Uranium Mines Activities;
- Coordination and Cooperation at National Level;
- Regional and International Cooperation;
- Quality Management.

A committee was setup at NRPA to develop a strategy to share knowledge in the different departments. |An overview of the radiation safety infrastructure in Cameroon was presented by the National Nuclear Regulatory Portals (NNRP) Coordinator after the IAEA workshop in Nairobi, Kenya in 2013. The recommended actions that came from this meeting to address these were:

- To adopt a strategic approach. NRPA should have a strategy for the strengthening of radiation safety infrastructure. NRPA should develop their own strategy in line with the IAEA strategy;
- A policy ensuring that NRPA website has clear objectives, achievable outputs and adequate funding, should be developed and applied;
- High priority should be given for developing regulations on radiation safety and sharing knowledge after attending IAEA events;
- To provide assistance for NNRP and website to be regularly updated and validated;
- To create Nucleus accounts and seek access to FNRBA portal. Existing network should continue to share experiences;
- Outreach and high level sensitization. Outreach activities to sensitize and to enhance awareness on the importance of radiation safety should be carried out.

3.ACHIEVEMENTS AND BENEFITS OF NNRP

(a) Successful implementation of most of the planned activities (90.6% of the total allocated information was filled). Cameroon was the first country in Africa to appear on National Nuclear Portal of IAEA that was presented at AFRA-Nest in June 2015 [3].
(b) Organised 16 restitution training courses, 9 expert missions and 8 meetings/workshops, notably:
(i) On authorization, inspection and enforcement;
(ii) School of drafting regulations;
(iii) On regulating uranium mining and milling activities;
(iv) On staff organisation and competence for regulators.
(c) Overall improvement of the management system.
(d) Enhanced skills of participants at events led to an increase in the usage of national experts.
(e) Promoted the sharing of experience and lessons learned between the participating staff.

(f) Better understanding of the regulatory functions as a result of the IRRS mission uploaded into NNRP;
(g) Facilitated the use of Regulatory Authority Information System (RAIS) and IAEA Self-Assessment of Regulatory Infrastructure for Safety (SARIS) by consulting the Frequently Asked Questions (FAQ) under Global Nuclear Safety and Security Network (GNSSN) of Thematic Network.

4.CHALLENGES IN NNRP

(a) Numerous staff found it difficult to register to Nucleus and gain access to NNRP in order to maintain updated national data of sources.
(b) NRPA does not have an established training programme in place for the training of their staff to have adequate competence to effectively carry out its activities.
(c) Application of the graded approach in all regulatory body activities which will lead to an optimization of the use of the available resources for the Regulatory Body to effectively and efficiently carry out its regulatory functions.
(d) Developing a pyramid for the legal and regulatory infrastructure.
(e) The understanding of NNRP as a tool for an Integrated Management System to effectively and efficiently carry out all regulatory functions.
(f) Updating information on NNRP on SharePoint.
(g) National Coordination of NNRP.
(h) Collecting reliable documents, of which, some are considered confidential.
(i) Integration of NNRP and NRPA website Action Plan into National Strategic Action Plan
(j) Not enough time due to limited staff or other tasks being assigned.
(k) Provision of information on NNRP only in English.

5.CONCLUSIONS

With IRRS and INSServ missions done in 2014, various recommendations ditched out, NRPA is improving its Information Management System, defining measurable quantities to monitor the performance of the authorization process, inspection and enforcement systems. Keep an electronic copy of all process documentation in RAIS and NNRP, so that it can readily be accessible to the management and all staff of the regulatory body with connection to IAEA GNSSN knowledge management principles [1]. Regulatory Body staffing and training will continue, especially new recruits, as sharing of nuclear knowledge management is concerned.

FIG. 1 Cameroon in national platform of IAEA GNSSN

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EMERGING CHALLENGES IN THE DEVELOPMENT AND MANAGEMENT OF NUCLEAR KNOWLEDGE IN KENYA

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Abstract

Nuclear knowledge remains a crucial asset in the nuclear industry. Establishment of new nuclear builds, operations, maintenance and the decommissioning of nuclear power plants (NPPs) essentially are knowledge intensive endeavors that require a lot of technical expertise. The expertise is defined by knowledgeable and competent personnel that range from nuclear engineers to nuclear economists, nuclear lawyers, and environmentalists among others. The technological challenge facing the industry currently is the aging experts that have created a huge knowledge gap that threatens the future of the industry. This realization has caused an alarm and has led to concerted efforts aimed at facilitating knowledge transfer to younger generations at a global scale especially in countries with established nuclear industry. This effort has led to development of nuclear knowledge management best practices models by knowledge experts at IAEA that seeks to assist member states in coping with the present day challenges in the industry.

1.INTRODUCTION

Knowledge base is a crucial asset in the establishment of new nuclear builds, operations, maintenance and the decommissioning of Nuclear Power Plants (NPPs) [3]. It is evident that nuclear industry is a knowledge intensive field that needs high level of expertise defined by knowledgeable and competent personnel that range from Nuclear Engineers, Nuclear Chemists, Chemists, Physicists, Nuclear Economists, Nuclear Lawyers, and Environmentalists among others [4].

In the modern day nuclear industry, the global challenge facing the industry is the aging experts that have created a huge knowledge gap in the industry [3]. This realization has seen concerted efforts aimed at facilitating knowledge transfer to younger generations at a global scale especially in countries with well established nuclear industry. The effort has led to development of Nuclear Knowledge Management best practices models by knowledge experts at IAEA that seek to assist Member States in coping with this striking reality.

Kenyan nuclear industry is still nascent and this calls for development of expertise to help the industry sail smoothly. As such the practice of nuclear knowledge management and subsequently, knowledge transfer is not so well structured, although nuclear knowledge-based institutions such as Kenya.

Nuclear Electricity Board (KNEB), Kenya Radiation Protection Board (RPB), Kenya Bureau of Standards (KEBS), Institute of Nuclear Science and Technology (INST), National Commission for Science, Technology and Innovation (NACOSTI), among others, have demonstrated a commitment in knowledge management aimed at building the institutional capacity to promote peaceful uses of nuclear science and technology in the country. Despite the effort, it is evident that the quest of nuclear energy has brought about mixed reactions ranging from inadequacy in expert knowledge to security fears amid the Al Shabaab terror threats that continue to disturb peace and tranquility in the region.

It is against this background that the author(s) sought to share Kenyan emerging challenges in regard to nuclear knowledge management and best approaches for facilitating knowledge transfer and building expert knowledge base.

2.NUCLEAR KNOWLEDGE MANAGEMENT (NKM) FUNDAMENTALS

Nuclear knowledge essentially relates to people, processes and the nuclear technology. IAEA knowledge experts have postulated the knowledge concept in a 3-D approach as shown in Figure. 1 demonstrating the complex view of the knowledge aspects that need to be managed.

In the first dimension, the concept illustrates that, the primary knowledge domains are about the people, processes and nuclear technology. As mentioned in the preceding sections, people working in the nuclear industry need to have competence demonstrated by the necessary and relevant combination of appropriate knowledge, skills, experiences, attitude and self motivation. To achieve optimum efficiency, nuclear processes, methods and practices have to be controlled by competent personnel in a more orderly and consistent way. In addition, the technology in use must be well understood and maintained by the relevant personnel in the industry [4]. The second dimension illustrates that the nuclear life-cycle relates to research and development (R&D) through design, licensing, construction, commissioning, operations, maintenance, refurbishment and decommissioning being the final stage of the nuclear project cycle. On the other hand, the third dimension recognizes and looks at the different levels of concerned entities and the nature of expertise exhibited by the individual(s), organizational competency and /or the national capacity [3].

In Kenya the industry is growing and the necessary structures to undertake the aforementioned important processes aimed at utilizing nuclear science and technology appropriately are being considered. Therefore, the main areas of application of nuclear knowledge are currently limited to education and training, basic research and development, medical applications and licensing especially in regard to radiation services in the country. This makes nuclear knowledge management outlook in Kenya take a 2-D approach since there are no Nuclear Power Plants (NPPs).

NKM complexity and scope (Source IAEA)

3.CHALLENGES IN POLICIES AND STRATEGIES IN MANAGING NUCLEAR

KNOWLEDGE IN KENYA

Kenya has embarked on an ambitious program to lay a firm foundation for its quest for nuclear energy. The country is working closely with IAEA to put in place adequate and effective policies and strategies to ensure best practices are achieved in managing nuclear knowledge as the country anticipates generating nuclear electricity in the near future. KNEB was established by the government through the Kenya Gazette Notice on the 19th November 2010 initially as Nuclear Electricity Project Committee (NEPC) to fast track development of nuclear electricity in order to enhance the production of affordable and reliable electricity in the country. The growing energy in demands in the region necessitated Kenya to develop a robust energy plan - Least Cost Power Development Plan (LCPDP) that seeks to make Kenya a self energy reliant and a major player in Eastern Africa Power Pool [6]. The plan includes nuclear electricity in the energy mix as the first country's NPP is expected to be commissioned within the next decade.

Applications of nuclear science and technology in Kenya are for non-power aspects. In this regard, regulatory institutions such as Radiation Protection Board has put in place policies and strategies that help the board in discharging its duties of regulating radiation services in the country in industrial and medical applications [9]. This institution is complemented by the KEBS, a government agency charged with mandate to provide standardization and quality assurance. KEBS has an established Standard Secondary Dosimetry Laboratory (SSDL) with laid down policies and strategies to enhance services on dosimetry, and radiotracer techniques [5]. It also has strategies on human resource development through its National Quality Institute (NQI).

Regarding education, training and research, the National Commission for Science, Technology and Innovation (NACOSTI) is mandated to formulate and enforce science, technology and innovation policies and strategies in the country including streamlining the works by institutions of higher learning and individual or joint innovation ventures [7]. The nuclear knowledge-based training and research institutions such as Institute of Nuclear Science & Technology [2], remain among the few academic institutes in the country and have working policies and strategies that continue to drive operations in education, training and applied nuclear techniques in research. There also exist other non academic institutes of research and development such as the Kenya Marine Fisheries Research Institute (KEMFRI), the Kenya Agricultural Research Institute (KARI), Kenya Industrial Research Development Institute (KIRDI), and International Centre for Research in Agroforestry (ICRAF).

In medical applications of nuclear knowledge, Kenya National Hospital (KNH) remains the only public hospital with nuclear medicine equipment though there are also a few private hospitals such as Texas Cancer Centre, the Aga Khan and Mp Shah Hospitals. KNH relies on imported radioisotopes from South Africa and it has limited facilities/equipment thus impeding the provision of cancer care and treatment services in the country. In the recent past, cancer patients have been spotted seeking medical attention in India, United Emirates Arab, UK and the US.

4.CHALLENGES IN MANAGING NUCLEAR INFORMATION RESOURCES IN KENYA

IAEA knowledge management experts reiterate that, managing nuclear information sources is key in ensuring that information is well kept, stored, shared and disseminated to the relevant consumers and for ease of retrieval in future [4]. It defines best practices in nuclear knowledge management. Kenya has two main coordination centers for managing nuclear information. The first one being the National Commission for Science, Technology and Innovation - International Nuclear Information Systems(INIS) liaison office [7]. The INIS center is a custodian of nuclear information generated in the institutions of higher learning and research in the country as well as storing and sharing of IAEA nuclear information generated through technical cooperation on non-power applications. The second is the newly established nuclear resource centre/library at KNEB, which is also a custodian of information generated at the board as well as for sharing IAEA publications regarding nuclear energy. Inadequate coordination of manpower and dissemination of data/information remains the greatest challenge in these two centers.

5.CHALLENGES IN HUMAN RESOURCE DEVELOPMENT

Nuclear knowledge management itself requires technical expertise and effective policies and strategies to enhance service delivery. Subsequently, the nuclear industry is knowledge intensive and needs competent personnel to control competent processes and high end technology. In discharging its mandate as a promoter for nuclear energy development in the country, KNEB has laid down human resource development strategies to train a competent nuclear workforce as per the industry demands. This calls for adequate preparations in terms of human resources and legislative frameworks. Going by the saying “before you run, train first!” Kenya has no option other than to put adequate measures in place through competent personnel development [6].

Currently, there is collaboration between the government of Kenya and Republic of Korea to train and develop competent nuclear plant engineers at the Kepco International Nuclear Graduate School (KINGS). Such collaboration also exists with the Slovak government, and a total of sixteen Kenyans have been trained both at KINGS and in Slovakia. According to KNEB, other collaborations are being considered in Europe and the US to achieve a target of a hundred highly skilled workforce in the near future. At the local university, at least sixty students have been sponsored by the government through KNEB to undertake masters training programme in nuclear science at the Institute of Nuclear Science &Technology, University of Nairobi [6][2].

In addition through IAEA Technical Cooperation, a number of capacity building programs have been initiated by institutions coordinating such programs in the country. These include, Kenyatta National Hospital program on Radiology and Nuclear Medicine, the Institute of Nuclear Science & Technology program on Non Destructive Testing (NDT), KEBS program on NDT and Radiotracer techniques, radiation protection programs coordinated by Radiation Protection Board among others.

Other Technical Cooperation support realized in Kenya are the Technical Schools run jointly by Abdus Salam International Centre for Theoretical Physics, the IAEA and UNESCO in Trieste, Italy. A good number of Kenyans have attended the Italy based workshops/schools that include Nuclear Knowledge Management, Nuclear Energy Management and Nuclear Security among others. In addition, three Kenyans have since participated in the World Nuclear University Summer Institute (WNU–SI) and one other in WNU School of Radiation Technologies through Technical Cooperation programme.

Apart from the Institute of Nuclear Science and Technology, other local universities and colleges also administer academic programs relevant to nuclear science and technology. These are mainly multidisciplinary courses that encompass subjects such as Physics, Chemistry, Biology, and Mathematics and Computational Science as well as Social Sciences that include Human Resources, Sociology, Law and Economics.

Despite the measures being put in place, the greatest impediment is funding constrains in education, research and development. The institutions of higher learning have inadequate funds and institutional capacities to administer nuclear engineering courses in the country.

6.CHALLENGES FACING KNOWLEDGE TRANSFER MECHANISMS

As mentioned in the preceding sections, Kenya's nuclear industry is in the infant stages and it is grappling with growth challenges. Knowledge transfer mechanisms encompass methodologies to generate and disseminate knowledge aimed at creating sustainable nuclear programs. These methodologies include: nuclear education, training, research and development. The challenge experienced in human resource development directly affects the knowledge transfer amid other challenges touching on personnel competence, as well as organizational competence. It is worth to note that in Kenya, just like many other developing countries, the knowledge transfer mechanisms highlighted are practiced though not to a great extent due to inadequate policies in nuclear education and knowledge management [3][4].

6. NUCLEAR KNOWLEDGE MANAGEMENT BEST PRACTICES

Nuclear knowledge management best practices encompass the acceptable practices that enable nuclear knowledge to be generated, stored and transferred and also building competent organizational leadership though maintaining expertise at individual, organizational and national level. Expertise is achieved when nuclear knowledge is well utilized through creation of professional networks (formally or informally) referred as Communities of Practice (CoPs) that bring professionals together for a common purpose. According to IAEA, CoPs form the core of an organization's knowledge management system. The activities of CoPs support the development and maintenance of organizational and personal competency through incorporating expertise into improved practices, recognizing and introducing new external knowledge, codifying and validating knowledge, as well as sharing knowledge by connecting experts, knowledge workers and knowledge seekers across organizational and national boundaries [3][4].

Currently, there exist several CoPs in Kenya associated with different professional fields/networks in the country. Regarding nuclear knowledge management, there exist few CoPs such as the Eastern Africa Association for Radiation Protection – an associate society to International Radiation Protection Association (IRPA), Kenyan Young Generation in Nuclear (KYGN) – an affiliate organization to the global young professional networks in nuclear industry under the umbrella of the International Youth Nuclear Congress (IYNC), Radiological Society of Kenya and NDT Society of Kenya. Other relevant professional societies include Physics Society of Kenya, Chemical Society, and Engineers Board, among others, though the level of nuclear knowledge practice is not well enhanced.

Kenya has demonstrated commitment to initiate nuclear energy development through the ongoing collaborations in education, training, research and development. Kenya is part network of the African Member States countries promoting education in nuclear science and technology in Africa (AFRA-NEST). The country is on course setting up structures and infrastructure that conforms to the laid down knowledge management best practices by the agency and the international community. KNEB has come out strongly in promoting nuclear energy developments and has so far built a robust network among key stakeholders at national level, regional, continental and global scale. NACOSTI continues to play a vital role in coordination of science, technology and innovation activities in the country through policy formulation and strategies that incorporate funding of research and innovation.

7. CONCLUSIONS

Industry experiences especially in countries with robust nuclear power programs, the challenges facing new builds and or upcoming countries like Kenya, demonstrate clearly that effective nuclear knowledge management practices inform and support business and decision making processes. Owing to this, expert knowledge is of essence and many nuclear organizations have appreciated the significance and benefits of having a robust and comprehensive knowledge management policy and procedures. With close technical assistance from the agency (IAEA), Kenya is in a position to address the nuclear knowledge management challenges through an integrated nuclear education system capability assessment and planning (CAP) framework focused at the national level.

ACKNOWLEDGMENT

The author(s) would like to appreciate the efforts of the listed organizations in providing up to date information to the general public regarding their mandates and more so the utilization and management of nuclear knowledge. Special thanks to the heads of the following institutions; Kenya Nuclear Electricity Board; Institute of Nuclear Science & Technology; Radiation Protection Board; Kenya Bureau of Standards and National Commission for Science, Technology & Innovation.

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BATAN ACTIVITIES IN DEVELOPING NUCLEAR KNOWLEDGE MANAGEMENT

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Abstract

BATAN (National Atomic Energy Agency of Indonesia) was established in 1964, and after the issuance of Law 10 of 1997 it become National Nuclear Energy Agency. During the last seven years, BATAN has suffered the loss of many of its valuable human resources due to the zero-growth policy of the government in recruiting new staffs. The uncertain future of nuclear power programme in Indonesia has also reduced the interest of young generation to study nuclear related subjects, resulting in the closing of several departments in universities that once offered nuclear sciences as subject of studies. These situations triggered management of BATAN to develop various efforts to keep nuclear knowledge exist and disseminate among BATAN itself, university students, and public as a whole. BATAN has in recent years established higher school of nuclear technology and organized various nuclear related training programmes, and also in cooperation with other governmental organizations establish nuclear zones, nuclear information centres and nuclear corners in public as well as in high school areas throughout Indonesia. All these efforts are aimed to transfer and preserve nuclear knowledge for the better future of the applications of nuclear science and technology in Indonesia.

1. INTRODUCTION

BATAN (National Atomic Energy Agency of Indonesia) was established in 1964 following the enactment of Law 31 of 1964 on the main provisions of atomic energy. Before that, the activities in development and application of nuclear technology in Indonesia were initiated with the establishment of a State Committee for Radioactivity Investigation in the year 1954. The State Committee had the duty to conduct investigation towards the effects of radioactive fall-outs from nuclear weapons testing in the Pacific Ocean. Later on, by enactment of Law 10 of 1997, the National Atomic Energy Agency became the National Nuclear Energy Agency, but retaining the acronym of BATAN. This new law separated the tasks of executing body, which is implemented by BATAN, and the tasks of controlling body, which is implemented by the Indonesian Nuclear Energy Regulatory Agency (BAPETEN).

In 2008, BATAN had 3461 employees. In 2014 this number, however, was reduced significantly to 2835. Of 2835 employees, 95 persons held doctoral degree, 309 persons held master degree, 1025 persons held bachelor/diploma 4 (D-IV) degree, and 1406 persons held diploma 3 (D-III) degree or less. This significant reduction was not compensated with new recruits due to the zero-growth policy imposed by the government until 2013. Fig.1 shows the number of BATAN employees during the 2008-2014 period [1,2].

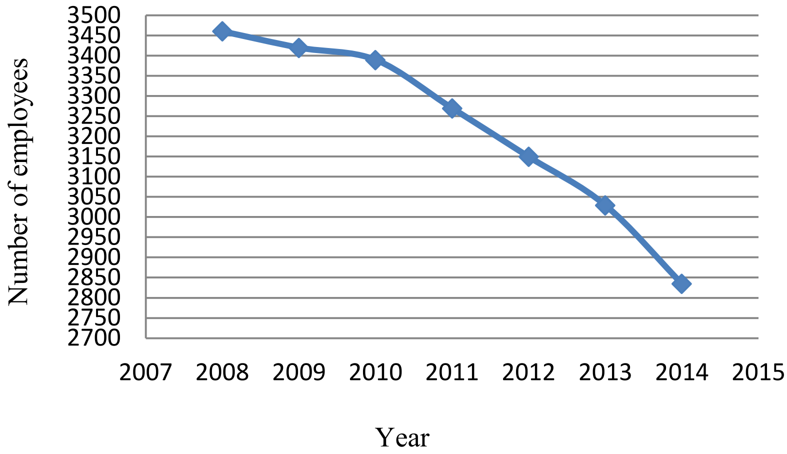

FIG.1. Number of BATAN employees during 2008-2014.

In the society, the vast development in the field of information technology and its related subjects, which offers a better future in terms of career and earning, has the power to pull the science students to this field and forget the nuclear related studies. This in turn reduces the the number of departments in universities that offer nuclear sciences as subject of studies. In 1989, for example, there were 13 departments in several universities in Indonesia offering nuclear sciences; but this number slowly decreased to 10 in 1994, 7 in 1999, 6 in 2004 and only 5 in 2009.

The above situation triggered management of BATAN to develop various efforts to keep nuclear knowledge alive and to disseminate it among BATAN itself, university students, and public. This paper describes some of the efforts that are applied by BATAN.

2.EDUCATION AND TRAINING PROGRAM

The education and training programmes in BATAN are organized by the Center for Education and Training. BATAN education programmes aim at fostering formal higher education for its employees, while the training programmes are designed to capture and transfer both explicit and tacit knowledge [3].

In the case of formal education, BATAN as well as the Ministry of Research, Technology and Higher Education, every year offer scholarships to pursue master and doctoral degrees in universities both domestically and abroad. The subjects that can be attended should be nuclear-related, and after finishing the studies the students are required to work at BATAN for several years, with the formulae 2n+1 where n is the duration of study in a year. Some foreign institutions, e.g. Monbukagakusho of Japan, DAAD of Germany, ADS of Australia, and KEPCO of Republic of Korea, also regularly offer scholarships to BATAN employees.

For training, BATAN organizes technical training and coaching. Technical training is aimed at mastering a certain kind of expertise, and is conducted both for a BATAN employee and for employees outside BATAN. As for coaching, this kind of training is usually attended by employees within limited centers of BATAN to acquire some expertise needed in those particular centers.

Technical training that is conducted regularly includes radiation protection for new BATAN recruits, radiochemistry, controlling radiation and non-radiation safety in nuclear installation, and refresher courses for operators and supervisors of research reactors, as well as radio metallurgy laboratory.

Technical training for employees outside BATAN is conducted in cooperation with the Nuclear Energy Regulatory Agency (BAPETEN) to prepare experienced and skillful workers to control the safely application of radiation in private sectors. The training offers include radiation protection officer in industry and medical sectors, each consists of three levels of officers, industrial radiographer officer (level I and II), officers in irradiator facility (irradiator operator, dosimetry officer, and maintenance officer), and officers in radioisotope and radiopharmaceutical production facility (operator and maintenance officer). After completing a course in BATAN, a candidate officer should pass the examination before he/she is given a license by BAPETEN to work in one of those areas of work.

Coaching is usually conducted based on a request by one of the centers of BATAN a year in advance. Several coaching sessions have been organized so far, including testing of impurity in nuclear fuel using AAS and GTA, state system of accounting for and control of nuclear material (SSAC), reactor instrumentation and control system, maintenance of electromechanic ventilation system of RSG-GAS reactor, analysis of Cs-137 and isotopes of U and Pu in nuclear fuel, and operation of hand manipulator for handling radioactive waste of sealed sources.

3.DOCUMENTATION, DISSEMINATION AND INFORMATION

Beside education and training, BATAN also develops database of expertise within BATAN, as well as infrastructure and facilities for dissemination of information in nuclear science and knowledge to the public. Database of expertise is in principle a curriculum vitae in-large, which contains not only expertness or competence of an employee, but also his/her formal education, training attended, papers published, involvement as editor/reviewer, etc. This database, as well as other information such as the list of competencies of BATAN staff, is under construction and will be available in the nuclear knowledge management section of BATAN website [4].

BATAN also establishes and manages a nuclear digital library (digilib.batan.go.id). As other digital libraries, this BATAN digital library provides free access to abstracts and some full papers of various manuscripts authored by international, as well as national scientists. Flagship of BATAN journal, Atom Indonesia, is featured as one of the sections, as well as information on various publications of some BATAN research centers.

To bring nuclear issues down to earth, BATAN manages some nuclear zones in various public areas [3]. In the city of Yogyakarta there is a nuclear zone in the Smart Park and in the Beautiful Indonesia Miniature Park in Jakarta a nuclear information center exists. BATAN also supports the establishment of a nuclear corner in some high schools throughout Indonesia. Central for all these efforts is the Nuclear Science and Technology Exhibition in Pasar Jumat, Jakarta, where students as well as public can learn and practice some simple experiments using radiation.

More recently, opened in December 2015, three Agro Techno Parks (ATPs) located respectively in Klaten regency in Central Java, in Musi Rawas regency in South Sumatra and in Polewali Mandar regency in West Sulawesi, as well as one Science Techno Park (STP) located in Pasar Jumat, South Jakarta, have been inaugurated. ATP is an area built to be a center for transferring agricultural technology to public and pilot center of integrated agriculture on a national level, while STP is an area built to develop a business-based science and technology activities. While these parks are actually part of a national programme, which aims for general science and technology, BATAN puts nuclear as the pivot point for the activities performed.

4.DISCUSSION

The zero growth policy of government for new recruits is not the only reason why BATAN employees have steadily decreased. Those who got a higher degree and were trained during 1980s and 1990s to learn about a Nuclear Power Plant and who became operators are now gradually retiring. However, the uncertainty in government's policy toward the Nuclear Power Plant programme has discouraged the young generation to study nuclear related subjects. Due to this rationale many of BATAN experienced employees were moved to private sectors or became lecturers at universities that offer higher earning potential.

From 2013, the government realized that the shortfall of its employees may hinder its mandate to serve people better. Thus new recruits are currently allowed, with BATAN accepting around 60 in 2014 and who took up their jobs from the mid-2015. Greater potential earnings also seem to attract young generation to apply at BATAN.

All efforts mentioned thus far are implemented to cope with the loss and brain drain of nuclear knowledge within BATAN. The fellowships offered are effective in attracting younger generations to pursue higher degrees. However, the current policy to cut some allowances after six months of admittance in foreign universities has lessened the enthusiasm of the young generation to study abroad; this is something that has to be faced by the government.

Other actions, meanwhile, can still be implemented by BATAN to preserve nuclear knowledge. First of all a strategy should be developed to identify critical knowledge that might be lost, what would be the impact of this loss to BATAN as an institution, and what are the efforts necessary to address this. Analysis about the need of certain knowledge should also be performed. Technical cooperation with international organizations such as the IAEA would be beneficial in order to address the specific needs of Indonesia for nuclear knowledge management and preservation.

To be more effective, nuclear knowledge management could also be linked to the management system. IAEA has pointed out that this linkage would be beneficial in terms of the elevation of knowledge management into the core business activities [5]. As a central element of the management system, knowledge management will receive attention, review and audits, both internal and external.

5.CONCLUDING REMARKS

Nuclear knowledge management plays an important role in transferring and preserving knowledge, information exchange, establishing and supporting cooperative networks, and training the next generation of nuclear experts. BATAN realizes this important role and has taken the actions to implement nuclear knowledge management for a better future of the application of nuclear science and technology in Indonesia.

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PLANNING AND NUCLEAR KNOWLEDGE MANAGEMENT

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Abstract

The present case aims to share the experience of the Intellectual Capital Section (ICS), part of Planning, Coordination and Control Department of the Argentine Atomic Energy Commission (CNEA) in its search for a sustainable knowledge management. Among the strategic objectives included in CNEA´s Strategic Plan (SP), is the development, preservation and transference of knowledge and experience. Under this framework, the role initially assumed by the ICS, consisted on the observation and diagnosis of the situation of the Institutional Human Capital (HC), through the study of the main characteristics of the staff of CNEA. The second stage of SP (2015-2025), which consisted of updating the HC data, the incorporation of the concept of "knowledge management" was approved by the authorities of the Institution. Based on this background, in 2016 the objectives of the ICS are aimed at organizing and coordinating a network of knowledge management that involves the entire organization. This new phase implies, among other things, the proposal of a Knowledge Management Policy, interaction with other sectors of CNEA for implementation, analysis of the tools to be used, in order to determine a way and work style that suits the culture and structure of the organization.

1.ORGANIZATIONAL CONTEXT

Argentine Atomic Energy Commission[6] was created by Decree No. 10936. Since then, the organization has been dedicated to the research, development and applications in all the aspects related to the peaceful uses of nuclear energy.

One of the objectives included in CNEA´s SP is to preserve and repower the IC of the Institution. The ICS, that depends of the Planning, Coordination and Control Department, carries out the survey and analysis of the staffing evolution and subsequent analysis of risk of loss and difficulty of replacement of critical knowledge.

The main challenge and contribution of ICS is the systematic and in-depth study of features of the staff in relation to the quantitative and qualitative aspects for knowledge management, thus fulfilling its strategic objective: "Ensure the development, preservation and transfer of knowledge and experiences in order to contribute to the sustainability of the nuclear industry".

At the end of 2015, the institutional staff of CNEA consists of 3400 people[7], divided in 27 Thematic Areas (TA): Raw Materials Exploration, Raw Materials Production, Uranium Mining Environmental Restoration, Nuclear Fuels, Uranium Enrichment, Research and Radioisotope Production Reactors, Nuclear Technology Applications to Health, Industry and Agriculture, Radioactive Waste and Spent Fuels Management, Decommissioning, Safety, Radiation Protection, Physical Security and Safeguards, Environmental Management, Quality Management, Planning, Human Resources, Administration and Finance, Institutional

[6] http://www.cnea.gov.ar/

[7] Updated 31/12/2015

Communication, Institutional, Domestic and International Affairs, Development and Promotion of Economic Resources Related to Science and Technology Entities, Assistance and Technology Transfer, Academic Institutes, Resource Management and Scientific-Technological Information Services, Information and Communications Technologies and Administrative and Technical Management.

2.OBJECTIVES OF THE KM INITIATIVE

According to the implementation of the Institutional SP (2009-2019) and in accordance with the revival of nuclear activity in the country in 2006, during the years 2009/2010, the objective related to KM, was working on the survey of staffing data. Due to the number and diversity of this population, the survey was carried out in stages, where each Coordinator of TA, reported those people with critical skills and knowledge that were considered at risk of loss and replacement. Being:

Risk of loss: is given by the possibility given to a person of retiring and the criticality of the knowledge/skills he or she performs and how this would affect the results of the area.

Difficulty of finding: a replacement takes into account the possibility of replacing the member if he or she leaves, considering the availability of the profile in the market, specialization of required knowledge, existence of a member to cover the replacement and time to train a replacement at the same level. The analysis was carried out in the following way:

1) The required data about each person was filled into an Excel document.
2) Each of those persons were classified by their manager/boss according to their risk of loss and difficulty of replacement.

A value was assigned to each factor, according to the following scale: 1. Very high 2. High 3. Medium 4. Low. The crossing of both factors matrix was generated which allowed to visualize and detect those people at very high risk of loss and additionally were very difficult to replace[8].

This resulted in the first survey of risk of loss for the institution, from which the following information was obtained: among a total of 3200 people, 4% of that population were classified with a very high risk of loss and very difficult to replace. 25% of them were in condition to retire in the following ten years. In 2012 the first update for the 2010 survey was carried out. The following information was obtained: 5% of the staff of CNEA presented a very high risk of loss and very high difficulty of replacement. 40% of them were in condition to retire.

During the period 2014-2015 the ICS proceeded in updating staffing data for each TA, in order to update the SP of CNEA (2015-2025). The results at this time showed that 4% of the staff was considered of very high risk of loss and very high difficulty of replacement, which reflected little change in the previous five years. Also a big percentage of that staff whit full retirement age (50 %), which hold senior positions and whose professional training was in the fields of Engineering, Physics and Chemistry.

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[8] Knowledge Risk Assessment, López Paula, 2012.

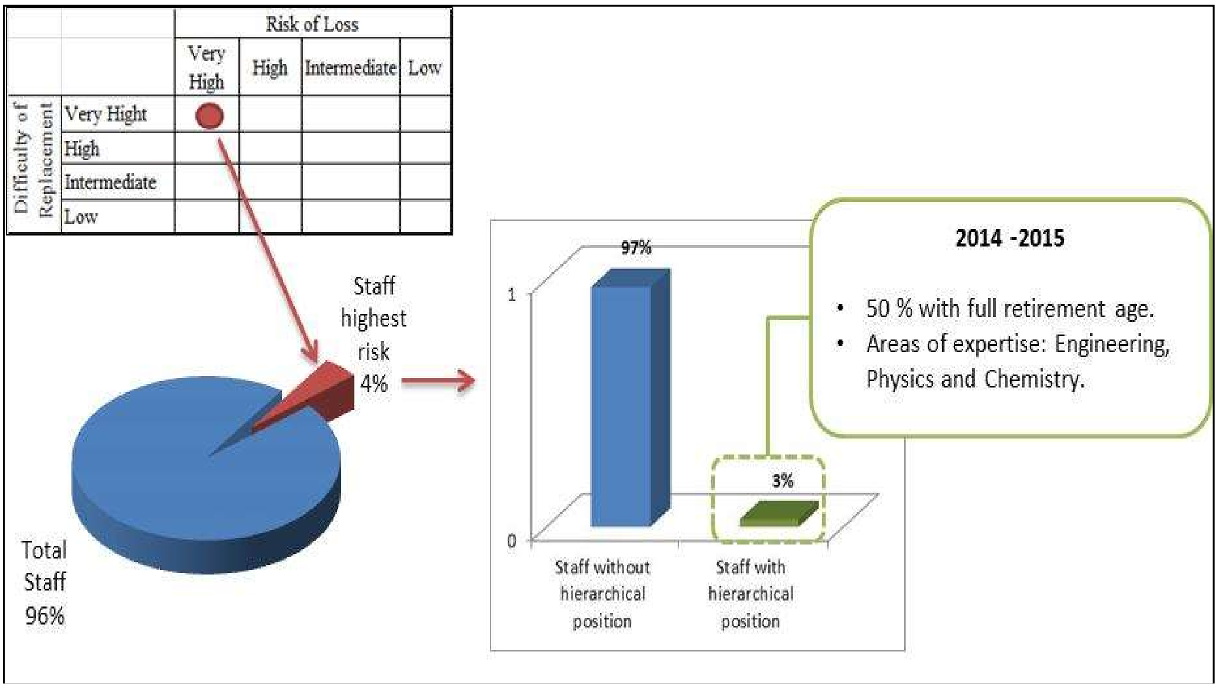

FIG 1. 2014-2015 Risk of loss Assessment

3. DESCRIPTION OF THE KM INITIATIVE

In November 2014, a new objective for the ICS was included in the SP: "Implement and coordinate an institutional network to promote and organize a Nuclear Knowledge Management Programme". For the first time, the support of the authorities to work in NKM became explicit in the institutional strategy even though several NKM projects had already been carried out in CNEA. This support enabled ICS to contact other sectors to formalize a future network of Nuclear Knowledge Management.

Because of this, during the first semester of 2015 the person in charge of ICS launched KM working group. A NKM expert who worked in KM projects since 2000 in CNEA was summoned to the team. Both of them have wide experience and have participated in many NKM related activities organized by the IAEA.

Furthermore, two young professionals from the Human Resources Section and two other young professionals that worked in ICS were summoned, who in different years have attended ICTP-IAEA´s NKM Schools that have taken place in Trieste, Italy.

This working team began to meet once a month to share experiences about the subject and to analyze IAEA´s guidelines[9] regarding the implementation of KM within a Nuclear R&D Organizations.

This activity was considered in line with the "Stage 1 – Orientation", part of the Five Stage Implementation Process[10].

During the second semester 2015, this group wrote down a proposal for KM policy at an institutional level, which is expected to be approved by CNEA´s authorities during the first semester of 2016. The aim of this document is to underpin future activities. Once approved, the beginning of a new stage which consists of the interaction between the different institutional departments is expected, in order to determine a way and style of work that adapts to the organizational culture and structure. Given this, such actions previously described are related to what is suggested in the "Stage 2 – Strategy Formulization".

4.MAJOR CHALLENGES AND ACHIEVEMENTS

The challenge is to continue that work, capitalizing what has been done and focusing on the analysis and identification of the critical knowledge, how to prevent its loss, ensure its continuity, establish future replacements and finally manage the transmission and preservation of that knowledge to future generations.

Based on such background, in 2016 the objectives of the ICS, are aimed at organizing and coordinating a network of Knowledge Management that commits and involves the entire organization with the representatives of each TA in order to coordinate the initiative.

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[9] Methodology for Self-assessment of Capacity Building, IAEA, 2012, and Knowledge Management Assessment tools for R&D Organizations.

[10] IAEA-TECDOC-1675, Vienna, 2012.

Making a comparison between the conducted activities and the framework proposed by IAEA´s "Critical knowledge retention flow chart"[11] which consists of three steps, we can say that during the period 2010-2012 the Step 1 ("Conduct of risk assessment") was carried out. This stage remained also during the period 2014/2015, but the fact that a more profound analysis was conducted and the strengthening the ICS, it would be possible to reach Step 2 in 2016. When Step 2 is up and running, it is expected to work as a network with the rest of the organization.

Finally, the creation of the first maps and plans for retaining and preserving knowledge at an institutional level will result on reaching stage 3.

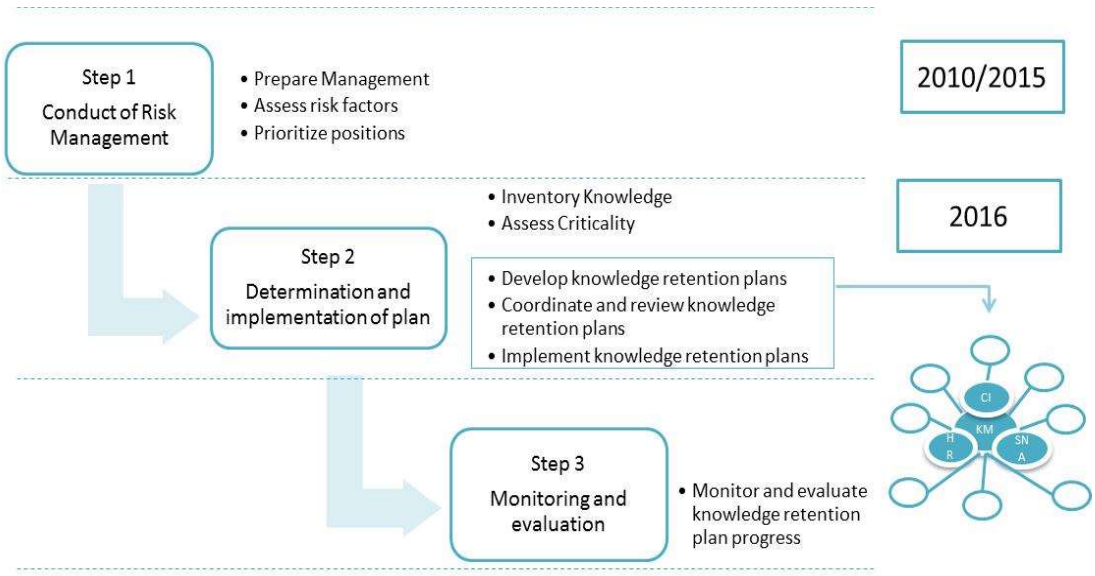

FIG 2. Critical knowledge retention flow chart

5.LESSONS LEARNED / KNOWLEDGE DERIVED

According to the experience gained so far and seeking to improve these activities, the following are the lessons learned:

TABLE 1. LESSONS LEARNED

Experience	Lessons Learned
Slow development of the "Five Stage Implementation Process"	It is mandatory to count on the support of the authorities so KM actions can be planned and carried out.

[11] Risk management of knowledge loss in nuclear industry organizations, IAEA, Vienna (2006)

Lack of KM institutional culture	It is important to understand that without an institutional policy, no effective action can be taken. The KM must be a constant work accompanying the planning of activities and institutional projects.
Lack of unified criteria related to KM.	It is important to "speak the same language, the one of knowledge management" in order to be able to transmit and ensure that the terms used are understood, through awareness-raising and education. In addition, the disclosure of the work done collaborates with the involvement of staff in knowledge management.
Unavailability of a computer system that ensures efficient management of the data	It is essential to use databases that complement KM activities.

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IMPROVING KNOWLEDGE PRESERVATION STRATEGY AT ORGANIZATIONAL LEVEL THROUGH KNOWLEDGE LOSS RISK ASSESSMENT (KLRA)

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Abstract

Identification of critical knowledge is one of the important steps before any knowledge preservation activities can take place. Preserving all information including less priority knowledge materials is an ineffective way of doing it. By determining critical knowledge at the very beginning will eliminate such unnecessary waste of resources. It is suggested that Knowledge Loss Risk Assessment (KLRA) tool be used to determine the critical knowledge area of an organization before performing any knowledge retention activities. KLRA techniques were used in a nuclear research institute in Malaysia to assess the knowledge loss as part of its knowledge preservation program. Coincidently, it was found that the tool or techniques could also be used to assist in the mapping process of critical knowledge areas. This paper describes the experience of implementing KLRA in a nuclear organization by illustrating how KLRA can assists in the mapping process of critical knowledge areas at the organizational level. The paper also discusses issues and challenges of implementing KLRA.

1.INTRODUCTION

Many nuclear organizations are going through the phases whereby many nuclear experts have retired or retiring while others are changing jobs. In the event when nuclear experts retire or leave the organization, the big question mark as to whether the knowledge of the experts has been systematically preserved in the organization surfaced. The importance of the answer to this question bears heavy implication towards the sustenance of the usage of nuclear knowledge and creation of new nuclear knowledge pertinent to the benefits towards the organization and the nation. If no systematic way of preserving knowledge exists in an organization, this could lead to several key questions, such as how the knowledge preservation can be started, do we need to preserve all knowledge at one time and what would be the priorities. Today, Malaysian nuclear experts are also retiring in numbers. According to records, by the end of the year 2017, the majority of the first generation of experts in a nuclear organization in Malaysia would have retired [16]. Consequently, and in line with IAEA Knowledge Management Assist Visit (KMAV) and Expert Mission, which was conducted in 2014, the Knowledge Loss Risk Assessment (KLRA) was recommended to be conducted immediately and on regular basis. During the conduct of the KLRA, it is found that, this tool is very useful in identifying the critical knowledge loss. In addition, it helps the organization to prepare the appropriate knowledge preservation strategy which focuses on how to retain the critical knowledge. This paper shares the experience of implementing KLRA in a nuclear organization.

2.KNOWLEDGE LOSS

The knowledge loss phenomena is faced by many industries [13] such as the Batik industry [15], the manufacturing, services [3], the Small and Medium Size Enterprise (SME) [11] and the hospitality sector [18]. The knowledge loss in nuclear industry may be greater than those industries that have been mentioned as the amount of knowledge in nuclear industries is tremendous and has grown since they started and the risk of losing nuclear knowledge has a greater impact compared to the other industries. In nuclear industries, knowledge is an important factor due to the nature of the technology itself [10]. The operators, managers, technicians, engineers and researchers working in a nuclear industry really depend on knowledge and skills to conduct their tasks and activities. Furthermore, the workers should know what material that they are dealing with, how much exposure levels they may gained, how to safely conduct the activities and what to do in any emergency situation. For example, at the engineer's level, knowledge of know-why is essential so that they know why things are designed in a certain way, so that they may innovatively improve the design and operation, as needed. The current scenario in the nuclear industries had shown that the potential of losing experienced and knowledgeable workers is real. Many factors led to this situation; retirement, internal transfer, resignation [2], ageing workforce, less effective KM implementation, mishandling of accumulated knowledge [10], industrial trends, less knowledge takers [9], are among the factors which somehow or rather contribute to the knowledge loss. Therefore, it is important to really know the risk of knowledge loss before any action toward knowledge retention can be made.

2.1 Knowledge Loss Risk Assessment (Klra)

KLRA is a well-known technique that is being used to measure the risk of knowledge loss and has been successfully implemented at the Tennessee Valley Authority public utility [12][1] and at Duke Energy [8] while the Michigan Department of Agriculture has adapted the technique for its own use [7]. This technique is also recommended by IAEA to be used by its member states [10]. In the computation of KLRA, the total attrition index is an important measure as it represents the risk of knowledge loss of each individual in an organization. The attrition index is computed based on the retirement factor and position risk factor of each expert. The value of the expert's retirement factor and the expert's position risk factor against the criteria set are shown in Table 2.1 and Table 2.2 respectively.

TABLE 1. CRITERIA OF THE RETIREMENT RISK FACTOR [2]

Retirement Factor	Criteria
5	Projected retirement date within current fiscal year or next fiscal year
4	Projected retirement date within 3rd fiscal year
3	Projected retirement date within 4th fiscal year
2	Projected retirement date within 5th fiscal year
1	Projected retirement date within or greater than 6th fiscal year

TABLE 2. CRITERIA OF THE POSITION RISK FACTOR [2]

Position Factor	Criteria
5	Critical and unique knowledge or skills. Mission critical knowledge/skills with the potential for significant reliability or safety impacts. TVA Nuclear or site-specific knowledge. Knowledge undocumented. Requires 3–5 years of training and experience. No ready replacements available.
4	Critical knowledge and skills. Mission critical knowledge/skills. Some limited duplication exists at other plants or sites and/or some documentation exists. Requires 2–4 years of focused training and experience.
3	Important, systematized knowledge and skills. Documentation exists and/or other personnel on-site possess the knowledge/skills. Recruits generally available and can be trained in 1–2 years.
2	Proceduralized or non-mission critical knowledge and skills. Clear, up to date procedures exist. Training programmes are current and effective and can be completed in less than one year.
1	Common knowledge and skills. External 'hires' possessing the knowledge/skills are readily available and require little additional training.

An example that illustrates the calculation of the total attrition index is shown in Table 2.3. The detailed explanation of KLRA can be found in IAEA-KLRA, 2006.

From the attrition index, the critical knowledge area at organization level can be easily identified through the KLRA. It also showed that simple knowledge mapping can be made at organizational level before more critical knowledge mapping process can be further developed at individual and smaller unit in the organization. Later, appropriate mapping of critical knowledge will be used in knowledge transfer activities [4]to retain the knowledge in an organization. To represent the situation visually, a graph that represent each individual data which can later be generated, will show the variation of individuals or experts index that represent their criticality in terms of potential knowledge loss to organization [14] [2].

TABLE 3. EXAMPLE OF THE CALCULATION OF TOTAL ATTRITION INDEX [2]

Projected retirement within 1 year	Retirement factor =	5
Projected retirement within 1 year Critical/unique knowledge/skills	Position risk factor =	5
Total	Total attrition factor = 5 × 5 =	25

3.METHODOLOGY

The KLRA [14] was conducted in a workshop participated mostly by 115 workers of divisional and managerial levels at a nuclear research organization in Malaysia. Participants were grouped based on their own division, which represent their own knowledge domain area at organizational level. Before the KLRA session is started, each group was briefed on how to conduct KLRA. The KLRA session covers such criteria as how to identify the index of position factor and retirement factor and calculate the attrition factor for each individual. The data of the KLRA is collected and used for further analysis using Ms Excel tool.

4.RESULTS AND DISCUSSION

In identifying the critical knowledge area, only the highest attrition index of individual employee from the division is considered because it represents the employee, which has most critical knowledge. This identification will reveal the knowledge area that has the highest priority for knowledge retention. This would assist the knowledge retention process and improve knowledge preservation strategy. Figure 1 shows five (5) divisions representing their knowledge domain area have highest total attrition factor. This indicates that this knowledge should be the highest priority for retention process. The knowledge domain areas (KDA) that have highest priority for knowledge retention are KDA1, KDA6, KDA7, KDA8 and KDA9. Second highest are KDA3, KDA4 and KDA5. While, the less priority are KDA10 and KDA2.

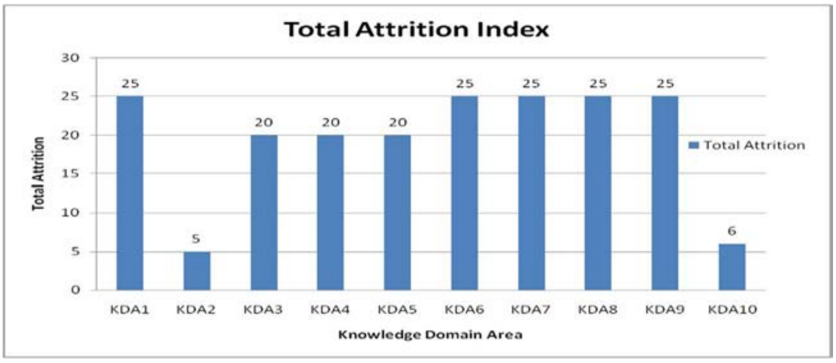

FIG 1 Attrition index of each Knowledge Domain Area (KDA)

In the exploration on the usage of KLRA, further investigation was made for knowledge area of KDA6. This is important to see the gap between employees in the same KDA. From there, effective techniques such as how to transfer critical knowledge could be planned as part of knowledge retention process to improve strategy for organizational knowledge preservation. Figure 2 shows the variations of attrition index within the KDA6. The distribution of total attrition factors within the division has shown that the gap is significantly big between the employee no.1 and employee no 4 onwards. However, the gap is significantly acceptable between employee no. 1 and employee no.2 and no.3.

Therefore, as far as knowledge retention process is concerned, it is very important to decide the right method of transferring knowledge within the division or KDA. It is recommended that a program with multiple activities such as mentoring and coaching, sharing best practices and lesson learned and documentations [6] be implemented. In the context of transferring tacit to tacit knowledge, mentoring and coaching is ideally to be conducted among employee no.1, employee no.2 and no.3.

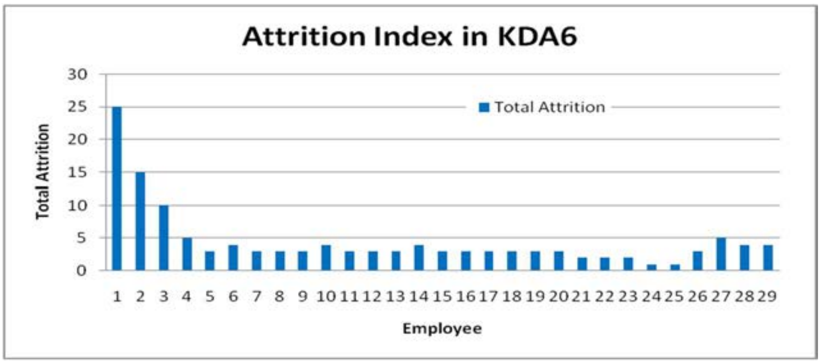

FIG. 2 Attrition index within KDA6

This is due to the fact that the transfer of knowledge among three of them could be easier due to less gap in position, time for retirement and knowledge. In the context of knowledge level, tacit to tacit knowledge transfer to employee no.2 and no. 3 will be more effective because they could understand better than other employees. This transfer must also consider the factors of organizational culture and organizational structure [17]. At the same time, KLRA is found to be having a significant role in identifying critical knowledge loss at the organizational level. Identification of critical knowledge at the very beginning stage of retention process may significantly reduce unnecessary waste of resources and prevent critical knowledge loss from organization.

5.ISSUES AND CHALLENGES

Several issues are discovered during the conduct of this study. These include issues in conducting risk assessment, knowledge retention and knowledge transfer. As far as risk assessment on knowledge loss is concerned, the conduct and analysis of KLRA in nuclear research type of organization should be improved further. The attrition index suggested by TVA and IAEA only represent the major part of the position and attrition factors. These may have some shortcomings in doing the mapping process of critical knowledge, because factors that consider the knowledge level of employee is not equally dominant. In the context of tacit knowledge, this study is valid because knowledge is embodied in individual employee. Using KLRA at organizational level by following the organization's structure is difficult since it is quite hard to specifically explore the potential knowledge loss at individual employee level. Few stages are needed to narrow the critical knowledge at unit or sub unit level to reach at each individual employee. Therefore, it is important to include knowledge factor components in this perspective, which could possibly improve the identification of critical knowledge through risk assessment and the mapping process of critical knowledge at the organizational level. In this perspective, assessing knowledge loss at the individual level rather than at the positional level [5] is something that should be further considered in future studies. This would also tackle both benefits in knowledge retention process to improve preservation strategy where the KLRA with knowledge factor component could include the mapping of important and critical knowledge loss at the beginning stages.

6.CONCLUSIONS

In conclusion, KLRA is found to effectively improved knowledge preservation strategy through the identification of critical knowledge loss at the very beginning stage of the retention process. Although several issues pertaining to the KLRA technique to identify critical knowledge were found, several recommendations to improve the KLRA were suggested. From the analysis of KLRA conducted in a nuclear research type organization in Malaysia, it can be concluded that the technique can be extended to the mapping process of critical knowledge at organizational level. By identifying the right critical knowledge at the very beginning of the knowledge retention process, transferring the right knowledge at the right time to the right person could prevent the potential loss of critical knowledge from the organization. Furthermore, it may also improve the utilization of resources for successful implementation of knowledge preservation at the organizational level.

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ESTABLISHING SUSTAINABLE NUCLEAR EDUCATION: EDUCATION CAPABILITY ASSESSMENT AND PLANNING (ECAP) ASSIST MISSION

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Abstract

The development of nuclear education, science and technology programmes is affected by the national context including national needs and capacities. The role and expectations for nuclear education and training might be different in technically matured countries, from countries where the technology is emerging. In this regard, particularly in developing countries, there is a need to balance nuclear education and training between immediate critical issues of radiation safety or human health and longer-term priorities in agriculture or industry. These priorities may or may not include the nuclear energy option. This paper shows how the Education Capability Assessment and Planning (ECAP) Assist Mission can contribute towards establishing sustainable nuclear education, including highlighting the various activities of each phase of the ECAP Process.

1.ECAP ASSIST MISSION OVERVIEW

Education Capability relies on a balanced interaction between three sectors in society, the education sector, industry and policy making sectors such as governments. The ECAP process is designed to determine this balance and provide priority areas to support improving the education capability in the long term.

The overall objective of the ECAP Assist Mission is to help MS in arriving at programmes or strategies for enhanced nuclear education. In turn, enhanced nuclear education will lead to enhanced application of nuclear techniques thus support the Member States (MS) development strategies for any sector where nuclear techniques are applied. To this end, the ECAP Assist Mission provides a forum for strategic stakeholder engagement (cf. FIG. 1) to exchange experiences and information on nuclear education programmes.

The ECAP process involves addressing sustainability factors such as social acceptance, resource mobilization, human capital, job opportunities, recruitment sustainability and nuclear contributions to society, that need to be carefully monitored and managed in order to derive maximum benefits from nuclear education, science and technology. Specific objectives of the ECAP Assist Mission include:

(1) Improve understanding of the strategic importance, shared responsibility, and specific challenges to establishing and sustaining the nuclear education needed to improve the application of nuclear science and technology;
(2) Identify common concerns, issues and challenges related to the institutional coordination for nuclear education, science and technology at national level to leverage resources and build capability;

(3) Develop a benchmarking system, involving government, education and industry stakeholders, for the planning and monitoring of national nuclear education programmes, policies and strategic plans that provides information on their current status and future sustainability.

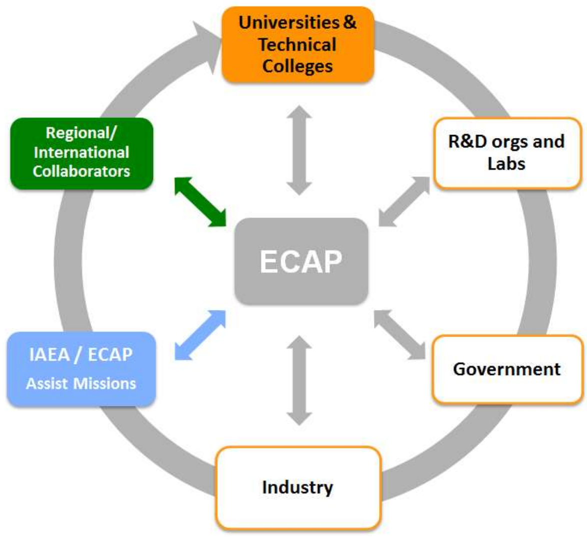

FIG. 1. Strategic stakeholder engagement for an ECAP assist mission

2.MISSION ACTIVITIES

The ECAP Assist Missions are designed to support the MS with the ECAP process (cf. FIG. 2) and can be done in a series of 4 (or more) separate missions with the assistance of the IAEA. The four phases of the ECAP Process can be completed within a span of 2-4 years depending on the maturity levels of the nuclear education and allied institutions from government and industry in the country.

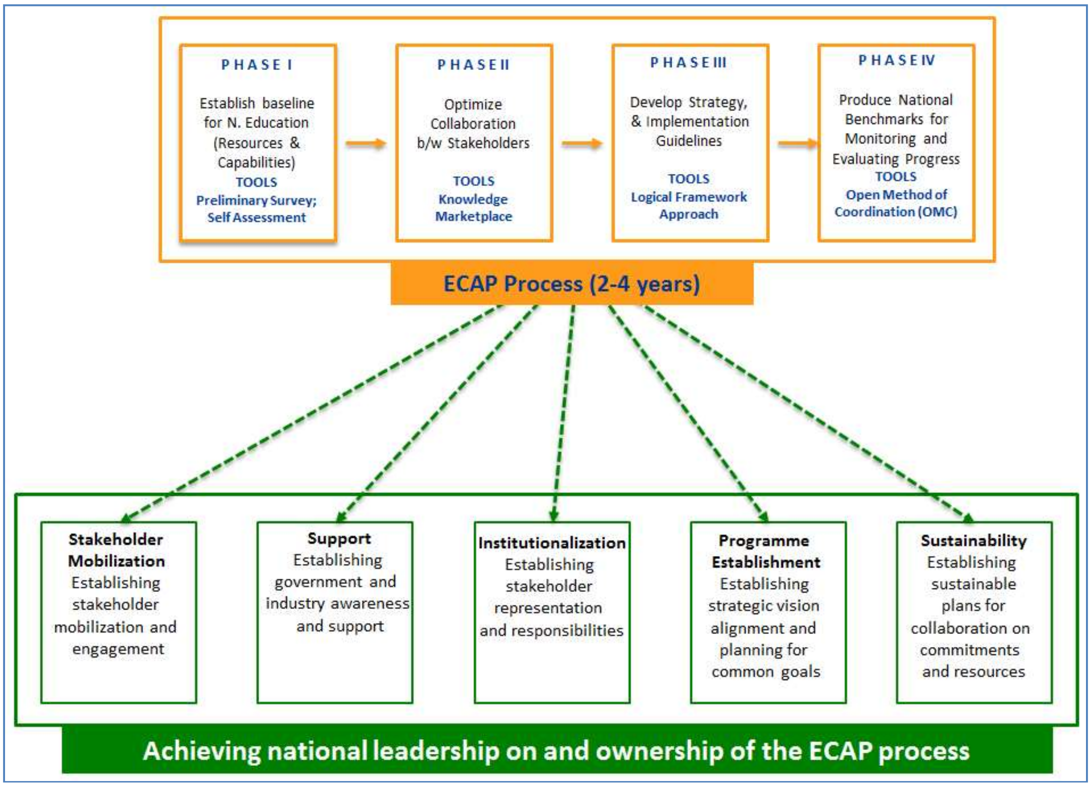

FIG. 2. Stepwise process for sustainable national nuclear education system

Each mission can be conducted over a period of three to five working days, depending on the agreed scope of the mission. The preliminary survey (cf. TABLE 1) is expected to be conducted ahead of the Phase I ECAP Assist Mission (cf. Section 2.1). For an effective mission, especially for Phases II, III and IV, key stakeholders identified in Phase I (cf. FIG. *1*) are expected to be present. Phases III and IV Assist Missions can be expected to be recurring over time as new programmes/projects are developed and new benchmarks (and indicators) are established.

TABLE 1: PRELIMINARY SURVEY QUESTIONS FOR NUCLEAR EDUCATION

1	What are the Government priorities in the area of nuclear science and technology?
2	What are the existing policies and strategies governing Nuclear Education, Science and Technology?
3	What is the assessment of national demand for nuclear specialists? a. What kinds of specialists are needed? b. What areas of nuclear science or industry are these specialists needed? c. How many and when are these nuclear specialists needed?

4 Which technical and vocational education and training (TVET) and higher education institutions currently offer programmes with a nuclear content related to the demand?

a. For each institution what is the total number of students, including number of graduates, (and their level), and technicians produced;
b. For each institution, describe the teaching capabilities / faculty; is there any access to specialist teaching staff from elsewhere? How does it work?
c. For each institution describe the laboratory facilities available; is there access to specialist facilities elsewhere? If so, what are they and where are they located?

5 Do any of the TVET and higher educational institutions collaborate in a formalized committee or network?

6 Are there any international partnerships in teaching and/or research of nuclear topics;

7 How is funding obtained, including details of government/state contributions, industry contributions and student fees including the provision of any bursaries

The findings should be presented in an overview preliminary survey report

The following Sections 2.1 to 2.4 summarize the specific activities of each ECAP Phase which in turn sets the scope for the ECAP Assist Missions. The Terms of Reference (ToR) for each ECAP Assist Mission would typically refer to these activities.

2.1 Phase I: Establish baseline for nuclear education

- To present an overview of the IAEA guidance on ECAP;
- To present the results of the national preliminary survey (cf. TABLE 1);
- Strengths Weaknesses Opportunities and Threats (SWOT) analysis of nuclear education
- To provide international experience on networking nuclear education;
- Workshop on the analysis of current and desired state of nuclear education system, using the self-assessment tool. Results of the workshop are used to facilitate discussion on national priorities;
- Stakeholder analysis and identification of communication needs and outreach tasks;
- Round table discussion to finalize recommendations, including areas where the IAEA could promote effective implementation.

2.2 Phase II: Optimize collaboration

- Status of previous undertakings in Phase I;
- Knowledge Marketplace Workshop;
- Development of action plans for collaborative tasks;
- Establishment of a National Steering Committee and National Network on Nuclear E&T [1];
- Round table discussion to finalize recommendations, including areas where the IAEA could promote effective implementation.

2.3 Phase III: Develop strategy, programme and projects

- Status of previous undertakings in Phase II;
- Objective and problem analysis using the logical framework analysis;
- Design of strategy, programme and projects and present in a logical framework matrix;
- Allocation of roles, responsibilities and task schedules;
- Round table discussion to finalize recommendations, including areas where the IAEA could promote effective implementation.

2.4 Phase IV: Produce national benchmarks for monitoring and evaluation

- Status of previous undertakings in Phase III;
- Develop indicators and benchmarks for sustainable nuclear education;
- Establish a workflow process for producing indicators;
- Provide general guidance on ICT tools for indicators;
- Round table discussion to finalize recommendations, including areas where the IAEA could promote effective implementation.

3.CONCLUSIONS

While each phase of the ECAP Process is different, with specific set of objectives, the expected outputs of the phase would need to be fully realized at the national level before proceeding to the next phase. For this to be effective, it is important that the ECAP process is Member State driven, and that all activities, including international experts, would need to have experiences relevant to the Member State context. In this connection, the IAEA's role throughout the phases would be relegated to the Article III of the IAEA Statutes [2], wherein the transfer of Nuclear Knowledge is fundamental to the IAEA mandate.

At the time of this writing ECAP methodology has been applied successfully in South Africa [3], Kingdom of Saudi Arabia [4], and the United Republic of Tanzania [5] with piloting experiences reported during the 2nd AFRA-NEST General Assembly, attended by over 30 participants.

The approach also supports broader international priorities such as the United Nations Sustainable Development Goals (SDG Targets 4.3 and 4.4 on Quality Education), adopted by over 150 world leaders at the UN Sustainable Development Summit on 25 September 2015 [6]. Furthermore, the required human and financial resources to support the national development objectives can also be reconciled with the Country Programme Framework (CPF) and the National Development Plans.

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BUILDING BRIDGE BETWEEN END-USERS AND E&T ORGANIZATIONS CASE STUDY: ROMANIA

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Abstract

Over the last decade a constant concern of both E&T providers and end-users was formalizing and shaping the content of transmitted knowledge in order to fit most the industry needs. The EU Member States were invited to relate their national qualifications systems and to use an approach based on Learning Outcomes when defining and describing qualifications, and promoting the validation of non-formal and informal learning. This approach is the European Credit System for Vocational Education and Training together with the implementation of already existing in industry Systematic Approach to Training. Nevertheless a gap between the provided education and industry expectations still exists and the purpose of the case study was to build a bridge between E&T providers and end-users regarding exchange of information, needs, methodologies and tools, with the expected outcome of shaping the curriculum according to actual industry needs. University Politehnica Bucharest together with partners from industry (Energonuclear-Romania), research (Josef Stefan Institute-Slovenia) and training (Tecnatom-Spain) developed a project aimed at filling this gap. Following the analysis of specific personnel needs based on a new proposed methodology, the partners evaluated the learning outcomes and proposed correction of curricula by new learning activities.

1.ORGANIZATIONAL CONTEXT

1.1 Status or maturity of KM or its implementation

Over the last decade a constant concern of both E&T providers and end-users was formalizing and shaping the content of transmitted knowledge in order to fit most the industry needs. Vocational E&T process is now considered a lifelong learning pathway to acquire the competences needed to perform a professional job. This pathway is built by the formal education and training (school, university, dedicated training), the work experience, the informal learning and non-formal learning (by companies).

Developing competent workers through education and training (E&T) should respond the End user's needs for qualified personnel. These needs are very specific and are tuned with the development or status of the national nuclear program.

In EU countries the Bologna Process was a major reform aiming at introduction of the three cycle system (bachelor/master/doctorate), quality assurance and recognition of qualifications and periods of study. The European Credit Transfer System (ECTS) makes teaching and learning in higher education more transparent across Europe and facilitates the recognition of all studies. According to [1], ECTS is a credit system designed to make it easier for students to move between different countries. Since they are based on the learning achievements and workload of a course, a student can transfer their ECTS credits from one university to another so they are added up to contribute to an individual's degree programme or training. This system allows for the transfer of learning experiences between different institutions, greater student mobility and more flexible routes to gain degrees. It also aids curriculum design and quality assurance. Institutions which apply ECTS publish their course catalogues on the web, including detailed descriptions of study programmes, units of learning, university regulations and student services. Course descriptions contain 'learning outcomes' (i.e. what students are expected to know, understand and be able to do) and workload (i.e. the time students typically need to achieve these outcomes.

Fitted to the lifelong learning pathway, the European Credit System for Vocational Education and Training (ECVET) is also based on definition of "learning outcomes", and on identification of portfolios of learning outcomes that allow an individual to prove competencies in a coherent manner (job profile). ECVET proposes a common understanding of basic definitions of education and training as well as of the new proposed concepts: knowledge, skills and attitudes/competences. This way are established the fundamentals for a common understanding of the vocational E&T and is proposed a unitary formalized framework, accepted by both ends of the educational process- providers and end-users.

1.2 Background drivers or rationale of the KM programme/initiative

Despite ECTS proven efficiency it seems that end-users have very little information about E&T a person received, or about the level of knowledge an individual received during its academic period or during its training period in various training centres. This missing information the employer lacks could have an impact over the possible hiring of a qualified person for a specific job. Also, the companies invest more resources to train persons to acquire working skills according to the company needs, usually overlapping some learning outcomes and knowledge. Despite the fact the Universities and training centres provided trained and skilled personnel, people have found themselves difficult to be employed directly, with no other training inside the companies.

1.3 Organization's KM challenges or issues at start of project/initiative

Under these circumstances, European Commission took a series of initiatives aiming at better understanding and organization of vocational E&T, supporting programmes and projects related to topics presented above. Erasmus + is the EU programme for Education, Training, Youth, and Sport for the period 2014-2020. The Erasmus+ programme aims to boost skills and employability, as well as modernising Education, Training, and Youth work. Erasmus+ will support transnational partnerships among Education, Training, and Youth institutions and organisations to foster cooperation and bridge the worlds of Education and work in order to tackle the skills gaps we are facing in Europe. It will also support national efforts to modernise Education, Training, and Youth systems [2].

In the framework of the EU Erasmus+ program, University Politehnica Bucharest is leading the project Better undeRstandIng anD recoGnition of nuclEar skills and qualifications (BRIDGE), aiming to fill the gap exiting between the use by academic institutions of European Credit Transfer and Accumulation System (ECTS) and the use by end-users (industry, regulatory bodies, research and development entities) of Systematic Approach to Training (SAT) in view of future implementation of European Credit System for Vocational Education and Training (ECVET) in nuclear field. Analysis was carried out for the people with a qualification (undergraduate or graduate level) in Nuclear Engineering, aiming to work in industry, research or training. Following the analysis of specific personnel needs based on a new proposed methodology, the partners evaluated the learning outcomes and proposed correction of curricula by new learning activities.

The expected outcome of the BRIDGE project is to improve the end user's needs for properly qualified personnel by improving the level of key competences and skills, with particular regard to their relevance for the labour market, through increased opportunities for learning mobility and through strengthened cooperation between the world of education and training and the labour market. Type of organization including main stakeholders /departments involved in KM, their functions, and roles. In order to have a large representability, organizations involved in this case study are represented by:

(a) University Politehnica of Bucharest (UPB), Romania, as a higher education institution.
(b) Josef Stefan Institute (IJS) in Ljubljana-Slovenia as a typical research organization.
(c) TECNATOM SA in Spain, as a representative training organization.
(d) ENERGONUCLEAR in Romania as a typical end-user.

2.OBJECTIVES OF THE KM INITIATIVE

2.1 Background and objectives of the KM programme/initiative

One important outcome of project's activity is to develop methodologies, tools, approaches and practices to support all interested parts in clearly defining the needs and the path to develop the competencies required in Industry, Research and Training. For this purpose an analysis of the nuclear sector needs (for each country where project's partners are located) was done at national level, as well as of the dynamics of recruitment. Special attention was payed to Romanian's nuclear sector. The next step was to determine the needs the beneficiaries have for their personnel. Afterwards it was developed a data base with employer's requirements and an analysis tool which defines the most important issues and needs regarding new personnel to be taken into consideration from a double perspective: the perceived likelihood of the need, and the perceived impact for a specific personnel education/training target or a specific nuclear program.

The second important outcome is related to shaping the vocational education delivered by Academia, based on the learning outcomes characteristic for required competencies. Each partner institution analysed the existing curricula of UPB and draw necessary conclusions. A SAT based continuous evaluation methodology needs to be developed. This evaluation methodology addresses not only usefulness of information provided to already employed individual, but addresses also to teaching/training techniques for students.

People educated and trained usually in high-education institutions and entering into their profession face usually little choices regarding their working place: research, design or operation in a field related to nuclear energy. The BRIDGE consortium was projected to cover these types of end-users as follows:

- University Politehnica of Bucharest (UPB) as a higher education institution, the represents one of the fundamental and prestigious institutions of the Romanian higher education, being the main source of technical specialists in Romania. UPB is the largest technical university in Romania delivering a complete program of Nuclear Engineering (at undergraduate, graduate and PhD level);
- Josef Stefan Institute (IJS) in Ljubljana-Slovenia as a typical research organization, leading the national nuclear program, and involved as well in EU research partnership;
- TECNATOM SA in Spain, as a representative training organization, responsible with the training and authorization of nuclear power plant personnel in Spain, developing also support programs for newcomer countries who aim to implement a nuclear energy program;
- ENERGONUCLEAR in Romania as a typical end user responsible for the implementation of a nuclear program.

2.2 Description of the KM initiative

Each partner institution will analyse the existing curricula of UPB and draw necessary conclusions. On this basis a continuous evaluation methodology will be developed. This evaluation methodology should address not only usefulness of information provided to individuals already employed, but also to existing analysed teaching/training techniques for students. Therefore the evaluation methodology should address on one side the learning outcomes assessment, validation, transfer and recognition and, on the other side, the teaching/training techniques. As a product of this analysis the most useful tool will be therefore a “handbook” reffering to guidelines for design, development and implementation into academic institutions of a Systematic Approach to Training (SAT) model, based on specific industry needs. These guidelines, mutually recognized by the E&T providers and end-users, ensure the continuous analysis of the teaching methodology, the evaluation of the training techniques, the accordance between the curriculum and course contents with specific job requirements, and the recommendations on adapting the curricula and other activities to end-user needs.

2.3 MAJOR CHALLENGES AND ACHIEVEMENTS

An Evaluation Methodology was used by all partners for the case study of University Politehnica Bucharest, based on accepted quantitative and qualitative common benchmarking criteria regarding the learning outcomes assessment, validation, transfer and recognition and, on the other side, the teaching/training techniques. These criteria reffer to: policy, strategy, vision and mission of the educational organization, to its capacity to deliver nuclear engineering programmes, to the Educational Curricula, outcomes of the program, quality assurance and accreditation, human resource policy and collaboration with industry.

The information provided by UPB was analysed using a set of quantitative and qualitative criteria. Regarding the policy, strategy, vision and mission of the educational organization these criteria referred to:

- How the educational organization and the nuclear engineering department’s policy, strategy, vision and mission are aligned with national policy;
- Where does the nuclear engineering program sit – undergraduate, postgraduate, part-time, full-time etc.;
- To what extent are the short, mid and long-term strategies of the organization and department developed;
- How much collaboration is there with industry, how does it contribute to the delivery of the program, is it being developed;
- What are the student enrolment and selection criteria etc.

The evaluation of existing nuclear engineering program also stressed staff qualification and quantity, existing experimental facilities, simulators, libraries, distance learning possibility, all these reflecting the (national) ranking of the analysed program.

2.4 LESSONS LEARNED /KNOWLEDGE DERIVED

As a result of evaluation of the undergraduate and graduate curricula for Nuclear Engineering were proposed corrections and new courses, answering the end-user needs. Part of these reccomendations are planned to be implemented starting with the next semmester. There were identified common gaps regarding:

- Operating Experience-the knowledge of Operating Experience and its use on the daily tasks performance should be covered in some subject of the educational program. Use of own and others feedback as background information, is essential for enhancing the human performance;
- Human Factors-human factors are essential in a NPP worker background. These enable to develop essential soft skills of workers belonging to an industry as unique as the nuclear industry. The enhancement of these skills results in a better performance of all the individuals regardless of the specific task they carry out;
- Systematic Approach to Training (SAT)-methodology should also be introduced to the students as the process used in the nuclear industry training. This methodology describes the different stages required to define a training program based on the worker profile needs;
- Constructive Culture-knowledge about how to promote a constructive culture within the group is a basic skill for a trainer as a group leader.

These last two topics could be incorporated to some of the already existing pedagogy subjects within the UPB educational program.

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KNOWLEDGE INCUBATION AND COLLABORATION FOR SCIENCE, TECHNOLOGY ADOPTION, RESOURCING AND TRANSFER (KIC-START)

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Abstract

In order to address the effectiveness of national networks in Member States, and to implement regional and national strategies, it is important to understand the necessary conditions that ensure successful creation and sharing of knowledge, including, effective policy and programme incentives, promoting collaboration, innovation and networking. Furthermore, Member States with aspirations to develop their nuclear programs (power and non-power applications in agriculture, industry and health sector), need to develop their own capabilities if they are to fully benefit from the social and economic opportunities from nuclear science and technology. Ultimately nuclear innovation programmes that take into account the role of universities, education and industry would lead to a robust nuclear program that maximizes social and economic benefit. This paper presents an initiative for capturing best practices in the areas of university collaboration and innovation, which are driven by learning, research and entrepreneurship. The initiative covers Knowledge, Innovation and Collaboration for Science and Technology Adoption, Resourcing and Transfer (KIC-START).

1.INTRODUCTION

Key features of innovation in science and technology will differ from region to region as will the nuclear aspirations. In developing nations, innovations will likely be incremental as these nations acquire appropriate technology, assimilate, adopt, adapt and then learn to invent something new. More developed nations might have mature structures for innovation management designed for new discovery and transformational innovation, but might not have foundation for nuclear knowledge management. In all cases the nuclear aspiration may be for an entirely new nuclear power programme, further development of an existing program or may be focused on non-power applications in agriculture, industry and health sector. The innovations needed may be technological or they may be societal, process or policies oriented [2].

In all cases, innovation driven by education, research and entrepreneurship are keys to the achievement of the economic and social development goals provided it is linked to:

- The safe and responsible application of nuclear technology [3];
- The national policy objectives;
- The needs of the industry.

2.KIC-START INITIATIVE

The objective of the KIC-START is to capture case studies of proactive interventions (policies, programmes and project) from government, education and industry, in the areas of university collaboration and innovation, driven by learning, research and entrepreneurship in order to provide information and support in a variety of areas (such as innovation management, technology assessment and transfer). KIC-START interventions (cf. Figure 1), captured in the repositories (cf. Section 4) showcase innovative ways to unlock entrepreneurship opportunities even after scientific research and education are completed, thereby producing more socially and technologically aware nuclear learners.

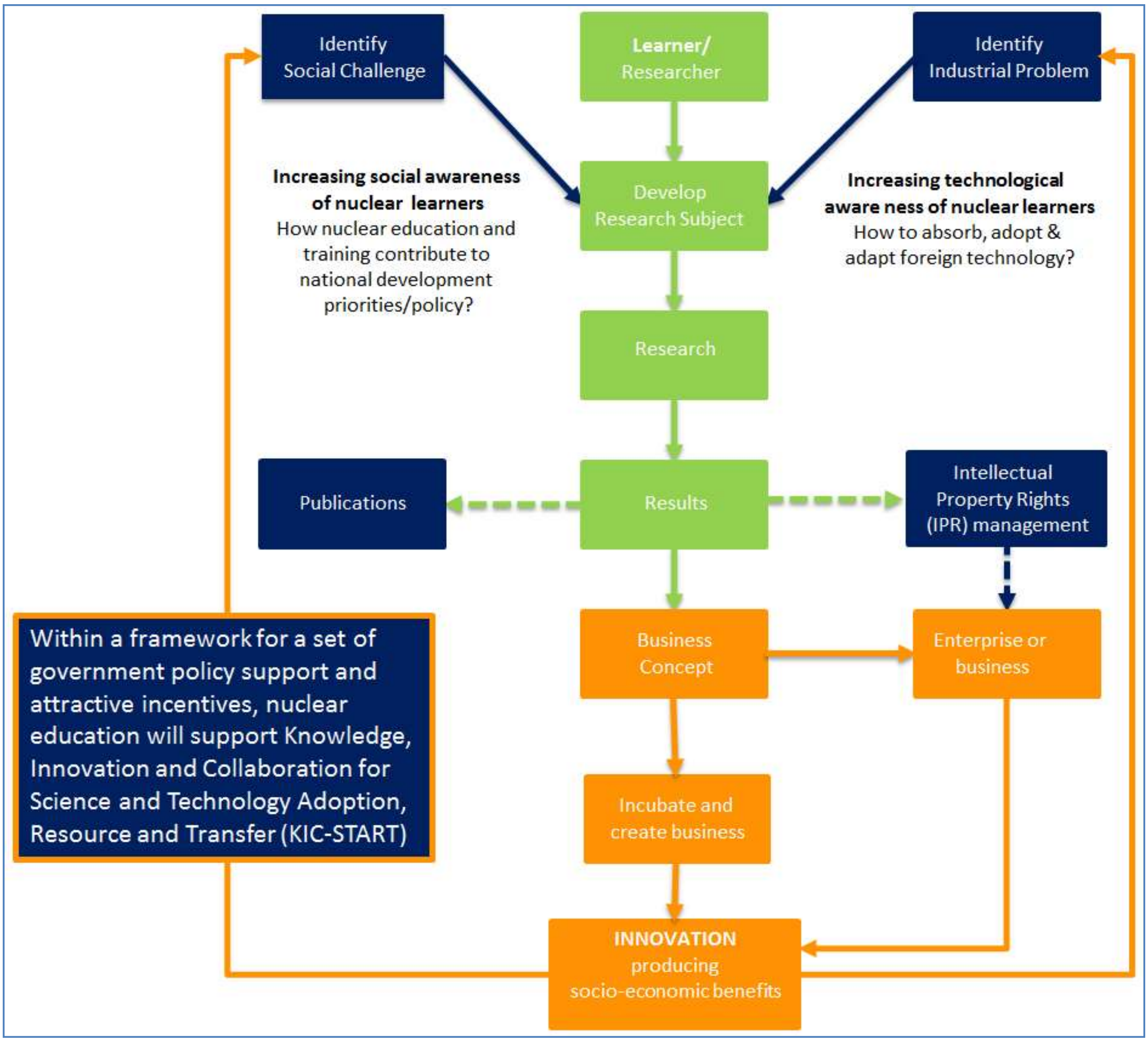

FIG 1. KIC-START interventions schematic

The primary audience of the proposed KIC-START initiative are envisaged to include Member States with aspirations to develop their nuclear programs (power and non-power applications in agriculture, industry, health and other sectors) that support university innovation centres and forward-thinking institutions, characterized by a strong network of institutes, universities, clusters, enterprises, and scientists.

3.UNITED NATIONAL SUSTAINABLE DEVELOPMENT GOALS

United Nations Specialized Agencies like the IAEA play a critical role in leveraging the knowledge and resources of all relevant actors in order to maximize the impact of development strategies at the national and regional levels [4].

In this connection, KIC-START initiative supports international priorities such as the United Nations Sustainable Development Goals (SDG) [5], including the following specific SDG targets:

3.1 SGD targets 8 on decent work and economic growth

- 8.2 to achieve higher levels of economic productivity and technological upgrading;
- 8.3 to promote development-oriented policies;
- 8.6 by 2020, to substantially reduce the proportion of unemployed youth, education or training.

3.2 SGD Target 9 on industry, innovation and infrastructure

- 9.5 Enhance scientific research, upgrade the technological capabilities of industrial sectors in all countries, particularly in developing countries. This includes, by 2030, to encourage innovation for substantially increasing the number of professionals in research and development per 1 million people while increasing public and private research and development spending;
- 9.6: Support domestic technology development, research and innovation in developing countries, including by ensuring a conducive policy environment for, inter alia, industrial diversification and value addition to commodities.

3.3 SDG Target 17 on Partnerships

- 17.6: Enhance North-South, South-South and triangular regional and international cooperation on and access to science, technology and innovation and enhance knowledge sharing on mutually agreed terms, including improved coordination through existing mechanisms, in particular at the United Nations level, and through a global technology facilitation mechanism;
- 17.7 Promote the development, transfer, dissemination and diffusion of environmentally sound technologies;
- 17.8 Fully operationalize the technology bank and science, technology and innovation capacity-building mechanism for least developed countries Capacity-Building;
- 17.16 Enhance the global partnership for sustainable development, complemented by multi-stakeholder partnerships that mobilize and share knowledge, expertise, technology and financial resources, to support the achievement of the sustainable development goals in all countries, in particular developing countries.

4.KIC-START REPOSITORIES

KIC-START repository will capture case studies according to a predefined standard as shown in the Table 1 below. The repository provides a searchable database of experience that will assist member states in the development of their own programs. This is done through lessons learned (both positive and negative) as well as program implementation and outcome. IAEA and member state experts of similar past or existing programs can support new member state programs by expanding the experience network of program managers. The repository can also be used to support Establishing Sustainable Nuclear Education: Education Capability Assessment and Planning (ECAP) Assist Missions [6], where MS can search for examples of projects and experts.

5.CONCLUSIONS

Entrepreneurship is often the missing link in nuclear technologies. After scientific developments and education are in place, innovative ways to unlock entrepreneurship opportunities is required. The KIC-START initiative is being developed to catalogue innovative approaches (cf. Table 1) used by Member States to strengthen their Knowledge, Innovation and Collaboration for Science and Technology Adoption, Resourcing and Transfer. This is achieved by making 1) identifying best practices in policy, programme and project development for university innovation centres; as well as 2) focusing on collaborative initiatives, supported by policy incentives with the aim of building or strengthening university education, through cooperation with national Research and Development (R&D) laboratories and industry.

TABLE 1: KIC-START CASE STUDY TEMPLATE

1. Introduction
   - Background;
   - Objective;
   - Scope/Sector;
   - Stakeholders.
2. **Sustainability considerations [6]**
   - Social Acceptance;
   - Resource Mobilisation;
   - Human Capital;
   - Job opportunities;
   - Recruitment sustainability;
   - Nuclear contributions.
3. KIC-START methodology
4. Required resources
   - Strategic partnerships;
   - Finances;
   - Facilities;
   - Human resources.
5. Implementation Plan
   - Outputs;
   - Timeline;
   - Work breakdown structure;
   - Activities;
   - Management plan.
6. Outcomes
   - Human Capacity Building;
   - Intellectual Property;
   - Publications;
   - Value added services (Impact);
   - SDG Targets addressed.
7. Lessons learned
   - Success cases;
   - Failed cases.
8. Key performance indicators
9. Taxonomy (keywords)
10. Supporting documents
11. Key contact persons and experts
12. IAEA project
    - Evaluation summary of completed project (IAEA).

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DESIGN AND IMPLEMENTATION OF AN ONLINE COURSE ON NUCLEAR KNOWLEDGE MANAGEMENT IN SPANISH

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Abstract

This course aims the development of competencies in Nuclear Knowledge Management, both from the view of strategy and from that of the specific operation, within the organizations of the nuclear sector. It is an online course in Spanish, including didactic multimedia material specifically developed for the objectives of the course, having virtual tutoring activities in each thematic module. Active and collaborative learning is encouraged by means of forums for the interchange of opinions and experiences, as well as an exercise of converting the learning experience into initiatives that may be implemented within the organizations of the participants. A final questionnaire allows the evaluation of the main facts of the contents of the course. The experience has run very successfully in this first edition, and mechanisms for the evaluation of this initiative have been implemented, using learning analytics philosophy and retrieving data from activities proposed as surveys. We can highlight in this case the impressive networking achieved by the interaction of participants from different nuclear stakeholders, and the learning experience that sharing personal experiences in each course member organization has enabled. Lessons learned are also explained in order to implement them in next editions of the course.

1.ICOURSE MOTIVATION

Recently the Spanish Fission Technological Platform CEIDEN proposed the creation of a special work group on Nuclear Knowledge Management, due to the need within the Spanish nuclear sector of an improvement in this direction. The creation of this group, called KEEP (Knowledge Exchange, Elicitation and Preservation [1]), led us to propose the design of an online course with the collaboration of ICA2 Innovación y Tecnología, experts in Knowledge Management with experience in the nuclear field, and Universidad Nacional de Educación a Distancia (UNED), with a long expertise in education innovation, knowledge Management and Nuclear Engineering, both of us members of KEEP group.

The design of the course was presented in the annual meeting of the Spanish Nuclear Society [2], and a long dissemination work has been performed, specially within the Spanish nuclear sector, to have a wide participation in its first edition. This course is part of the activities in which the UNED multidisciplinary team for educational innovation in the nuclear field is involved in [3].

2.COURSE OBJECTIVES: COMPETENCIES TO BE DEVELOPED

The main competencies to be achieved in the course are the following:

— Assimilate the motivation and the importance of preserving knowledge, as well as the evolution of scientific information, technology and qualified personnel.

— Understand the basic roots of the work with intangible assets (persons, structures and relations) from the study of the intellectual capital.
— Understand the need of implementing a knowledge management model to enhance the organization.
— To develop a set of competencies from various proposed paths to deal with this key concept.

3.DESIGN OF THE COURSE

The course: "Gestión del conocimiento en las organizaciones del sector nuclear", will be taught using UNED methodology, with more than 40 years of experience in distance educational programs. This course covers 5 ECTS credits (each credit equivalent to 25-30 hours of student work), and allows an accreditation within the university offer of lifelong learning education [4].

3.1 Timetable of the course

The course started 18th January 2016 until 13th May 2016. Each thematic module is 2 or 3 weeks long, with a final week to keep track of all the activities.

3.2 Course participants

Although this course could be easily followed by participants in all Spanish speaking countries, in this first edition we have had 27 of them, all from Europe and mainly in Spain. The participation has been very varied, including participants from the regulatory body, engineering companies, nuclear power plants, etc. We think this has happened because the dates of the beginning of the course were those when most summer holidays take place in Latin America, and also because our main dissemination activities of the course have been done within the Spanish nuclear sector.

3.3 Course contents

The didactic scheme describing the contents of the course is specially targeting our participants' organizations: those of the nuclear sector, divided in 4 thematic modules, as shown in Table 1.

TABLE 1. COURSE CONTENTS

Parte 1	***El valor del conocimiento en las organizaciones del sector nuclear*** ***(the value of knowledge in the organizations of the nuclear sector)***
Parte 2	*Los activos intangibles: El capital intelectual en las organizaciones del sector nuclear* *(The intangible assets: the intellectual capital in the organizations of the nuclear sector)*
Parte 3	*Modelo y Estrategias de Gestión de Conocimiento para las organizaciones del sector nuclear" y "Competencias para la Gestión del Conocimiento.* *(Model and Knowledge Management Strategies for the organizations of the nuclear sector)*
Parte 4	*Competencias para la Gestión del Conocimiento* *(Competencies for Knowledge Management)*

3.4 Course methodology

The course uses UNED´s learning management system aLF, where all the academic offer of the university is implemented. We start with a study guide, and each course part contains the main elements to guide the distance students, with the following learning resources:

- *Videos:* each thematic module has an initial introductory video by a course teacher, and interview video to an expert from the nuclear sector talking about personal and real experiences and situations related to the subject of the thematic module. These videos have been recorded in UNED studio and are open to the public via our CanalUNED and YouTube UNED channel. Other videos of interviews to experts in the nuclear sector have also been recorded and offered in the course in the video channel resource area [5].
- *Reference Material:* created for each thematic module, with the compulsory study material.
- *Additional resources:* a list with links to additional material is given in each thematic module with additional indications. These additional resources have been also elaborated in collaboration with students form degrees in engineering in UNED, who have worked in their final project with this subject, in a team collaboration with the teaching team that also are also the directors of the projects [6]. We plan to have these finished projects available in the next editions of the course as part of the additional resources.
- *A thematic forum* for the exchange of opinions and experiences, in order to know the real situation of each participant, and to reaffirm the understanding of the reference material.
- *A learning activity connected to initiatives that can be implemented within the organizations of the participants*. The objective of this type of exercise is to allow the participant to make a preliminary diagnosis of the situation in his/her organization, and to promote searching solutions of improvements for the implementation of a model of organization for the knowledge management. These activities will consist on the creation of a documents covering the specific aspects explained in each thematic module, describing the needs and the proposals that may enrich the actual knowledge management within the organization where they work.
- *A questionnaire* with multiple-choice questions auto-corrected, to evaluate the assimilation of the contents of the thematic module.

Apart from these resources an open blog in Spanish has been created to network all the people interested in nuclear knowledge management [6].

3.5 Tutoring and dinamization activities

The course has asynchronous virtual tutoring activities with forums and email communication within the learning platform. The main forums are a general one called "Cafetería del conocimiento", and the thematic forums for each thematic module. The forum "Cafetería" allows each participant to make a presentation and to share the experience of the course between participants, open to any subject with the objective of having a conversation and exchanging opinions. The thematic forums are designed to exchange opinions and experiences that allow the clarification of aspects related to each thematic module as well as the debate and the reflection, gathering conclusions and motivated solutions over the subjects proposed for discussion. There is also a forum for technical assistance related to the use of the learning platform. In this way this interactive communication method between the teachers and the participants enables the development and the understanding of the course, as well as the exchange of information and experiences.

3.6 Course evaluation

The evaluation considers the active participation in the thematic forums (50%), the delivery of the exercise (40%) and the questionnaire (10%).

- The participation in the forums is set from 3 of quality (with relevant content, exposing an experience, a case of success a lesson learned, etc.);
- The exercise must allow the design of a knowledge management initiative to be developed in the participant´s organization. This exercise is being made in each thematic module until arriving at the end with a concrete and well-defined proposal;
- The questionnaire is based in a multiple-choice set of questions, being asynchronous and all material allowed for support.

4.LEARNING ANALYTICS

An important part of the course is the possibility to study the learning process and to extract learning lessons from these data. We are designing anonymous surveys and we are gathering the data the platform is giving us to be able to make these studies, and the results are not yet available at the time this paper is written, but relevant data will be delivered in the material presented at the congress.

5.EXPERIENCE OF THE FIRST EDITION OF THE COURSE: MAYOR CHALLENGES AND ACHIEVEMENTS, LESSONS LEARNED AND CONCLUSIONS

At the time of the presentation of this paper the course was not yet finished, so we shall only present here a few ideas that we will further develop in the final material presented at the conference.

This course gives new and interesting opportunities to the Spanish speaking nuclear sector, it has shown us the power of this type of environments to develop and encourage learning, as well as the possibility to build networking experiences and to co-create knowledge, ideas and proposals.

This online environment and the particular design of the course allow the flexibility many workers need to be able to attend, when they are too busy or too far to attend face-to-face courses, in line with the development of numerous long life learning programs all over the world.

The active and participative learning experience by means of forums allows the acquisition of competencies very much needed for knowledge management.

The course has a very practical approach for each organization; by means of the exercise of transposing the learning experience to initiatives that may be implemented within the participants' organizations.

As this is not a very common learning environment in the nuclear sector, the interaction between the participants could be more encouraged in next editions. The idea of discussion forums and work in groups could be examples of means of increasing the engagement and the interaction, so important dealing with the Knowledge Management concept.

The development of knowledge management initiatives aims to respond to a business objective, thus assuring the generation of efficiencies, savings and improvements (innovations) that help to reach the challenges and business objectives of the organization.

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We want to thank CEIDEN, and in a special way all the members of the Knowledge Management KEEP group, for the interesting exchange of experiences and for the interest shown in the course and in its coordination with the objectives of this group. We would also like to thank FORO NUCLEAR and SOCIEDAD NUCLEAR ESPAÑOLA (SNE) for the course dissemination effort. And of course many thanks to our students Sara Bravo Calvo, Sergio de la Rosa and Sara Muñoz Sánchez for their excellent work and their learning experience co-working with the teaching team and between them to co-create with us valuable contents for the course.

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DIGITAL INNOVATION AND NUCLEAR ENGINEERING EDUCATION IN UNED: CHALLENGES, TRENDS AND OPPORTUNITIES

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Abstract

Innovation in nuclear engineering education should reflect the current challenges, trends and opportunities that digital technologies are promoting in the whole educational field. The European Commission has recently stressed that technology and open educational resources represent clear opportunities to reshape EU education, contributing to the necessary modernization of higher education in order to give response to XXI century challenges. In this paper, the innovations that the Spanish National Distance Education University (UNED) are making in the digital education domain, including open educational resources (OER) and massive open online courses (MOOCs) developments applied to science, technology, engineering and mathematics (STEM) and the nuclear engineering field, are presented.

1.INTRODUCTION

Higher education is facing great challenges to be adapted to XXI century educational needs. On the one hand, lifelong learning has become one of the most relevant issues to be accomplished by universities, as we are living in a complex world in which knowledge and continuous learning are considered the main capital for societies' development [1]. In this sense, the so-called XXI century skills, integrated not only by basic foundational literacies, but also by other competences such as critical thinking, creativity, communication and collaboration, as well as personal characteristics such as persistence, adaptability, leadership, initiative, etc., are becoming more and more relevant. These skills enable us to approach complex challenges and changing environments. However "*on average, by 2020, more than a third of the desired core skill sets of most occupations will be comprised of skills that are not yet considered crucial to the job today",* p. 20 [2].

On the other hand, digital revolution is radically transforming our daily lives and works, "application of technology has already changed when and where work is done in practically every industry, as workplaces of the industrial age give way to work practices of the digital age, including remote work, flexible work and on-demand work, p.9 [2]. That implies that our traditional ways of teaching and learning should also be adapted. That is, not only should we re-design our curricula to be adapted to XXI century demands and characteristics, but we should also re-think our methodologies and educative technologies in order to take advantage of the great potential digital technologies bring us and allow us to give response to the challenges we have to face. Digital literacy and a whole range of more advanced digital competences have become necessary for both, academic staff and students, as digital technologies push educative innovation by creating new enriched and technology mediated teaching and learning environments promoting increased access to higher education, more flexible, self-directed and personalized educational pathways, increased global visibility and local and global cooperation. These are some of the big challenges to be faced in the educational field in the coming years.

In sum, a bridge between the skills people learn and the skills people would really need in the nearer future is strongly required, as a clear gap is observed in current educational programs.

We need to discover, thus, how all these skills can be best trained and developed. This should be also applied to STEM field.

Taking into account these main reasons, the European Commission recently launched the agenda for the *Modernization of Higher Education* [3][4] and the *Open-Up-Education program* [5] stressing new modes of learning and teaching in higher education. According to these proposals, the EU highlights the need to incorporate digital and online education in its different modalities (digital technologies in the classroom, blended and online learning) in combination with the possibilities of *Open Educational Resources* (OER), [6] mainly represented by the current development of *Massive Open Online Courses* (MOOCs) all over the world. In the words of the European Commission, "*technology and Open Educational Resources are opportunities to reshape EU Education*" [4]. However, the group of experts responsible for the *Modernization of Higher Education* agenda has observed that, in general, Europe's institutions and Governments are reluctant to changes and slow to innovate and integrate digital technologies in the educational field. In this sense, the traditional model of students physically attending lectures is still the dominant paradigm. In spite of this reluctance to change, e-learning is not a recent phenomenon in the educational field, something that suddenly appeared with the explosion of MOOCs in the educational horizon. More than twenty years of experience in e-learning is behind the European Commission recommendations about ICT integration in the educational domain, a period of time in which traditional distance education universities have already come a long way, before MOOCs' appearance.

The Spanish National Distance Education University (UNED) is one of them. Since it opened doors in 1972, it has delivered distance education in its different traditional modalities, such as other big open universities in Europe (e.g. the OPEN University of UK). However, in 2000 online learning and digital technologies were integrated and during the past 16 years further technological developments in the digital domain have been taking place in any area of university management, both academic and administrative, including some basics such as *Learning Management System* development, web conference platform, and OPEN UNED, the platform of digital open educational resources (library, digital TV and radio, electronic books, OCW, MOOCs, etc). Thus, at present we have 250,000 students formally registered in undergraduate, postgraduate, doctoral and lifelong programs, all of them in blended-learning or fully online modalities. An even larger number of people follow OPEN UNED and have been registered in our MOOCs. Part of this huge number of students belong to our Science Faculty and our two engineering schools in which distance education is applied and mediated by technologies.

2.STEM AND DIGITAL EDUCATION: CURRENT TRENDS AND PERSPECTIVES

In 2013, just one year after what was called "*the year of the MOOCs*", UNED took part in the development of the *Technology Outlook* on STEM and Education 2013-2018 [7], a report on the Horizon Project series on technology applied to education. In this report, two main reflections were given; first, that education paradigms were clearly experimenting a shift to include online and hybrid modalities of learning, as well as more collaborative models mediated by technological tools; and secondly, that the great abundance of all types of educational resources and interactions easily accessible via Internet was rapidly growing. This presented a real challenge for our roles as educators, a role we should be revising in depth, as we are becoming more and more tutors that guide our students in their learning process. A brief comparison between Horizon Reports made in 2013 and the most recent one from 2016 provided us with a brief overview of those technologies "to be watched", some of which have not been or are being implemented in many higher education institutions.

With respect to the OER and MOOCs world movement thousands of institutions, such as those belonging to the *Open Course Ware Consortium* (OCW) launched by the MIT, and MOOCs platforms such as Coursera, Khan Academy, EdX, FUN, Future Learn, or the EPFL (more specifically related to STEM) are expanding open knowledge all over the world giving support to millions of students in their development and sharing of basic and advance knowledge in the STEM field.

Aligned with these on-going innovations applied to STEM in higher education, since 2000 UNED Schools of Engineering have been facing some of the early XXI century educational challenges by working in different technological developments applied to education [8] such as LMSs, augmented reality [9], virtual and remote laboratories [10], online authentication models [11] or geolocation and mobile learning [12], among others. Also, STEM OER resources have been developed and are available in UNED OCW and MOOCs platforms (https://unedabierta.uned.es/catalogo/). Under a learner centred approach, issues such as interoperability, ubiquity, compatibility, and security are important requirements in building new learning environments to give support to digital modalities in education.

3.THE APPROACH OF NEW EDUCATIONAL TOOLS AND METHODOLOGIES WITHIN THE NUCLEAR ENGINEERING AREA

The extensive expertise of UNED in education innovation has been incorporated to propose new teaching and learning initiatives in the nuclear engineering field. The participation in FP7 ENEN III project led us to propose a fully online international course on a particular Generation IV matter [13], showing the need and usability of this type of online education. This experience and the need of education innovation in the field [14] encouraged us to create at UNED a multidisciplinary team of experts to enhance nuclear engineering education mediated by technologies. After proposing several initiatives in this direction [15] [16], we are now engaged in the following guidelines [17] [18].

3.1 Production of a specialized MOOC in H2020 ANNETTE project

Our participation in ANNETTE project will give the guidance to assist partners on the introduction of e-learning approaches in their educational activities, and on how to develop a MOOC in a nuclear subject, assisting the content experts to develop the course contents and activities, as well as offering our media recording installations and covering the hosting of the MOOC in a suitable platform.

3.2 A dissemination course on Fukushima Dai-ichi Accident in OCW, mobile app and MOOC versions

A basic course in Spanish for the general public is being designed in a format easily convertible in a MOOC when a wider team of experts is gathered in order to have the right quality and prestige necessary to have success. An experience with nuclear engineering students previous to the publication of the OCW in UNED Portal is expected in order to further test the course and to include contents co-created by students with the supervision of our team.

3.3 An online course on Nuclear Knowledge Management in Spanish

This course has run from January to May 2016, and it is the first online course in Spanish on Nuclear Knowledge Management, with dedicated multimedia material and extensive tutoring and collaborative activities to enhance peer-to-peer learning and networking activities in addition to the assimilation of the course contents.

3.4 An online pilot international course on accelerator driven systems for nuclear waste transmutation

This initiative aims to test the suitability of the development of fully online international courses on specific technical subjects that have been traditionally taught using scarce and expensive face-to-face courses in order to use blended learning when necessary and to optimize the use of e-learning methodologies when suitable, taking the best international experts to guide the course, and having as well the benefit of the flexibility to be able to have a much more extensive number of participants enabling the growth of knowledge transfer. This course is to be implemented and tested by nuclear engineering students of UNED´s Master in Industrial Engineering.

3.5 Development of a methodology for the recording of videos for Computer Science MOOCs for IN-CLOUD Erasmus+ project

MOOCs have become a very useful tool for open education, but making a video for a MOOC hasn't always been an easy task for a STEM teacher or an expert. In this sense a guide has been developed initially in the context of a European project applied to the computer science field [19], however the indications in this guide are completely applicable to other STEM MOOCs, thus it will be used also in the nuclear engineering field. Some other fields of research have been identified and will probably be addressed by UNED team in the near future, as in the case of the creation of a Learning Object Repository for open courses in the nuclear engineering field using Data Mining techniques and semantic web technologies.

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KNOWLEDGE TRANSFER AND CULTURE EXCHANGE BETWEEN HEU AND TAMU THROUGH A SUMMER SCHOOL ON NUCLEAR POWER ENGINEERING

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Abstract

Since 2012, Harbin Engineering University (HEU) and Texas A&M University (TAMU) hold an annual Summer School on Nuclear Engineering. By now, the activity has been held 4 times. Each year, 15-20 students are selected from their respective institutions and paired with a counterpart to form partners. They study lectures in the first week at HEU and tour 3 Nuclear Power Plants (NPP) in the second week, visit the NPP simulators, and learn the nuclear safety culture. This activity expands the scale of international nuclear educational exchange, provide a platform for the students from different countries to communicate and exchange insights into their respective culture.

1.INTRODUCTION

Harbin Engineering University (HEU) has the largest nuclear engineering program in China. The College of Nuclear Science and Technology (CNST) at HEU is committed to educating and training nuclear engineering professionals for China's nuclear industry. Texas A&M University (TAMU) has the largest nuclear engineering program in the United State. The mission of the Department of Nuclear Engineering at TAMU is to serve the state and the nation by nurturing future nuclear engineering professionals and leaders.

In today's university education, the students need to have international vision more and more. In our education program, the practice is an important part. China's nuclear power industry is developing rapidly. The students and even the teachers may not have a very clear picture of the China's nuclear power plants. In this context, in order to follow the global development of nuclear energy, serve the nuclear energy safety and sustainable development, enlarge the students exchange, expand the scale of international nuclear educational exchange, provide the most internationally competitive compound talents and future nuclear leaders, the two universities initiated a Summer School on Nuclear Power Engineering. The Summer School is a China-US joint education program instituted by the CNST at HEU and the Department of Nuclear Engineering at TAMU.

2.DESIGN OF THE SUMMER SCHOOL

The summer school is arranged in July, during the summer vacation of the two universities. Both universities select 15-20 students from the applicants respectively. 2-3 faculty members from each university take part in the summer school. Each student from HEU will pair with a counterpart from TAMU to form partners.

This activity provides participants with instruction of nuclear power engineering and internship visit to nuclear power stations. The summer school arranges 1 week class lectures at Harbin Engineering University, Harbin, Heilongjiang Province and 1 week visit to 3 nuclear power plants (NPP) including Hongyanhe NPP at Dalian, Liaoning Porvince, Sanmen NPP at Sanmen, Zhejiang Province, and Daya Bay NPP at Shenzhen, Guangdong Province. The schedule of this program consists of three parts:

(1) One-week of lectures on selected nuclear engineering topics. The lectures are given in English by professors from both universities, nuclear professionals from the power industry, and guest speakers from nuclear management and regulation agencies in China. The topics cover nuclear safety, thermal-hydraulics, reactor physics, power engineering, nuclear materials and waste management. In addition to lectures, the participants also have the opportunity to participate in hands-on learning experiments and exercises in Radiation Detection Lab, Nuclear Power Simulation Research Center, Nuclear Power Plant Lab (3A Lab).

(2) One-week of visits to three selected nuclear power facilities. These include: Hongyanhe, a Chinese designed CPR-1000 PWR; Sanmen, a US designed AP-1000 PWR; and Daya Bay, site of several PWRs and training facilities for nuclear plant personnel. The visits provide a unique perspective on the different stages of construction and commissioning as well as differences in plant design and construction techniques.

(3) One-week tours of cultural and historical sites. The cultural and historical tours are interspersed throughout the summer school and provide an excellent opportunity for the student pairs to learn and discuss the rich history and culture of China.

The students who successfully complete this summer school will get credit for the practice from their university. Tables 1 and 2 show the agenda of a certain year's Summer School.

TABLE 1. AGENDA FOR THE SUMMER SCHOOL

Day	Events
Day 1 (Sun)	Arrive in Harbin, USA-> Beijing-> Harbin
Day 2-6 (Mon-Fri)	Harbin: Opening Ceremony Lectures, workshop, Lab (See lecture agenda Table 2 for details)
Day 7 (Sat)	Cultural Activity (Harbin city tour). Harbin -> Hongyanhe NPP
Day 8-9 (Sun-Mon)	Visit Hongyanhe NPP ◆ Safety education ◆ General Introduction to Hongyanhe NPP ◆ Visit the CPR-1000 MWe Nuclear Power Plant under construction- Conventional Island, Nuclear Island, and get an overview of the NPP programs – Generation II +, in China ◆ Visit NPP simulator
Day 10-11 (Tue- Wed)	Hongyanhe NPP -> Sanmen NPP Visit Sanman NPP ◆ Safety education ◆ Introduction to AP1000 NPP ◆ Visit the exhibition hall of Sanmen NPP, ◆ Visit the simulator of AP1000 ◆ Lecture of nuclear culture
Day 12 (Thu)	Sanmen NPP ->Daya Bay NPP base

Day	Events
Day 13-14 (Fri-Sat)	Visit Daya Bay NPP ◆ Introduction to M310, CPR1000, CPR1000+ NPP ◆ Visit the skill training center, ◆ Visit the NPP simulator ◆ The Daya Bay NPP view from the viewing platform ◆ Visit the refuelling pool Daya Bay NPP -> Beijing
Day 15-18 (Sun-Wed)	Cultural Activity (Beijing city tour). Beijing ->USA

TABLE 2. AGENDA FOR ACTIVITIES AT HEU (DAY 2 - DAY 6)

	Monday	Tuesday	Wednesday	Thursday	Friday
8:00 -9:50	Opening Ceremony Reactor Physics	Introduction to Nuclear Power Plants	Advanced neutron detecting technology	Introduction of transport phenomenon	Thermal hydraulics II
10:00 -11:50	Introduction to characteristics of Generation IV nuclear power system	Materials issues in nuclear engineering I	Thermal hydraulics I	Materials issues in nuclear engineering II	Industry practice on Nuclear Power Plant Simulator in Building 31
	Lunch Break	Lunch Break	Lunch Break	Lunch Break	Lunch Break
14:00 -15:40	Nuclear Safety	Visit Harbin Electric Company Limited	Visit teaching lab	Natural Circulation	*Team Project Presentations* *Evaluation feedback form*
15:40 -17:30	Cultural activity, Campus tour		HEU History Museum, The Ship Museum	Visit Lab 3A	

3.IMPLEMENTATION OF THE SUMMER SCHOOL

This program has been successfully held for undergraduates since 2012. It provides a platform for the young generation of nuclear professionals to gain unique nuclear power technology knowledge, promote integrating theory with practice, broaden horizon, develop an appreciation for an international nuclear exchange, and participate in a rich cultural exchange.

The summer school provides a platform for interaction between the U.S. students and their Chinese partners, professors, and nuclear professionals that will greatly impact the students' understanding of international cooperation and globalization. All participants are encouraged to actively question and discuss course material and knowledge gained at the nuclear facilities, and to present their opinions on nuclear relative topics in group. The diversity of majors of the student (i.e. nuclear engineering, health science, radiation detection) allow for a broad range of nuclear knowledge to be discussed during the summer school.

In addition, the summer school provides students from both sides of the globe a better understanding of the development of China's nuclear power industry. Having both in class lectures, simulator experience, and plant visits allows for an excellent and unique opportunity to integrate theory and practice. The opportunity to tour nuclear power plants under different stages of construction allows students to develop a deeper, richer understanding of the scope and scale of nuclear power facilities which enhances their academic knowledge.

Participants visit several famous places throughout China. In Harbin, student activities have included visits to the Confucian Temple, Siberian Tiger Park, Sun Island, Central Street, and on-campus museums. A tour of historical sites in Beijing include the Great Wall, the Summer Palace, and the Forbidden City. The activities promote friendly relationships between all the participants while promoting China-US cultural exchange.

Based on the great success and experience accumulated over the last four years (2012-2015) and very positive feedbacks from all participants, the Summer School will continue to be held each year.

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THE ROLE OF A SHORT-TERM EDUCATION PROGRAMME IN INTERNATIONAL NUCLEAR HUMAN RESOURCE DEVELOPMENT AND KNOWLEDGE MANAGEMENT

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Abstract

The Nuclear Energy Management School is proposed as a good tool to structure the experiences of industries. The importance of a short-term international education programme for gathering knowledge regarding nuclear embarkation projects is discussed in this paper. The results of evaluating education efficiency from 2013 to 2016 will also be introduced in this presentation (or poster).

1.INTRODUCTION

The University of Tokyo has hosted the Japan-IAEA Joint Nuclear Energy Management School [1] since 2012, as a member of the Japan Nuclear Human Resource Development Network [2]. The Nuclear Energy Management School is a three-week course developed by the International Atomic Energy Agency (IAEA) to teach the management of nuclear projects, and is held for young professionals (preferably less than 40 years old) with managerial potential who have worked in the nuclear field for at least three years. The lecturers are experts from both the IAEA and Japanese organisations. Half of the participants are Japanese, and the other half are from abroad, especially nuclear embarking countries. Nuclear utilities, government organisations (both organisations for nuclear promotion and regulatory bodies), and research institutions send their employees to the school.

Why do we make a great effort to organise a short-term programme for professionals who are not our regular students? We consider that the school can be a good tool to collate the experiences of nuclear industries and governmental organisations. We select the lecture topics based on our current understanding of nuclear energy management, and look for good lecturers from IAEA, nuclear industries, and/or governmental sections.

We observe the efficiency of the education programme carefully, and review our understanding of nuclear energy management. The contents of the lectures are summarised, and some of them are published with the permission of the lecturer [3]. We aim to develop knowledge bases by structuring the understanding of lecturers, and utilise it for our regular education and researches. This activity is based on the concern that an individual organisation (such as a company) may not be enough to manage the knowledge obtained by a nuclear project.

2.STRUCTURING IMPLICIT KNOWLEDGE OWNED BY MULTIPLE ORGANIZATIONS

A typical character of nuclear facilities is a long lifecycle that has many phases, such as siting, biting, construction, commissioning, operation, maintenance, and decommissioning. The IAEA (2006) pointed out the need for “carry-forward” knowledge management, which enables the transfer of knowledge toward the next phase. However, it also indicated that “an organisation’s focus and [knowledge management] priorities may be quite different depending on where the [nuclear power plant] is in its life cycle” [4].

Knowledge management has been developed as a method to treat "interactions" between an organisation (such as a company) and the member (such as an employee). For example, Nonaka, et. al., (1996) described the knowledge created by individuals, groups, and companies, and discussed the relation between these knowledge creations and innovation in the form of new services and/or products [5]. In the case of nuclear industries, there are few nuclear utilities that can conduct new construction projects regularly. Many nuclear utilities may not have a strong incentive to structure and maintain the knowledge created during the nuclear embarkation phases because the next project would be started after decades. Much knowledge, obtained by huge effort, would be lost because of this. Could universities play a role in storing such knowledge?

A strong driving force to collect and structure the knowledge possessed by multiple organisations would be created when an education programme for young professionals is prepared by collaboration between an industry and a university. For example, a series of textbooks for nuclear engineering was once prepared in the 1970s, but was not updated for 20 years. In 2005, a new department for young professionals was established based on the standards for establishing a professional graduate school. The curriculum is linked to national qualifications such as Chief Engineer for Reactor, and many experts from nuclear industries and research institutes are invited to be a part of the lectures [6]. A new series of textbooks based on the lectures was prepared quickly. The textbooks have been widely used in Japan, and some of them were translated into English [7].

The Integrated Engineering Committee of the Science Council of Japan (2010) pointed out the limitations of collaboration with an industry in a state. It indicated that "the objective of industries shifted from manufacturing to the creation of added-value. It is recognised that the needs of engineering were also changed." (Translated by the author) [8] Nuclear engineering education should also respond to the paradigm shift in engineering. The development of strategic technology roadmaps based on the discussion of experts who belong to multiple organisations is one of the ways one can respond to the paradigm shift. The objective of the roadmaps is to visualise technical problems to be solved, and accelerate innovation. Recently, the promotion of strategic development of technologies and human resources for light water reactor safety was discussed through the interaction between the Ministry of Economy, Trade and Industry's advisory committee and the Atomic Energy Society of Japan [9, 10]. Structuring a roadmap is a good method to share knowledge gathered by multiple organisations beyond industries, and conduct research and development efficiently. However, there is a concern that the roadmap can be affected by the state's policy, and some useful knowledge can be lost because of a mismatch with domestic situations.

3.ROLE OF INTERNATIONAL PROGRAMME

A unique character of the Nuclear Energy Management School is the target of the education. Participants from both nuclear embarking countries and Japan study the same subjects together. We assume that the knowledge required for young leaders from nuclear embarking countries would be indispensable for Japanese participants as well. The nuclear safety reform plan of the Tokyo Electric Power Company (2013) pointed out their "passive approach toward appropriately capitalising on investigations of operational experiences in other countries to formulate safety-improvement measures". The report also indicated that it "relied too much on the judgment of regulatory authorities and it fell short of the inclination to discover problems by independently observing events carefully” [11]. The Atomic Energy Society of Japan (2013) requires “a questioning and learning attitude” toward nuclear education to “appropriately analyse and evaluate lessons learned from past events and operating experiences in nuclear power plants at home and abroad; based on these, the necessary improvements to facilities and the modifications of operating procedures will be made”. [12]. We would like to provide the chance to learn internationally recognised good practices for starting nuclear projects through the Nuclear Energy Management School. The participants from countries that already have nuclear power plants can also learn good practices. We want to emphasise their ability to recognise gaps between their activities and best practices with new reactors, and find ways to reduce this gap [13].

Programmes of the Nuclear Energy Management School were established based on a number of discussions between lecturers and programme co-ordinators, reflecting the competency area of the International Nuclear Management Academy [14]. The performance of the participants was reviewed every year, and the efficiency of the programme was evaluated. Two types of surveys, a questioner—survey on the experience, and a keywords survey were prepared. The survey on the experience is a method that has been used in some universities in Japan for many years. It focuses on abilities that we want the participants to develop, and asks whether the school helps to acquire these abilities [15]. This survey has been conducted since 2013, and the results were evaluated and utilised for the betterment of the programme [16]. The keyword survey focuses on the important words regarding nuclear energy management and asks about the understanding of such keywords. This survey has been conducted before and after the programme since 2015, and the difference of the results represent the understanding the participant acquired during the programme. The results of the survey from 2013 to 2016 will be introduced during the presentation (or poster).

4.SUMMARY

The need for an international short-term education programme to teach the management of nuclear embarking projects was discussed from the viewpoint of knowledge management. We sincerely hope that our activities will benefit international society.

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AN APPROACH TO BUILDING CAPACITY FOR NUCLEAR SECURITY AND SAFEGUARDS IN THAILAND AND THE SOUTHEAST ASIAN REGION

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Abstract

A master's degree program in nuclear security and safeguards has been developed and offered at Chulalongkorn University for the first time in 2013 in order to develop necessary human resources in the fields of nuclear security and safeguards who can continue to work, conduct research, or serve as educators in these fields in Thailand and the Southeast Asian region. The first group of 20 students joined the program in 2013 and recently graduated. The program was one-of-its-kind, as there have not been many similar specialized programs in nuclear security and safeguards in the past. In this paper, challenges and lessons learned throughout the program are reported. Experience from the pilot program will be used to improve the next round of the program which is expected to start in 2017. With this program, more nuclear knowledge can be shared and maintained among the Association of South East Asian Nations (ASEAN) countries to ensure the peaceful utilization of nuclear technology in the region.

1.ORGANIZATIONAL CONTEXT

Thailand and other countries in the Southeast Asian region have observed a rapid increase in the presence of nuclear and radioactive materials in recent years. Whether they are produced or utilized within the country or they are transported through the border, the trend has generated nuclear security and safeguards concerns both domestically and internationally. In Thailand, human resources development was identified during the INIR mission in 2010 as one of the national infrastructure issues that required "significant action" [1]. A lot of capacity building effort has been made since then, but it is apparent that the capacities for nuclear security and safeguards are still several steps behind the capacity for nuclear safety.

A program to build capacity for nuclear security and safeguards in Thailand and the Southeast Asian region has been implemented at the Department of Nuclear Engineering under the Faculty of Engineering of Chulalongkorn University in Bangkok, Thailand. The Department has been offering graduate programs (Master's and Ph.D.) in nuclear engineering as well as nuclear technology since 1973, and has always worked closely with both the Thai government and the industry to support development of necessary human resources in the nuclear field.

Prior to 2013, the Department only offered degree programs related to nuclear applications with only emphasis on operational safety. In recent years, however, the Department has been involved with several nuclear security and safeguards projects, such as the US Megaports Initiative [2] and the government project to establish dual-use item list. The experience from the projects and the increase in awareness of potential security and safeguards threats of the government and the international community has led to the conclusion that capacity building for these two areas are needed in Thailand and in this region. The Department thus decided to create a new curriculum with emphasis on nuclear security and safeguards, and offered it for the first time to students in 2013.

2.OBJECTIVES

The program aims to develop necessary human resources in the fields of nuclear security and safeguards who can continue to work, conduct research, or serve as an educator in these fields to ensure the peaceful utilization of nuclear technology in Thailand and the Southeast Asian region.

3.DESCRIPTION OF THE PROGRAM

The nuclear security and safeguards curriculum was offered as a specialization under the Master's Degree in Nuclear Technology Program which normally took two years to complete. In order to accommodate students from other ASEAN countries, English was used as a working language in all the courses and activities. Since this was the first time that the Department offered this program, it was decided that we would wait until the first group of students graduated before accepting another group so that we had time to evaluate and improve the program.

The first group of students started in the second semester of the 2013 academic year and recently graduated after the first semester of the 2015 academic years (total of 4 semesters or 2 years). The group consisted of 20 students from Cambodia (4), Indonesia (1), Lao People's Democratic Republic (2), Malaysia (4), Myanmar (1), Philippines (1), Thailand (6), and Viet Nam (1). All of the students received full financial support (tuition and living expenses) during their study from the EU CBRN Center of Excellence.

The selection of students was based on the nomination from their national focal point for the EU CBRN Center of Excellence. Applicants who already worked in a nuclear or CBRN related institution in their country were given priority since they would have higher chance to contribute in the field after graduation. If available, their educational background and English proficiency were also considered.

Most students had either science or engineering undergraduate background with one exception who had a background in international relation. Six of the students had a background in nuclear-related fields. Their employment status prior to entering the program were as follows: nine of them were already working in the nuclear or CBRN related institution; three of them were an academia; four of them were freshly graduated; two of them worked in a private company; and two of them worked in a governmental office.

The nuclear security part of the curriculum followed the recommendations published in the IAEA Nuclear Security Series No. 12 [3] by the International Nuclear Security Education Network (INSEN) in which the Department is one of its members. The nuclear safeguards part followed the recommendations of various experts from the IAEA and those who worked in the Megaports Initiatives. Table 1 shows some of the courses available

TABLE 1. EXAMPLE OF COURSES AND THEIR TYPE AND CREDIT HOURS IN THE NSS

PROGRAM

Title	Type	Credit Hours
Introduction to Nuclear Science and Technology	Pre-requisite	3
Applied Mathematics in Nuclear Technology	Pre-requisite	3
Nuclear Security	Core	3
Weapon Mass Destruction Nonproliferation	Core	3
Method and Instrumentation for Nuclear Security and Safeguards	Core	3
Method and Instrumentation for Nuclear Security and Safeguards Laboratory	Core	1
Strategic Trade Control	Elective	3
Nuclear Safeguards	Elective	3
Nuclear Fuel Cycle and Environmental Impacts	Elective	3
Physical Protection of Nuclear Materials and Facilities	Elective	3
Advance Detection Technologies for Radioactive and Nuclear Materials	Elective	3
Thesis	Common	12

All of the lecturers in the program received master's or doctoral degree in nuclear engineering and related fields. They also received additional training in nuclear security and safeguards related subjects from various organizations such as IAEA and JAEA.

In order to provide for the students, the tacit knowledge that comes mostly from actual experience, the program made extensive use of seminars, conferences, guest speakers, guest lecturers, and field visits.

A learning management system called MyCourseVille, which has been developed and maintained by Chulalongkorn University, was used to manage document, activities, and discussion in several courses. All courses and the lecturers were evaluated by students at the end of each semester through the online student course evaluation system (CUCAS) which graphically showed the evaluation result to the lecturer as well as the university administrator. CUCAS is part of the Quality Assurance program that the university has implemented. All engineering programs at the university must be approved by both the university and the national education boards, and must be evaluated against the national QA standard on education.

In order to graduate, the students must fulfill all the master's degree requirements which included a passing grade-point-average (B and above), a publication of their work in either a conference or a journal forms, and a thesis defense.

4.MAJOR CHALLENGES AND ACHIEVEMENTS

One of the major challenges in this program was to make sure that all of the students who came from a wide spectrum of academic and cultural backgrounds were able to learn and work together. In term of academic background, pre-tests were given at the beginning of two introductory courses (Introduction to Nuclear Science and Technology, and Advance Mathematics for Nuclear Technology) in order to gauge the knowledge of the students. Students who passed were exempted from the courses although they were encouraged to at least do the sit-in. English proficiency test was also given, and those who still did not meet the minimum requirement were required to take additional English language courses.

Another major challenge was due to the fact that there had not been many implementations of a similar specialized program in nuclear security and safeguards in the past. Many existing training courses in nuclear security and safeguards, which were provided by many institutions around the World, were mostly customized for professionals and on certain specific topics. Although the INSEN network has in recent years made course materials and textbooks in nuclear security available to its members, the program at Chulalongkorn University was still the second of its kind. Many trial-and-errors were still required in order to manage and implement the program effectively.

Another major challenge came from the lack of prior experience in supporting international students. The Department had accepted some international students into our program in the past, but this was the first time that a big and diverse group of international students joined the Department at once. Much preparation was required in order to assist them settling down in Thailand. Lectures also needed to prepare or converted their existing lessons and materials into English language. This required a lot of work, but it also gave a good push on the Department's internationalization policy.

At the end of the two-year program, eighteen students were able to fulfill all the graduation requirements and graduated. The two students who could not graduate were presented with a certificate to show that they had completed all the required classes.

5.LESSONS LEARNED

Since this was a pilot program at the university, many lessons have been learned and will be used to improve the program for the next group of students. Some of the important lessons are as follows.

- More detailed evaluation of applicant's educational background, such as courses taken and the descriptions of the courses, should be implemented during the application process. Educational standard can be different from one country to another. Students could have learned different materials (topic and depth) under the programs or courses with the same name.
- Students from different cultural backgrounds may learn differently. The type of teaching method should be carefully selected based upon both the learning material and the students in each class.

Lecturers must be mindful of each student's reaction to the type of teaching method used, and can also try to encourage students to adapt to the teaching method as much as possible.

— Having the multi-cultural setup in this program helped tremendously with the student's learning. Compared to other students in the normal program, the students in this program, including the Thai students, were more active in classes, and able to graduate faster. It is believed that the students in this program collaborated more because they had many activities together, and most of them were in a similar situation (being away from home and had been nominated by their country). They both motivated and, to a certain degree, competed with each other, resulting in an overall satisfactory performance.

6.ADDITIONAL INFORMATION

Additional information about the program can be found at http://ne.eng.chula.ac.th/NSS/2nd_Page.html.

Graduates of the program were also encouraged to establish an alumni network as they are expected to become the driving force in the area of nuclear security and safeguards in their own country.

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HUMAN RESOURCE AND NUCLEAR AWARENESS DEVELOPMENT – A COMMON SYNERGETIC APPROACH

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Abstract

The nuclear education problem is treated as societal optimization task of nuclear energy management, with the key parameter of optimization—stakeholder awareness level. As the key principles of optimisation are chosen: a self-organization concept, the principle of the requisite variety, where as a primary source of growth of internal variety is information and knowledge. We have shown: public education, social learning and the use of mass media are efficient self-organization mechanisms, thereby forming a knowledge-creating community. Such a created knowledge could facilitate solution of key issues: a) public acceptance of novel nuclear objects, b) promotion of adequate risk perception, and c) fostering of interest to nuclear energy. Comprehensive knowledge management and informational support firstly is needed in: a) for increasing general nuclear awareness and confidence level to nuclear activities, b) personnel education and training, c) reliable staff renascence, d) public education and involvement of all stakeholder categories in decision making, e) risk management. A common approach to nuclear education should include also comprehensive research activities, thereby joining knowledge acquisition with the generation of novel advanced knowledge.

1.INTRODUCTION

Specific characteristics of nuclear energy as well of its management modes include the exclusively strong requirements for operational safety of nuclear facilities and their significant number worldwide. These characteristics force us to develop advanced education approaches and tools, with the aim to maintain and develop reliable professional resources, with the knowledge, skills and access to information that enables them to perform effectively. Reliable professional resources are one of the basic components for operational safety in nuclear facilities.

On the one hand, the permanently growing public concern about possible nuclear risks as well as the public legal rights in decision making on nuclear object siting and operation, and the real and imaginary nuclear risks and the growing complexity of nuclear energy management, we propose a common interdisciplinary approach to nuclear education – having considered education as a social optimization task and by extending the concept human resources to all stakeholders, including public, participating in nuclear decision making. The key methodology of our interdisciplinary approach - the use of principles which could manage with the knowledge and information qualities: 1) the self-organization concept, 2) the principle of the requisite variety.

2.SOCIETAL OPTIMIZATION OF NUCLEAR ENERGY MANAGEMENT – KEY ITEMS OF THE METHODOLOGY

A huge practical experience accumulated in nuclear energy management and the studies on societal issues in this area show that nowadays it is difficult to perform main tasks of nuclear energy management and, especially to develop and implement novel nuclear facilities without involving society. On this basis one can suppose predominance of societal factors in solving the nuclear energy issues, especially those related to the siting of nuclear objects. Thus, stakeholder involvement could be considered as a key element to modern governance of nuclear energy management, having been already recognized in international binding documents [3-5], forums and researches [6-8].

However, in parallel with the implementation and observing legislative instruments national and international efficient involvement of various groups of stakeholders having different interests and, thus, development of socially favourable and technically advanced nuclear projects require the promotion of approaches, based on stakeholder education, information, communication and interactions.

2.1 Stakeholder awareness level – the key parameter of societal optimization

Multidisciplinary complexity and specific features of nuclear energy management lead to aggravated public perception of associated risks and such public perception of nuclear risks markedly differs from the scientific assessment of these risks. The important role of public education, distribution of all relevant information and development of communication options in the areas of the spent nuclear fuel and waste management safety has been underlined, in particular, via setting up a requirement to make information on the safety of nuclear objects available to public [3, 4].

For our approach, let us take into account that: i) the public awareness and knowledge level about nuclear energy management problems is different, and ii) are inherently incomplete with data on nuclear safety. On the basis of these premises, as the key principles in our approach we choose the principles which could manage with the knowledge and information qualities: a self-organization (SO) concept, 2) the principle of the requisite variety.

2.2 Synergetic approach

As nuclear energy management nowadays has acquired a multidisciplinary nature, it can be considered as an object of an interdisciplinary science, synergetic, [9] being a tool for description of complex system evolution. Due to growing social activities also in the nuclear area, there is developing such global tendency as a shift from relations based on separation, control and manipulation towards participation, appreciation and self-organization (SO) [10]. Taking into account that basic mechanisms of SO [11] can be attributed also to information phenomena [8], as well as the decisive role of information and knowledge in the management of stakeholder involvement and participation, we apply the synergetic concept, namely – SO – to information and knowledge aspects [12], with the aim to consider the key societal nuclear knowledge management issues.

Bearing in mind the *"principle of SO"* [13] "a dynamical system, independently of its type or composition, always tends to evolve towards a state of equilibrium", we will use also the adaptation concept: "if we consider a particular part of the original, self-organized system as the new "system", and the remainder as its "environment", then the part will be necessarily adapted to the environment".

Taking such a self-organized nature of adaptation as a basic criterion of social optimization, we choose the principle of requisite variety, stating: for successful development of a given system (e.g. human being(s)) in external environment its inherent variety should exceed the variety of its environment. " Such an approach can enable us to consider the problem of social optimization as a problem of social adaptation; we should specify a real content of the meanings of: i) external environment, ii) internal complexity, iii) a given system.

2.3 Self-organization of stakeholder community

Taking into account the marked changes in the societal environment for decision making in siting of nuclear facilities [14], let us define - the concept "external environment" as an non-equilibrium creation, representing a tiad (an analogous triad – the concept of human's three worlds [15] including: (1) the natural environment, (2) the social world, (3) artificial environment – a set of objects and conditions emerged as the result of human activities). In such an extended definition the concept "external environment" includes a set of physical, ecological socio-economic and other factors. Thus, a necessary condition of successful adaptation to a changing *external* environment will be the predominance of humans' internal complexity over the environmental complexity.

The growing complexity of the external environment markedly displayed in the decision-making on siting of facilities, demands to develop approaches to manage the societal requirements to the siting of new nuclear facilities. Emphasizing here two key factors - information and knowledge - via which we relate to our environment by SO processes [16] and taking into account that the knowledge about the world contains possible interactions between subjects, we can propose to reveal relations between different stakeholder groups and their concerns and to find out possible forms of SO of such stakeholder groups into a stakeholder community having common strategic aims. Such a joint stakeholder community including all involved parts participating in decision making is considered as the given system.

3.SOCIAL LEARNING AND OPTIMIZATION OF RISK PERCEPTION

3.1 Social learning via a self-organizing web

Thus, our task of optimization of stakeholder involvement can be defined as the need to increase the internal complexity of the joint stakeholder community. Viewing knowledge as a complexity factor, all available forms of stakeholder involvement and their education can be regarded as societal optimization being achieved via social learning, thereby activating interaction between stakeholders. A key mode of this interaction can be seen as the recognition by operators and regulators of the need to increase their knowledge level and to enhance mutual understanding. As the knowledge itself is able to self-organize [17], the whole process of mutual learning and educating of stakeholders can emerge in a knowledge creating stakeholder community able to use novel [18] communication and knowledge management forms, e.g., the Internet - a global socio-technical system, where humans renew the global knowledge storage mechanism by producing new informational content [19]. The Internet can be viewed as an important case of SO, thereby fostering [11] information retrieval. Development with the aim to provide socially informed decision making such web-based approach being an advanced way for all stakeholders to access permanently updated data, has been already elaborated and applied for the geological repository development [18].

3.2 Optimization of risk perception

The role of social learning will appear also in risk communication. The importance of uncertainties management displays in: 1) confidence building for safety assessments, 2) in the decisive role of the unknown factors [20] in determining risk perception by the public, 3) in the social learning where the basic component of social learning can replenish deficiency in the necessary information [21]. Thus, as the perceived risk of a nuclear facility could be regarded as a function of the knowledge of facility issues [20], the role of social learning in solving risk perception issues consists in diminishing the unknown factor of perceived risk when the affected communities become familiar with nuclear issues.

Another side of social learning: the ability to understand how the community perceives all possible, as well as imaginary risks. To reach such understanding one could propose a program aimed to identify public and other stakeholder concerns. This could be achieved by increasing – via versatile communication – the levels of such trust components [22] as openness, caring and competence enabling to include these items in the decision-making mechanism and raising the decision-making capacity of stakeholder community and public acceptance.

4.DEVELOPMENT OF HUMAN RESOURCES

In line of the elaborated concept of information and knowledge role in optimization of risk management and finally – fostering safe management of nuclear energy, exclusively important task consists in preparing and preserving for nuclear facilities highly professional personnel having advanced reliable knowledge and skills allowing the personnel to operate effectively.

This aim is to be realized mainly via [23, 24]:

(a) Education at all levels, especially using modern international education networks (as European Nuclear Education Network, World Nuclear University, as well as the European Nuclear Safety and Security School.
(b) Training – for all categories and ages of nuclear workers, in the frame of International Atomic Energy Agency (IAEA) training courses, in the European Fission Training Schemes projects: for nuclear engineering, for radiation protection, for geological disposal of radioactive waste and for the nuclear safety culture.
(c) Research and knowledge management, using contemporary international databases, electronic communication portals and capabilities of specific projects, e.g., Euratom Framework Programmes, the Joint Research Center.

4.1 Basic challenges in nuclear education

In order to develop an efficient education system of high-level professionals, one should attract and motivate even young-age pupils to various measures on nuclear theme. Inclusion of basic nuclear knowledge in secondary level education could give such benefits as [25]:

(a) Attraction of young people to nuclear education when they already have some fundamental nuclear knowledge.
(b) A large percentage of students that decide their future career as they complete their secondary education. Exposure to nuclear technology could help them choose a nuclear related career.

Acquisition of sufficient level of nuclear awareness already in the school will promote more reasonable perception of radiation and nuclear risks and improve attitude of population towards nuclear activities. In turn, the university level education should stress the research, as well as engineering aspects, including collaboration with universities, providing [25] scholarships for students studying nuclear subjects.

4.2 Development of research activities

Among the main research directions in the nuclear energetics safety, firstly we should focus on the areas highlighted by the accidents and get safe solutions for critical situations. This includes, firstly:

(a) Extreme natural events - to provide safety against them.
(b) Management of severe accidents.
(c) Loss of heat sink.
(d) Spent fuel accidents.
(e) Post-accident monitoring systems in extreme environments.

Secondly, to develop novel safe and efficient technologies, in particular, next generation reactors – in the frame of various international projects and forums. Thirdly – to clarify possible impact of nuclear energetic practices on people's health and take relevant measures to minimize such impact. The key research issues shall be the following:

(a) Low-dose ionising radiation risks.
(b) Molecular level and genetic effects.
(c) Epidemiological studies.
(d) Development of scientific monitoring system and international collaboration – research projects.

Lastly, referring to the EC policy programme "Europe 2020 strategy for smart, sustainable and inclusive growth", as a primary general tasks, we shall concentrate on:

(1) Creation and transfer not only of knowledge, but also of skills and competences [26].
(2) On development of "governance of Euratom R&T based in participation, accountability, effectiveness and coherence" - using here just above developed synergetic approach on stakeholder involvement and education.

5.CONCLUSIONS

On the basis of contemporary non-linear science concepts, the decisive role of information and knowledge in the societal optimization of nuclear energy management area has been outlined. There are indicated possible ways to enable social learning, the recognition of stakeholder concerns, as well as efficient risk communications. The following as a possible interdisciplinary approach towards societal optimization and confidence building in nuclear activities are forwarded and developed:

(a) Self-organized social learning, knowledge and risk management could promote adequate perception of risk and prevent, by diminishing uncertainties, social amplification of an imagined risk, as well as to increase the trust level and facilitate more adequate equity perception.
(b) Knowledge management, social learning and self-organized communication of all stakeholders is capable to provide a reliable basis for a new integral type of thinking being

so critical for development of safe and environmentally friendly future generation nuclear facilities.

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STATUS OF NUCLEAR SCIENCE EDUCATION AND THE NEEDS TO COMPETENCY BASED EDUCATION AT THE BEGINNING OF NUCLEAR POWER PROGRAMME IN TURKEY

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Abstract

In Turkey, in recent years, the public opinion is mostly positive to the establishment of nuclear power plants (NPP) because the electricity demand is ever-increasing with a growing population and fast developing economy. For peaceful nuclear energy use, Turkey ratified the Non-proliferation treaty (NPT) in 1979 and has had a safeguards agreement, and it's Additional Protocol since 2001. However, Turkey has not accumulated the essential nuclear knowledge and experience until now. The present nuclear higher education and training programs are not focused on nuclear power technology. Since NPP was not operated in past, the interests of Universities to the nuclear sciences and technology education have been quite limited. In general, this can be attributed to the decreased student's interest, decreased course numbers, aging faculty members and insufficient or aging facilities. From practical point of view, the key question is that how the competency based education programs should be organized to produce the well-educated workforce. It is worth noting the present nuclear education should also have the curriculum covering nuclear safety culture and nuclear security culture to instil the Younger generations. For a safe operation of any facility, nuclear safety and security are key requirements especially for newcomers embarked on utilizing nuclear technology. In this paper, the present status of nuclear science education and training programs in Turkey is discussed briefly and the fundamental arguments are dealt to focused on competency based nuclear education.

1.INTRODUCTION

For peaceful nuclear energy use, Turkey has started Nuclear Power Program since 2012, but it is a fact that it needs to develop its nuclear capacity building (NCB). The level of NCB processes indicates professionalism, scientific skills and expertise, the management of knowledge gained from a variety of sources, which might lead to solve the problems to be encountered in NPP installations. According to NCB strategy, the nuclear education and training infrastructures and processes should also be well established because nuclear education and training programs provide a structured knowledge base for individuals involved in the utilization or control of nuclear technologies. The present paper will give brief information about status of nuclear science education structure in Turkey and but it also highlights on some fundamental arguments concerning with competency based nuclear education in future.

Turkey imports much of its energy, including 98% of its natural gas and 92% of its oil, and this amounts to more than US$70 billion per annual (EUAS, 2016). Hence nuclear energy is a viable energy option for electric production in Turkey. In the coming decades, it is evident that use of nuclear energy will play a vital role for the electricity demand of the Country.

Currently, primary energy demand is met by natural gas (35%), coal (28.5%), oil (27%), hydro (7%), and other renewable (2.5%). This requires new investments estimated to around 100-150 billion $US and the present installed plant capacity of 74 GWe have to increase 96 GWe by 2023. Electricity production in Turkey by fuel is dependent mainly on the imported natural gas (EUAS, 2016). In order to meet Turkey's growing energy needs, the present energy supply's plans are revised by the energy policy-makers. As a result, NPP projects are now underway in

Turkey and the first NPP with four reactor units (Russian VVER-1200 PWR type design, 4800MWe capacity) has already started to build in Akkuyu reactor site at Mediterranean coast.

In addition, Turkey's second NPP will construct at Sinop on its Black Sea coast, which was proposed to feature four Atmea 1 reactors supplied by Areva and MHI. Construction of the plant is expected to start in 2017, once Sinop site is licensed and an environmental impact assessment has been approved An intergovernmental agreement was ratified by Turkish parliament in March 2015 (WWN, 2016).

Turkey’s economy needs ever-increasing amounts of energy to sustain economic growth, raise living standards, and reduce poverty. But today’s trends in energy supply are not seen to be sustainable. Hence, the energy issue has always the first priority for the Country’s development.

2.NUCLEAR EDUCATION AND TRAINING PROGRAMS IN TURKEY

There are two undergraduate programs related to nuclear engineering education conducted in Hacettepe University and Sinop University. In each service is given to the limited number of BSc students of about 20-30 in a year. It is worth noting that most of the higher-graded nuclear engineering scholars generally prefer to go abroad for the post-graduate education. After completing their post-graduate education, they usually work in abroad and hardly ever return to Turkey.

Currently, graduate programs in nuclear science education are actively conducted at four Nuclear Institutes, established under Ankara University, Ege University, Hacettepe University and Istanbul Technical University. These programs are servicing to approximately 80-100 students per year in MSc and PhD. Istanbul Technical University has also a 250 kW TRIGA Mark II research reactor for education and research purposes.

3.OTHER PUBLIC INSTITUTIONS RELATED TO NUCLEAR TRAINING, RESEARCH AND DEVELOPMENT ACTIVITIES

As a regulatory body, Turkish Atomic Energy Authority (TAEK) establishes all legislative regulations concerned with radiation protection and nuclear safety, and gives also licenses to the facilities in medicine and industry. Additionally, nuclear material safety and security, illicit trafficking of nuclear materials, environmental issues are also dealt with and conducted at the same time. TAEK has a secondary role that promotes to conduct some nuclear research and training activities. TAEK have two nuclear research and training Centres. The one is called as ÇNAEM in Istanbul and the other is SANAEM in Ankara. Both are the governmental organisations managed by TAEK, and on its behalf, these Centres conduct some radiation protection training courses, accomplish nuclear research activities such as radiation applications in medicine and industry. TAEK can sometimes ask for technical and scientific support from IAEA to fill the gaps in achieving the highest possible levels of safety and security for nuclear reactors, waste management, radiation protection and its applications.

4.DISCUSSION

IAEA suggests a nuclear capacity building (NCB) strategy to the Member States. It is based on four elements and therefore, NCB concept can be applicable at three levels in any State that are: (a) Governmental, (b) Organizational and (c) Individual (IAEA, 2016). These components are very closely related with each other. For instance, graduate education programs have a great importance to gain the competence within nuclear field consistent with International and EU standards to produce the educated workforce that is able to meet the future need of nuclear power programme within framework of economic and social needs. In Turkey, it is a fact that there is a serious lack of competency and well-educated workforce capacity in the nuclear field. Hence it is an important point that how the interest of the young scientists and engineers can be attracted to graduate and post-graduate programs concerning nuclear science and technology, given by National Nuclear Institutes.

The second issue is that how these education programs should be well-organized for human resource development and further improved nuclear infrastructure by replenishing modern equipment. For example, even if the nuclear technology transfer agreements are to be made between Turkey and NPPs vendors, it seems that there are still open question marks on knowing and absorbing fully nuclear safety, security and technology aspects because of insufficient number of the well-educated workforce and infrastructure. Now, Turkey has to find smart solutions to obtain valuable knowledge from international nuclear community to eliminate the shortage of qualified professionals. At first sight, first two NPPs should be operated or supervised to ensure reactor safety by foreign nuclear experts. However, in near future, there needs to find alternative methods to start competency bas education by taking the supports of NPP vendors and other related Nuclear Countries.

The present National Nuclear Institutes and Faculties might be re-organized to focus on competency based nuclear education by developing bilateral and/or multilateral collaborations and joint initiatives. In NCB, Turkey has to estimate the human resources needs for future NPP programmes, assess their existing capability, identify competences gaps, plan and implement the required activities to meet the needs. In this context, it is anticipated that the Department (NEPUD) of Ministry of Energy and Natural Sources identify the gaps since 2011. This new governmental organization might also play an important role in preserving nuclear knowledge, making knowledge networks and managing for NPP project implementations. It is clear that high quality nuclear education and training is essential to maintain the high level of nuclear safety and nuclear security matters in a nuclear facility. But, this is not only the task of academic institutions in the Country but also of regulatory bodies and other research Centres.

This can be achieved by collaboration with leading universities and educational institutions in other Countries. For instance, there is a plan to establish Turkish-Japan Nuclear Technology University in Sinop. Turkey can also make a collaboration with EU Joint Research Centre (JRC) because the JRC can actively contributes to consolidating and improving educational tracks, by providing its knowledge and expertise in fields of nuclear security and safety, nuclear materials, nuclear data exchange, etc. Thus, the nuclear education activities can be organized in four pillars:

(1) The higher education pillar concerns academic education which comprises academic courses and special educational activities for students (workshops, summer schools and inter-semester courses).
(2) The vocational training pillar focuses on the training of young professionals in the nuclear sector. They have no specific expertise in the nuclear field. This pillar can be developed with opening new nuclear Vocational Higher Schools and Vocational Intermediate Schools with the directives of Higher Education Council and Ministry of Education, together with the partners from the European and with other educational institutions in Europe.
(3) The user access programme organized by the JRC can also serve to Turkish researchers to make research opportunities. Applicants can perform dedicated experiments on nuclear materials, or

materials relevant to nuclear technology, that cannot be performed in their laboratories of the applicants in Turkey.

(4) At least two nuclear information centres can be established in Mersin and Sinop cities near to NPPs sites. This fourth pillar can provide independent information about nuclear science and technology to the general public.

In coming decades, nuclear energy will become a vital option for supplying of Turkey's electricity demand. This pressure comes from the decreasing stocks of domestic fossil fuels, with increasing reliance upon politically volatile nations for the provision of oil gas and from the increasing prices of domestic and imported fuels. Finally, the pressures are thus resulted in emerging new concern in taking of advantage of future nuclear industries. Therefore, the need for nuclear competence is greater now than earlier anticipated.

5.CONCLUSIONS

Turkey must set up a comprehensive program that seeks to develop human resources and harmonise nuclear skills and competencies with national recognition, and contribute to nuclear education, training and knowledge management (KM). The most urgent need is to give a priority to the competency based education programs in which utilization of nuclear technology should inspired confidence to the Younger generations. The curriculums of nuclear higher education programs should also include the training courses to enhance both nuclear safety culture and nuclear security culture. This must be a key requirement for newcomers to nuclear technology in order to protect human, environment and to secure radioactive materials associated with facilities against malicious acts from insiders or outsiders.

Modern methods and techniques/tools can be used for the preservation and dissemination of the vital importance nuclear knowledge and information. This approach can also contribute to enhance the nuclear safety and security culture and competitiveness of energy supply from NPP programs by following new trends and developments in nuclear energy sector. Knowing that education and training provides the basis for human resource development, it is underlined other pillars that are knowledge management and knowledge networking mechanisms. These can be established to promote the pooling, analysis and sharing of nuclear safety, nuclear security and other technical knowledge and experiences at national levels. It will be stressed that Turkey can strive for collaborations within international community, and can be considered the new challenges to tackle with the present difficulties in higher nuclear education programs.

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DISSEMINATION OF NATIONAL NUCLEAR-HRD NETWORK FOR EFFICIENT AND EFFECTIVE N-HRD FOR NPP-EMBARKING COUNTRIES

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Abstract

Close mutual cooperation among nuclear-related organizations, such as government, industry and academia is extremely useful to promote Nuclear Human Resources Development (HRD). National HRD network has already been established in Japan since Nov. 2010[1]. The network has promoted the following five discussion on (1) Elementary to High School Education (2) Nuclear Education at Universities and Colleges, (3) HRD for Working Engineers, (4) HRD to Internationalize National Human Resources, and (5) Supportive HRD Activities to newly NPP Introducing Countries successfully. Through the establishment of the network, the communication has been strongly improved so that the Japan-IAEA joint Nuclear Energy Management School can be held successfully every year. Based on the good experience with the network, Japan would like to recommend the introduction of national Nuclear HRD (N-HRD)-Network to the NPP-embarking Countries. We are interested in cooperation with IAEA for establishment of National N-HRD Network for efficient and effective N-HRD.

1.INTRODUCTION

Global momentum toward expansion of nuclear energy has become more evident due to several factors, such as issues related to stable supply of energy and environment concerns symbolized by global warming. Under this circumstance, Nuclear Human Resources Development (N-HRD) is one of the most crucial tasks for any country utilizing or planning to introduce nuclear as energy. In order to solve national-level various issues related to N-HRD (education, training, knowledge management, public relation, etc.), the close cooperation among all of relevant organizations in the government, the academia, and the industry is inevitable.

Some countries have started to organize national network bridging organizations concerned in the government, the academia, and the industry, but still many of the network activities are inactive due to several reasons. First, it is not clear which ministry or organization is expected to lead the network, and they haven't set up a solid secretariat. The networks lack the initiative by leaders and staff officers to strategically implement projects. Next, they haven't set up specific common goals for member organizations to achieve. As results, member organizations don't get interested in the networks. The network lacks the unifying and driving force of missions. Lastly, once they decide some projects for N- HRD as the network's goals, they should allocate appropriate people from member organizations to run the projects, and also get budget if necessary. The network lacks human and financial resources. Some of developing countries lack leadership and resources more or less. However, their activities will be active if they can constantly get advice and encouragement from other successful networks about what they are missing and what they should do.

National N-HRD network has already been established in Japan to promote the cooperation in the HRD since Nov. 2010[1]. Japan has promoted the following five discussions on for (1) Elementary to High School Education (2) Nuclear Education at Universities and Colleges, (3) HRD for Working Engineers,

(4) N-HRD to Internationalize National Human Resources, and (5) Supportive HRD Activities to newly NPP Introducing Countries successfully. Based on the good experience, we would like to recommend the introduction of national N-HRD network to the NPP-embarking Countries.

2.OBJECTIVE OF NETWORK

The N-HRD includes wide range of activities. For example, for nuclear-energy new comers, fostering officials of a regulatory body or promoting body, and engineers and workers working for NPPs are an important issue. For countries where construction of new NPPs is suspended, inheriting knowledge to build a NPP is an issue. For countries where the number of NPP construction is growing, fostering human resources capable of risk communication is important. For countries introducing advanced nuclear technology, designing and building a research reactor themselves can be an issue. These are just some examples. Each country has certain issues for the N-HRD depending on their situation. The biggest and broad issue of them is fostering the engineers and workers working for a NPP in the countries embarking newly in NPP business. Any large task requires negotiation and consultation among related organizations and people. Organizations and people gather for an individual issue to solve problem. Networks will be national and start with goals of fostering basic human resources. Furthermore, some years after starting this project, each network has potential to set higher goals such as functioning as the one-stop window to negotiate with foreign organizations to support their N-HRD projects. Such networks will lead to solving higher-level of goals for N-HRD such as fostering young generation for innovative R&D.

3.MEMBER OF ORGANIZATION

Member of the network are wide-ranging and almost all organizations in the nuclear sector in country will be involved; Government (central ministries, local governments), academia (universities, R&D organizations), and industry (electricity power company, vendors, trade associations). All nuclear-related organizations should be members of a network. All member organizations of a network are the contributors, end users, and beneficiaries of the network at the same time. They are also sponsors for the network. Even if they don't contribute money to the network's budget, all the member organizations can contribute to the network by providing their facilities for education or training, or providing staff as trainers for projects or to the secretariat of the network. All of the member organizations are required to contribute to the network within their capacity. Then, they will learn they can achieve a goal which can't be achieved by individual organization if they work in cooperation. The members in Japan N-HRD network consist of electric power companies, nuclear manufacturers, universities, research institutes, Ministries and nuclear related organizations. The total number of them is 71 (Feb.1st 2016).

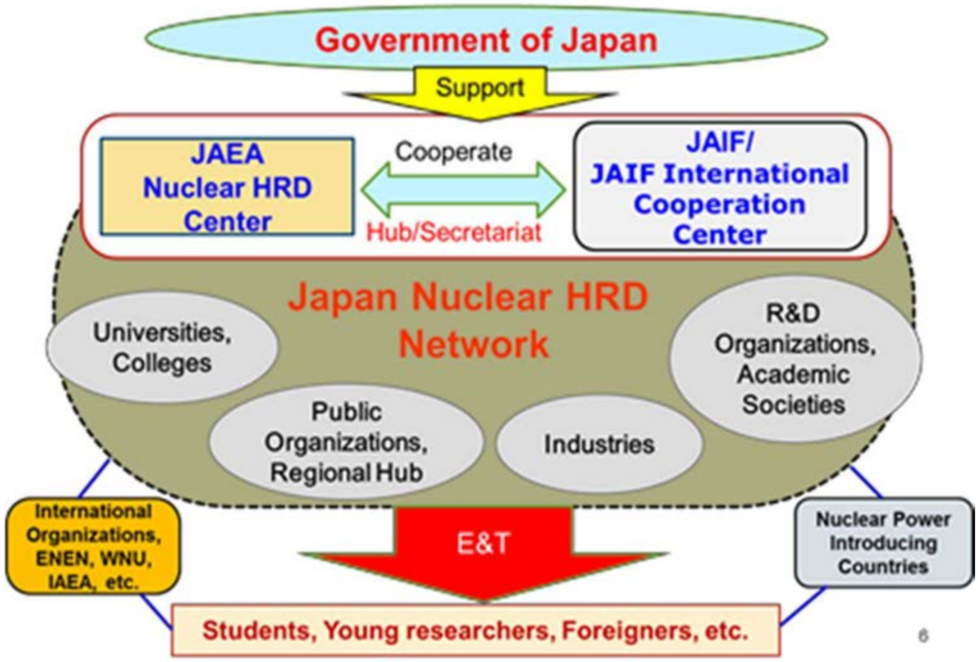

FIG.1 Structure of Japan N-HRD

4.STRUCTURE

4.1 Secretariat

The most important for the establishment of useful and active network is to allocate cleaver and active secretariat that have good relations with all members because the secretariat have to be strong promoter of N-HRD as hub of the network. In Japan N-HRD network, three organisations are cooperating as co- secretariat, namely, Japan Atomic Energy Agency (JAEA), Japan Atomic Industrial Forum (JAIF) and JAIF-International Cooperation Center (JICC). Also, it is the most important to have solid budget sources that can powerfully support the activities of the network and to coordinate academia (Universities and Colleges), public organisations, industries (Electricity power company, and NPP- makers) and R&D organisations. Main budget is provided by ministry of education culture sports science and technology (MEXT) and ministry of economy trade and industry (METI). Figure 1 shows structure of the Japan N-HRD network as a sample.

4.2 Steering Committee, Planning Working Group and Sub-Working Group

Activities of the network are discussed and evaluated in steering committee, planning working group and sub-working groups according level of activities and problems.

Steering Committee

It is the highest decision-making body of the network. It decides on the basic policy for activities of the network. JAEA, JAIF and JICC work together as co-secretariat.

Planning Working Group

This group plans, and evaluates the entire activities based on the decisions made of the Steering Committee and also reports back and the implementation results to the Steering Committee. JAEA, JAIF and JICC work together as co- secretariat. This co-secretariat manages the operations of the sub-working groups.

Sub-Working Groups

There are five sub-working groups that carry out essential implementation to solve problems related to N-HRD. The members of the group consist of electric power utilities, nuclear manufacturers, universities, research institutes, ministries and nuclear related organizations. The following five sub- working groups mainly cover the various activities carried out in line with the objectives of this network.

Discussion on Supportive Activities for Elementary to High School Education Discussion on Nuclear Education at Universities and Colleges.

— Discussion on HRD for Working Engineers
— Discussion on HRD to Internationalize National Human Resources
— Discussion on Supportive HRD Activities to newly NPP Introducing Countries

5.ACTIVITIES OF JAPAN N-HRD NETWORK

Steering Committee meeting are held about two times in a year. It reviews the activity of the network in the last year and makes guide line for the activity in the next year beside of decision of on the basic policy of the network. The members consist of representatives of governments (Cabinet office, MEXT, METI, and Ministry of foreign Affairs (MOFA), of Universities and colleges, and of industries and electricity companies as shown in Fig. 3. All activities of the network are given in the home page.

Some examples of the activities are given in below.

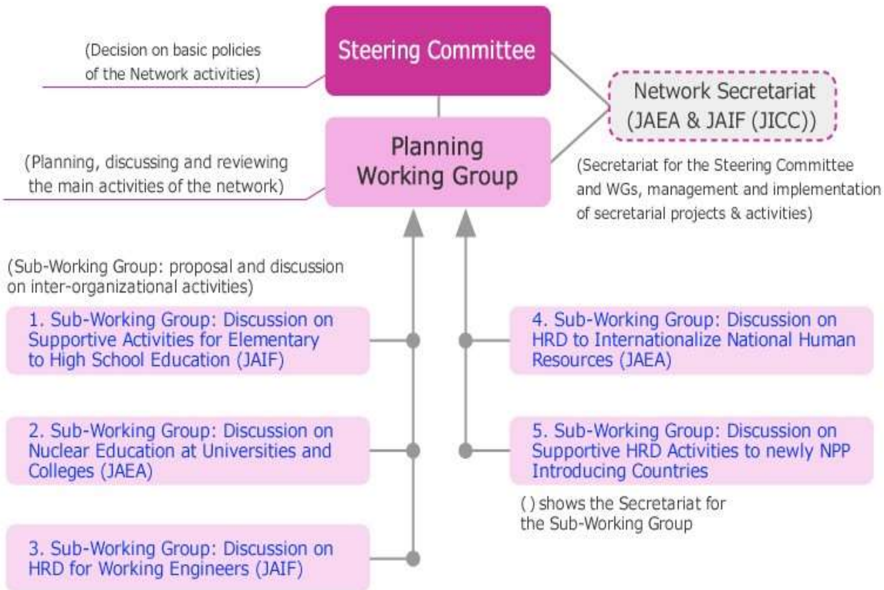

FIG. 2 Structure of Japan N-HRD network

FIG. 3 Steering committee meeting

5.1 Advanced-Nuclear Technology Tour for Students

The network organizes tours for students to provide experience with Advanced-Nuclear Technology directly. Students in non-nuclear field will be major engineers in nuclear business such as students for mechanical engineering, electrical engineering etc. These students have usually no occasion to see and to touch advanced- nuclear technology directly and no chance to awake the interest in the nuclear technology. The network invites students from all over Japan for sit visit tours of world- leading nuclear companies, electricity power companies, and nuclear research institutes (see Fig.4).

FIG. 4 Advance-nuclear technology visit tour

5.2 Activities to Support School Teachers on Radiation Education

It is important to support and motivate school teachers. Members of network provide attractive materials for teachers as well as students. The activities are well evaluated by IAEA and some of them are requested to provide to IAEA's activities "compendium for introducing nuclear science and technology to secondary schools"

5.3 Japan-IAEA Joint Nuclear Energy Management (NEM) School

The network holds the NEM School in cooperation with IAEA every year. The purpose of the school is to provide a unique international educational experience aimed at building future leadership to manage nuclear energy programs, to nourish a wide range of knowledge on issues related to the peaceful use of nuclear technology, and to broaden individual networking with people interested in nuclear energy from all over the world. The curriculum consists not only of lectures but also of visit of advanced nuclear technology. Lecture in the school is shown in Fig.5. The NEM School of 2016 is planned in coming July [3].

FIG.5 Japan-IAEA NEM School

6.DISSEMINATION OF NATIONAL N-HRD NETWORK

The meeting of the Forum for Nuclear Cooperation in Asia (FNCA) noted that the national N-HRD network has been officially set up in the Republic of Korea, Japan, Malaysia (see Fig. 6) and Thailand. Some other FNCA Member Countries are the process of preparing the official set-up of this network [4].

N-HRD network is good tool to solve the problems effectively and efficiently. The most important is to clarify the N-HRD problems to be solved. Following points are necessary for establishment of networks.

- To determine which ministries or organizations are responsible for the network and support financial.
- To appoint the representative (chairman) of the network
- To appoint the head of the secretariat of the network
    - Tasks to be done by the secretariat to establish networks are as follows.
- To list up all potential members of the network
- To list up potential responsible people for each project
- To draft how to finance each project
- To draft how many numbers of staff the secretariat needs and how to recruit them

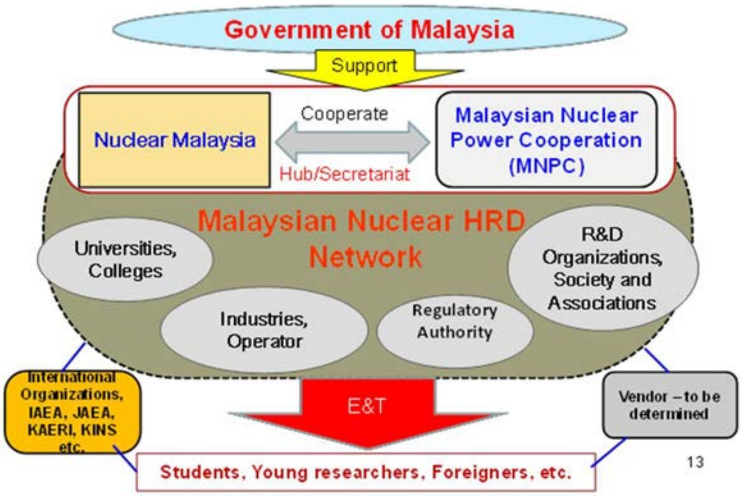

Fig.6 Malaysian Nuclear HRD Network

7.SUMMARY

Japan N-HRD Network conducts many national and international N-HRD activities. Through the establishment of the network, the communication has been strongly improved so that many N-HRD activities such as Japan-IAEA joint NEN School can be held successfully. Japan N-HRD network is interested in supporting establishment of N-HRD network of countries that have plans to introduce NPPs seriously.

ACKNOWLEDGEMENT

Due to good experience with Japan N-HRD network we intended to inform the idea of National N-HRD network to NPP-embarking countries. Ms. Fumio Adachi and Mr. John de Grosbois advised and encouraged us for dissemination of the idea. We would like to express our sincere thanks to them for valuable advice and continuous encouragement.

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INTERNATIONAL COOPERATION IN NUCLEAR EDUCATION AND TRAINING: ON THE WAY TO NUCLEAR TRAINING HARMONIZATION

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Abstract

Global use of nuclear power is likely to continue to grow in the coming decades. Some countries have chosen to invite multiple vendors for NPP technology supply. The worldwide expansion of nuclear power use and the multi-vendor paradigm inevitably lead to the need of harmonized approaches towards safety and the initial step here is harmonization of education and training (E&T) efforts between recipient and vendor countries and between vendors as well. Establishing international and regional E&T networks is the vital mechanism of the harmonization. The present paper gives an example of collaboration between the Russian Federation and the EU through achievements of ENEN-RU projects aimed at harmonization of E&T efforts in nuclear field. One of the goals of this activity is to introduce double-degree programmes in nuclear engineering in Russian and EU universities. To support this initiative ROSATOM-CICE&T is currently developing multimedia-based fundamental educational courses in Russian and English languages. The courses will be also used as the backbone for new nuclear engineering programmes in the universities of newcomer states. To provide a harmonized development of operating personnel career trajectories in these countries an applied bachelor programme for operating personnel has been developed.

1.INTRODUCTION

Global use of nuclear power is likely to continue to grow in the coming decades 0. There are 30 countries operating NPPs in the world and many other countries, which are interested in introducing nuclear power in their energy mix [2, 3]. Development of a nuclear power programme is a long term commitment which, in order to be sustainable, requires long term collaboration with the supplier country 0. Additionally, some newcomer countries and countries expanding their nuclear power programmes (i.e. Viet Nam, Turkey and Finland) have chosen to follow the practice of China 0 and India in inviting multiple vendors for NPP technology supply. This brings to them the necessity to learn the standards and approaches to safety regulations of various vendor countries. In view of globalization of nuclear power and the multi-vendor paradigm all this inevitably leads to the need of harmonized approaches towards safety and the initial step here is harmonization of Education and Training (E&T) efforts.

The harmonization in E&T could be seen in two ways, both resulting in a benefit for a recipient country: first – between vendor states (and/or E&T providers) for the multi-vendor case and second – between a vendor and a recipient country. The latter is seen to be important for efficient addressing the situation in the customer state and better integration of its national resources and capabilities.

It is important to mention that the harmonization of education and training efforts between E&T providers (for the multi-vendor case, for example) should not be considered as 'unification' – not necessarily to teach the same, but to teach in the same way.

2.ENEN-RU PROJECTS AND THE EXPERIENCE OF COOPERATION WITH EDUCATION AND TRAINING PROVIDERS

Establishing international and regional E&T networks is the vital mechanism for the implementation and dissemination of all related recommendations developed by the International Atomic Energy Agency (IAEA) and facilitation of cooperation and networking in the field of human resource development (HRD) and research. The collaboration inside and between such E&T networks could work as a driver for the harmonization among providers of E&T services leading to a broader basis of human resources and more efficient development of nuclear energy related projects in customer states in a safe and secure manner.

Since 2011, the Rosatom Central Institute for Continuing Education and Training (ROSATOM-CICE&T) has been actively involved in ENEN-RU cooperation projects aimed at harmonization of E&T efforts in nuclear field between the European Nuclear Education Network Association (ENEN) and main Russian E&T providers. The main outcome of the first project was initiation of a mechanism for cooperation in E&T and establishment of the foundation to define a detailed implementation plan for cooperation in future and to implement the plan in a sustainable manner.

The first project (ENEN-RU I) started in 2011 for the duration of three years aimed at the analysis of the situation on both sides, definition of opportunities and barriers for cooperation and continued further by carrying out pilot exercises (courses) and definition of a road map for the expansion of the cooperation. The project was focused at the mutual recognition of the E&T programmes on both sides (EU and the Russian Federation) and further extension of the exchanges to offer to nuclear research and industry a broader basis of human resources and foster cooperation in nuclear power development 0. The objectives of the project were:

- to define a common basis to allow effective cooperation between the European and Russian networks for nuclear E&T;
- to define the needs of cooperation in the long term;
- to establish a framework for mobility of teachers and students;
- to conduct some pilot items for E&T;
- to launch the knowledge management framework; and
- to list up and promote further use of E&T facilities, laboratories and equipment.

Based on the achievements of the ENEN-RU I the ENEN-RU II project was started in 2014 for next three years with the aim of further definition of a common basis for effective cooperation between the European and Russian networks for nuclear education and training 0. The updated objectives of the project are following:

- to define a detailed implementation plan based on the needs of cooperation in the long-term agreed during the ENEN-RU project;
- to solve the difficulties for cooperation found during the ENEN-RU project;
- to implement the plan in a sustainable manner;
- to operate the knowledge management framework;
- to list up and promote further use of E&T facilities, laboratories and equipment.

Some of the results relevant for the topic of this publication are outlined below.

In the field of nuclear education an introduction of the Bologna Process in nuclear education system of Russian Federation has been initiated to allow easier exchange of students and recognition of the educational programmes. Currently the work is focused on the development of Russia-ENEN analog of the EMSNE (European Master of Science in Nuclear Engineering) certificate to be mutually recognizable by European and Russian nuclear universities 0.

The next step towards harmonization is seen to be development and implementation of double-degree educational programmes in nuclear engineering. More details on supporting activities for this initiative can be found in the next section in the description of double-degree programmes for universities in newcomer countries.

Considering nuclear training, three main lines of activities were identified for the short-term perspective:

- cooperation between training providers (ROSATOM-CICE&T and Tecnatom, for example) to support training programmes in newcomer states;
- development and implementation of joint training courses with the focus on safety culture.

ROSATOM-CICE&T experience under the ENEN-RU projects shows that cooperation with E&T networks as well as between such networks could be a good way towards harmonization of E&T efforts among the providers and/or vendors, which is especially beneficial in case of multi-vendor approach for efficient development of nuclear energy related projects in a safe and secure manner.

3.HARMONIZATION OF EDUCATION AND TRAINING EFFORTS WITH A RECIPIENT COUNTRY

For a vendor it is important to harmonize educational and training approaches with a customer country to take into account the present state of its education system and training capabilities and to use efficiently the local resources. The activities being done by ROSATOM-CICE&T towards development of double-degree programmes are aimed not only at EU as mentioned above, but mainly at newcomer states and universities which are planning to open nuclear engineering programmes.

First, an applied Bachelor programme to prepare the NPP operating personnel developed in ROSATOM-CICE&T is seen to be as one of the base educational programmes for implementation in both Russian and foreign universities. The developed programme reduces the operator training period by 1,5 years comparing to the ‘classical’ specialist-engineer degree used in the Russian Federation, and focuses more on engineering subjects, close cooperation with NPPs for practical training, development of individual educational trajectories and the use of full-scope simulators. Comparison of the two programmes is shown in Figures 1 and 2.

Applied Bachelor course – 4 years				Reactor shop – 1,5 years	
1st year	2nd year	3rd year	4th year	1,5 years	
Mathematics (17)	Mathematics (10)	Fluid mechanics(4)	Nuclear, radiation and environmental safety at NPP (5)	Safety* and reactor field operator programme	Reactor field operator individual work
Physics (13)	Physics (12) Nuclear and neutron physics	Electrical equipment at NPP (3)	Physics and kinetics of WWER-1200 reactors (9)		
Health and safety	General chemistry Chemistry of NPP water and media (8)	Steam generators and turbo-machines at NPP (6)	Automated control systems of NPP with WWER-1200 (5)		
Educational introductory practical training	Safety culture fundamentals	Cross-cultural communication in nuclear industry	International nuclear law		
	On-the-job training	On-the-job training	Full-scope simulator of WWER-1200		
			Pre-graduation and thesis training, graduation thesis		

Remarks:

1. Workload is shown in credit points (1 credit point = 36 AH)
2. Duration of the educational introductory practical training and on-the-job training are 18 days each
3. Pre-graduation and thesis training - 50 days

*Occupational, workplace, fire and radiation safety

FIG. 1. Training programmes for operating personnel based on the developed Applied BSc course

'Classical' Specialist-engineer course – 5,5 years						Reactor shop – 1,5 years	
1st year	2nd year	3rd year	4th year	5th year	6th year	1,5 years	
Mathematics (20)	Mathematics (13)	Physics and nuclear physics (11)	Physics and kinetics of nuclear reactors (12)	Dosimetry and protection (4)	Training	Safety* and reactor field operator programme	Reactor field operator individual work
Physics (10)	Physics (15)	Fluid mechanics (5)	Steam generators and turbo-machines at NPP (8)	Automated control systems of NPP (6)	Graduation thesis training		
General chemistry (7)	Electronics and electrical engineering (4)	Heat and mass transfer in power equipment (8)	Nuclear power plants (7)	Physico-chemical processes at NPP (2)	State exam		
	Applied physics (4)	Equations of mathematical physics (3)	Nuclear power reactors (5)	Electrical part of NPP (3)	Graduation thesis defence		
	History of nuclear power development	Math. methods in modeling (4)	Health and safety	Nuclear power economics (3)			
		Educational introductory practical training	On-the-job training	On-the-job training			

*Occupational, workplace, fire and radiation safety

FIG. 2. Training programmes for operating personnel based on the 'classical' specialist-engineer course

The enhanced efficiency of teaching and focus on practical studies in cooperation with NPPs will allow effective development of a pool of operating personnel (Russian and foreign) to support start-up and operation of Russian-built nuclear power plants in a recipient country.

Second, four fundamental multimedia educational courses in the field of nuclear science and technology are currently under development in Russian and English languages to be the basis of the double-degree programmes. The 'multimedia educational course' stands for a set of materials containing a handbook as the base for the educational process and a corresponding multimedia course as a very useful and easily accessible innovative tool [9]. The topics covered by the courses are:

- the basic course on introduction to nuclear power, physics and reactor technology, developed in cooperation with industry and academia;
- the specific course on NPPs with WWER reactors including information about operation physics and the design evolution;
- the course on radiochemistry and nuclear fuel cycle;
- the course on radiation technologies (non-power use of nuclear energy).

As the summary of this section the following sequence of initial steps is proposed to provide a harmonized development of career trajectories for nuclear industry personnel (case of operating organization) in customer countries, the process can be carried out in parallel with the development of a NPP project:

The initial meeting between a university in a customer country and ROSATOM-CICE&T and signing of a Memorandum of Understanding for cooperation in the field of nuclear education, training and research;

- Organization of 'train-the-trainer' courses in the Russian Federation for staff of the foreign university to learn the methods, approaches, capabilities and culture – harmonization;
- Introduction on the applied BSc programme in the customer university;
- Agreement between the customer university, one of the Rosatom core universities and

ROSATOM-CICE&T for the development and implementation of double-degree programmes in nuclear science and technology utilizing the fundamental multimedia educational courses as the basis.

4.CONCLUSIONS

The harmonization of E&T offers is the possible way to address the expansion of the use of nuclear energy taking in account lessons learned from the Fukushima-Daiichi accident and the need for safe, secure and efficient development of nuclear industry in newcomer countries and countries expanding their nuclear power programmes. The harmonization in E&T is to be seen in two ways: between vendor states (and/or E&T providers) for the multi-vendor case and between a vendor and a recipient country. Regional and international E&T networks play a vital role for cooperation towards the harmonization of E&T efforts. ROSATOM-CICE&T has experience in collaboration with European Nuclear Education Network under ENEN-RU projects resulted in organization of joint training courses, establishment of a framework for exchange of students and lecturers and the basis for development of double-degree programmes between Rosatom core universities and EU universities.

To provide a harmonized development of career trajectories for nuclear industry personnel in customer countries a sequence of initial steps is proposed. The process is supported by products being developed by ROSATOM-CICE&T, including the applied Bachelor programme for NPP operating personnel, the double-degree programmes in nuclear engineering and the fundamental multimedia educational courses as the basis for the educational programmes.

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NUCLEAR KNOWLEDGE MANAGEMENT IN VIET NAM: CHALLENGES AND APPROACHES

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Abstract

In Viet Nam, nuclear knowledge in general, and in particular on nuclear power remains at a low level, due to a long stretch of thorns, training, human resource development in this area has not been adequate attention. August 18, 2010 the Prime Minister issued decision 1558 approve the scheme "Training and development of human resources in the field of atomic energy"; then, on 10/15/2015 The Prime Minister has issued a decision in 1756 approving Plan for training and retraining of state management personnel, research and development and technical support to 2020 served nuclear power development. To implement the training and development of human resources, the organization in the field of atomic energy was planning to conduct recruitment, training and development of human resources. Thus, Viet Nam has a policy and plan for the development of nuclear knowledge. However, the implementation of knowledge management has yet to be thoroughly, at Government level there is no specific policy decisions on knowledge management; level implementation units have not implemented the scientific step, the switch serving the knowledge management. This is one of the reasons leading to the development of human resources in the field of atomic energy has been slow.

1.INTRODUCTION

Knowledge Management is a science involves a set of explicit knowledge and tacit knowledge in a coherent, logical, orderly and classified, codified in order to store and transmit easily from person to person, from generation to generation. Although newer than the other knowledge, nuclear knowledge has been accumulated over 100 years and has developed very fast. For developing countries, knowledge management often overlooked, but this is a mistake. On the contrary to be able to grow fast, catch up with the advanced countries, the developing countries should and must be a strong emphasis on knowledge management; because it is the staircase leading to the shoulders of giant.

1.1 What is Knowledge Management?

The most important factor in knowledge management is how to knowledge not only kept by one person, but is captured by several people in a working group; followed by knowledge transfer must be complete and accurate to the correct address (the right people needed) and finally documented to be of this knowledge. Do the 3 above things, we do the knowledge management.

In addition, knowledge management is also building a training strategy. For organizations, the expansion and therefore need to recruit people is necessary, but not always recruit people who are knowledgeable enough to be recruited for the job that has to train new recruits to ensure adequate process at the request of the job. Develop training plan how to work most effectively train all the time, funding and knowledge needed for the job. Currently in some developing countries, where the field of knowledge management has not been implemented effectively, sending officers to train also brought emotional factors, depending on the will of the leader subjective so much as the training is not effective in all 3 aspects: time, finance and knowledge.

For example, users sending inappropriate training leads to knowledge gained is not as expected (due to lack of basic knowledge, so do not understand all the knowledge of the course, ...), take some time do not do the work of the organization (by attending courses), organizations spend a significant budget for this course (with more in-depth training courses, funding higher).

2.THE BASIC ELEMENTS OF KNOWLEDGE MANAGEMENT

Three factors play a key role in knowledge management are: People, Process and Technology, in which the human factor plays a dominant role and decision. Because knowledge is due to man- made and the man use knowledge to create wealth and create new knowledge.

Besides the three factors, there are four stages of knowledge management:

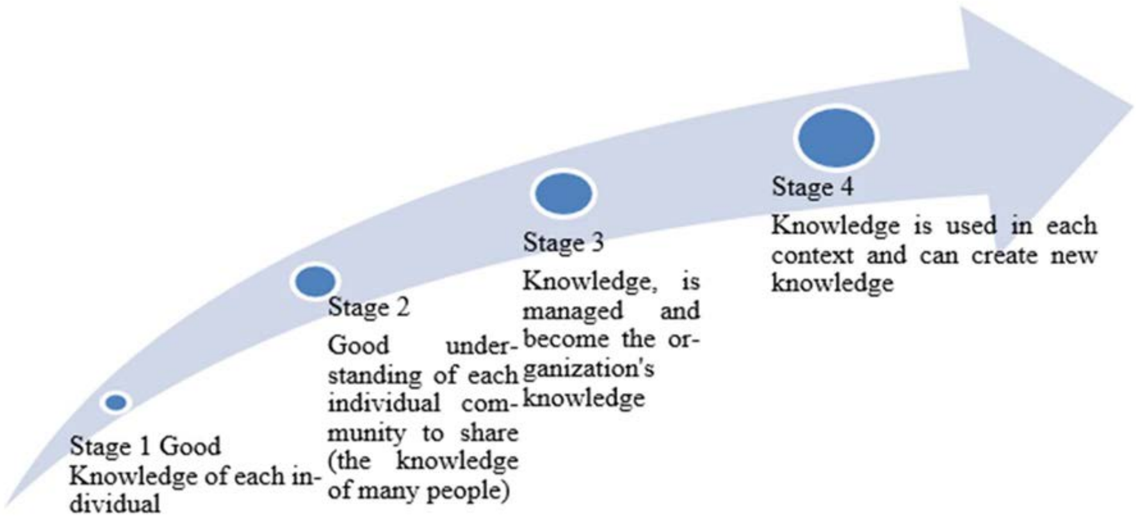

FIG. 1. The four stages in knowledge management

Knowledge management cycle can be represented as shown in Figure 1; Inside:

The first stage of knowledge management is how to capture knowledge, in other words, to get knowledge. by the capture knowledge can not be systemtized, classifyed; so after having knowledge then, need to be organized, systemtized; in adition, for knowledge is not eroded over time, we must keep our conduct; continue to need improvement knowledge, eliminating the cumbersome and supplement missing knowledge; and finally, after having a perfect knowledge, at which point it will be exploited, used for creation, wealth creation, material and create new knowledge.

2.1 Difficulty of Nuclear Knowledge Management in Viet Nam

Although the applications of radioactivity in Viet Nam from the early 20th century, however, these applications slowly development and is primarily focused on the healthcare and industry. Only in recent years, the process of rapid industrialization in Viet Nam, the new radiation applications developed. Nuclear power also been mentioned in recent years. Therefore, human resources in this field are limited, and the persons in the high are rare. According to statistics, by 2015, human expertise is directly related to nuclear field in 3 agencies active in the field of atomic energy of Viet Nam: Institute of Vietnam Atomic Energy, Vietnam Atomic Energy Agency and Agency for Radiation and Nuclear Safety has about 600 staffs.

TABLE 1. Current Status of Human Resources for Nuclear Power Program

	Field		BSc/ Engineer	Master	PhD.
1	Accelerator Technology	5	4	0	1
2	Applied Nuclear Engineering (Traces, NCS, Isotope Hydrology...)	18	10	7	2
3	Radioisotope and Radio-pharmacy Production Technology	13	10	4	0
4	Electronics and Control	31	26	4	1
5	Environment Radiation Monitoring	27	17	8	2
6	Instrument and Control of reactor	5	4	1	1
7	International Relationship and Enforcing International Convention in the field of Atomic Energy	11	7	5	0
8	Legislation, Regulation, Polycy and Mechanism in the field of Atomic Energy	7	5	2	0
9	License, Inspection of Radiation and Nuclear Safety	16	8	8	1
10	Material Technology	32	25	4	4
11	Non-Destructive Test (NDT)	25	23	3	0
12	Nuclear Analysis	35	18	12	6
13	Nuclear Fuel Technology	12	9	2	2
14	Nuclear Physics and Nuclear Data, High Energy Physics	48	21	17	10
15	Nuclear Safety	28	17	12	0
16	Operate Nuclear Research Reactor	6	5	2	0
17	Power Reactor Technology	2	2	0	0
18	Project Management (Nuclear power, Science and Technology..)	17	6	7	5
19	Public Relationship, Information and Communication about Nuclear Power	9	8	1	0
20	Physics and Dynamics of Reactor	11	7	3	2
21	Radiation and Nuclear Emergency Preparedness and Response	5	5	1	0
22	Radiation Dispersion Calculation	2	0	2	0
23	Radiation Safety	38	30	7	2
24	Radiation Technology	32	19	10	4
25	Radioactive Mine Processing Technology	13	9	4	1
26	Radioactive Waste Processing Technology	21	16	3	3
27	Radiobiology	27	16	9	2
28	Radiochemistry	3	1	3	0

29	Reactor Chemical	1	1	1	0
30	Reactor Thermohydraulics and Safety Analysis	4	2	2	1
31	Safeguard and Nuclear Security	4	2	2	1
32	Others	79	71	9	2
Total		612	404	155	53

From the table above, we can see, the highly qualified human resources are not many, there are only 53 Ph.Ds, thus the transmission of knowledge from the previous generation to the next generation is limited. Another difficulty of Viet Nam is the training and management of human resources is not really good. The authorities in the field of nuclear energy in Viet Nam is not used SARCoN in finding the gaps in knowledge of the staff, which plans to provide additional training for staff knowledge. Therefore the training plan development and implementation of training have not achieved the desired expectations. The authorities in the field of nuclear energy in Viet Nam did not have a human resource management processes and manage their intellectual methodically and scientifically. Therefore, in many cases when the retirement age expert, there is no person replacing. A typical example is in a standard neutron dose room, while officials in charge of the room, at the same time as the person of implementation retired, the remaining staff was not able to continue the work. Are qualified staff do not want to transfer the knowledge to the next generation; or is the successor cannot learn from the expert? The issue is mechanism, policies and management processes, training the human resources.

3.HOW KNOWLEDGE MANAGEMENT DEVELOPMENT IN VIET NAM

Determination of human resources is the leading factor in ensuring the successful implementation of the program of nuclear energy in Viet Nam. In 2010, the Prime Minister issued decision 1558 approve the scheme "Training and development of human resources in the field of atomic energy"; then, on 2015 The Prime Minister has issued a decision in 1756 approving Plan training and retraining of state management personnel, research and development and technical support to 2020 served nuclear power development. Thus, at the government level, there has been timely policies promoting human resource development. However, there are currently no policies at the government level of knowledge management. In deploying cables, most organizations in the field of nuclear energy in Viet Nam has gradually concerned, implementing knowledge management. For example, the Agency for Radiation and Nuclear Safety is planning development of human resources 2020 include things recruitment plans, training plans, which were used SARCoN in finding the gaps for building design training plan, use the SAT to develop training programs.

However, despite the very real example of the loss of knowledge when staffs retire or transfer, almost organizations in the field of nuclear energy in Viet Nam do not have plan about the transmission of tacit knowledge from the expert to the young staff. Maybe it's time for the organizations to pay more attention to this issue.

4.CONCLUSIONS

Viet Nam is hard to come to the shoulder of giant in the field of nuclear energy without a policy, knowledge management plan, and if so, the result is a pity and then strategic of application of atomic energy for peaceful purposes in Viet Nam is hard to progress rapidly. There is the premise of nuclear knowledge management in Viet Nam; for becoming a reality, it needs a drastic policy and decisions at government level and local level.

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MANAGING KNOWLEDGE FOR OPERATORS OF CHASHMA NUCLEAR POWER GENERATING STATION (CNPGS) AT CHASHMA CENTRE OF NUCLEAR TRAINING (CHASCENT)

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Abstract

It is important for a developing country with expanding nuclear power program to acquire the ability for the safe and efficient operation of nuclear facilities such as nuclear power plants. Nuclear knowledge and its effective management are key drivers of both performance and safe operations of NPPs and educational establishments. Nuclear facilities operate over very long timescales, during which operational conditions and technologies change. Knowledgeable decision-making is vital especially for operators involved in decision making because their wrong actions may compromise nuclear safety due to lack of knowledge. Effective knowledge management informs and supports safe operation and decision processes throughout the whole plant life when needed for decision makers and operators. This paper focuses upon people, processes and technology to manage knowledge, skill and ability of NPPs operators using critical review/discussion summary of MCR logbook, Integrating related Operating Experience (OE) in lesson plans, acquiring tacit knowledge from Subject Matter Experts (SMEs) and lesson learnt from training activities reports at organization level.

1.ORGANIZATIONAL CONTEXT

1.1 Introduction

Chashma Nuclear Power Generating Station (CNPGS) working under Pakistan Atomic Energy Commission(PAEC) is located on the left bank of river Indus, 280 km south-west of capital Islamabad, Pakistan with two independent units of Two-loop Pressurized Water Reactors (PWRs) C-1(325MWe) & C-2(330MWe) in operation. Two more units C-3 & C-4 (340MWe each) are near to start commercial operation. Chashma Centre of Nuclear Training (CHASCENT) is playing vital role in providing a quality of training to fresh graduate engineers, operators and maintainers to fulfill trained manpower requirements of C-1/C-2/ C- 3/ C-4/K-2/K-3 NPPs.

1.2 Main Stakeholders and their Role

Main stakeholders and their role in NKM is discussed below:

Head of Organization

— Responsible for appointment of a focal person and approval of section
— Approval of the Nuclear Knowledge Management Program
— Responsible for provision of resources to accomplish tasks

Manager Operation Training

— Approval of the Nuclear Knowledge Management procedures
— Approval of action plan on critical knowledge preservations
— Approval of the results of the critical knowledge preservation (Plans, Instructions, Training materials, etc.)
— Approval of the knowledge loss risk management reports
— Providing training for personnel involved in knowledge management.

— Ensuring the organizational culture supporting preservation of critical knowledge
— Approval of MCR discussed logbook summary for inclusion in database
— Raising concern on safety significant event observed in daily logbook and assigning task for summary report preparation

Coordination Committee of Section Heads

— Review of documentation on Nuclear knowledge preservation process
— Request to plant for nomination of Subject Matter Experts
— Finalization of Subject Matter Expert list
— Recommendations for a specific Subject Matter Expert for discussion/interview on a specific topic
— Assign task to FSTS Instructors for discussion of daily MCR logbook/OE/lesson learnt with operators and preparation of summary for safety concerns identified in logbook
— Coordination for implementation of recommendation /lesson learnt regarding train-ing or simulator
— Support for the Knowledge Management activities
— Communication with NKM section
— Coordination with SME.

NKM Working Section/ Head (NKM)

— Development of Procedure for NKM
— Identification of critical knowledge
— Determination of critical knowledge recipients
— Knowledge loss risk assessment
— Development of Plan for the critical knowledge transfer
— Implementation of organizational and technical measures in accordance with the NKM Procedure
— Evaluation of the programme implementation
— MCR logbook discussion with SMEs, collection of discussed MCR logbook summary from section heads, report development and preservation
— Communication with SME.
— Conducting table top analysis with SMEs for their valuable feedback in job analysis phase of SAT

Subject Matter Experts (SMEs)

— Coordination with FSTS Instructors
— Participation and valuable feedback in analysis phase of SAT during development of Job Analysis Cards
— Knowledge transfer according to training demand
— Consulting on specific issues related to their competence
— Transfer of personal knowledge to young specialists by personal example or/and through lectures
— Development of training material
— Development of training programmes and curricula
— Identification of problems in the training process.

IT specialists from Information System Division (ISD)

- Responsible for smooth operation of intranet LAN based portal
- Responsible for Database management
- Responsible for Management information system(MIS)
- Responsible for smooth operation and up-to-date Learning Management System(LMS)

FSTS Instructors

- Conduct simulator and in-class training /Recreation of Scenarios
- Prepare schedules keeping in view the availability of SME
- Coordination with SME
- Assessment of operators and trending
- Collect Feedback from operators
- Collect Feedback from operators
- Work as a SME in their areas of expertise
- Implementation of recommendations/lesson learnt related to training or simulator

Operating Experience Feedback (OEF) Coordinator

- Screening of received OE
- Forwarding of screened OE to respective Head for inclusion in respective training package
- Coordination with NKM through section head coordination committee

Operators/Shift Supervisors

- Receive training to improve their knowledge skills and abilities
- Provide suggestions/feedback on training
- Senior operators/shift supervisors deliver lecture to junior operators according to level and field of expertise
- Senior shift supervisors also fill self-assessment form for identification of critical knowledge and work as SME

1.3 Organization's Knowledge Management Challenges & Issues at Start of Initiative

Preservation and transfer of plant specific knowledge and expertise was a great challenge for reliable and safe operation of the plant. Knowledge loss was identified as critical issue as many shift supervisors who were pioneer in the operation process were started to be taken out from shift duties and many others were transferred to other projects which created risk of plant specific knowledge loss. Without any assist mission and external benchmarking starting NKM initiative and creating knowledge culture was a great challenge. Also to get support of top management for creation of NKM section was very important task. Development of new specialists and raise the awareness level of staff active involvement in knowledge process were major concerns at the start of the project

1.4 Maturity of Knowledge Management at Operation Training, CHASCENT

KM practices like MCR logbook discussion/summary, knowledge management through operating experience (OE), capturing tacit knowledge from subject matter experts (SMEs) and lesson learnt from training reports had been carried out since long but formal NKM section was established in 2015. Proper procedure for NKM was prepared and implemented for management of knowledge in an organized way. See Figure#1.

1.5 Rationale of the Knowledge Management Programme/Initiative

My coworkers participated in IAEA meetings related to NKM and briefed higher management in post participation presentation to convince them for creation of NKM section at training centre to preserve critical knowledge. Above all it was commitment of Manger Operation Training to develop NKM section to preserve critical knowledge for operators.

2.BACKGROUND & OBJECTIVES OF THE KNOWLEDGE MANAGEMENT INITIATIVE

2.1 Background

— Retirement /Transfer of experts (shift supervisors taken out from shifts)
— Ageing staff
— Utilization of Expert experience
— Risk of plant specific knowledge loss

2.2 Objectives

Following are main objectives of KM initiative

— To Identify unique and critical knowledge
— To Prepare SME list
— To perform Knowledge loss risk assessment
— To prepare action plan for Knowledge transfer
— To capture unique and critical knowledge
— To preserve unique and critical knowledge
— To utilize unique and critical knowledge
— To improve organizational knowledge culture for transfer and retention of critical knowledge
— To improve quality and effectiveness of training

3.DESCRIPTION OF THE KNOWLEDGE MANAGEMENT INITIATIVE

3.1 Knowledge Management Projects

— KM through MCR logbook Discussion
— KM through OE
— KM through SMEs
— KM through Training Activities Reports

Key results are operators and trainee instructor’s performance improvement

3.2 Knowledge Processes

Details of knowledge processes are shown in Figure 2, 3 and 4

3.3 Supporting Documents

Following is the list of supporting documents:

- Process procedure/ Model
- Approval for NKM section/Management support
- SMEs list
- SME contribution in SAT analysis phase for preparation of JAC/Test items development
- Employee self-assessment form
- Knowledge Identification form
- Knowledge loss risk assessment matrices
- Action Plan for transfer & retention of Knowledge
- Experts Interview questionnaire
- Knowledge Process Evaluation forms
- Radar Charts for KM maturity trending

3.4Related business (management system) processes

Main business process is operations for which operation training division(OTD) at CHASCENT is conducting Certification training, Licensing Training and Retraining for Field & MCR operators for which NKM plays a key role to manage core competencies.

3.5 Knowledge Management Tools Used

Following KM tools are used:

- Management Information System(MIS)
- Radar Chart for NKM evaluation
- Audio/Video Capturing
- PCR (LAN based)
- Data Record Library(DRL)
- Knowledge identification
- Action plan for knowledge transfer
- Knowledge loss risk assessment
- Database server
- Simulator

4.Challenges and Achievements

4.1 Difficulties Encountered

Following difficulties encountered:

— SMEs busy schedule due to routine activities
— Lack of motivation
— Will for sharing knowledge
— Mutual trust

4.2 Methods used to Overcome

These difficulties were overcome by following steps:

— Flexible schedule for SMEs
— Some incentives for SMEs to improve their motivation
— Engaging SMEs in Job Analysis Card(JAC) preparation
— Development of test items in subtask analysis phase of SAT
— Blame free environment
— Safety Culture
— Learning environment
— Knowledge culture

4.3 Impacts of the Knowledge Management activity or process

Profile of every operator is developed indicating his or her weak and strong areas which is considered positive by operation division

Feedback from operators also indicate it as positive.

4.4 Achievements

During Chashma-1 OSART mission from 23rd November to 10th December 2015, CHASCENT was awarded with "**Good Practice**" in the field of Training and Qualification for daily MCR logbook studying classroom, its discussion and critical review on operator actions. IAEA included it in OSART mission review (OSMIR) database. Indeed it is a great achievement and motivation for further improvement in this area. For detail please visit link: www-ns.iaea.org/downloads/ni/s-reviews/gp-2009/2.3.pdf.

5.LESSONS LEARNED /KNOWLEDGE DERIVED

Before starting a KM programme adopt following pre-requisites

— Integrate KM in management policy
— Get top Management Support
— Prepare strategy/Procedure
— Ensure sufficient resources
— Strong knowledge culture in organization
— Start with a pilot project and get quick successes
— Motivation/incentives for experts
— Strong safety culture in organization

Daily discussion of MCR logbook with operators at training Centre is a proven and very effective method for knowledge creation and utilization for performance improvement and error reduction. Weakness of operator actions are identified in MCR logbooks and after discussion with SMEs same scenarios are recreated at simulator for practice of retraining crew operators which have following benefits:

- Operation and training manpower remain updated with the latest plant conditions and status through daily study and discussion on MCR Logbooks
- It helps in improvement of training material and simulator exercises in the light of latest events and near misses at MCR
- Significant logbook events undergo critical review with reference to human error reduction tools and operator fundamentals. Deficiencies encountered thereafter are focused during subsequent training
- Significance of different components, equipment, Operation Instruction, temporary and permanent modifications are highlighted for the participants during these
- sessions.

Integration of relevant OE with relevant lesson plan package is a good approach for knowledge preservation and future utilization

Setting contacts with experts, identifying critical knowledge, preparing experts list, engaging them to deliver lecture, capturing their expertise and hence preservation of knowledge is a strong technique to improve the abilities and skills of young operators for safe and reliable operation of plant.

Lesson learnt from training activities reports play vital role for further improvement performing those activates much better next time.

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CASE STUDY: STRATEGY FOR THE ESTABLISHMENT OF THE CENTRE FOR NUCLEAR SAFETY AND SECURITY IN SOUTH AFRICA

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Abstract

The establishment of a dedicated nuclear safety centre as part of nuclear industry infrastructure is a common practice among nuclear countries that is also recognized and recommended by the International Atomic Energy Agency (see, for instance, IAEA GSR Part 1). However, South Africa currently does not have such a centre. This paper presents a strategy that has been developed for the establishment of a nuclear safety centre that will support the nuclear knowledge management infrastructure of the National Nuclear Regulator of South Africa. After a brief introduction, the challenges faced by the Regulator are presented. Next, the minimum requirements for addressing the challenges are summarized by providing an outline of strategic objectives to be fulfilled. This is followed by the description of the strategy developed to fulfil the objectives, including key programmes that will be implemented. A qualitative evaluation of benefits that will result from the implementation of the strategy is also presented. Additional provisions which are required in the national legislation to facilitate successful implementation of the strategy are highlighted based on lessons learned from other regulators. Finally, lessons learned during the execution of this project are summarized in order to provide guidelines for similar projects.

1.INTRODUCTION: ORGANIZATIONAL CONTEXT

The National Nuclear Regulator (NNR) of South Africa is an Agency of government that is empowered through the NNR Act (No 47 of 1999) [1], which came into effect on 20 December 1999 and established the NNR as an autonomous statutory body. According to Section 5 of the Act, the mandate of the NNR is to provide for the protection of persons, property and the environment against nuclear damage through the establishment of safety standards and regulatory practices. In order to accomplish its mandate, the NNR implements programmes necessary for the regulation of nuclear power facilities (Koeberg Nuclear Power Station), research reactor facilities (SAFARI 1 Research Reactor), several fuel cycle facilities, over 200 Mining and Mineral Processing facilities; as well as transport operations for radioactive materials. Nuclear safety regulation is performed by two technical divisions, namely, SARA (Standards, Authorizations, Reviews and Assessments), and CAE (Compliance Assurance and Enforcement).

2.BACKGROUND AND STRATEGIC OBJECTIVES

In order to maintain and improve the country's current nuclear safety record, the NNR, like most Regulators, proactively undertakes and participates in relevant initiatives to assess the safety performance of the country's nuclear infrastructure (including regulatory infrastructure) and identify challenges (which are relevant to nuclear safety) faced by the NNR and Nuclear Industry operators. Table 1 provides a list of current challenges. In order to identify these challenges, the NNR undertook and or participated in two initiatives, namely, a SAT (Self-assessment Tool) Project for assessment of regulatory infrastructure and an ECAP (Education Capability Assessment and Planning) workshop. The latter event was held from 3 to 5 November 2015, at North West University, Potchefstroom, as part of the SAN-NEST (South African Network for Nuclear Education, Science and Technology) Project. SAN-NEST is part of a larger collaboration network or called AFRA-NEST (African Network for Education in Science and Technology). Some of the challenges listed in Table 1 are confirmed in an independent report produced by the Education Sub-committee of the Nuclear Industry Association of South Africa (NIASA) [2].

In order to address the challenges listed in Table 1, most countries have established dedicated nuclear safety centres and developed suitable programmes related to provision of training, undertaking research & development (R&D); as well as provision of technical support and expertise to the regulatory body and the nuclear industry. This approach is recognized by the International Atomic Energy Agency (IAEA) [3]. Examples of nuclear safety centres or institutes include, amongst others, the Korea Institute of Nuclear Safety in the Republic of Korea, the Dalton Nuclear Institute in the United Kingdom, the Japan Nuclear Safety Institute in Japan and the Gulf Nuclear Energy Infrastructure Institute in the United Arab Emirates. Likewise, the NNR has adopted a similar approach for addressing the challenges listed in Table 1 by developing an appropriate Strategy [4].

The main objective of the NNR Strategy [4] is to address the challenges highlighted in Table 1, in the context of the Medium Term Strategic Framework (MTSF) which is Government's strategic plan for the period 2014 to 2019 [5]. The long term objective is to enable the NNR to develop the necessary capacity and to be self-sufficient in all areas relevant to the regulation of the country's current and future nuclear programmes. Since South Africa is the only country with an established nuclear power program in Africa, and within the Southern African Development Community (SADC), the Strategy will also play a key role in the development of nuclear safety regulation in these regions and contribute to the fulfillment of regional objectives through NNR's association with SAN-NEST and AFRA-NEST. Other objectives of the strategy are to:

- Demonstrate compliance with IAEA Requirements [3] and international best practices;
- Demonstrate compliance with the NNR Act [1] which provides for the NNR to establish and control facilities for the collection and dissemination of scientific and technical information;
- Facilitate the implementation of the Integrated Resource Plan for Electricity 2010-2030 (IRP 2010) [6] and the Radioactive Waste Management Policy (RWMP) [7];
- Support the mandates of the Department of Science and Technology (DST) and National Research Foundation (NRF) regarding the provision of core research and development (R&D) programmes to support national science and technology capacity building;
- Support the mandate of the Department of Labour (DOL) which is empowered, through Skills Development Act (Act 97 of 1998) [8], to devise and implement national, sector and workplace strategies to develop and improve the skills of the South African workforce;
- Support the implementation of the National Development Plan and MTSF [5] which aims to eliminate poverty and reduce inequality by 2030.

3.DESCRIPTION

The strategy developed by the NNR involves the establishment of a nuclear safety centre which has been named 'NNR Centre for Nuclear Safety and Security (NNR CNSS)'. Project Cycle Management (PCM) and Logical Framework Approach (LFA) were used as methodologies for designing, monitoring, and evaluating the development of the Strategy to establish the NNR CNSS. Project management tools utilized to guide the project include PRINCE2® and the latest PMBOK® Guide2013. A web application platform (SharePoint2013®) was used to implement project management processes and steps recommended in these guidelines, as well as store, track, and manage project documents, including project cost and schedule. The project was overseen by a Steering Committee consisting of representatives from various divisions of the

NNR. The project was monitored by the NNR project management office (PMO) for compliance with NNR internal business processes, including quality, cost and schedule requirements.

The Centre can be considered as a nuclear technology training and research centre with a specific mandate to support the NNR. The proposed Centre will implement the following key programmes:

— Education & training (E&T) programmes in nuclear safety, radiation protection and nuclear security;
— Research, development and demonstration (RD&D) programmes in nuclear safety, radiation protection and nuclear security;
— Technical support service programmes in nuclear safety, radiation protection and nuclear security.

By implementing the programmes listed above, the Centre will support the NNR to promote nuclear safety; and to maintain and improve the country's current nuclear safety record. The Centre will advance these objectives with activities to:

— Teach: Introducing nuclear safety courses in graduate and undergraduate curriculum, as well as training programs for nuclear safety professionals.
— Discover: Research projects, consultancy and project implementation.
— Outreach: Nuclear Safety conferences and seminars to enable nuclear safety professionals from around the world to network and explore the state of the art and new nuclear safety technologies; as well as promoting awareness and undertaking public advocacy around nuclear safety.
— Practice: Training staff and students on safe working practices in all aspects of nuclear operations.

4.EXPECTED IMPACTS

Business outputs will be used to measure the impact of the strategy. The outputs are described using both qualitative and quantitative measures. Four categories of outputs were identified namely, IAEA related outputs (i.e. outputs that are relevant to meeting IAEA requirements), NNR and Nuclear Industry outputs (i.e. outputs that address NNR and Nuclear Industry challenges 2-20 as listed in Table 1), Socio-economic outputs (outputs that address national challenges such as unemployment as articulated in National Development Plan and MTSF [5]); as well as cross-cutting outputs which addresses the mandates of other ministries (DST, NRF and DOL). In this paper, only qualitative impacts are described (see Table 2).

5.MAJOR CHALLENGES AND ACHIEVEMENTS

Implementation of the strategy will involve diversification of the NNR's organizational structure into further programmes and sub-programmes that are not currently provided for in the NNR budget. The cost of programmes and activities that cannot be accommodated within the current NNR budget will have to be funded/co-funded by alternative mechanisms. Since the NNR had never engaged in a similar project, developing a funding model for implementation of the project proved to be a challenge. As a result the project team conducted research and undertook two study tours to gather lessons learnt from other regulators. Typical funding approaches followed by other countries are summarized below.

In the United States of America, the US Department of Energy funds nuclear R&D through budget appropriations and grants to institutes. In Finland, the Finnish funding agency for technology and innovation funds industrial and research projects in all technological branches, including nuclear technology. Finnish utility companies also have a mandatory share in financing nuclear R&D. The same approach followed in Finland is also practiced in Sweden.

In France, civilian programmes receive partial funding from government, private companies and external sources such as the European Union. Large public corporations such as Areva fund nuclear R&D from nuclear technology sales. In Japan, nuclear R&D is largely funded by government. However, private sector companies such as Hitachi, Toshiba and Mitsubishi are self-funded. In the Republic of Korea, nuclear R&D is funded through direct grants from government, nuclear power generation levies and industry.

Similar funding mechanisms are recommended for South Africa. However, since the national legislations of the countries highlighted above contain explicit provisions regarding the funding mechanism for nuclear R&D, it is also necessary to include similar provisions in the NNR Act [1]. The required provisions are listed in Table 3. The proposed revisions have been researched and confirmed by means of workshops which took place during November 2015 between the NNR, the Swedish; as well as the Finnish Regulators.

6.LESSONS LEARNED

The NNR does not have the entire infrastructure, including skilled and trained human resources, necessary for the implementation of the strategy. However, the capability of the strategy to support the mandates of several government departments, including academic and research institutions, made it possible for the NNR to seek opportunities for cooperation in order to optimise the use of resources. Participation in the ECAP initiative; as well as the SAN-NEST Project provided the NNR with the right platform to identify key institutions to partner with as part of cooperative agreements and the correct tools to use for this project. The use of appropriate project management tools facilitated the development of the strategy; as well as the management of knowledge generated during the project.

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COMPETENCE MAP OF REGULATORY BODY: PERSONAL AND INTERPERSONAL EFFECTIVENESS COMPETENCES

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Abstract

The paper presents implementation stages and outcomes of the project “Nuclear Facility Competences” fulfilled in JSC “Rosenergoatom” and outcomes of the project “Knowledge Management, Training and Staff Retention” fulfilled for Romania regulatory authority. The goal of the project was a development of competence profiles for nuclear power plant and corporate inspectorate key job positions. The paper is focused on personal and interpersonal effectiveness competencies for inspectorate job positions which are a part of well-known 4-Quadrant Competence Model. Each competence is described by one or two behavior scales. One can consider those competencies like common ones for organizations implementing inspection activity and could be used in human resource management processes like personnel selection, job assessment, career planning, training, and mentoring.

1.INTRODUCTION

Let’s consider a work situation when the inspection round during maintenance period occurred. The maintenance was implemented by a contractor. One inspector of NPP inspector team, who fulfills manufacturing supervision, visited some maintenance work place. However he or she did find any contractor workers. The contractor personnel left the work place because they got informed that the inspector will be coming. In the work place one can see abandoned tools, blind flanges kept incorrectly and apertures that are not covered. The inspector having no “company” moved to the next working place and did not pay attention to these working place conditions.

Another inspector in analogous situation stopped in the working place left by contractor maintenance team. He or she called for NPP operative personnel responsible for maintenance implementation in the place and has cleared that contractor workers have left the place and did not inform NPP operative personnel, broken occupational safety and health and maintenance work requirements. The contractor team has been found and inspector implemented his or her job. Obviously the second inspector is more successful and his or her activity is more efficient. Why? It could be said, with great probability, that personal traits of the inspector are more matured.

Regulatory body establishes regulations and controls its implementation. Following such regulations nuclear facilities can reach business goals while providing a high level of safety. Regulatory body activity efficiency is defined by personnel competences, high level maturity and organizational processes (human resource management, knowledge management) and managing the development and application of those competences. A well-known 4-quadrant competence model for regulatory body is presented in (Figure 1) [1].

1. Competences related to the legal, regulatory and organizational basis	**2. Technical disciplines competences**
1.1 Legal basis 1.2 Regulatory policies and approaches 1.3 Regulations and regulatory guides 1.4 Management system	2.1 Basic science and technology 2.2 Applied science and technology 2.3 Specialized science and technology
3. Competences related to regulatory body's practices	**4. Personal and behavioural competences**
3.1 Review and assessment 3.2 Authorization 3.3 Inspection 3.4 Enforcement 3.5 Development of regulations and guides	4.1 Analytical thinking and problem solving 4.2 Personal effectiveness and self-management 4.3 Communication 4.4 Team work 4.5 Managerial and leadership competences 4.6 Safety Culture

FIG 1. Quadrant model of competences for Regulatory body

In my opinion, the "Personal and behavioural competences" quadrant is no less important than any other; however it is not studied in depth like the other quadrants. This fact has predetermined the project addressed to develop personal competences for NPP key job positions, including positions relevant to inspection activity.

2.PROJECT TO DEVELOP PERSONAL AND BEHAVIOURAL COMPETENCE PROFILE

Methodologically the project was based on the practical guide to adapt competence models for work [2] and corresponding approaches in Russian Federation [3]. The duration of the project was three years. Around 2200 employee from six nuclear power plants were under investigation. Around 150 NPP key job positions were in the project's focus. In order to obtain information for analysis the following actions were fulfilled:

- Interview (behaviour patterns) with NPP personnel – 1037;
- Job analysis questionnaire -1513;
- Focus-groups – 915;
- Motivation questionnaire -734;
- Job relevant documents analysis.

The project outcomes were:

- Personal and interpersonal competence dictionary consisting of 45 competences. Each competence is described in terms of work behavior (behavior scale);
- Personal and interpersonal competence profiles;
- Dictionary of key performance indicators for NPP job positions and compartments.
- Motivation potential (number of motivators) for NPP job positions;
- Psychogram. This is a profile of psychological functions parameters. It reflects, for example, what characteristics of a worker cognitive processes are more enabled when job performance for the job position;
- Software to analyse job positions and develop competence profile.

Using any instrument for the assessment of individual characteristics and the whole work with personnel becomes meaningless, aimless, without existence of the objective requirements for the staff member, presented by job content, its nature, job conditions and parameters of acceptability. Therefore this set of profiles plus professional (technical) competence profile should be considered as a unique language to manage human resources and work performance effectiveness.

3.EXAMPLE OF INSPECTOR PERSONAL AND INTERPERSONAL COMPETENCE PROFILE.

Let’s consider a job position of an Inspector. Below you can see text which is a part of competence job description.

3.1 Obligatory traits

Thinking;

- Reproductive thinking (ability to work with logs, documents); abstract and logical thinking (ability to argue own point of view); rationality (ability to act advisedly); questioning attitude (capability to detect nonconformities and information inconsistency); analyticity (capability to analyze information);
- Job relevant personal traits;
- Interpersonal traits: communicativeness (skill for business conversation, capability to explain clearly, listen to other point of view); leadership and prescriptiveness; diplomacy (capacity to express an opinion frankly); skills for organization (capability to control work performance).
- Self-management and personal effectiveness: accountability; self-reliance;
- Motivation aspects: devotion to an organization, commitment to safety, interest in work, aspiration for high-quality work performance.

3.2 Inadmissible traits

- Cognitive style characteristics: propensity to take information as a fact without desire to structure and reorganize it; impulsivity (thoughtless decision making);
- Self-management and personal effectiveness: inclination to risk.

3.3 Competence profile

The profile contains 18 personal and behavior competences (Figure 2). The competences could have one, two or three behavior scales (A, B, C). The scale level displays the competence maturity.

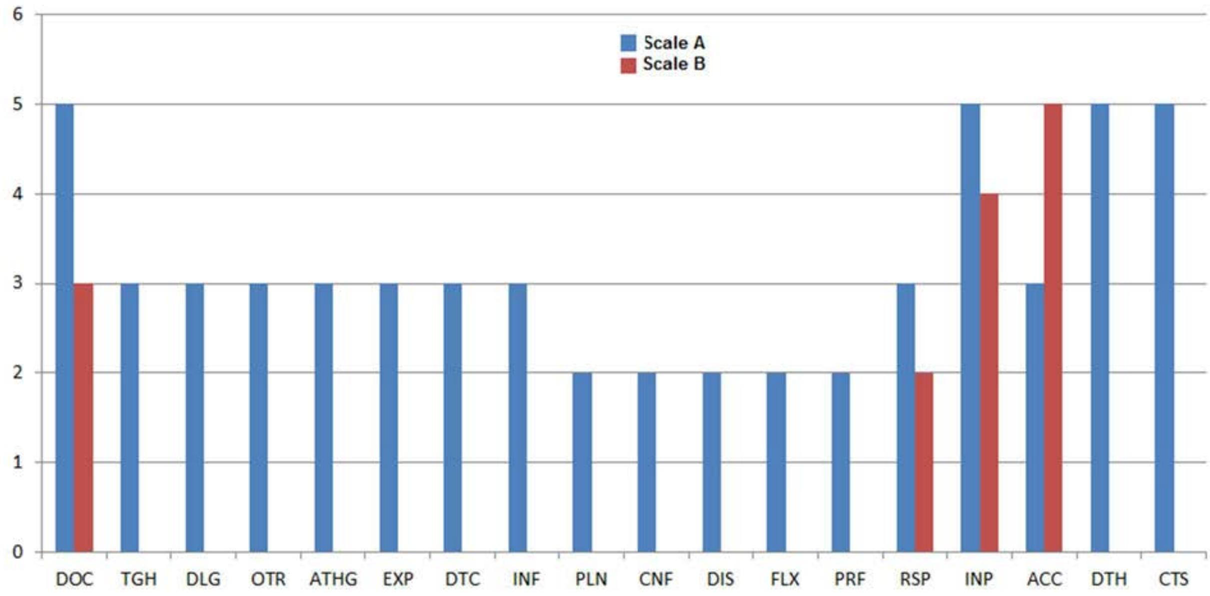

FIG 2. Competence profile for "Inspector" job position

For example, Table 1 shows description of "Work with documentation" competence level.

TABLE 1. "WORK WITH DOCUMENTATION" COMPETENCE LEVEL

Code	Competence title	Scale Level description
DOC	Work with documentation	A.5. Be able to go over and compare documentation with necessary speed. B.3.Clearly, correctly and briefly writes own thoughts on paper, develop document by oneself.

3.4Dictionary of used traits

Below one can see a list of the profile competences (Table 2)

TABLE 2. "INSPECTOR" PROFILE COMPETENCES

№	Code	Competence title	Brief competence definition
1.	DOC	Work with documentation	Skill to view, subscribe, compare with, search and use necessary documentation in fast and thoroughness manner. Awareness and understanding of documents logic. Ability to prepare arrangements, clear and correctly express own thoughts.
2.	TGH	Thoroughness	Scrupulousness, punctuality, aspiration for completeness displaying attention to nitty-gritty details.
3.	DLG	Diligence	Aspiration to follow manager's order, instruction requirement, rules, plans and programs..

№	Code	Competence title	Brief competence definition
4.	OTR	Attitude to achievement	Aspiration for high quality job performance, for high level of competence, desired social status.
5.	ATH G	Analytical thinking	Ability to decompose facts, phenomena on parts, to understand structure, to single out the main part.
6.	EXP	Expert knowledge	Perfect possession of extensive knowledge volume and/or deepness, devoting to professional activity, presence of motivation to use it. Interest to different disciplines, breadth of specialization.
7.	DTC	Devotion to the organization	Ability and readiness to behave in accordance with organizational values and goals.
8.	INF	Influence and Impact	Aspiration to influence, convince people in order to reach an organization/ division/section/team goal. Ability to motivate, and to find effective managerial style.
9.	PLN	Planning and organization	Planning and active, energetic fulfillment of own suggestions, and not only a reflection. Skill to plan taking in attention possible obstacles, to try to fulfill them in time. Ability to use work time effectively.
10.	CNF	Conflict management	Skills to manage conflicts in teams.
11.	DIS	Self-discipline	Internal precision and orderliness. Concentration on work performance.
12.	FLX	Flexibility	Ability to adapt and work efficiently in various/new situations. Capability to work with people having opposite point of view.
13.	PRF	Professional preferences	Enjoying and feeling delighted from work performance and results. Interest in various aspects of work. Anxiety because of inauspicious events.
14.	RSP	Responsibility	Highly developed sense of duty and respect for own work responsibilities.
15.	INP	Interpersonal interaction	Honesty, consistency, display of responsibility in interactions with people, efficient carrying out of one's obligations.
16.	ACC	Accuracy and order	Aspiration for order and systematization. Aspiration to put object environment to certain standard.
17.	DTH	Development of others	Aspiration to teach or develop one or few people, motivation for learning.
18.	CTS	Commitment to safety	Aspiration for job performance professionally and with adherence to safety requirements.

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STRATEGIES FOR HUMAN CAPACITY DEVELOPMENT IN NUCLEAR SAFETY AND SECURITY IN THE NNRA

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Abstract

The Nigerian Nuclear Regulatory Authority (NNRA) is charged with the responsibility for nuclear safety and radiological protection regulation. With Nigeria as one of the Nuclear Power States, NNRA has since 2010 intensified efforts in developing capacity to license the first set of nuclear power plants in Nigeria. The NNRA has employed several strategies in developing building and strengthening the human capacity to fulfill its statutory functions. This paper describes available human capacity development programmes and the strategies for implementing them including, knowledge retention and management strategy. The strategy commences with the recruitment process, initial training and education and continuous training. As a Technical Support arm of the NNRA, the National Institute for Radiation Protection and Research offers Postgraduate Diploma and Masters Programmes in Radiation Protection, where many NNRA Officers have been trained. The NNRA also leverages on its collaboration with different international organizations for the training of its manpower in the area of nuclear safety and security. NNRA Officers participate in various IAEA organized programmes including fellowship for postgraduate diploma and master programmes, Training Course, Workshops, Seminars, Conferences, Scientific Visits and on-the-job-training (OJT). Collaborations with other international organizations are also presented.

1.INTRODUCTION

The Nigerian Nuclear Regulatory Authority (NNRA) is charged with the responsibility for nuclear safety and radiological protection regulation in Nigeria. Its core functions are radiation protection of workers, patients and the public; safety and security of nuclear material and radioactive sources, safeguards of nuclear material and the physical protection of nuclear installations in Nigeria. The NNRA has since 2009 intensified efforts in developing regulatory framework and human capacity to license all practices and facilities involving the use of nuclear and other radioactive material in Nigeria. The main focus of NNRA regulatory activities are the licensing of the first set of nuclear power plants and the proposed multipurpose research reactor. The NNRA has therefore employed several strategies in building and strengthening the human capacity to fulfill its statutory functions. This paper describes available human capacity development programmes for NNRA and its Technical Support Organizations (TSO) and the strategies for implementing them.

2.RECRUITMENT, INDUCTION AND PLACEMENT

The strategy commences with the recruitment process of qualified individuals with relevant background in Physical Sciences and Engineering. The process uses professional interviewing techniques to understand the candidate’s skills and motivations to make a move, and screening of potential candidates. The recruitment is always announced through Authority websites, Print media (newspapers), Networking at conferences and meetings, External recruiting firms, Employee referrals and other events. The induction training is normally a two – four week intensive programme for newly recruited staff. The training course covers general topics on the activities and mandate of the Authority. Selected qualified individuals are then posted to different Departments where they are required to go through on-the-job training for two years before being assigned responsibilities.

3.NATIONAL/REGIONAL TRAINING COURSE FOR REGULATORS ON AUTHORIZATION AND INSPECTION

This is a four – six week basic training course which was normally organized by the NNRA in collaboration with the IAEA. It was intended to assist IAEA Member States need to establish or improve their national radiation safety infrastructure in order to implement the requirement of IAEA standards. It is also directed at personnel who had role in establishing, upgrading or managing a national radiation regulatory programme as well as those who may have responsibility for managing particular sections of a regulatory program. The course covers the elements of a radiation safety infrastructure at the national level needed to apply the Standards to radiation sources such as those used in medicine, agriculture, research, industry and education. The NNRA has developed in-house capability for conducting this training for its junior officers. The overall structure of the training programme is shown in Figure.1.

4.TRAINING NEED ASSESSMENT

A competency gap analysis has been conducted for the NNRA for Junior, Intermediate and Senior level positions. This was carried out through quantitative analysis using the questionnaire tool developed by IAEA-TECDO-1254. Junior level comprises staff from Regulatory Officer II to Senior Regulatory Officer; Intermediate level are Principal Regulatory Officer to Chief Regulatory Officer and Senior level are Assistant Director to Director. The Competency profile was applied to the four core functions of Regulatory Body on NPP using the IAEA self-assessment questionnaire for developing competency profiles for regulatory bodies. The information derived from the questionnaires was used to produce analysis in form of plots, charts and tables.

5.TRAINING POLICY

The direct consequence of the Training need assessment was the development of a Training Policy for NNRA Officers. The training and qualification of personnel in the NNRA is a very important element of human resource development. The policy is to ensure the use of a systematic approach to training (SAT) for attaining and maintaining the competencies of the NNRA. NNRA sponsors Officers for further educational programmes in Nuclear Fields. The policy allows Officers to pursue post graduate education in relevant fields. For degree of Masters programmes, Officers are granted a maximum of two years study leave with pay. However, for doctorial programmes, Officers are granted study leave without pay for the duration of their programme; such candidates will enjoy their normal promotion and retain their seniority.

Officers are required to undergo a set of trainings before deployed for any regulatory assignment. The training courses are mostly sourced through the IAEA and other international organizations with established international training and educational organizations to fill the identified knowledge gap. The policy is therefore implemented through sponsoring of Officers for further educational programmes in Nuclear Fields, nomination and sponsoring of officers for IAEA and other training courses within and outside the country, nomination of officers for IAEA fellowships and scientific visits.

6.EDUCATION AND TRAINING AT THE NATIONAL INSTITUTE OF RADIATION PROTECTION AND RESEARCH

The National Institute of Radiation Protection and Research (Institute) serves as a Technical Support Organization (TSO) to the NNRA. The institute in cooperation with the University of Ibadan, Nigeria administers Professional Training and educational programmes for newly recruited regulatory Officers in the following areas:

- Radiation Safety Officers (RSO) Training;
- Post Graduate Diploma (PGD) in Radiation Protection, and;
- Masters in Radiation Protection (MRP).

The setting up of the institute was facilitated by the IAEA and Lecturers are drawn from the University of Ibadan and the Institute. The Institute has graduated several candidates for the PGD and MRP in Radiation Protection programmes and these Officers have been absorbed into the mainstream of the NNRA regulatory activities.

7.IAEA TC PROJECT

The NNRA benefitted immensely from technical assistance under the Technical Cooperation (TC) Project NIR/9/010, Developing Capabilities for Regulatory Oversight of Nuclear Power Programme. The TC Project commenced in 2009 and consisted of activities which included:

- Conducting of competency mapping and gap analysis to determine training needs and development of training programme;
- Conducting of training to develop regulatory skills to implement regulatory functions and processes;
- Establishment of appropriate NPP regulations and guides;
- Conducting of training to develop regulatory skills to implement regulatory functions and processes.

The following training and education programmes were achieved in the TC Project:

7.1 Basic professional training course

The training was aimed at providing comprehensive introductory background on nuclear safety for Nuclear Power Plants based on the IAEA safety standards. The Basic Professional Training Course (BPTC) on Nuclear Safety develops competences by providing training on the basic safety concepts and their application in the design and operation of nuclear power plants, research reactors and fuel cycle facilities. The first National Course was conducted in 2009. The second BPTC on Nuclear Safety was held in March 2014.

7.2 Licensing of new NPP projects and special on the job training (OJT) for regulatory inspection of NPP under construction

The training was held at International Nuclear Safety School (INSS), Korea Institute of Nuclear Safety (KINS) and Four (4) NNRA Staff participated in the training from September – October 2009.

7.3 Advisory mission in relation to the regulatory requirements for licensing of sites for nuclear power plants in Nigeria

The Mission was held from 26th to 30th October, 2009. During the workshop, the IAEA Experts Team reviewed the regulatory requirements document with respect to the siting requirements for Nuclear Power Plants as contained in the Draft Nigerian Regulations for Siting Nuclear Power Plants and made some recommendations which were later incorporated into the Regulations by the NNRA.

7.4 Consultancy on the training need assessment for Nigerian Nuclear Regulatory Authority

The aim of the Mission which was held from 6th to 8th September, 2010 was to enhance NNRA capabilities to carry out competency mapping and gap analysis in the NNRA. The Training was also to determine the training needs and subsequently, develop training programmes for the Authority. At the end of the Mission, participants were trained on competency mapping analysis for Regulatory Organization based on IAEA documents.

7.5 IAEA fellowship in Nuclear Science and Technology (M.Sc.)

One NNRA staff participated in an M.Sc. programme at the University of Manchester, UK which took place from September 2009 to September 2010. The aim of the training was for human capacity building in nuclear engineering.

7.6 National training course on authorization, licensing, review and assessment for nuclear power plant

The training was held from 6th – 17th December 2010. It was aimed at strengthening the technical capabilities of NNRA Staff on licensing Nuclear Power Plants. A total of thirty (30) participants from the NNRA took part in the training.

7.8 National workshop on state system of accounting and control of nuclear materials

This Workshop was held from 22nd - 26th November 2010. The aim of the Workshop was to further strengthen the capacity of the NNRA to carry out its safeguards in connection with the NPT (INFCIRC/358).

7.9 Expert mission to assist with developing action plans for Nuclear Power Infrastructure Development in Nigeria and to provide technical advice for a new TC project

An expert mission was held from 7th – 11th November 2011 and the objectives were to:

- Contribute to the discussion to clarify the status of the nuclear power infrastructure of Nigeria, including regulatory infrastructure for nuclear safety;
- To make a lecture on Human resources Development for Regulatory Body;
- To share national experience on Human Resources Development for Regulatory Body and provide technical support and advice on human resource development, with a focus on Education and Training.

7.10 IAEA fellowship on the conversion of HEU to LEU, Nigeria Research Reactor-1 (NIRR-1)

Two officers participated in the IAEA fellowship at Argonne National Laboratory (ANL), USA on Core Conversion studies from July to November 2012. The Officers were trained on the verification and validation of the Codes used for the conversion analysis of NIRR-1 as well as the commissioning plans and development of licence requirements for NIRR-1 Conversion. The training has enhanced NNRA's technical capability for reviewing and approving Core Conversion application for NIRR-1.

7.11 IAEA fellowship on the implementation of regulatory oversight in the licensing, review and assessment of NPP

An Officer participated in a fellowship programme with the aim of acquiring on the job training and sharing experiences on the implementation of the regulatory oversight in the licensing of the nuclear power plant site and the nuclear license reviews and assessment for the nuclear power plant. The fellowship programme took place in 2012 at the National Nuclear Regulator, Pretoria and South Africa. Knowledge was gained in the areas of site selection, evaluation and assessment of technical and safety criteria with respect to site licence for NPP from regulatory perspective.

7.12 Training workshop on human resource management for Regulatory Bodies

The workshop which was organized in December 2012 by the NNRA was designed by the International Atomic Energy Agency (IAEA) for its Member States that have decided to implement Nuclear Power Plant Programme. The purpose of the training workshop was to help the NNRA identify related competence gaps within its workforce using the IAEA's four quadrant competence model and fill these gaps through training, recruitment and use of external support.

7.13 Workshop on the regulatory framework and the licensing process for nuclear power plant

In collaboration with the International Atomic Energy Agency (IAEA) a workshop was organized by The NNRA on Regulatory Framework and the Licensing Process for Nuclear Power Plants in Abuja from 9th to 13th December 2013. The objectives of the workshop were to provide an overview of the key issues and subjects concerning the development of an effective national regulatory framework for NPPs in line with the relevant IAEA safety requirements, develop the capacity of NNRA Officers who shall be involved in the licensing process for nuclear power plants in the country and to provide detailed information on the establishment and implementation of the licensing process for NPPS. NNRA has developed a Guide on Licensing Process for nuclear power plants.

8.OTHER INTERNATIONAL COOPERATION IN HUMAN RESOURCE DEVELOPMENT

8.1 European Commission

Nigeria through the NNRA entered into nuclear safety cooperation with the European Union Commission and European countries. Nigeria is currently participating in the Instrument for Nuclear Safety Cooperation, (INSC) Project MC.03/10 for the training and tutoring for experts of the NNRA and its technical support organizations (TSO). This initiative was launched in 2012. Consequently, a national training plan was developed in 2012 under the framework of the European Commission financed INSC Project. The main objective of this project was to enhance the capability of NNRA and its TSOs in the major functions of authorization, review, and assessment, inspection and enforcement, issue of regulations and guides, management of licensing process and related decision making. Nigeria has been participating in the training since 2013.

8.2 United States department of state's Partnership for Nuclear Security (PNS)

Furthermore, Nigeria is collaborating with the United States Department of State's Partnership for Nuclear Security (PNS). The training was for Officers from Nigerian nuclear technical organizations; scientists, technicians, and engineers from NNRA and NAEC; security organizations and academics from the Nigerian nuclear academic community. The training aimed at incorporating nuclear security culture into academic curriculum in Nigeria for sustainability. The knowledge acquired from these workshops has enhanced the capacity building on nuclear security in Nigeria. Furthermore, PNS also sponsors NNRA staff to various Nuclear Security workshops and conferences around the world.

8.2 Korea Institute of Nuclear Safety (KINS)

To further strengthen human capacity development the NNRA has entered into partnership with the Korea Institute of Nuclear Safety (KINS) for the training of technical officers in nuclear safety and radiation protection at Masters Level. The cooperation commenced in 2010 when two (2) Officers of the NNRA were admitted by KINS in full time Masters Degree Programme on Nuclear Safety and Radiation Protection. One of the Officers was fully sponsored by KINS while the other was sponsored by the NNRA. Thereafter, KINS has always offered scholarship to at least One (1) NNRA staff annually on this programme.

8. E-LEARNING AND ONLINE RESOURCES

The NNRA has also utilized available E-learning and online resources to build capacity of its staff. Prominent among the online resources include:

— The IAEA Learning Management System (CLP4NET) which contains e-learning training modules covering: Nuclear Energy, Safeguards, Safety and Security, Sciences and Applications, Legal, Technical Cooperation, Knowledge Management, Partner Organizations and Miscellaneous. The resources can be obtained from the website after registration at http://plms-nkm.iaea.org/.
— Furthermore, the other educational resources can also be obtained from the following website which provides E-learning for Nuclear Newcomers: https://www.iaea.org/NuclearPower/Infrastructure/elearning/index.html
— Several NNRA Officers have also obtained World Institute for Nuclear Security certification through WINS Academy online Portal, www.wins.org/academy. The certifications include amongst others:
    - WINS Academy Certification in Foundation
    - WINS Academy Certification in Science and Engineering for Nuclear Security

9. KNOWLEDGE RETENTION

NNRA has instituted programmes for knowledge retention and these include:

10.1 Coaching and mentoring

Coaching and mentoring are among the most efficient methods for capturing and transferring tacit knowledge. The junior officers are always attached to senior and competent Officers in carrying out regulatory activities such as inspections, licensing, review and assessment activities. Coaching helps to identify the skills and capabilities that are within the person and enabling them to use them to the best of their ability. Mentoring is an effective way of helping people to progress in their careers and is becoming increasingly popular as its potential is realized.

10.2 In-house seminars, trainings and workshops

An officer is required to share the knowledge he/she acquires during his/her training with colleagues in an in-house training programme and seminars.

10.3 Sharing of training materials

Training materials received during any training are deposited at the NNRA library for management. Also within the Nuclear Safety, Physical Protection and Safeguards Department, materials are shared in the local network drive for accessibility to other members of the Department.

10. CONCLUSIONS

The NNRA is implementing a strategic educational and training programme in nuclear science and technology and other associated disciplines in order to fill the identified gaps. The NNRA should anticipate its future staffing, competence and performance needs by:

- Effective workforce planning, including anticipating needs for new employees, succession planning, and assessing demographic and economic conditions;
- Developing and maintaining relationships with educational and professional organizations;
- Identifying and planning for needed changes in the organization’s processes, tools and equipment, and related staffing implications;
- Monitoring situations external to the organization for conditions that may impact on its human resources;
- Effective knowledge management.

Evaluation should be continually and systematically undertaken in order to determine the effectiveness of training and educational programmes in developing competent employees who can achieve the organization’s mission, goals and objectives.

KNOWLEDGE MANAGEMENT IMPLEMENTATION IN P2STPIBN AS INTERNAL TSO OF BAPETEN

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Abstract

Awareness of the importance of knowledge management impementation is growing since the launching in 2014 of BAPETEN's (Nuclear Energy Regulatory Agency of Indonesia) vision to become a world-class nuclear energy regulatory agency. BAPETEN's prime challenge arises since most of its human resources are still lacking experience, and many senior proffesionals have retired or are approaching retirement age. These challenges made P2STPIBN (Center for Regulatory Assessment on the Science and Technology of Nuclear Installation and Material) as an internal technical support organization (TSO) in BAPETEN aware that knowledge management should be implemented in advance. Following the BAPETEN Knowledge Management Guideline which was launched at the end of 2015, P2STPIBN, as part of BAPETEN, activated the knowledge management programme by creating a roadmap and programmes, such as a knowledge map and taxonomy, and a portal for knowledge repository (in progress). In the first quarter of FY of 2016 we started to build CoPs (community of practices) for the Nuclear Reactor Analysis, Nuclear Cyber Security and Nuclear Safety Culture based-on consideration of the needs on the most urgent knowledge. The CoP programme has run from the 2nd week of March 2016. The estimated challenges and anticipations are also discussed.

1.INTRODUCTION

BAPETEN (Nuclear Energy Regulatory Agency of Indonesia) has a task to carry out supervision over all utilization of nuclear energy activities in Indonesia through regulation, licensing and inspection in accordance with the applicable legislation. Since 2014, vision of BAPETEN is set to become a word class nuclear energy regulatory agency to create conditions of nuclear safety, security and safeguards and to improve national competitiveness. To achieve this vision, it is necessary to apply knowledge management, as knowledge is necessary to improve performance and product innovation. The government also sets a reformation program in which one of the programs is change management using knowledge management. BAPETEN's policies for product innovation regulation of nuclear power has been incorporated in BAPETEN Management System (BMS), by identifying the need for innovation; establishing and maintaining innovation processes effectively and efficiently; and providing the resources needed. BMS also sets the planning innovation; innovation inputs; innovation outputs; a review of innovation; verification of innovation; validation of the innovation; and change control innovation [1].

As well as other institutions, the problems we face is a gap between the skills of senior professionals and junior ones as many seniors professionals have retired or are approaching the retirement age. Much of the knowledge is not presented in explicit documents but resides in the form of tacit knowledge. The problem became bigger when our institution declared the organization's vision to become a world-class organization, where we could no longer do the bussiness as usual but should do more to produce new knowledge through innovation. This challenge we face can be resolved through knowledge management. In this paper we elaborate on the implementation of knowledge management at the level of P2STPIBN as internal TSO of BAPETEN.

2.ORGANIZATION P2STPIBN

BAPETEN as nuclear regulatory body in Indonesia has 2 Deputies which covers 7 Technical Directorates and 2 Regulatory Assessment Centers. One of the Regulatory Centers is the Center for Regulatory Assessment on the Science and Technology of Nuclear Installation and Material (P2STPIBN).

Duties and functions of P2STPIBN according to Chaiman of Bapeten Decree No. 01 Rev.2 / K-OTK / V-04 is carrying out the preparation of technical policy formulation, training, development and assessment of regulatory control in the areas of safety, security and safeguard of Nuclear Power Reactor System, Nuclear Non-power Reactor and Non-reactor Nuclear Installation that includes the site, design, construction, operation, maintenance, and decommissioning of nuclear installations and materials. P2STPIBN is an internal technical support organization in BAPETEN under Deputy of Nuclear Safety Assessment (PKN) with the task of exercising oversight in terms of regulation, inspection and licensing. Thus, in the course of its business, P2STPIBN provides assessments and recommendations regarding the regulation, licensing and inspection as shown in the Figure 1.

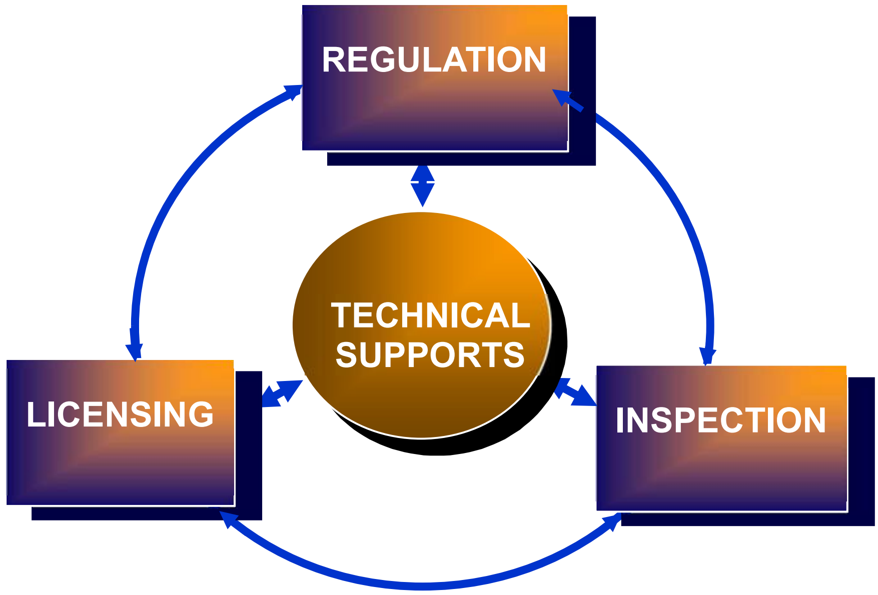

FIG 1. Role of P2STPIBN among the other Directorates

P2STPIBN has 3 division :

(1) Division on the Assessment of Nuclear Power Reactor (PRD).
(2) Division on the Assessment of Nuclear Non-power Reactor (PRND).
(3) Division on the Assessment of Non-reactor Nuclear Installation (INNR).

P2STPIBN has 25 human resources with education level of S1 (Undergraduate), S2 (Master Degree), and S3 (Doctor Degree) from various disciplines which graduated from local universities and abroad as shown in the Figure 2.

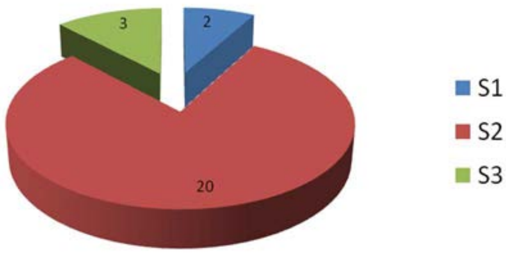

FIG 2. Human Resource Education Level in P2STPIBN

The organization performance is achieved through:

(1) Quantitative and qualitatively assessment in the various fields for regulation revision.
(2) Research cooperation with universities and other institutions.
(3) Incorporation activity in the international nuclear association (ANSN etc.).
(4) Transfer technology from other countries.
(5) To organize and participate in the Workshop / Seminar.
(6) To conduct a comparative study to industry.

3.KNOWLEDGE MANAGEMENT IMPLEMENTATION ROADMAP

BAPETEN Knowledge Management Guideline was launched at the end of 2015. P2STPIBN as part of BAPETEN in the FY of 2015 started to design Knowledge Management program through creating a roadmap and programs such as knowledge mapping and taxonomy generation and a portal for knowledge repository and file sharing. In the first quarter of FY 2016 we started to build CoPs (Community of Practices) on the Nuclear Reactor Analysis, Nuclear Cyber Security and Nuclear Safety Culture. We created the CoPs based-on consideration of the needs of the most urgent current challenges .

The roadmap of knowledge management can be obtained in the Figure 3 which covers steps such as collect, analysis, resolve, design, implement, use and evolve. Since 2016, we had implemented the knowledge management based on program and technology generated in the FY of 2015. The implementation of knowledge management will be continuously improved through utilization and evolvement.

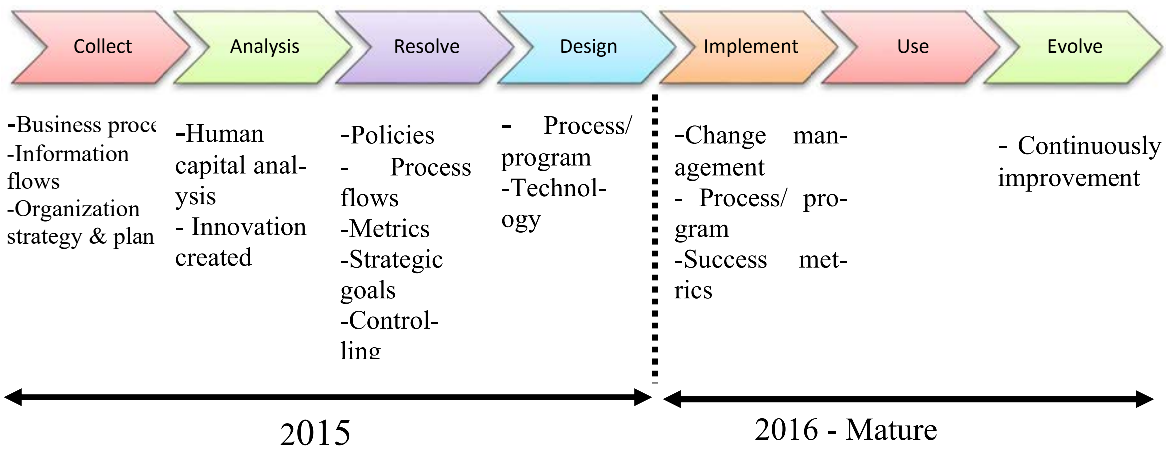

FIG 3. Roadmap of the Knowledge Management in P2STPIBN

3.1 Knowledge mapping and taxonomy

To reach the performance targets, P2STPIBN created activities such as safety assessments of Nuclear Power Reactor, Nuclear Non-power Reactors and Non-reactor Nuclear Installation from regulatory aspects, creates and participates in Nuclear Safety Seminar, creates Management System Documents. Although P2STPIBN consists of 3 Divisions as stated above, the knowledge to achieve organizational goals is almost the same. Therefore, in the bussiness process, the distribution of tasks related to the scope of work performed by the level of division (PRD/PRND/INNR), for the field of expertise is distributed on the level of the center (P2STPIBN) and not on the level of division. In knowledge mapping, we identify the knowledge needed by interviewing structural and functional level employees in the organization besides IAEA SRS-no 79 document [2]. Based on the identification, we articulate the knowledge map in the taxonomy mind map as shown in the Figure 4.

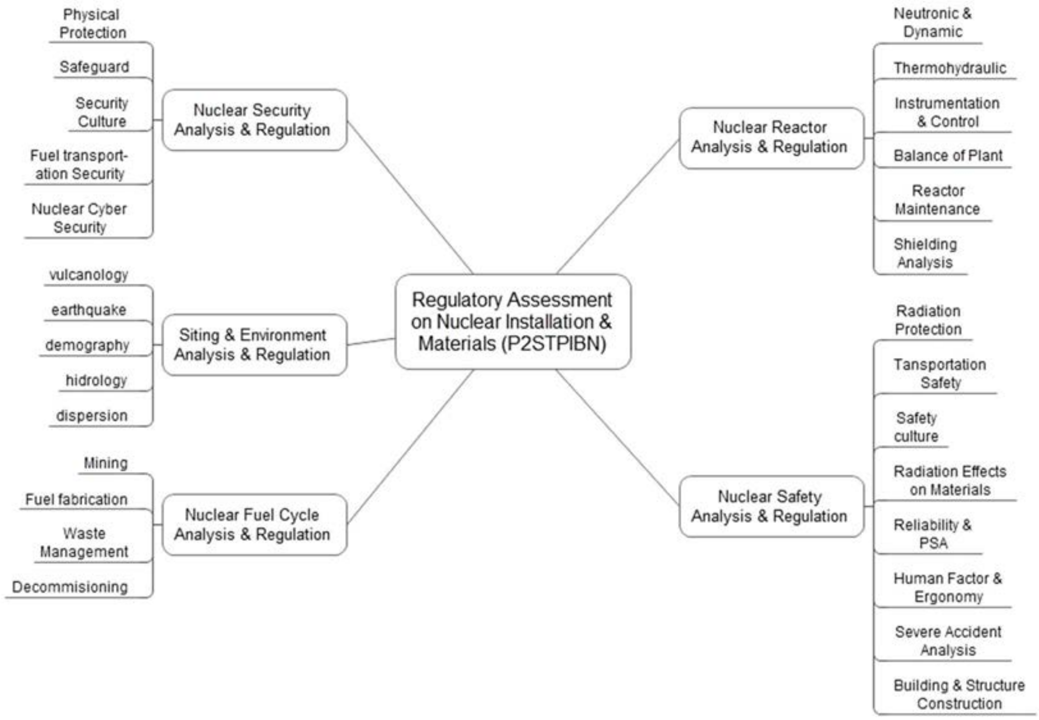

FIG 4. Knowledge Taxonomy in P2STPIBN

3.2 Knowledge repository and file sharing

As an internal TSO that provides services to the directorate of regulation, inspection and licensing, P2STPIBN have a lot of assessment and recommendation results. These results are planned to be stored in the portal that will be established by the staff and mounted on the institution's intranet. The knowledge repository is also completed with service for on-line papers delivery and check on Nuclear Safety Seminar event which is held every year. Besides, P2STPIBN staff have a relatively high mobility which requires information technology system support to allow them to work from the outer office. They can upload the results of their studies and they can also access the computational server from wherever they live in. On the other side, if the staff makes a trip to other institutions, the document can be also accessed and utilized by the other staff members as a reference and for further study. For example the preparation of input code reactor safety calculations could take a long time, around three months. If inventory system is already available, then the staff who will conduct a study does not need to start from scratch in order to compile the code input, but they can use the code input located in the server. The portal is now underconstruction and we hope that it can be utilized soon.

3.3 CoPs

Based on IAEA Tecdoc 1675, we build Community of Practice (CoPs) as a network of people who work on similar processes or in similar disciplines, and who come together to develop and share their knowledge in that field of study [3]. We have created three CoPs on the Nuclear Reactor Analysis, Nuclear Cyber Security and Nuclear Safety Culture based-on consideration of the most urgent knowledge needs and also readiness of the experts in the field as Coordinators. We predicted that sustainability of CoP mostly depends on the Coordinator, therefore we promoted an expert in the field as a Coordinator. The CoPs will be initially delivered once a month, but frequency of the meetings will be determined by the community themselves. We plan to run the CoP program since the 2nd week of March 2016.

3.4 Challenges

Lessons learned from other institutions' Knowledge Management approaches suggested that there are many challenges we will be faced with, such as silo operating environment, staff that has been working in their individual comfort zones, difficulties to teach smart people to learn and share their knowledge, opinion that staff will loose their power if they share knowledge with others, the succession of leadership in the organization is not easy, etc. To anticipate the challenges, as a learning organization, we plan to:

- Implement the change management program regarding the knowledge sharing culture;
- Include to the knowledge management community;
- Benchmark to other institutions' knowledge management approach/activities;
- Activate champions of the knowledge management circle;
- Conduct periodic meetings among initiators and champions of the knowledge management process to get their feedback for improvement;
- Conduct periodic meetings with managers to assure their commitment.

4.CONCLUSIONS

BAPETEN vision is set to become a word class nuclear energy regulatory agency to create conditions of nuclear safety, security and safeguards and to improve national competitiveness. Figure 5, visualizes BAPETEN organizational structure. P2STPIBN as an internal TSO in the BAPETEN has started Knowledge Management program since the end of 2015 following BAPETEN Knowledge Management Guideline, by creating knowledge map and taxonomy and building a portal for knowledge repository and file sharing. In the first quarter of FY of 2016 we also started to build CoPs (Community of Practices). The first meeting of CoP will be conducted on the 2nd week of March 2016. There are many predicted challenges which should be anticipated.

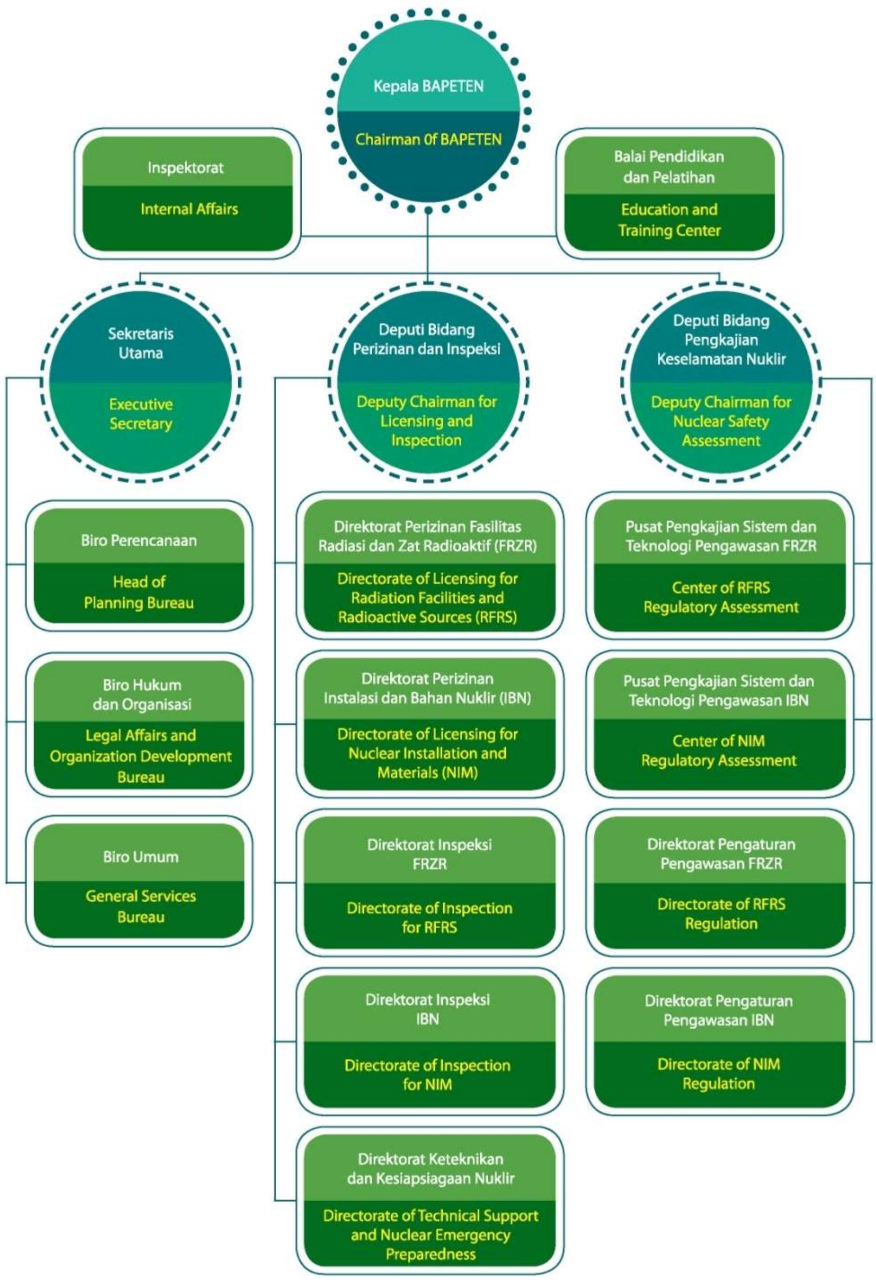

FIG 5. Organization of BAPETEN

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TECHNICAL SUPPORT ORGANIZATION KNOWLEDGE MANAGEMENT FOR NUCLEAR REGULATORY SUPPORT

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Abstract

Knowledge management awareness has increased through the nuclear industrial and regulatory community leading to better understanding of the handling of critical information. Utilizing, managing and regulating the application of nuclear power require an extensive system of expertise and associated research through established organizations. The US Nuclear Regulatory Commission (NRC), Office of International Programs international assistance, training, and technical support include wide ranging regulatory and technical areas through cooperative training programs, workshops, and joint projects. The main benefit of the regulatory and technical cooperation is the improvement in regulatory and technical capabilities both at the nuclear regulatory agencies and the respective Technical Support Organizations (TSOs). The future challenge is to ensure the strengthening the regulatory and technical capabilities of the foreign nuclear regulatory organizations under the NRC international regulatory support program with respect to knowledge management. The paper will further explain the various components, which are used to transfer technologies and establish cooperative projects. The cooperative regulatory and technical assistance program improves the capabilities of the regulatory agencies and TSOs in the licensing process allowing improved reviews and confirmation of technical approaches selected by the licensees and insuring that adequate safety is maintained.

1.INTRODUCTION

Knowledge management awareness has increased through the nuclear industrial and regulatory community leading to better understanding of the handling of critical information. Utilizing, managing and regulating the application of nuclear power require an extensive system of expertise and associated research through established organizations. The long-term maintenance of the specific expertise is only viable by using scientific knowledge management principles all through the national nuclear infrastructure involving regulatory, industrial, academic and other research institutions. National governments in countries operating or planning to establish nuclear facilities have instituted regulatory regimes on the use of nuclear materials and facilities to insure a high level of operational safety. The management and maintenance of expert knowledge must also be extended to the nuclear safety culture allowing maintaining, organizing, and preserving useful practices and organizational know-how. Technical support organizations play a crucial role in providing individual, expert knowledge and institutional organization for support in the nuclear regulatory environment and also applying specific knowledge intensive methodologies for industrial needs.

Nuclear energy offers long-term economic and environmental benefits providing a reliable energy source with significant environmental advantages in reducing the effect of human activities on global warming. The national regulatory environments fully recognize the potential risk involved in operating nuclear facilities and the additional risk that could extend beyond national boundaries. This unique feature of the risk in operating nuclear facilities require international cooperation among nation states regardless whether they actually operate any nuclear facility. International cooperation allows addressing safety problems in an international forum going beyond national regulatory regimes and offers the potential for cooperation and promotion of common nuclear standards through international regulatory coordination. It aims to provide advice and assistance to international organizations and foreign countries to develop effective regulatory organizations and safety standards. Many of these activities are carried out in direct cooperation with the International Atomic Energy Agency (IAEA), the Nuclear Energy Agency (NEA), or other international organizations. In addition, a number of programs in foreign countries are conducted directly with the counterpart agencies under bilateral regulatory and research cooperation agreements.

The US NRC Office of International Programs provides overall coordination for NRC's international activities, in concert with other NRC offices, carrying out policies in the international arena. The OIP establishes and maintains working relationships with individual countries and international nuclear organizations, as well as other involved U.S. Government agencies. The NRC actively participates in international working groups and provides advice and assistance to international organizations and foreign countries to develop effective regulatory organizations and enforce rigorous safety standards. Many activities are conducted directly with counterpart agencies in other countries pursuant to regulatory and research cooperation agreements. The NRC provides safety and safeguards advice, training, and other assistance to countries that seek U.S. help to improve their regulatory programs.

Technical support organizations primarily provide intellectual and service capabilities centered on their extensive knowledge base of individual experts and institutional know-how. Each type of knowledge represents different challenges as the individual expertise is “implicit/tacit” residing within a specific individual (experience, skills, technical knowledge), while the institutional know-how or explicit knowledge must reside in a codified media either in reports, data, or recordings. The corporate knowledge management involves a culture of distributing and sharing information at all levels, from the individual experts up through the corporate infrastructure in an effective and dynamic exchange process.

Maintaining knowledge throughout the nuclear infrastructure is a critical process insuring that all nuclear safety related know-how is preserved and shared through the nuclear complex. Sharing and generating knowledge based information must be consciously organized with the view of managing and developing a strategy for Knowledge Management (KM). Technical support organizations are especially well placed in supporting international efforts in implementing and evaluating country specific KM structures. TSOs are able to assist in developing unique methodologies; provide analysis of organizational needs through training, technology transfer, and KM specific tool developments. An important aspect of the nuclear regulatory assistance effort is to assess comprehensive risk evaluations for knowledge and/or information and data loss.

2.PROGRAM CHALLENGES

In the early 1990s the NRC OIP established an international regulatory safety assistance program in countries with Soviet-designed nuclear reactors. In many of those countries the nuclear regulatory authorities were not well established, had no clear division of responsibility, and had difficulty in enforcing regulatory requirements due to lack of basic nuclear regulatory laws and legal requirements. The initial safety assistance programs provided critical training and technical knowledge of regulatory personnel using US technical experts based at NRC and DOE laboratories such as Brookhaven National Laboratory (BNL). The international assistance, training, and technical support include wide ranging regulatory and technical areas containing a significant knowledge management component. The nuclear regulatory support program is part of a large US international nuclear technical and regulatory assistance that is authorized by the US Government.

The TSOs traditionally have been a significant factor in contributing to the regulatory process of the licensing, constructions, and operation of nuclear power plants. Historically, the TSOs helped establishing the licensing framework in conformance of the regulatory standards existing in each country including appropriate laws and regulations. In many countries, the TSOs have seen increased activities due to potential expansion of the nuclear industry including plans for constructing new reactors and becoming a critical resource in the licensing process. The regulatory bodies play a significant role in clarifying the role of TSOs, the expectation of their responsibilities, and support the TSOs efforts in improving their in-house technical capabilities and financial resources. The US NRC's regulatory assistance program fully recognizes that while the TSOs are largely independent organizations, they still have a specific relationship and perform most technical work at the request of the nuclear regulator.

The US NRC fully recognizes that TSOs providing support in regulatory decisions, in general, do not carry out technical developments to improve technologies or operational methodologies, which are more appropriate for the nuclear industry. The technical developments performed by TSOs are primarily serving the needs of the licensing processes and regulatory decisions making sure that the methods used by industries provide adequate safety. Regulatory reviews require certain capabilities that provide the basis for selecting the organizations serving as a TSO for the nuclear regulator, such as a) technical competency in reviewing licensee's methodology and proposed actions, b) capability of carrying out plant specific analysis, and c) have analytical capabilities, computer codes, and sufficient plant operating experience, which require specific knowledge management strategies and structures.

In the early 1990s, the US NRC regulatory assistance program was originated under the Lisbon Nuclear Safety Initiative recognizing the potential nuclear safety concerns in countries that had Soviet-designed nuclear reactors. The objective of the US NRC's technical assistance program is the comprehensive improvement in the regulatory capability of not only the nuclear regulator, but also the TSOs technical ability to provide significant support in regulatory decisions and also developing a regulatory regime that insures adequate nuclear safety. One of the key elements that determine the nuclear safety is a robust nuclear regulatory regime with an independent nuclear regulator at its center. In many countries, there is an expectation of a large expansion of nuclear power in the coming decades raising the concern of the nuclear regulator's status, the organization and relationship of the nuclear industry, regulator, and the TSOs, and the availability of critical manpower for all these institutions. The assistance program, besides providing specific technical assistance, all along emphasized the importance of an effective regulatory structure to help sustaining a viable nuclear industry and establishing and maintaining an independent and effective nuclear regulation.

The international regulatory assistance program faced many challenges and successes in strengthening the regulatory and technical capabilities of the foreign nuclear regulatory organizations and the TSOs. Over the years the NRC's international regulatory support program has expanded beyond its original scope and includes strategies for supporting the development of KM techniques that may provide long-term support for maintaining the technical viability of TSOs for nuclear regulatory support roles.

One of the critical areas is the ability in assessing any existing KM capability of the organization and identifying potential improvements. The present approach is the use of pre-assembled questionnaires with a list of topical areas, which was put together by an expert panel using technical experts who are familiar with the TSOs role and responsibilities as well as its future goals. The goal of the process is to identify the risk of losing capabilities in specific areas due to either attrition or potential loss of an employee. The process allows establishing priorities based on technical areas and also specifically by key employees. As part of the KM process the TSOs are encouraged and cooperatively assisted to identify critical technical areas including the associated key employees.

The KM assistance program recognizes the importance of organizational culture including the recognition from upper levels of management. This allows the development and placement of KM structures to become significant elements in the whole organization implementing KM processes. TSOs are encouraged to develop a management position on how to identify existing KM processes and develop new ones to fully implement a KM organizational structure. Knowledge development is based on research and development activities and the associated strategic goals are usually defined based on the long-term R&D program [1]. Technical staff is assigned into small groups that are responsible for specific, well-defined topical areas, that serve the bases for identifying critical knowledge.

The R&D activities use existing knowledge, methods and techniques primarily in support of the nuclear regulatory activities ensuring safe operation of nuclear facilities. It involves a wide range of scientific disciplines producing outputs that are usually documented in reports, and/or scientific papers. TSOs rely on a group of highly specialized personnel, who are technical experts in their respective fields and usually do not have immediate replacement or back-up. An institutionally established KM process is especially important when aging nuclear technical personnel is coupled with reduced funding opportunities, which is common in many countries with mature nuclear infrastructure [2]. The KM techniques help addressing the difficulties in recruitment of younger personnel and preserving institutionally critical knowledge areas. Worldwide most TSOs are facing funding pressures and the application of efficient KM processes will increase productivity and could even help reducing cost.

The KM assistance program is often tailored by encouraging the TSOs to develop and maintain close contact with the nuclear installations through the regulatory agencies. In addition, the support programs have a significant component making sure that there is access and information exchange on international KM experience. The technical support program provides a mechanism through which KM methodologies are established insuring the preservation of in-depth technical knowledge, supporting exchanges with the design and operating organizations, and providing the latest KM developments and scientific results from the international nuclear community.

The program recommends a structured technique to preserve knowledge that is inherent in the TSO organization. It involves a combination of structured interviewing and documentation process combined with a peer review group. It provides limited support for mentoring relationships with new less experienced, younger staff combined with consultancy arrangement with recently retired personnel. The documentation and preservation of “tacit knowledge” is a key element especially for technical bases for existing and potential future nuclear design concepts. Many of the KM program elements were developed supporting comprehensive data bases at the TSOs including operating events, installation specific design and operating information, technical data, technical and regulatory assessments. The NRC’s nuclear regulatory assistance program has changed over the years responding to new, international developments, specifically the planned expansion of nuclear installations in countries with relatively limited nuclear regulatory infrastructure. The program recognizes that KM is an integral part of the technical and programmatic assistance to countries with new or expanding nuclear power programs and helps in establishing and maintaining an effective nuclear safety program.

3.CONCLUSIONS

Technical support organizations are especially well placed in supporting international efforts in implementing and evaluating country specific KM structures. TSOs are able to assist in developing unique methodologies; provide analysis of organizational needs through training, technology transfer, and KM specific tool developments. The main benefit of the regulatory and technical cooperation in improving the KM capabilities of the TSOs is the improvement in regulatory and technical capabilities both at the nuclear regulatory agency and the TSOs. The future challenge in supporting further development of KM capabilities is to ensure that the cooperation between NRC and foreign regulatory agencies responds to the country specific regulatory needs and further increase the capabilities with an overall increase in the safety of the nuclear facilities. One of the important functions of the TSOs is to develop and maintain well trained experts in the respective technical and scientific fields using well established and robust KM processes.

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INITIATING KNOWLEDGE MANAGEMENT PROJECT IN A REGULATORY BODY IN THAILAND

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Abstract

Thailand is one of countries that have adopted the use of nuclear technology in various applications such as medical, agricultural, industrial and research applications. Recognizing this enormous potential in many applications, the Office of Atoms for Peace (OAP) as a regulatory body under the Ministry of Science and Technology, carries out a variety of activities to disseminate and promote youth, entrepreneurs and public on the awareness of the atomic energy in Thailand. In recent years, “knowledge management” is one of the key factors that contribute to safe, secure and efficient operation of nuclear activities and facilities but also for the regulatory processes as well. In this regards, the OAP is aware and recognize of the importance of studying and initiating nuclear knowledge and human resource development programme in the regulatory body. Even though, the OAP has been initiating the project on nuclear knowledge and human resources for several years but the present status of the projects still remain in primarily stage of the initiating. This paper describes the initiating of nuclear knowledge in the past and present status for knowledge management project in regulatory body in Thailand.

1.ORGANIZATIONAL BACKGROUND

Thailand is one of the countries that have adopted the use of nuclear technology, thus the need for a governmental body to control and regulate safe uses of it. This is the main responsibility of The Office of Atoms for Peace (OAP), a regulatory body, which is under the Ministry of Science and Technology. It was founded in 1961 as the Office of Atomic Energy for Peace (OAEP) before changing its name to the OAP on October 3,2002 according to the act amending ministry, sub – ministry and department B.E. 2545 [1]. The OAP are responsible for licensing the use or possession of nuclear material, radioactive material as well as the utilization of atomic energy. In addition, the OAP is in charge of monitoring, assessing and inspecting the licensees to ensure that all operators are safely performed. There is a 24/7 network on radiation surveillance and emergency notification, all is for the usage of atomic energy in the safe and efficient manner. This is a place where all scientists, academic partners and staff work together under the same mission, which is to regulate the use of atomic energy, and to create public awareness on nuclear science and technology. This place is also a center for collaboration relating to nuclear energy both domestically and internationally [2].

2.HISTORY OF KNOWLEDGE MANAGEMENT IN THAILAND

The world in the twenty-first century is moving towards a more complex and dynamic environment so the way that an organization successfully practiced in the past may not be applicable in the future [3]. To improve public sector organizations to be high performance organizations, in past several years, public sector organizations in Thailand have been introduced to various management concepts and tools which were initiated and developed in order to increase effectiveness and efficiency in the public sector. “Knowledge Management” is one of the management applications that were introduced to the public sector in Thailand on a very large scale.

“Knowledge Management” was first addressed in the Thai public sector formally in part III “Result-Based Management” section 11 of the Royal Decree on Criteria and Procedures for Good Governance , B.E. 2546 (2003) as follow;

"The government agency, for result-based management under this Royal Decree, shall make itself to be global learning organization. For this purpose, the government agency shall acknowledge and analyze information in all aspects and shall then apply analytical result to its administration for correct, quick, and suitable service. The Government agency shall also promote and develop capability, vision, attitude and co-learning of its official" [4]

Knowledge management is also inserted as one criterion in other mandatory management tools, e.g., quality assurance of universities, the National Economic and Social Development Plan, and the Public Sector Management Quality Award (PMQA)[1]. Each university has to prepare a self-assessment report annually according to the criteria set by the Office of National Education Standards and Quality Assessment (PO). Presently, most government agencies are initiating and implementing knowledge management in their organizations, especially in hospitals, universities, other government agencies in the central administrative system, and state enterprise [5].

3.INITIATING KNOWLEDGE MANAGEMENT PROJECT IN A REGULATORY BODY IN THAILAND

3.1 Journey in the past

Since 2005, the OAP, a nuclear and radiation regulatory body in Thailand, recognizes the importance of studying and initiating knowledge management in organizations specifically related to the knowledge management application and action plan initiation in Thai public sector by the Office of the Public Sector Development Commission (OPDC). In 2006, the OAP has been initiating a knowledge management project "Nuclear Science and Technology Knowledge-Base Development". The project is an activity plan from 2006–2016 which aims to promote and disseminate nuclear knowledge about nuclear application, safety, regulation, inspection to people of Thailand including schoolchildren, teachers, local people, community leaders, media, and entrepreneurs through various form of activities such as nuclear exhibitions, nuclear youth camps, nuclear knowledge caravans, local seminars and nuclear knowledge corners. In this regard, the target population in every activity can learn directly from the OAP's scientists. Since the project initiation, the activities have been conducted in more than 40 provinces all around Thailand as shown in Figure 1. In addition, the OAP has given importance to developing human resources by providing and supporting employees to participate in training courses related to nuclear subjects both on national and international level.

In parallel, 2012 – 2013, the high level executives of the OAP have been considered to improve the knowledge management project by establishing a knowledge management committee in order to develop an internal knowledge management plan and system. However due to the rapidly changing internal environment the limitations of the traditional characteristics of the organization [5] such as cultural, structural, technological and human resource aspects [3] were present and therefore the project still remains in primarily and pending stage of the initiating.

3.2 Present status of knowledge management project

In 2016, the OAP's Secretary-General has been given priority to carry on knowledge management and human resource development system inside the OAP and gave the following suggestions:

Current guideline for knowledge management

- Revision of the membership of a previous knowledge management committee and improving and updating the function and responsibilities of the committee;
- Study and conduct more research on the related reviews and existing literature about knowledge management, especially knowledge management for nuclear and radiation regulatory body, both from IAEA and relevant organizations;
- Issue internal policies to advocate the initiating and implementation of the knowledge management system;
- Adopt effective and efficient knowledge management method and tools;
- Develop an internal effective knowledge action plan and implementation process;
- Implement knowledge management plan.

Current guideline for Human resource development

- Study and conduct more research on the related reviews and existing literature about human resource development and also IAEA publication on SARCoN in order to analyze employees' competence gaps;
- Issue internal policies to advocate the initiating and implementation of the human resource development;
- Adopt effective and efficient human resource development method and tools;
- Develop a formal human resource development plan and implementation process;
- Employees' self-assessment to analyze gap competence.

4.CONCLUSIONS

Initiating knowledge management system in an organization might be difficult but initiating the management in a nuclear and radiation regulatory body organization in order to ensure the future effectiveness and competitiveness might be more difficult due to several major obstacles within the organization such as, rapidly changing internal environment and cultural, structural, technological and human resource aspects. But because of awareness and recognition of the importance of knowledge management, the OAP will continually precipitate the organization into knowledge-based organization.

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MANAGING NUCLEAR KNOWLEDGE IN THE HUNGARIAN ATOMIC ENERGY AUTHORITY

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Abstract

This paper describes the background and status of the Knowledge Management System (KMS) of the Hungarian Atomic Energy Authority (HAEA). The KMS is dedicated to identifying, preserving, acquiring, developing, sharing, using and evaluating knowledge in a consistent way. A KMS is an essential tool for maintain the state of the art knowledge in our authority. This paper presents the project that was created to establish a KMS in the HAEA. After describing the project, it presents elements of the KMS, and the future development ideas related to the KMS.

1.INTRODUCTION

The missions of the Hungarian Atomic Energy Authority (HAEA) are the supervision of the peaceful application of the nuclear energy for purposes of a safe environment and to protect the people. Tasks are: licensing and inspection and assessment of nuclear facilities in Hungary. The medium-term objective of the strategic plan of the HAEA is to keep human resources and knowledge base at a high level. To optimize the internal efficiency of the HAEA is essential to improve the organizational culture and organizational knowledge.

A knowledge management system (KMS) provides a relevant accessible tool for these. There are many definitions of the knowledge management (KM). KM definition in the HAEA is: Knowledge management includes all methods, instruments, tools and activities that contribute to identifying, attaining, developing, transferring and preserving knowledge.

It was recognized that a fully functioning KMS makes, individual and organizational knowledge transfer and preservation aimed at efficiency of official work, easier. A KM program was launched in 2015 in the HAEA with the management's commitment. This program was started by the HAEA because it faced challenges such as: the life time extension of Paks NPP, building of a new NPP, the extension of the official tasks, doubling the numbers of the HAEA, generational changing, retirements, recommendations of IRRS.

It is presented below what tasks were done in relation to the establishment of the KMS, what tasks await us in the future, what challenges did we face and what are the positive and negative experiences with the program. This summary is based on the results achieved by us.

2.PROGRAM BACKGROUND

The initial step in the development of the knowledge management program was to select the person responsible for KMS. A steering committee was created with representatives from across the organization. After the decision of the establishment of KMS project a project plan was done. Below I present elements that are essential to achieve the objectives.

2.1 Knowledge identification

The purpose of the identification of the knowledge is to get an accurate picture about the available and the missing individual knowledge of the HAEA. The aim was to create a kind of knowledge catalogue, to know where the knowledge is assessable. A knowledge catalogue was created which shows knowledge elements and its locations. The knowledge catalogue is also filled in with personal data (name, degree, education data) and the measure of specialization knowledge.

2.2 Knowledge attainment

2.2.1 Internal knowledge attainment-Human Resource

The HAEA should ensure that all of its personnel have the competencies needed to perform their assigned tasks. Recruiting and selecting suitable candidates are the first important steps for ensuring competence and attain knowledge. [1]

2.2.2 External knowledge attainment-Technical support activities

The international agreements on nuclear safety specify requirements for the technical background. The Act on Atomic Energy also orders that the safe use of atomic energy and the solution of the corresponding technical support tasks shall be facilitated by scientific and technical development, coordinated organization of research activities and practical use of the results of international and domestic scientific research. The coordination and financing of technical background activities in relation to safety and security of the peaceful use of atomic energy in Hungary meant to support the regulatory oversight is the task of the HAEA. Various background programs support the regulatory oversight activity regarding the peaceful use of atomic energy. Since 1996 the programs have been developed in multi-annual task plans. The implementation of the tasks takes place according to annual support contracts according to a negotiation process including a tendering system. In the field of regulatory activities related to nuclear safety it is a requirement to incorporate the Technical Support Organizations (TSOs) in order to support the regulatory work. During the technical support programs of recent years a network of technical support organizations assisting the regulatory activity of the HAEA has been formed. It provides the necessary independent background for the HAEA with qualified professionals. The independence of expertise support is guaranteed by high level quality management systems introduced at the TSOs.

2.3 Knowledge development - SAT training program

The systematic training method of International Atomic Energy Agency (Systematic Approach to Training-SAT) was implemented and applied as follows:

(a) Analyze the evolution of the institutional knowledge and training needs,
(b) Plan the longer and shorter term training objectives and programs,
(c) Develop training systems,
(d) Implement the agreed training programs, and
(e) Assess the training programs carried out.

Training programs can be divided into three groups: training for new entries, training, advanced training. In any case, the HAEA training programs follows the principles of the SAT.

2.4 Knowledge transfer

2.4.1 Mentor program

The goal of the mentor program is to ensure the effectiveness of the new entries and transfer the accumulated professional knowledge and experience to the new generation. A mentor is a person who provides guidance to a less-experienced employee, the mentee.

The scope of the professional mentor program is determined by the education of new entries, professional background, and the HAEA's current tasks.

2.4.2 Identification of risk of knowledge loss

HAEA has internal regulation to identify persons with critical knowledge and areas where critical knowledge transfer is necessary. At the beginning of each year persons who are expected to be years out of the HAEA determine and assess those fields where knowledge transfer is necessary. An action plan is to be done to transfer knowledge. The identification of the critical knowledge is done with use of the data of knowledge catalog. The identification of the critical knowledge of the IAEA is based on the method of IAEA. [2]

A personalized knowledge transfer technique may be selected. Knowledge transfer technique: descriptions, professional summary, practical knowledge transfer, mentoring, part-time employment, interviews.

2.5 Knowledge preservation-Hungarian Nuclear Knowledge Basis (HNKB)

The goal of HNKB is to preserve and maintain the common knowledge gained during the years of the utilization of nuclear energy. The HAEA has decided to prepare a national level knowledge management strategy for the further and future nuclear power generation, and for the related regulatory activities. The first phase was the establishment of a knowledge basis related to the regulatory activities, based on a computer aided experience feedback system. The second phase was the establishment of the HNKB with the wide participation of the interested utilities, engineering companies, research institutes, institutions and authorities. The information sources consist of four groups. The first group is the personal experience of the HAEA senior staff, which is to be collected by preparation of personal memories about reactor events, assessment activities, inspection reports, evaluated documents, and the personal annotations and comments. The personal memories will be transformed into common knowledge by systematic organization and structuring the individually gathered information pieces and by introducing it into a computerized database application. The second group consists of the international level event reporting systems, such as the Incident Reporting System (IRS, IAEA-NEA), the Incident Reporting System for Research Reactors (IRSRR), International Nuclear and Radiological Event Scale (INES) and the domestic system of event investigations, such as the database of the Hungarian events. The third group of information sources includes the policy making documents, standards and recommendations coming from the IAEA, NEA, organizations of EU, or VVER Forum, etc. The fourth group is the knowledge gained from the reports of the research and development projects supporting the sustainability of nuclear operations or assisting the regulatory activities. Computerized database applications are needed to empower the human intelligence with the data organizing, seeking, searching and visualizing functions. The results of the above listed information and knowledge collecting efforts are promoting the effectiveness of the regulatory activities, and the well grounded decision making. [3]

3.OUTLOOK ON THE FUTURE USE OF THE KNOWLEDGE MANAGEMENT SYSTEM

The KMS of the HAEA is in its early development phase. KM is not only the responsibility of an organization's information technology, human resources, or training departments. To be effective, a KMS should be organization-wide. The IT and KM strategies of the HAEA are not aligned. The KMS operated by the HAEA requires advanced computer-based tools. The long term goal is to develop an intranet portal that provides further tool to develop and expand the knowledge management in the HAEA.

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KNOWLEDGE MANAGEMENT FOR ENHANCING REGULATORY BODY CAPABILITIES IN THAILAND

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Abstract

In order to be a learning organization, the Office of Atoms for Peace (OAP) has appointed a knowledge-management team in an attempt to manage internal knowledge, both tacit knowledge and explicit knowledge, systematically. In principle, the seven steps of knowledge management will be applied for OAP KM, namely: knowledge identification including the knowledge required of the Regulatory Body, knowledge creation and acquisition including knowledge sharing, transfer and how to maintain knowledge external factors such as a customers, stakeholder, etc., Knowledge organization based on knowledge structure is needed for systematic knowledge retention in the future, knowledge refinement with ISO standards in document storage., knowledge access for example, using information technology management through web board, knowledge sharing, OAP staff through numerous methods designed to transfer implicit and tacit knowledge such as formal classroom and on-the-job training, informal Communities of Practice, mentoring, learning is OAP group continually enhancing their capabilities and making decisions, solving problems and improving the organization. OAP staff could apply knowledge for organization development and planning for a supporting guideline.

1.INTRODUCTION

Thailand has been utilizing the nuclear energy and radiation for many decades. The utilization is applied for medical, industry, education in science and technology, etc. At present, the nuclear regulatory activities are focused on the research reactor. Office of Atoms for Peace (OAP) is governmental organization under the Ministry of Science and Technology of Thailand, was established in 1961. OAP takes responsibility as nuclear and radiation regulations coordinate and support for safety, security and safeguards, research and development for regulatory purposes. So, Knowledge Management (KM) is important for enhancing an organization's capability to deal with its mission and maintain high standards of safety while ensuring that regulation is effective, its ability to deliver the result and to be able to cope with change. The main requirement of KM is a system for collecting, building, and providing, enhancing, performing and applying organizational knowledge by technology information. OAP's KM specifies its maintaining knowledge goals, particularly of retiring experts and transferring this knowledge to the next generation. In addition, KM methods should become an integral part of daily management, thus ensuring the sustainability of the effort.

2.METHOD

KM is a systematical process which includes collecting, organizing, clarifying, disseminating and reusing the information and knowledge throughout an organization. KM deals with explicit knowledge and tacit knowledge and should possess maturity attribute, dynamic attribute and self-growth attribute.

All knowledge can also be among "know-what," "know how" and "know why" levels of knowledge.

"Know what," knowledge specifies what action to take when one is presented with a set of stimuli. For instance, a salesperson who has been trained to know which product is best suited for various situations has a "know what," level of knowledge.

The next higher level of knowledge is “know how” –i.e., knowing how to decide on an appropriate response to a stimulus. Such knowledge is required when the simple programmable relationships between stimuli and responses, which are the essence of “know what” knowledge, are inadequate. This might be the case, for instance, when there is considerable “noise” in symptomatic information so that the direct link between symptoms and a medical diagnosis is uncertain. “Know how” type knowledge permits a professional to determine which treatment or action is best, even in the presence of significant noise.

The highest level of knowledge is “know why” knowledge. At this level, an individual has a deep understanding of causal relationship, interactive effects and the uncertainty levels associated with observed stimuli or symptoms. This will usually involve an understanding of underlying theory and/or a range of experience that includes many instances of anomalies, interaction effect, and exceptions and the norms and conventional wisdom of an area.

OAP has appointed knowledge management team in attempt to manage internal knowledge both tacit knowledge and explicit knowledge, systematically. In principle, the seven steps of knowledge management will be applied for OAP KM, namely:

- Knowledge Identification - to make the organization’s knowledge assets visible, it is necessary to explore knowledge within the organization;
- Knowledge Creation and Acquisition – knowledge creation is the knowledge created within the organization for example; new skills, ideas which can improve organizational processes and also competencies, meanwhile, knowledge acquisition is the required knowledge that obtained from external sources;
- Knowledge Organization – an organizational knowledge structure shall be mapped as a part of knowledge identification. Knowledge structure can be updated or extended as necessary. Knowledge organization based on knowledge structure is needed for a systematic knowledge retention in the future;
- Knowledge Refinement – it is the processes and mechanisms to select, filter, purify and optimize knowledge included in various storage media. It is the process required for continuous quality improvement of explicit knowledge management with ISO standards in document storage;
- Knowledge Access – the knowledge and experiences should be readily accessible to others and replicated if desired. This is to allow users to access the knowledge desired easily and conveniently by using information technology management through web board;
- Knowledge Sharing - knowledge can be shared by the organization with its staff, between staff of the organization as well as with people outside of the organization. Implicit and tacit knowledge transfer can be done by various means for example; formal classroom, on-the-job training, informal Communities of Practice, and mentoring;
- Learning – organizations and staff need to learn and internalize relevant knowledge experiences and actions through personal and group interactions within the organization.

3.CONCLUSIONS

In Sum, it was found that by using seven processes of knowledge management required of the Regulatory Body including knowledge sharing and transfer, maintenance of knowledge factors based on knowledge structure with ISO standards through the use of information technology, will be able to enhance organization capability and improvement. OAP staff could apply this knowledge for organization’s development and planning for a supporting guideline. In addition, OAP has to develop a human resource development plan and formulate internal training programs for knowledge transfer and exchange between staff so as to keep organizational knowledge developed and sustainable.

4.CHALLENGES

The challenge for OAP in managing organization knowledge is how to maintain the currency of organization's knowledge. To address this challenge we need tools for design and development of a KM system.

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EMPLOYEE DEVELOPMENT CAPABILITIES OF THE REGULATORY AUTHORITY IN THE NUCLEAR FIELD IN ROMANIA

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Abstract

The paper provides information about CNCAN (general presentation of CNCAN responsibilitiesas a regulatory body) and about the general human resources management withinour institution regarding the following: legal framework regarding resources; knowledgemanagement; staff employment financial resources continuous focus on improvement ofstaff performances through dedicated training programmes. The process to develop andmaintain the necessary competence and skills of staff of the regulatory body, as an element ofknowledge management. Training for CNCAN staff is provided either in-house or throughtechnical cooperation programmes with the IAEA. CNCAN has made arrangements forspecific staff training using training courses and programmes provided by internationalorganizations. The specific training is provided predominantly with the economic supportfrom outside of the country.

CNCAN has a process to develop and maintain the necessary competence and skills ofstaff of the regulatory body, as an element of knowledge management. To maintain anappropriate competence level, an annual plan for staff training is in place and each staffmember has an individual training plan.

Project supports CNCAN in the development of knowledge management and capacitybuilding frameworks to secure long-term availability of regulatory competency.

KNOWLEDGE MENAGEMENT IMPLEMENTATION IN INDONESIA NUCLEAR ENERGY REGULATORY AGENCY (BAPETEN)

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Abstract

Indonesian Nuclear Energy Regulatory Agency (BAPETEN) acquires the task and function to control the safety, security and safeguards in the field of nuclear energy through the development of legislation, licensing services, inspection and enforcement. This is supported by review and assessment, emergency preparedness. Knowledge Management (KM) is importance for BAPETEN to achieve the Regulatory body effectiveness and product innovation. The Chairman of BAPETEN has set policies statement for KM implementation. To implement a knowledge management program, BAPETEN creates KM guidelines that include Blueprint and Roadmap KM program based on a KM Readiness survey. The KM readiness survey involves 20% of staff who represent each unit and discussions with the senior manager of BAPETEN, and the result of readiness survey produce 13 KM BAPETEN initiatives strategic. After the initiative strategic has been obtained, BAPETEN creates the Roadmap of BAPETEN Knowledge Management for 2015 – 2019 program for KM People with the activity socialization of KM Guidebook, workshop SMART knowledge worker, nurture Community of practices (COP) and develop social network analysis (SNE). KM Process with activity focus group discussion, KM Readiness survey, KM Statement, KM Bapeten Guidebook, knowledge mapping, knowledge harvesting. KM Technology with activity develops knowledge system or portal, e-learning.

1.INTRODUCTION

Indonesian Nuclear Energy Regulatory Agency (BAPETEN) was established by Act No. 10 of 1997 on Nuclear Energy. BAPETEN set a vision to become the world class nuclear energy regulatory agency to achieve nuclear safety and security conditions and improve national competitiveness. One of the world-class organization' characteristics is a world-class innovation done by implementing knowledge management (KM) that set to improve performance and product innovation. BAPETEN Management System creates policies for knowledge management and innovation. Indonesia, as an IAEA Member States, is expected to implement the Nuclear Knowledge Management. Not only does it occur in the change management program, but also in implementing knowledge management.

To implement a knowledge management program, BAPETEN creates a KM guideline that includes Blueprint and Roadmap of KM program based on a KM readiness survey. The KM readiness survey involves 20% of staff who represent each unit and discussions with the senior manager of BAPETEN. The knowledge management guidelines are expected to be useful for the following:

— Understanding KM from the perspective of BAPETEN, the IAEA and Change Management of Bureaucracy in realizing the vision and product innovation of BAPETEN;
— To give guidance for employees in BAPETEN to be a SMART knowledge worker through the activity of learning and sharing knowledge on a basis of continuous learning and sharing, and apply them in their daily work to improve the effectiveness of BAPETEN;
— Understanding the BAPETEN KM Blueprint which includes the Vision, Mission, Values, Strategies and Initiatives, as well as utilizing KM Roadmap to guide the implementation of KM in BAPETEN.

2.KM POLICY STATEMENT OF BAPETEN CHAIRMAN

The Chairman of BAPETEN has established a policy for implementation of BAPETEN Knowledge Management, as follows:

- Active participation of all management as a role model in knowledge management activities in accordance with the Blueprint and Roadmap of KM BAPETEN;
- Knowledge sharing as part of the Key Performance Indicator (KPI) as outlined in the determination of annual performance;
- Make sure the output and product innovation based on knowledge of BAPETEN;
- Ensuring that knowledge management is a part of the Bureaucracy Reformation program carried out by all BAPETEN units.

3.KM READINESS SURVEY

It is a method that is carried out to determine the readiness of the implementation of KM in the organization. The survey was conducted mainly to get the flow of knowledge in the organization by using questions relating to the method Socialization - Externalization - Combination - Internalization (or commonly abbreviated as SECI). From the analysis of the survey results, it gives out 13 initiative strategies that serve as a basic for KM Implementation:

- Coordinate and coach the implementations of KM and socialize the benefits;
- Get support from Board of Directors and Senior Management Team regarding KM initiatives;
- Get support and coach from KM team to ensure the communities discussion forums to be informal, fun, and have values in every meeting;
- Initiate and nurture Smart Knowledge Worker that will lead to an excellence knowledge sharing culture;
- Develop methodology and knowledge documentation media that can be used in daily work, such as After Action Review (AAR);
- Establish procedures, guidance, reference, and system that support knowledge sharing and documentation;
- Increase employees' abilities in knowledge writing and documenting and to nurture the culture of writing;
- Appoint knowledge intermediates: personnel/team specialized in managing information;
- Develop and integrate KM System that supports the processes of Sharing, Capturing, Organizing, and Accessing Knowledge;
- Develop knowledge taxonomy for ease of classification of important knowledge, and a guidance to store and seek important documents / information;
- Arrange & develop KM reward & incentive system;
- Develop both internal KM System and external knowledge acquisition process in the plan of being the center of knowledge in 3S;
- Develop Social Network Analysis.

4.ROADMAP OF BAPETEN KM PROGRAM 2015 – 2019

Based on the KM Readiness Survey, we prepare the Roadmap of KM BAPETEN for 5 year program as follows:

4.1 2015: KM strategic goal

(KM Process)

- Focus Group Discussion;
- KM Readiness Survey;

- KM Statement;
- BAPETEN KM Guidebook.

4.2 2016: KM development

(KM People)

- KM Socialization;
- KM Guidebook Socialization;
- Workshop Leading / Becoming SMART Knowledge Worker;
- Pilot Nurture COP.

(KM Process)

- Knowledge Mapping;
- Develop Knowledge Harvesting Team.

(KM Technology)

- Prepare KM Taxonomy & Evaluate Existing System;
- Prepare KM Portal;
- Design E-Learning System.
-

4.3 2017: KM internalization

(KM People)

- Nurture COP (Knowledge Sharing Session);
- Prepare Internal Social Network Analysis.

(KM Process)

- Knowledge Mapping;
- Knowledge Harvesting.

(KM Technology)

- Design & Establish BAPETEN KM System (Repository, Collaboration, e-Learning).

4.4 2018 – 2019: KM sustain the initiative

(KM People)

- Nurture COP for performance & innovation;
- Develop Social Network Analysis for Internal & External.

(KM Process)

- Validate & Utilize BAPETEN Knowledge Map;
- Knowledge Harvesting.

(KM Technology)

- Maximize The Utilization of BAPETEN KM System.

5.CONCLUSIONS

The Chairman of BAPETEN has set policies for KM implementation. In order to ensure the effectiveness of KM activities, the program planning activities of KM BAPETEN 2015-2019 have to begin with conducting readiness surveys and producing 13 KM BAPETEN strategic initiatives. The analysis from the survey results are used for creating the roadmap of KM ready for implementation.

REFFERENCE

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KMPlus, Knowledge Management SELECTION AND TRAINING OF PERSONNEL FOR THE NEW NUCLEAR MEDICINE AND RADIATION THERAPY CENTRE IN BARILOCHE

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Abstract

A basic strategy for the development of a new organization is the selection of personnel, especially if it is an institute that offers a technological and professional innovation. This work aims to define specific profiles for the Centre for Nuclear Medicine and Radiation Therapy Bariloche and to design a plan for selecting and training professionals.

1.ORGANIZATIONAL CONTEXT

Radiotherapy and nuclear medicine centres in Argentina are located in Buenos Aires (about 60% are in that province), and a few big cities inland. The majority (90%), of these medical centres are private.

In order to facilitate access to cancer treatments to the entire population, the previous government launched the National Plan for Nuclear Medicine and Radiotherapy. The proposal of the National Plan is to create eight Centres of Nuclear Medicine and Radiotherapy in different cities in the country. One of them is being built in the Bariloche Atomic Centre, in the city of San Carlos de Bariloche, Patagonia Argentina.

The Bariloche Atomic Centre is a facility for research, development and training of the National Atomic Energy Commission of Argentina. The Commission also operates the Ezeiza Atomic Centre, the Constituyentes Atomic Centre and several academic institutes (Balseiro, Sabato and Beninson). It also participates in the nuclear medicine services at Roffo Hospital and Nuclear Diagnostic Centre Foundation in Buenos Aires city, and the School of Nuclear Medicine Foundation in Mendoza.

The Centre for Nuclear Medicine and Radiation Therapy of Bariloche will have a diagnosis and treatment area equipped with two linear accelerators, one high dose brachytherapy room, a PET/CT, a SPECT/CT, and radiopharmacy laboratory, including a cyclotron.

The mission of the Centre for Nuclear Medicine and Radiation Therapy of Bariloche is to become a centre of excellence for the research, innovation of Medical Physics, and for training professionals in that area. These developments are transferred directly into the health care services, to provide a better quality of diagnose and treatment.

To this end, the facility in Bariloche includes laboratories of dosimetry and computational medical physics, the development of radiopharmaceuticals and biomedical engineering. It also has a room for preclinical studies, classrooms, a library and an auditorium for conferences. This building will have about 7000 m2 of total floor area. In the case of the new Centre of Bariloche, the Commission is responsible of all the operation and management, including the health care service.

2.OBJECTIVES OF THE KM INITIATIVE

The selection of candidates for key positions is strategic for the development of an organization, especially if it is a new one that will offer technological innovation as well as professional training. This is relevant in the case of the Centre for Nuclear Medicine and Radiation Therapy in Bariloche, because of the lack of experts in the field of Medical Physics within Atomic and Nuclear Energy Commission, and in the country.

Two steps should be considered before defining the personnel profiles. First, the strategy of the organization has to be defined. Second, the design of the organizational structure is derived from that strategy. Finally, the parameters for the selection of personnel are established [1].

The organizational structure determines the staff required to operate the health care facility of the Centre [2, 3]. However, since the Centre is aimed to research and technology development in Medical Physics arena, the professional roles of the staff need to match this innovative healthcare approach.

The aim of this work is to define one of these profiles, the specialist medical physicist in radiotherapy, and to establish the recruitment and training strategies that would fit the needs and possibilities of the Centre.

3.DESCRIPTION OF THE KM INITIATIVE

The job description was prepared based on individual interviews with specialists in radiotherapy physics, including the head of the radiotherapy service in Mendoza. The objective was to determine the responsibilities, tasks and requirements of the role, focusing on the level of development it involves; the knowledge, skills and attitudes required [4]

The main areas of knowledge arose from the analysis of the interviews, and constitute the minimum requirements that a candidate must meet. The new technologies demand postgraduate studies for this role. This should provide the candidates with a know-how that broadens their professional vision, and with an increasing level of abstraction. It is fundamental that they are very familiar not only with local but also with international healthcare practices.

Research is a key aspect of the profile: the candidate has to be passionate about research, and willing to teach.

Another essential aspect of the role is to foster the interaction of the various professionals in the clinical area. This interdisciplinary work is fundamental in the daily processes of patient care. Therefore, the collateral relations and teamwork have to be defined by the organizational structure and encouraged by managerial levels.

The full job description is included in section 6.

The selection of candidates begun with announcements to the students of the Master in Medical Physics at the Balseiro Institute. They were offered to join the Atomic and Nuclear Energy Commission once their degree was obtained, to continue training under the supervision of specialists and renowned researchers.

The training program has a theoretical part, followed by a clinical training period in one of the authorized radiotherapy services in the country. It also includes the participation in conferences, the visits to medical facilities, and the full access to research laboratories and libraries.

The students must develop a training topic, prepare written reports and present periodically their advances orally. However, the main attractive of this program is the chance to participate in the current development of the Centre, the start-up of the services and commissioning of the equipment.

At the end of this program, the candidate gets the license of specialist in radiotherapy physics by the National Nuclear Regulatory Authority. To this date, the program allowed to incorporate a group of medical physicists that constitutes the initial staff of the Centre.

4.MAJOR CHALLENGES AND ACHIEVEMENTS

Main challenges were:

— Since the postgraduate training period of a specialist in radiotherapy physics is at least three years, while the proposed schedule for the opening of the Centre was one year and a half, it was necessary to start training people well in advance;
— There are very few specialists in the labour market, because there are few schools and hospital training programs;
— Training centres are concentrated in major cities, following the pattern of radiotherapy centres in the country, most of them located in large urban areas;
— Professionals who are trained in those centres are commonly employed there, and there are no plans or programs to stimulate their relocation to other cities;
— Professionals in public healthcare services are not paid according to the level of responsibility and commitment that those facilities demand. They are usually attracted by better salaries of the private practice;
— The Bariloche Atomic Centre and the Balseiro Institute are recognized centres for training and research that gather specialists with broad experience. This attracts young and enthusiastic candidates, although a long-term retention strategy is needed to balance the difficulties in hiring.

The greatest achievement was the incorporation of a minimum group of specialists to the Centre, using the strategy summarized in section 3.

5.LESSONS LEARNED / KNOWLEDGE DERIVED

A few highlights among the experience obtained are:

— The presence of a nearby training centre was the fundamental factor that allowed the development of a training program for professionals in medical physics;
— Training centres tend to retain professionals and there are few possibilities for exchanges. Therefore, the preparation of professionals should be carried out locally;
— Experienced specialists with a well-established career path attract young talent;
— A plan to retain trained professionals should be developed, that include an outreach program, offers for international training and job alternatives that take into account individual motivations.

6.ADDITIONAL INFORMATION

Job Description: Radiation therapy physicist responsibilities:

- Commissioning of the facility;
- Participate in the design of the facility, defining the technical specifications of the equipment.
- Supervise the installation and calibration of the treatment equipment. Perform the customer acceptance tests and commissioning of equipment;
- Treatment planning;
- Carry out patient's data acquisition using diagnostic imaging equipment (CT, MRI, PET / CT).
- Plan and deliver of radiotherapy treatments;
- Perform the measurement, calculations and verification of the applied dose to patients;
- Quality Assurance;
- Collaborate with the design and implementation of a program of Radiological Protection of patients, staff of the Radiotherapy Department and public;
- Participate in the implementation and monitoring of a quality assurance program;
- Perform quality control of treatment equipment and treatment planning system.

Education requirements and further studies [5]:

- Degree in Physics, Medical Physics or Bioengineering;
- Master degree in Medical Physics (or equivalent courses recognized by the Nuclear Regulatory Agency);
- Supervised clinical training in a Radiotherapy Department;
- Single license of Radiotherapy Physics Specialist Granted by the Nuclear Regulatory Authority.

Training time:

- 18 months to obtain a Master Degree in Medical Physics, plus;
- One/two years of supervised training to obtain the single license of Radiotherapy Physics Specialist.

Specific Knowledge Areas [6]:

- Treatment planning;
- Dosimetry;
- Quality assurance;
- Radiation protection;
- A high level of knowledge and information on international practices is needed.

General Skills:

- Capacity to focus on innovation and the application of new developments;
- High level of conceptualization and abstraction;
- Capacity to work in a team and to establish collaborative relationships with other professionals, especially in the radiotherapy process;
- Interest in research. Authored original publications in medical physics applications;
- Ability to make technical or scientific public presentations;
- Ability to write and to communicate in a scientific language;
- Interest or a background in university teaching;
- Commitment with the clinical practice, the project and the organization.

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KM FOR THE APPLICATION OF RADIATION SOURCES IN MONTENEGRO

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Abstract

Successful implementation of international norms on the effective utilization of radiation sources requires a number of prerequisites at the State level – provision of adequate legal, institutional, financial, technical and human resources. Among these, it is often taken for granted that necessary knowledge and competence do exist per se. However, this is not always the case, just the contrary – time, efforts and resources are frequently wasted because these fundaments are not built solid at first. Montenegro is a small "non-nuclear" country, the use of radiation sources being limited to mainly medical applications Experiences with KM are outlined, state university having the central role. The role of networking and international cooperation, particularly with IAEA and EU (the latter in light of the current Montenegro accession process), is emphasized.

1.SCOPE OF THE APPLICATION OF RADIATION SOURCES IN MONTENEGRO

Montenegro is a small (population 625.000), developing and "non-nuclear" country (no nuclear installations or fuel cycle elements). The use of radiation sources is modest and limited to a few ordinary applications – primarily in health care and sporadically in some other fields.

Even though, there is (or will be in the near and mid-term future) a significant need in nuclear knowledge, competence and expertize – directly or indirectly related to proper and effective utilization of radiation sources, as well as to related-to-this safety and security issues. It goes about the following, the list being not exhaustive: (i) medical applications (diagnostics, radiotherapy, palliation, sterilization of equipment, consumables, blood products, etc.), (ii) radiation protection, including various dosimetry services and QC/QA of radiation sources; (iii) environmental protection (radioecology, analytical and monitoring services, etc.), (iv) low and medium activity radioactive waste management (including a newly licensed storage), (v) industrial, geological, hydrological, agricultural, biochemical and archaeological applications (non-destructive testing, various gauges, radioisotope labeling, harmful insects sterilization, etc.), (vi) scientific, educational and training uses, (vii) cultural heritage preservation and investigation, (viii) legislative and regulatory aspects, including complying to international safety/security norms and joining international conventions in he field, (ix) preparedness and response to radiological and nuclear emergency situations, (x) combating illicit trafficking of nuclear and other radioactive materials, (xi) nuclear forensics, (xii) security systems based on X-rays and other nuclear methods, (xiii) introduction of some future topics (e.g. nuclear power for electricity generation and sea water desalination), (xiv) public information and communication with media, etc. [1,2].

2.KNOWLEDGE AND COMPETENCE – FUNDAMENTAL PREREQUISITES FOR THE PURPOSEFUL AND SAFE USE OF RADIATION SOURCES

Successful implementation of international norms on the utilization of radiation sources, including safety and security issues, requires a number of prerequisites at the State level. This primarily means provision of adequate legal, institutional, financial, technical and human resources. Among these, it is often taken for granted that necessary knowledge and competence do exist per se. However, this is not always the case, just the contrary – time, efforts and resources are frequently wasted because these fundaments are not built solid at first.

Provision of adequate knowledge, competence and expertize represents consequently a major concern in small countries – if inadequate (FIG. 1), safety and security will eventually be jeopardized. The above are thus the fundamental prerequisites not only for the meaningful and purposeful utilization of radiation sources, but also for their safe and secure employment at all. Universities, state ones in particular, are the logical and regular points of creation, dissemination and preservation of nuclear (incl. radiation source) knowledge, competence and expertize in small countries.

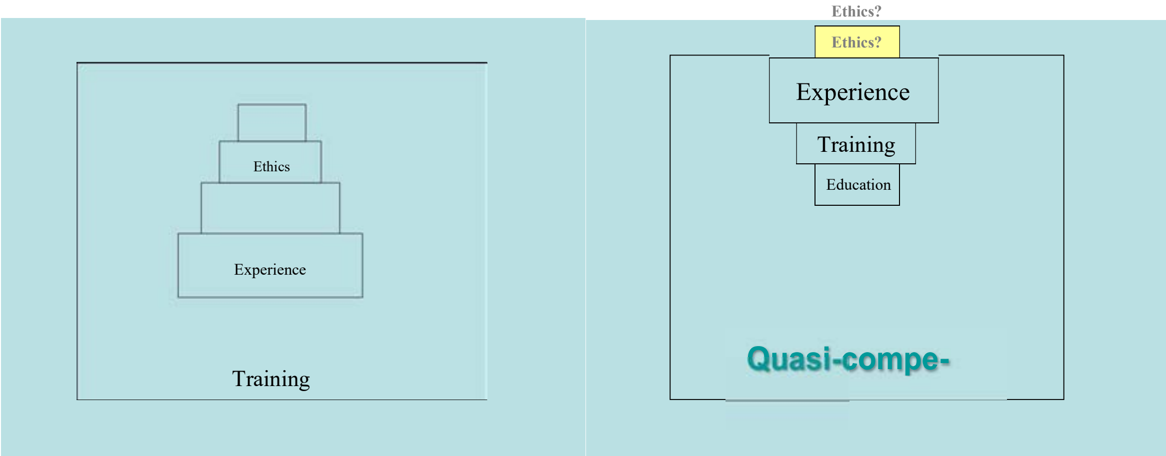

FIG. 1. Education as the fundament of competence (left); competence vs. quasi-competence (right).

3.UNIVERSITY OF MONTENEGRO

University of Montenegro (UM) is the only state university in the country and the only one providing higher education, scientific research and expertise in natural and technical sciences, including nuclear/ radiation-related ones – it is the statutory duty of UM to do so, and to do it in a manner commensurate to the country needs [3]. By far the most relevant expertise in the country is either concentrated at UM or is deriving out of it; it therefore goes without saying that UM has fundamental role in meeting KM related goals in Montenegro, including the application of radiation sources [4].

4.IAEA AND EU ASSISTANCE

Small issues in big countries are often big issues in small countries. IAEA offers the unique and equal opportunity for all Member States to come up with their problems and seek for cooperation/assistance in order to cope with them; there are numerous modalities in pursuing these goals.

Montenegro became an independent country and IAEA member state in 2006. It has since successfully participated in various IAEA activities, including several cycles of technical cooperation (TC) projects. In the beginning the focus was on developing regulatory infrastructure (legal and institutional) and upgrading capabilities in medical application of radiation sources (diagnostics and therapy). Given the fact it is an “ecological state” – as defined by the first article of its constitution – emphasis was put on environmental protection as well (radioecology and application of nuclear techniques in environmental monitoring). Security was addressed through participation in dedicated activities organized by the IAEA, with emphasis on combating illicit trafficking of nuclear and other radioactive materials; in particular, border police capabilities were upgraded towards meeting international norms.

Being in the accession/negotiation process to the European Union (EU), Montenegro is also in position to benefit from various mechanisms existing in the EU to strengthen capacities in non-power applications of nuclear energy, safety and security of radiation sources in particular. In this sense, our positive experience with IAEA cooperation was affirmatively reflected/accepted during negotiations on Chapter 25 – Science (in particular cooperation with EURATOM), which was the first to be opened (and preliminarily closed) in the negotiations.

It is the policy of the country (institution in charge is Ministry of Science) to approach cooperation with the two (IAEA and EU) in the way that activities complement and resonance with each other, rather than overlap or excess – fortunately/helpfully, it is already in the mechanisms of IAEA and EU for the most part. This is reflected inter alia in the latest Country Program Framework (CPF), specifying priorities in TC for the period 2014-2020, with human resource development (HRD) among the first priorities [5]. Note that the CPF period coincides with the final stage of Montenegro accession to the EU.

5.NETWORKING

Networking is becoming increasingly important for building/sustaining a national body of knowledge, competence and expertize. This is particularly valid for those countries whose domestic resources are limited and/or where no critical mass of the above three constituents exists, which could sustain the system on its own. For instance, IAEA-based international networks for nuclear security education (INSEN) [6] and training&support (NSSC) [7], even relatively recent, proved pivotal/fundamental in this respect.

At UM (Department of Physics) we have launched several targeted educational courses at post-graduate level, following INSEN guidelines [8]; the pioneering educational materials developed within the network represent the basic literature for both students’ and lecturers’ use [9]. We also participate in nuclear knowledge management (NKM) activities and use their information system (INIS) when sourcing relevant data. UM is also national contact point for INES (International Nuclear and Radiological Event Scale) and has trained staff for properly reporting in case of incident/accident. UM participates in IAEA-supported Nuclear Instrumentation Laboratory Network (NILNET) and aims at participating at newly started Internet Reactor Laboratory (IRL).

Selected laboratory services are offered as well, primarily for educational/training purposes, but also for routine measurements, monitoring of radioactivity and radiation parameters in the living, working or outdoor environment. Laboratory for nuclear spectrometry has classic NaI and HPGe detector systems, very high sensitivity anti-coincident spectrometer, etc., while environmental laboratory offers atomic absorption spectrometer, medical QC/QA control devices, radon equipment, etc. [10]. These are all at students’ permanent disposal for educational purposes at various levels (B.Sc., M.Sc., Ph.D.) and within various educational programmes (radiation protection, safety and security of radiation sources, radioecology and environmental protection, etc.).

6.WAY FORWARD

In concluding, UM is (or is acting towards): (i) becoming national center of competence and expertise in nuclear/radiation related issues, (ii) assessing, creating, preserving and transferring nuclear knowledge (NK), commensurate to Montenegro needs (nuclear knowledge management – NKM), (iii) offering consultancies and technical support services to all relevant stakeholders, (iv) being advisory body to the government for nuclear/radiation related issues and (v) focal point for dissemination and exchange of NK, in particular with the IAEA and European Union (EU), (vi) promoting nuclear/radiation applications for peaceful purposes, in particular medicine and environmental protection, (vii) being national radiation protection centre, (viii) developing curricula for nuclear/radiation related studies at all levels, (ix) supporting young students and scientists in nuclear/radiation related field and facilitate their exchange with reputed institutions abroad and (x) giving proper and timely information and comments to the public and media on relevant topics/subjects.

An IAEA NKM expert mission to UCNC in 2009, including representatives from NKM centres in the region, affirmatively reviewed the above goals and encouraged both IAEA and Government of Montenegro to continue supporting its realization [1]. Ever since, UCNC stays on the above course, while our new visions – following Montenegro EU accession process – extend to EU perspectives, Horizon2020 in particular.

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CAPACITY BUILDING PROGRAM FOR NUCLEAR R&D PERSONNEL AT KAERI

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Abstract

The Nuclear Training & Education Center (NTC) at the Korea Atomic Energy Research Institute (KAERI) has established a capacity-based education and training system for research and development (R&D) personnel and offers more than 40 training programs a year. This paper introduces KAERI's capacity-based education and training system, and shares experiences gained from the operating cycle. In addition, it describes the development of the professional capacity building program, which incorporates the institute's key technological strengths. KAERI, which conducts comprehensive research in nuclear technology, consists of professionals in various fields, with R&D personnel accounting for 82% of its employees. In consideration of this unique feature, the institute has developed a capacity building program for nuclear R&D personnel. To reflect the organizational diversity and interdisciplinary requirements of each division/department, the various fields of nuclear R&D were divided into 16 modules, each of which was developed into a training course. This module-based training program can be integrated into domestic training programs for industrial technology personnel and international training courses for nuclear-related professionals in developing countries.

1. INTRODUCTION

The fostering of professionals in nuclear R&D is a long-term process given the technical complexities of the field. As such, education and training of nuclear R&D personnel should be provided in a systematic and continuous manner. This highlights the need for a capacity building program based on a specialized education and training system.

The Nuclear Training & Education Center (NTC) at the Korea Atomic Energy Research Institute (KAERI) has established a capacity-based education and training system for research and development (R&D) personnel and offers more than 40 training programs a year. Every year, the center analyzes the demand for training and assesses HRD activities. The results are then reflected in education and training plans for the following year. This is referred to as the education and training operating cycle, and the goal is to expand the cycle into an education and training operating system.

The number of employees in the nuclear industry at the end of 2013 was 28,974, an increase of 779 from 2012. The number of nuclear R&D employees was 1,948, accounting for 6.8% of the total. Notably, KAERI makes up 56% of nuclear R&D personnel and 49% of PhD-holding researchers in this field in the Republic of Korea. For the development of the national nuclear industry, it is essential to build up the capacity of R&D personnel at KAERI.

2.NUCLEAR EDUCATION AND TRAINING SYSTEM

2.1 Change in Employee Structure

As an R&D organization, KAERI classifies employees according to projects, and project manager positions are held by experienced principal researchers and senior researchers aged 50 and above. With the increase in retirees and new employees, the average age is expected to drop to 43 years old by 2024. Given the younger average age of new employees and lower income, there is a need to provide non-formal training such as S-OJT and mentoring, and to continuously enhance the capacity of R&D personnel.

2.2 Nuclear Education and Training System

To achieve KAERI's vision and instill ideal values in employees, the NTC has established talent cultivation strategies, and established an education and training system based on the capacity mode. This education and training system has been named KAERI-ACE (Atomic Community of Education). By analyzing the demand for employee training and assessing HRD activities, details of implementation were derived for the long-term plan for education and training. Continuous improvements are being made to the education and training system. In particular, more than 40 training courses are being offered under KAERI-ACE 4.0 established in 2014.

To further improve HRD activities, a training demand analysis and an HRD assessment are performed every year. Executives and staff members are surveyed, and the results are analyzed using a self-developed assessment tool. A total of 384 executives and staff participated in the 2015 survey. HRD assessment, which measures the level of HRD maturity, divides HRD development into six stages.

The goal (to-be) stage is set for each stage, and the present (as-is) stage is assessed to derive recommendations for improvement. The 2014 long-term roadmap for education and training was established based on the assessment results, and HRD level 4 was attained by standardizing the training development system in 2014.

2.2.1 Capacity Building Program

KAERI's education and training system aims to foster creative and passionate research experts who understand the value of teamwork. Goals have been established for various capacities: general capacity, management capacity, job capacity, and individual capacity. These capacity types are further classified into organizational development training, class training, job training, and self-development. The NTC first established the capacity model in 2009, and improved the education and training system by modifying the model in 2014 (see Table 1).

TABLE 1. KAERI's CAPACITY-BASED EDUCATION AND TRAINING SYSTEM

Capacity type	Training category		Items
General capacity	Organizational development training		Sharing of KAERI's core values Active communication across generations and departments within the organization Education on legal regulations
Management capacity	Management training		Enhancement of leadership (management capacity) for more effective supervision over a class of employees
Job capacity	Job training	Professional job training	Training of relevant knowledge/skills for professional job development
		General job training	General training (research management, research planning) for professional job development
Individual capacity	Self-development	Global capacity enhancement	Acquisition of foreign language, global mindset, and related knowledge/skills

		Self-directed learning	Enhancement of individual competitiveness based on broad professional knowledge through expanded opportunities for self-development
		Life planning	Preparation for independent living after retirement

The education and training system was formerly more focused on enhancing the general capacity or basic research capacity of R&D personnel rather than their professional capacity. However, the survey on employee demand revealed a growing need for job/research-related professional training, leading to the development of the capacity building program for nuclear R&D personnel in 2015.

The capacity building program for nuclear R&D personnel incorporates the institute's key technological strengths, and divides the various fields of nuclear R&D into 16 modules, Two courses (nuclear engineering, global business management) were offered in 2015, and two courses (nuclear thermal hydraulic, nuclear safety and integrated safety evaluation) will be offered in 2016. The other training courses will be conducted upon the employee's demand.

Course (Module) 1 Nuclear engineering
Course (Module) 2 Nuclear thermal hydraulic
Course (Module) 3 Nuclear safety and integrated safety evaluation
Course (Module) 4 Reactor design: Small and medium reactors (SMART)/research reactors
Course (Module) 5 Nuclear Instrumentation & Control
Course (Module) 6 Nuclear power plant structure and system
Course (Module) 7 Nuclear fuel cycle and reactor core design
Course (Module) 8 Nuclear facility decontamination and decommissioning
Course (Module) 9 Spent fuel processing technology (PYRO) and SFR
Course (Module) 10 VHTR hydrogen production technology
Course (Module) 11 Nuclear material technology
Course (Module) 12 Radiation convergence technology (accelerator)
Course (Module) 13 Utilization of radiation technology
Course (Module) 14 Nuclear quality assurance
Course (Module) 15 Nuclear regulations and licensing
Course (Module) 16 Nuclear business management (overseas)/outcome diffusion

11. CONCLUSIONS

KAERI offers more than 40 training courses for nuclear R&D personnel, and these courses have been developed based on the capacity model, which encompasses general capacity, class capacity, and professional capacity. The capacity-based education and training system is being continuously improved through demand analysis, HRD assessment, and renewal of the capacity model. This paper introduced the education and training system and professional capacity building program at KAERI. The emphasis on the education and training operating cycle and sharing of experiences is expected to be a valuable reference for similar organizations.

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EXPERIENCE AND KNOW-HOW SHARING PROJECT AT KAERI[12]

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Abstract

The Korea Atomic Energy Research Institute (KAERI) has accumulated a number of technology development and research outcomes, including its representative achievements, such as atomic energy technology independence and the first exporting of an atomic energy system, since it was established in 1959. With its long history of over 50 years, KAERI (Korea Atomic Energy Research Institute) has produced a large amount of information and explicit knowledge such as experiment data, database, design data, report, instructions, and operation data at each stage of its research and development process as it has performed various researches since its establishment. Also, a lot of tacit knowledge has been produced both knowingly and unknowingly based on the experience of researchers who have participated in many projects. However, in the research environment in the Republic of Korea where they focus overly on the output, tacit knowledge has not been managed properly compared to explicit knowledge. This tacit knowledge is an asset as important as explicit knowledge for an effective research and development. Moreover, as the first generation of atomic energy and research manpower retire, their accumulated experience and knowledge are in danger of disappearing. Therefore, in this study, we sought how to take a whole view and to document atomic energy technology researched and developed by KAERI, from the background to achievement of each field of the technology.

1.INTRODUCTION

To prepare effective documentation on atomic energy technology, it is important to document every single process without omission, not only in the research and development process of the relevant field but also every step from its background to achievement. Therefore, to make an overall summary from background to achievement, it should be prepared systemically without omission through a well-made TOC (Table of Contents), and the content of each section of TOC should be well summarized and documented. In addition, all data related to documented content should be attached to support the record.

2.SELECTION OF FIELD

To select a field to be the subject of documentation, we organized research projects that have been performed or are being performed in the institute from the main fields to detailed fields and the considered technical and historical values. A field that has rich data to document was also selected considering the level of utilization after the documentation. Because the documentation of a technology that has been transferred or that is not being performed is difficult, and the level of utilization is relatively low, we therefore made a mid-term roadmap

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[12] This article is revision of former released article (Thoughts on Documentation of Atomic Power Technology, Transactions of the Korean Nuclear Society Spring Meeting, Jeju, Republic of Korea, May 17-18, 2012) for poster presentation.

for an efficient accomplishment of the knowledge management system by the KAERI board members. This roadmap is a 5-year master plan for capturing knowledge from 116 key projects

3.TOC PREPARATION AND TECHNICAL DOCUMENTATION

The draft of the TOC was prepared through a discussion with the core researchers of each selected field, and the TOC was finally completed with several adjustments. With the completed TOC, we selected specialists who were able to prepare an overview of each item and a technical summary and commissioned the writing. The completed copy was reviewed by an knowledgeable expert for corrections and supplementation. The final copy was completed through preparation, review, and continuous correction and supplementation by the participants. After completing the preparation and review of the copy, copies prepared for each item and copies completed with a review were compiled by the participating researchers for a report.

In particular, we invited retired veteran experts to hear from them about the background and process of technical development in the early years, in a discussion session that was recorded in a video clip. In addition, all available relevant research reports, pictures, plans, and documents were collected to compare the list and original source. Figure 1 shows the process of TOC preparation and technical documentation.

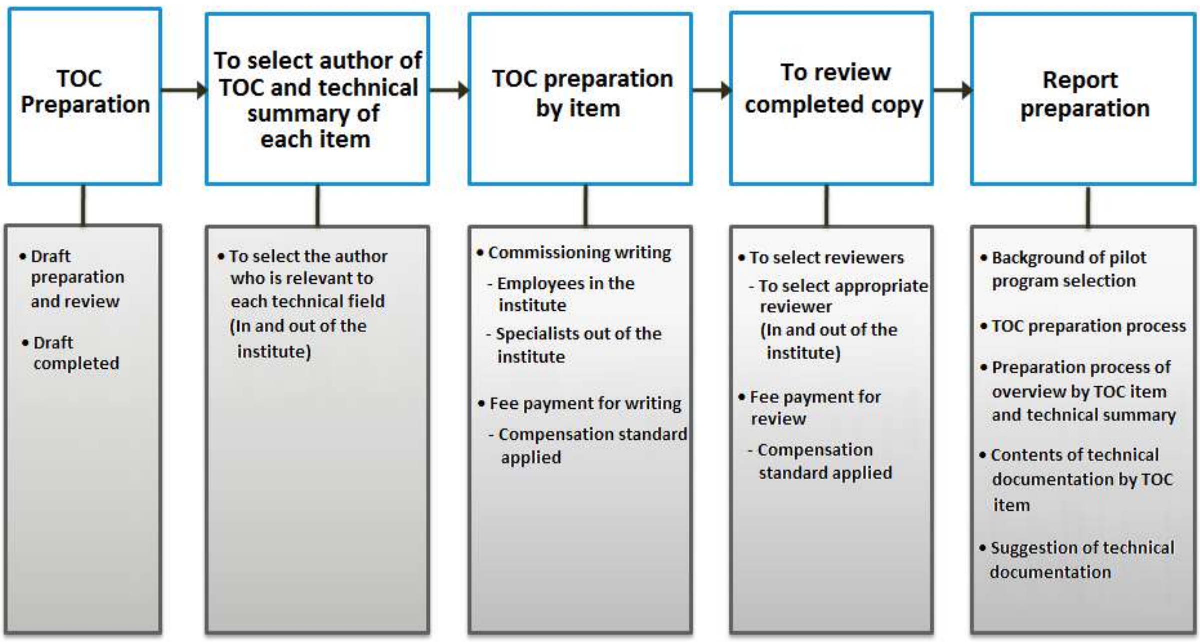

FIG.1. Process of TOC preparation and technical documentation

4.CONCLUSIONS

All types of records produced during the process of research and development are an important source of information for the benefit and advancement of the institute, helping prevent a duplication of research projects, and the realization of research projects, not to mention contributing to the validity of the project and the establishment of the research ethics. In addition, these records are a comprehensive knowledge resource that can secure an evidence-based copyright, a steppingstone to the creation of a new information value. Therefore, the systematic management of various records produced and collected throughout the whole cycle of a research and development project is used to manage knowledge resources and is equipped with a sustainable inheritance system.

As the fields of atomic energy technology documentation, 116 fields were selected as the representative fields of atomic energy technology, considering the technological and historical values mentioned above, and the technical documentation of these fields was initiated. However, we found a few problems to consider during the process of initiation. First, it is a problem of recording the experience of failure cases. While successful experience and research achievements are documented in detail in reports and papers, the experience of an inevitable failure during research projects has not been recorded, but hidden. However, if these failure cases are not recorded, it will be harder to remember them later, and moreover, it will be technically impossible to find their support data. Therefore, a way to preserve a failure of current researchers should be found for later generation researchers, and the related records are required to be systematically collected and managed. Researchers in the later generation then do not have to repeat the same failure when they conduct research, and ultimately, the economic effectiveness of the research can be improved in a large part. Second, there is a problem of setting up the range and level of technical records. Some parts can be missed during the technical documentation leading to a limitation of its utilization in the future. The range and level of technical documentation should be accurately set up considering this fact. Third, there is the need to establish a data management system. In addition to data possessed by a project, data preserved deep in a cabinet in a laboratory and privately owned should also be documented. Therefore, a management system of these data needs to be established.

A comprehensive management system of a national atomic energy technology record will be established through this atomic energy technology documentation project, and will make a foundation of technical data preservation, and of the advancement and development of atomic energy technology. Records accumulated through an atomic energy technology documentation project will be a measure of the effective inheritance of experience and knowledge between generations of atomic energy researchers, as an important resource of atomic energy knowledge management. In addition, knowledge and information resources like this can be utilized as a key information resource for promotion and achievement diffusion.

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PUBLISHING VINATOM ANNUAL REPORT: A WAY FOR DEVELOPMENT, RETENTION AND SHARING OF NUCLEAR KNOWLEDGE IN THE VIETNAM ATOMIC ENERGY INSTITUTE – CASE STUDY

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Abstract

Paper describes the role of publishing VINATOM Annual Report in development, retention and sharing of nuclear knowledge in the Vietnam Atomic Energy Institute and in Viet Nam. Activities and experience in process of publishing and distribution of VINATOM Annual Report to advance the publication quality is presented.

1. A GLANCE AT VIETNAM ATOMIC ENERGY INSTITUTE AND CHALLENGES OF KNOWLEDGE MANAGEMENT

Major targets of Viet Nam nuclear sector in period 2007-2020 are: preparing to introduce the first NPP and developing nuclear infrastructure for nuclear power programme.

The Vietnam Atomic Energy Institute (VINATOM) takes an important role for the two targets: scientific and technological support for NPP projects; and enhancement and development of nuclear scientific and technical capability in Viet Nam.

The VINATOM is organized from scientific and technological units, including:

- Headquarters (locates in Hanoi),
- Institute for Nuclear Science & Technology (locates in Hanoi),
- Institute for Technology of Radioactive and Rare Elements (locates in Hanoi),
- Nuclear Research Institute (locates in Dalat),
- Centre for Applications of Nuclear Techniques in Industry (locates in Dalat),
- Research and Development Center for Radiation Technology (locates in Ho Chi Minh City),
- Center of Nuclear Techniques (locates in Ho Chi Minh City),
- Hanoi Irradiation Centre (locates in Hanoi),
- Center for Non-Destructive Evaluation (locates in Hanoi).

One of main challenges for the VINATOM development is to have competent staff along with strong and sound nuclear knowledge resources. Presently, the VINATOM is encountering:

- Workforce is aging;
- There is difference in knowledge background between older and younger generations;
- There is not yet attraction of excellent university graduates.

Being an organization of research and development in nuclear sector of Viet Nam, the VINATOM has implemented many projects of basic research, technology study and development, application and deployment of nuclear techniques for economic and social purposes.

Big projects of ministrial level and of governmental level have been implemented by research groups, including lead scientist and young researchers.

However, owing to lack relevant documentation tool, for many years results and products of the projects have not been made retention and sharing not much in Viet Nam nuclear community. So there was the 'loss' of nuclear knowledge when few people knew it or could access. Some studies reduplicates without knowing the problems was solved before.

Specialist knowledge is needed to apply nuclear technology in medicine, agriculture, industry, disease prevention, water management, electricity production and mineral exploration. If the knowledge accumulated to date is lost, applications will stall and many generations could have a less secure and sustainable future. These factors have led to the need for effective strategies and policies for knowledge management [1].

2.DOCUMENTATION AND PROMULGATION OF OUTPUT OF THE VINATOM'S R&D PROJECTS

In recent years, the VINATOM set up a policy to disseminate, make retention and share results and products of R&D projects through:

- publishing VINATOM Annual Report;
- proclaiming in international and Viet Nam journals;
- presenting at the National Conference on Nuclear Science and Technology organized every 2 years;
- introducing in the VINATOM Bulletin.

3.PUBLISHING VINATOM ANNUAL REPORT

Publishing VINATOM Annual Report began from year 1998. To date, the publication is developed through 2 periods:

a) Period 1 (1998-2009). Initially, the publication was published as an informative literature that consisted of summaries or abstracts (in English) on R&D projects to introduce the projects. Parallelly, details of the projects were published in preprint form (in Vietnamese). VINATOM Annual Report in that time was published every 2 years. Submission of project reports was optional, so the publication not showed all R&D projects. In addition, parallelly publishing two literature forms (Annual Report and preprint) was expensive and made inconvenient in bibliographically linked store. After 4 years, the preprint was terminated. However, because responsibility for submission of project report (both format and time) was not attached to research group, the Annual Report included projects reports that were not consistent in format and content or short or long, or detailed or sparse). It made the publication not appropriate for retention and exchange of nuclear knowledge.

b) Period 2 (2010- now). After reviewing, the VINATOM determinate that VINATOM Annual Report must to be a publication showing fully activities of nuclear research and development of the VINATOM for the target year, and to be a literature type for retention, sharing of nuclear knowledge among Viet Nam nuclear community and for international exchange. The publication is published annually. To meet that requirement, all R&D projects which finish in the target year have to submitted mandatorily a project report representing in details about the problem to be solved; method, material and equipment used, results attained, recommendations, etc. Especially, project report should show inheritance of previous projects (if available). Bringing projects to public make projects heads to be serious and honest in writing reports.
   - Editorial Board (6 persons), includes: the Chairman, a Vice-Chairman of the VINATOM, a physicist, a chemist, an official of scientific and technological management, an official of publishing.

- Format of project report: Research groups are required to write projects reports in accordance to defined format, in which problem to be solved; method, material and equipment used, results attained, recommendations, inheritance must be showed in details. Especially, ministerial and governmental projects have to represent knowledge transfer from old generation to young generation. In addition, there is some data, such as project code, implement time, allocated fund, email contact, and journal articles and conference papers as a part of output of the project.

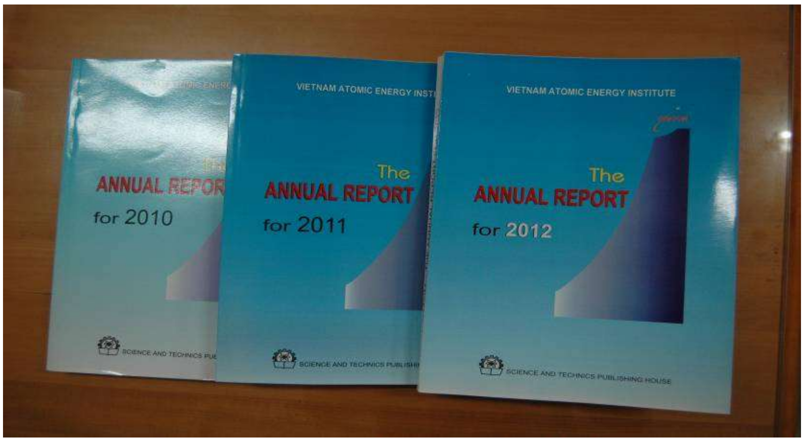

FIG. 2. VINATOM Annual Report published annually

Publishing procedure: A procedure is set up in which showing:

— firm direction of the VINATOM leaders in project implement to be in time;
— collaboration and cooperation scheme between project heads and system of scientific and technological management of the VINATOM;
— assessment and consultancy of the check and acceptance boards to projects quality;
— respect for honestness of project heads.
—

Subject category classification. Editorial Board creates a table of subject category classification in which classification criteria is mentioned. 10 subject categories are used to classify to project reports [2].

1. Nuclear Physics, Reactor Physics
2. Research Reactor, Nuclear Power Technology, Nuclear Safety, Nuclear Power Economy
3. Instrumentation, Nuclear Electronics
4. Industrial Applications
5. Applications in Ecology, Environment and Geology
6. Applications in Biology, Agriculture and Medicine
7. Radiation Protection and Radioactive Waste Management
8. Radiation Technology
9. Radiochemistry and Materials Science
10. Computation and Other Related Topics

— Distribution: VINATOM Annual Report is published in 2 forms: hardcopy and e-copy. Hard copies are distributed to libraries of universities, academies, research institutes, and to nuclear authorities. E-copy is sent to nuclear scientists and researchers.

4.LESSONS

— Keeping a publication of a R&D sustainable and prestigious is difficult, especially involving different people. A publishing procedure that is clear and applicable is necessary. Collaboration and cooperation in management system is inevitable.
— A KM activity in a R&D institute is effective when it demonstrates its usefulness and when leaders of the institute understand its significance and take principal position.

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IMPROVING INDUSTRY RELEVANT NUCLEAR KNOWLEDGE DEVELOPMENT THROUGH SPECIAL PARTNERSHIPS

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Abstract

South African Network for Nuclear Education Science and Technology (SAN NEST) has the objective to develop the nuclear education system in South Africa to a point where suitably qualified and experienced nuclear personnel employed by nuclear science and technology programmes in South Africa are predominantly produced by the South African education system. This is done to strengthen the nuclear science and technology education programs to better meet future demands in terms of quality, capacity and relevancy. To ensure sustainable relevancy, it is important to develop special partnerships with industry, this paper describes unique partnerships that was developed with nuclear industry partners. The success of these partnerships has ensured more industry partners to embrace the model which has proven to develop relevant knowledge, support research and provide innovative solutions for industry.

1.TYPE OF ORGANIZATION AND CONTEXT OF THE CASE STUDY:

South Africa has long been regarded as active in the nuclear industry with two operating power reactors and a research reactor. In recent years' research and development projects, such as the PBMR, has established additional expertise in the country situated at various institutions often fragmenting the nuclear expertise in the country. A number of training and research facilities has also completed its research cycle and are in the process of being decommissioned.

With the renewed interest in nuclear technology and the states position to complete the procurement of 9600MW of nuclear power before the end of the year, a renewed interest in nuclear power and expanding the knowledge base in the country is growing. Unfortunately, due to the uncertainty of final decisions regarding the build programme, industry remains apprehensive to commit extensive resources to building the skills base in the country.

Problems to be addressed:

b) Nuclear industry in South Africa has become rather static with a limited drive to invest in research or new developments. This results in a slow degradation of the knowledge base in the country.
c) Industry focusses on business as usual with most new developments being imported from abroad.
d) Universities are starved of resources to conduct nuclear research and develop new knowledge.
e) Universities has a responsibility to develop nuclear skills for the proposed new build programme within this constrained environment.

2.BACKGROUND AND OBJECTIVES OF DEVELOPING SPECIAL PARTNERSHIPS WITH INDUSTRY

The outcome of the South African Network for Nuclear Education, Science and Technology is to strengthen the nuclear science and technology education programs to better meet future demands in terms of quality, capacity and relevancy. Within the described an initiative was launched for educational institutions to engage with industry directly in order to find the specific requirements for skills development and develop education and research initiatives around these requirements.

The start-up of such an initiative is not trivial, it requires a trust and mutual respect between all stakeholders engaging in these special partnerships. The required level of cooperation can often take years to build but from the South African experience it worth the effort and very rewarding.

The initiative was originally started with Eskom, the South African power utility that also owns and operates the Koeberg Nuclear Power Plant North of Cape Town. Based on these successes it was expanded to also include Necsa (the Nuclear Energy Corporation of SA) that owns and operates the SAFARI-1 research reactor as well as the National Nuclear Regulator (NNR). It is important to note that the partnerships with Necsa and the NNR was developed more naturally because of the demonstrated success of the initial partnership with Eskom.

3.METHODOLOGY OF THE SPECIAL PARTNERSHIPS INITIATIVE

a) Maintain a close link with Eskom Koeberg Nuclear Power plant, Necsa and National Nuclear Regulator (NNR) management. An open channel of communication is important, in this way any problems within the specific industry will be openly communicated to be addressed through the initiative. The industry management will also entrust some of the employees' time to the university with an expectation of a return on this investment.
b) Identify research project needs at Koeberg, Necsa and NNR with strong academic base (important but not urgent projects). The focus on important but not urgent is important. The industry cannot be expected relinquish control of core business activities or critical path activities for knowledge development purposes.
c) Enrol employees or students into M.Eng program to conduct the research on these (Research and modules).

4.BENEFITS OF THE SPECIAL PARTNERSHIP INITIATIVE.

a) The industry gets a deliverable as well as better qualified (specialised) employee.
b) The employee gains recognition in area of expertise at work together with a qualification.
c) Research at university is relatively low cost compared to contracting a project out.
d) The initiative requires little resources and in many cases optimises resource spending.

5.CONCLUSIONS

In South Africa where plans for a new build nuclear programme is considered very seriously but the economy is under strain and resources to develop the required skills are very limited. Innovative solutions within strong partnerships between industry and research institutions are extremely important.

The proven success of relevant research projects being conducted within the industry with the support of universities is going a long way in solving these problems in a very cost effective way.

THE SPANISH CEIDEN TECHNOLOGY PLATFORM: ACTIVITIES ON KNOWLEDGE MANAGEMENT

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Abstract

CEIDEN is a Spanish organization for the coordination of the needs and efforts on nuclearfission research and development (R&D). It was created in 1999 and since 2007 has the statusof technology platform. The main functions of CEIDEN are to define and develop joint R&Dprojects, and to present a common position for national and international commitmentsand proposals in the nuclear fission R&D field. With around one hundred of Spanishmembers and a significant number of foreign collaborative entities, CEIDEN groups allsectors involved in this field.

In 2011 the CEIDEN F□ permanent group was created to cope with the E&T issues. Themain objectives of F□ are to promote the coordination of E&T programmes in a nationallevel and to support the Spanish participation in international networks, programmes andprojects in this field.

INCORPORATION OF NUCLEAR KNOWLEDGE MANAGEMENT INTO THE INTEGRATED SYSTEM OF QUALITY- SCIENCE AND TECHNOLOGICAL INNOVATION IN CUBAENERGÍA

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Abstract

Technical knowledge management and innovation became important tools for organizations to meet the needs and expectations of the market and society in general; especially those related to the peaceful use of nuclear energy. Since 2011 CUBAENERGÍA, under the model of the UNE 166002, integrated process management Scientific and Technological Innovation to the requirements of the NC-ISO 9001, compliance with national regulations applicable to the sector. In September 2015 the new ISO 9001 includes a clause that makes explicit mention knowledge. Although this clause is not a standard for knowledge management nor does it imply its obligatory; CUBAENERGÍA decided to expand its integrated management system to include the Nuclear Knowledge Management system. In this article the conceptual framework for the integration of these three systems, diagnosis in the organization and the proposed design and implementation plan of management knowledge management integrated analyzes R & D and the quality management system in CUBAENERGÍA.

1.INTRODUCTION

Many institutions, such as those applying nuclear technologies, are characterized by complex processes and high social and economic impact. Consequently, the demand to implement management systems to assure efficiency and effectiveness is highly required. This is crucial to achieve their mission; based on the Deming Cycle (PDCA, plan-do-check-act) or the spiral of continuous improvement.

Managing an organization includes quality management, among other disciplines such as environmental, safety and health at work, financial, risk, knowledge management and others.

There are three disciplines that are strategic tools and determine and guarantee the status of an organization in the market: Quality Management (QM) –with the aim of satisfying the necessities and expectations of the stakeholders; R&D resulting in science and technological innovation -to offer new products and improved processes; and Knowledge Management (KM) -to be trustworthy that the involved staff have booth the knowledge and the necessary competence (training, skills and expertise).

Another current trend is to integrate all the applicable requirements to the organizations in one management system, in order to achieve higher coherence and systemic focus in the executions of the mission and its objectives. [1]

An interest for developing a quality system (QS) appropriate for R&D is manifested by various sources, such as accreditation bodies, funding organizations and others in whose interest the research is being performed. This need is conditioned by scientific, economic, human and social factors [2]. Maybe, the most pressing factor that proves the need to focus quality on research is the ever increasing impact of science and technology in modern society.

CUBAENERGÍA, Center for Information Management and Energy Development, manages projects and provides scientific and technological services that promote sustainable energy development in the country and the application of information technology. It is also the representative of Cuba on the International Nuclear Information System (INIS).

In 2011 and in compliance with national regulations applicable to the sector, CUBAENERGÍA began an integration management process of Scientific and Technological Innovation (UNE 166002:2006) into the already existing Quality Management System (NC-ISO 9001:2008).

In addition, under the research project: "PRN 7-1-3 2 Design of a Cuban System for Nuclear Knowledge Preservation and Management" (2010-2012), a knowledge management system was organized to provide a solution to the current and future challenges of nuclear development and its applications in Cuba based on: the identification of challenges of the Cuban Nuclear Program; study and implementation of Integrated Nuclear Knowledge Management Methodology (INKM: 2011) [3]; design and structure of databases to collect and process information on knowledge management and proposal of an action plan for effective management of nuclear knowledge.

During 2015 there were two events that improved CUBAENERGÍA knowledge management. The first: results of the updated INKM (2015) applied to nuclear medicine [4] and the second one: highest recognition given to knowledge management and competence management at ISO 9001: 2015 standard.

Knowledge Management has appeared as a line item in the Quality Standard ISO 9001:2015 and it is time for a KM Standard [5]. There are already various standards for KM: the British Standard Institute Guide [6], published in 2001; the Australian Standard [7], published in 2003 and the Israeli standard [8], published more recently, in 2013, but there is not an ISO standard for knowledge management.

Much work has been done by the IAEA in addressing the knowledge management needs and establishing management systems for facilities and activities of different nuclear organizations, resulting in publications that define the requirements for establishing, implementing, assessing and continually improving a management system. [9] [10] [11]

In absence of an ISO standard for knowledge management, it was necessary to adapt the Integrated Nuclear Knowledge Management Methodology (INKM: 2015), based on IAEA KM (2012), with requirements established in Australian KM Standard (2003), British KM Standard (2001) and Israeli KM Standard (2011), which resulting the indicators to be taking account in the Integrated Nuclear Knowledge Management System (INKM: 2016), as presented in this paper.

This research deals with the theoretical and conceptual framework for the integration of these three systems: Scientific and Technological Innovation (UNE 166002:2006) [12], the Quality Management System (NC-ISO 9001:2008) [13] and the Nuclear Knowledge Management System (INKM: 2016).

2.MATERIALS, METHODS AND PROCEDURES

Main methods and research techniques:

- Observation
- Documentary Analysis
- Experts Criteria
- Interviews
- Teamwork

3.RESULTS AND ANALYSIS

3.1 Nuclear Knowledge Management System (INKM: 2016)

A total of 4 methods were analyzed Australian KM Standard (2003), British KM Standard (2001), Israeli KM Standard (2011) and IAEA KM (2012) [6]- [9]; and ten integrated indicators of KM were established in accordance with the standard's requirements:

(1) Policy/strategy; management's commitment: responsibilities and requirements of the organization's management.
(2) Human resource (HR) planning and HR processes; resource investment-human resources and technological infrastructure required.
(3) Competence development
(4) Methods, procedures & documentation processes for improving KM; documentation-documentation goals; detailing the content documented.
(5) Technical (IT) solutions; current Knowledge Management solutions
(6) Approaches to capture/use of tacit knowledge.
(7) KM culture/workforce culture supporting KM; culture-defining our desired knowledge managing culture, diagnosing our current culture and writing a program that addresses the difference between the two.
(8) Assessing and evaluating- goals and fields of KM
(9) Knowledge Management implication- guidelines for initiation, execution and assimilation of the knowledge according to the process-based approach.
(10) Lessons learned from the organization's KM activities/measurement and evaluation

3.2 Development of procedures and records required as requirements in standards NC/ISO 9001:2008, UNE 166002, INKM: 2016.

TABLE 1. POINTS OF AGREEMENT OF THE THREE REGULATIONS: NC/ISO 9001:2008, UNE 166002, INKM: 2016.

Requirement	UNE 166002:20	NC-ISO 9001:2008	INKM: 2016
Management system. Terms and Definitions	4.1.1	Field of application. 0.3, 0.4, 1, 1.1, 1.2, 2, 3	Introduction
Management system, general requirements, documentation	Management system R & D + i: 4.1.2- 4.1.2.2	Quality Management system: 4, 4.1, 4.2, 4.2.1, 4.2.2, 4.2.3, 4.2.4	(4) Methods, procedures & documentation processes for improving KM

Requirement	UNE 166002:20	NC-ISO 9001:2008	INKM: 2016
Administrator's responsibility Management review	Administrator's responsibility; Policy of R & D + i: 4.2.1, 4.2.2-4.2.6.	Administrator's responsibility to quality 5.4, 5.4.1, 5.4.2, 5, 5.1, 5.25.6, 5.6.1, 5.6.2, 5.6.3	(1) Policy/strategy; Management's commitment: responsibilities. (8) Assessing and evaluating- goals and fields
Planning	Objectives R & D + i, system planning R & D + i 4.2.4, 4.2.4.1, 4.2.4.2	Quality Planning 5.3, 5.5, 5.5.1, 5.5.2, 5.5.3,	(9) KM implication- guidelines for initiation, execution and assimilation of the knowledge according to the process-based approach.
Resource management. Infrastructure. Work environment. (human resource motivation, Competence)	Provision of resources 4.3, 4.3.1, 4.3.2.2, 4.3.2.3, 4.3.3, 4.3.4	Resource management 6, 6.1, 6.2, 6.2.1, 6.2.2, 6.3, 6.4	(2) Resources and technological infrastructure required. (3) Competence development
Product	Product R & D + i 4.4.1, 4.4.1.1, 4.4.1.2, 4.4.1.3, 4.4.1.4 4.4.6, 4.4.7.1, 4.4.7.2, 4.4.7.3, 4.4.8, 4.4.8.1, 4.4.8.2, 4.4.9	Realization of the product: 7, 7.1, 7.2, 7.2.1, 7.2.2, 7.2.3, 7.3, 7.3.1, 7.3.2, 7.3.3, 7.3.4, 7.3.5, 7.3.6, 7.3.7, 7.4, 7.4.1, 7.4.2, 7.4.3, 7.5, 7.5.1, 7.5.2, 7.5.3, 7.5.4, 7.5.5	(5) Technical (IT) solutions (6) Approaches to capture/use tacit knowledge; (7) KM culture/workforce culture supporting KM difference between the two.
Measurement, analysis and improvement	Measurement, analysis and improvement 4.2.6-4.2.6.3 4.5.2-4.5.6, 5.5.5, 5.5.7	Measurement, analysis and improvement: 8, 8.1, 8.2, 8.2.1, 8.2.2, 8.2.3, 8.2.4, 8.3, 8.4, 8.5, 8.5.1, 8.5.2, 8.5.3	(10) Lessons learned from the organization's KM activities/Measurement and evaluation

4.CONCLUSIONS AND RECOMMENDATION

The integrated indicators of KM, based on IAEA KM (2012) and in accordance to the standard's requirements of Australian KM Standard (2003), British KM Standard (2001) and Israeli KM Standard (2011), were defined as INKM: 2016.

t was demonstrated compatibility between the requirements of Quality, R&D and Knowledge management systems what allow the integration of those three systems and its inclusion as a unified documentation scheme, based on ISO 9001:2008, (UNE 166002:2006) and IAEA KM (2012) respectively.

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THE INFORMATION MANAGEMENT PLATFORM ON NUCLEAR EMERGENCY RESOURCES OF CHINA

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Abstract

The Chinese government has always attached great importance to nuclear emergency work, and has invested to form lots of nuclear emergency resources. Meanwhile, there also exist some management problems such as repeated investment, fragmented inventory list, inefficient management, etc. To achieve integrated management on the nuclear emergency resources of China, the Chinese government initiated the project 'The Information Management Platform on Nuclear Emergency Resources of China'. The goal of the project is to support a timely, managed, controlled, coordinated and effective response while the resources managing process remains economically efficient. The project team firstly completed the nuclear emergency resources classification and encoding. Based on these, the nuclear emergency resources information management software system was developed. The pilot operation in the system was carried out both in Guangxi and Liaoning Province at the same time. Nuclear emergency resources survey was done as the relevant information was put into the database in these regions. The evaluation result on the pilot operation showed that, the information management platform on emergency resources would apparently improve efficiency of nuclear emergency preparedness and response, and it also would increase economical efficiency on inventory list, information management and invest decision.

1. BACKGROUND

Nuclear emergency resources management is an important component of nuclear emergency preparedness and response work. The lessons learned from the severe nuclear accident such as Chernobyl accident in 1986 and Fukushima nuclear accident in 2011 show that a timely managed, controlled, coordinated and effective response depends on effective and efficient emergency resources management. The nuclear emergency organizations on all the levels have invested a lot to form kinds of nuclear emergency resources. However, these resources scattered in different entities. This mode led to problems such as repeated investment, fragmented inventory list, inefficient management, etc. After the Fukushima nuclear accident in 2011, the Chinese government decided to initiate the project 'The Information Management Platform on Nuclear Emergency Resources of China'.

The main stakeholders involved and their roles and functions are as follows:

China national nuclear emergency response office (NNERO) acts as organizer, coordinator, investor, and also user. In addition, it is responsible for the project framework arrangement and the relationship coordination between all the stakeholders. Its responsibilities also include providing financial support for fundamental research, system development and platform operation, and proposing user demands on the system.

China national nuclear emergency response technical assistance center (NNERTAC), as system operator, authorized by NNERO, is responsible for the daily operation in the server side of the system.

Tsinghua University, as technical support supplier, entrusted by NNERO and other user, is responsible for the system design and development. It also supplies consultation and technical support services on the data acquisition, input process and system operation.

Relevant national government departments / local nuclear emergency authorities / nuclear power group & NPPs, as investors and users as well, are responsible for routine maintenance in the client side of the system including data updating. Their responsibilities also contain providing financial support for the data acquisition and input process, client of the system running, system customization, and proposing user demands on the system.

2. GOAL AND OBJECTS

The goal of the whole project is to support a timely, managed, controlled, coordinated and effective response while the resources managing process remains economically efficient.

The specific objects include:

(1) To define and standardize the scope of the nuclear emergency resources;
(2) To achieve integrated management on the nuclear emergency resources of China;
(3) To achieve highly efficient enquiry and statistical function on nuclear emergency resources information;
(4) To promote nuclear emergency resources survey and to form a complete inventory list;
(5) To achieve the sharing of the nuclear emergency resources information nationwide;
(6) To increase economic efficiency on management by improving the mechanism in the process of emergency material purchasing, renting, storage, managing, dispatching, returning or compensating.

3. PROCESS AND ACHIEVEMENTS

The project initiated in Jan. 2012, including four stages (early stage, system development stage, pilot operation stage, comprehensive promotion stage), and is scheduled to the end in 2020.

3.1 Early stage (2012.1-2012.12)

The project team firstly investigated and discussed the scope of the nuclear emergency resources and the principles for classification and encoding. The general consensus include: the scope of the resources should cover all kinds of items necessary for nuclear accident precaution, emergency preparedness and response, and recover; the principle of 'one thing one code' should be adhered to; it is necessary to set a category for future expansion and refining with encoding of '9' or '99' or 'Y00'; it should be consistent with the classification and encoding of the national general emergency resources. The experts agreed with the methods adopted as follows: the line classified method was used for classification to avoid cross duplication; the physical function was adopted as the primary classified basis to promise the respective resource under unique category; three-layer classification system was adopted for better understanding; encoding by numbers adding characters was recommended to remember more easily. Finally, the project team completed the nuclear emergency resources classification and encoding content. The structure of the content is demonstrated in Table 1.

3.2 System Development Stage (2013.1-2013.12)

Based on the achievements of the first stage, the project team developed the nuclear emergency resources information management system, including the process of user demand confirmation, system design, software development and inner test. The main functions of the system include:

data input, check, correct / update, export in categories; inquiry, statistics and analysis on resources data; user management in groups. The system interface design allowed updating in the future, for example, embed with a geography information system.

3.3 Pilot Operation Stage (2014.1-2015.12)

The system pilot operation was carried out both in Guangxi and Liaoning Provinces at the same time. Guangxi, a provincial region in South China, is the location of the Fangchenggang nuclear power plant. Liaoning, a province in Northeast China, is the location of the Hongyanhe nuclear power plant. NNERO organized training courses for relevant staff in both regions. Tsinghua University supplied consultation and technical support services. The nuclear emergency organizations in the two regions are responsible for data acquisition and input of the system, as well as for the daily operation in the client side of the system. Nuclear emergency resources survey was done as the relevant information was put into the database in these regions. Expert meetings and Seminars were held to evaluate the pilot operation process, discuss the challenges and share the experience.

TABLE 1. THE NUCLEAR EMERGENCY RESOURCES CLASSIFICATION AND ENCODING CONTENT STRUCTURE

Code & Categories (Level Ⅰ)	Code & Categories (Level Ⅱ)	Code & Categories (Level Ⅲ)
41000 Organizations	41B03 Nuclear Emer. Office ……	41B03.A00 NNERO ……
42000 Human Resources	42A00 Experts ……	42A00.E00 Experts in nuclear reactor engineering ……
43D00 Equipments	43D01 Protection Equipments ……	43D01.A00 Personnel breath protection equipment ……
43E00 Engineering Material	43E02 Borax ……	…… ……
49A00 Facilities	49A04 Medical Care Facilities	49A04.A00 Factory Clinic ……
	49A05 Refuge Area ……	49A05.A00 Emergency settlement point ……
50000 Knowledge	55000 Case Study ……	…… ……
60000 Emergency Plan	61000 National Emer. Plan ……	61B00 Special Plan ……
90000 Others	……	……
8 in total	56 in total	▪ total

3.3 Comprehensive Promotion Stage (2016.1-2020.12)

Based on the feasible study and positive experience from the pilot operation, the system would be promoted to operate in the relative provincial regions. When the data input work is done in every relative region, the national nuclear emergency resources survey would be achieved. All the systems are planned to be interconnected with each other, in order to share the nuclear emergency resources information nationwide. Supported by the national nuclear emergency resources database, it would be feasible to increase economical efficiency on management by improving the mechanism in the process of emergency material purchasing, renting, storage, managing, dispatching, returning or compensating.

3.5 Major Achievements

The nuclear emergency resources classification and encoding content is characterized as systematicness, normativeness, compatibility and flexibility. It provides a sound theoretical basis for the whole project.

The nuclear emergency resources information management system, is characterized by powerful inquiry and statistics functions, friendly operation interfaces, and extendable design. It provides an advanced tool for information management and survey on nuclear emergency resources.

The nuclear emergency resources database includes complete inventory lists and comprehensive record or information on the nuclear emergency resources in the regions. It provides fundamental basis for analyzing and improving the mechanism in each process of the emergency material management.

The information management platform on nuclear emergency resources of China, would be comprised of the interconnected systems, databases, and series of management mechanism.

4. EXPERIENCE

Nuclear emergency resources information management may have a broad effect on other branches of nuclear emergency work. For example, based on the regional nuclear emergency resources survey result, some experts proposed to reserve capacity instead of physical objects in some special resources, such as medical pills with quality guarantee period. Another example, when the survey result showed the emergency power suppliers in different NPPs have different interfaces, whether to unify these interfaces became an important problem.

The nuclear emergency resources classification and encoding content should be emphasized because of its fundamental effect. If two information management systems based on the same resources classification and encoding system, it may be easy for them to be compatible with each other, or vice versa. The information management platform on nuclear emergency resources was designed to be compatible with the national general emergency resources information management system, which means it should be consistent with the classification and encoding of the national general emergency resources.

The advanced computer software/system should be utilized to facilitate nuclear emergency resources information management. For example, if the geography information system were embedded with the platform in the future, it would be much easier to assist decision on the resources deployment and scheduling under the visual environment.

We should insist on giving priority to the actual need of the nuclear emergency work when a problem arises. For example, whether to put the information of the screws into the management system, the answer is not simply ‘yes’ or ‘no’. Based on the actual need for nuclear emergency response, it is not necessary to input the information of most common screws. However, those screws in the nuclear power plants with special functions must be registered in the system, with a detailed explanatory note in the remarks column.

5. CONCLUSIONS

Nuclear emergency resources management is an important basic work for nuclear emergency preparedness and response.The evaluation result of the pilot operation showed that, the information management platform on nuclear emergency resources would apparently improve the efficiency of nuclear emergency preparedness and response, helpful to support a timely, managed, controlled, coordinated and effective response, and it would increase economically efficient on inventory list, information management and invest decision as well.

ACTIVITIES ON NUCLEAR KNOWLEDGE PRESERVATION IN TAJIKISTAN

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Abstract

The availability of nuclear knowledge is the result of the past and present conditions of organizations of knowledge in the field of atomic and nuclear physics in Tajikistan. It is shown, that despite today's weak material resources, with the support of IAEA and other intergovernmental contracts and the international funds, and also presence of rich intellectual fund of the republic, it is possible to reserve Nuclear Knowledge in Tajikistan.

1. BRIEF INFORMATION ABOUT THE COUNTRY

The Republic of Tajikistan is mountainous country. 93% of the territory of Tajikistan is mountains and 7% is plain. The population of Tajikistan is 7 million people. Total area is 143 000 sq. km. There are 4 administrative regions. The capital city is Dushanbe.

It is known that attitude to nuclear knowledge varies considerably in the world. While developed countries, and particularly European community countries, pay the required attention to fundamental investigations and begin to show a tendency to gradual orientation towards nuclear power engineering, many developing countries aspire to develop knowledge in the field of nuclear science and nuclear techniques.

The Republic of Tajikistan is not a nuclear country, but it uses achievements of nuclear science and technology in a number of manufacturing branches. That is why the important problems for us are training of staff and preservation of nuclear knowledge. During the Soviet period we did not have such problems, as during that time well-educated specialists, both in central institutes of higher education and particularly in the Chair of Nuclear Physics of the Tajik State National University (TSNU) were trained regularly and according to plan.

Chair of Nuclear Physics of TSNU was established in 1961. Well known physicists from Moscow worked in the field of cosmic rays in the Chair of Nuclear Physics. They simultaneously worked in Pamir expeditions of the Physical Institute of the Academy of Sciences of USSR (PIAS). The research theme of the Chair of Nuclear Physics until 1975 has been devoted to research in the field of physics of space beams. In 1970 and the beginning of the 1980, employees of the Chair were also engaged in physics activation analysis and radiation physics. Sometimes scientific themes and training directions were changed. The reasons for the changes were:

- Need of national economy for experts in particular specialities (nuclear spectroscope analysers, experts on cosmic rays, experts on nuclear physical methods of element analysis, geophysicists, radiologists, etc.);
- Need for new research managers and new heads of Chair.

During the entire period of its existence, the Chair was engaged in the training of experts in different fields of nuclear physics, jointly and in close cooperation with the Laboratory of High Energies, Laboratory of Neutron Physics, Laboratory of Nuclear Reactions, and Laboratory of Theoretical Physics of the Joint Institute of Nuclear Researches (JINR), Dubna Moscow, the

Moscow State University, MlPhI, INPh AS RU, FIAN RF and many other centres of science in the Soviet Union.

After the disintegration of the Soviet Union and rupture of scientific connections with other scientific centres on the one hand, and low financing and absence of their own scientific and technological base on the other hand caused a considerable decrease in the training quality of nuclear physics specialists in different fields.

Starting in 2002, we began to re-profile directions of specialists' training in the Chair of Nuclear Physics of TSNU from the fundamental fields to applied fields. Applied fields include training of medical physicists, radiation ecology, dosimetry and radiation protection physics, which our country desperately needs.

Training of these specialists (physicists) is carried out according to classical programmes of universities, i.e., from the 1st to 3rd years they study general subjects, higher mathematics and general physics, and from the second semester of the 3rd year, students choose specialties in different chairs, and during 2.5 years study of special courses, pass special rates, perform term papers and degree works and pass a magistracy.

The Chair of Nuclear Physics of TSNU presently trains specialists in medical physics, dosimetry, and radiation protection physics. Today our country has urgent need for these specialists, as during the Soviet Union these specialists were trained in the Centre. All of them were visitors, and after the disintegration of the USSR, several of them left Tajikistan.

In training specialists we also widely use the regional and interregional training projects of IAEA and other international organizations.

Since 2003, more than 200 our oncologists, radiotherapists, radiologists, dosimeters, and etc. were trained in training courses, fellowships, and scientific visits under projects of IAEA.

Many of these specialists train their colleagues at the local level. Though training of nuclear physics specialists in the field of radiation protection, nuclear medicine, radiation ecology is in its infancy, taking into account the availability of highly qualified teachers (doctors and professors), who were trained during the Soviet period, and IAEA assistance in this direction give us hope that in the near future we can train the necessary numbers of specialists, for different fields of national economy of Tajikistan.

Despite of existing difficulties, our physicists within the framework of various international projects (ISTC, INTAS, etc.), also with the support of presidential funds and joint agreements with JINR (Dubna), MSU, are engaged in basic research.

We finalized a number of interstate, interacademic, and interuniversity agreements and treaties with foreign countries, academies and universities in the field of education, science and personnel training.

The Tajik International Nuclear Information System (INIS) Center was established in 2003 under the Nuclear and Radiation Safety Agency (Regulatory Authority) of the Academy of Sciences of the Republic of Tajikistan (NRSA AS RT) to build up capability of providing relevant information services in all aspects of peaceful applications of nuclear sciences and technology in support of the national nuclear programme with support and funding of Technical Cooperation Department of IAEA.

The objective of the project TAD/0/002 “Establishment of INIS Centre” was to establish a national International Nuclear Information System (INIS) centre capable of providing the relevant information services in all aspects of the peaceful applications of nuclear sciences and technology in support of the national nuclear programme.

Under this project employees of Tajik INIS Center of NRSA AS RT were trained in the Islamic Republic of Iran and Russian Federation. After the training they obtained very good theoretical knowledge and practical skills about milestones and particularities of National INIS center daily activity and services, which it provides to scientists.

Currently this center is working in the field of Nuclear Information Processing, Capacity Building. The main tasks of the center are:

- Selecting the relevant nuclear literature produced within country;
- Preparing the associated input in accordance with INIS rules and submitting it to the IAEA;
- Forwarding a hard or soft copy of the full text of those items of literature which is not available through normal commercial channels;
- Providing INIS information and products to users (scientists, post-graduate-students, scientists and etc.) within the country;
- Promotion of INIS products at meetings and conferences;
- Information exchange with INIS Center in Vienna.
- Owing to project TAD 0/002 “Establishment of Tajik INIS Center”, Tajik INIS Center of NRSA AS RT obtained up-to-date equipment and technique, besides the library of Tajik INIS Center of NRSA AS RT received all IAEA publication in the amount of 1700 pieces. The library of Tajik INIS Center is the biggest one because-of availability of all IAEA publications in Central Asia. But due to lack of English knowledge this library is not so required and demanded at the present time but new generation is eager and aspire to learn English and we hope that this library will be requested in the nearest time.

At the present time the NRSA AS RT not only provides relevant information services to scientists and students in all aspects of the peaceful applications of nuclear sciences by the help of its INIS Center but carry out research in the following fields:

- Nuclear Physics;
- Radiation Monitoring of Biosphere;
- Atom-hydrogen Energetic.

Training of the Experts at the Present is carried out in:

- Tajik State National University;
- Khujand State University;
- Kurgonteppa State University;
- Khorog State University.

Training of with high level of qualification is carried out in:

- S.U.Umarov Physical-Technical Institute of the Academy of Sciences of RT;
- V.I.Nikitin Institute of Chemistry of the Academy of Sciences of RT;
- Nuclear and Radiation Safety Agency of the Academy of Sciences of RT.

2. WHAT IS OUR NEED FOR PRESERVATION OF THE KNOWLEDGE?

We need orientation to the following important moments:

- Men capital and human resources are important factor for the development of the country;
- Science and Education are determinative factor for the development of any country.

TABLE 1. SCHEME OF PRESERVATION OF THE NUCLEAR KNOWLEDGE IN TAJIKISTAN

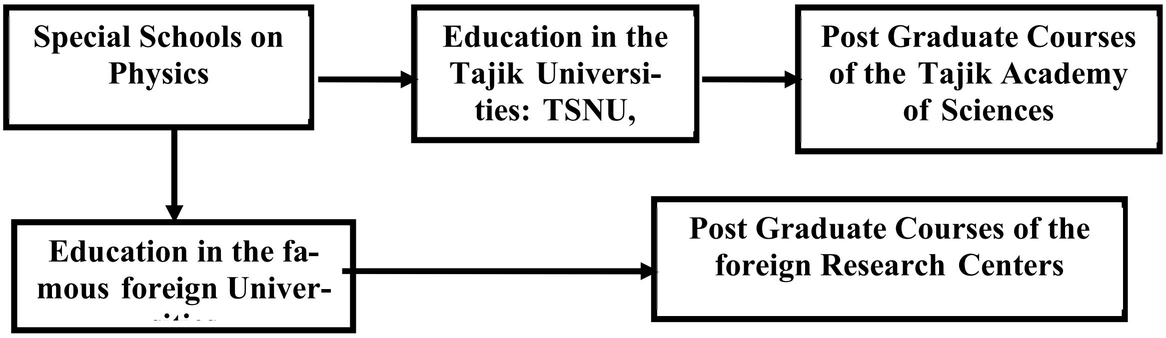


TABLE 2. SCHEME OF PRESERVATION OF THE NUCLEAR KNOWLEDGE IN TAJIKISTAN

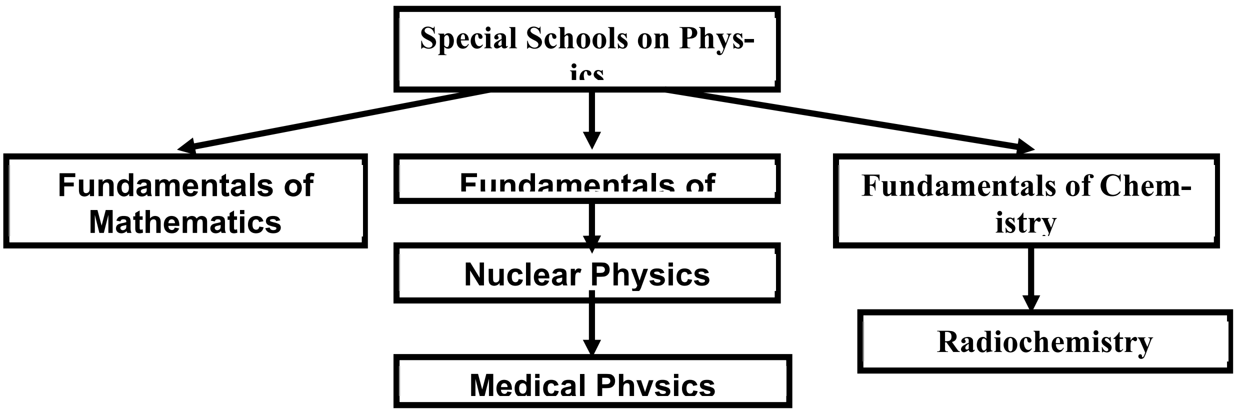


TABLE 3. SCHEME OF PRESERVATION OF THE NUCLEAR KNOWLEDGE IN TAJIKISTAN

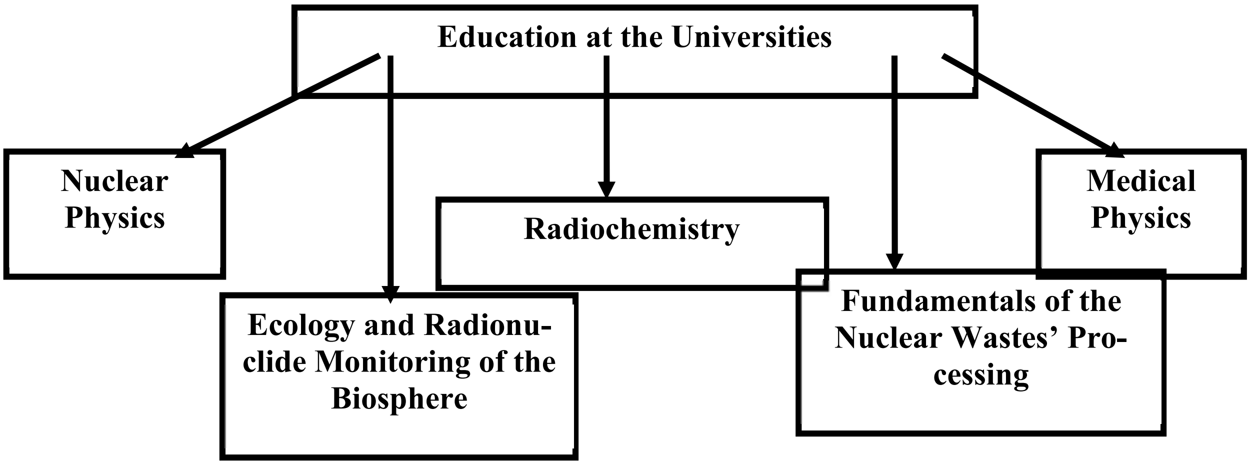
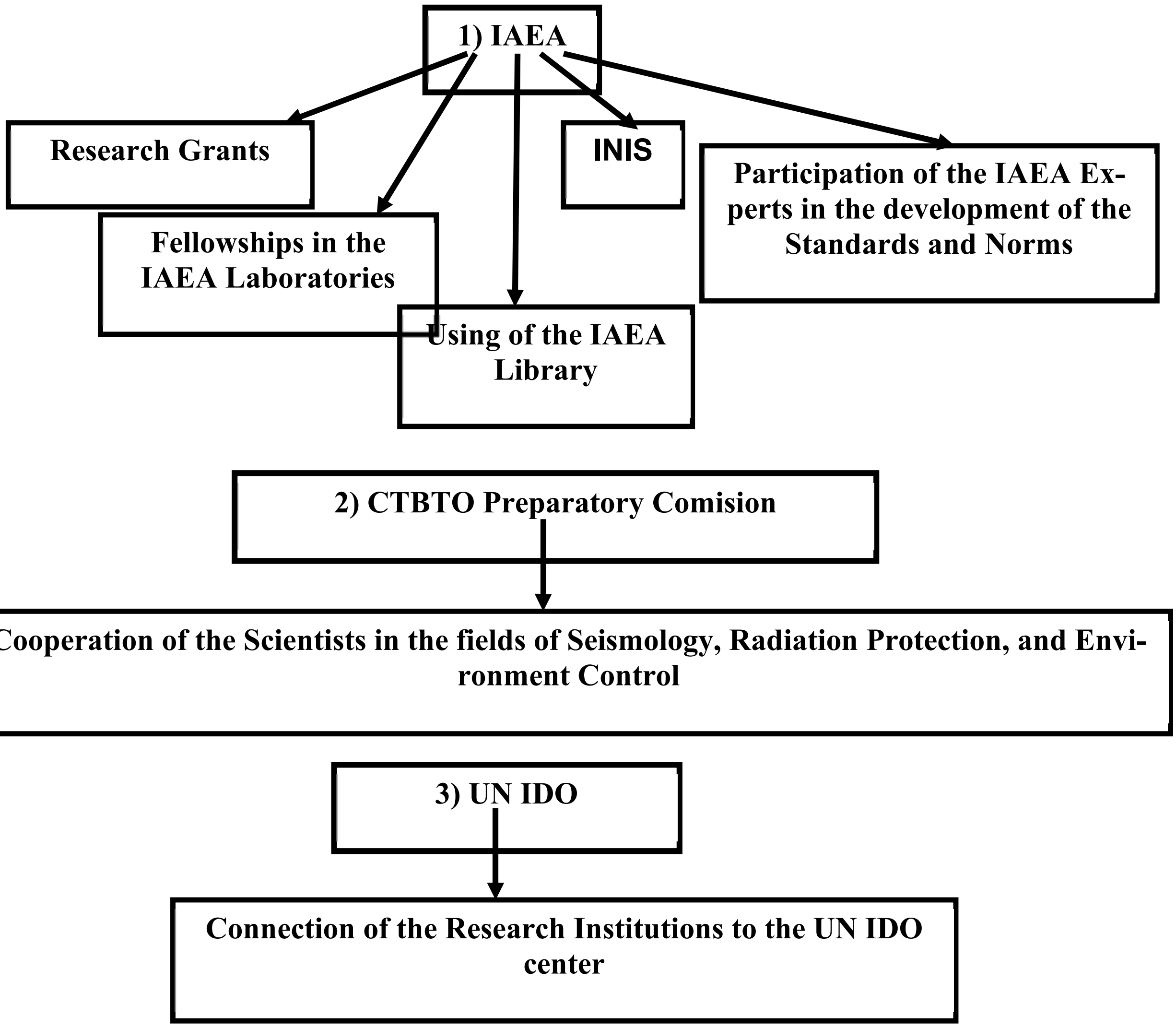


TABLE 4. PART OF THE INTERNATIONAL ORGANIZATIONS IN THE PRESERVATION OF THE NUCLEAR KNOWLEDGE



All the above-mentioned factors, in aggregate, allow us to preserve knowledge in Tajikistan, particularly, in the field of fundamental nuclear physics, nuclear science and engineering.

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SAFETY CULTURE FOR REGULATOR COMPETENCE MANAGEMENT IN EMBARKING STATES

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Abstract

Safety is based on preventive actions where the ability of a regulatory body to fulfill its responsibilities depends largely on the competence of its staff. Building employees' skills and knowledge is an investment for each employee and in the future of the organization. This building must be the competence of its staff integration with their safety culture, the essential to ensure competent human resources as required in the IAEA safety standards and other documents, in which the need and importance of ensuring regulatory competence is emphasized. As it involves both operational and management issues, safety culture is a sensitive topic for regulators whose role is to ensure compliance with safety requirements and not to intervene in management decisions. A number of embarking States are aspiring to develop nuclear power generation and this means that, among other things, regulatory bodies have to be established and rapidly expanded. This paper reports major considerations on the integration of safety culture with an adequate competence management system for regulators in embarking states.

1. INTRODUCTION

Regulatory bodies are required to have a management system for the management of their activities [1–3]. Competence management needs to be integrated into the management system. The transparency and auditability, inherent in such a system, facilitates self-assessment and supports the confidence of interested parties in the regulatory body's processes and competences. In order to implement this requirement, a regulatory body needs to establish the related budgetary provisions. Competence management includes, in particular, an overall training and development Programme that takes into account the operational and long term needs for specialists and managers, and a training and development plan for each employee which is tailored to the employee's needs and roles in the regulatory body.

Managing competent regulatory staff is difficult in many States due to retiring staff members and the challenges in recruitment and replacing them. Additionally, the reduction in higher education opportunities in the nuclear area and competitive market conditions have resulted in a reduced availability of qualified personnel for regulatory bodies. Furthermore, States have declared an interest in 'embarking' on or expanding nuclear power Programmes (generally referred to as 'embarking States'), putting further pressure on the existing pool of experienced regulatory staff. This increases the need to establish Programmes to develop and to manage the competence of States' regulatory bodies.

Safety Culture Is Extremely Important since, All the major nuclear accidents such as events are apparently rooted in the organizational cultures, all events have happened in developed countries and The root causes appear to have been established many years before the event, yet went undetected.

Leadership in embarking states for safety must have clear attributes such as: Senior management is clearly committed to safety, Commitment to safety is evident at all management levels, Visible leadership showing involvement of management in safety related activities, Management assures that there is sufficient and competent staff, Management seeks the active involvement of staff in improving safety, Safety implications are considered in the change management process, Management shows a continuous effort to strive for openness and good communications throughout the organization, Management has the ability to resolve conflicts as necessary, Relationships between management and staff are built on trust.

Accountability in embarking states for safety have clear attributes such as: Appropriate relationship with the regulatory body exists, which ensures that the accountability for safety remains with the licensee, Roles and responsibilities are clearly defined and understood, There is a high level of compliance with regulations and procedures, Management delegates responsibilities with appropriate, authority to enable accountabilities, Ownership for safety is evident at all organizational levels and by all individuals.

In embarking states, the regulator must accomplish the Safety that integrated into all their activities and has many attributes such as: Trust permeates the organization, Quality of documentation and procedures is good, Quality of processes, from planning to implementation and review, is good, Individuals have the necessary knowledge and understanding of the work processes, Factors affecting work motivation and job satisfaction are considered. Good working conditions exist with regards to time pressures, work load and stress, Cross-functional and interdisciplinary cooperation and teamwork are present

In embarking states , Safety is learning-driven must has many attributes such as: A questioning attitude prevails at all organizational levels, An open reporting of deviations and errors is encouraged, Internal and external assessments, including self-assessments are used, Organizational and operating experience (both internal and external to the facility) is used, Safety performance indicators are tracked, trended, evaluated and acted upon, There is a systematic development of staff competencies[4]

Managing the competence of staff members who perform primarily in the areas of review and assessment, authorization, inspection, enforcement, and development of regulations and guides, is depended on a strong safety culture. It is possible to identify several categories of staff by virtue of their experience and capabilities: newly recruited staff (with basic knowledge); developing staff (working knowledge); and established staff, experts and managers (advanced knowledge). This research also addresses the regulatory body's need to have adequate competence to make informed decisions when receiving external advice and to exercise an 'intelligent customer' capability when using external support.

2. A COMPETENCE MODEL FOR THE REGULATORY BODY

A basis for assessing competence needs for both the near and the longer term. By mapping existing competences and comparing them with required competences, a gap analysis can be conducted and priorities for action developed.

2.1. Quadrant Model of Competences

Each regulatory body needs to establish its own sets of competences, levels of competences and standards for evaluation. This model is a valuable instrument for competence management in the regulatory body. The competence model is based on a quadrant structure: Quadrant 1 contains the competences related to the legal, regulatory and organizational basis; Quadrant 2, the competences related to technical disciplines; Quadrant 3, the competences related to a regulatory body's practices; and Quadrant 4, the personal and behavioral competences (see Fig.1).

Each quadrant comprises a set of competence areas with a set of specific competences (KSAs)[5].

The regulatory body's practices referred to in Quadrant 3 are the operational processes, based on the State's legal system, culture and regulatory philosophy, whereby the regulator delivers specific tasks to achieve certain regulatory functions. Regulatory functions have associated tasks which require certain sets of KSAs. Managers determine the necessary tasks to accomplish the function of the organizational unit. This may be done through a collective judgment by the manager and others involved. Safety culture shall not be seen as a part of the organizational culture, but rather as that organizational culture which has safety as a perceived, effectively shared and prevailing value.[6]

1. Competences related to the legal, regulatory and organizational basis 1.1. Legal basis 1.2. Regulatory policies and approaches 1.3. Regulations and regulatory guides 1.4. Management system	**2. Technical disciplines competences** 2.1. Basic science and technology 2.2. Applied science and technology 2.3. Specialized science and technology
3. Competences related to a regulatory body's practices 3.1. Review and assessment 3.2. Authorization 3.3. Inspection 3.4. Enforcement 3.5. Development of regulations and guides	**4. Personal and behavioural competences** 4.1. Analytical thinking and problem solving 4.2. Personal effectiveness and self-management 4.3. Communication 4.4. Team work 4.5. Managerial and leadership competences 4.6. Safety culture

Figure 1. Quadrant model of competences for regulatory bodies.[6]

3.Competent Management and THE ORGANIZATIONAL Safety culture

The competent management practices affect attitudes and behaviors, and consequently, the underlying assumptions of the organizational culture. Organizational culture affects which management practices will be emphasized.

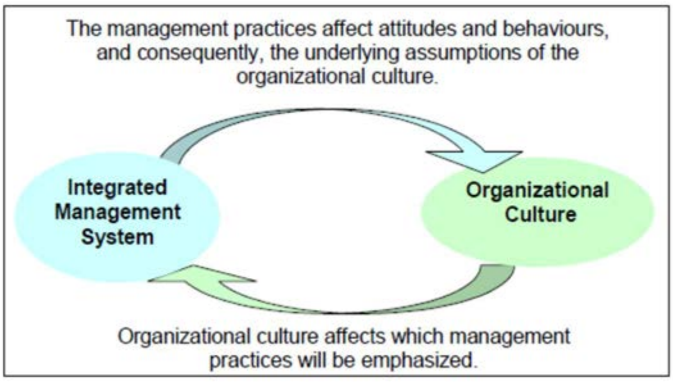

Figure 2. Adaptive Approach for Managing Change

The integration of competent managements into the work of vendors, operators and regulators is an effective means to strengthen their safety culture and such to enhance nuclear safety. Competent managements and safety culture are of equal importance for all phases of the lifecycle of a nuclear installation, the safety culture of all organizations having a stake in the nuclear safety system Interim conclusion. Integration of competent managements into safety culture is the responsibility of all major players concerned with nuclear safety, most important, it is the government, the regulator, and the operator assisted by their Technical Support Organizations (TSOs).

The government should promote the integration of competent managements into the safety culture concepts by the legal demand that the level of protection from the risks of nuclear energy has to comply with the progressing state of the art in science and technology, has to establish the required infrastructure for research, education and training. Doing so, the government should elaborate an inventory of necessary research and education, identify the research centers and the universities, which offer or can implement corresponding research programs, close gaps in the national research and education capacity, e.g. by arranging support from international collaboration, maybe with the help of international organizations like NEA, EURATOM, and IAEA.

The core inventory of safety culture research and education includes e.g. reactor and radiation physics, thermal hydraulics, materials sciences, electrical engineering, etc., geological and hydrological sciences, human factor and organizational sciences. A competent regulator is aware of the fact that safety is best served by combining a customary conservative approach and innovation. Government-Regulator-Interface. The government needs to provide the regulator with sufficient funding for all activities [7] including for getting access to research and training capacity to be able to practice a questioning attitude.

4.CONCLUSIONS

In recent years, various Member States have shown their interest to embark on a nuclear power Programme. This has highlighted the need to provide recommendations to these Member States on different phases of the development of a nuclear power Programme and their regulatory infrastructure. A competent regulator (may be assisted by its TSO) establishes a research program for safety culture which defines technical and temporal priorities, identifies the resources needed, identifies domestic or foreign research institutions or possible international collaborations that can satisfy the demand. The international exchange facilitated by NEA, IAEA, or EURATOM is key to create international collaboration for making efficient use of the scarce research resources for competent managements. The regulator has to have the capability of an intelligent customer. Regulatory bodies need: assistance in maintaining and continuously developing the knowledge base and associated items like computer codes, methods, and data, sufficient education and training capacity.

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