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Knowledge Management for Nuclear Industry Operating Organizations

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FOREWORD

The nuclear energy sector is characterized by lengthy time frames and technical excellence. Early nuclear plants were designed to operate for 40 years but their service life now frequently extends between 50 and 60 years. Decommissioning and decontamination of nuclear plants will also be spread over several years resulting in a life cycle — from cradle to grave — in excess of 100 years, which gives rise to two challenges for the nuclear industry:

(1) Retention of existing skills and competencies for a period of over fifty years, particularly in countries where no new nuclear power plants are being planned; and
(2) Development of new skills and competencies in the areas of decommissioning and radioactive waste management in many industrialized countries if younger workers cannot continue to be attracted to the nuclear disciplines.

As many nuclear experts around the world are retiring, they are taking with them a substantial amount of knowledge and corporate memory. Typically, these retirees are individuals who can answer questions very easily and who possess tacit knowledge never before extracted from them. The loss of such employees who hold knowledge critical to either operations or safety poses a clear internal threat to the safe and reliable operation of nuclear power plants (NPPs). Therefore, the primary challenge of preserving such knowledge is to determine how best to capture tacit knowledge and transfer it to successors.

These problems are exacerbated by the deregulation of energy markets around the world. The nuclear industry is now required to reduce its costs dramatically in order to compete with generators that have different technology life cycle profiles. In many countries, government funding has been dramatically reduced or has disappeared altogether while the profit margins of generators have been severely squeezed. The result has been lower electricity prices but also the loss of expertise as a result of downsizing to reduce salary costs, a loss of research facilities to reduce operating costs and a decline in support to the universities to reduce overheads. The above factors have led to a reduction in technical innovation and a potential loss of technical competences that have drawn the attention of many concerned parties to the need for effective strategies and policies for nuclear knowledge management.

The Director General of the IAEA, Mohamed ElBaradei, in his statement to the forty-seventh regular session of the IAEA General Conference 2003, said:

> *"Whether or not nuclear power witnesses an expansion in the coming decades, it is essential that we preserve nuclear scientific and technical competence for the safe operation of existing facilities and applications. Effective management of nuclear knowledge should include succession planning for the nuclear work force, the maintenance of the 'nuclear safety case' for operational reactors, and retention of the nuclear knowledge accumulated over the past six decades".*

This report is intended for senior and middle level managers of nuclear industry operating organizations and provides practical information that can be used to improve knowledge management (KM) in such organizations. The information provided in this report is based upon actual experiences of Member State operating organizations as well as other related industries.

The Nuclear Power Industry's Ageing Workforce: Transfer of Knowledge to the Next Generation, IAEA-TECDOC-1399, highlighted some of the knowledge management issues in Member States resulting from the large number of retiring NPP personnel who had been

involved with the commissioning and initial operation of NPPs. This report complements that publication by broadening the scope of KM strategic issues, methods and techniques for nuclear industry operating organizations.

Appreciation is expressed to all the participants who contributed to the technical meeting activities listed at the end of this report. Particular thanks are due to L. Durham (USA) for his assistance in the preparation of the final manuscript.

The IAEA staff members responsible for this publication were A. Kosilov, T. Mazour and Y. Yanev of the Division of Nuclear Power.

EDITORIAL NOTE

CONTENTS

1. INTRODUCTION 1

1.1. Objectives 1
1.2. Scope 1
1.3. Background 1
1.4. How to use this publication 4

2. ASPECTS OF KNOWLEDGE MANAGEMENT 4

2.1. Facility life cycle considerations 4
2.2. Organizational overview model 5
2.3. Categories of knowledge 7
2.4. Related organizational factors 9

3. KM POLICIES AND STRATEGIES 10

3.1. Knowledge management elements for a NPP 10
3.2. Elements of KM strategies and policies 12

4. MANAGING KNOWLEDGE 15

4.1. KM elements 15
4.2. Noted KM practices 15
4.2.1. Training and qualification 15
4.2.2. Communication methods and techniques 16
4.2.3. Human resource management 16

5. KNOWLEDGE MANAGEMENT METHODS AND TECHNIQUES 17

5.1. Knowledge capture/transfer methods and techniques 17
5.2. Methods for effectively learning from operating experience 17
5.3. Work control methods to facilitate KM 18
5.4. Implementing procedures and documentation 19
5.5. Information technology solutions supporting KM 19

OBSERVATIONS AND RECOMMENDATIONS 20

6.1. Observations 20
6.2. Recommendations 20

APPENDIX I: KNOWLEDGE MANAGEMENT REVIEW ELEMENTS RELATED TO DOCUMENT APPENDICES 25

APPENDIX II: LESSONS LEARNED FROM APPLYING KM ACROSS EUROPEAN BUSINESSES 26

APPENDIX III: ORGANIZATIONAL KNOWLEDGE MANAGEMENT RISK ASSESSMENT GUIDE 30

APPENDIX IV: TRAINING RECORDS AND INFORMATION NETWORK (TRAIN) ... 31

APPENDIX V: KNOWLEDGE MANAGEMENT OF THE SUSPENDED NPP 34

APPENDIX VI: PROCESS KNOWLEDGE MANAGEMENT 37

APPENDIX VII: KNOWLEDGE REPRESENTATION AND MODELING AT GRS 41

APPENDIX VIII: KNOWLEDGE MANAGEMENT APPLICATIONS AT THE PAKS NPP LTD 44

APPENDIX IX: IDENTIFYING KEY SKILLS & COMPETENCIES ACROSS THE ENTERPRISE 48

APPENDIX X: KNOWLEDGE CAPTURE CHECKLIST 56

APPENDIX XI: KNOWLEDGE TRANSFER WITHIN THE SWISS NUCLEAR INSPECTORATE 60

APPENDIX XII: CAPTURING AND USING HIGH-VALUE UNDOCUMENTED KNOWLEDGE IN THE NUCLEAR INDUSTRY: GUIDELINES AND METHODS 67

APPENDIX XIII: CAPTURE OF PROFESSIONAL/PERSONAL NETWORK TACIT KNOWLEDGE 69

APPENDIX XIV: TACIT KNOWLEDGE CAPTURE IN THE UK NUCLEAR INDUSTRY 70

APPENDIX XV: KEPCO'S E-LEARNING SYSTEM 75

APPENDIX XVI: IMPLEMENTATION OF KNOWLEDGE PORTAL 78

APPENDIX XVII: WORKSHOP ON KNOWLEDGE DISSEMINATION FOR NPP SENIOR MANAGERS 84

APPENDIX XVIII: 'BATCH' APPROACH TO NEW EMPLOYEE ENTRY AND SOME OTHER TRAINING SCHEMES OF DAE 87

APPENDIX XIX: ASIAN NUCLEAR SAFETY NETWORK (ANSN) 90

APPENDIX XX: NUCLEAR ENERGY KNOWLEDGE PORTAL 93

APPENDIX XXI: WORKFORCE PLANNING APPLICATIONS AT THE PAKS NPP LTD 96

APPENDIX XXII: TVA WORKFORCE PLANNING MODEL 98

APPENDIX XXIII: KNOWLEDGE MANAGEMENT/HUMAN PERFORMANCE PLAN 100

APPENDIX XXIV: HUMAN RESOURCE PLANNING AND TRAINING FOR NUCLEAR POWER PROJECTS IN CPI 105

APPENDIX XXV: NATIONAL INITIATIVE ON NUCLEAR EDUCATION IN CHINA 108

APPENDIX XXVI: HUMAN RESOURCE PLANNING IN CGNPC 109

APPENDIX XXVII: SUCCESSION PLANNING APPLICATIONS AT THE PAKS NPP LTD 113

APPENDIX XXVIII: WORKFORCE PLANNING MODEL 117

APPENDIX XXIX: SUCCESSION MANAGEMENT IN BRITISH ENERGY 119

APPENDIX XXX: LEADERSHIP/SUCCESSION PLANNING AT TVA 122

APPENDIX XXXI: KNOWLEDGE MANAGEMENT ASSESSMENT TOOL 125

APPENDIX XXXII: PERIODIC, UNANNOUNCED EVALUATION OF HUMAN PERFORMANCE 133

APPENDIX XXXIII: BENCHMARKING KM IN BRITISH ENERGY POWER & ENERGY TRADING 136

APPENDIX XXXIV: EFFECTIVE WORK TEAM BRIEFINGS 139

APPENDIX XXXV: COMMUNICATING EXPECTATIONS 140

APPENDIX XXXVI: INTEGRATING KNOWLEDGE WITHIN BUSINESS PROCESSES 143

REFERENCES 147

BIBLIOGRAPHY 149

ABBREVIATIONS 153

ANNEX: DEFINITIONS OF TERMS IN THE FIELD OF KNOWLEDGE MANAGEMENT FOR NUCLEAR ORGANIZATIONS 155

CONTRIBUTORS TO DRAFTING AND REVIEW 175

1. INTRODUCTION

1.1. Objectives

The purposes of this publication are:

(1) To identify the fundamental elements needed for an effective knowledge management (KM) system;
(2) To share with nuclear industry operating organization managers the lessons learned in the industry regarding KM and, where they are judged to be relevant, by organizations outside the nuclear industry;
(3) To provide guidance concerning methods for KM implementation.

Intended as an introduction to KM approaches and practices, this document also provides practical information that can be used to improve KM practices in nuclear industry organizations. KM needs to be considered as an integral part of a nuclear operating organization's overall management system, not as a separate, stand-alone programme. KM needs to be part of the long term strategy of the organization. Indeed, as noted in Ref. [1]: "The information and knowledge of the organization shall be managed as a resource."

Managers should assess the situation in their respective organizations with respect to the issues presented. If sufficient concerns are raised regarding a particular issue, a review of the effective practices identified in the report might suggest ways to deal with the issue.

1.2. Scope

The IAEA is developing a series of guidance documents on KM including knowledge preservation, knowledge loss risk assessment, and knowledge transfer in the nuclear sector.[1] Related activities are being designed to assist nuclear organizations in Member States in applying this guidance and in benchmarking their practices against those of other industry organizations. This publication represents one such activity.

The first Technical Meeting to Develop a Guidance Document on the Preservation (and Enhancement) of Knowledge for Nuclear Power Plant Operating Organizations was held 14–17 June 2004 in Vienna. At that meeting, a preliminary draft document that had been prepared by the IAEA on the subject was reviewed and the outline of the new TECDOC was developed. Participants in that meeting encouraged the IAEA to work closely with other nuclear industry international organizations that were also working on nuclear KM. Those organizations included: the NEI, OECD/NEA, WANO/INPO and EPRI. As a direct result of that encouragement, experts from different Member States and internationally recognized nuclear-related organizations assisted in the development of this report. This report applies to primarily to NPPs, but it may also prove to be useful to design organizations, regulatory bodies, and other nuclear-related groups.

1.3. Background

IAEA-TECDOC-1399 The Nuclear Power Industry's Ageing Workforce: Transfer of Knowledge to the Next Generation [2] was developed to provide information on experiences gained in retaining the knowledge needed to design, operate and maintain nuclear power plants in IAEA Member States in the context of the ageing nuclear workforce. Information is provided on the transfer of knowledge — particularly tacit knowledge — including lessons

[1] For already issued publications, see http://www.iaea.org/Publications/index.html.

learned in nuclear operating organizations and selected examples of management strategies and initiatives that may protect these organizations against significant loss of explicit, implicit and tacit knowledge. Awareness and use of this information can assist nuclear power plants and training organizations in dealing with challenges of the ageing and retirement of the NPP workforce and the recruitment of new personnel.

In many Member States, working in the nuclear power industry has less prestige today than it did in the 1970s when many NPPs were first commissioned. There are also greater uncertainties today about the long term future of nuclear power than in earlier times. In some Member States, measures have been taken to terminate operations prior to the scheduled end of plant life, or agreements have been made to phase out nuclear power. Privatization and more open energy markets have created greater financial uncertainty.

Downsizing and right sizing efforts in NPP operating organizations can result in the departure, almost simultaneously, of much of the organizational knowledge. Collectively, these factors mean that, in many Member States, it is more difficult today to attract people into the nuclear power industry. Additionally, the growth in information technology opportunities for young professionals has resulted in fewer students pursuing traditional engineering degrees, not just in nuclear engineering. In still other Member States, significant numbers of experienced personnel have emigrated to other countries due to better opportunities. It is also important to recognize that the situation described above does not apply in all Member States. In some, particularly those with continuing construction and commissioning of new plants, there are few concerns or issues with respect to an ageing workforce and transfer of knowledge.

Recent positive trends in the nuclear power industry include continuing new construction in Asia, a return to new construction in Europe, new plants being seriously discussed in North America, plant life extensions being implemented for many existing plants, improved operational and safety performance of plants overall, and innovative designs being developed through the Gen IV initiative. The success of all of these efforts depends upon having sufficient well-qualified personnel for their implementation

As a field, KM is relatively new. It is an amalgam of concepts borrowed from the artificial intelligence/knowledge-based systems, software engineering, business process reengineering, human resource management, and organizational behavior fields [3]. Large management consulting firms and other companies began to manage knowledge internally in 1989 and the early 1990s. In 1994, large management consulting firms first offered KM services to clients. KM is evolving and being refined through implementation.

KM has been most visibly introduced to the nuclear industry as a response to the aging nuclear industry workforce in Member States, where the generation that designed, commissioned and initially operated these plants has begun to reach retirement age. KM tools for capture and transfer of knowledge from this aging workforce to its younger replacements have been emphasized. While KM has certainly been used successfully for this purpose, KM has a larger, on-going application over the life of an NPP and beyond.

Knowledge management is defined, in this report, as *an integrated, systematic approach to identifying, acquiring, transforming, developing, disseminating, using, sharing, and preserving knowledge, relevant to achieving specified objectives.* Knowledge management consists of three fundamental components: people, processes and technology. Knowledge management focuses on people 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 and make knowledge accessible and to allow people to work

together without being together. People are the most important component, because managing knowledge depends upon people's willingness to share and reuse knowledge.[2]

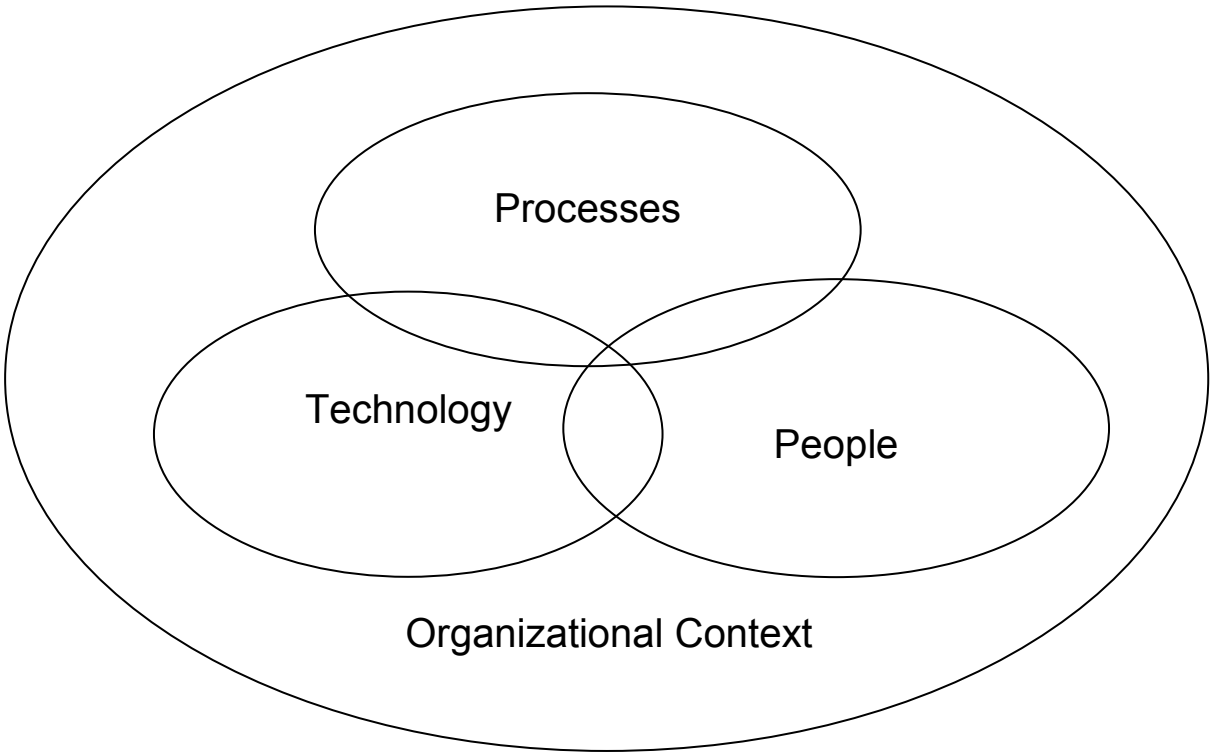

FIG. 1. The organizational context for KM.

Many people see knowledge as power, and some fear that if they share their knowledge they will lose their importance, their marketability. Organizations can try to overcome this deep-seated concern by providing incentives to workers to share their knowledge. However, incentives are not enough to overcome cultures that reward and promote workers who hoard knowledge or that foster competition among employees or groups that should be complementary. Figure 1 illustrates that KM includes people, processes and technology interacting within an organizational context. Clearly, established operational processes are essential to safely operating and maintaining nuclear facilities. Nuclear facilities must rely on strict adherence to procedural requirements in order to assure safe operation and core integrity. Although there are companion procedures through which those processes may be changed, it is imperative in the nuclear industry that any changes to established procedures and processes be rigidly controlled. Indeed, this need illustrates KM in one of its most critical applications.

Trust plays an important role in the sharing and use of knowledge. If people believe they will benefit from sharing their knowledge — either directly or indirectly — they are more likely to share. The use to which people put the knowledge of others often depends on whether they know and trust the source of the knowledge. For example, people are more likely to believe

[2] Discussion of people, processes and technology from *Managing Knowledge & Work: An Overview of Knowledge Management*, PLUNKETT P.T. (author) for the Knowledge Management Working Group of the Federal Chief Information Officers' Council, US General Services Administration, Washington, DC (2001).

and use the equation $e = mc^2$ knowing that it came from a renowned physicist rather than from a newly employed intern. This is an example of why KM efforts that focus primarily on technology are not always sufficient. Studies show that, more frequently than not, people will contact someone they know before they search the corporate database or data warehouse [4]. Technology is an important enabler to the success of KM. But people make or break it.

1.4. How to use this publication

As noted in Section 1.1, this report has been developed to serve practical needs. While its first two sections provide background and context for those readers who are less familiar with KM, Section 3 is designed to provide senior and middle managers a checklist of policies and strategies derived from desirable KM practices. Then, Sections 4 and 5 describe methods and techniques meant for those directly involved in implementing specific KM measures. However, this suite of approaches should be applied with caution in any given organization. As with any form of benchmarking and transfer of practices, what works in one organization may produce different results in another organization. And, as noted in Section 1.3, the interactions of people, processes, and technology ultimately determine the success of such initiatives. Therefore, Section 2 addresses a variety of KM aspects that can influence organizational effectiveness.

Where examples of practical application were found in the nuclear industry regarding KM programmes, the organizations responsible for the applications were asked to prepare brief descriptions of their approaches. These examples are identified in the body of the document where the topic is discussed and the descriptions are included as Appendices. To facilitate the identification of examples applicable to a given topic, Appendix I provides a cross-reference matrix. Finally, terms in the field of nuclear knowledge management are provided in the Annex.

2. ASPECTS OF KNOWLEDGE MANAGEMENT

2.1. Facility life cycle considerations

Data, information and knowledge critical to the operation of a nuclear facility are generated from the initial phases of research and development across the facility's life cycle including its decommissioning. As an example, the fundamental engineering principles incorporated into the design of a NPP constitute essential knowledge for subsequent considerations in the licensing process as well as in considering later changes to the design basis to support facility modifications. Another obvious example is the accumulation of operating experience for use in developing 'lessons learned' and conducting training of new and incumbent personnel. Also, the importance of radiological exposure data in relationship to the optimal use of personnel in both routine operations and abnormal situations constitutes a critical body of knowledge. As a final example, consider the importance to successful decommissioning of the knowledge accumulated on equipment and materiel contamination over a NPP's operating life. Figure 2 illustrates the 'carry-forward' KM needs.

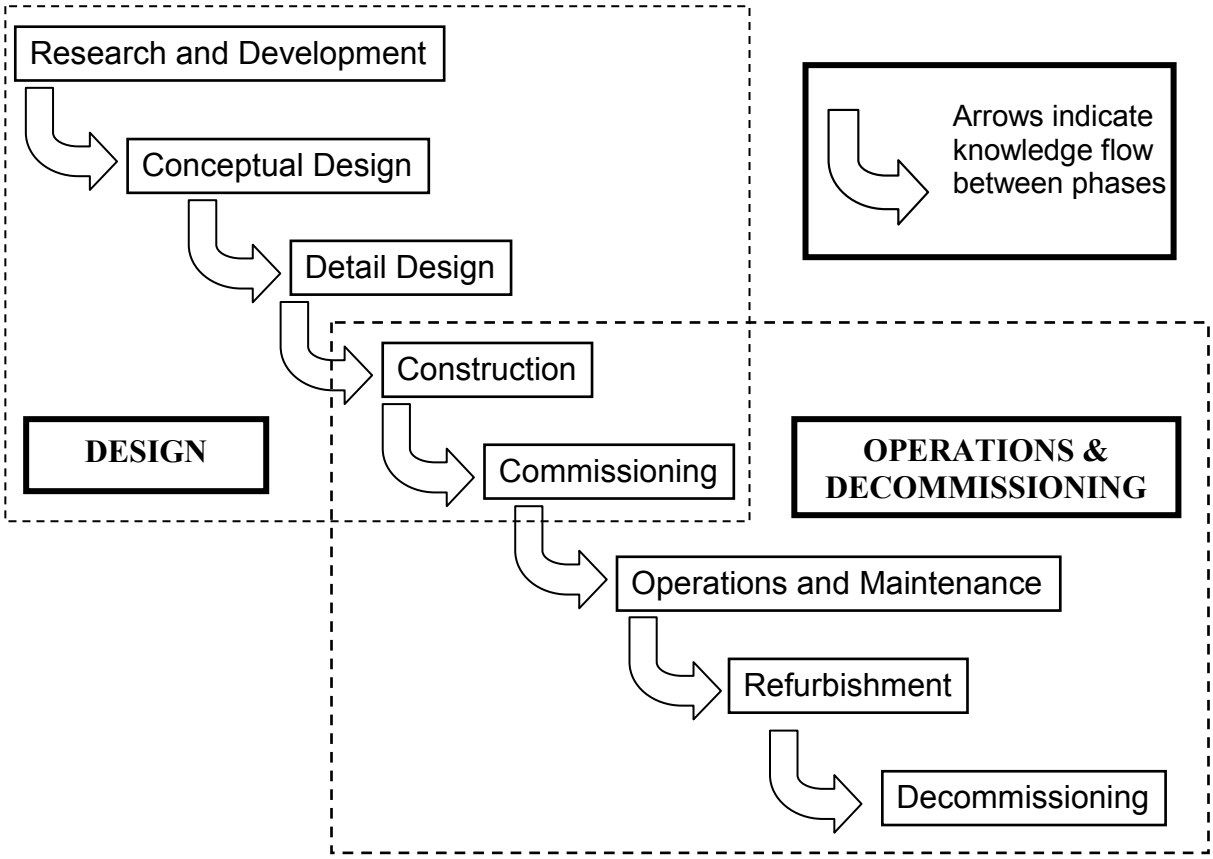

FIG. 2. Knowledge transfer through the phases of a NPP life cycle.

It is important to note that an organization's focus and KM priorities may be quite different depending on where the NPP is in this life cycle. Some KM methods and techniques may stay essentially constant while others may vary considerably. As noted earlier in this document, the people, processes, and technology involved will determine the KM needs and methods.

2.2. Organizational overview model

In order to more fully appreciate KM's pervasive nature and importance to an organization, it is useful to make reference to an overview model. The Fraunhofer Reference Model for knowledge management presented in Fig. 3 has been recognized as one of the few holistic KM frameworks for standardization in Europe. The model is a three-layer schema that depicts the relationships between *value-adding business processes*, four *knowledge management core processes*, and six *design fields of knowledge management*. The following companion definition of KM complements the working definition provided in Section 1.3:

> *Knowledge management includes all methods, instruments and tools that contribute to the promotion of an integrated core knowledge process — with the following four core activities as a minimum, to **generate** knowledge, to **store** knowledge, to **distribute** knowledge, and to **apply** knowledge — in all areas and levels of the organization in*

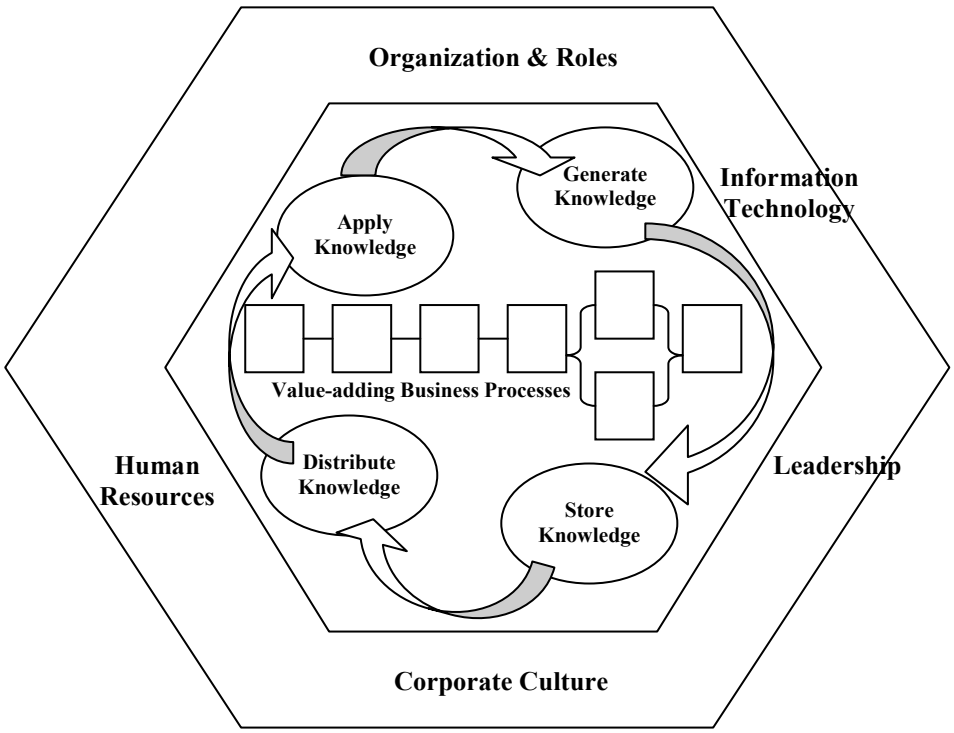

FIG. 3. Fraunhofer Reference Model for knowledge management.

> *order to enhance organizational performance by focusing on the value creating business processes.*[3]

Note the pervasive impact of KM across the entire organization. This is consistent with yet another business-oriented definition of KM used by KPMG International:

> *Knowledge management is a business model that embraces knowledge as an organizational asset to drive sustainable business advantage. It is a management discipline that promotes an integrated approach to create, identify, evaluate, capture, enhance, share and apply an enterprise's intellectual capital.*

Succinctly put, KM is the process through which organizations generate value from their intellectual and knowledge-based assets.[4] As with all such concepts, the role of the leaders of an organization cannot be overstated. The tone and level of expectations set by the most senior manager of an organization will drive both the implementation and the results. Knowledge management is a vital component of change management. As KM initiatives are undertaken or enhanced, it is imperative that expectations and the reasoning behind those expectations are clearly communicated throughout the organization. And, as made reference to earlier in this document, a spirit of knowledge sharing must pervade the organization if the full potential of KM is to be realized. Sensitivity to the need for continual, consistent KM must become ingrained in the very fabric — the culture — of an organization if its benefits

[3] KEMP, J., et al. *KM Framework.* Research paper of the European KM Forum (IST Project no 2000-26393) and WEBER, F., et al. *Towards Common Approaches and Standards for Knowledge Management in Europe*. (Forthcoming). Commentary reported by MERTINS, K., et al [*Knowledge Management: Concepts and Best Practices.* Berlin: Springer-Verlag. (2003).] on the model depicted in Fig. 3 [copyright: Fraunhofer IPK in 2003].

[4] SANTOSUS, MEGAN, and SURMACZ, The ABCs of Knowledge Management, Knowledge Management Research Center, accessed on 09 December 2005 at http://www.cio.com/research/knowledge/edit/kmabcs.html.

are to be achieved. Its practices must become a 'way of life' — not just a temporary, passing management fad. Knowledge management must be integrated into strategic planning; analysis and decision-making; implementation of plans; and, evaluation of results. This is why KM is vital to an integrated management system and is advocated by the IAEA for protecting people and the environment [1].

2.3. Categories of knowledge

There are three different types of knowledge: ***explicit***, ***implicit*** and ***tacit*** knowledge.

Explicit knowledge implies declared knowledge (i.e. knowledge that is conscious to the knowledge bearer). Explicit knowledge is why it is not a problem for the employee to tell about rules and obviously learned facts. Very often this knowledge is already written down in books. The most important aspects of knowledge can be illustrated by using a knowledge map. Such a tool is helpful in the transfer of knowledge from departing employees to their successors (see Fig. 4).

In contrast to such relatively accessible information, ***implicit knowledge*** is difficult to reveal, but it is still possible to be recorded. Usually knowledge bearers cannot recall this knowledge by themselves, because the information is too obvious to them. When people are asked, what they are doing in the morning, they might answer "getting up, taking a shower, having a coffee, going to work, checking the e-mails…" without first thinking about their having had to get undressed to take a shower; without thinking about the multiple steps involved in making coffee; and, without thinking about their having had to switch on the computer before being able to read their e-mails. It is generally feasible to convert implicit knowledge into explicit knowledge through documenting it.

The third type of knowledge, ***tacit knowledge***, is the most difficult to recall and, thus, to transfer. Tacit knowledge includes knowledge about topics such as how to ride a bicycle or how to talk. These examples describe knowledge everybody just has. However, every individual possesses a lot of tacit knowledge. Employees, for example, tacitly know how they persuade other people, how to behave in different situations, or how to organize a meeting. Such knowledge cannot be completely explained, since it is wholly embodied in the individual, rooted in practice and experience, expressed through skillful execution, and transmitted by apprenticeship and training through watching and doing forms of learning [5]. Tacit knowledge can be observed; however, it is doubtful that all of this knowledge can be converted to explicit knowledge. This fact is why it is said, "We know more than we know that we know."

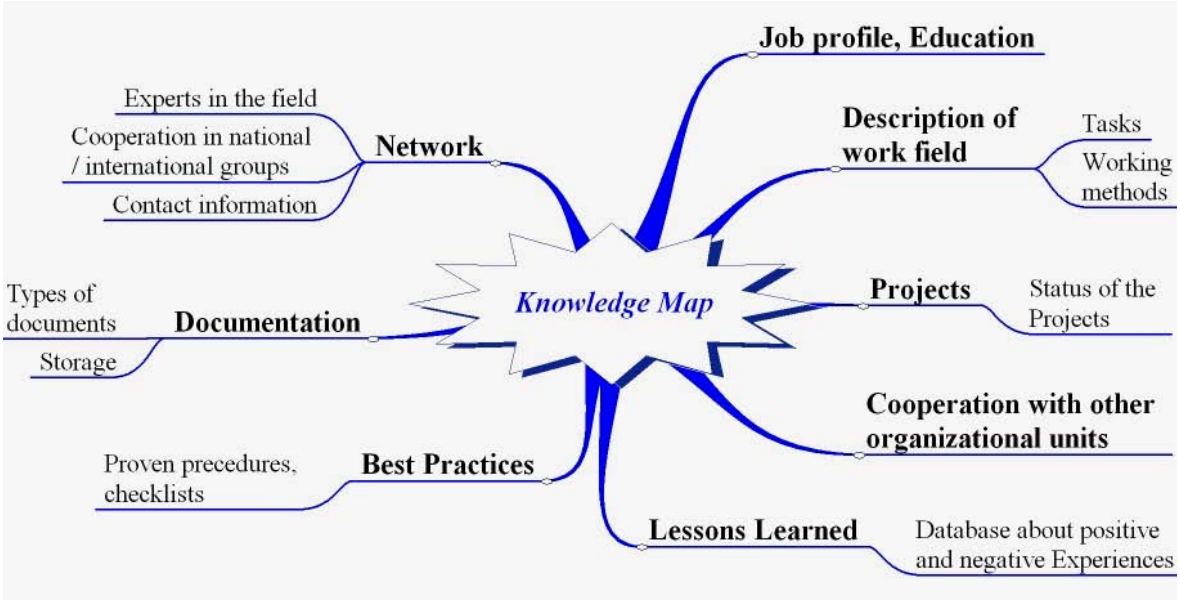

FIG. 4. Example of a simplified knowledge map.

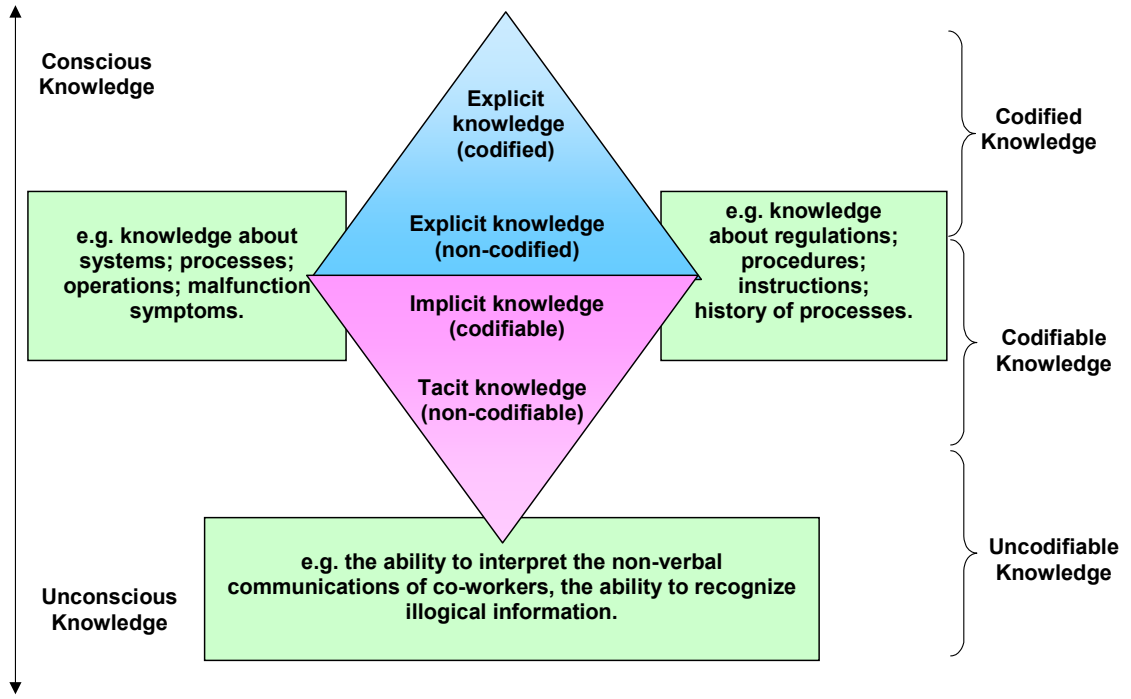

FIG. 5. Explicit, implicit and tacit knowledge.

These three types of knowledge — explicit, implicit and tacit — can be depicted using a diamond model (see Fig. 5). The top half of the diamond represents explicit knowledge — or conscious level knowledge — which has either already been codified or could be codified. The bottom half of the diamond represents unconscious knowledge — both *implicit knowledge* and *tacit knowledge.* The former can be codified if brought to the conscious level. However, the latter cannot be codified directly because it is at the deep-unconscious level. This model helps to demonstrate how important it is to coax departing workers to focus on the

totality of their respective job experiences in order to move tacit knowledge to implicit knowledge and implicit knowledge to explicit knowledge that can be codified.[5]

2.4. Related organizational factors

By the early nineties, it was clear that there were two distinct branches of KM.

First-generation KM involves the capture of information and experience so that it is easily accessible in a corporate environment. Managing this capture allows the system to grow into a powerful information asset. This first generation had its roots in the use of information technology (IT). In this view, KM is an issue of information storage and retrieval. It uses ideas derived from and management theory. Typically, first-generation KM involved developing sophisticated data analysis and retrieval systems with little thought as to how the information they contained would be developed or used. This led organizations to invest heavily in technological fixes that had either little impact or a negative impact on the way in which knowledge was used. Faced with the theoretical and practical difficulties of first generation techniques to live up to their promise, theorists began to look more closely at the ways in which knowledge is created and shared.

Along with this realization came a change in metaphor. Organizations came to be seen as being capable of; and, so, a link grew between learning theory and management. Second-generation KM gives priority to the way in which people construct and use knowledge. It is closely related to organizational learning. The goal of KM in its second generation is to improve an organization's effectiveness by leveraging three learning processes in smart and lasting ways:

(1) Learning from successes and failures at the individual, team and organizational levels;
(2) Learning from peers and colleagues in the organization;
(3) Learning from the outside: suppliers, customers, competitors, and non-nuclear enterprises.

KM should empower plant staff to integrate these learning processes into their work practices and habits. However, learning should take place in a focused, relevant way because learning itself is not the goal, but, rather, is a tool to improve the organization's performance and capabilities.

Today, increased attention is being given to phenomena such as learning organizations, human and organizational performance improvement, change management; knowledge management, and integrated management systems. As companies are increasingly recognizing employees as being their most valuable assets, increased focus is being put on the critical roles that humans play in each of these phenomena. The increasing recognition of the invaluable NPP asset known as human or intellectual capital is having enormous impact on the attention being paid to knowledge management. In that process, NPPs have become increasingly sensitive and responsive to the urgent need to maintain full complements of competent, qualified workers lest their very licenses to operate be revoked for inadequate talent. Without due and timely attention to KM strategies and programmes, NPPs will close due to lack of qualified personnel.

This area of concern is referred to in the trade as 'loss of knowledge risk assessment'. Be it through retirement or poor retention and recruitment experience, nuclear utilities simply cannot function absent well-qualified, competent, properly authorized plant personnel. As

[5] This discussion of the three different types of knowledge derives from a presentation developed by KURONEN T. of the BIT Research Center, Helsinki University of Technology entitled "What is tacit knowledge in NPP maintenance and what are the prerequisites for sharing it?" It was presented to the CSNI International Workshop, Ottawa, Canada, 3-5 October 2005.

with their reactors, NPPs cannot function without a 'critical mass' of competent personnel. KM strategies can assure that such pre-conditions are met in a timely fashion. Appendix III addresses this phenomenon in a most practical, transferable manner. Put quite simply, workforce planning, personnel training, and operational units must now work together in an integrated fashion or risk not having the personnel needed to do the jobs safely and effectively. In summary, effective functioning of an NPP's management system requires effective KM measures to be in place and functioning well. In this information age, effective KM programmes are essential to the safe, reliable, and cost-effective operation of an NPP. Appendix III contains a brief overview of knowledge risk assessment as implemented at a major US NPP operating organization.

3. KM POLICIES AND STRATEGIES

3.1. Knowledge management elements for a NPP

The following elements are typically a part of existing KM practices for an operating NPP organization (whether recognized as such or not):

(1) Plant policies and procedures:
- Management system definition and requirements
- Safety policies and procedures (both nuclear and industrial)
- Administrative procedures
- Technical procedures and instructions
- Abnormal and emergency operating procedures
- Emergency plan

(2) Document control:
- Engineering drawings
- Safety analyses
- Technical manuals
- Surveillance test results

(3) Configuration management:
- Plant status control
- Plant modification and change control

(4) Training and qualification:
- Approved training materials
- Fidelity of simulators, laboratories and shops
- Training and qualification records
- Examination records
- Pre-job briefing packages
- Mentoring, shadowing and tutoring
- Human performance improvement

(5) Learning from operating experience:
- Internal and external events analysis
- Reportable occurrence reports

- Near miss reports
- Appreciative inquiry
- Benchmarking (internal and external)

(6) Work control system:
- Standard work packages for routine work
- Records of completed work packages
- Post-job de-briefs and resolution of identified opportunities for improvement

(7) Corrective action tracking:
- Identification of existing deficiencies, their planned resolution and status of resolution
- Record of earlier corrective actions, including those closed out, and any recurrences

(8) Human resource management:
- Workforce plan for the organization
- Relevant demographic data for the NPP's service area
- Recruitment plans
- Retention plans
- Succession plans for key positions
- Individual development plans
- Personnel performance appraisal results

(9) Communications:
- Plant status information including outage status reporting
- Newsletters and other routine communications
- Information captured and disseminated through plant meetings
- Leadership in the plant through observation, coaching and feedback
- Peer-checking
- Shift turnover, pre-job briefs, post-job debriefs
- Reporting of near misses and improvement opportunities
- Appreciative inquiry
- Correct behaviours modelled by managers
- A community of practice or some other structured form of knowledge sharing and creation

(10) Company intranet and other web-based solutions:
- Access points for administrative and technical information, including much of the information/knowledge identified above
- Approved external websites for benchmarking and relevant research

All NPP operating organizations have programmes in place to capture, store and retrieve much, if not all, of the information/knowledge identified above. Therefore, implementing a KM programme is **not** about discarding existing practices; rather, applying a KM approach should improve the value of existing programmes to the organization through:

— Identifying business, operational and safety risks due to knowledge gaps (such as knowledge loss risk assessment to identify were the organization is most at risk of loosing mission-critical knowledge);
— Increasing the value of existing knowledge (through mechanisms such as making it easier to retrieve knowledge/information when it is needed in the workplace and potential integration of data systems/banks);
— Converting tacit knowledge to explicit knowledge (where the value to the organization justifies the resources needed for this effort);
— Improving operational and safety performance through creating both new knowledge and better access to existing knowledge;
— Continually learning in a smart and lasting way from successes and failures at the individual, team and organizational levels;
— Effective transfer of knowledge from an ageing workforce to younger workers; and
— Improved strategic planning and decision-making resulting from access to more, and more reliable knowledge/information.

3.2. Elements of KM strategies and policies

The following paragraphs provide experiences regarding NPP operating organization strategies and policies related to KM. One paragraph is provided for each noted practice; beginning with a statement of the practice and followed by a brief description and reference to an appendix or related publication for additional details/examples.

Top-level policies and associated procedures provide an integrated strategy and implementing approach for KM, including identification of roles and responsibilities of an accountable manager for KM. This KM strategy is linked to the organization's business plan such that KM is used as a tool for continuous improvement in the organization's performance. The KM strategy assures that KM is an integral part of the NPP's integrated management system. The IAEA is revising its requirements and guidance in the subject area of quality assurance contained within the Safety Series 50-C/SG-Q (1996) into a new Safety Series on 'management systems' planned to be issued in 2006. The term 'management system' has been adopted in the revised series of publications instead of the term quality assurance/quality assurance programme. This development integrates all aspects of managing a facility, including the safety, health, environmental, security, quality and economic requirements into one coherent system.

The approach in Refs [1, 6] includes managing information and knowledge as an integral part of an operating organization's management system. This integrated management approach is intended to replace IAEA's quality assurance and quality control guidance and requirements. Appendix II provides common lessons learned about KM initiatives and management strategies. Appendices XIX, XXV, XXXV and XXXVI provide examples of management support for KM initiatives.

(1) **A communications strategy** is in place that supports the organization's vision, mission and change initiatives by identifying strategies, objectives, and tactics for communicating with key stakeholders. This strategy should include communications related to the value and importance of knowledge management to the organization. Senior corporate and plant managers, through personal involvement, foster open communications; up, down and horizontal. Appendix II provides common lessons learned with regard to communications about KM. For examples of communication strategies, see Appendices XV–XVII and XIX.

(2) **A workforce planning strategy** has been developed to ensure that staffing needs for the life of the organization are identified and tracked. This strategy addresses areas such as risks associated with losing mission critical knowledge, succession planning and developing leaders and managers. Workforce planning is a continuous process that ensures an organization has the right numbers of people in the right jobs at the right time, with the right qualifications. A typical workforce planning approach is as follows:

- Set strategic direction;
- Analyse workforce, identify skill gaps and conduct workforce analysis;
- Develop action alan;
- Implement action plan;
- Monitor, evaluate and revise.

Appendix III provides a summary of very practical knowledge loss risk assessment methods used by an NPP operating organization. Appendices XXI–XXX provide examples of workforce and succession planning approaches within an overall workforce plan.

(3) **A human performance improvement programme** is established to continually identify opportunities to improve plant performance and expand the knowledge of the organization, particularly for those activities related to safe and reliable plant operation. INPO in the USA has a comprehensive human performance programme which has its principal focus on error prevention techniques. Through WANO these techniques are being transferred to NPP operating organizations outside the USA. Reference [7] provides information regarding human performance improvement approaches in a number of NPP operating organizations, while Ref. [8] provides examples of human performance improvement programmes in other industries. These approaches could have potential application in NPP operating organizations. See Appendices XXIII and XXXI–XXXVI for descriptions of programmes designed to improve human performance through using KM effectively.

(4) **Strategies for knowledge transfer and retention** are developed and implemented to preserve unique knowledge and skills that could be lost through attrition or planned staffing changes. One of the most pressing issues currently facing NPP operating organizations in this regard is the large number of personnel who have already or soon will retire. Reference [2] provides information regarding how this issue is being addressed in some Member States. Appendix III also addresses these issues in a very practical way through a knowledge loss risk assessment method. Appendices X–XIV provide examples of knowledge capture and transfer techniques.

(5) An effective process is established that **clearly define expectations for procedure use** that takes into account the complexity of the task, the skill and training of plant personnel, the extent of supervisory involvement, and the potential consequences of improper performance**.** Reference [9] provides examples of methods that NPP operating organizations have used in this regard. It is suggested that a graded approach be taken regarding expectations for procedure use in order to ensure that procedural compliance does not become rote compliance with rules to the exclusion of a thoughtful, questioning attitude.

(6) **The culture of the organization** promotes the transfer of knowledge, particularly tacit knowledge among plant personnel. Evidence of this culture is seen through:

- managers serving as role models for others to emulate regarding knowledge transfer;

— mutual trust existing between managers and the workforce, including trade unions, if applicable.

Methods are in place to periodically assess the status of this culture. The transfer of tacit knowledge needs to be done on a person-to-person basis. Thus the success of tacit knowledge transfer depends a great deal on the extent to which the organization's culture encourages such transfer, and being aware of cultural barriers in the organization that discourage knowledge transfer. For example, does the organization reward employees based upon their being the sole source of critical knowledge and information, or does it reward employees for sharing their knowledge and information widely? Appendix II provides common lessons learned with regard to motivational and cultural issues and the use of a proven KM tool: communities of practice. Appendices X–XIV describe methods through which various organizations have sought to capture and transfer knowledge effectively. Appendix XXXIII describes an effort by a part of British Energy to systematically and periodically assess employee opinions.and to benchmark its KM practices based upon the British publication: Knowledge management — *A Guide to Good Practice* (PAS 2001) [10]. This benchmarking included the use of a survey to collect information regarding employee opinions concerning the organizational climate for knowledge sharing. Appendix XXX provides a brief description of a utility operating organization's culture change process that has been in place for a number of years.

(7) **Managers are personally involved** in ensuring that the KM programme is developed, implemented, continuously improved and integrated with the organization's overall management system. One example of this involvement is that managers feel accountable for the training, qualification, and performance of their personnel**.** A strategy should be developed to reward and recognize people for their contributions to growing the knowledge assets of the organization. Appendix II provides common lessons learned with regard to leadership and middle management. As discussed earlier with respect to item (1), the IAEA is replacing its publications related to quality assurance and quality control requirements to instead establish requirements and generic guidance for a management system that integrates safety, health, environmental, security, quality and economic objectives. The approach in these publications includes managing information and knowledge as an integral part of an operating organization's management system [1].

(8) **Benchmarking** is an established policy to transfer knowledge, improve performance, and emulate best industry practices. Identification and correction of problems and use of operating experience, benchmarking, and self-assessment should be integral to the organization's culture. Appendix XXXI provides a KM self-assessment tool developed based upon benchmarking established practices both within the nuclear industry and in other high hazard industries. The KM elements and practices listed therein can be used for both self-assessment and independent reviews of KM programmes. Appendix XXXIII provides an example of a benchmarking approach for KM based upon a UK standard.

(9) Managers have established a **continuous learning environment** that encourages employees to continually improve individual and station performance. Appendices XV–XVIII and XXXIV–XXXVI provide examples of initiatives that have been proven to be effective in this area. Note that these techniques range from basic communication of expectations to the employment of user-friendly electronic technology.

4. MANAGING KNOWLEDGE

4.1. KM elements

It was noted in Section 3.1 that all NPP operating organizations have programmes in place to capture, store and retrieve much, if not all, needed information and knowledge; that implementing a KM programme is **not** about discarding existing programmes; and, that applying a KM approach should improve the value of existing organizational programmes. It was also noted that the effective implementation of KM practices typically contributes to organizations' achieving results in the following ways:

- Identifying business, operational and safety risks due to knowledge gaps;
- Increasing the value of existing knowledge;
- Converting tacit knowledge to explicit knowledge;
- Improving operational and safety performance;
- Continually learning at the individual, team and organizational levels;
- Transfering knowledge effectively to younger workers; and
- Improving processes for strategic planning and decision-making.

4.2. Noted KM practices

This section provides noted practices regarding managing knowledge. One paragraph is provided for each practice; beginning with a statement of the practice, and followed by a brief description and reference to an appendix or related document for additional details/examples.

4.2.1. Training and qualification

(1) **A systematic approach to training (SAT)** is implemented to achieve, maintain, and improve personnel knowledge, skill, and performance to support plant safety and performance goals. For more than 15 years the IAEA has been encouraging NPP operating organizations to implement SAT-based training programmes. In many Member States, SAT-based training is the accepted standard for training of NPP personnel. Appendix IV provides an example of one NPP's training records and information network and Appendix XVIII describes another NPP's training programme for newly-hired personnel. Appendix XXV describes China's national nuclear education initiative. References [11, 12 and 13] are some of the IAEA publications regarding SAT-based training. The bibliography provides a comprehensive listing of IAEA publications related to this topic.

(2) **Continuing training,** including just-in-time training (JIT) ensures that plant personnel maintain their job-specific knowledge and skills. Reference [14] provides examples of how such simulators are used to meet job-specific training needs for control room personnel. Appendices XV–XVII describe knowledge dissemination programmes designed to complement the continuing training of organizational staff. Appendix XXXII provides an innovative example of how one NPP operating organization periodically conducts unannounced assessments of the job-specific knowledge and skills of its personnel.

(3) **Training materials and examinations are current, accurate, and of high quality.** Reference [13] provides examples of methods used by some NPP operating organizations to develop high quality, SAT-based training materials. An IAEA

TECDOC on the development and use of competency-based tests for nuclear industry personnel has been approved for publication and should be in print in 2006.

(4) **Contractor personnel** involved in plant activities and assigned to work independently perform to the same standards as the plant staff and are verified to have the specialized skills and training appropriate to the tasks they perform. Responsibilities are established for oversight of contractor personnel who work independently. Reference [15] provides examples of methods that NPP operating organizations in Member States have used to address this need.

4.2.2. Communication methods and techniques

(1) Managers practice **visible leadership in the field** by observing performance; coaching and mentoring personnel; and, reinforcing standards**.** One area where observation of performance is particularly difficult is for cognitive tasks such as those typically performed by engineers or other technical support personnel. Appendix XXXV gives an example of the manner through which one NPP chose to address this vital need.

(2) Managers encourage **cooperation and teamwork** among plant organizational units, especially when successful implementation of work activities requires support from several groups. The organization's values and behaviors are modeled by its leaders and practiced by all plant staff. Effective mechanisms are in place to promptly transfer these values and expected behaviors to new staff. Appendix II provides common lessons learned with regard to the use of a proven KM tool: Communities of Practice. Appendix VIII provides information regarding the Paks induction and mentoring programmes for an NPP operating organization.

4.2.3. Human resource management

(1) Managers ensure that **future staffing needs** are identified and tracked through an ongoing workforce planning process. This planning process includes a knowledge loss risk assessment that identifies knowledge that is critical to the organization's mission and that may be lost in the near future. Appendix III provides a summary of the knowledge loss risk assessment method of one NPP operating organization. Appendices XXI–XXVI and XXVIII address the topic of workforce planning.

(2) **Succession plans** are in place for key corporate and plant positions. The succession plan includes rotational assignments, project assignments and other means to develop staff for advancement. A profile defining the competencies needed for key jobs is established and used to identify candidates for leadership positions and to guide their development. Appendices XXVII, XXIX and XXX provide descriptions of succession planning processes for NPP operating organizations.

(3) **Candidates for leadership positions are developed** through training and assignments in a variety of positions within the organization. On an ongoing basis, senior nuclear managers assess the progress of individuals identified as having management and leadership potential and their readiness for future management positions. Appendices XXVII, XXIX and XXX provide information regarding the tools used by three different NPP operating organizations for development of future leaders.

(4) **Human resource personnel work as a team with line managers** to anticipate personnel needs and recruit to ensure sufficient staffing of knowledgeable and skilled personnel. Appendix XXVII provides information at to how the HRD Department of an NPP operating organization works together with line managers to anticipate plant staffing needs.

5. KNOWLEDGE MANAGEMENT METHODS AND TECHNIQUES

This section provides noted practices regarding knowledge management methods and techniques. One paragraph is provided for each practice; beginning with a statement of the practice, and followed by a brief description and reference to an appendix or related publication for additional details/examples. Appendix II summarizes lessons learned through a survey of KM practices across European businesses.

5.1. Knowledge capture/transfer methods and techniques

(1) Effective use is made of **knowledge elicitation tools** to assist in identifying critical knowledge held by employees/experts, to present this knowledge in a manner that facilitates its transfer to others and to ensure that elicited knowledge is both current and validated. Appendix IX describes the methods used by a multi-location company to identifying key skills and competencies across the enterprise. Appendix X provides an example of a knowledge capture checklist used by an NPP operating organization to address the issues identified above. Appendix XI gives an overview of knowledge transfer considerations being made by a regulator. It examines features of several viable methodologies and discusses in some depth the utilization of structured interviews with and written reports by departing employees. Examples of the capture and transfer of tacit knowledge are provided by Appendices XII–XIV.

(2) Plant personnel **document and transfer information** accurately. Plant activities, conditions, and decisions are documented in sufficient detail to enable personnel to re-create and address plant problems or events. In addition to traditional doucmentation methods, such as plant procedures, some NPP operating organizations are beginning to implement techniques such as concept maps to capture and transfer information in a manner that is based upon how the information may be organized by an expert performer. Two such representation/modeling initiatives are described in Appendices VI and VII.

(3) Managers and coworkers frequently **observe work** and training activities to ensure that knowledge capture and transfer methods are being effectively applied and to identify needed improvements. Appendix XXXV provides the expectations of an NPP operating organization regarding its programme — LEADING — to make observations, provide coaching, and utilize feedback mechanisms to improve personnel, plant, and organizational performance.

5.2. Methods for effectively learning from operating experience

(1) Plant personnel are **self-critical** and frequently provide feedback to improve knowledge management processes, plant performance, processes, plans, procedures, and training. They willingly report problems, near misses, error-likely situations, and safety hazards. To monitor this area some NPP operating organizations use as an indicator the percentage of the total number of plant deficiencies in a given period that are self-reported. Targets are established for the minimum percentage considered to be acceptable (some organizations have used 50%). Appendix XXXII illustrates this KM element. Appendix II provides lessons learned with regard to results and metrics.

(2) **Lessons learned from operating experience** are institutionalized through changes to station processes, procedures, equipment, and training programmes. **Change initiatives** are well managed and coordinated. The potential effects of organizational changes and staff reductions are considered and addressed before such changes are initiated.

Reference [16] provides examples of methods used in some Member States for managing such changes. In 2006, the IAEA plans to publish an update of this TECDOC, reflecting additional lessons learned in this area since 2001. Reference [17] provides practical information regarding corrective action systems to ensure that lessons learned are effectively utilized.

(3) **A feedback process,** including post-job reviews and management observations, is used to improve human performance and knowledge transfer. Appendix XXXV provides the expectations of an NPP operating organization regarding its programme — LEADING — to make, record and report observations in a fashion conducive to 'real-time' information exchange; reinforcement of desired behavior and coaching on non-satisfactory performance; and, organizational learning.

(4) A process is in place to encourage, monitor, and address **employee feedback** on KM and other organizational initiatives. One such process that is based on seeking to learn about and transfer internal organizational process successes is known as 'appreciative inquiry' — a strategy of asking positively-framed questions to focus on what is going right within an organization.

5.3. Work control methods to facilitate KM

(1) **KM methods, are built into processes,** wherever practical, rather than being separate, add-on tasks in order to increase effectiveness and reliability of knowledge capture and transfer. Past performance shows that KM and HPI tools are typically more effective if they are embedded in the process as part of the task, rather than used as an external add-on applied during the task. The 'embedding' may be as simple as proceduralizing the use of the tool at specific steps known to be critical to the task outcome, or may involve hardware changes to eliminate error-likely situations (e.g. lighting or labeling changes, bar code scanning, etc.). Appendix XXXIII provides an example of a KM/HP plan as a tool for building KM and HP into plant processes. Appendix XXXIV presents another example that describes effective work team briefings. This 'embedding' process is also consistent with the establishment and maintenance of an integrated management system designed to cover all aspects of an NPP's operation including safety, health, environmental, security, quality and economic elements as described in Ref. [1].

(2) **The composition of operating crews** and other teams takes into account individual experience and attributes to enhance knowledge transfer. This can include distributing more experienced and more capable persons across teams, and giving these individuals specific responsibilities for transferring their knowledge to others in the team. See Appendices XXIII and XXXIV for relevant examples.

(3) Maintenance, operations, engineering, and other work groups have an effective, **integrated role** in monitoring plant performance and in documenting this knowledge in such a way that it can be effectively retrieved and utilized when needed**.** Some organizations have established a system engineer position to provide this integration. System engineers are the people in the organization who are expected to be the focal points for information and knowledge regarding their respective assigned systems. They are not expected to be an expert on all components and technologies of the system, but rather, they know where to find such information or knowledge in the organization.

5.4. Implementing procedures and documentation

(1) **Plant procedures** are a logical location in which to store knowledge that is captured from experts. However, the inclusion of such knowledge in procedures is structured in such a way that information as to why something is done does not detract from the effective and reliable use of the procedure. Procedures need to be writtend at a level apropriate for the persons performing the task. As the workforce that initially operated the plant is replaced, the level of detail of procedures may need to be re-assessed. Reference [11] provides examples of how such issues have been considered by some NPP operating organizations.

(2) Design calculations, drawings, analyses, procurement specifications, and other **design documents** are readily retrievable and clearly describe the bases for the function of plant systems and components. Licensing and design requirements need to be well defined, documented, controlled, and retrievable. Consistent with these critical requirements, Appendix V describes KM in a suspended NPP.

(3) Procedures, drawings, training lesson plans, and related documentation are **updated promptly** following implementation of configuration changes. Reference [18] provides examples of configuration management approaches being used by some NPP operating organizations. Design change and plant modification processes should include training impact assessments in the procurement requirements to assure that needed configuration changes to simulators and laboratories are identified and properly funded at the pre-procurement stage.

5.5. Information technology solutions supporting KM

(1) **The organization's information technology (IT) strategy is based upon achieving its KM objectives.** The function of a typical IT organization is to provide services that facilitate the collection, storage, and access of NPP data, information and explicit knowledge. Appendix II provides common lessons learned with regard to IT-enablers.

(2) **Information technology is used effectively to capture and share knowledge critical to the organization's mission.** Appendix VIII provides information regarding how one NPP operating organization uses IT to support its knowledge management functions. Legacy documents, particularly from older plants, or those whose completion has been delayed present particular challenges. Appendices XV and XVI give further examples of the application of IT to achieve KM objectives.

(3) **IT products and services are developed based upon customer KM needs.** Operational area managers retain responsibility for the timely, effective utilization of available knowledge components including their explanation and interpretation.

(4) **It is recognized that not all KM needs can be addressed through IT solutions.** The reader is referred to the dicussion in Section 2.3. A key point in this section is that transfer of implicit knowledge depends upon person-to-person transfer, and is thus not amenable to IT solution.

6. OBSERVATIONS AND RECOMMENDATIONS

6.1. Observations

Increasingly, it is being recognized by businesses throughout the world — including those enterprises engaged in activities related to or employing nuclear technology — that deliberate and effective attention must be paid to the management of an organization's knowledge. As intellectual capital has come to be recognized as a principal asset, the capture, retention and utilization of an organization's knowledge has become a critical element of the business strategy formulation process. Organizations that neglect these imperatives will do so at their peril.

In the last twenty years, much has been learned about ways by which KM can most effectively be implemented in an organization. The bibliography provided in the rear of this document lists several sources of such experience. Knowledge management: Concepts and Best Practices (Second Edition) edited by Kai Mertins, Peter Heisig, and Jens Vorbeck, includes a chapter authored by Rob van der Spek and Geoff Carter entitled A Survey on Good Practices in Knowledge Management in European Companies. Appendix II is comprised of excerpts from that chapter including the authors' conclusions from their survey research on lessons learned from applying KM across European businesses.

6.2. Recommendations

Knowledge is the key resource of most organizations in today's world. Managing knowledge effectively requires understanding of and attention to the concept of organizational knowledge rather than just the traditional notion of individual-centered knowledge. This shift can be addressed through the utilization of organizational core competencies that have proven themselves to be of value within many Member State (MS) organizations.

The management system is recommended to promote and support nuclear knowledge management as a primary opportunity for achieving competitive advantage and maintaining a high level of safety. This approach ensures that organizations are able to demonstrate their long term competitiveness and sustainability through actively managing their information and knowledge as a strategic resource that supports the establishment and maintenance of safe, high-level organizational performance.

The knowledge management process within organization is to be addressed and improved. The knowledge management process normally includes knowledge identification; knowledge acquisition and development; knowledge dissemination and use; and, knowledge preservation.

At the technical meeting held in Vienna on 28 November–2 December 2005, the assembled representatives of the nuclear industry identified the following needs in the KM area that warrant further attention by Member States (the perceived degree of urgency is indicated by the timing indicated in the parentheses):

(1) Establish an industry KM community of practice (high priority);

(2) Develop and publish a KM fundamental principles document (short term);

(3) Develop and publish a KM self-assessment tool (short term);

(4) Identify and make known appropriate industry KM benchmarks (short term);

(5) Coordinate and lead KM assist visits to nuclear facilities (short and long term);

(6) Develop and publish a detailed KM implementation guide (long term);

(7) Develop and publish specific KM analysis tools (long term).

The consensus of the experts convened by the IAEA was that while most organizations doing work related to nuclear technology have some form of knowledge management in place, the effectiveness range of those programmes is quite broad. Consequently, further guidance and assistance in the subject area would meet continuing industry needs for establishing and enhancing knowledge management programmes. The group also noted that KM is closely related to change management and human performance improvement programmes; and, that organizations in the Member States should think holistically about these related concepts as they move toward integrated management systems as outlined in newly updated IAEA Safety Series publications.

APPENDICES
I–XXXVI

The following appendices have been divided into five categories for reader ease in focusing on particular topical areas. The very nature of the general topic, KM, causes many appendices to cut across several of these categories. Therefore, the reader should consider reviewing all appendices as time permits to gain the insight that comes from looking at this subject in a macroscopic, integrated manner.

A matrix relating the appendices to the primary elements addressed in the text is provided in Appendix I. The five categories are as follows:

- Knowledge management — general
- Knowledge capture and transfer
- Knowledge dissemination
- Workforce and succession planning
- Management techniques

Appendix I

KNOWLEDGE MANAGEMENT REVIEW ELEMENTS RELATED TO DOCUMENT APPENDICES

This matrix is designed to correlate the elements of a knowledge management review to related appendices in this document.

Element\Appendix	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Policies & procedures	P	P		P	P		P			S	S					P	P	P			P		P	P	S	S	S	P	P	P	P		P	P	P
Communication strategy	P					S		P						P	P	P		P	P					S					S	P			P	S	S
Workforce planning	S	P		S	S		S		P	P	P		P				P			P	P	P	P	P	P	P	P	P	P	P					
HPI programme	S																					P								P	P	P	P	P	P
Knowledge preservation	P	P		P					P	P	P	P	P		S	S	S		S	S	P		P			S		P	P	P					
Procedure use	S				P						S				S		S		S											P	P			S	S
Open communication	P														S	P		P	S									S		P				S	P
Organizational culture	P	S		S	S		S	S	P	P	P	P	P		S	P	P		S	S					P	S		S	P	P		P		S	P
Manager involvement	P				S			S								P					S					S		S	P	P	P			P	S
Benchmarking	P											P				S		P												P		P		S	S
Learning organization	S		P				S		S	S	S			P	P	P	P		P		S							S	S	P			P	P	P
External resources							P					P				S		P					S			S				P		S			P
Training & qualification	P		P	S		S	S	P	S		S			P	P	P	P		P	S	S		P	P	P	P		P	P	P	P		P	S	
Communication M&T	P						P	S			P	S			P	P	S		P									S	S	P		P		P	
Human resources mgmt.	S	P		S			S	S	S	S	S		P			S	P			P	P	P	P	P	P	P	P	P	P	P				S	
Capture/transfer M&T	P	P			P	P	S	P	P	P	P	P	P		P		P		P	S			S					S	P	P				P	
OE M&T												S			S	S	S		S											P	P		S	P	
Work control M&T	S																S			S		P							P			P	P	S
Procedures/documentation		P		P	P	P	S	P		S	P		S		S	S	S	S	S	S	P							S	S	P				S	P
IT solutions	P		S				P	P			P			P	P			S	P							S				P					S

Legend: P = primary association between topics and appendix; S = secondary association with appendix.

Appendix II

LESSONS LEARNED FROM APPLYING KM ACROSS EUROPEAN BUSINESSES

Knowledge management: Concepts and Best Practices (Second Edition) edited by Kai Mertins, Peter Heisig, and Jens Vorbeck, includes a chapter authored by Rob van der Spek and Geoff Carter entitled A Survey on Good Practices in Knowledge Management in European Companies. The work is based on research conducted in 2001 under the auspices of the European Foundation for Quality Management (EFQM). The survey results reported by these authors align quite consistently with the experiences related by representatives of the Member States during the technical meetings convened by IAEA to support the development of this publication. The researchers' findings are also reflected in a variety of ways in the other appendices included in this IAEA TECDOC. Therefore, direct excerpts from that research report have been provided below since the multiple messages contained therein are so pertinent to the implementation and enhancement of KM in organizations related to the application of nuclear technology.

*Common lessons learned by respondents about **knowledge management initiatives:***

- Leadership from the top is a pre-requisite.
- All KM activities should fit in the strategy and the value impact should be clear from the start.
- Starting with pilots and building on success works better than the 'big bang' approach.
- Learn by doing.
- Be aware of overselling knowledge management and deliver first.
- Communications is an important factor. Keep the message simple and consistent.
- Address the 'soft factors'; they are real!
- It is especially difficult to organize knowledge management in a decentralized company though the potential benefits of sharing knowledge across operations may be the highest in these companies.
- KM-activities should be focused top-down but also emerge bottom-up. To find a balance between these two strategies is a major key to success.
- There is no blueprint and one-size-fits-all within companies. Allow for flexibility in your corporation.
- Communities are key to success.
- Knowledge management is mainly change management and people oriented. Tools are very important but not decisive. At the same time a majority of the best efforts are based upon ICT-tools! (ICT: information communication technology).
- Create 'Quick wins' from the beginning but do not forget to create a sustainable environment.
- In the end knowledge management should be integrated in daily operations and processes.

*Common lessons learned by respondents about **knowledge management strategies:***

- One needs a corporate strategy to align to and it is necessary to have explicit goals! When the business strategy is unclear or implicit, knowledge management initiatives will suffer because there is no clear focus possible.

- Different knowledge strategies, focused on codification and/or communication, can live next to each other in companies.
- Communities are the major platforms for knowledge exchange and transfer and also for the codification of experiences and re-use of this information. They emphasize the fact that knowledge must be shared before it can be managed! Networks of people should ensure that the relevant experiences are codified in shared databases, web sites or any other tool, which they think, is useful. Information without ownership is useless. Re-use of information relies heavily on teamwork, trust in others and shared passion.
- Codification costs money, energy and time. Before undertaking it an organization must think about the added value and decide whether it is worth it.

*Common lessons learned with regard to **IT-enablers** are:*

- People must be involved and motivated to use IT-tools. It must make life easier for them.
- IT-enablers should be integrated in daily operations. When the gap between work and IT-tools is too large, people will not spend the required additional efforts.
- People should be trained to use the IT-tools. You cannot expect that all employees can use them in the best way.
- Yellow pages or personal home pages only work when people provide content, keep them updated and when they have clear benefits from profiling themselves via these media.

*Common lessons learned by respondents about **communities of practice** as an enabler:*

- It was important to demonstrate the power of communities both to the members as well as involved managers.
- The role of the community facilitator/content editor is key to success.
- Thriving communities will take their own responsibilities for their knowledge processes and the proficiency of their members.
- Communities require a marketplace that enables their members to collaborate, co-learn and to share their resources.
- Communities should be empowered to create their 'own identity', shared language and products.
- You need social behaviors in order to design good virtual spaces. It is necessary to lead the intranet by people not only from IT-departments. It is a cultural change working with intranets. 'We are at the beginning of this new way of behavior and we need to develop new spaces for the people working at the shop floor.'

*Common lessons learned by survey respondents with regard to **motivational and cultural issues:***

- Change takes time; it is necessary to be patient and to invest in creation of the required pre-conditions.
- Leaders are necessary to initiate, support and guide.
- It is not possible to force people to share knowledge. It can only happen voluntarily.
- Money is not the only way to reward people for their contribution. Recognition and providing more challenges were seen as important ways to stimulate these employees.

*Common lessons learned by respondents with regard to **leadership and middle management:***

- Managers seem to be resistant to the term knowledge management. Language is important here. Managers do not like jargon and creating a shared language about KM is an important step towards understanding and thus support.
- It is necessary to have support at all levels of the organization.
- In order to convince managers, a business case is crucial. However, evidence that KM activities deliver better results is very difficult to provide because many factors can influence corporate performance.
- KM should be aligned with the strategy and demonstrate how it fits.
- Do not sell cheap! Real KM activities, which create substantial benefits, require investments that should not be hidden from management upfront. Be clear on what you would like to achieve, how it fits in the strategy and what it will cost.
- Start from the strategy:
  - must be directly and visibly linked to the delivery of the strategy;
  - look for hooks;
  - specify clear purpose, vision and mission for KM in terms of strategy.
- Balance sustainability versus quick wins:
  - If quick win achieved, then 'so this is KM', if not achieved 'so this was KM';
  - Think big, act small;
  - Show a tangible and sustainable impact on business performance;
  - Be comprehensive in terms of approach and business coverage;
  - Clarify that this does not come for free!

*Respondents' reports about **competency building** in knowledge management:*

- 50% of the respondents organized stand-alone programmes about KM in which training played a key role. Reasons for **not** organizing specific KM training programmes included:
  - lack of time, staff and budget;
  - no interest or support from management.
- 37% of respondents address KM issues in general training programmes for managers, executives and employees.
- 63% of respondents use a Community of Practice to connect people who are involved in KM-activities.

*Main lessons learned by respondents with regard to **communications** about KM:*

- Keep the messages simple and consistent over time. Use few but clear models to explain concepts. Always link to real issues that the audience can relate to. Think carefully about developing awareness programmes. Persist! Build a marketing plan and implementation. Don't oversell. Undersell but outperform.
- Be concrete, give examples rather than theories. Show people where they and their business can benefit. It is a good opportunity to get some people 'into the limelight'.
- Know your audience and their interests.
- The more you talk about it, the more people will understand it and want to get involved.
- Use the complete spectrum; communication is a major part of change management!
- Communication is the main element of success. You must be willing to repeat, repeat and repeat.

— We would rather communicate after there is a deliverable rather than making promises and setting up expectations that might not be fulfilled.

*Main lessons learned by respondents with regard to **results and metrics:***

— Be careful with trying to prove that KM has a significant impact on business performance. It might bring more costs in terms of measurement than it will bring benefits.
— Be aware of too simplistic and one-dimensional metrics.
— Start from result areas that are well known in the company such as market share, employee satisfaction, financial results and customer satisfaction. That's why the Balanced Scorecard and the EFQM Excellence Model form a good starting point.

***Authors' conclusions** from the survey research: Regardless of where one is on the 'maturity spectrum' there are always key points to remember and implement as a KM mantra:*

— Always start by keeping the organization's strategy in mind.
— Keep the messages about knowledge management simple and consistent and prevent using jargon.
— One can read all the KM textbooks in the world, study theories and plan forever but at the end of the day there is no substitute for practical experience. Learn by doing.
— Balance sustainability versus quick wins and avoid single-leader dependency.
— Technology is a significant and necessary enabler but it is not sufficient. The 'people dimension' is crucial[1].

[1] VAN DER SPEK, R. and CARTER, G., A Survey on Good Practices in Knowledge Management in European Companies; *Knowledge Management: Concepts and Best Practices (Second Edition)* edited by MERTINS, K., HEISIG, P., and VORBECK, J., Berlin, Springer-Verlag, (2003).

Appendix III

ORGANIZATIONAL KNOWLEDGE MANAGEMENT RISK ASSESSMENT GUIDE

III.1. Source

The Tennessee Valley Authority, USA. Also: Risk Management of Knowledge Loss in Nuclear Industry Organizations, IAEA, 2006.

III.2. Introduction

This tool is designed to provide guidance for NPP management in conducting a knowledge management risk assessment for an organization, plant, or department. This guide can be used to access the overall level of risk of knowledge loss for an organization including specific threats caused by attrition of expert personnel. The output of this effort should provide a comprehensive assessment report detailing the level of risk to the organization with recommendation for specific action plans.

III.3. Issues to considerations

What the current staffing levels are vs. future or approved.
What levels of attrition are expected (near and long term).
How many positions will require backfill.
How difficult positions are to backfill.
What level new employees will be required (entry, experienced).

III.4. Conduct a risk assessment base on the following

The NPP management team should conduct a knowledge management risk assessment. The team should be representative of the organization, including all key departments (operations, maintenance, engineering, training, human resources, etc.). The assessment report should address the following areas:

— **Identify areas where critical knowledge and skills are at risk:** Based on current information identify any areas that exist where critical knowledge and skills are at risk to the organization. These areas may be general areas (e.g. system engineering) or specific to individual experts (turbine specialist). List each area or individual and include ‘what’ is at risk. Include the cause of the threat (e.g. retirement, transfer, other).

— **Current work load assessment:** Provide an assessment of the current workload in the organization or department. Consider current work backlogs, amount of overtime (paid and unpaid), and levels of stress in workforce. Identify core and non-core functions performed and the impact of not performing. Identify options to address any potential knowledge loss issues (e.g. process improvements, reorganization, and elimination of non-core activities).

— **Risk and impact assessment:** Based on the workload assessment what risk exist and what will the impact be to organizational performance. Consider what work can go forward and what will be deferred. Where possible, quantify the impact on safety, performance, and cost.

— **Identify current or proposed action plans to address general or specific KM issues:** Be as specific as possible including what is in placed or pending.

Appendix IV

TRAINING RECORDS AND INFORMATION NETWORK (TRAIN)

Train is training and records tracking system that allows administrators to plan and schedule required training for employees efficiently and effectively. The system is based on requirements-driven activities and can support large numbers of employees, significant work place hazards, and a wide variety of job/task assignments in addition to tracking employee' training completions. In providing for the protection of workers, facilities, and the environment, it is critical that each employee assigned a task has been adequately trained to ensure safe and competent completion of that task. To support this critical need, **train** is able to:

- Identify the training required for each employee based on their job assignments;
- Adjust the training requirements for employees in an accurate and timely manner when the job assignments are changed;
- Provide real time status reporting to the managers and supervisors responsible for making job assignments;
- Notify the employee, manager, and supervisor when the training requirements have not been completed or have lapsed.

There are five major informational categories within **train** that function interactively to provide forecasting, scheduling, and notification capabilities.

(1) **Employee Information** — Demographic information that includes employee ID numbers, names, work locations, and phone numbers. For timeliness and accuracy, this demographic data is imported directly from the company's Human Resource system, which precludes manual maintenance by the training organization. An additional interface has been established with the security database to update the employee demographics based on the granting or removal of security clearances.

(2) **Training Elements Information** — Course, Qualification, Certification, and Reading requirements used to meet the defined needs of tasks and jobs. Courses are structured in training settings that include formal classroom instruction, web based training, and informal discussion sessions presented by supervisors in the field. Qualification/Certification requirements are structured to comply with codes and regulations or tailored to be unique to the company. **Train** includes a multiple criteria qualification granting process that is able to assess combinations of completed requirements to calculate and update qualification expiration dates and anniversary dates. Reading requirements may be used to satisfy training requirements, or merely to document assigned reading requirements, as determined by the company. An additional interface has been established with the Occupational Medical database to maintain or expire an employee qualification if the qualification is contingent on physical examinations (such as respiratory protection) or other evaluation programmes.

(3) **Job Information —** Jobs are with the corresponding training requirements that have been defined by the company. Jobs are structured to include the course(s), qualification(s), certification(s), and/or reading(s) that were defined in the original training process. With predetermined job codes, the same training requirements are assigned to each employee responsible for performing the same tasks. Should it be appropriate to add or delete a job's training requirement, the addition/deletion is entered at the job level and the system automatically updates the training plans for all affected

employees. Personal job codes are also available for those requirements unique to the individual employee.

(4) **Scheduling Information —** Used to schedule training delivery classes based on the forecasted needs of employees. This category assists schedulers in determining the most appropriate location for a class, in situations where travel is required, and in selecting the most cost-effective format for presenting the training. Where it is necessary to charge for training for cost recovery, an additional interface has been established with the Finance database for billing and cost distribution. Automated e-mail notes notify employees when enrolled in a class and provide a reminder notification a few days before the start of the class.

(5) **Reporting Information —** Available in 'real time', and may be reviewed on-line or through printed reports. A job requirements report (JRR) is available to determine if an employee is up to date in the training and qualifications necessary to safely and competently perform a job assignment so that people facing decisions on worker safety and work assignments can answer the following questions:

- Managers — What training programmes and resources must be provided and maintained to ensure my employees are fully trained to safely and competently perform their job assignments?
- Supervisors — Are my workers fully trained to safely and competently perform the jobs that I will be assigning them?
- Work planners — Which employees meet the job training requirements for the tasks and activities being planned?
- Employees — Have I met all of the requirements necessary for my assigned jobs? What training do I need? Is it current?

Other reports include the employee's training history, job requirements, qualifications and/or certifications, training schedules, course wait lists and tickler reports for tracking impending expiration dates. Automated e-mail notes provide 90/60/30 day notification of an impending qualification lapse to employees, their line management, and their training coordinators.

Train provides a tool to ensure activities are performed in a safe, compliant and environmentally responsible manner and it is:

- Easy to use with rapid access to data;
- Quick to determine employee training status;
- Real-time data entry, tracking, and reporting;
- Intranet accessible throughout the companyBased on job training requirements determined by the user;
- Designed with an inventory of standard reports;
- A relational database for ease in creating additional and ad hoc reports;
- Capable of forecasting training/budgetary needs;
- Available on-line so that hard copies are not necessary;
- Secure, where necessary, so sensitive data requires correct access to view;
- Available to any individual through web-based reports;
- Capable of timely notification of impending training lapse;
- Integrated with company e-mail system for e-mail notifications;

- Capable of forecasting training needs and numbers, thereby allowing better planning for training managers and administrators;
- Integrated with other systems affecting employee training, such as company medical systems.

Train tracks training and qualification requirements for company jobs, makes those requirements visible to all users, provides reports and notifications on the training status of those requirements, and supports a timely and informed decision making process **before** workers are assigned job responsibilities.

Further information:

Mr. Richard Ludholtz, the Idaho National Laboratory, USA,
Email: Richard.Ludholtz@inl.gov

Appendix V

KNOWLEDGE MANAGEMENT OF THE SUSPENDED NPP

V.1. Source

Korea Electric Power Corporation (KEPCO). KEPCO is a government-owned company owning the five fossil power generation companies and one hydro-nuclear power generation company, including four NPP sites with 20 units in operation and two under construction.

V.2. Introduction

WHAT

This appendix shows the knowledge management in suspended NPP had been developed and applied at KEDO NPP Project.

WHY

This process and development will provide for basic concept of knowledge management in suspended NPP to be referenced to other countries' suspended NPP, to preserve and maintain the suspended NPP with an international practice and requirements.

V.3. Method

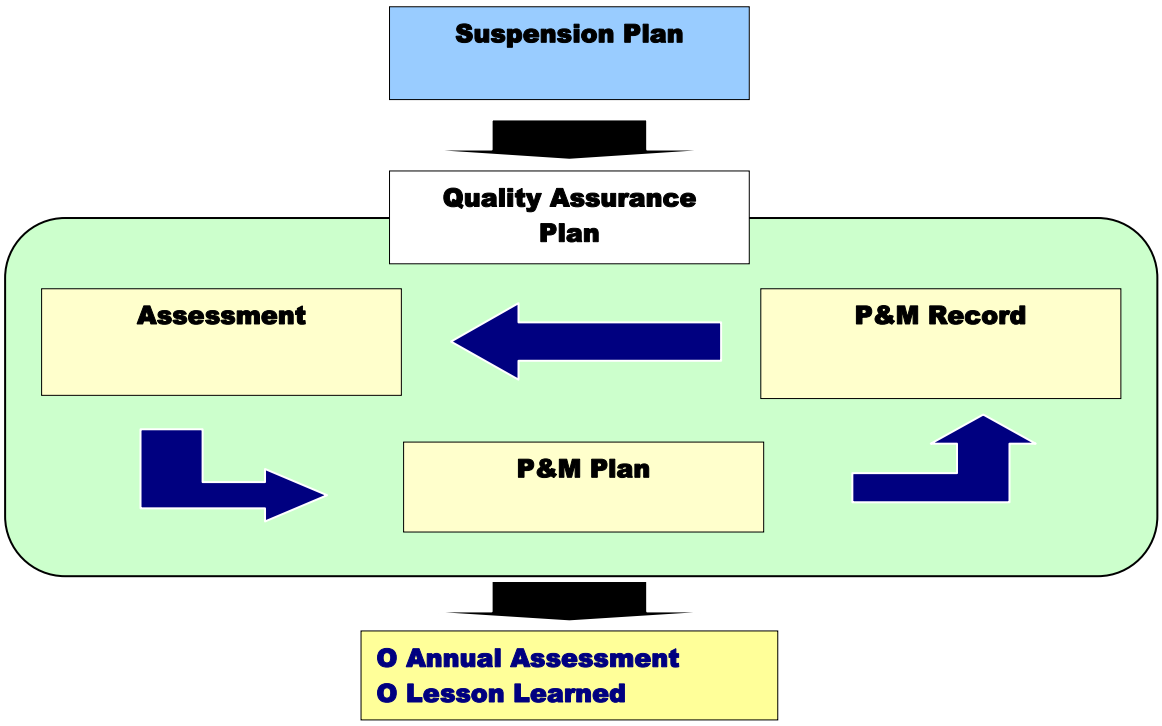

FIG. V.1. Basic concept of suspended NPP KM.

V.4. Suspension plan

The suspension plan is intended to be the road map, which identifies what is to be done to implement a successful suspension of the project as well as to establish the information base necessary for the successful restart of the project at some time in the future.

The areas to be covered by the plan are as follows:

- Assessment
- Preservation criteria
- Preservation workscope
- Quality assurance
- Regulatory review and inspections
- Contract management
- Contract demobilization and suspension period staffing
- Site security
- Organization and responsibility

V.5. Assessment

(1) The assessment activities to ensure the project quality at the project resumption include the following:

- Determination what preservation and maintenance measures should be applied;
- Basis for continuing assessment during the suspension and determining the activities needed to restart the project;
- Secure work's quality during the suspension period.

(2) Due to the varying nature of the scope to be assessed, different approaches to assessment and documentation will be applied for construction, manufacturing, procurement, engineering activities.

(3) The assessment programme should include the construction materials and equipment inventory, sensitive documents and equipment inventory, flammable and hazardous materials inventory.

V.6. Promotional and marketing (P&M) plan

The purpose of P&M is to set forth guidelines to be used by KEPCO to establish a P&M plan, which will be acceptable to regulatory authorities but also minimize the costs.
The plan consists of multiple steps including:

- Establish P&M guideline: guidelines have been developed to ensure that the P&M measures to be applied to the project are clearly and consistently specified and that clear, consistent and detailed records of the implementation of those measures are kept.
- Identify P&M work packages: KEPCO shall identify a complete set of work packages, which define all of the P&M activities which will be applied to the project and record them on a master list. The identification of these packages should be consistent with the assessment packages.
- Develop P&M criteria and procedures: utilizing the P&M guidelines, KEPCO shall develop detailed criteria and procedures for implementation of each identified work package. These procedures shall specify the level of quality assurance to be applied.

— Implementation P&M plan: KEPCO shall develop a schedule for implementation of P&M activities on a package-by-package basis and shall implement the plan in accordance with that schedule.

V.7. P&M record

All P&M record is shown in P&M procedures and constitute that the P&M activity has been performed. A P&M record should be contained these elements, P&M identification No, Unit#/Category/Subcategory, P&M Type, quality level, results, etc.

Further information:

http://www.kepco.co.kr/customer/electric_info/kedo01.html

J-S Beom, Korea Electric Power Corporation, Email: jsbum@kepco.co.kr

Appendix VI

PROCESS KNOWLEDGE MANAGEMENT

VI.1. Source

US Department of Energy (DOE). DOE is a government agency responsible for energy research, development and policy for the USA. The principal missions of the department are science and technology, national defense, and environmental cleanup.

VI.2. Introduction

WHAT

This practice is an overview of knowledge retention activities at three DOE facilities. The focus of this practice is the codification of mission critical knowledge though process mapping.

WHY

This practice serves to promote process improvement as well as capture expert tacit knowledge of the ageing workforce.

VI.3. Method

A process map is considered to be a visual aid for picturing work processes, which show how inputs, outputs and tasks are linked.

VI.3.1. Identify and prioritize process to capture

Candidate processes are rated considering their uniqueness or whether the process output could be accomplished another way. Criteria for evaluating which processes are selected to be captured:

- *Loss of key personnel*. Skilled operators, process engineers, product engineers or process owners that may leave within the next five years and hold critical process or product knowledge that must be captured before their departure.
- *Process shutdown*. Known or potential shutdown of a critical process within the next five years.
- *Process relocation*. Known or potential relocation of a critical process within the next five years.
- *Infrequently used process/restart difficulty*. Processes that are used infrequently or are difficult to restart because of their infrequent use.
- *Non-routine process.*
- *Difficult to develop processes.* Processes that are not well characterized or that represent a special capability.

VI.3.2. Prepare 'as is' process map using established process mapping methods

Use Six Sigma or similar process mapping techniques to map process as currently performed. Capture process and task steps, precautions and limitations, operational parameters, expected

actions and contingency actions, interactions with other work processes and relevant knowledge of process design.

VI.3.3. Gather process documentation

Gather all necessary documentation for the knowledge capture process such as:

- Work instructions/drawings;
- Process, system or component specifications;
- Process related event or production reports;
- Training lesson plans;
- System or component modification histories;
- Any background information that explains the process historic information resulting in a process change;
- Problems with process resulting in faulty parts;
- Special lab requirements or specs.

VI.3.4. Capture tacit or undocumented information

(1) Use trained knowledge elicitors to capture tacit knowledge of:
   - Engineers;
   - Scientists;
   - Process operators or technicians;
   - Training personnel;
   - Safety specialists;
   - Retired experts if necessary.

(2) Conduct job task analyses as appropriate.

(3) Use concepts maps, digital videos, audios to enhance knowledge elicitation and capture.

(4) Capture.
   - Updated process documentation indicating changes, but reasons not documented;
   - '**Caution**', '**note**' or '**warning**' added to documentation, but reasons not documented;
   - Safety or environmental concerns;
   - Operator technique, expertise or refined method over time not documented;
   - Cause costly mistakes if performed incorrectly;
   - Interactions with other operational or administrative processes;
   - Process operator stories of operational incidents or process improvements Rarely performed steps;
   - Relevant information not well documented;
   - Operator logs, notes or performance aids that individual operators have developed to support process performance;
   - Prerequisites;
   - Preparatory tasks;
   - Post-job tasks;
   - Hazards that may be encountered;

- Controls for the hazards;
- Emergency actions to follow in the event that the controls fail.

VI.3.5. Revise process map to incorporate total design and operational knowledge.

The collective set of knowledge and information that should be preserved for a process should include at a minimum:

- Work tasks;
- Step-by-step listing of tasks described in work instructions;
- Hazards;
- Description of hazards and potential accidents that worker may encounter;
- Controls;
- Description of controls, measures and boundaries that are in place to reduce risk to an acceptable level or to prevent an accident from occurring;
- Supplemental documents;
- Listing of permits, operating manuals, or other documents with which worker should be familiar;
- Training;
- Listing of training requirements that worker must have completed prior to performing work.

The process knowledge preservation should consider:

(1) Deliver information in multi-media form to capture information in formal facility knowledge media so as to have a full record of all relevant knowledge but not burden procedures or operating instructions with potentially distracting supporting knowledge.

(2) Capture full body of process knowledge though:
   - Procedures or work instructions;
   - Performance aids to augment work instructions, as necessary;
   - Video clips;
   - Audio clips;
   - Animations;
   - Text documents;
   - Graphics;
   - Process history records;
   - Drawings;
   - Specifications;
   - Training material.

VI.3.6. Roles

(1) Management
   - Establish, staff and fund critical process mapping initiative.
   - Communicate to facility staff the purpose of the process mapping initiative and how it will be conducted.
   - Provide training for knowledge facilitators and process mapping team members.

- Approve list of mission critical processes to be mapped.
- Approve revised process maps and revisions to existing knowledge repositories (e.g. procedures, work instructions, drawings, training material, etc.).

(2) Process mapping team

- Technically knowledgeable key personnel and process owners support each knowledge preservation project.
- Process mapping team identifies initial list of mission critical processes and submits to management for approval.
- Process owners are responsible for developing complete process maps.
- The knowledge preservation team works with the process owners to identify the critical processes and steps for knowledge capture.
- The team submits recommendations on process knowledge revisions to management for approval.

(3) Subject matter experts

- Subject matter experts (SMEs) include operators, engineers, technicians, scientists, trainers, event analysts, work planners, etc. who have knowledge, information or experience relevant to the processes under study.
- SMEs work with the knowledge preservation team to contribute their individual and collective knowledge about work processes history and performance.

VI.4. Results

The process based knowledge preservation approach has been used at three DOE facilities for over 50 critical processes and other process based knowledge preservation projects are underway.

Further information:

http://www.isixsigma.com/tt/process_mapping/ online portal dedicated to Six Sigma and publisher of *iSixSigma Magazine*;

http://www.manufacturing.net/ctl/article/CA633177 *Article on Knowledge retention and Honeywell knowledge retention programme*;

W. Earl Carnes, Nuclear Industry Liaison,US Human Performance Improvement Lead, Office of Regulatory Liaison (EH-21), Department of Energy, USA, 1000 Independence Avenue, SW Washington, D.C. 20585-0270, tel.:301 903-5255, Fax: 301 903-6172,
Email: earl.carnes@hq.doe.

Appendix VII

KNOWLEDGE REPRESENTATION AND MODELING AT GRS

VII.1. Source

GRS — Gesellschaft für Anlagen- und Reaktorsicherheit mbH — is a scientific-technical expert and research organisation. It provides interdisciplinary knowledge, advanced methods and qualified data for assessing and improving the safety of technical facilities and for further developing the protection of man and the environment from technical hazards and risks. GRS activities are mainly focused on the area of nuclear safety, where it is Germany's central expert institution.

VII.2. Introduction

Knowledge representation as a scientific domain has gained strong momentum, particularly in view of the 'Semantic Net' proposed by Tim Berners-Lee (the 'father' of the Internet) as the next 'intelligent' Internet. Several methods such as Topic Maps, Concept Maps or Ontologies are available, differing in the degree of formalization. In general, they offer a systematic approach to knowledge representation and a controlled vocabulary set up by experts to describe the domain as well as visualization and search facilities to navigate the maps. In more formal cases such as ontologies, the domain may be 'understood' by machines to e.g. draw inferences or check consistency.

VII.3. Methods

In addition to more traditional ways of representing the knowledge in a given domain (e.g. dossiers, summary reports, web sites), some powerful tools have been tried out in prototype applications. One of the tools is the CmapTools set for constructing concepts maps developed by the Institute for Human and Machine Cognition (IHMC), which is extremely easy to learn and use. The prototype applications are related to the knowledge domain of Component Safety and representing the knowledge management activities at GRS in the form of a concept map. An example of utilizing this tool for representing the knowledge activities a knowledge base on the safety of pressurized components is given in the Fig. VII.1. When the icons in the lower part of some concepts are clicked, a list of resources is presented, such as lsub-concept maps or any type of documents and links. For further information on Concept Maps, please follow the link to IHMC given in the Section VII.5.

A second tool, the Semantic Miner by Ontoprise, has provided the basis for a pilot project aimed at mapping the GRS-knowledge in the domain of Containment. To develop the containment ontology, a two-day workshop has been held with four experts in the field and three knowledge workers. In this workshop, a skeleton ontology has been developed, which was subsequently refined by including relations and resources. The controlled vocabulary (the ontology's concepts) is used for searching either the GRS document management system, or the Internet. By using search terms, which have been agreed to be the right ones by the field experts, search is distinctly improved. A figure from the visualization of the containment ontology is given below.

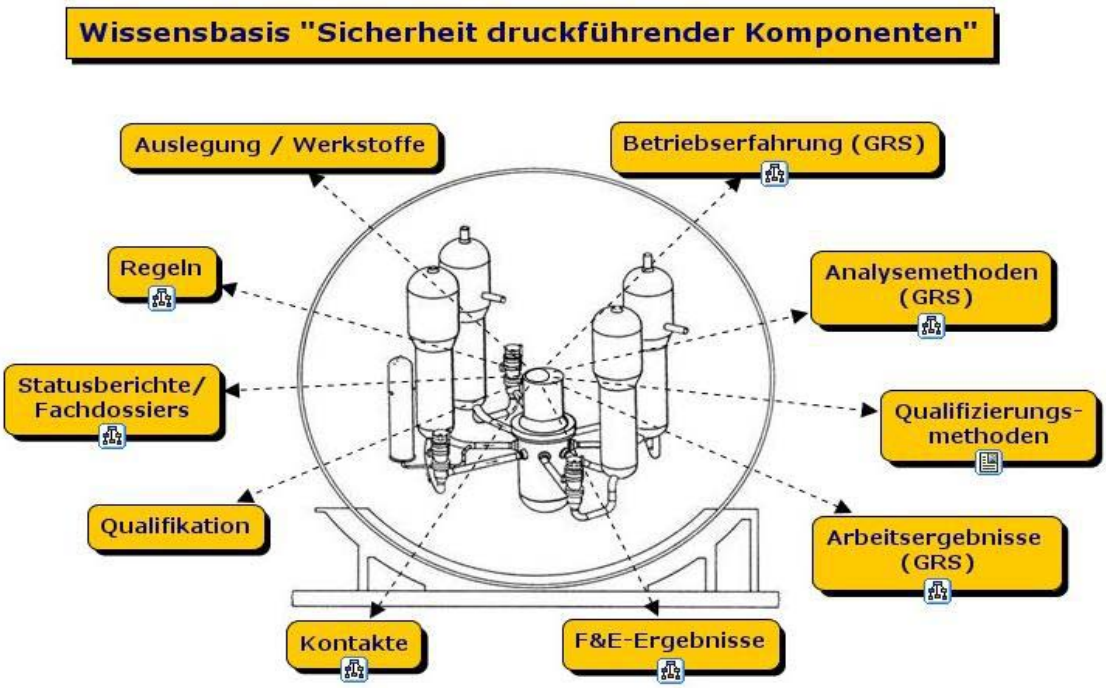

FIG. VII.1. Knowledge base on component safety.

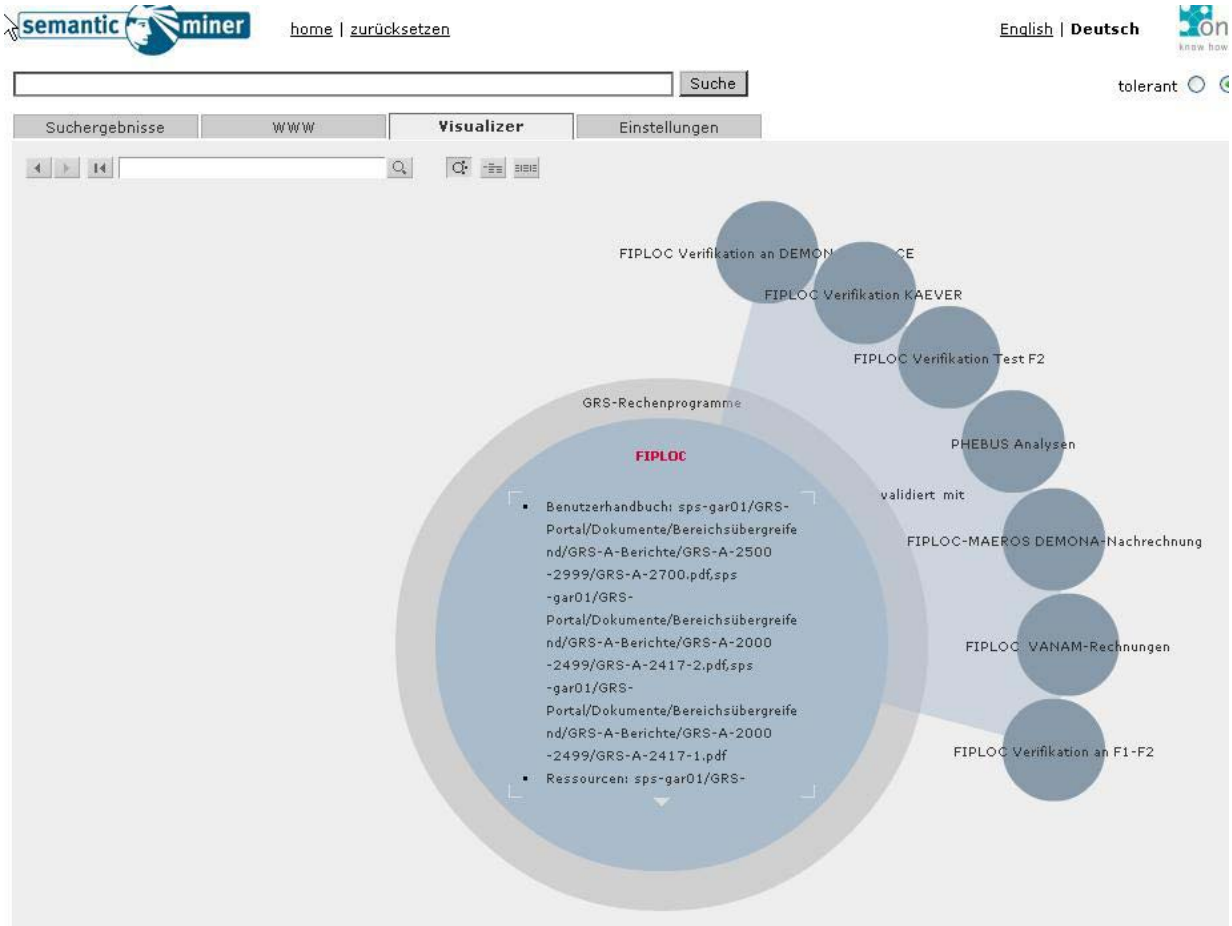

FIG. VII.2. Screen shot of a visualization of the containment ontology.

For the future, another promising way of dealing with dynamic, collaborative information is indicated by the success of the open net encyclopaedia, the Wikipedia.

VII.4. Results

First experience with the above mentioned methods in prototype applications shows that these methods are effective to model domains of knowledge, providing quick navigation through the main concepts and resources of the area.

Further information:

Concept Mapping: http://cmap.ihmc.us

Wikipedia: http://www.wikipedia.org

Ontology Tool (Semantic Miner): http://www.ontoprise.com

Dr. David Beraha, Head of Knowledge Management Department, Forschungsgelände, 85748 Garching, Germany; tel: +49 89 32004 377

Appendix VIII

KNOWLEDGE MANAGEMENT APPLICATIONS AT THE PAKS NPP LTD

VIII.1. Source

Paks Nuclear Power Plant Ltd, Hungary. Paks NPP Ltd is a state owned Public Stakeholders' Corporation with one nuclear site with four reactors in operation.

VIII.2. Introduction

WHAT

The process describes the knowledge management policy at the Paks NPP Ltd established to make available personnel in optimal quantity, properly selected, trained and equipped with all knowledge, skills and attitudes required for the long term safe, competitive and reliable operation of the plant with focus on the plant's service time extension recently approved. For this end — using knowledge related to the corporate recruitment needs and the job-specific requirements/expectations — personnel are selected from internal or external resources to become prepared through expedient, targeted development programmes to succeed in specific positions.

WHO

All corporate and contracted staff of Paks nuclear power plant.

WHY

A decisive factor of the present and future achievements of the plant is the properly prepared staff performing jobs-related tasks with maximum professionalism. The accumulated collective knowledge and experience of the long years are corporate assets, which are subjects for retention for the sake of long term business and professional success while meeting nuclear safety standards constantly high.

VIII.3. Method

VIII.3.1. Task

Many people say the plant is in the 24th hour from the aspect of introducing KM. The majority of the staff is yet at the peak of performance but year to year an increasing number of staff members retire and leave with a portion of the plant's 'intellectual assets'

An expectation from KM is the increase of efficiency by, among others, that it makes available the needed information in an immediately applicable format, properly timed and addressed to each individual staff member. From the plant's strategic objectives the programme of service time extension is already known by the public. The analyses performed show that the lifetime of the units of the plant, after appropriate preparation and technical actions, could feasibly be prolonged up to 40–45 or even 50 years. From KM point of view this means that instead of filling in staffing gaps, a completely new operating generation has to be developed with efficient means provided.

VIII.3.2. Spontaneous knowledge management at the Paks NPP

In the plant, the explicit knowledge (taking one of its definitions, the knowledge that can be fixed and put on paper) appears in all technical documentation, operating manuals, technologies, procedures, training materials, studies and reports.
The hidden (tacit) knowledge is the complex summary of knowledge and experiences of the staff members ever in connection with the design, construction, operation of and services provided for the plant, impossible, or very difficult to put on paper, best phrased as the know-how of the plant.

Hidden knowledge is not easy to manage, for — among other reasons — it is evidently a private property. Its owner uses it, lives on it, it's his/her intellectual asset, in many cases it's the means of maintaining the professional prestige or even keeping the position. The owner's interest in demonstrating this knowledge and in its organized transfer in many cases is subject to the corporate attitude determined by the management and the organizational/working culture of the given unit. The plant assigns the duties of providing support to the complicated technology to smaller-larger teams specializing in the given subjects, the traditions of rotation techniques and cross-training ensuring a more comprehensive knowledge have never been in place thus hidden knowledge appears distributed to countless of places.

VIII.3.3. Shifting over to a conscious knowledge management

VIII.3.4. Starting point

One preparatory step of introducing KM is tracing the knowledge to be incorporated in the system. A part of this knowledge is accessible today in an explicit form, requiring only a systematic restructuring and, in some cases, reshaping to the appropriate format. The proprietors of the hidden knowledge are those professionals who perform operation, maintenance, surveillance and technical support duties but from KM aspects, — beside the technical know-how — the plant control and management related knowledge is also significant and is owned obviously by persons on the different level of leadership.

The introduction of KM is efficiently supported by many recently finished or yet ongoing programmes for they make up a state-of-the-art appearance for the given mass of explicit knowledge or contribute to documenting the hidden knowledge simply as a by-product of their activities. Without the intention to list them all, the following description depicts such programmes:

- Starting from the mid 1990s the plant has performed a major scale **safety upgrading programme** and has implemented many reconstruction, refurbishment programmes from technical considerations. These activities, projects were typical for their careful preparation, the proper QA programme, the neatly designed and delivered training programmes, thus the knowledge in connection with these activities is turnkey ready for KM use.
- In the second half of the 1990s, a training **reconstruction project** ran with support from the International Atomic Energy Agency. This large project, beside the infrastructural, methodological and equipment development for NPP personnel training, had all training materials restructured and rewritten. From KM considerations it is fortunate that the project management had the training materials developed by corporate staff instead of inviting external support from institutes thus, in addition to the technical information, significant emphasis was placed on highlighting the operational know-how and experiences therein.

— A few years ago, the management made a decision that the plant is to update the **technical specifications** of the technological systems and components. Consequently, the technical descriptions representing the majority of the explicit knowledge are also available to KM.

— One of the basic documents of the plant prescribed by the Regulator is the **Final Safety Report (FSR).** The role of this material of large volume is to evaluate the realized, operating plant comprehensively from safety aspects starting from the design basis. The volume of the safety upgrading actions and reconstruction works performed in the plant in the past period was so large in scale that the Regulator has requested that the plant would totally reconstruct the FSR. The reconstruction involves a number of institutes which possess the formerly mentioned, fading institutional knowledge also. The requirements set against the reconstruction ensure that the final product will also be consistent with KM expectations.

VIII.3.5. Tools of knowledge transfer

At the Corporation the transfer of knowledge is accomplished through the following means:

— management development programmes;

— professional training programmes;

— adjustment and mentoring programmes.

VIII.3.6. Other corporate activities taking knowledge management functions

— National Physics Contest — Leó Szilárd;
The Corporation is a lead supporter of the contest organized once a year announced by the Leo Szilárd Foundation of Talents Care. This year was the 8th turn for primary and secondary school students.

— Contact with teachers of physics;
We organize annually a special course for primary and secondary school teachers of physics with the objective that the theoretical and practical questions of the use of nuclear energy would be addressed with more emphasis in the curriculum of physics

— Regional meetings with municipal governors;
The plant maintains a credible, long term and balanced relationship with the region around the plant. The general public contacts are established primarily through the municipal governments. The plant's professionals regularly meet with members of the municipal governments and the majors on the actual events as well as report on the plans of the plant. The municipal governments convey the information to the public of the region in written info leaflets or casually in public hearings.

— Operating the Public Information and Visitor Center;
At the Paks NPP, the Public Information and Visitors' Center was inaugurated in 1995. the objective of its creation was to let people gain information on the peaceful use of nuclear energy from direct sources. To date, the Visitor Center has become a major tourist attraction receiving nearly 30 000 people a year.

- Family day and open day events;
  Traditionally, the first weekend of September each year would host this programme. On the Saturday guests are welcome from the municipalities of the region who may visit the environment and the operation of the plant; children are taken the best care of, with amusement and fun programmes. Sunday is reserved for the family members of the corporate staff members to take a visit.

— Cooperation with universities and scientific institutes;
We maintain a regular contact with the Budapest University of Technology and Economics in the frame of which we run common PR projects, job-shows, provide practice opportunities and internal consultants for university students and co-operate in training material development and other common projects.

VIII.4. Results

As for the SAT-based training of the technical staff, training programmes for somewhat 35 positions have been developed to date and the number of positions involved is constantly increased.

Fifty-seven staff members hold the 'qualified NPP instructor' qualification working in different fields in the plant. The number of the qualified instructors is raised with 10–12 annually.

Further information:

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Appendix IX

IDENTIFYING KEY SKILLS & COMPETENCIES ACROSS THE ENTERPRISE

IX.1. Source

AMEC NNC is a privately owned international engineering, project management, safety and technical consultancy, dedicated to providing expert advice and solutions to complex engineering and project management challenges in the nuclear and non-nuclear markets. Employing in excess of 1000 people, our network comprises 31 offices across the world.
AMEC plc is a world leader in technical services and project management, employing around 45 000 people in some 40 countries around the world. AMEC specializes in the design, delivery and support of infrastructure ranging from local technical services to international landmark projects.

IX.2. Introduction

In the UK nuclear industry, and many other sectors where safety is a major issue, it is very important to provide evidence to the regulator that staff are suitably qualified and experienced for the work they carry out. Also, the international standard, ISO 9001:2000 requires that staff skills and competencies are determined, evaluated and effective training provided.

Many organisations have a poor understanding of the skills, experience, and qualifications etc. that are available in their staff. Some organisations use a database of CV's or provide staff profiles via their intranets. This paper describes how a bespoke enterprise solution is provided to assist in identification and communication of skills and competencies using a structured database approach based on web technologies.

Following a two-year study and implementation programme, a competency based taxonomy for identifying qualifications, skills and experience has been successfully created and implemented across the enterprise with details of over 1000 staff captured. The solution known as 'QuEST' (Qualifications and Experience System Tool) is regarded as one of the organisation's key knowledge management tools allowing particular expertise to be quickly located.

The specific business problems that the case study addresses are listed below:

- To identify and capture qualifications, skills and experience for all staff in all locations worldwide to demonstrate staff are competent in support of activities in the nuclear sector.
- To provide evidence that staff are competent and experienced in the skill areas claimed.
- To share information about staff skills and competencies for use throughout the organization in all locations.
- To integrate skills information with other related issues such as training and development, CV's, academic and professional qualifications.
- To provide a process and a system that is easy to use by all staff requiring minimal training.

AMEC NNC's initial strategy was to locate a system 'off the shelf' that would do the above but market research showed that there was no such system available that would meet all the necessary requirements. A development programme was thus established with a team leader and a small number of support staff to design and implement a process and system from first principles.

IX.3. Method

AMEC NNC's approach to the implementation of such a system began in January 2001 when the Company's Technical Director was nominated as sponsor for the project. A project team was established with a structure outlined below in Fig. IX.1.

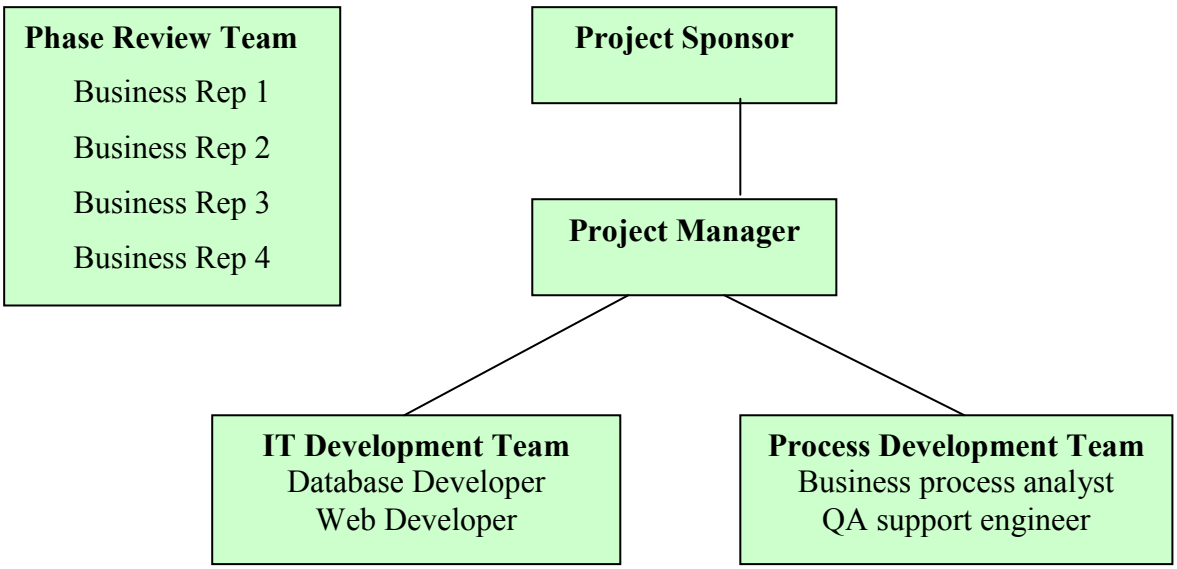

FIG.IX.1. Project team structure.

Apart from the Project Manager, the project team was not engaged on the project full time. To obtain early buy-in and ensure that the work would reap business benefit, members of the main business units were involved in reviewing the project on a periodic basis (Phase Review Team).

One of the first activities undertaken in July 2001 was to produce a Technical Specification describing the aims of the system and general requirements of what scope it would cover and what it needed to achieve for the business. The Technical Specification is aimed at vendors as it was assumed at this time that an off-the-shelf system would be procured and configured in-house. The Technical Specification, therefore, contained not only typical database requirements but also details of user interface, training, reports, data management, response times, system security, system integrity, administration features etc. By September 2001, it was clear that there was no ready-made solution for qualifications, skills and experience management and that a development programme was needed.

The implementation of AMEC NNC's Qualifications and Experience System Tool (QuEST) is a development and implementation project rather than a research project. The content and layout of this section therefore reflects this type of project.

IX.3.1. Project programme

An outline project programme for the implementation of QuEST is given below in Table IX.1 with major milestones indicated:

TABLE IX.1. PROJECT MILESTONES

Date	Milestone
January 2001	Project agreed and sponsor and project manager assigned
July 2001	Technical Specification available
September 2001	Commercial products evaluated
November 2001	Taxonomy Defined
December 2001	Database development commenced
May 2002	Database & user interface complete
June 2002	User training complete
November 2002	Data load from users complete
December 2002	Data attributes validated

The full duration of the project from inception through to roll-out and data validation of user information (1000 staff) was two years.

IX.3.2. Taxonomy development

Table IX.2 below defines the main areas where taxonomy was needed to support the QuEST database construction.

TABLE IX.2. TAXONOMY SCOPE

Area	Definition
Technical discipline	The main technical disciples for staff (e.g. mechanical, electrical, safety, IT, QA etc.)
Skill	Particular areas and sub areas of expertise within the technical discipline
Experience	Industrial sectors (e.g. nuclear, defense, aerospace, automotive etc.) and for nuclear the types of reactor system and locations worked
Level of competence	6 levels of competence for each skill from international expert to basic knowledge
Academic qualification	University and School qualifications for UK awarding bodies
Professional Qualification (Chartered status)	Levels of award (e.g. CEng, fellow, member, associate member etc. for all recognized professional institutions
Client awarded qualification	Client specific awards and accreditations
Understanding of regulatory requirements	Licensing regulations and standards experience

Fortunately much of this information was already available within the organization but a considerable amount of effort was required to develop the relationships between discipline, skill and experience.

The full taxonomy comprises 30 pages of tables and thus cannot be fully reproduced in this document. However, the full listing can be made available on request by contacting the author.

IX.3.3. Web user profiles & interface

All inputs, reports, administrative actions etc. required for interfacing with QuEST is carried out using a standard web browser. Access to the system is available to all users via the company intranet.

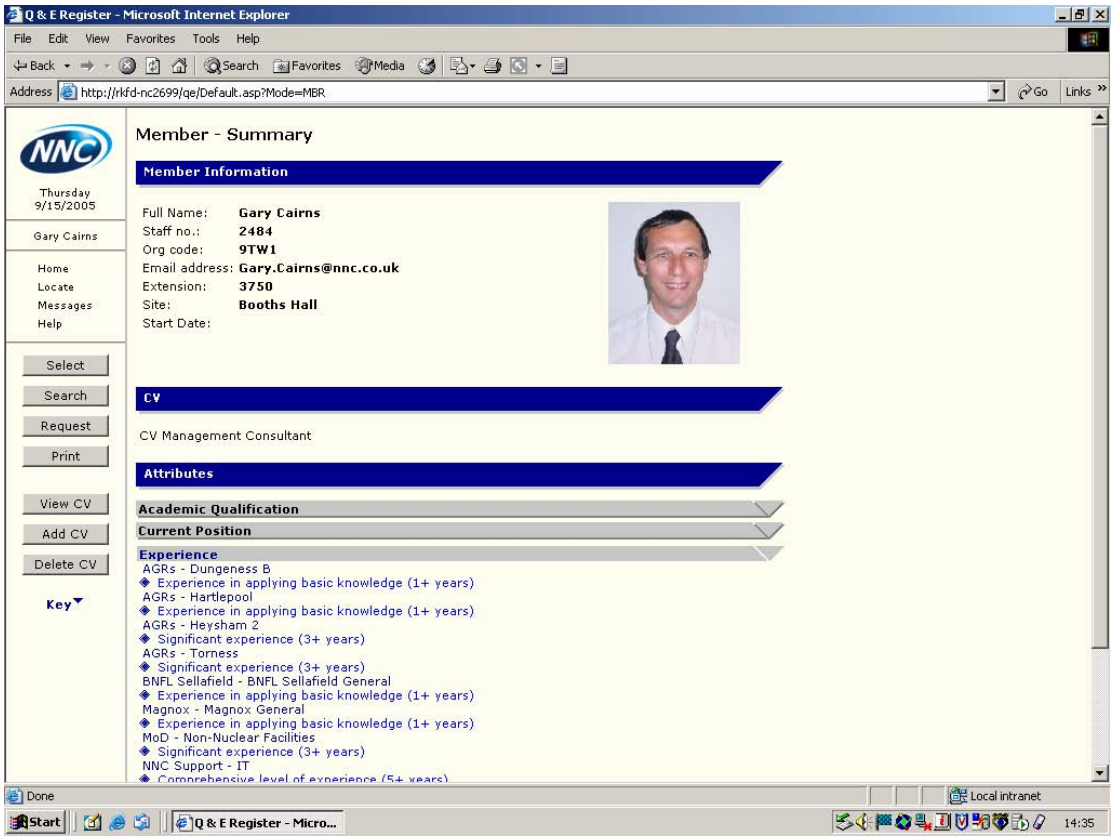

FIG. IX.2. QuEST database — Members Area.

In total there are nine user interface areas or profiles, each with the following functionality:

- Administrator — used to set up user permissions, upload/download data into other applications, system messages, general database admin etc.;
- Statistics — used by managers to review incomplete user profiles, status of assessments, number of logins etc. to help measure full roll out across the enterprise;
- Attribute Maintenance — used by the systems manager to set up taxonomies and data attributes in these taxonomies;
- Engineering/Technical Manager — used by senior management to set up and allocate staff to job roles;
- Manager — used by line managers to search entire database for any attribute, including training & development data;
- Training & Development Plans — used to collate training and development plans across the enterprise and for approval of specific training objectives;
- Technical Supervisor — used by line managers and senior staff to oversee the assessment process;
- Assessments — used by line managers and senior staff to provide an overview of the status of the assessment process;
- Member — Main end-user interface with the system;

— A typical end user will have restricted access to only his/her skills & competency details, training & development plans and CV's. A screen shot showing the layout of these is given in Fig. IX.2 with the 'experience' attributes expanded;

IX.3.4. Database structure

The QuEST database is a SQL Server 2000 database that is designed to hold details of its member's competences and provide an assessment process that verifies the information entered is accurate.

All business rules are encapsulated in SQL stored procedures. Client applications access the stored procedures through a thin VB COM layer. The following diagram illustrates the N-Tier architecture used:

FIG. IX.3. QuEST N-Tier architecture.

Database tables are structured to allow the uploading of personnel data from other in-house systems.

A database attribute structure is designed as shown in Fig. IX.4, which allows drill down functionality against each main attribute type.

IX.3.5 Competency assessment workflow

Within AMEC NNC, a process was developed and agreed to ensure validity of the following data provided by staff:

— Academic qualifications (evidence from certificates obtained from awarding bodies);
— Professional qualifications (evidence from certificates obtained from awarding bodies);
— Skills (evidence of significance competence from technical papers, personal knowledge, verbal questioning, witness testimony);
— Experience (evidence of significance competence from technical papers, personal knowledge, verbal questioning, witness testimony).

In QuEST colour coding is used to distinguish between information that has been accepted (green), not assessed (blue) or rejected (red).

To ensure that competency attributes can be assessed and validated by the relevant person, the QuEST system has a built-in workflow to allow managers to delegate assessment where these are needed. For example a line manager may delegate the assessment of technical skills to a technical expert who may be better qualified to make the judgment. A permanent record is kept on the system of the individuals who made the assessment and the assessment criteria used.

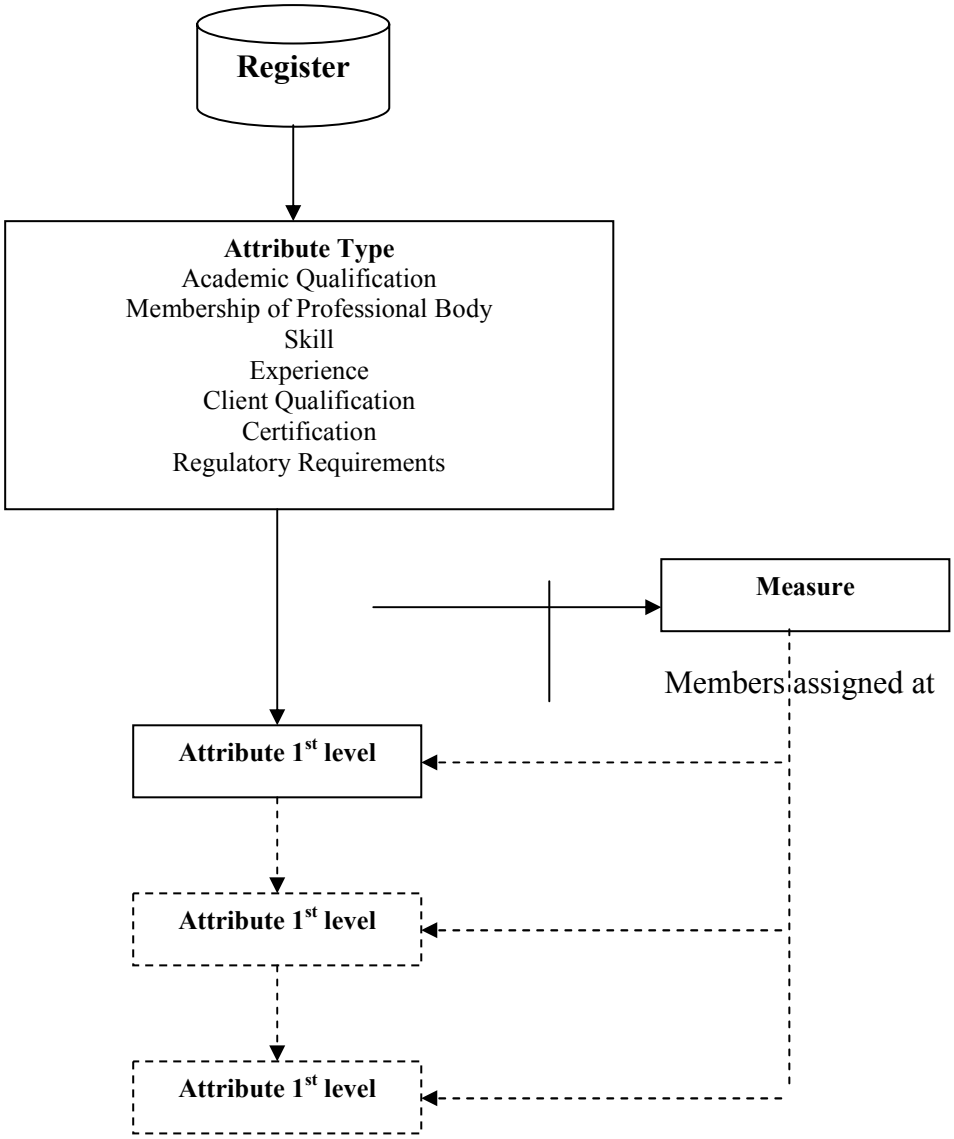

FIG.IX.4. Database attribute structure.

IX.3.6. Implementation strategy and roll out

To trial the system before full roll out, a small business team was chosen to take part in a pilot project. This demonstrated the feasibility of the concept and provided valuable information on expected timescales for full implementation across the whole organization.

For complete company roll out it was decided to run the project as a change management initiative and adopt best practices such as:

- Effective sponsorship and communication (to ensure that top-level commitment was obtained and that all stakeholders were aware of developments. Communication was targeted at several organization levels with details available in corporate communication briefs and newsletters.)
- Education and training. Educating users of why these changes were needed together with the basic simple training needed to interface with the system.
- Adoption of project management and planning techniques. All aspects of this initiative were carefully planned with resourced project plans and full supporting documentation.

— Risk management. Risk management techniques were deployed which identified the major project risks together with planned mitigating actions.
— Stakeholder buy-in analysis. An analysis was undertaken to look at particular stakeholders and identify those who needed to be targeted to ensure buy-in. Thais was part of the above risk analysis.
— Process integration. To ensure the new processes emerging from this initiative were successfully integrated into the company's existing processes and procedures.
— Technical support. Assistance with entering and viewing information via the web interface and the database.
— Budget provisions for time and cost allocation. To ensure that costs were correctly monitored and controlled.

Technical skill areas across the business were targeted first and, after this had been completed, the system was then implemented for all support staff. In total approximately 1200 staff in various locations in the UK, Canada, South Africa and Eastern Europe were added to the system and input data validated.

IX.4. Results

Implementation of the QuEST system was generally regarded as a success story, but like with the introduction of any new system or processes there were a few teething troubles along the way. In general, the system implementation and software was completed without too many problems. The main issues centered around:

— Time to input data. Typically 1–2 hours is needed per person to input all the relevant data relating to qualifications and experience. Although not considered excessive, there have been numerous occasions where individuals have claimed that they had not enough time to do this. Strong line management is needed to overcome such objections for success.
— Non-standard data. The decision was made early in the project to pre-populate the database with various attributes (e.g. skill types, experience areas, types of qualification etc.) and to make these accessible to users via drop-down menus. Although relevant to most users, occasionally there was found to be an ongoing needed to add non-standard data to allow users to complete their profile. In the early stages of the project this proved to be a bottleneck but with time proved to be less of a problem.
— Database search facility. The database search facility, used by predominately by managers, allows advanced search capability across numerous areas simultaneously. However, it was later discovered that managers also wanted very simple search criteria such as locating all engineers in the organisation with a mechanical engineering background. Modifications had to be made to the search facility to allow this.
— Taxonomy describing experience. Following extensive use of the system it was decided to abandon the taxonomy describing experience. Due to the large diversity of experience within the organisation it was decided to allow users to input their experience in more of a free format nature but based on an internal guidance note for consistency.

Metrics on user input and validation were built into the administration modules of the system to show the uptake of new users, new data entry and validation statistics. From these measurements, we now know that over 95% of staff details have been correctly input into the system and are being used by others (mainly line management) for knowledge sharing purposes.

From other feedback comments and staff surveys, it has been decided to increase the functionality of QuEST to allow:

- Integration with training and development systems;
- Tracking of training and development objectives at Department and individual level;
- CV information to be input and linked to skills;
- Easier searching.

These improvement are planned to take place in the last quarter of 2005 and early 2006.

Further Information:

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Appendix X

KOWLEDGE CAPTURE CHECKLIST

X.1. Source

Texas Utilities. Texas Utilities Corporation operates the Comanche Peak Nuclear Power Station, a two-unit site.

X.2. Introduction

Managers at Comanche Peak are provided a checklist with which they can assess the state of the knowledge needed to conduct their department function, and begin to plan action to resolve any gaps.

X.3. Method

X.3.1. Assessment of need

How is the loss of expertise being managed?

What groups are considered?

— Examine entire business process;
— Can use NEI process model to guide.

How often are they updated?

— Annually, every two years, etc. This is driven by loss rate.

What types of loss are considered?

Permanent (both general functions and specific individuals):

— Retirement
— Outsourcing
— Downsizing
— Transfer
— Death
— Quitting

Temporary (these tend to focus on specific individuals):

— Illness
— Vacation
— Training
— Not staffed 24 hours per day
— Conflicting demands

X.3.2. Identification of critical knowledge

How are they identifying where mission critical knowledge exists?

Sources considered:

— Polling managers, supervisors, etc.;
— Self-identification by the target population;

— Industry consensus;
— Corporate history.

What do they consider to be an expert?

— Typically recognized by management and peers as a person having valuable and unique knowledge.
— The ‘go-to’ person when a demanding task, job, or situation is encountered; this person may be asked to provide advice (consult) or to handle the situation.
— Often the person assigned to perform the most difficult and/or important tasks and jobs.
— The person that peers and management recognize as someone ‘we can least afford to lose.’
— The person aware of important lessons learned based on previous participation in demanding situations.
— The person involved in successfully handling rare or infrequent but important events, e.g. events occurring once every 5 or 10 years.
— The person who observed and/or performed a previous activity in which something occurred that had (or could have had) major positive or negative consequences.
— Others should be made aware of this knowledge before the activity is performed again.

What are the skills that define an expert?

— Ability to look at a situation and properly to envision a range of possible outcomes.
— An expert forms expectancies and usually notices when these are violated.
— An expert can identify the problem without wasteful consideration of a large range of alternative diagnoses and solutions.
— Experts perceive situations as wholes, rather than in terms of situational components.
— An expert knows what to expect in most situations and how to modify things as required.
— Experts note the subtle but critical cues that others miss.

How are they filtering out target knowledge that is not really critical?

— Vetting by peers;
— Ranking / prioritizing by managers.

Separation of types of critical knowledge (each has different strategies):

— Knowledge that can be trained (specialize base knowledge);
— Knowledge that can be hired;
— Knowledge located in an existing pool with different attrition dates;
— Knowledge that is unique and tacit;
— Knowledge that is explicit but under-documented;
— Knowledge whose need can be designed away;
— Replace or redesign old equipmen;t
— Automate out need for expertise.

Graded response:

— Which information needs separate elicitor?
— Which information can be self-elicited?
— Which information can be allowed to lapse?

X.3.3. Replacement planning

For critical needs, is there a staffing plan?

- Considers time lag to develop new expertise;
- Succession needs considered;
- Worker retention;
- Development of acceptable candidates for hiring;
- Collaboration with educational programmes;
- Public outreach;
- Scholarships;
- Nuclear programme support at universities;
- Mentoring/partnering.

X.3.4. Knowledge capture techniques

- Expert/extractor interactions:
  - Interview;
  - Audio or video recording of ‘storytelling’;
  - Concept map;
  - Critical decision making method;
  - Critical incident technique;
  - Knowledge audit method;
  - Case study simulation and walkthrough;
  - Task diagram.
- Self-capture/self-elicitation;
- Annotation of existing documents, calculations, procedures, etc.;
- System engineering notebooks;
- Database capture;
- Concept mapping;
- Visualization;
- Video capture of tasks;
- Training/mentoring of new people;
- Enhanced as found as left work history.

X.3.5. Are knowledge capture challenges recognized and dealt with?

- Willingness of experts to share knowledge;
- Experts too busy to participate;
- Expert's manager/supervisor clearly supports and allocates time to extracting information;
- Time for backend processing too daunting and so captured knowledge is accepted ‘as is’.
  - For example, interview notes, video or audio tapes need to be edited or transcribed to prepare them for use.
  - Rule of thumb: 8 hours backend processing for every hour of audio or video tape.

X.3.6. How is captured knowledge stored?

- Format
- Ease of retrieval
- Ease of searching
- Expectations for use
- Data life cycle maintenance

X.3.7. How is captured knowledge maintained? — Expectations and actual

- Is the captured knowledge initially reviewed/approved after capture?
  - Backend processing to verify content
  - Backend processing to convert to appropriate format
  - Backend processing to create procedures, videos, training material, etc.
- Is it integrated into configuration management?
- Is it integrated into training?
- Is it routinely reviewed by expert to keep it current?
- Is it routinely reviewed by expert to extend it?

X.3.8. Personnel coordinating capture/elicitors

- Have they specified qualifications of elicitor?
- Have elicitors been trained on elicitation techniques?
- Are there procedures and guidance?
  - Is preparation time to become familiar with domain built into process?
  - Is elicitor paired with a person familiar with target expert's domain?
- Are elicitors involved in Industry benchmarking and joint industry efforts?
- Is there clear management support and resources for the elicitors?

X.3.9. Reducing vulnerability to knowledge loss

- Organize work processes around teams of people rather than by discipline or company lines.
- Cross train to spread knowledge.
- Proceduralize identified critical tasks.
- Plant modifications to eliminate unique systems and components with single experts.
- Use systematic knowledge capture throughout key organizations.
- For example, joint work on concept maps of group tasks.
- Hire replacement personnel with adequate overlap before loss of experience personnel.
- Consider incentives for knowledge sharing, either through reward or through avoidance of adverse consequences.
- Use Challenge Dialogue[1] to increase leader awareness of tacit knowledge.
- Use Centers of Excellence to spread knowledge within a group.

Further information:

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[1] Challenge dialog is a method used at Comanche Peak for reinforcing behaviors and confirming alignment between stated expectations and actual behaviors.

Appendix XI

KNOWLEDGE TRANSFER WITHIN THE SWISS NUCLEAR INSPECTORATE

XI.1. Source

Abridged excerpts from a paper prepared for the Human Resource Management in Safety and Regulation, OECD-NEA — CNRA International Workshop hosted by the Swedish Nuclear Safety Inspectorate (SKI) 25–26 October 2005, by Brigitte Faust, Christiane Fricke and Cornelia Ryser of the Swiss Federal Nuclear Safety Inspectorate (HSK), CH-5232, Villigen, Switzerland. Complete copies of the original paper may be secured by contacting the authors at the cited address.

XI.2. Method

In the last few years, knowledge transfer has become a central topic within the overall knowledge management process in the nuclear industry. Loss of knowledge does not only threaten the safety of nuclear power plants, but is also a safety relevant subject within the safety authority. Beside the explicit knowledge, implicit knowledge should be preserved within an organization. To enhance the availability of departing employees' important know-how, HSK is currently testing a combination of different knowledge transfer methods:

— A **mentor programme** meant to make trial periods easier for new employees concerning all types of knowledge;
— **Written reports** by the departing employees; and,
— **Interviews** that allow for the documentation and, hence, the conservation of knowledge in case the departing persons are no longer available when their successors start working.

This paper concentrates on interviews with departing persons conducted by trained interviewers within the frame of the whole process of knowledge transfer. These interviews are meant to elicit the interviewees' knowledge and experience as well as their personal perceptions relating to HSK's work processes and organization. *An important aim is knowledge transfer to successors and improvement potential for the organization*.

XI.2.1. Knowledge management versus knowledge transfer

In this paper, knowledge management is defined as the whole organization of knowledge, beginning with the detection of information and ending in the analysis of knowledge [XI.1]. *Knowledge transfer is considered here as that part of knowledge management which refers to the transmission of explicit and implicit knowledge from a person or organization to one or to several people, even including to the complete organization* [XI.2].

When any knowledge, which is necessary for one's special work or for *any* working area, is detected, it should be documented. Only documented knowledge allows the transfer of knowledge, especially if the predecessor is not available anymore. The various methods for transferring knowledge differ in the possibility of documentation and in the different kinds of knowledge that can be gathered. This paper discusses the transfer of three types of knowledge — explicit, implicit, and tacit — through different methods.

XI.2.2. Methods for knowledge transfer

Many methods for knowledge transfer exist (see Fig. 2). The most widely spread method is the **mentor programme**. In a mentor programme one person — usually the predecessor — shows the new employee the ropes for some time, for example for a period of three months dependent upon the position, expertise, etc. They are working in parallel, so that the successor gets an insight in the working method, benefiting from the advantage of asking questions right away when problems are arising.

A similar method used for knowledge transfer is **observation**. Successors observe either their predecessors or someone whose work could be of use to the successor — without working in parallel. This might be advisable where the work is very complex and where different actions could be dangerous or have serious consequences. For example, consider a medical student watching an operation. It is not always possible to learn how to do a new job immediately just by doing the job.

Similarly, sometimes it is not possible for retiring persons to just 'hand over' their work. In such cases, they could write **reports** about their work describing subjects of high importance and what factors their successors will have to consider. Such reports would then be provided to successors or to other people to whom the documented information might be of assistance. These people can read the reports in order to gain insight into the work done by the authors.

Another practical method for transferring knowledge is **job rotation**. Through job rotation, an employee can get an overview about the entire work environment. Employees get the chance to recognise in which processes their specific work is implemented. They work in different departments for short periods of time in order to learn a little bit about a lot of things.

The last method that will be introduced in this paper is doing **interviews** with predecessors. In interviews, it is possible for interviewers to learn more about topics in which either they or the predecessors are interested. If good notes are kept, an entire organisation can often benefit from knowledge gained through such interviews.

These mentioned methods do not just differ in the way the knowledge is gathered. With the help of these methods different kinds of knowledge can be detected. It has already been explained, that there are three types of knowledge: explicit, implicit and tacit knowledge. The detected explicit and implicit knowledge can be evaluated, but the transferred tacit knowledge will just be speculation. The only way of getting a clue as to how much tacit knowledge has been transferred is by asking the successors involved in the knowledge-transfer process.

The following paragraphs briefly explain operational assumptions concerning the transfer of the different types of knowledge.

- **Mentor programmes** allow the transfer of implicit as well as explicit knowledge; and, it can be assumed that it is even possible to transfer important elements of tacit knowledge.
- **Observations** allow a lot of explicit knowledge to be transferred as well as a lot of implicit and tacit knowledge — even though less may be transferred than by use of mentor programmes.
- **Reports** written by predecessors usually only document explicit knowledge unless the report authors make the difficult effort to also record some implicit knowledge. However, it is rare that much, if any, tacit knowledge is transferred through this method.
- **Job rotation** allows transfer of both explicit and implicit knowledge; and, depending on the time spent in a given role rotation, it might even be possible to transfer some tacit knowledge. But, this method does not guarantee *thorough* information. It typically

allows the rotator to acquire only general knowledge; and, thus, might be of greater help to heads of departments.

— **Interviews**, especially half-standardized interviews, are usually able to detect both explicit and implicit knowledge. When interview reports are documented and provided to successors, it is assumed that some tacit knowledge will also be transferred by this method.

Thus, it may be concluded that mentor programmes can assure tacit knowledge transfer; while observations, job rotations and interviews only allow transfer of partial tacit knowledge. Reports are of no use for tacit knowledge. *So, when only looking at the different parts of knowledge, which can be transferred, the mentor programme turns out to be the best method.* But there is still one problem: *What shall be done, when the predecessor is not available any more?* There are a lot of reasons why this can be the case. When thinking about starting successors in new jobs without the help of predecessors and their knowledge, it becomes obvious that as much information as possible should be pre-documented. So, it is necessary to have a second look at the mentioned methods. Reports and interviews are the only methods for which documentation is planned. Observations, mentor programmes and job rotations are, in contrast methods, which — under normal circumstances — are not documented.

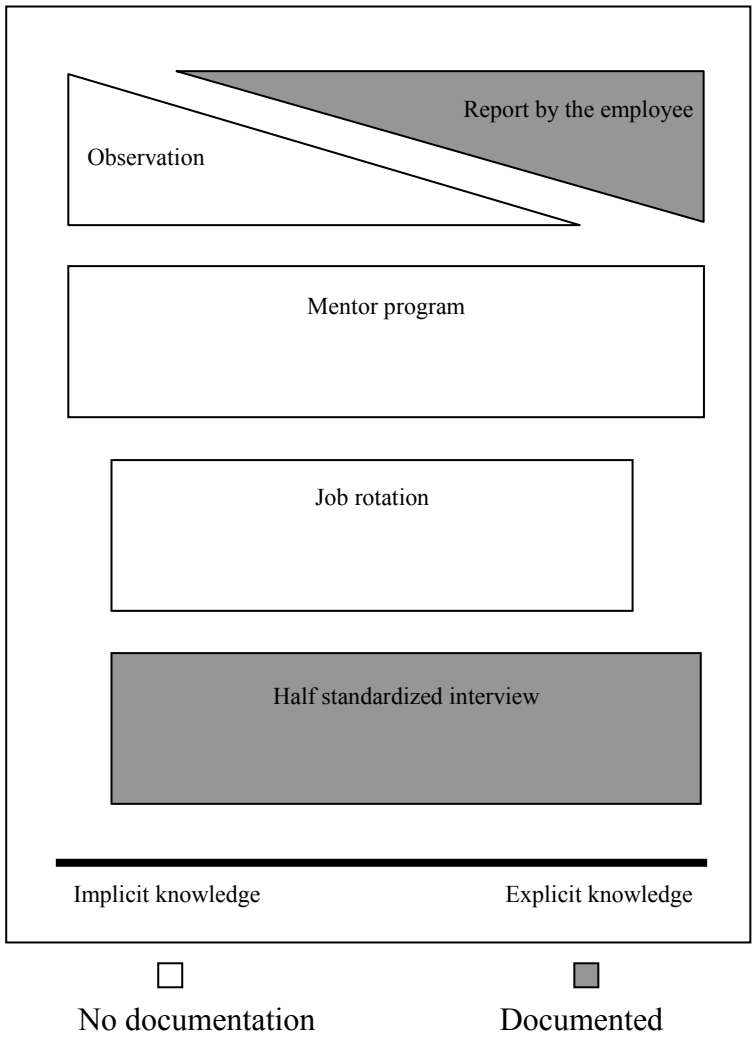

FIG. XI.1. Four methods concerning implicit/explicit knowledge and documentation.

Because mentor programmes seem to provide the best method to transfer even tacit knowledge, HSK is considering implementing such a programme. But, experience shows that such programmes are very difficult to put it into practice. That is why two other methods are also to be used: a report by the predecessor and a half-standardized interview. Reports allow the documentation of explicit knowledge; and, interviews allow for the documentation of implicit knowledge and, probably, even some tacit knowledge. Therefore, the combination of these three methods should guarantee the transfer of most of the important knowledge that will be needed by successors as they begin their new duties.

XI.2.3. Interview considerations

HSK is currently evaluating the merits of different knowledge transfer techniques focusing on interviews. Using only a mentor programme cannot assure knowledge transfer, because of the above mentioned reasons. However, for a successful application of the interview technique in combination with writing a report, two important problems still have to be discussed. In the following discussion, the methods for knowledge transfer developed and currently being tested by HSK are presented. Besides the mentor programme, HSK combines a half-standardized interview and a written report in what is called the 'Bi-functional Method of Knowledge Conservation'.

The first problem relates to the question-who should lead the interview. If interviewers trained in interview techniques come from another area of expertise than the interviewees, it is recommended that the interview is not conducted only by such interviewers, since they might not be able to understand all the explicit knowledge reported by the interviewee. On the other hand, somebody with the necessary knowledge in the specific area might not be trained in doing interviews. So, the idea that two interviewers are indispensable suggests itself. For this reason, the applied method is called bi-functional: two different interviewers having two different functions contribute to the success of capturing knowledge. First, elicitation of experience-based knowledge is performed by the trained interviewer; secondly, detailed investigation of technical details is performed by a colleague from the technical department. The term 'bi-functional' was chosen because both functions are considered equally important.

Still, interviewing with two interviewers at the same time is not advisable for two reasons:

(1) the atmosphere will be more relaxed being asked by only one person (and this atmosphere is very important for a profitable interview); and,
(2) the interview can be better structured with only one interviewer because two interviewers might disrupt each other's thoughts. That could lead to unstructured and seemingly chaotic interviews. Taking this into consideration, two independent interviews should be carried out: one by the trained interviewer, the other by a colleague from the pertinent area of expertise.

The second problem relates to the question of when departing persons should write their reports. If the reports are written before they are interviewed, the interviews are biased from the beginning and the interviewees might answer many questions referring to what they have already written. Yet, even though they have already written some things, other ideas usually come to mind while one is talking. In an interview setting, the interviewer can ask questions that can probe deeper to get a more thorough insight of the subject. It is not easy to tell the interviewees that they have to tell everything again. And, some interviewees might even take out their reports and read answers to the questions. For this reason, departing employees are encouraged to write their reports after being interviewed. The interviews actually 'prime the pump' thus helping departing employees better organize their thoughts to write their reports.

The trained interviewers ask interviewees questions about processes concerning their work, about strategies and their perception of the organisation, as well as other parts of implicit knowledge. The second interview is conducted by colleagues of the interviewees from the same area of expertise or by someone else with a similar education [XI.3]. In this interview, the interviewees are asked to specify in more detail their business, single parts of their work and other things that their colleagues want to delve into. In both interviews, the interviewees decide what information they want to have collected; what information they only want to pass on to special people; and, what information they do not want to have written down at all. The information collected in both interviews can then be integrated in one document together with the supplemented facts of the interviewees. These interview reports will be handed out to the successors and deposited in archives. Relevant parts of implicit knowledge will be passed forward directly to the impacted organization to be used for improving rules or procedures and to enable organizational learning [XI.4].

An interview-guideline for knowledge transfer should include general questions about the work, questions about the specific work area and about individual projects. The interviewees should think about the most important work in the last year and about issues, which might become important in the future. Above all, these questions serve to elicit the explicit knowledge and have to be completed by questions going deeper and by motivating interviewees to tell stories about informative circumstances they still remember, for example about their initial period in the organization. Moreover, questions should be formulated concerning the interviewees' perceptions of the organisation.

Usually an interview starts with an introductory phase, clarifying fundamental questions such as how it will go on and creating a pleasant atmosphere. Interviewers change smoothly to the second phase by asking questions. After having obtained the answers to all the questions, effective interviewers close the interview with a third phase in which open questions are cleared and interviewers ensure that interviewees leave with good feelings. They should never leave with an unpleasant feeling by having told too much [XI.5]. After the interviews, reports are written by the interviewers, so that the important information given by the departing persons can be conserved for following generations and for the whole organization. Again, it has to be pointed out, that such instruments do not replace any other methods. Interview-reports are only an additional method to be used if predecessors and successors cannot interact in person.

Interviewers who want to discover implicit knowledge need special training for interviewing. Otherwise, they will not be able to gain more information than the interviewees could write down themselves. Interviewers have to know *how* to ask questions; how to behave when conducting such interviews; and, what they have to bear in mind during the whole interview. They have to consider four polarities: structure versus dynamics; facts versus personal characteristics, asymmetry versus reciprocity; and, pleasant atmosphere versus distance. Whereas *structure* allows an orientation through the interview for both interview partners, *dynamics* allow for taking into account the specific characteristics of the interviewee. As far as the collection of information is concerned, *facts* are the fundament for further questions about *personal characteristics* out of which the implicit knowledge can be deduced. *Asymmetry* and *reciprocity* deal with the balance of power between interviewer and interviewee. The interviewer has the power to ask whatever he wants to, but if the interviewee does not want to contribute to the work the interview is bound to failure. The last poles concern a *pleasant atmosphere* versus *keeping distance* during the interview. For a successful interview — for interviewers as well as for interviewees — it is important that interviewers balance these four opposing pressures. For more information about interview techniques see Refs [XI.6, XI.7].

XI.3. Necessary further work

As already mentioned, the first interviews have been carried out and the evaluations have been done for three interviews. But there is a lot of work to do to be sure that the effort, which is connected to this method is really worth it.

First, the successors or other concerned people have to be asked, what they think about the gathered information. If the successors think that this information was helpful for the initial period, the method will allow additional information and might be useful in the future. If not, there is no reason to go on with it. When thinking about the profit of the interview, not only the successors and colleagues should be asked about the advantages of the collected information. The management of the organization should also be asked if the feedback is of help for organizational development.

Second, HSK has to decide, if the gathered knowledge is worth the effort. A lot of time is needed to prepare and carry out the interviews and to write the reports. Additional experience is needed to decide if these interviews are cost-effective. But, when thinking about that, total working time of everyone involved should be considered because the interviewees might be able to write their required reports in less time than had they not been interviewed.

If interviews are to be carried out in the future, two more thoughts have to be considered. On the one hand, a discussion whether the interview should be voluntary or obligatory is required. If the interview is dictated by the management, some employees without any interest in the interviews might be skeptical and unwilling to contribute to successful interviews. On the other hand, a decision about who the interviewers should be is necessary because persons who are already working in the organization might be adequate; but both the interviewers and the interviewees know which organizational component they are talking about. And, it might also be difficult to interview a colleague of the same department (such as the head of the department). It might also be problematic for interviewees to tell colleagues organizational problems if they are to be working together every day until they depart. These potential problems could be solved by outsourcing. Interviewers should then come to the organization just to carry out the interviews with the departing employees. The results could then be discussed with a contact-person in the organization.

In addition, an exchange of experience with other organizational units having similar problems would significantly improve the outcome of the process. When deciding about preserving knowledge with interviews, management should bear in mind that interviews are one method by which to show departing employees high regard. That is a very important aspect, since an unsatisfied pensioner will not understand why he should help the organization when needed. *In summary, this well-intentioned project is 'a work in progress'.*

References to Appendix XI

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Appendix XII

CAPTURING AND USING HIGH-VALUE UNDOCUMENTED KNOWLEDGE IN THE NUCLEAR INDUSTRY: GUIDELINES AND METHODS

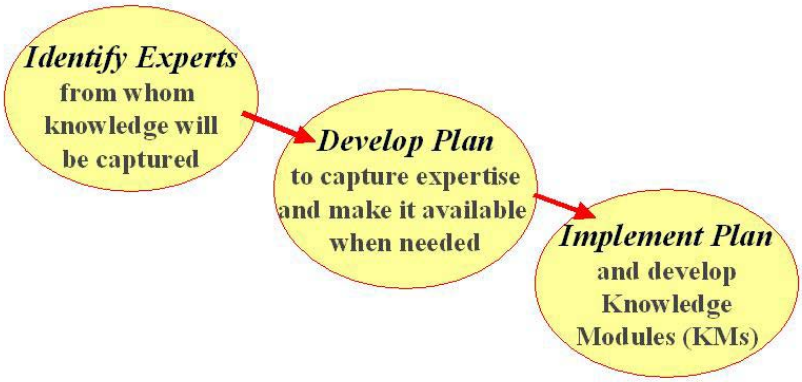
XII.1. Source

EPRI is the electric utility industry's collaborative research and development organization, based in the USA.

XII.2. Introduction

EPRI's reports (see section XII.4 below) provide practical tools for immediate use in securing the tacit knowledge capital held by expert workers and managers and in making it available to other personnel. The tools and methods are applicable to any organization at risk of losing important knowledge due to aging workforce, rotation of personnel, or attrition from all causes.

XII.3. Method



EPRI's interactive report contains easy-to-use steps for eliciting, capturing, and passing along the high-value knowledge residing 'in the heads' of expert personnel in the electric power industry. It is especially valuable for managers evaluating and planning for the potential departure of experienced and highly knowledgeable employees. Such experience is often distributed throughout the company, and comes into play in many mission-critical situations involving electricity infrastructure.

EPRI's product provides a three-step process, detailed guidance, and reference materials that may be applied to identify experts and their valuable undocumented knowledge, develop a plan to elicit and capture that knowledge, and implement the plan for knowledge capture and packaging for subsequent use.

Fundamental methods provided in the report include:

— Concept mapping method;
— Critical decision method;

— Critical incident technique;
— Interview methods;
— Knowledge audit method;
— Simulations and constructed scenarios method;
— Task diagram method;
— Self-elicitation techniques;
— Storytelling;
— Updating procedures; or
— Lesson plans.

The tool focuses on tacit knowledge, which consists of unique capabilities, skills, and knowledge developed-or known based on previous experience-by an individual or shared by a team of workers. Experts with this kind of knowledge do certain jobs or tasks more quickly and with fewer errors than others. In a few cases, they may be the only ones who can perform the job or task. They are the ones assigned difficult and demanding activities. If their expertise is not available, potential adverse consequences may include reduced reliability, increased errors, and/or higher costs.

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EPRI Report 1009581, Real-time Expert Knowledge Acquisition and Transfer, Palo Alto, CA: EPRI (2004).

Further information:

www.epri.com

David Ziebell, Manager, Human Performance Technology, Email: dziebell@epri.com

EPRI Customer Assistance Center, 800.313.3774 or Email: askepri@epri.com

Appendix XIII

CAPTURE OF PROFESSIONAL/PERSONAL NETWORK TACIT KNOWLEDGE

XIII.1. Source

Center for Advanced Energy Studies (CAES), Idaho National Laboratory. CAES is a principle agent of the Idaho National Laboratory in the areas of next generation nuclear energy policy, research, training and education.

XIII.2. Introduction

Perhaps the most deep-seated tacit knowledge that any individual retains is that concerning his/her relationships with others and the depth and breadth of those relationships. In considering all types and elements of knowledge capture, it is essential to remember that most individuals that have achieved technical success in their disciplines have not done so singularly by virtue of sheer technical knowledge or individual effort. Success is achieved through their ability to work with and through others to achieve the goals and mission of the organization. This said it is necessary to consider, when capturing the knowledge of those that are leaving an institution for whatever reason, the knowledge that the individual possesses concerning the relationships they have with others. These relationships contribute to the comprehensive picture of what has helped the individual be successful in supporting the organizations goals and without it the organization and the individual's successor is left with an incomplete recipe for success. These relationships might be with vendors, peers within their or other organizations, mentors, subordinates, managers, and many others. The list may be long and varied for those that have supported an organization for many years.

XIII.3. Method

Several approaches to this type of knowledge capture can be taken including appreciative inquiry, naturalistic inquiry, employee questionnaire followed by debriefing, storytelling and group inquiry that includes the employee and individuals that they identify as important to their 'professional network'. The latter is particularly effective in that it helps to identify the extended network of individuals engaged in the activity and promotes identification of other resources as well as individuals that might likely fill the role being vacated.

XIII.4. Results

Literature reviews do not reveal any approaches to this issue from the knowledge management perspective although there may be some information in Bayesian networks of relevance to the discussion.

Further information:

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Appendix XIV

TACIT KNOWLEDGE CAPTURE IN THE UK NUCLEAR INDUSTRY

XIV.1. Source

AMEC NNC is a privately owned international engineering, project management, safety and technical consultancy, dedicated to providing expert advice and solutions to complex engineering and project management challenges in the nuclear and non-nuclear markets. Employing in excess of 1000 people, our network comprises 31 offices across the world.

AMEC plc is a world leader in technical services and project management, employing around 45 000 people in some 40 countries around the world. AMEC specializes in the design, delivery and support of infrastructure ranging from local technical services to international landmark projects.

XIV.2. Introduction

This appendix describes the methodology used by AMEC NNC to capture tacit knowledge from experts in the nuclear sector inside — both inside the organization and externally for our clients. The methodology can be applied to long term capture of knowledge when the need is identified well in advance of an expert's departure. Alternatively, the methodology also lends itself to emergency capture of knowledge when only a few weeks notice is given of departure.

A necessary pre-requisite for beginning the process is to establish the key staff at risk and to formulate a formal succession plan. AMEC NNC carries out a risk assessment to identify probable leavers who should participate in the knowledge capture process.

XIV.3. Method

There is no 'magic formula' that can be used to extract and transfer knowledge between staff. A lot of hard work is needed by all parties, especially the 'givers' and 'receivers' of knowledge. Without a coherent team approach and dedicated time commitments from all members involved, any such initiative will surely fail.

The overall approach to knowledge acquisition can be sub-divided into the 6 stages (see Fig. XIV.1). A brief descriptions of each stage are given below:

XIV.3.1. Stage 1 — Identify leavers

This stage is straightforward and involves identifying staff, which are at risk of leaving. Most organisations have a 'notification of leavers' list or database that is used to identify staff who are on some kind of notice period. In other cases (e.g. sickness) it is down to line management to be aware of potential leavers and ensure that preventative measures are in place for a relevant handover of work. The important point is to be aware of potential leavers and take action before the resource has left the organization.

XIV.3.2. Stage 2 — Risk analysis

This stage can be used proactively to determine staff at risk of leaving (outside the scope of this study) or can be used to analyse the importance of the skills/knowledge of staff. Stage 2 acts as a decision point or filter to establish whether staff should participate in the emergency knowledge capture process. If the knowledge of an individual is important then that individual is identified as a candidate for stages 3–6 as described below.

The criteria used to determine an individual's importance and participation in future stages will be governed by three key factors:

(1) The importance of the role and the work of the individual (e.g. strategic, fee earning);
(2) The ability and availability of others inside and outside the organisation to do this work;
(3) The psychological profile of the individual with regards the ability and willingness of that individual to share information and knowledge.

A risk factor based on product of the above criteria can be generated to help determine whether a member of staff undergoes the knowledge acquisition process and to assign priorities.

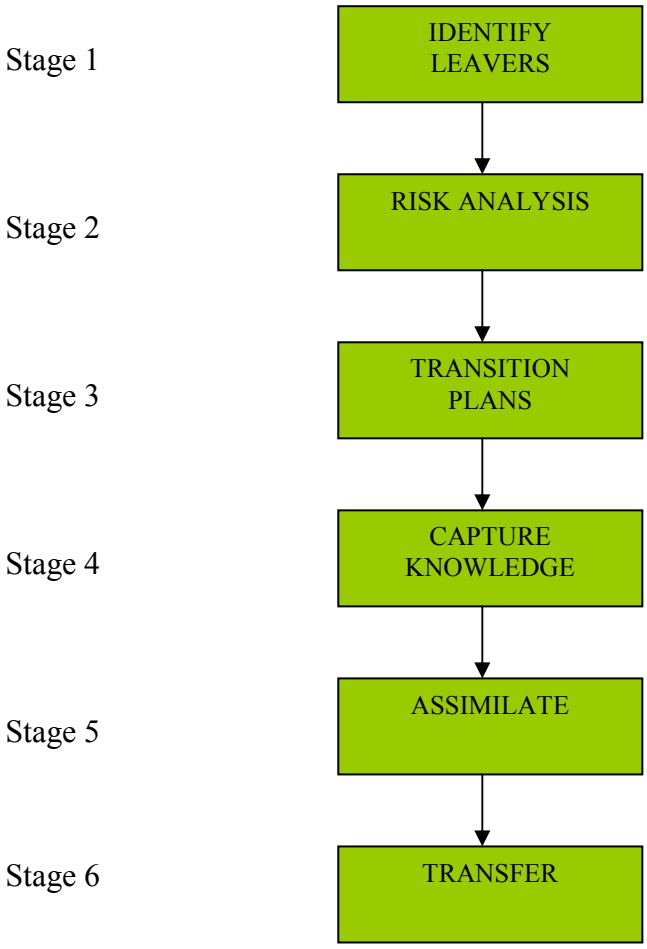

FIG XIV.1. Stages of overall approach to knowledge acquisition.

XIV.3.3. Stage 3 — Develop individual transition plans

This involves interviewing key staff and developing realistic plans for skills transitioning in the short period the individual has left with the organisation. The main purpose of this phase is to generate 'buy-in' from the leaver from the outset to ensure completion of subsequent stages.

Each leaver will be encouraged to produce his/her own transition plan comprising:

— The nature of the role (role profiles should be included if applicable);
— Ongoing and future work commitments;

— Possible replacement staff options (including identifying suitable successors);
— Timescales for action;
— Estimated costs (e.g. internal/external training for replacement staff).

The transition plan is an action plan for exit and should be based on a simple protocol or checklist for rapid completion (2 hrs max). The transition plan is not intended to capture knowledge — this is done in the next stage as described below.

XIV.3.4. Stage 4 — Capture knowledge

Stage 4 is the most important step in the process and requires the most time commitment from the leaver. It involves two iterative phases:

(1) Codifying knowledge
(2) Structured interviews

The first phase involves the initial capturing of knowledge in the form of a 'knowledge portfolio', which is an attempt to define, in writing, the most important aspects of the role and the pre-requisites needed for another person to take on the ongoing work requirements. The knowledge portfolio is essentially a handover document that is used by a new starter or replacement person to act as a reference guide for the role. The contents of the knowledge portfolio will vary according to the role but will typically contain the following information or 'explicit knowledge':

— Role description or role profile;
— Training information (any training pre-requisites for the role and details of training courses attended whilst in the role);
— Reference document guide (Generic guides, standards, customer reports, drawings, forms, templates etc. pertinent to the role. Full description and location);
— Specific systems knowledge (details of buildings, plant systems, designs, computer programmes etc. relevant to the role together with hints, tips, known problems and ongoing development needs;)
— Process information (processes, procedures and methodologies adhered to whilst performing the role);
— Best practice and deviations (areas where formal processes/procedures have been replaced with alternative methods of working that may or may not relate to best practice);
— Lessons learned (details of potential traps, near misses or failures associated with the role and its execution. Also to cover areas of innovation to overcome problems and positive learning experiences if these can be found);
— Contact details (network of contacts both internal and external that are relevant to the role);
— Previous roles and corporate knowledge (details of other roles and engagements that the leaver has been involved with. This could include internal working parties, task forces, corporate initiatives etc. that are outside the normal role).

Completion of the knowledge portfolio may take several man-days effort and experience shows that the quality of the output can vary considerably at the first draft. It is therefore necessary to supplement the knowledge portfolio with a series of interviews that will tease out more information and fill in the missing gaps that the leaver may knowingly or unknowingly omit. Additionally the interview stage will allow further anecdotal information (story telling)

to be expressed in the context of the role that will provide valuable insights to how/why/when/where the work should be performed. This is particularly useful in the lessons learned category and provides the most valuable part of a true knowledge capture process.

The initial interview should be of a generic nature (covering similar ground to the knowledge portfolio). Following this, a specialist interview is carried out involving a Company expert, manager, team leader or external specialist.

The process is iterative and can be represented diagrammatically as below:

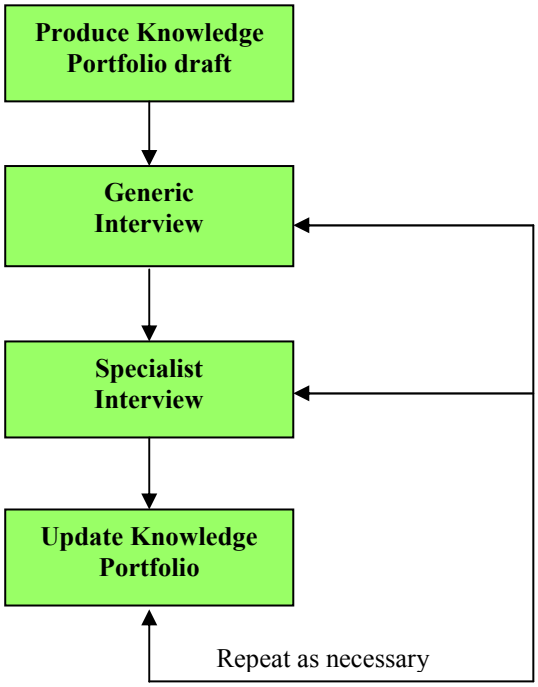

FIG. XIV.2. Creation of knowledge portfolio.

It is suggested that two or three interviews of each type are carried out in quick succession of 1–2 hours duration over an elapsed period of 5–10 days. Experience shows that the output from each interview drops exponentially with time and begins to lose value after each iteration.

XIV.3.5. Stage 5 — Assimilate information

This involves reviewing the completed knowledge portfolio (by suitable peer groups) for consistency and relevance. The peer groups should involve immediate line management, co-workers and replacement staff if known. If there is Company system (e.g. document management, Intranet, etc.) then this should be used for long term storage and records.
If suitable peer review groups cannot be found or made available then it is incumbent on the leaver and interviewing staff to review the information prior to storage and transfer.

XIV.3.6. Stage 6 — Transfer knowledge

This stage actively involves the identified staff from stage 3 in structured training and learning activities. A multi-strand approach is needed here involving:

- Internal/external training courses;
- On-the-job training;
- ‘Budding’ between target staff;
- Leadership and line management skills.

The information contained in the knowledge portfolio provides a valuable reference guide to facilitate the above.

XIV.4. Results

The above capture process has been applied to a number of staff inside and outside the industry with positive results. In all cases feedback from staff involved in the handover process has suggested that the process is worthwhile and worth the initial investment.

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Appendix XV

KEPCO'S E-LEARNING SYSTEM

XV.1. Source

Korea Electric Power Corporation (KEPCO). KEPCO is a government-owned company operating three training centers (one central training center and two local training centers) providing the off-line and on-line education regarding the duty-related and general education.

XV.2. Introduction

WHAT

This appendix shows KEPCO's conceptual E-learning system based on Information Technology (IT) had been developed to train/educate the employee at any time and place.

WHY

This will provide for basic concept in knowledge management to be suggestive to non-IT based NPP utilities and nuclear regulation group to capture, preserve and transfer the knowledge established on IT.

XV.3. Method

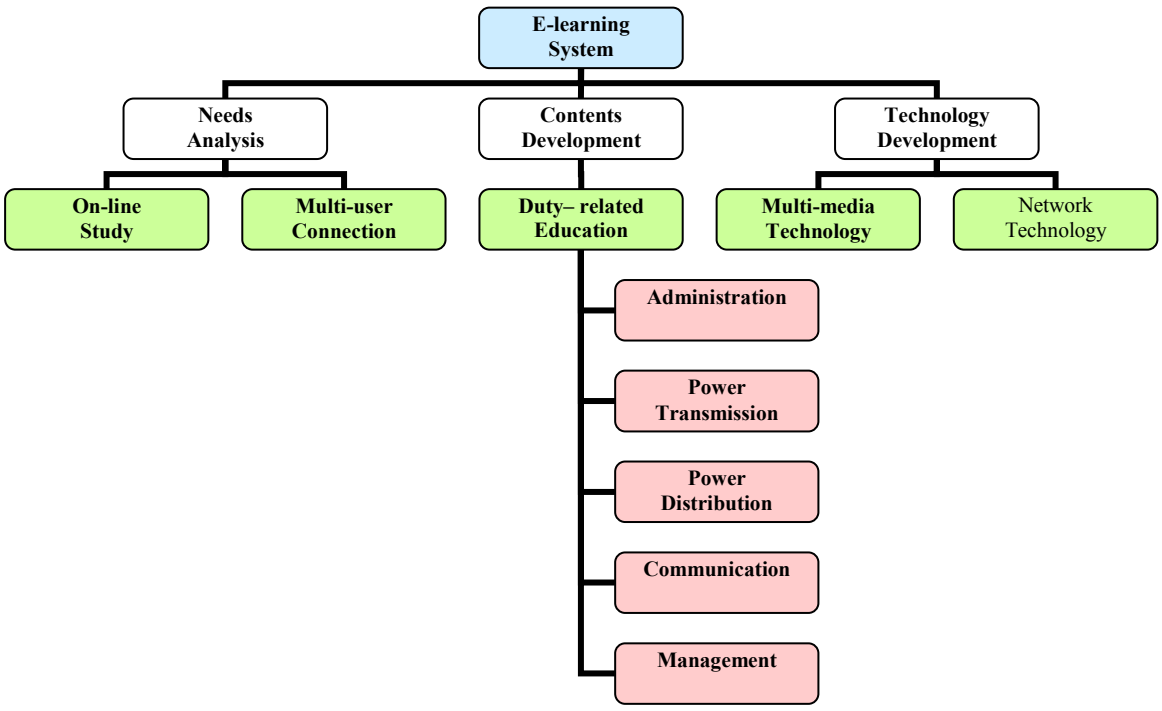

FIG. XV.1. KEPCO's E-learning system.

The E-learning system based on IT can be accomplished by the reliability of three critical areas: needs analysis, contents development and technology development.

XV.3.1. Needs analysis

Since most of KEPCO's office spread into all over the country far from training center, inexperienced employee being short of practical knowledge in local should be vacant to learn the knowledge at the training center and their family would like to learn general & cultural education. KEPCO's top management section should consider employee's satisfaction and knowledge sharing/transfer relevant to work duty. 'E-learning System' was decided to be adaptable to network knowledge management.

The areas to be considered in 'needs analysis' as follows:

— Online study
— Spontaneous multi-user capability

XV.3.2. Contents development

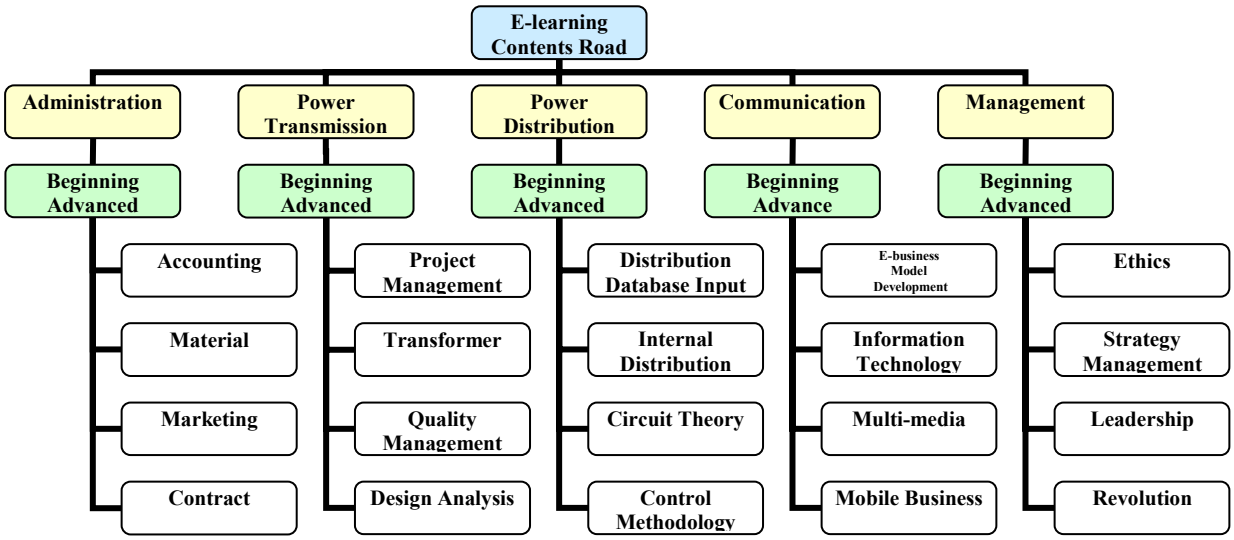

FIG. XV.2. KEPCO's E-learning contents map.

As a leading power company in Asia, KEPCO should develop the diverse E-learning contents (duty-related contents, cultural contents, etc). Each content was divided into beginning, expert course and more ancillary course was presented into E-learning. KEPCO's E-learning contents are as follows:

— Administration
— Power transmission
— Power distribution
— Communication
— Management

XV.3.3. Technology development

In order to diverse the contents and increase the multi-user, newly developed information technology should be adopted to E-learning system and Some contents based on image/live education/animation might be more effective than teaching materials, can easily accomplish the education objectives.

IT in association with E-learning compose Database Design Tech, Web Design Tech, Multimedia Tech, Network Tech, etc.

Furthermore, since most of E-learning student can only use the contents in PC connected to Internet so far, KEPCO is plan to develop the mobile E-learning system — easily utilize the E-learning contents at any place and time by mobile phone, PDA or Notebook (Ubiquitous, Wireless Broadband Internet can bring into fruition).

The areas to be deliberated at Technology development:

- Multimedia technology
- Network technology

Further information:

http://hana.hq/OFFICE/GENERAL_AFFAIRS/WRK80/init.htm

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Appendix XVI

IMPLEMENTATION OF KNOWLEDGE PORTAL

XVI.1. Source

Department of Nuclear Safety and Security, IAEA.

XVI.2. Introduction

The Department of Nuclear Safety & Security (NS) has approximately 190 staff. The information and knowledge repositories are many and diverse. Information exchange has in the past mostly been done through one common network drive or by E-mail.

WHAT

The objective has been to provide an integrated solution to capture, preserve, create and share safety knowledge amongst staff in NS. This has been achieved by implementing an intranet based knowledge portal for the staff at the Department of Nuclear Safety and Security (NS) at the International Atomic Energy Agency (IAEA).

WHO

All staff at the NS Department.

WHY

To provide a solution to capture, preserve, create and share safety knowledge amongst staff in NS. The portal provides a single point of access to relevant technical, managerial and administrative knowledge and information used by the staff in the Department.

Expected benefits:

- Faster decision making and better quality decision;
- Greater opportunities for collaboration and sharing knowledge;
- Better and faster access to expertise, when needed;
- More targeted and effective education and training;
- Wider dissemination of nuclear safety knowledge.

XVI.3. Method

KM strategy has been to first identify major nuclear, radiation, waste and transport safety knowledge domains and then to capture and share the critical knowledge in each domain in order to preserve the institutional memory and stimulate new knowledge for current as well as future generation of scientists, engineers and technicians. An important issue has been to have a distributed ownership. This means, the different knowledge domain 'owners' have full control over their respective domains, while all other users have read-only access.

XVI.3.1. Map the critical knowledge

Through a thorough analysis, the critical knowledge domains of the Department were identified.

These knowledge domains, with related sub-domains are illustrated in the simplified knowledge map (Fig. XVI.1).

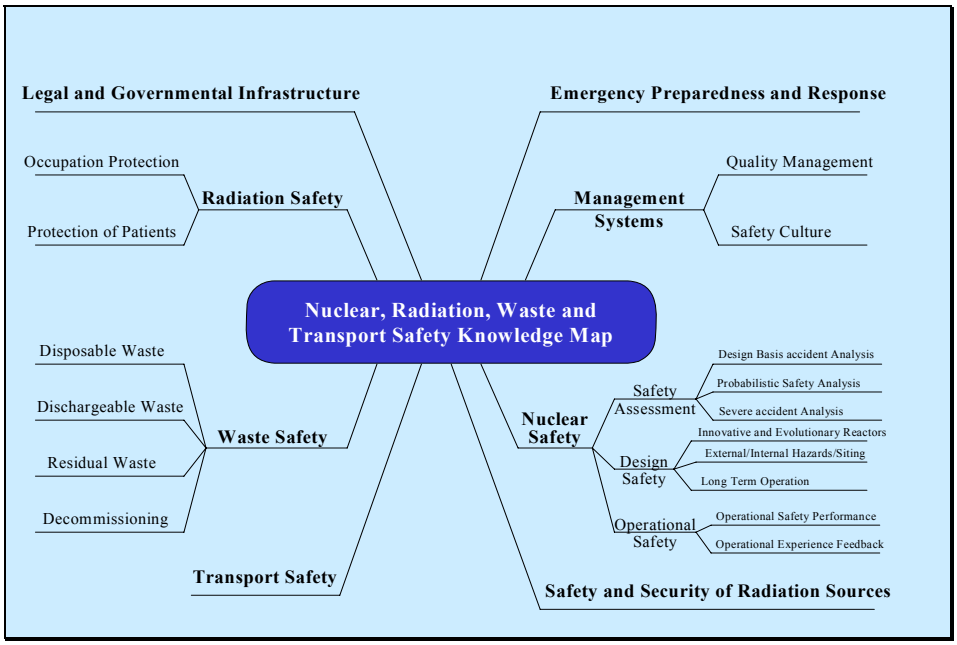

FIG. XVI.1. Simplified knowledge map.

XVI.3.2. Design the knowledge portal

Once the questions of what are the knowledge domains in nuclear safety and security department and what is relevant knowledge in each domain are resolved then the next most important step is to build a framework for preserving, sharing and synthesizing the critical knowledge in each knowledge domain.

The structure of the NS KM portal is dynamic. That is, it will evolve over time as needs arise. However, the initial structure is shown on Fig. XVI.2.

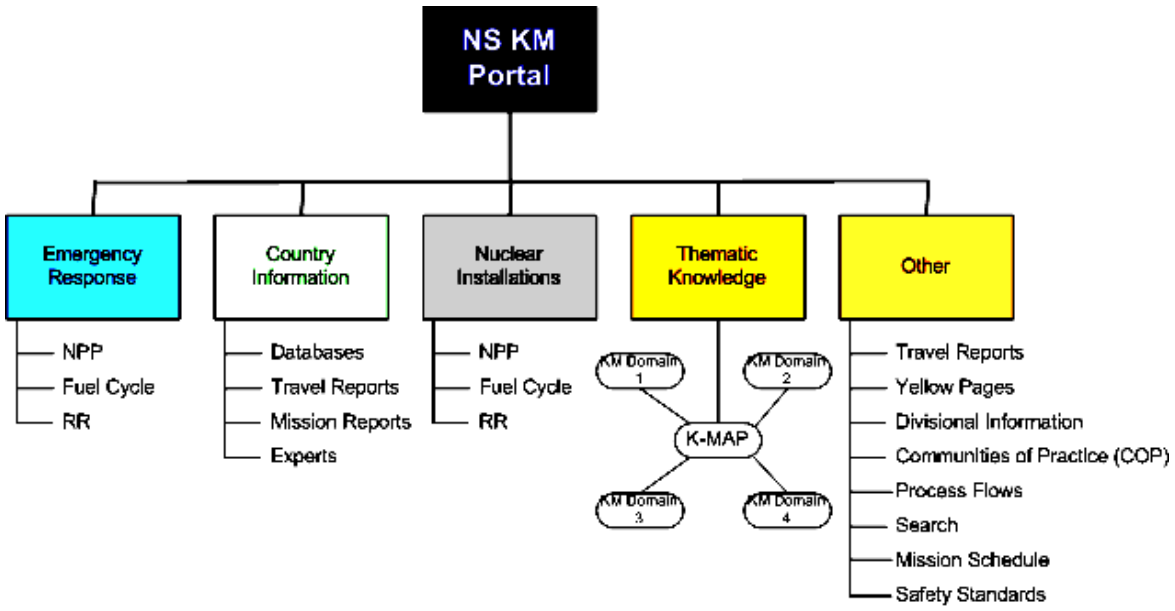

FIG. XVI.2. The NS KM portal structure.

The knowledge portal has been implemented partially using the 3rd party software '*Livelink'*. The user-interface is implemented through simple html pages.

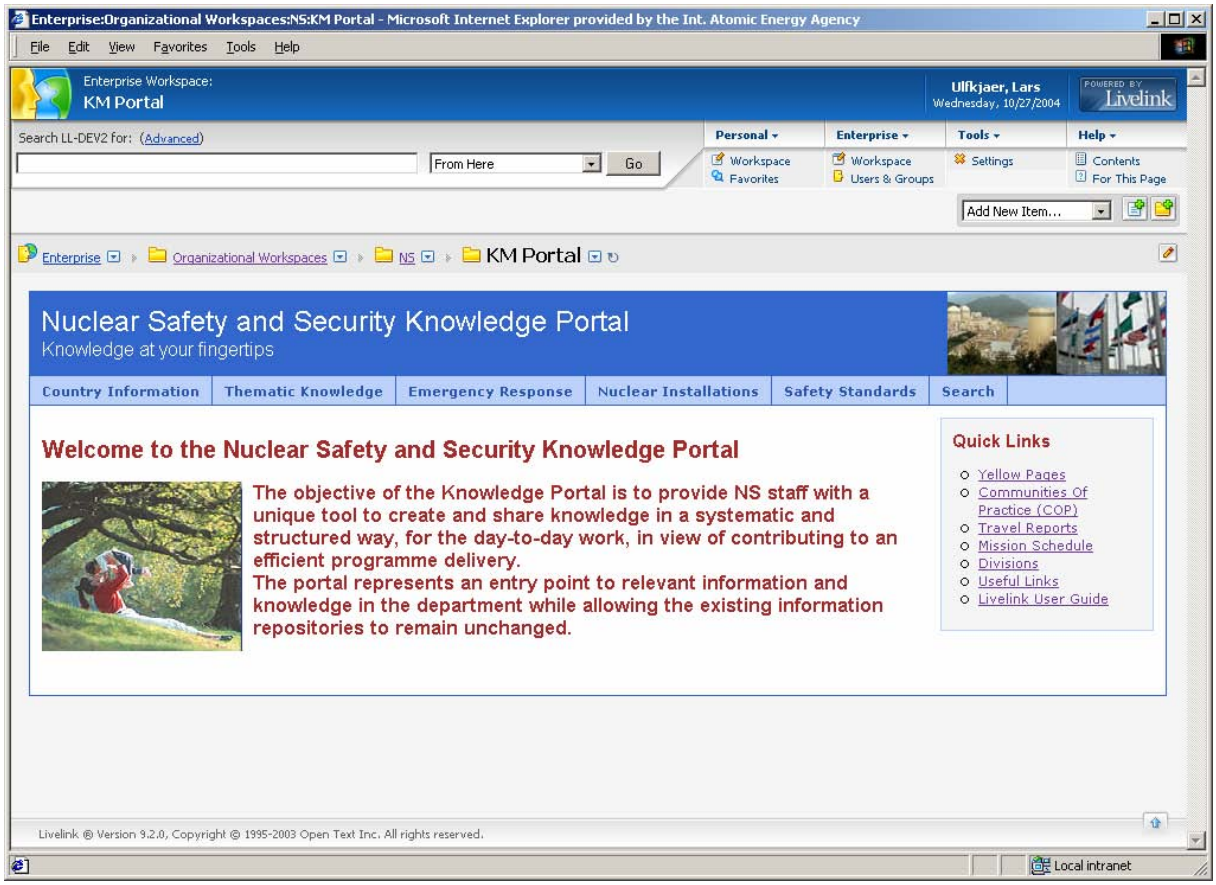

FIG. XVI.3. User-interface.

The knowledge domains can be accessed through click-able areas:

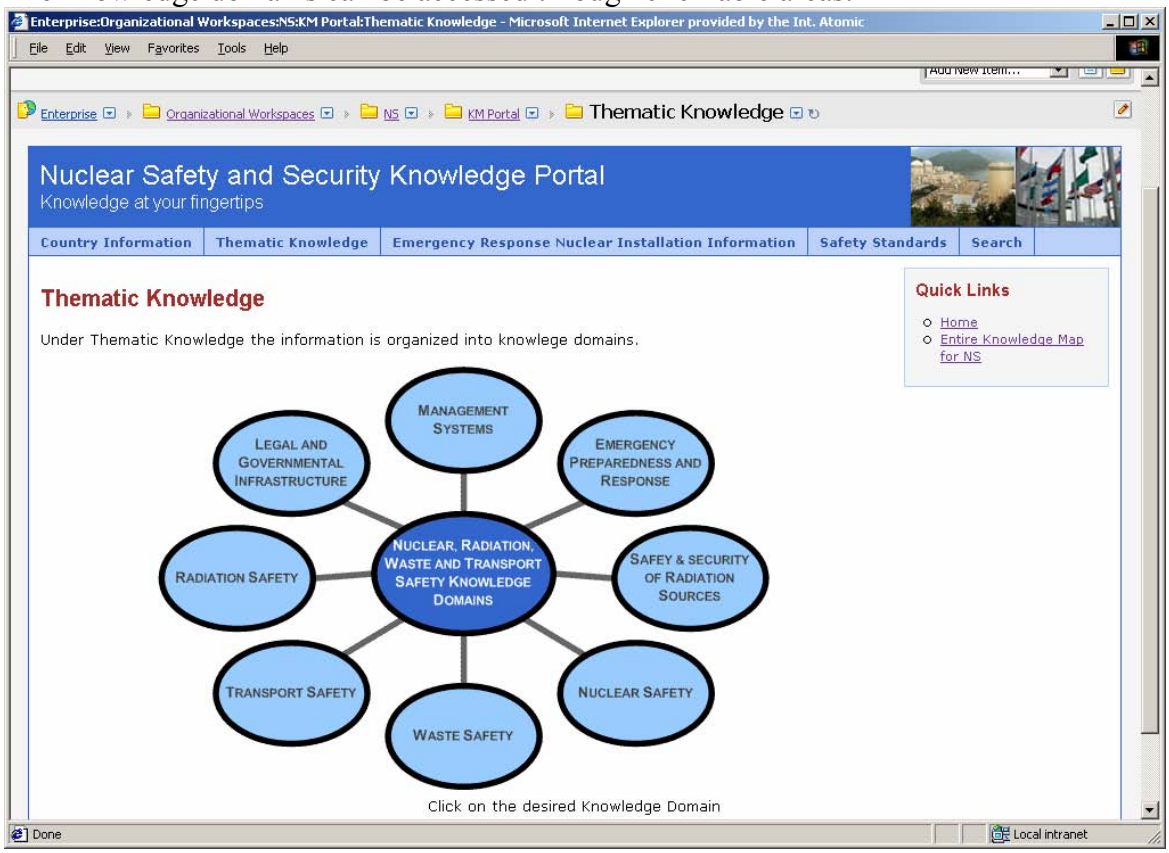

FIG. XVI.4. Thematic knowledge domains.

FIG. XVI.5. Thematic areas for nuclear safety.

Each knowledge domain or sub-domain is having the same structure:

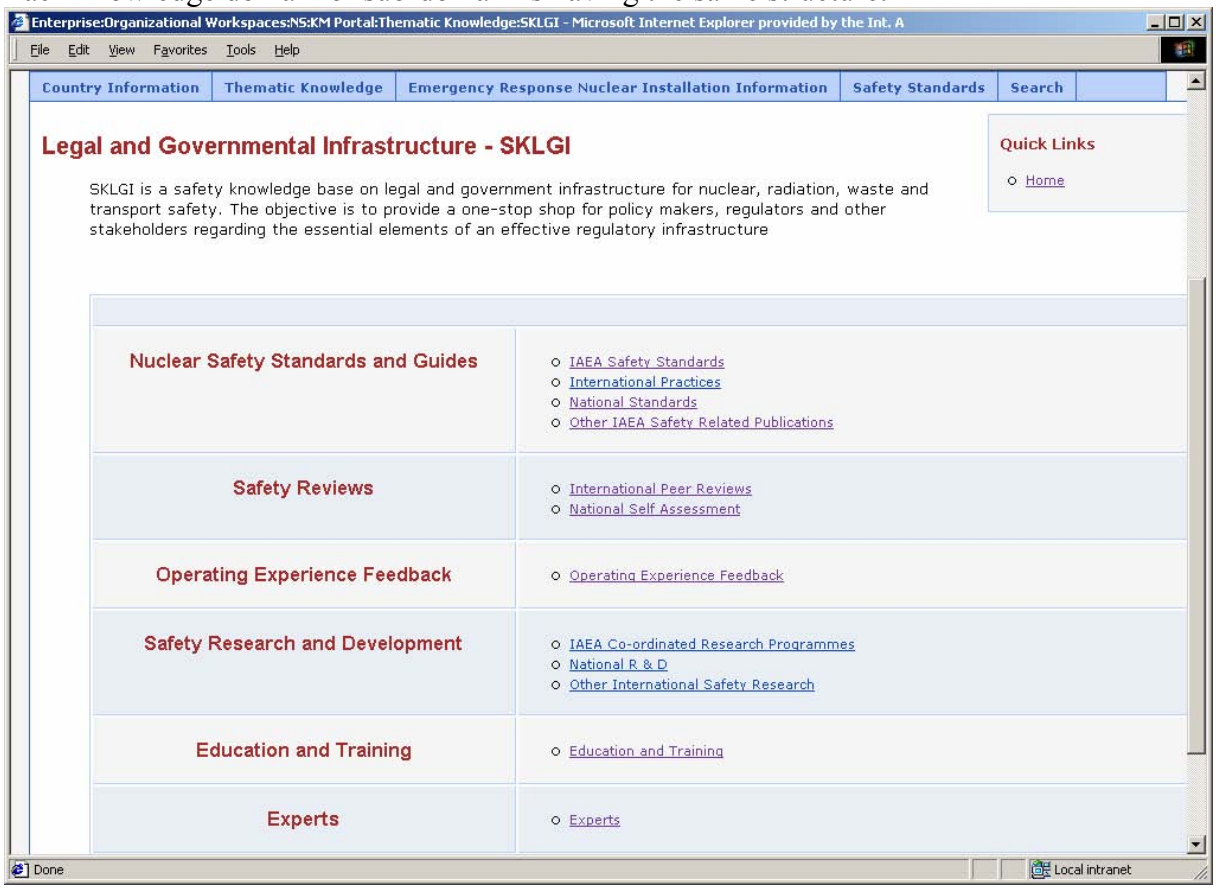

FIG. XVI.6. Example of knowledge domain structure.

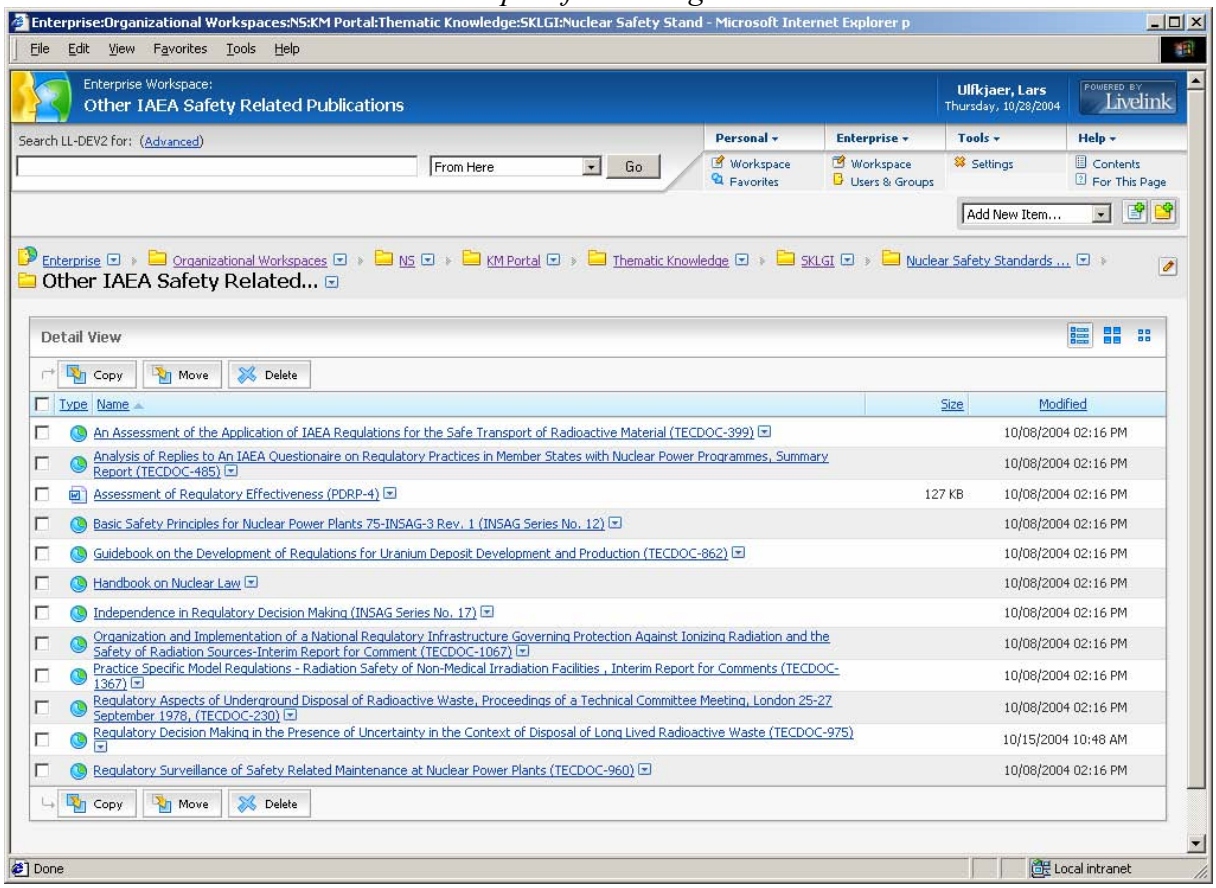

FIG. XVI.7. Example of knowledge sub-domain structure.

XVI.4. Results

The first version of the knowledge portal was installed in April 2005 and is expected to be improved over the next 2 years.

Further information:

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Appendix XVII

KNOWLEDGE DISSEMINATION FOR NPP SENIOR MANAGERS

XVII.1. Source

Proneos GmbH is an Innovation Management Consultancy providing advisory services to energy and utility corporations, with a specialization on Nuclear Knowledge Management (NKM). The material presented in this appendix is related to work with a leading European Utility Corporation operating several NPPs.

XVII.2. Introduction

A pivotal element of KM in NPP, and a crucial prerequisite for its success, is the proactive support of knowledge dissemination by senior management in technical, commercial and legal domains. The practice described in this appendix is targeting this proactive support through demonstration of KM benefits in a workshop with NPP senior managers.

This practice is applicable to organizations operating several NPP and experiencing technical, process-related, organizational and/or cultural challenges of inter-NPP knowledge exchange.

XVII.3. Method

The objective of the workshop is to motivate proactive support of senior management for knowledge dissemination. Such proactive support comprises, but is not limited to, two factors:

(1) Senior managers play a KM **role model**:
   - Communicate personal, critical experiences;
   - Quote experiences of key experts in meetings;
   - Actively approach key employees to discuss KM;
   - Explain the value of KM through success stories.

(2) Senior managers **set expectations**:
   - Ask for specific experience reports;
   - Honor good KM contributions;
   - Promote networks with employees of other sites;
   - Reward related initiatives;
   - Provide time for KM-related activities;
   - Fully prioritize expected deliverables.

A workshop for senior NPP managers may help to achieve these two factors. The event lets senior managers:

- **Experience** KM in comparable organizations, as presented by an external senior managers at peer level (dinner guest speaker);
- **Discuss** the current and target situation on site regarding:
  - degrees of personal freedom for informal knowledge dissemination at all levels;
  - management fairness in dealing with negative experiences;
  - first steps to actively develop a **culture** promoting knowledge dissemination.
- **Set clear commitments** for next steps (in particular regarding role model playing and expectation setting);

— **Appreciate** a transparent, continuous cultural development process.

The target participant group to be invited to the workshop consists of the following candidates. For each NPP involved:

— Plant manager(s) (technical and commercial fields);
— Division managers;
— Local trade union representative;
— Local HR manager (optional).

For headquarters:

— Manager of Nuclear Power division (typically workshop sponsor);
— HQ HR manager (optional);
— HQ trade union representative (optional);
— KM responsible (typically operative workshop organizer).

The target group size is 20 participants.

The **workshop sponsor** (or mentor) is typically one of the senior managers also participating in the workshop. The operative **workshop organizer** is typically the KM responsible (e.g. knowledge manager), possibly supported by an experienced consultant. The **workshop facilitator** should be an experienced, senior external consultant.

The workshop consists of three parts:

(1) **Personal briefing** of at least one senior management representative ('opinion leader' or 'multiplier') per NPP involved prior to the workshop. The briefing should be conducted by the workshop organizer and by the facilitator. The briefing's purpose is:
   — to inform the representative about objective, agenda and details of the workshop event;
   — to manage the expectation for the event;
   — to spur commitment for active participation within and beyond the workshop.

   The time target for the duration of the briefing is 90 minutes. Proposed location should be the NPP of the representative to be briefed.

(2) **Joint dinner** on the workshop eve for all participants, entertained by an invited external speaker. This speaker is ideally a senior manager of a comparable, but not competing organization:
   — with seniority at peer level to the most senior event participants;
   — with strong, demonstrated commitment to KM;
   — with credible success and failure stories.

   The dinner speech should be followed by Q&A typically leading to an in-depth discussion. The time target for the duration of the dinner including speech is 4 hours. The proposed location should be external, e.g. a hotel easy to reach for all participants.

(3) **KM workshop day**, with the objective to jointly formulate an action plan to reflect knowledge dissemination as a task for NPP senior management. The following workshop agenda is proposed:
   — Introduction of all participants, specification of expectations (30 min);
   — Agenda review, changes if needed (15 min);
   — Short presentation of select and relevant aspects of current KM concept and local activities in place (45 min);

- Analysis of current and ideal situation regarding:
  - degrees of personal freedom of NPP staff for informal knowledge exchange (60 min);
  - management fairness regarding communication of critical experiences (including negative experiences) (60 min);
  - active development of a culture promoting knowledge dissemination (60 min).
- Discussion of the gap between current and ideal situation (60 min);
- Formulation of an action plan to minimize this gap, with focus on;
- Role model playing (20 min);
- Expectation setting (20 min);
- Agreement on next steps to implement this action plan, including a review meeting to discuss achievements regarding gap minimization about 6 months after the workshop event (60 min);
- Review of expectations set at the beginning of the meeting (15 min).

The target for the total time span of the workshop is 9 hours, including a one-hour lunch break and coffee breaks in the morning and in the afternoon. Workshop results are to be recorded during the workshop (e.g. via flipchart), and documented and sent to the workshop participants after the workshop.

XVII.4. Results

Feedback to the general idea of KM workshops for NPP senior management in the described format has been very positive. The impact of such workshops on the organization(s) has been positive as well, as it has promoted transparency and coordination at senior management level. Yet, to yield a resilient success, such workshops must be repeated periodically, or even be instituted.

Further information:

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M: +49 160 9774 3600, Email: frank.kirschnick@proneos.com

A complete concept for NPP decommissioning, including concept elements targeting persuasion and leadership, are covered in the following paper:

http://www.iaea.org/km/cnkm/papers/kirschnickgermany.pdf

Appendix XVIII

'BATCH' APPROACH TO NEW EMPLOYEE ENTRY AND SOME OTHER TRAINING SCHEMES OF DAE

XVIII.1. Source

Nuclear Power Corporation of India Ltd. — NPCIL is Government of India Enterprise under Department of Atomic Energy engaged in Design, Construction and Operation activities of Nuclear Power Plants.

XVIII.2. Introduction

The Department of Atomic Energy (DAE) of India has a long running induction training programme run by the Human Resource Division of Bhabha Atomic Research Center (BARC) also known as BARC Training School. This is considered a unique and valuable scheme to impart nuclear knowledge towards meeting the goals of DAE and constitutes one of the important knowledge management activities. This and other training schemes of DAE are brought out as below.

XVIII.3. Method

The new recruits for the posts of scientists and engineers are required to undergo one year Orientation training in Nuclear Engineering and sciences. The intake comprises of engineering graduates (B.Tech) of various disciplines such as Mechanical, Chemical, Electrical, Electronics, Computer Science and Metallurgical Engineering. In Science, Post graduates (M.S.) of physics, chemistry and Biology disciplines are recruited. The programme comprises of about 450 lectures encompassing common nuclear engineering/science subjects such as Nuclear Physics, Reactor Physics, Reactor Engineering, Nuclear Power Plants, Health Physics plus subjects of in depth nature pertaining to the particular discipline.

The training also includes periodic tests for each of the subjects, practicals, visits to the various Laboratories/reactors of the Center, an outstation study tour to one of the operating stations/site under construction for engineers and another research center/laboratory for scientists, viva voce, project and project viva-voce. Project is to be done in-site at the units in Mumbai.

During the training, stay at the BARC Training school hostel is mandatory. The hostel has facilities such as library, Internet terminals, sporting/recreation facilities.

The trainees are thus in close proximity to each other and develop a strong sense of camaraderie, which develops naturally since they meet from various far flung areas of India with diversity of culture/language etc.

Each year of training is known by the designated 'Batch' i.e. the year from commencement of this training scheme. This 'Batch' concept gives a strong sense of belonging and identity to the recruits, which remains throughout the subsequent professional life of about 40 years. Presently, the training under 49th Batch for the academic year 2005–2006 is in progress. This is indicative of the continuity of the organizational growth and knowledge transfer. Since this has been the predominant recruitment method for the officer cadre, the alumni of the training school occupy a full range of positions downward from the top management of the DAE units and a common thread exists. This concept of 'Batch' introduces a degree of informality, which has been found to be extremely useful for the smooth functioning.

End of the training programme is marked by convocation function, when the top performers of each of the disciplines are awarded Homi Bhabha Prize. The chief guests of this function are eminent public figures and full attendance from 'ex-trainees' is assured. A Souvenir in the form of trainees' journal containing various technical articles and group photos is released on this occasion. Finally, trainees attend a posting interview wherein they are required to choose the posting from available vacancies in various units across India in the order of merit list. i.e. a topper would get all the choices whereas a low rank would mean lesser choice. The prestige of the Homi Bhabha Prize and the fact that good performance will ensure choice of posting ensures healthy level of competition and focus on academic aspects of the training. Formal feed back on the lectures also ensure that the lecturers take care to be regular and well prepared for the lectures. A viva-voce by a group of lecturers tests the basic concepts of the trainees. Fairly high weightage is given to these oral exams. These also give a feed back as to the effectiveness of the lectures being taken and the comprehension of basic concepts by the trainees.

The technical management aspects of the training school include an Apex committee of senior officers for overseeing the functioning and individual discipline committees to periodically review and update the syllabus to fine tune it to evolving requirements and associated R&D needs. Faculty consists of in-house personnel with teaching being a combination of textbook theory and practical experience. Some evening lectures are organized with unit heads in the hostel auditorium that enables interaction on one is to one basis between the trainees and senior officers. Similarly periodic workshops on some advanced topics are arranged to widen the knowledge base.

On formal placement, career in DAE include aspects such as merit based promotions preceded by technical interview, housing in sprawling and well laid out complexes, health care and schooling facilities for families which ensure low rates of attrition.

This 'hire and train' approach has produced about 6000 graduates so far.

The NPCIL also has an in-plant training scheme at the training centers of the operating stations the graduates of which are posted for O&M duties of Nuclear Power Plants. About 1000 graduates have come out of this training scheme.

Recently, additional schools affiliated to BARC Training School have opened at the Center for Advanced Technology, Indore that concentrates on training in the areas of lasers and accelerators. Another school is at Nuclear Fuel Complex, Hyderabad, which concentrates on training manpower for manning Heavy Water Plants, Fuel Fabrication Plants and Fuel Reprocessing Plants and Waste Management Facilities.

From the year 2002, a DAE Graduate Fellowship Scheme (DGFS) has been started. Students who have been selected for admission to the Masters programme in Engineering at select institutes, can apply for this scheme in the beginning of the programme and if selected, have to take up electives and project work in an area of interest to DAE. After completion of the Masters Programme, they join BARC Training School for one semester to study Nuclear Engineering. This scheme has twin objectives viz. Human Resource Development and involving the faculty at the select institutes in the programmes of the DAE.

Research centers and autonomous institutions of the Department of Atomic Energy also run doctoral programmes and 100 students get Ph.D every year from the R&D centers and aided institutions.

Several other training schemes such as Diploma in Radiological Physics, Diploma in Radiation Medicine and Diploma in Medical Radioisotope Techniques are conducted but these are not followed by assured placement.

XVIII.4. Results

A large pool of engineers and scientists has emerged from the above training schemes and are occupying key positions in the various units of DAE.

Bibliography

Report of the 1st ANENT Coordination Committee meeting, 23–27 February 2004, Kuala Lumpur, Malaysia, organized by the IAEA in co-operation with and hosted by MINT, Malaysia. Link: www.iaea.org/KM

Further information:

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Appendix XIX

ASIAN NUCLEAR SAFETY NETWORK (ANSN)

XIX.1. Source

IAEA and China Atomic Energy Authority (CAEA).

CAEA is a government organization to provide administration and supervision on development of nuclear industry in China. CAEA coordinates the development and maintenance of the ANSN China hub.

XIX.2. Introduction

The ANSN is a regional network to facilitate pooling, analyzing, and sharing existing and new technical knowledge and practical experience to further improve the safety of nuclear installations in the South East Asia, Pacific and East countries. Focus of the ANSN is on knowledge related to strengthening regulatory infrastructure and the safety of research reactors and NPPs.

XIX.3. Method

The network is operated in a coordinated yet decentralized manner with hubs in China, Japan, Korea, Australia, France, Germany and USA are assisting the ANSN development and sharing safety knowledge.

National Centers are being established in Indonesia, Philippines, Malaysia, Thailand and Vietnam, to host knowledge and to serve as portals to ANSN. The national Centers can also be used as national networks for sharing safety knowledge among institutions and experts in each country.

Topical Groups composed of specialists from the participating countries have been created as forums for exchanging experiences and addressing current safety issues. Each topical group is led by a coordinator from one of the ANSN hubs. Currently, four active topical groups are as follows:

- Safety analysis (led by Republic of Korea)
- Education and training (led by Japan)
- Operational safety (led by China)
- IT supporting group (led by IAEA)

And several new topics are suggested for Topical Groups in 2006:

- Safety management of research reactors
- Application of Safety Standards for new design
- Emergency preparedness and response

The ANSN structure is as on the Fig. XIX.1.

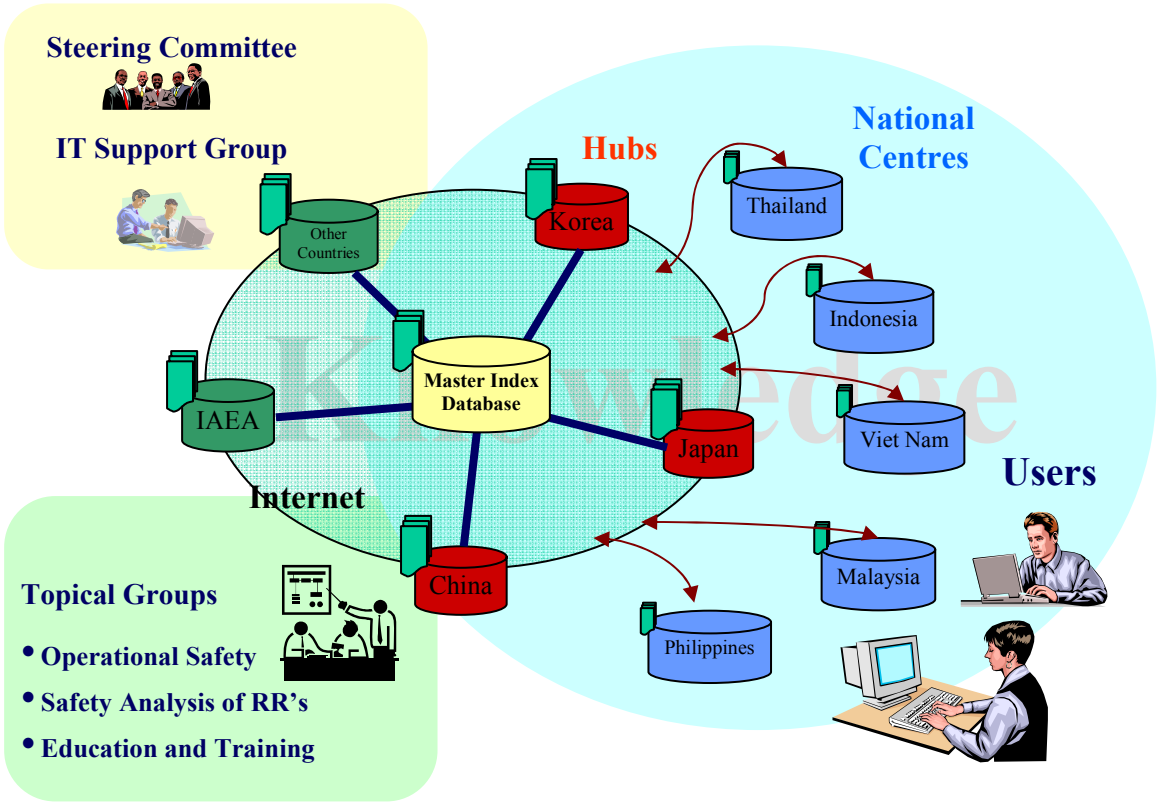

FIG. XIX.1. The ANSN structure.

Development of the ANSN is highlighted as follows:

— February 2002 — ANSN project initiated. Project scope, time frames and pilot phases initially discussed.

— December 2002 — First prototypes were developed. Project scope, classification schemes (Taxonomy) and metadata agreed upon. A pilot project to assess the usefulness of the project initiated.

— December 2003 — Pilot web sites and databases developed and evaluated. The pilot project included four websites and the database contained several hundred documents related to Education and Training.

— August 2004 — Web sites under development in several countries. The ANSN database contains more than 1000 documents. Topical groups for Safety Analysis, Education and Training and Operational Safety established.

— March 2005 — First issue of the biweekly ANSN newsletter published.

— June 2005 — ANSN web sites and databases operational in nine countries.

— December 2005 — New common design for the ANSN web sites being implemented. Several new countries have applied for membership. Three new Topical groups are under consideration: Safety Standards, Emergency Preparedness & Response and Safety Management of Research Reactors.

XIX.4. Results

All persons from participating countries can easily access to the ANSN hubs and national centers through single sign-on procedure.

Further information:

China ANSN National Center	http://www.cnsn.org
Indonesia ANSN National Center	http://ansn.bapeten.go.id
Japan ANSN National Center	http://www.ansn-jp.org
Korea ANSN National Center	http://ansn.kins.re.kr
Malaysia ANSN National Center	http://ansn.aelb.gov.my
Philippines ANSN National Center h	http://ansn.pnri.dost.gov.ph
Thailand ANSN National Center	http://ansn.oaep.go.th

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Chunning Jing, Director of Chief Engineer Office, Beijing Institute of Nuclear Engineering, Mashenmiaou 1, Haidian District, Beijing 100037, China, tel.: 86-10-88022314, Email: zgb@bine.com.cn

Supporting countries and organizations:

France ANSN National Center	http://www.cnsn.org/France
Germany ANSN National Center	http://gnsn.grs.de
USA ANSN National Center	http://ansn.anl.gov
ANSN IAEA Center	http://www-ansn.iaea.org

Appendix XX

NUCLEAR ENERGY KNOWLEDGE PORTAL

The purpose of the Nuclear Energy Knowledge Portal is to offer professionals in the nuclear field a direct and efficient access path to scientific and technical expert knowledge.

XX.1. Context

Knowledge ultimately resides with people, it comprises the information and skills that a *knowledgeable person* commands. In complex systems, knowledge may also exist in a distributed form: A group may be able to succeed in tasks, which exceed the knowledge of every one individual member of the group. In the latter case, there must be at least one person who has the additional organizational knowledge of where key subject knowledge resides within the group.

Individual experts may gain knowledge in three ways:

- by studying (reading and understanding documented information);
- by example and explanation from an expert (on-the-job training, tutoring);
- by research (observation, discovery, reasoning).

Research is the only way of creating original knowledge which is either truly novel or has existed before, but was lost without sufficient record. It is also the slowest, most expensive and in some cases (failed experiments) the most dangerous way. However, given time and resources, research work will always enable mankind to regain lost knowledge, how ever expensive that may be.

While the IAEA has been actively coordinating and fostering nuclear research and development for many years, there are other aspects of nuclear knowledge management, which are now gaining in importance, too. In particular the stimulation of interest in the nuclear field in the younger generation and activities associated with succession planning are increasingly recognized as important aspects of knowledge management.

Experts who are presently leaving the nuclear field due to retirement or because of professional re-orientation have in many cases gained their knowledge by direct research (scientists) or have been instructed by the original researchers (engineers). Ideally, they should now pass their knowledge on to the next generation of nuclear workers. However, because of the generally reduced interest in the nuclear field, the nuclear workforce is shrinking in a number of countries and it becomes therefore more and more difficult to extend or even to maintain humankind's present knowledge in the nuclear field.

The main function of the proposed nuclear knowledge portal is therefore to support and enhance the existing infrastructure for knowledge transmission. The portal will facilitate access to archived materials (on-line and off-line) and foster professional contacts in academic and industrial contexts by identifying centers of excellence (universities, institutes, industries) where nuclear knowledge presently resides.

XX.2. Types of contents

The contents of the portal can be classified into two major groups, *archived materials* and *locators of active knowledge*.

XX.2.1. Archived information and data

This category of materials includes all information and data, which have either been instrumental in the initial creation of knowledge or are compilations, which have been created by experts. Examples include:

- documentation of measurements, experimental data;
- evaluated data — based on both measurement and theory;
- textual descriptions, textbooks, scientific and technical papers;
- related speculations, judgemental and historical views;
- related observations, operational experience.

For electronic information, direct access can be given in some cases (on-line databases, electronic versions of publications, etc.). All other information, residing in various types of archives, cannot be accessed directly, but metadata can be provided in order to facilitate the finding of such information. Suitable metadata include bibliographic materials, descriptions of databases and directories to related materials on the Internet.

XX.2.2. Locators of active knowledge

Knowledge resides with people. In order to access knowledge directly, it is therefore necessary to find people who carry that knowledge. The locator of active knowledge could therefore contain a maintained list of experts. Such a list could draw from a number of sources, such as the author information in bibliographic records or the participants' lists for specialized meetings. Experts could also be nominated by academic, professional and industrial organizations.

Another — indirect but important — means of locating active knowledge is by contacting associated institutions such as universities, laboratories and relevant industries.

XX.3. The main components of the IAEA nuclear knowledge portal

The main portal components are:

- factual data — most often associated with computerized data bases;
- descriptive materials — designed for direct human consumption;
- contact information — can point either to institutions or to persons.

XX.4. Components of the NE Nuclear Knowledge Portal already available through the Internet (www.iaea.org/km)

XX.4.1. Find an expert facility

The International Nuclear Information System (INIS) operates the largest and most comprehensive bibliographic database in the nuclear field. By searching recent entries to the INIS database of scientific publications for authors in the nuclear field, experts can be identified who are presently active in a given subject domain. The query will return the names and affiliations of experts together with the titles of recent publications.

XX.4.2. IAEA Nuclear Knowledge Desk

This facility is intended for students and professionals in nuclear and nuclear related fields. If the searching of public resources does not provide satisfying answers, the users of the service who submit queries concerning nuclear R&D and applications will be put into contact with an

expert on the relevant subject or will receive a reply from the Nuclear Knowledge Desk, as appropriate.

XX.4.3. Nuclear Reactors Knowledge Base

Provides comprehensive information on specific reactor types. In the nuclear reactors knowledge base, technical information and information related IAEA activities and activities in Member States are arranged by reactor type or by working area. Presently this resource concentrates on gas-cooled reactors, fast reactors and accelerator driven systems for actinide and long-lived fission product transmutation. The Reactors Knowledge Base focuses primarily on the informational needs of professionals in the field of nuclear reactor R&D.

XX.4.4. IAEA databases

The IAEA maintains well over 100 databases related to its activities in the nuclear field, most of them are available to the public.

XX.4.5. IAEA web resources

Provides a tool to find information related to the required subject area. The IAEA maintains a public web site with more than 50 000 individual web pages. This page facilitates access subject oriented to the main working areas of the IAEA.

XX.4.6. Internet directory of nuclear resources

The IAEA maintains a growing database of annotated links to Web sites on the Internet that are related to various fields of nuclear science and technology and the IAEA' work.

XX.4.7. Science analysis

In 1998, INIS started to utilize the contents of it's database for analysing trends in nuclear related areas. Such bibliometric studies exploit the fine granularity of the database records and are based on the high quality of indexing performed by INIS and it's participating members. The bibliometric studies present a statistical analysis of thousands of database records concerning publications in a particular field covered by INIS' subject scope. The main objectives are to provide statistics and scientific indicators for INIS' users, namely science managers, researchers, engineers, operators, scientific editors and publishers, decision-makers in a particular field.

XX.4.8. IAEA publications

Extensive information on IAEA publications issued since 1960. Data on new publications, as well as their full text PDF version, appear on the web site on the day they are released.

XX.4.9. World's nuclear literature

The INIS produces the world's leading bibliography and full-text collection on the peaceful uses of nuclear science and technology (requires subscription).

XX.4.10. Meetings on atomic energy

Contains an edited worldwide listing of current and planned conferences, symposia, seminars, exhibitions and training courses related to nuclear energy and its peaceful uses.

Appendix XXI

WORKFORCE PLANNING APPLICATIONS AT THE PAKS NPP LTD

XXI.1. Source

Paks Nuclear Power Plant Ltd., Hungary. Paks NPP Ltd. is a state owned Public Stakeholders' Corporation with one nuclear site with four reactors in operation.

XXI.2. Introduction

WHAT

The process describes the long term workforce planning policy at the Paks NPP Ltd. The objective of the human resource policy at the Paks NPP Ltd. is to make available personnel in optimal quantity, either employed or contracted, that are properly selected, trained and equipped with all knowledge, skills and attitudes required for the long term safe, competitive and reliable operation of the plant.

Accordingly the primary goal achievable by the plant is job positions (requiring managerial, professional or special expertise) be filled in by staff members performing at the highest possible level of professionalism and the most efficient manner.

WHO

All Paks nuclear power plant organizations.

WHY

On 21 November 2005 the Parliament of Hungary ratified the service-time extension of the Paks units. The deadline for submitting the programme of service-time extension of Unit 1 is 15 December 2008. For the continuous provision of prepared staff it is required that job-positions with fundamental significance to the functioning of the Corporation today and during the extended service time become selected.

XXI.3. Method

XXI.3.1. Expectable changes in the legislation

The European Union turns more and more attention to harmonizing the employment policies of the member states. According to the employment political guidelines of the EU, aimed at decreasing the burden on member states and achieving economic competitiveness, an increasing part of the employees in the active ages become retained in the labor market. For this end, the retirement is planned to be prolonged up to 65 years of age. In Hungary, most expectedly, the existing retirement control shall remain intact up till 31 December 2012, which most presumably shall be replaced with the EU standard.

For providence and advance planning the operative social security and retirement law comprises all those regulations based on which — in case of pensions to be determined after 31 December 2008 — the control of retirement claims shall happen to take place. Due to the more stringent regulation to come, we expect to get a boosted retirement in 2008.

XXI.3.2. Determination of the composition of the required professionals

The HR organization administers a short, a medium and a long term workforce planning. Annually analyzed are the short term (two years) and once every three years the medium term (4–5 years) retirement claims. The analyses that support the long term plans are induced by the alterations of the legislation, the periodic national surveys or by some more significant organizational/functional changes.

In the second half of each year is the circle of staff members surveyed who are eligible and intend to submit retirement claims in the next two-year period. The staff statements taken at the time of the survey are not obligatory, prior to the submission of the claims each staff member can change minds and decide to maintain the active employment. The precise statements of terminating the employment is done at the end of the given year so that planning for the coming year can be performed.

In case of retiring staff members, each is individually determined in which position the successor/replacement shall enter the job. For the apprehension of nuclear power KSAs and the necessary practice the replacement typically enters not in the job-position of the retired person but the entry post of the job-hierarchy. The lack of manpower in the job position is terminated with an internal migration programme.

The initiatives for the examination of the composition of the required professionals are the changes in the personal structure of the past years, the retirements and the replacements as well as the short and medium term succession plans developed on these bases. With the acceptance of the service time extension it has become inevitable that we revise the existing structure of job-positions. The determination of the labor stock with appropriate number of employees in proper composition shall rely greatly on the results upon termination of the corporate process-revision currently underway.

XXI.3.3. Changes in the workforce

According the latest survey concentrating on the long term staff size alterations, in the next 15 years, 55% of the existing staff shall become eligible for retirement (unless the legislation shall remain as known). To provide sufficient players of succession, the job-positions that require extraordinary preparation time and special NPP practice have been identified for each professional area.

15% of the staff members eligible for retirement bear high academic education. To make sure of enough young starting out on a career as replacement with appropriate qualifications, the Paks NPP Ltd. conducts negotiations with many national universities about long term co-operations. In frame of such agreements, the institutes launch faculties, which shall produce graduates that the nuclear power plant is in need of, and shall place emphasis on the training of job-incumbents in positions with manpower shortages, easy to plan on the medium term.

In relation with the cooperation, the opportunity is there to more and more apply higher quality replacements. For the sake of increasing manpower qualification, it is typical that in replacement of a retired staff member with lower academic education, a new employee with high academic (typically engineer) qualification is hired.

Further information:

http://www.atomeromu.hu/

Katalin Buza, HR Department Head, Email: buzak@npp.hu

Appendix XXII

TVA WORKFORCE PLANNING MODEL

XXII.1. Source

Tennessee Valley Authority (TVA). The TVA is a government owned Federal agency consisting of multiple sites with three NPP sites, and five reactors in operation, one (Browns Ferry Unit 1) being returned to service.

XXII.2. Introduction

The TVA Workforce Planning process, represented by the attached model (see Fig. XXII.1) was developed to provide an integrated approach to address aging workforce issues. At the time the process was developed in 1998 the average age was 47 years. Thirty to forty percent of TVA's employees would be eligible to retire within 5 years.

XXII.3. Method

The process linked related process such as succession planning, training, recruiting and knowledge retention to ensure that qualified human resources were available when needed.

XXII.4. Results

The Workforce Planning process proved to be an effective tool in identifying future staffing needs and integrating with existing process to address these needs. In October 2005, approximately 6 per cent of the TVA workforce were pipeline trainees (Operations, Maintenance, etc.).

Further information:

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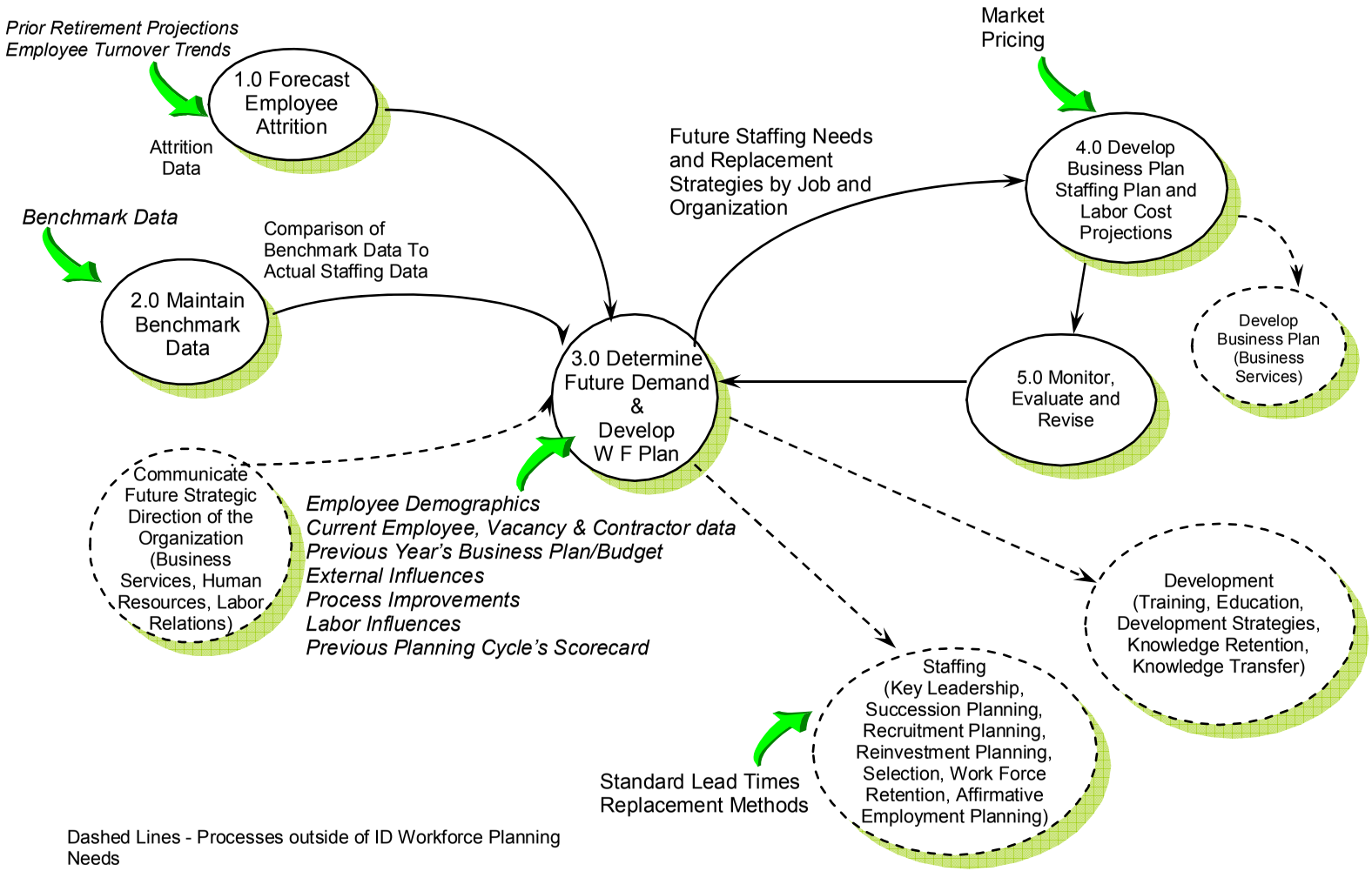

FIG. XXII.1. Workforce planning program flow diagram.

Appendix XXIII

KNOWLEDGE MANAGEMENT/HUMAN PERFORMANCE PLAN

XXIII.1. Source

Texas Utilities. Texas Utilities Corporation operates the Comanche Peak Nuclear Power Station, a two-unit site.

XXIII.2. Introduction

Managers at Comanche Peak are provided a planning tool (a simple form) with which they can identify critical actions and transfer the knowledge necessary to perform those steps to the people who will be responsible for performing the action. The instructions for filling out the form provide the main parameters of what the manager needs to address.

XXIII.3. Method

XXIII.3.1. Form

KM/HP Plan for _____

Critical Tasks and human performance tools:

Communication Plan:

Training Plan:

Opportunities to Embed KM/HP tools into procedures or processes:

Reinforcement Plan:

Assessment Outage Human Performance Plan Need:

Assessment of Non-station Personnel or Supplemental Personnel Human Performance Plan Need:

Action Plans (SmartForm number(s) _____):

Approved by _____ Date _____

XXIII.3.2. Instructions how to complete your KM/HP plan

(1) **Critical tasks and human performance tools**: The purpose of this section is to discuss how critical tasks will be proactively managed to minimize the chances of human error and/or mitigate the consequences of such an error. A critical task is defined as a task for which an error could result in either immediate undesirable consequences or in which an error would result in undesirable, delayed consequences and for which the error would be difficult to spot once committed, before the consequences are realized. All critical tasks should have corresponding error management defenses/tools. The frequency of the task and common sense typically suggest the strategy for preparing the people involved in the task to use the defenses. For critical tasks that occur frequently in an organization, the corresponding error management tools would typically have training, communication and reinforcement plans. Better yet, the processes would be changed to specifically incorporate error management at the critical steps. For infrequent or one-time critical steps/tasks, the error management tools would be prepared and trained as part of the setup for the task.

- *Description of the critical tasks:* The purpose of this section is to discuss how errors and their consequences are proactively managed. The methods for managing this, typically through human performance tools, should be matched to the types of tasks. As such the section should discuss the types of tasks either generally or specifically **only** to the extent necessary to support why specific human performance tools have been chosen. As such this part of the section should be brief.

- *Description of the human performance tools:* The primary purpose of this section is to discuss how errors and their consequences are managed. For most organizations, this means a choice of human performance tools to be focused on. Typically, between three and six tools are chosen so as to have a manageable set on which to focus. The number, however, is not the point. The important point is the correlation between critical tasks and the tools chosen to manage them. For large organizations with a variety to activities, different work groups in the organization may choose to different tools for different functional groups. For example, the tools chosen for system engineers may be very different from those chosen for modification engineers. Similarly, the tools chosen for Operations Work Control may be different from those chosen for PEOs.

  - Level of detail: Tools for which there is already a base of information if procedures and training need only be briefly listed. (For example, self-checking, peer checking, three-way communication, procedure use and adherence, question attitude, pre/post-job briefs, or the PII Engineering human performance tools such as OAQ-3 pass). For less known tools or strategies, enough detail should be given to provide a clear understanding of what the tool is and how it addresses the critical task.

  - Choice of tools: For most departments, tools have already been selected and training provided. This is not meant to undo those choices but rather to build on it. This section may be as simple.

(2) **Non-critical tasks**: In theory, non-critical tasks are ones in which errors are readily detectable and correctable or for which an error if undetected will not cause significant impact. For these tasks, the decision of how much effort to prevent errors has four elements:

- first is simple cost/benefit question;
- the second is whether every time is necessary because it's too hard to be certain of the outcome (complicated system interactions);
- the third is political ('right now we just can not afford another stain on the image');
- and the final is the question of whether or not doing a particular error tool always makes us better or worse at doing it properly when it is really needed.

The decision to what extent non-critical tasks will be defended is an economic/business decision.

Human performance tools are neither 'silver bullets' nor universally applicable to preventing errors. Tools must be matched to the task being performed. The intent is to choose and master a small number of tools matched to the tasks being performed. These tools should be heavily emphasized and reinforced such that their use becomes routine. These will necessarily vary between departments or even within departments as the tasks vary. The detailed focus on these tools should be matched with a general understanding and use of six 'universal' tools: self-checking, peer checking, three-way communication, procedure use and adherence, question attitude, pre/post-job briefs. These six tools are generally useful in all jobs and should be understood and used by all personnel when needed.

(3) **Communication plan**: This section discusses plans for communicating to departmental personnel how errors are expected to be managed and the specific expectations for front line workers, support personnel, and managers and supervisors for implementing those plans.

(4) **Training plan**: This section discusses plans for training personnel on specific tools. Training was provided in September 2003 on departmental choices for human performance tools. This section is not meant to duplicate that training. If training on the 'how to use' of the selected tools has already been accomplished, say so. Where gaps exist, or new needs have been identified, describe these needs.

(5) **Opportunities to embed KM/HP tools into procedures or processes:** Past performance shows that error management tools are typically more effective if they are embedded in the process as part of the task, rather than used as an external add-on applied during the task. The 'embedding' may be as simple as proceduralizing the use of the tool at specific steps known to be critical to the task outcome, or may involve hardware changes to eliminate error-likely situations (e.g. lighting or labeling changes, bar code scanning, etc.). It is not expected that all possible opportunities to embed error management be identified at once. However, this plan should be a living plan and should be continually seeking to identify and optimize performance of critical tasks. Therefore, this section should seek to identify opportunities, initially for the most critical challenges, and build on these in the future.

The **SPE** or the SPEAK process can be used to identify targets of opportunity. Are there **S**afety critical steps, where either **P**rior performance or an **E**rror-likely situations (driven be known error precursors) suggest errors are both likely and critical? For an example on using this technique see[1].

For example, if reviews were considered a critical task of the modification process and the OAQ-3 Pass tool were selected as the tool for managing errors here, then this

[1]NOD EVAL 2003-033, Event Prevention Framework review of turbine controls digital modification test plan.

section might target changes to the review process such that the OAQ-3 Pass was built into the review itself. By completing the review section of the modification, the OAQ-3 Pass was automatically performed and its results captured. Similarly, for work orders being planned, the critical tasks could be identified in the planning and the selection of error management tools built into the work order itself.

Examples of embedding human performance tools include when Engineering's problem solving technique was added as a template for SmartForm resolutions and revising maintenance procedures to specifically build error reduction tools into the procedure.

(6) **Reinforcement plan**: This is the most important aspect of the plan. All of the elements above are 'antecedents' to the desired behavior (managing errors). These antecedents are necessary for successful implementation but are not in and of themselves enough to guarantee success. In order to maximize the successful adoption of the desired behavior, typically three factors have to be managed: the perceived burden imposed by the desired behavior, the perceived risk of not performing the desired behavior, and the reinforcement received each time the behavior is either performed or not performed. A successful reinforcement plan will minimize the burden of the requirement, maximize the reinforcement of the behavior, and ensure that the risks of non-performance are both realistic and clearly understood.

This section should assess the perceived burden imposed by the expectation, the understanding on the part of the effected personnel of the risks of not meeting the expectation (both the risks to the plant and to the individual), and the actual consequences and reinforcements received when either using the human performance tools or choosing not to. The BEAR ABC analysis is a simple technique for assessing these factors. Where the perceived burden is a barrier to repeated performance, action plans to reduce the burden. Similarly, where the risks of non-performance are not understood, either training on the real risks, or management actions to change the consequences may be necessary.

Typically, the most important part of the reinforcement plan is the actual reinforcement received each time the behavior takes place (hence the name). Reinforcement is critical for establishing long term changes in behavior. Reinforcement typically can take place before or after the behavior.

Planning, pre-job briefs, human performance meetings, training, etc. are all reinforcement before the behavior. Observations, coaching, post-job briefs, post work reviews, EQRT, etc. are all reinforcements after the behavior. The most effective reinforcements are those that are soon, certain and positive. This is typically received either by having the process or procedure immediately detect and confirm successful use of the error management tool, or having an observer/coach provide immediate feedback (for example, LEADING or BEAR).As a minimum, this section should include a plan for frequent observation and feedback until the desired behaviors are sufficiently ingrained and long term observation sufficient to identify and correct behavioral drift.

(7) **Assessment of outage human performance plan need:** For organizations whose work activities change significantly during outages, outage specific human performance plans should be established. These plans have a similar structure to departmental human performance plan but focuses on error management for the new functions. As a minimum, this section should state whether or not outage specific plans are needed.

(8) **Assessment of non-station personnel or supplemental personnel human performance plan need:** For organizations in which work is performed by non-station

personnel or for which personnel may routinely be supplemented (for example, during outages or for NOD for supplemental personnel for audits), specific plans should be developed for steps necessary to ensure that such personnel meet departmental human performance expectations or to ensure compensating defenses have been established. As a minimum, this section should state whether or not such plans are needed.

(9) **Action plans:** Action items arising from the plan should be put on SmartForms and tracked. The plan should be a living document, updated at least annually. It should neither be considered complete nor carved in stone. Changes should be made as new opportunities or insights arise or as routine analysis of human performance data (center of excellence analysis) indicates needs for changes.

Departmental managers may choose to divide their plan into multiple plans for different business functions. This decision is based on the nature of the differences between functions, the differences in focused tool sets between functions, the size of the group, etc.

The plan is owned and approved by the SmartForm owner, typically the department manager. However, the initial plan and the subsequent annual updates of the plan should be sent to the Human Performance Steering Committee for review and comment. The Steering Committee members should review the plans for consistency between similar functions and with the station expectations and provide comments and suggestions. The Steering Committee chairman or his/her designee should coordinate the review. This review is intended as a consultation rather than an approval. Typically, this review should be collaborative between the Steering Committee, the departmental human performance center of excellence and the department manager to allow plan implementation to proceed while still allowing for adjustments should they become necessary.

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Appendix XXIV

HUMAN RESOURCE PLANNING AND TRAINING FOR NUCLEAR POWER PROJECTS IN CPI

XXIV.1. Source

China Power Investment Corporation (CPI). CPI is one of the five largest state-owned power generation groups in China with controllable installed capacity of 28 000 MW(e) and 70 000 staff. CPI owns shares of five operating NPPs and four new planed NPP projects. CPI is also working on preparations for new in-land NPP projects. At present, CPI is investing in, with major shares, and developing Shangdong Haiyang NPP and Liaoning Hongyanhe NPP projects.

XXIV.2. Introduction

XXIV.2.1. Demands

Based on CPI's nuclear power development plan, CPI is selecting and training nuclear professionals on nuclear engineering, construction, operation and management.

XXIV.2.2. Planning

Based on demands on nuclear professionals and very limited human resources available in China, a plenty of professionals from conventional power industry, the strategy of human resource planning for CPI's nuclear projects is defined as 'Introduction from outside, while mainly reliance on training by CPI'. That is, on one hand, to directly introduce experienced nuclear professionals, and on the other hand, to train and strengthen the prominent staff with rich construction and operation experience in conventional plants, in nuclear construction, operation and management.

XXIV.3. Method

The practice of nuclear professional training is as follows:

XXIV.3.1. Trainees

Trainees are categorized into:

- Managers who are already experienced in conventional plant management and engineering practices;
- Engineers who are less than 30 years old and already experienced in conventional plant construction and operations;
- New graduates from nuclear engineering and other specialties.

Their training programmes and courses are respectively developed based upon their categories.

XXIV.3.2. Selection approach

Trainees are selected based on their competency and previous performance by the following steps:

- Application, recommendation by previous employer and open recruitment;
- Written exams, and
- Interviews.

XXIV.3.3. Training resources

The training resources inside and outside CPI are integrated to enhance training quality and cost-effectiveness:

- *CPI resources*: the training facilities and training management from CPI advanced training center,
- *Resources from university*: basic training courses on nuclear construction and operation from Shanghai Jiaotong University;
- *Resources from the nuclear industry*: nuclear expertise lectures by famous experts from the regulatory body, institutes and senior engineers with rich experiences in nuclear construction and operation;
- *Site visits*: visiting NPPs in operation or under construction and NPP equipment manufactures.

XXIV.3.4. Training plan

Training courses, with different scope, difficulty and style, are developed based on the category of trainees and their requirements.

Trainees should complete all-round and systematic training courses in nuclear science and engineering basics, nuclear engineering practices including nuclear safety regulations, safety culture, and teamwork spirit cultivation.

XXIV.3.5. Training management

IAEA SAT approach is adopted in training management, including demands analysis, planning, training material development, conduct of training, evaluation and feedback. Experienced nuclear training experts act as training supervisor to monitor training performance, evaluate training effectiveness, and feed back for continuous improvement.

XXIV.3.6. Training methods

Various training methods are used, such as in-class lectures, workshops and seminars, site visits, thesis writing, etc.

XXIV.3.7. On-Job Training (OJT)

OJT is conducted with emphasis on complying with regulations, standards, procedure adherence and skills.

XXIV.3.8. Qualification

Personnel qualification and authorization system with quality assurance and audit is being developed within CPI.

XXIV.3.9. Training feedback

Prompt training feedback from trainees, instructors, supervisors and employers is always encouraged. As the administrator for training experience feedback, headquarter of CPI is responsible for overall coordination of training activities and continuous improvement.

Further information:

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Appendix XXV

NATIONAL INITIATIVE ON NUCLEAR EDUCATION IN CHINA

XXV.1. Source

China Atomic Energy Authority (CAEA).

CAEA is a government organization to provide administration and supervision on development of nuclear industry in China.

XXV.2. Introduction

The central government has decided to actively develop nuclear power in China with the goal of 40 000 MW(e) of capacity in operation and 18 000 MW(e) under construction by 2020. CAEA has been working with the industry and universities to develop nuclear education plan for the period of 2006–2010 and beyond till 2020 to address the challenges in nuclear education.

XXV.3. Method

XXV.3.1. Challenges

Nuclear related majors with less attention paid, and hence investment reduced from government.
Expertise loss exaggerated by retirement and brain drains in universities.
Facilities aging without enough resource for refurbishment.
Many textbooks are in the status of out-of-date, or even yet to be developed.

XXV.3.2. Count-measures

— Enhance the national coordinating mechanism to cope with issues raised in nuclear education, such as nuclear related majors' composition, education investment, education capability buildup, and demand of graduates etc. Representatives from related government organizations, the industry and universities are involved.

— Upgrade nuclear related majors in the national major categories that are composed of nuclear reactor engineering, nuclear chemistry and fuel engineering, RP and nuclear environment engineering, nuclear technology applications, and nuclear resources engineering.

— Raise funds for nuclear education capabilities build-up:

- Fund for faculty training abroad and fellowship
- Fund for R&D in nuclear basics
- National scholarship for nuclear education
- Fund for post-graduate education in research institutes

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Appendix XXVI

HUMAN RESOURCE PLANNING IN CGNPC

XXVI.1. Source

China Guangdong Nuclear Power Holding Company (CGNPC).
CGNPC owns four operating units with a total capacity of 3948 MW(e) at Daya Bay site. CGNPC has a vision of building at least one 1000 MW unit per year (on average) from now on for meeting Guangdong's electricity demand and fuel diversity programme.

XXVI.2. Introduction

According to the forecast of manpower demands in the next 15 years, the quantity of employees in the nuclear field in CGNPC will attain on 8000 to 16 000 while 3000 today, which causes a big challenge in terms of manpower development in CGNPC. Hence, a tangible human resource plan should be in place to address the problem.

XXVI.3. Method

XXVI.3.1. Key issues

— *Shortage of nuclear engineering graduates.* In the past 3 years, there were 372 B.S. level graduates of nuclear engineering each year and 145 M.S. each year, of which only 30% are employed in nuclear industry. Fewer students are pursuing traditional engineering degrees, let alone the nuclear engineering. Therefore, a significant gap between the number of B.S. graduates available and will demands exists and become even worse in the near future.

— *Shortage of potential staff with experience in nuclear engineering*. Many of the people who pioneered development of commercial nuclear power plants have retired or are close to retirement.

— *Shortage of trainer in nuclear power plants*. Shortage of trainers in nuclear power plants is the key obstacle for conducting on-the-job training of staff.

XXVI.3.2. Strategies for enhancing HR management

Two critical questions to be addressed in the development of our human resource strategy:

— What kinds of people do we need to manage and run our business to meet our strategic business objectives?

— What programmes and initiatives must be designed and implemented to attract, develop and retain staff to compete effectively?

Therefore, we have addressed four key dimensions for the human resource strategy development: **Culture, organization, people, and human resource system.**

(1) Culture

In order to unite the group culture, CGNPC has taken follow means:

— Implementing a 'policy manual' in group level to identify the management principle and basic process for business in field of Cooperation Governance, strategy management, human resource management, finance, safety quality and environment, science and technology, commercial, information, public and culture, administration.

— Key position assignment. Main mangers and key staff will be selected from group internal and send to the new projects in order to transfer the beliefs, values, norms and management style of group. Exchange of management people for different projects in group will be more and more in the further.

— Resource sharing. Management procedural, materials, staff, experience, etc, are shared by different projects in group as an important and effective way to support unite culture.

— Unite requirements and organization approach of training for new employees. Teams are consisted of HR and technical experts from different organization in group and follow same procedures in recruitment and selection of new employees. Same requirement of culture instruction for new staffs.

(2) Staffing plans/workforce plans

CGNPC has begun to implement ‘Manpower plan’ in 2003, and revised according the ‘Business development plan’ in 2004. It provides a standardized and consistent methodology for overall human resources planning driven by strategic and business goals. These plans identify planned retirements and vacant positions as well as the required staffing levels needed to support business strategies.

They are long term plans typically looking forward 10 years. Planning expected retirements 10 years or more in advance and making sure that the successors are recruited early enough to allow an overlapping of employment sufficient to transfer needed knowledge.

Manpower demands of production and construction of nuclear projects of CGNPC are shown in Figs. XXVI.1 and XXVI.2.

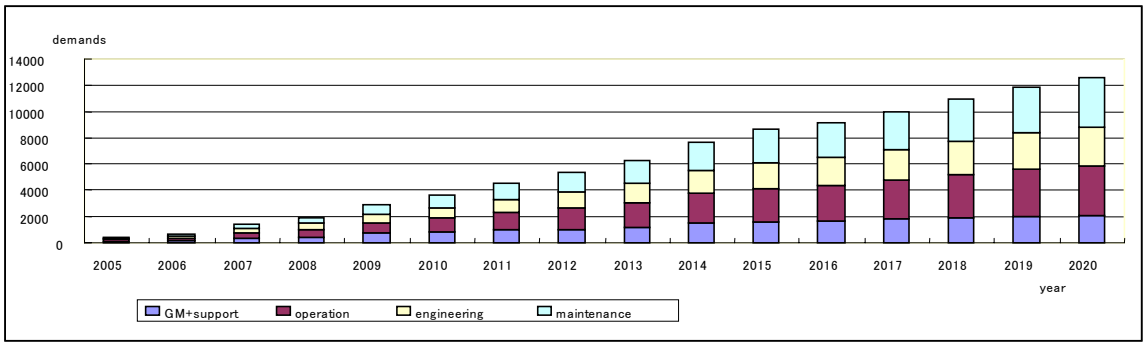

FIG. XXVI.1. Production manpower demands for new projects.

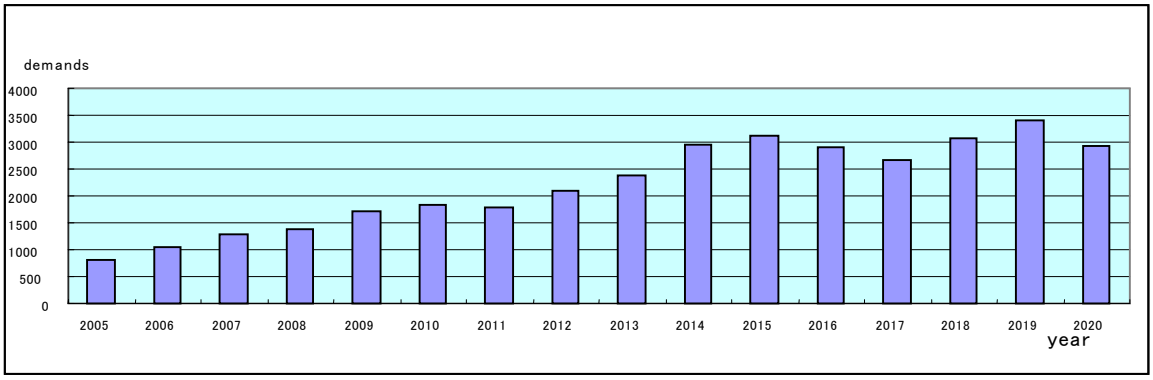

FIG. XXVI.2. Total demands for new projects construction management.

Structure of technical background of manpower demands:

- Electricity: 15–20%;
- Nuclear engineering: 15–20%;
- Thermal energy and power engineering: 15%;
- Mechanical engineering:10%;
- Civil engineering: 3–6%;
- Control system of thermal engineering: 5%;
- Electronic technology: 5%;
- Instrumentation and control technology: 3–5%;
- Nuclear medical: 0.3%;
- Material: 2%;
- Finance: 5~7%;
- Legal: 0.5%;
- Chemical technology: 1%.

Structure of education level of manpower demands:

- Operation staff: M.S. 5%, B.S. 55%, technical school 40%.
- Maintenance staff: M.S. 5%, B.S. 45%, technical school 50%.
- Engineering staff: M.S. 20%, B.S. 80%.

(3) HR System

CGNPC devotes itself to implement the people focused HR mechanism consisted of follow key elements:

- Talent revealing based staff selection
- Competence based training
- Job post based qualification
- Outstanding achievement based performance evaluation
- Ability based HR use
- Contribution based reward and restraint

XXVI.3.3. Practices

(1) Nuclear Power College (NPC)

CGNPC has decided to construct a college, the name is still in discussion, and it may be called ‘Nuclear Power Collage’ (NPC), to provide training to the potential staff in cooperation with universities. Undergraduates in nuclear engineering and thermal energy and power engineering in second semester of JUNIOR YEAR will be selected as pre-employed staff and sent to NPC in SENIOR YEAR to join the Combined Education-training programme. According to this programme, the following courses will be introduced:

- *Introduction to nuclear engineering;*
- *Fundamentals of nuclear engineering;*
- *Reactor operations (I);*
- *Nuclear power plant systems;*
- *Nuclear radiation measurements and protection*;
- *Reactor fluid mechanics;*

— *Reactor heat transfer;*
— *Reactor physics;*
— *Industry safety;*
— *Nuclear safety culture;*
— *Work process in nuclear power plant;*
— *Quality control and assurance;*
— *Fire protection, emergency;*
— *Environment protection, etc.*

During this period of JUNIOR YEAR, normally 11–13 months, students also study more thoroughly the conception, operation and safety of a pressurized water reactor.

The targets of the 'combined education-training programme' in NPC should include following:

— To combine the theoretical course and practical training by organize workshops visit and practice in nuclear power plants using summer vacation;
— To strengthen the competence of selected undergraduates by providing Pre–job-training and specifically tailored course;
— Make the distance between company and undergraduates more close;
— To optimize the pre-job-training in nuclear power plant and to train the graduates of NPC meet the requirements of potential engineers in nuclear engineering.

(2) Scholarships and funding

CGNPC provides scholarships and other funding for the students and teachers interested in the nuclear industry and grants for practical training in the nuclear industry.

Maintain visibility on university campuses, including participation in career fairs, and information sessions, as well as selection of nuclear specialists to deliver lectures in universities. CGNPC participates each year in educational trade job fairs and encourage young people into programmes that will prepare them to join their workforce.

CGNPC has well-established relationships with educational institutions of all levels — technical school, college, and university. The inter relations are regulated by long term bilateral contracts and are realized in many areas.

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Appendix XXVII

SUCCESSION PLANNING APPLICATIONS AT THE PAKS NPP LTD

XXVII.1. Source

Paks Nuclear Power Plant Ltd, Hungary. Paks NPP Ltd is a state owned Public Stakeholders' Corporation with one nuclear site with four reactors in operation.

XXVII.2. Introduction

WHAT

The process describes the complex career and succession planning policy at the Paks NPP Ltd. Making the competent labor force available is the responsibility of the corporate integrated HR system. A key item of this is operating the complex career and succession planning system, which covers the following prominent employee categories:

- managerial posts;
- non-managerial posts requiring higher academic education;
- posts, that require medium level academic education and extensive professional experiences;
- Posts of the operative scheme.

WHO

All Paks nuclear power plant organizations.

WHY

Planning and managing succession in different job-types in its full complexity is vital for the continuity of leadership and professional staff by identifying and developing potential candidates through expedient, targeted development programmes pursued to support the long term operational safety and business success of the plant.

XXVII.3. Method

Managing the recruitment planning in a complex manner is a highlighted task as the number of retiring employees bearing superior professional expertise and experiences is reported to significantly increase in the following years, placing extreme emphasis on the importance of the transfer of available corporate knowledge and experiences.

Typical to the corporate staff management is that the persons hired for basic job-positions are employed first by the workforce lending venture of the corporation (ATOMIX Ltd.) then following a period of initial training and preparation, the properly trained employees qualified for individual job performance are taken to become corporate plant staff. To ensure supply in positions that require a longer duration of preparation or specific NPP/professional skills we have created the so called 'apprentice posts'. These posts can only be filled in if a job-incumbent reports intention of retirement. In this case, the selected successor is shadowing the job-incumbent as an apprentice and shall be assigned when the predecessor retires. After the preparation period the apprentice post is terminated. For the sake of the preparation and the transfer of the professional experiences of the leaving staff members we continuously negotiate with the respective line organizations.

XXVII.3.1. Management pool of talents

The management pool of talents is the primary resource for the continuous and high standard recruitment supply for management posts. The decision for its establishment and operation was made back in 2001, and conditions for the on-going applications have been provided since the second half of the past year. Consequently the number of admitted applicants has risen from 77 to 125.

Our aim with the on-going functioning is to run a systematic search for and development afterwards of talented staff members with managerial or professional ambitions who are apt and able to accomplish management knowledge and could fill in such higher posts in a few years' period. Besides, we wish to provide the staff members with a continuous opportunity for realizing their career ideas and promotional possibilities within the Corporation. It is our intention too that we turn managers' attention to those talented colleagues of theirs who have already proved their preparedness and professional competence with their past activities.

The Corporation obviously cannot grant assignment to management positions for all admitted members of the Pool of Talents, but they are provided with such state-of-the art background information on leadership and an overall development of their capabilities that allow their inclusion into the circle of potential applicants. Considering this are the personal development plans defined using the Evaluating, Developing Center method and are the training programme contents compiled which basically builds upon the long term corporate management development programme currently being elaborated.

This is a management development system that is systematically adapted to the corporate systems and expectations and handles the creation and maintenance of management knowledge, skills and attitudes in a complex manner, providing both theoretical and practical preparation.

Results

To date, the 16 out of the admitted members of the Pool have been assigned to managerial posts (section head, department head) and 15 have been promoted to positions that represent higher professional challenges (team leader, expert, leading expert).

XXVII.3.2. Professional career development programme

The second key area of recruitment planning is the provision of high standard and on-going supply for posts that require higher academic education but represent no managerial functions and of those positions where medium level academic education as well as superior professional experiences are required. This objective is supported through the professional career development programme. Within its framework the acquisition, the extension, the development and the in depth upgrading of the professional knowledge are being accomplished. This may equally serve as a basis for promotion opportunities within the professional hierarchy. To this end, we provide the entries of this programme all conditions for the acquisition of continuously renewing and expanding information, for the accomplishment of specific abilities that are practical, up-to-date and market oriented. The circle of staff members to be admitted to this programme is defined according to the recruitment needs of the individual line organizations. The line organizations — considering the expected retirements — examine the best recruitment method for key positions with respect to the functioning of the organization and initiate the inclusion of that staff member into the programme who is selected to fill in the vacant job. The application for admission can also be accepted for the maintenance, extension, upgrading of the staff member's knowledge. A basic aspect of judgment is that hose staff members be admitted who have deserved the

distinguished attention with their performance to date, plus demonstrate appropriate motivation and determination to meet the ever increasing expectations in a given post.

The basis of the development of the admitted staff members is the personal development plant established by both the staff member and the manager that includes the theoretical as well as practical training programmes defined for the staff member.

The development may comprise training type programmes (academic education: first/post graduate diplomas) professional courses, conferences, personalized aptitude development training programmes) or non-academic settings, such as participation in professional projects, forums or consultations, and inclusion into mentoring programmes.

Results

Currently we keep records of 130 staff members admitted into the professional career development programme. According to the programme schedule, during the next semester, the personal development programmes will be compiled and the functional conditions established. The on-going functioning of the professional career development programme is expected to begin from 15 June 2006.

XXVII.3.3. Adjustment and mentoring programme

Organically tied with the Management Pool of Talents and the Professional Career Development Programme is the Adjustment and Mentoring Programme. An argument for the introduction of this programme is that the Corporation maintains highly qualified staff with special and excessive experiences. In the following years a significant number of professionals with experiences classified as of key importance is expected to retire. The transfer of their knowledge and experiences is considered to be vitally important from functional aspects. As a consequence of the generation change and the plant service time extension the number of vacant jobs to be filled in from both internal and external sources shall significantly rise. The condition of performance efficiency of the new entries and of those shifting positions inside the corporation is that they learn as quickly as possible about the corporation, their workmates and their tasks.

This concludes to the objectives of introducing this programme namely, providing support to the adjustment process, the initial training and personal development, as well as the transfer of accumulated predecessor knowledge to the next generation. A key item of the adjustment process is making available all kinds of information to the staff members that might be necessary for performing the job. This includes corporation-related general information as well as specific ones of the given post. Accordingly, the programme is composed of the general and the personalized phases. The general phase takes effect on all new entries, both corporate and those employed through the workforce lending venture. The personalized phase contains a programme fitted to the specific needs of the job to be filled in. The responsibility of running this programme is of the line manager and — if need be — the assigned mentor naturally, in close co-operation with the HR organization.

Results

The knowledge comprised in the general phase is transferred in frame of administered training programmes including also a two-day site visit which are arranged according to the recruitment schedules. The training material is ready, the programme is commencing in September. The functional conditions of the mentoring system are yet being finalized including the elaboration of the system of aspects for the selection of as well as of the establishment of a system of appropriate material/moral incentives for the mentors. The continuous functioning of the mentoring programme is expected to commence in July 2006.

XXVII.3.4. Additional HRM activities in support of the complex staff development system

- *Development of managerial/professional aptitudes*. Making properly prepared managers and professionals available is a definitive factor in the plant's economic achievements and the realization of safety culture. For this end, the company runs planned, ongoing and high-quality training activities in frame of the leadership and professional development programmes.
- *SAT-based training of the technical support staff*. The objective is to create and operate such a task-oriented, systematic training system (SAT) which would ensure the acquisition of KSAs and all competencies for the technical support personnel required for their job-related tasks.
- *Qualified nuclear instructors training programme — certificate for attendees*. For professionals of the plant with instructional duties the plant in co-operation with the Faculty of Psychology and Ergonomics of the Budapest University of Technology and Economics arranges annually a training programme on psychology and pedagogy, both initial and brush-up. The participants of this post graduate training at the finish of the programme are provided with the Qualified NPP Instructor Certificate.
- *Development of E-learning materials*. The company is currently working on introducing a complex E-learning system which would incorporate the training itself and the training-related work processes. The system efficiently supports the e-material development, the course management, exam arrangements, evaluations, the printout of certificates as well as the generation of statistics and reports in connection with the training programme and the participating trainees.
- *IT development, support.* The application of such an integrated corporate management system, which ensures that the management is supplied with appropriate information, supports the record keeping of the technical equipment stock, the work administration, and the management of the technical documentation. The application of such an Intranet Portal system which functions as a platform for the introducing and the functioning of the KM .

Further information:

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Appendix XXVIII

WORKFORCE PLANNING MODEL

This Appendix provides an outline of an example Workforce Planning Model. This model comes from the US Government's Office of Personnel Management.

XXVIII.1. Step 1: Set strategic direction

- An outline for setting a strategic direction;
- Organize and mobilize strategic partners;
- Set Vision, Mission, Values and Objectives;
- Review organizational structure;
- Conduct business process reengineering;
- Set measures for organizational performance;
- Position HR to be an active partner;
- Questions your strategic direction plan needs to answer;
- Where to go for help;
- References and resources.

XXVIII.2. Step 2: Analyse workforce, identify skill gaps and conduct workforce analysis

- The central personnel data file;
- Current population survey information;
- IPEDS fall enrollment data;
- US Census Data.

XXVIII.3. Step 3: Develop Action Plan

- An outline for developing a Workforce Action Plan;
- Design a Workforce Plan;
- Identify your stakeholders;
- Develop ways to address skill gaps;
- Develop a Project Plan;
- Set specific goals;
- Develop your communications strategy;
- Evaluate your progress;
- Where to go for help.

XXVIII.4. Step 4: Implement Action Plan

- An outline for implementing the Action Plan;
- Communicating the Action Plan;
- Marketing;
- Targeting and recruiting;
- Conduct recruiting and training;

— Implement retention strategies;
— Conduct organizational assessments.

XXVIII.5. Step 5: Monitor, evaluate and revise

— An outline for monitoring, evaluating and revising;
— Monitor: assess effectiveness;
— Evaluate: adjust plan as needed;
— Revise: address new workforce and organizational issues.

Further information:

http://www.opm.gov/workforceplanning/wfpmodel.htm

Appendix XXIX

SUCCESSION MANAGEMENT IN BRITISH ENERGY

British Energy has formal succession management arrangements, which have evolved over the years to meet the needs of the company. Whilst they are an ongoing process, the arrangements are most manifest in an annual review which results in an overall succession plan for the company. The process embodies a twin-track approach of reviewing existing managers whilst also identifying younger staff with significant potential. These younger staff members are allocated into one of two groupings: those identified as having director level potential, who have their development managed centrally, and those considered to have management potential, the development of whom is managed by the business unit to which they belong, with support from the center as requested. The staff members in both these groupings are kept under review and, if the circumstances warrant it, there may be movement between the two groupings.

The aim of succession management is to ensure the company has sufficient experienced, qualified and tested staff to provide succession to senior and other key posts.

It has three main perspectives:

- Posts — generation of succession plans to cover identified posts in the short (one year) and medium (2–5 years) term;
- Individuals — identification of those individuals with potential, who's development needs to be managed;
- Skill areas/vulnerabilities, including managerial and technical competences where the company needs to take action.

The succession arrangements include six key processes, as illustrated in Fig. XXIX.1. These are described briefly below:

(1) Company succession review process:

- this is a bottom-up business unit, division, company-wide review;
- to develop and maintain local, divisional and company wide succession plans;
- to establish overall succession health of the business;
- to identify new nominees for senior management development;
- to provide input to other processes described below.

(2) Developing staff with significant potential. This involves:

- putting nominees through assessment centers to validate their potential;
- developing personal development plans;
- managing learning opportunities;
- considering career moves (direct nomination for specific opportunities);
- mentoring;
- identifying/organizing appropriate external training/development activities.

(3) Developing existing managers:

- running assessment and development centers to create/enhance action plans;
- identifying/organizing appropriate external training/development activities.

(4) Resourcing senior posts:

— nominating candidates for vacancies from existing databases of competent staff;
— organizing interviews;
— involvement of succession management process owners in interview panels for senior.

(5) Providing support to local development:

— providing guidance and advice;
— coordinating/facilitating secondments, moves, job swaps, etc.;
— provision of assessment and development centers to support local succession arrangements.

(6) Input to company development:

— influencing company initiatives;
— data on capability of organization to accommodate different organizational patterns.

While much of the focus of the process is on people and their potential, an important element of the review process is to gather data on potential development opportunities, which exist, or are likely to arise, in the various parts of the organization.

Various tools are used to support the process. Example on Fig. XXIX.2 is that of the experience profile required for a Director-level appointment.

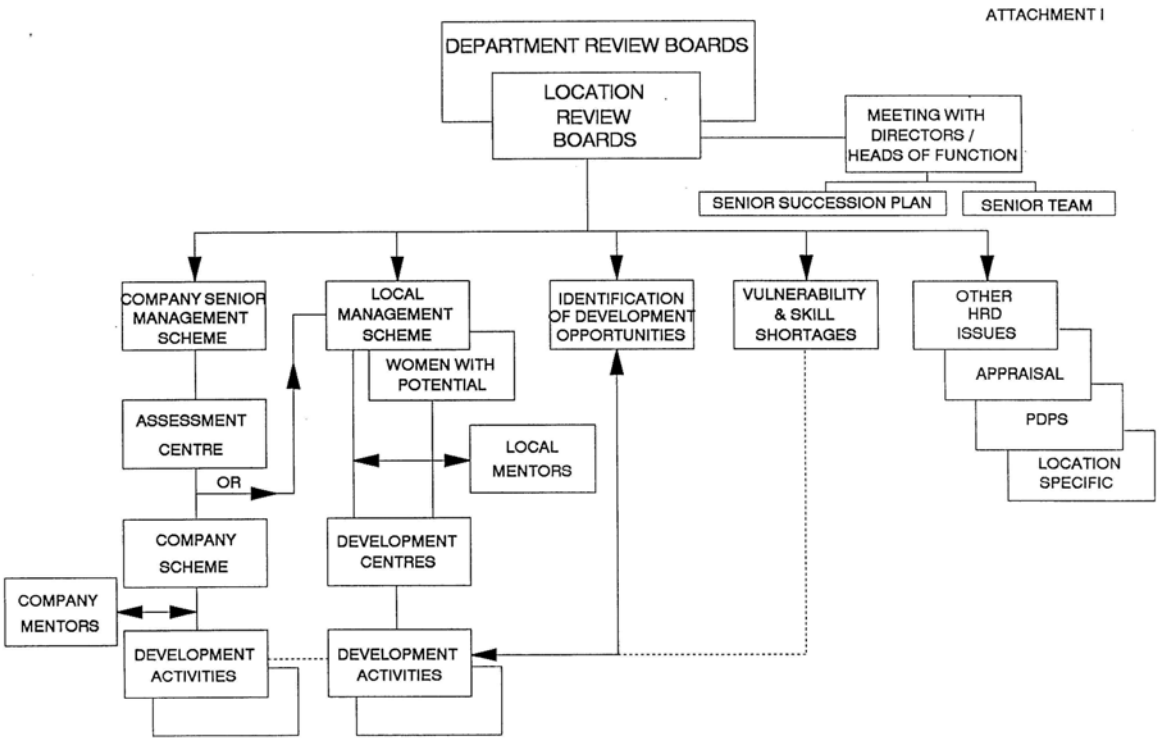

FIG. XXIX.1. The succession arrangements.

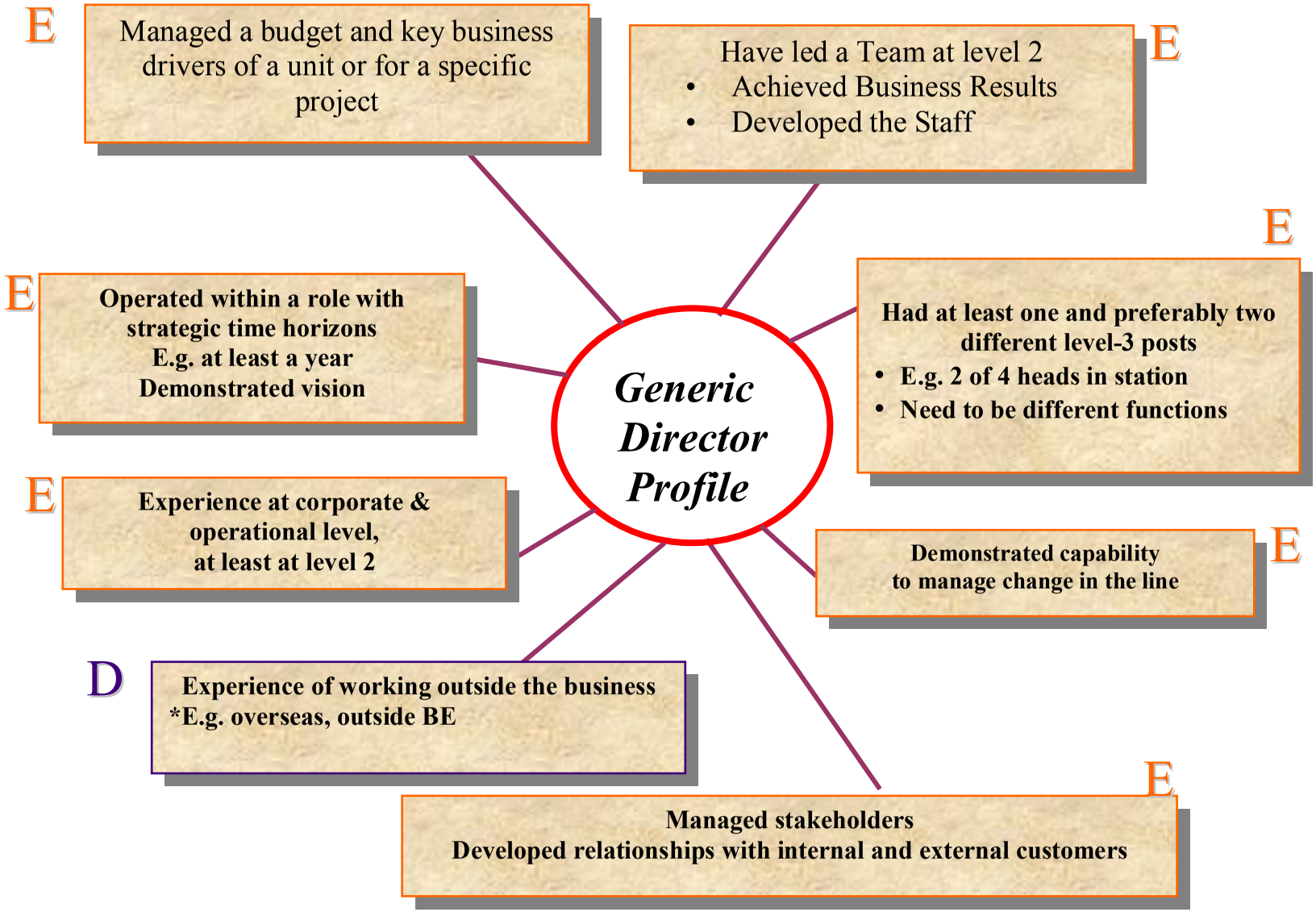

FIG. XXIX.2. Elements of Generic Director Profile (E – essential, D – desirable).

Appendix XXX

LEADERSHIP/SUCCESSION PLANNING AT TVA

XXX.1. Introduction

WHAT
This practice defines the leadership/succession planning process, which will be utilized to ensure that TVA can fill key organizational positions with qualified internal candidates, in advance of actual need, and to assist in managing diversity and workforce planning.

WHO

All TVA organizations.

WHY

This process will provide for continuity of leadership by identifying and developing potential candidates for key leadership positions and where necessary, recruit externally.

XXX.2. Method

The leadership/succession planning process includes the following steps:

XXX.2.1. Establish Leadership Planning Boards

Establish Leadership Planning Boards to provide oversight to the planning process. The Corporate-level board will include the Board of Directors and its designees. Each organization will also have its own board comprised of the Chief Officer, his/her direct reports, and a senior representative from human resources. Additionally, each reporting organization may have a board comprised of the organization's senior-level managers.

XXX.2.2. Identify key positions

The Leadership Planning Boards identify key positions within the appropriate organization that exert critical influence on organizational activities, operationally and strategically. Failure to fill these positions within a short timeframe would result in the inability to continue organizational and/or TVA's mission.

XXX.2.3. Establish criteria for key positions

The Leadership Planning Boards establish criteria for each key position considering the position description, organizational goals, strategic challenges that key positions face, and the requisite skills required for success.

XXX.2.4. Identify potential candidates

Key managers nominate employees who are to be considered succession planning candidates for key leadership positions to the Leadership Planning Boards. Candidates should demonstrate high potential/ability that will enable them to achieve success at senior and executive levels. The nomination process should promote a diverse slate of candidates where feasible including an adequate representation of qualified women, minority, and targeted disabled employees in the succession candidate pools.

XXX.2.5. Mentor assignments

Succession planning candidates will be assigned mentors who will guide and assist the candidate with his/her development. Mentors are chosen from those managers, who have demonstrated TVA's values, goals, STAR 7 winning behaviors, and have sufficient knowledge and experience in the key position or occupation group to enable them to oversee candidates' development. Mentors are responsible for offering support and guidance to the succession planning candidate. They enable the candidate to acquire new knowledge, skills, and standards of professional competence.

XXX.2.6. Candidate development plans

Each candidate will have a development plan, jointly developed by the candidate and his/her mentor with input from the candidate's supervisor that reflects the candidate's developmental needs. The candidate's individual development plan may reflect managerial, leadership, operational, and/or other technical needs with an associated timeframe for completion. The mentor will communicate the candidate's progress to the Leadership Planning Board.

XXX.2.7. Candidate review/tracking

The Leadership Planning Boards will meet quarterly or as needed to ensure that candidates are progressing in accordance with their developmental plans.

XXX.3. Roles

XXX.3.1. Board of Directors/Chief Officers

- Establish Leadership Planning Boards for their organizations.
- Review progress of succession planning candidates.
- Ensure qualified replacement candidates are identified for key positions in the organization.

XXX.3.2. Leadership Planning Boards

- Identify key positions.
- Establish criteria for each key position.
- Evaluate potential succession planning candidates.
- Promote/seek to develop diverse succession candidate pools where feasible.
- Monitor developmental progress of succession planning candidates.
- Review and revise candidate development plans as necessary to ensure that all developmental needs are addressed.
- Ensure that at least two succession planning candidates exist for each identified position or that appropriate action has been initiated to identify acceptable candidates.

XXX.3.3. Business unit human resources

- Provide succession planning candidate information.
- Maintain list of succession planning candidates.
- Assist Leadership Planning Boards in developing strategies to increase diversity of candidate pools.
- Monitor selections of succession candidates.

XXX.3.4. Corporate human resources

— Evaluate the effectiveness of the leadership/succession planning process
— Provide tools to enhance the leadership/succession planning process

XXX.4. Resource

— Business Unit Human Resource Representatives
— Leadership/Succession Planning Process

Further information:

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Appendix XXXI

KNOWLEDGE MANAGEMENT ASSESSMENT TOOL

XXXI.1. Knowledge management review elements

The following guidelines are intended to be used either by an NPP operating organization in conducting a self-assessment **against this publication** of its knowledge management functions, or for an independent, external review of an NPP operating organization. These criteria are not so much intended to provide a 'report card' as they are to help managers to identify strengths to build upon and weaknesses to be addressed in the knowledge management area.

Knowledge management is defined, in this publication, as an integrated, systematic approach to identifying, acquiring, transforming, developing, disseminating, using, sharing, and preserving knowledge, relevant to achieving specified objectives. (This is a definition that is being used for KM activities in the IAEA).

XXXI.2. Knowledge management policies and strategies

TABLE XXXI.1. KM POLICIES AND STRATEGIES

No	Description of elements	Exists in my Organization? (1 = not at all to 5 = fully)					Important to my organization? (1 = low to 5 = high)					Comments
		1	2	3	4	5	1	2	3	4	5	
1	Top-level policies and associated procedures provide an integrated strategy and implementing approach for knowledge management (KM), including identification of roles and responsibilities for KM. This KM strategy is linked to the organization's business plan such that KM is used as a tool for continuous improvement in the organization's performance.											
2	A communications strategy is in place that supports the organization's mission and change initiatives by identifying objectives, strategies, and tactics for communicating with key stakeholders. This strategy includes communications related to the value and importance of knowledge management to the organization.											
3	A workforce planning strategy has been developed to ensure that staffing needs for the life of the organization are identified and tracked. This strategy addresses areas such as risks associated with losing mission critical knowledge, succession planning and developing leaders and managers.											

TABLE XXXI.1. (cont.) KM POLICIES AND STRATEGIES

No	Description of elements	Exists in my Organization? (1 = not at all to 5 = fully)					Important to my organization? (1 = low to 5 = high)					Comments
		1	2	3	4	5	1	2	3	4	5	
4	A human performance improvement programme is established to continually identify opportunities to improve plant performance and expand the knowledge of the organization, particularly for those activities related to safe and reliable plant operation.											
5	Strategies for knowledge transfer and retention should be developed and implemented to preserve unique knowledge and skills that could be lost through attrition or planned staffing changes.											
6	An effective process is established that clearly define expectations for procedure use that takes into account the complexity of the task, the skill and training of plant personnel, the extent of supervisory involvement, and the potential consequences of improper performance.											
7	Senior corporate and plant managers, through personal involvement, foster open communications; up, down and horizontal.											
8	The culture of the organization promotes the transfer of knowledge, particularly tacit knowledge among plant personnel. Evidence of this culture is seen through: (1) managers serving as role models for others to emulate regarding knowledge transfer; and, (2) mutual trust existing between managers and the workforce, including trade unions, if applicable. Methods are in place to periodically assess the status of this culture.											
9	Managers are personally involved in ensuring that the KM programme is developed, implemented, continuously improved and integrated with the organization's overall management system.											
10	A strategy has been developed to reward and recognize people for their contributions to growing the knowledge assets of the organization.											

TABLE XXXI.1. (cont.) KM POLICIES AND STRATEGIES

No	Description of elements	Exists in my Organization? (1 = not at all to 5 = fully)					Important to my organization? (1 = low to 5 = high)					Comments
		1	2	3	4	5	1	2	3	4	5	
11	Benchmarking is an established policy to transfer knowledge, improve performance, and emulate best industry practices. Identification and correction of problems and use of operating experience, benchmarking, and self-assessment should be integral to the organization's culture.											
12	Managers have established a continuous learning environment that encourages employees to improve individual and station performance.											

XXXI.3. Knowledge management methods and techniques

TABLE XXXI.2. KNOWLEDGE CAPTURE/TRANSFER METHODS AND TECHNIQUES

No	Description of elements	Exists in my Organization? (1 = not at all to 5 = fully)					Important to my organization? (1 = low to 5 = high)					Comments
		1	2	3	4	5	1	2	3	4	5	
1	Effective use is made of knowledge elicitation tools to assist in identifying critical knowledge held by employees/experts, to present this knowledge in a manner that facilitates its transfer to others and to ensure that elicited knowledge is both current and validated.											
2	Plant personnel document and transfer information accurately. Plant activities, conditions, and decisions are documented in sufficient detail to enable personnel to re-create and address plant problems or events.											
3	Managers and coworkers frequently observe work and training activities to ensure that knowledge capture and transfer methods are being effectively applied and to identify needed improvements.											

TABLE XXXI.3. TRAINING AND QUALIFICATION

No	Description of elements	Exists in my Organization? (1 = not at all to 5 = fully)					Important to my organization? (1 = low to 5 = high)					Comments
		1	2	3	4	5	1	2	3	4	5	
1	A systematic approach to training (SAT) is implemented to achieve, maintain, and improve personnel knowledge, skill, and performance to support plant safety and performance goals.											
2	Managers feel accountable for the training, qualification, and performance of their personnel. They use appropriate tools (e.g. qualification matrix) to assist them in determining whether they have adequate numbers of qualified person to assign to tasks important to safe and reliable operations.											
3	Managers understand their roles in carrying out the organization's 'KM programme' and assign developmental activities, coach personnel, and counsel individuals to improve their performance.											
4	Continuing training, including just-in-time training (JIT) ensures that plant personnel maintain their job-specific knowledge and skills.											
5	Contractor personnel involved in plant activities and assigned to work independently perform to the same standards as the plant staff and are verified to have the specialized skills and training appropriate to the tasks they perform. Responsibilities are established for oversight of contractor personnel who work independently.											
6	Training materials and examinations are current accurate, and of high quality.											

TABLE XXXI.4. COMMUNICATION METHODS AND TECHNIQUES

No	Description of elements	Exists in my Organization? (1 = not at all to 5 = fully)					Important to my organization? (1 = low to 5 = high)					Comments
		1	2	3	4	5	1	2	3	4	5	
1	Managers practice visible leadership in the field by personally observing performance, coaching, mentoring, and reinforcing standards.											
2	Managers encourage cooperation and teamwork among plant organizational units, especially when successful implementation of work activities requires support from several groups.											
3	The organization's values and behaviours are modelled by its leaders and practiced by all plant staff. Effective mechanisms are in place to promptly transfer these values and expected behaviours to new staff.											

TABLE XXXI.5. HUMAN RRESOURCE MANAGEMENT

No	Description of elements	Exists in my Organization? (1 = not at all to 5 = fully)					Important to my organization? (1 = low to 5 = high)					Comments
		1	2	3	4	5	1	2	3	4	5	
1	Managers ensure that future staffing needs are identified and tracked through an ongoing workforce planning process. This planning process includes a knowledge loss risk assessment that identifies knowledge that is critical to the organization's mission and that may be lost in the near future.											
2	A profile defining the competencies needed for key jobs is established and used to identify candidates for leadership positions and to guide their development .											
3	Succession plans are in place for key corporate and plant positions. The succession plan includes rotational assignments, project assignments and other means to develop staff for advancement.											

TABLE XXXI.5. (cont.) HUMAN RESOURCE MANAGEMENT

No	Description of elements	Exists in my Organization? (1 = not at all to 5 = fully)					Important to my organization? (1 = low to 5 = high)					Comments
		1	2	3	4	5	1	2	3	4	5	
4	Candidates for leadership positions are developed through training and assignments in a variety of positions within the organization. On an ongoing basis, senior nuclear managers assess the progress of individuals identified as having management and leadership potential and their readiness for future management positions.											
5	Human resource personnel work as a team with line managers to anticipate personnel needs and recruit to ensure sufficient staffing of knowledgeable and skilled personnel.											

TABLE XXXI.6. METHODS FOR EFFECTIVELY LEARNING FROM OPERATING EXPERIENCE

No	Description of elements	Exists in my Organization? (1 = not at all to 5 = fully)					Important to my organization? (1 = low to 5 = high)					Comments
		1	2	3	4	5	1	2	3	4	5	
1	A process is in place to encourage, monitor, and address employee feedback on KM and other organizational initiatives.											
2	Plant personnel are self- critical and frequently provide feedback to improve knowledge management processes, plant performance, processes, plans, procedures, and training. They willingly report problems, near misses, error-likely situations, and safety hazards.											
3	Lessons learned from operating experience are institutionalised through changes to station processes, procedures, equipment, and training programs.											

TABLE XXXI.7. WORK CONTROL METHODS TO FACILITAYE KM

No	Description of elements	Exists in my Organization? (1 = not at all to 5 = fully)					Important to my organization? (1 = low to 5 = high)					Comments
		1	2	3	4	5	1	2	3	4	5	
1	KM methods, wherever practical, are built into processes, rather than being separate, add-on tasks in order to increase effectiveness and reliability of knowledge capture and transfer.											
2	The composition of operating crews and other teams takes into account individual experience and attributes to enhance knowledge transfer.											
3	Maintenance, operations, engineering, and other work groups have an effective, integrated role in monitoring plant performance and in documenting this knowledge in such a way that it can be effectively retrieved and utilized when needed.											

TABLE XXXI. 8. HUMAN PERFORMANCE IMPROVEMENT

No	Description of elements	Exists in my Organization? (1 = not at all to 5 = fully)					Important to my organization? (1 = low to 5 = high)					Comments
		1	2	3	4	5	1	2	3	4	5	
1	Change initiatives are well managed and coordinated. The potential effects of organizational changes and staff reductions are considered and addressed before such changes are initiated.											
2	There is a feedback process, including post job reviews and management observations, to improve human performance and knowledge transfer.											

TABLE XXXI.9. IMPLEMENTING PROCEDURES AND DOCUMENTATION

No	Description of elements	Exists in my Organization? (1 = not at all to 5 = fully)					Important to my organization? (1 = low to 5 = high)					Comments
		1	2	3	4	5	1	2	3	4	5	
1	Plant procedures are a logical location in which to store knowledge that is captured from experts. However, the inclusion of such knowledge in procedures is structured in such a way that information as to why something is done does not detract from the effective and reliable use of the procedure.											
2	Plant procedures, particularly emergency and abnormal procedures, are written in accordance with applicable owner's group guidance, plant-specific guidelines, plant-specific probabilistic safety analyses, and vendor technical manuals.											
3	Design calculations, drawings, analyses, procurement specifications, and other design documents are readily retrievable and clearly describe the bases for the function of plant systems and components.											
4	Licensing and design requirements are well defined, documented, controlled, and retrievable.											
5	Procedures, drawings, training lesson plans, and related documentation are updated promptly following implementation of configuration changes.											

TABLE XXXI.10. IT SOLUTIONS SUPPORTING KNOWLEDGE MANAGEMENT

No	Description of elements	Exists in my Organization? (1 = not at all to 5 = fully)					Important to my organization? (1 = low to 5 = high)					Comments
		1	2	3	4	5	1	2	3	4	5	
1	The organization's IT strategy is based upon achieving its KM objectives.											
2	Information technology is used effectively to capture and share knowledge critical to the organization's mission.											
3	IT products and services are developed based upon customer KM needs.											
4	It is recognized that not all KM needs can be addressed through IT solutions.											

Appendix XXXII

PERIODIC, UNANNOUNCED EVALUATION OF HUMAN PERFORMANCE

XXXII.1. Issue/challenge

Training assessment tools, used at the end of initial or continuing training courses, are not designed to identify the extent of degradation (over time) of human performance after completion of training, or inadequate reinforcement of the standards by supervisors. In response to this identified limitation, Exelon Nuclear (USA) developed what it calls an 'out of the box evaluation' (OBE). An OBE is an assessment in which fully qualified/authorized workers are evaluated on a specific work task by their supervisor and a training instructor. There is minimal time allotted for the worker to prepare for the evaluation because the exercise is designed to assess the behaviors that should be used as part of any task the individual is qualified to perform.

XXXII.2. Steps taken to resolve the issue

The first step was to create an evaluation process that identified weakness in the workers knowledge and skills prior to attending refresher training. The following steps are taken for implementation.

XXXII.2.1. Evaluation preparation

- First line supervisor (FLS), training instructor, and worker meet in private room.
- The FLS describes the overall outline of the OBE process to the worker.
- No formal pre-job brief will be given. No preconditioning, such as practicing the task, will be allowed.
- FLS reviews scoring criteria with worker.

XXXII.2.2. Implementation

- Worker reviews the work package for no more than 15 minutes.
- Worker performs/simulates task as required.
- FLS and training instructor conduct the evaluation using the OBE Evaluation Form, and Management Expectations.
- FLS and training instructor are not allowed to provide coaching of any kind to the worker during the performance of the task.
- The evaluation will be stopped for reasons of personnel safety and/or damage to equipment. The stoppage is then rectified to enable continuation of the evaluation. A complete evaluation of task performance must be conducted in order to grade the applicable maintenance fundamentals and management expectations. A worker has the potential to fail a number of criteria. Fully completing the task will allow all deficiencies to be recorded and lead to a thorough remediation.
- The FLS provides role-playing as needed:
- When verification is required, the worker will be the 'performer' and the evaluator will be the 'verifier'.
- If a field check is required, the FLS will grade the jobsite readiness as it stands when notified by the worker to perform the check.

XXXII.2.3. Post evaluation

— FLS, training instructor, and worker return to a private meeting room.

— Worker waits outside of room while FLS and training instructor compare scoring notes. The training instructor could possibly give the FLS a failing grade as an evaluator for not adequately upholding required standards. If this happens:

- The training instructor will be considered the higher authority;
- Counseling the FLS on the deficient standard will take place immediately;
- Use reference materials if needed (e.g. procedures, expectations, etc.);
- Ensure FLS is re-aligned with the standards;
- Continue with scoring the worker's performance.

— Debrief of the worker is led by the FLS. This is most important. Do not hurry through it. Line Supervisor should cover what the worker did well and what the worker did poorly.

— If worker scored a **passing** grade, gain buy-in from the worker:

- Ask — why do you think we are conducting Out of the Box Evaluations?
- Human performance tools are there to help you.
- Discuss past events that affected shop performance.
- Reinforce expectations and requirements.
- Coach severely on the negative comments.
- Ask worker what they are going to do differently going forward. This should be in their minds when they leave. Make these actions specific.

— Worker may return to work.

— The training instructor saves all documentation, performs record keeping, and practices exam security.

— If worker scored a ***failing*** grade — worker is ***not*** allowed to perform any plant work until remediation and reevaluation occurs.

XXXII.2.4. Remediation (if needed)

— Worker meets with Department manager to discuss failure.

— Department manager will note remediation plan.

— Worker reports to Training department or Shop for study time and remediation.

— Re-evaluation on the same task takes place the next business day.

XXXII.3. Benefits experienced

Reduced plant events due to improved knowledge and skills of the error prevention tools by the workers and supervisors. Improved alignment of the standards reinforced by supervisors. Improved coaching by the supervisors.

NPPs that have implemented OBEs in their training programmes have observed an increased level of engagement between workers and supervisors.

XXXII.4. Application to NPP operating organizations

The use of OBEs is applicable to reinforce and evaluate human performance behaviors associated with field workers and supervisors within the NPP organization.

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Appendix XXXIII

BENCHMARKING KM IN BRITISH ENERGY POWER & ENERGY TRADING

XXXIII.1. Introduction

The British Standard Guide to Good Practice in Knowledge Management (PAS 2001) was published in 2001. Shortly thereafter, the knowledge and information officer of British Energy Power and Energy Training (BEPET) was conducting the research phase of a work-based distance-learning M.S. degree in Information. As a part of this research, the KM practices of BEPET were benchmarked against PAS 2001, as it was easily accessible and, most importantly, impartial.

XXXIII.2. Study

Research showed that benchmarking KM was found to be quite a novel concept, particularly using PAS 2001 in any way. As the Guide provides a comprehensive overview of KM and all its practices, and being under a tight time constraint, a decision was made to focus on a few key 'benchmarkable' areas for the research. The performance categories from the Telios/KNOW Network's annual MAKE Awards were selected. Not only would these provide a basis for drawing information from PAS 2001, but they also, through the recent winners, supplied a ready-made list of best practice companies to further compare BEPET against.

The key areas used in the study were:

- Creating an enterprise knowledge culture;
- Top management support for managing knowledge;
- Developing and delivering knowledge-based products and solutions;
- Maximizing enterprise intellectual capita;l
- Creating an environment of knowledge-sharing;
- Establishing a culture of continuous learning;
- Managing customer knowledge to increase loyalty/value.

It was felt that these categories were clearly relevant to the study overall and so were applied (successfully and quite easily) to the design of the benchmarking exercise. To further compliment the study, a knowledge audit of BEPET was also carried out, and best practice company profiles based on five of the MAKE award winning companies were drawn up with the aim of matching them against the findings of the benchmark survey.

XXXIII.3. Benefits to be gained

It was felt that there were many benefits to be gained by the organization through the conduct of such an investigation. As PAS 2001 states "knowledge is now widely considered to be a company's key resource, and its effective use is vital for business success" and so one of the main benefit of the research to BEPET was the potential it brought with it to introduce best-practice KM practices into the Division. Through reading PAS 2001, it was felt that the study could bring many improvements, some of which might be:

- Individual employees being better informed and more effective;
- Improved teamwork;
- Innovation would increase;
- Continuous learning would be better facilitated and supported;

— That stakeholder relationships would be improved.

Using case studies of some of the ***make*** awards winners would enable BEPET to benefit from the experience of others, and from the current advice of leading KM practitioners. The study also allowed the close examination of an area of business practice not generally practicably possible due to time and cost constraints. And importantly, it gave scope for further benefits to the rest of British Energy, and the wider information and knowledge communities beyond the company, as the findings were disseminated and published.

XXXIII.4. Collecting the data and the findings

For each category, from five to ten best practice statements were drawn from PAS 2001 (with the KM and business jargon removed where necessary) and a staff survey was compiled. The survey asked BEPET employees to agree or disagree on a scale of 1 to 5 whether they thought the statement truly reflected the current practice in the company. As an example, 'The Working Environment' section from the survey is shown below, with the statements being drawn from section 2.2 'Establishing the right culture for success in KM' in PAS 2001.

Section A: The BEPET working environment

A1. People are encouraged to work together in BEPET.

Strongly disagree — Strongly agree

□ □ □ □ □ ○

1 2 3 4 5 no opinion

A2. There is a culture of trust here.

Strongly disagree — Strongly agree

□ □ □ □ □ ○

1 2 3 4 5 no opinion

A3. The hoarding of knowledge is actively discouraged.

Strongly disagree — Strongly agree

□ □ □ □ □ ○

1 2 3 4 5 no opinion

A4. In BEPET knowledge-sharing means power.

Strongly disagree — Strongly agree

□ □ □ □ □ ○

1 2 3 4 5 no opinion

A5. We have the correct balance between electronic and face-to-face knowledge sharing.

Strongly disagree — Strongly agree

□ □ □ □ □ ○

1 2 3 4 5 no opinion

A6. In BEPET I feel like a small cog in a big machine.

Strongly agree — Strongly disagree

□ □ □ □ □ ○

1 2 3 4 5 no opinion

The survey response rate was 40%, and following it five semi-structured interviews with a sample of BEPET staff were arranged.

XXXIII.5. Some general thoughts on the study

In the context of a general survey, it proved difficult to take into account different perceptions of individual staff and their awareness of issues. For example, the benchmarking survey included the highly subjective, but essential in terms of the benchmarking process, statement "there is an 'open book' approach to all information". It was recognized that each person will have their own view on the information that is shared to the staff by the management and how important or otherwise it is for them to know about everything that is going on in the business.

Also, it was not possible to include all areas within PAS 2001. So where no KM initiative existed, that area was left out of the survey. This meant that in the results phase, a judgment was made on their relative importance and a suitable score was factored in. An example of this is how the lack of a content management system in BEPET took 50% off the benchmarking score for that section. However, more time could have produced a more accurate method.

Note: The complete BEPET knowledge sharing survey is ***not*** provided in this appendix. However, it is available as an annex I in IAEA-TECDOC-1399, *The nuclear power industry's ageing workforce: transfer of knowledge to the next generation* (2004).

Appendix XXXIV

EFFECTIVE WORK TEAM BRIEFINGS

XXXIV.1. Issue/challenge

Work team briefings with maintenance or operating crews have the potential to significantly improve human performance. However, recent observations of these briefings reveal that in most cases a supervisor reads to the group from either a prepared script or from the employee safety handbook. These briefings are almost always one-way communications and within only a few minutes it is evident the workers quickly loose interest. The workers internalise little or no valuable information.

XXXIV.2. Steps needed to resolve the issue

To address this weakness, work briefings at one NPP operating organization were modelled from the US Special Forces lessons learned brief. Each day a first line supervisor (FLS) or department manager selects the best practice-briefing topic by reviewing the jobs accomplished that day. The team that completed the job presents their experience to the entire work group. A day in advance, the FLS notifies the selected work team that they need to discuss the job the following morning and answer the following questions. The lead worker of the team briefly addresses (1–3 min):

— What was the job?
— What were the major steps accomplished within the job?

The team then addresses (3–7 min):

— What went right with the job?
— What went wrong with the job?
— What did we learn?

The FLS should assist the workers in the presentation of information until the workgroup is comfortable. The FLS should also encourage open participation and discourage any inappropriate comments.

XXXIV.3. Results/Benefits

This type of brief allows the entire work group to benefit from the lessons learned from fellow workers. The appropriate issues or associated actions from the lessons should be captured. These briefings will increase the level of task specific knowledge within the entire work group, allow for input from other workers listening to the brief, and allow for lessons to be learned and problems corrected before they can occur.

XXXIV.4. Application to nuclear industry organizations

Work team briefings are recognized as important contributors to NPP HPI; however, many NPPs have difficulty in making these relevant, informative, and effective in knowledge transfer. The approach as discussed above is completely transferable as is.

Further information:

This application is being piloted at the Quad Cities and Peach Bottom NPPs, www.exeloncorp.com/generation/nuclear/

Appendix XXXV

COMMUNICATING EXPECTATIONS

XXXV.1. Source

Texas Utilities Corporation, operator of the two-unit Comanche Peak Nuclear Power Station.

XXXV.2. Introduction

All personnel at Comanche peak are expected to understand and participate in the site-wide management observation programme called 'Leading'. The programme is designed to collect and analyze data and information from a wide range of workers using a Web-based software tool called 'Proactive Assessment of Organizational and Workplace Factors' (PAOWF) obtained from Electric Power Research Institute. This attachment demonstrates one powerful method of communicating expectations for use of a knowledge capture tool. The method consists of a memorandum from the executive level of management to affected personnel.

XXXV.3. Method

To: Managers and supervisor **Subject: Expectations for leading**

XXXV.3.1. Expectations for use of leading

We are requesting that each of you use the **leading** programme to document your coaching, observations and feedback on organization, plant, and personnel performance. Specifically, we would like each manager and supervisor to document at least three observations per month. We will monitor and report statistics by department at the PMG meeting.

Some departments may already have formal observation programmes, such as the Operations Management Observation Programme (OMOP). Those departments may use **leading** instead of the department programme if the department manager is satisfied that **leading** meets all of their needs and is allowed by their procedures. Department managers should provide any additional or clarifying directions to their organizations.

For the Radworker Observation Programme, our expectation is that managers and supervisors who have workers performing work in radiological controlled areas should perform a radworker observation often. If you are uncertain how to perform one and want to be coached, contact Radiation Protection for assistance. For other special purpose observations, such as Operational Decision Making, you should perform those observations as opportunities present themselves.

XXXV.3.2. Expected coaching behaviors by manager and supervisors

(1) When conducting observations:

- Before you go to perform the observation, take a moment to review what you will be observing;
- Look at the observation questions. Know what you are planning to observe;
- When you are performing an observation, inform the individuals what you observed;
- Have them explain what you do not understand and discuss their view of how task went;

— Coach them where they succeeded, or where they fell short. It's a good opportunity to show that coaching is a two-way street.

(2) When reinforcing the use of the observation results:

— Inform your group what your expectations are for their use of **leading**;

— Share with them your expectations. Reinforce those expectations by example;

— Coach the people in your group on how to perform a **leading** observation;

— Check occasionally as to how often and how well they are meeting your expectations and provide feedback;

— When expectations are not being met, explore why not, eliminate barriers to meeting the expectations and then reinforce and encourage the people in your group to do better.

(3) Expectations for feedback:

At least quarterly, each organization should conduct a review of the leading observations done on their group. The review will look for at least four things:

— Where do your strengths lie?

— What are the issues arising from the collective look? The purpose of this review is to identify, track and resolve these issues.

— What is the quality of the observations? The purpose of this element is to ensure that the observations are serving us well and are meeting management's expectations.

— Are issues requiring a SmartForm being put on a SmartForm? The purpose of this review is to either ensure corrective action expectations are being met or issue SmartForms for those items needing them.

The results of the review will be brought to and discussed in PMG. This is intended to be a brief summary, typically a maximum of 5 minutes for a presentation

The results of the review should be documented on a SmartForm. This documentation serves two purposes: document that it took place, and capture and track any issues needing resolution.

Several departments are already performing such reviews. These reviews take different forms, such as Programme Review Boards, Programme Health, or periodic self-assessments. This expectation is intended to specify what needs to be done, not how or in what structure. Each of you is encouraged to use the vehicles that best fit your ongoing Performance Improvement/ Centers of Excellence efforts.

Frequently review what you have found and what others have found about your organization. Discuss with the people in your group the results of your review. Note any issues or concerns that were raised, and discuss what, if anything needs to be done. Let them know you are reviewing and acting on the information. If observations performed by individuals outside your organization are useful and if you know who made the observation, take a moment to contact the person and thank them for the feedback.

Remember, your feedback serves two purposes:

— to address the issues found by the observations; and,

— to reinforce the observation behaviors.

Finally, remind the people in your group that if they identify a SmartForm condition during an observation, they need to write a SmartForm. Documenting it in leading by itself does not

accomplish issuing a SmartForm. If during your review of the data, you see what appears to be a SmartForm condition, check to ensure the SmartForm has been written.

Signed by both the Vice President of Nuclear Operations and the Director of Nuclear Engineering.

Further information:

Jim Gallman, Performance Analysis Supervisor, Email: jgallma1@txu.com

Appendix XXXVI

INTEGRATING KNOWLEDGE WITHIN BUSINESS PROCESSES

XXXVI.1. Source

AMEC NNC is a privately owned international engineering, project management, safety and technical consultancy, dedicated to providing expert advice and solutions to complex engineering and project management challenges in the nuclear and non-nuclear markets. Employing in excess of 1000 people, our network comprises 31 offices across the world.

AMEC plc is a world leader in technical services and project management, employing around 45 000 people in some 40 countries around the world. AMEC specializes in the design, delivery and support of infrastructure ranging from local technical services to international landmark projects.

XXXVI.2. Introduction

This appendix describes the methodology used by AMEC NNC to capture knowledge and best practice within its business processes.

In 2003, AMEC NNC conducted an audit of its policies, processes and procedures. This resulted in a number of 'problem areas' being highlighted. We found conflicting business process information and in some cases key areas had no processes associated to them at all. It was felt that much of this had occurred due to rapid growth, confused process ownership and a complex arrangement of documented quality procedures. AMEC NNC decided there was a need to implement a new Integrated Management System (IMS) — a system based on processes and roles first, and supporting documentation second. Fundamental areas such as Quality and Health & Safety would now be inherent in key business areas such as engineering project management, procurement and administration. Additionally, it was deemed beneficial to link 'knowledge' to the execution of the process that would allow new or inexperienced staff to become quickly familiar with best practice and to execute tasks in an efficient and safe manner.

After competitive tender, AMEC NNC chose ARIS (Architecture of Integrated Information Systems) from IDS Scheer as the tool for designing and modelling its business processes and capturing best practice.

XXXVI.3. Method

Business process models for each core process within the organization were established and modeled using a top down approach. AMEC NNC's top-level model (see Fig. XXXVI.1) is based on a house analogy where the 'roof' represents management processes, the 'foundations' represent support processes and the 'rooms' of the house represent the main fee earning or operational process.

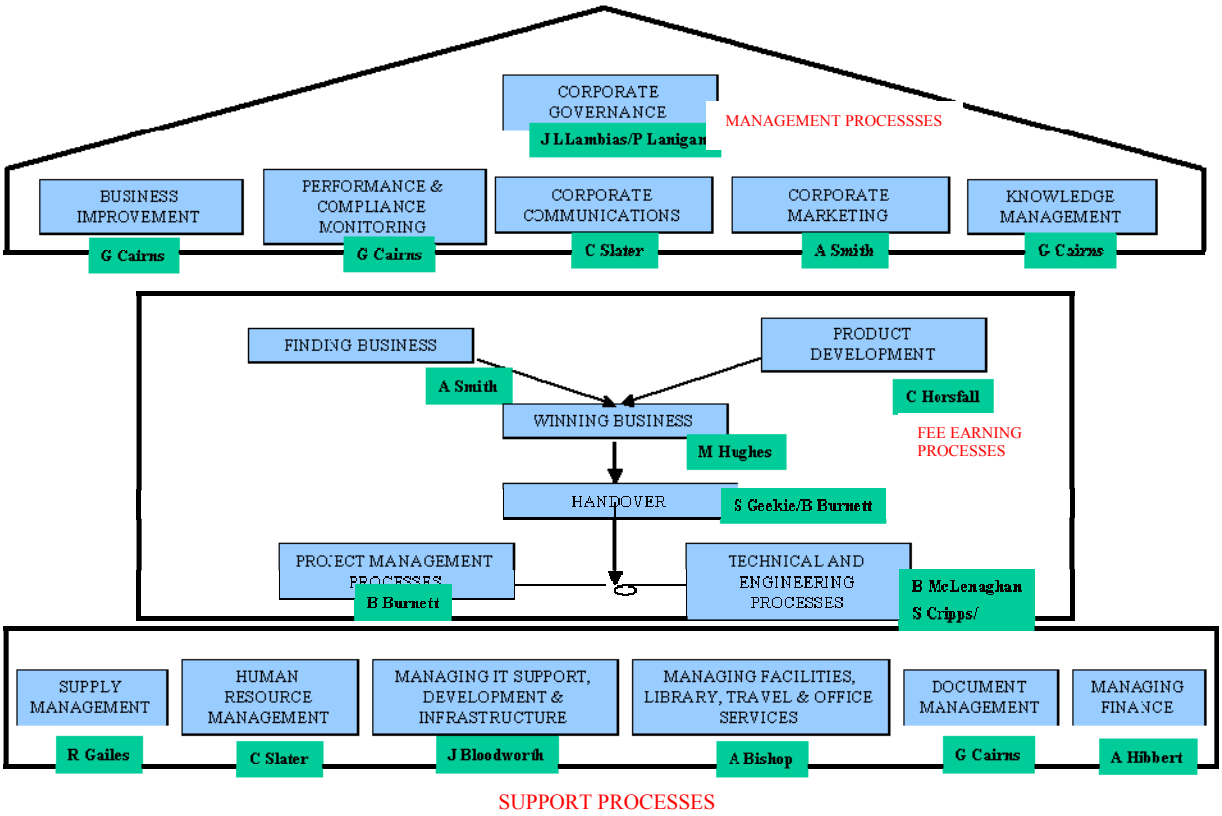

FIG. XXXVI.1. Top level process model.

Each core process has a process owner and at least two sub-levels, which describe, in more detail, aspects of the process including inputs, outputs and responsibilities for each stage.

Communities of Practice (COP) were established for each core process area led by the process owner. Over a period of several months details of each sub-process was agreed and modeled using the ARIS software. Additionally, each of the COP's agreed guidance and best practice methods for use at each stage and this information was added to the models in the form of a narrative description (see Fig. XXXVI.2). Within 12 months all processes were completed with additional guidance and this information provided to all users via the Company Intranet. For users who had no Intranet access, CD's were published containing all models, guidance and Company forms.

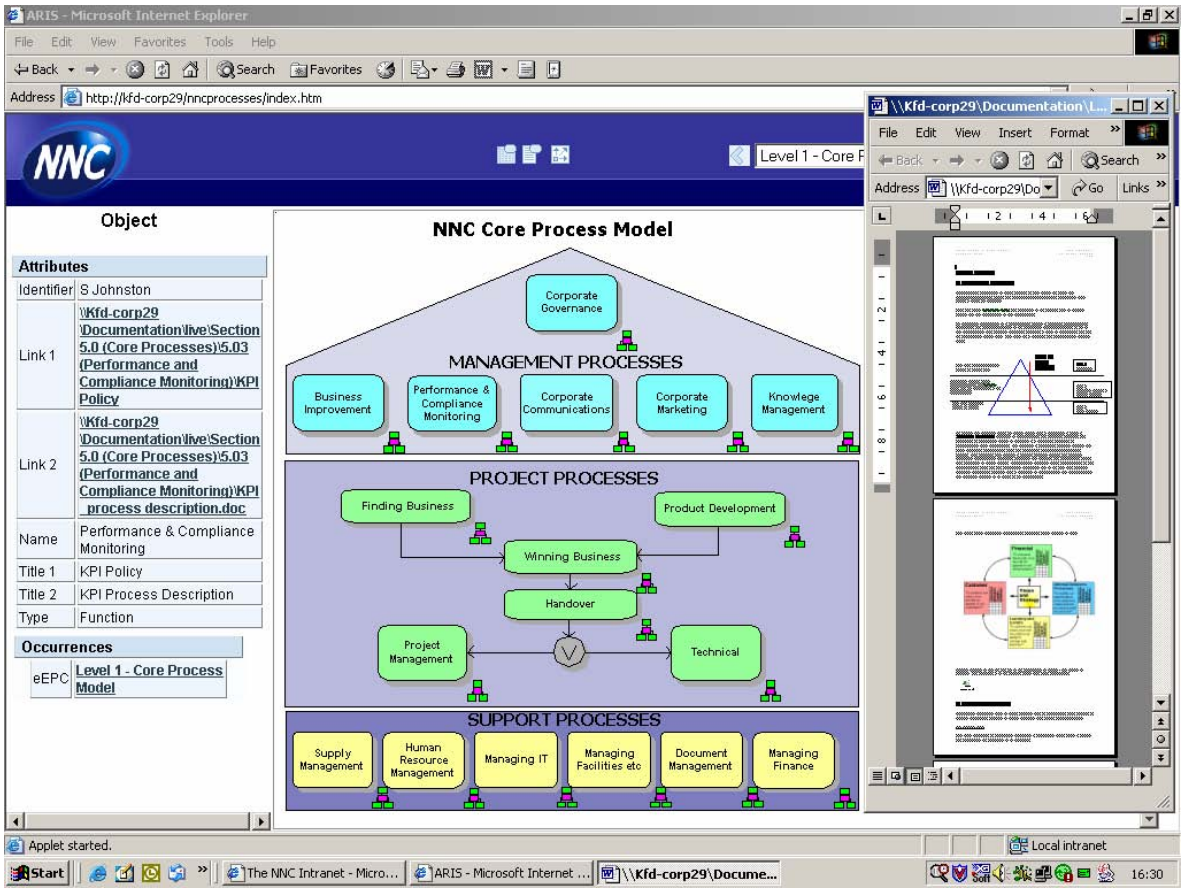

FIG. XXXVI.2. Screen shot showing annotated best practice information.

XXXVI.4. Results

In just under one year AMEC NNC had successfully managed to process map the entire business. Benefits to date include identifying missing key process areas, simplified project guidance, better compliance and improved supporting/best practice documentation. A solid foundation has now been established which can be used to measure and improve processes throughout the business.

Further information:

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ABBREVIATIONS

ARIS	Architecture of integrated information systems
BE	British energy
BEPET	British energy power and energy training
CAES	Center for advanced energy studies
CGNPC	China guangdong nuclear power holding company
CNRA	Committee on nuclear regulatory activities
COP	Communities of practice
DGFS	DAE graduate fellowship scheme
EFQM	European foundation for quality management
EU	European union
FLS	First line supervisor
FSR	Final safety report
GRS	Gesellschaft fűr anlagen
HP	Human performance
HPI	Human performance initiative
HR	Human resource
HRD	Human resource division
HRM	Human resource management
ICT	Information communication technology
IIS	Internet information services
IMS	Integrated management system
INIS	International nuclear information system
IPEDS	Integrated postsecondary education data system
IT	Information technology
JIT	Just-in-time training
JRR	Job requirements report

KM	Knowledge management
KSA	Knowledge, skills and/or attitude
NKM	Nuclear knowledge management
NPP	Nuclear power plant
O&M	Operations and maintenance
OBE	‘Out of the box evaluation’
OJT	On–the job training
OMOP	Operations management observation programme
P&M	Promotional & marketing
PAOWF	Proactive assessment of organizational and workplace factors
PDA	Personal digital assistant
PMG	Project management group
PR	Public relations
PRIS	Power reactor information system
QA	Quality assurance
QuEST	Qualifications and experience system tool
R&D	Research and development
RCA	Root cause analysis
RR	Research reactor
SAT	Systematic approach to training
SME	Subject matter expert

ANNEX

DEFINITIONS OF TERMS IN THE FIELD OF KNOWLEDGE MANAGEMENT FOR NUCLEAR ORGANIZATIONS

The following definitions of terms apply specifically to the field of Knowledge management. It should be noted that identical terms applied to, or used in, other fields may have somewhat different definitions.

Knowledge management is defined, in this glossary, as an integrated, systematic approach to identifying, acquiring, transforming, developing, disseminating, using, sharing, and preserving knowledge, relevant to achieving specified objectives. Knowledge management helps an organization to gain insight and understanding from its own experience. Specific activities in knowledge management help the organization to better acquire, store and utilize knowledge.

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adaptive learning

The use of knowledge to solve specific problems based on existing assumptions, and often based on what has been successful in the past. Also termed s*ingle-loop learning*.

Comment: In contrast, generative learning (also termed *double-loop learning*) goes a step further and questions existing assumptions in order to create new insights. For example, take the problem 'how to prevent earthquakes from killing people?' The single-loop answer would be to learn how earthquakes happen and try to predict them in order to be prepared. The double-loop answer would question the notion of 'earthquake' and might conclude that earthquakes do not kill people, falling buildings do. See *double-loop learning*.

after-action review

Structured and facilitating discussion to review an activity that is focused on performance improvement through reflection and learning.

Comment: After-action review allows participants to learn how to sustain strengths and improve on weaknesses in subsequent tasks or projects. It is used to help teams to learn quickly from their successes and failures and share their learning with other teams.

after-event review

A process that involves consideration of the what, how and why of events.

Comment: After event review includes analysis in sufficient depth to determine contributing factors (including behavioural, organizational and physical conditions), precipitating actions, consequences, probable causes, lessons learned, and corrective actions to minimize recurrence. In the nuclear industry, organizations focus attention on such problem-solving endeavours, through systematic and systemic analyses, to determine the most probable root causes of such events in order to correct problematic conditions and to prevent recurrence of similar events. See *lessons learned* and *root cause analysis*.

appreciative inquiry

A strategy of asking positively-framed questions to focus on what is going right within an organization. The aim is to help alleviate resistance to change and to improve processes, products, services, communication, leadership and other issues by focusing on the best possible outcomes and practices using the "four-d" cycle of discovery, dream, design, and destiny.

Comment: The nuclear industry has traditionally been inclined to "drive forward looking in a rear-view mirror" by devoting extensive resources to event investigation and techniques, such as root cause analysis. Complementing such necessary techniques with an appreciative inquiry can improve morale as well as performance. See *root cause analysis*.

artificial intelligence

(a) The ability of a computer or other machine to perform those activities that are normally thought to require intelligence.

(b) The branch of computer science concerned with the development of machines having this ability.

asset management

An approach to responsible management of an enterprise that considers, in a balanced fashion, the entirety of its resources. These include tangible assets such as personnel, facilities, equipment, fiscal investment, inventory, and intangible assets such as goodwill and intellectual capital.

Comment: Approaches such as the balanced scorecard can be employed to assure appropriately distributed attention to the whole of an organization's resources. In the nuclear industry, the combination of retirements and a more difficult recruitment environment requires even greater attention to achieving and maintaining such a balance. Well-planned knowledge management programmes can contribute to meeting such challenges.

See *balanced scorecard, intangible assets*, and also *intellectual assets*, and *knowledge assets*.

attrition

A decrease in the number of employees in an organization due to retirements and other terminations or transfers to other organizations.

Comment: In the nuclear industry attrition due to retirement is a particularly important issue because plants typically have stable workforces, many of whom joined during the commissioning phase, and thus they often have similar retirement dates.

balanced scorecard

A business model used as a tool to measure organizational performance against both short and long-term goals.

Comment: This model is designed to focus attention on the factors that most help business strategists and so, alongside financial measures, offers means of measuring internal processes and employee learning. Some organizations in the nuclear industry use the 'balanced scorecard' model in setting and measuring knowledge management strategies.

benchmarking

The practice of comparing features and performance of an organization, department or function with those of other organizations and standards.

Comment: The following axioms should be considered in benchmarking:

- what works well for a given organization in one situation may not work well in another organization under different circumstances;
- there are lessons to be learned from undesirable situations as well as from best practices – things that have been proven to work well and produce good results;
- examining the practices of organizations with fundamentally different aims can produce surprisingly useful insight about another organization.

best practice

A process or methodology that has been shown to work well and produce good results and is, therefore, recommended as a model. Also termed *good practice*.

capacity building

In the context of knowledge management the process of enhancing an organisation's ability to implement knowledge management principles and practices.

Comment: **C**apacity building includes: human resource development, the process of equipping individuals with the understanding, skills and access to information, knowledge and training that enables them to perform effectively; organizational development, the elaboration of management structures, processes and procedures, not only within organizations but also the management of relationships between different organizations and sectors (public, private and community); institutional and legal framework development, making legal and regulatory changes to enable organizations, institutions and agencies at all levels and in all sectors to enhance their capacities. Capacity building encompasses the country's human, scientific, technological, organizational, institutional and resource capabilities.

champion

A person who proactively promotes something with the aim of persuading others of its benefits.

Comment: In the nuclear industry a champion for organizational change is often a senior line manager who regularly monitors the plans and progress in implementing change, and helps to overcome barriers to change.

chief information officer (CIO)

A senior position with strategic responsibility for information management and information technology.

chief knowledge officer (CKO)

A senior position with strategic responsibility for promoting and implementing knowledge management.

coaching

A relationship between experienced individuals and less experienced individuals designed to enhance learning and performance of both individuals and teams, typically focused on the achievement of specified objectives within given time frames.

Comment: The role of a coach is to create a supportive environment that will develop the ability of those being coached to perform existing tasks better or new tasks. In the nuclear industry, coaching is a legitimate and effective teaching tool for situations like on-job training (OJT). Coaches may be from within or from outside an organization. See also *mentoring* and *reverse coaching and mentoring*.

codification

The process of converting people's knowledge into a form to enable it to be communicated independently of those people.

Comment: The most common method of codification is writing things down and incorporating them into documents and databases. Other methods include pictures, sound and video

recordings. In the nuclear industry codification has been particularly important in ensuring that the design basis for an NPP's safe operation is effectively maintained.

collaboration

A generic term to describe teamwork or group effort.

Comment: In knowledge management, collaboration is often used more specifically to describe close working relationships involving the sharing of knowledge. An example of collaboration in the nuclear industry is a cross-functional team.

communities of interest

Unstructured communities, which enable exchange of innovation and ideas. They can be formal or ad hoc groups with similar interests or concerns across organizational boundaries. As discussion takes place, tacit knowledge, in the form of conversations, is gathered and stored for later access.

communities of practice

Networks of people who work on similar processes or in similar disciplines, and who come together to develop and share their knowledge in that field for the benefit of both themselves and their organization(s).

Comment: Communities of practice may be created formally or informally, and they can interact online or in person. An example in the nuclear industry is the Nuclear Energy Institute's Community of Practice.

concept maps

Tools for organizing and representing knowledge.

Comment: Concept maps include concepts, usually depicted in circles or boxes of some type, and relationships between concepts or propositions, indicated by a connecting line between two concepts. See *knowledge mapping.*

configuration management

The process of identifying and documenting the characteristics of an organization's structures, systems and components (including computer systems and software), and of ensuring that changes to these characteristics are properly developed, assessed, approved, issued, implemented, verified, recorded and incorporated into the organization's documentation.

Comment: The IAEA report *Configuration management in nuclear power plants* (IAEA-TECDOC-1335, (January 2003) presents a basic approach to configuration management; it considers experience gained from discussions at meetings organized on the subject, and from organizations and utilities, which have successfully implemented partial or full configuration management programmes.

content management

A means of ensuring that computer-based information, such as the content of a website or a database, is relevant, up-to-date, accurate, easily accessible, or well organized, so that quality information can be delivered to the user.

corporate memory

The knowledge and understanding embedded in an organization's employees, processes and products or services, together with its traditions and values.

Comment: Corporate memory is utilized in all sorts of situations, from R&D through the design stage to commissioning, operation and eventual decommissioning. It also has a strong

input to the future. Corporate memory becomes a critical concern when there is sufficient migration of personnel from an organization as to cause a knowledge deficit. In this situation, the tremendous financial investment in an organization's personnel and their tacit knowledge becomes evident. In the nuclear industry corporate memory is particularly important in ensuring that the design basis for safe NPP operation is effectively maintained.

critical knowledge

The knowledge established in the context of a position particularly important to the continued success of the organization that is deemed imperative for incumbents of said position to possess before being allowed to perform associated duties and tasks independently.

culture

See *organizational culture*.

customer relationship management (CRM)

A business strategy based on selecting and proactively managing the most valuable customer relationships. A customer-focused philosophy is necessary to support effective marketing, sales and customer service processes.

data

A representation of facts, concepts or instructions in a formalized manner suitable for communication, interpretation or processing by people or by automatic means.

database

A collection of information organized in such a way that a computer program can quickly select desired pieces of data. Relational databases are organized by fields, records, and tables. A field is a single piece of information, a record is one complete set of fields, and a table is a collection of records. Storing content in fields rather than on static pages makes that content appropriate for dynamic delivery.

Comment: The nuclear industry has a variety of data bases; some are industry wide, such as the IAEA's Power Reactor Information System (PRIS) database and International Nuclear Information System (INIS) database. INIS, maintained by the IAEA in collaboration with its Member States and co-operating international organizations (138 Members in July 2006), is an international co-operative information system on the peaceful uses of nuclear science and technology. INIS processes most of the world's scientific and technical literature that falls within its subject scope developed to respond to the information needs of the international community and reflecting the IAEA's interests and activities with regard to peaceful nuclear applications. INIS maintains a bibliographic database, which currently contains over 2.7 million abstracted and indexed records and a comprehensive collection of over 650,000 of full texts, which are not easily available through commercial channels. The INIS Database contains references to journal articles, technical reports, conference papers, books, patents, laws and regulations, and other published literature. The main INIS products are the INIS Database on the Internet and on CD-ROM, and full texts of non-conventional literature on CD/DVD-ROM.

data mining

A technique for analyzing data in databases and making new connections between the data in order to reveal trends and patterns.

demographics

Social statistics that is often employed in workforce composition and planning.

Comment: Information on factors such as age, gender, race, ethnicity, educational level, and professional qualification can be most helpful in achieving organizational goals and objectives. For example, developing a demographic profile of an organization can help with succession planning and recruiting. In the context of knowledge management, attrition is the most relevant demographic. See *attrition*.

document

A record or the capturing of an event or knowledge, taken so that the information will not be lost.

Comment: Documents are usually written, but they can also be made up of images or sound. Documents can be put into electronic or digital form and stored in a computer as files.

document management

Systems and processes for managing documents including the creation, editing, production, storage, indexing and disposal of documents. This often refers to electronic documents and uses specific document management software.

Comment: The IAEA report *Information Technology Impact on Nuclear Power Plant documentation* (IAEA-TECDOC-1284, April 2002) addresses all aspects of documentation associated with various life-cycle phases of NPPs and the information technology (IT) that are relevant to the documentation process. It also provides a guide for planning, designing, and executing an IT documentation project. The TECDOC includes examples that demonstrate successful implementations at NPPs and also discusses issues related to the application of IT at NPPs and the trends for applications of IT at NPPs as well as the technology itself.

double-loop learning

Problem solving by means of adaptive learning uses knowledge based on existing assumptions and is often based on what happened in the past. Adaptive learning is also termed "single loop learning". In contrast, double-loop learning (also called "generative learning") goes a step further and questions existing assumptions in order to create new insights.

Comment: Single-loop learning has been compared to a thermostat that controls temperature to a fixed setting and double-loop learning to a thermostat that could ask why it was set on that particular temperature. In the nuclear industry, these learning concepts are particularly pertinent in root cause analysis, appreciative inquiry, and other performance improvement initiatives. Double-loop learning requires more introspection by participants as they must be willing to probe their own thoughts, actions, and attitudes rather than just seeking something or someone else to "blame" for problems. The use of such a process is essential for an organization to adopt a learning culture. See *adaptive learning*, *appreciative inquiry* and *root cause analysis*.

e-business

An abbreviation of electronic business. The use of electronic information systems (especially internet technologies) in business processes.

e-learning

An abbreviation of electronic learning. The use of electronic information systems (especially internet technologies) to deliver or receive learning and training.

Comment: A common application of e-learning in the nuclear industry is general employee refresher training. Due to the large number of trainees, the relatively high cost of e-learning can be justified, and the flexibility of e-learning is well suited to allowing the trainees to complete the training when they have the time available. Also, a "test-out" feature can allow trainees who already understand the material to complete a pre-test, and if successful to avoid spending time on topics in which they are already competent.

events

Activities, occurrences, or incidents — planned or unplanned — that have significance to society, organizations or individuals.

Comment: In nuclear technology fields, events are typically both unplanned and undesirable. Some regulatory systems have categories for events based on their levels of severity, i.e. their potential for harmful results. Within the IAEA, and specifically in the context of the reporting and analysis of events, an event is any unintended occurrence, including operating error, equipment failure or other mishap, the consequences or potential consequences of which are not negligible from the point of view of protection or safety.

exit interview

A survey that is conducted with an employee who is about to leave an organization.

Comment: In a knowledge management context, exit interview is one of the preferred ways of capturing tacit knowledge through a knowledge sharing process which results in the transfer of some of the tacit knowledge into explicit form. The real benefits of the process are often experienced by those employees who participate in the interview who will be taking over the area of work from the interviewee. The exit interview can also be the forum during which the departing employee can be requested to carry out a review of, or provide a commentary on, their previous work (reports, papers etc). The interview should be conducted at least 3 months prior to the employee's departure to enable follow-up work to take place. The output from the process can profitably be linked to a knowledge package. See *knowledge package*.

expert system

A data processing system that provides for solving problems in an expert manner within a given field or application area, by drawing inferences with the aid of a knowledge base developed from human expertise. An expert system is a branch of artificial intelligence. See *artificial intelligence* and *knowledge base*.

explicit knowledge

See *knowledge*.

extranet

A computer network that links an organization with other specific organizations or persons. Extranets are accessible only to specified organizations or persons and are protected by passwords. See also *intranet*.

generative learning

An alternative term for *double-loop learning*. See *double-loop learning*.

good practice

See *best practice*.

groupware

Computer software applications that are linked by networks, and so allow people to work together and share electronic communications and documents.

human assets

The knowledge, skills and attitudes of the people in an organization. Human assets are a component of intellectual assets. See *intellectual assets*.

Comment: The IAEA report Human Performance Improvement in Organizations: Potential Application for the Nuclear Industry (IAEA-TECDOC-1479, 2005) provides managers and specialists in nuclear facility operating organizations working in the area of human resource management with practical information that they can use to improve human performance in their organizations.

implicit knowledge

See *knowledge*.

information

Data that has been organized within a context and translated into a form that has structure and meaning.

information audit

A method of reviewing and mapping information within an organization.

Comment: An information audit examines what information is needed, what information there currently is, where it is, in what forms, how it flows around the organization, where there are gaps and where there is duplication, how much it is costing, what its value is, how it is used etc. See also *knowledge audit*.

information management

The management of an organization's information resources with the aim of improving the performance of the organization. Information management underpins knowledge management.

information overload

A state where persons have so much information that they are no longer able to effectively process and make use of it.

information technology (IT)

The elements of computing, including software, servers, networks and desktop computing, which enable digital information to be created, stored, used and shared.

institutional knowledge

The collective knowledge of all the employees working in an organization or institution.

intangible assets

The non-physical assets or resources of an organization.

Comment: Examples of intangible assets in the nuclear industry include the skills and knowledge of plant personnel, and the reputation of the organization (with the regulatory authority and the public) for safe and effective plant operation.

integrated staffing plan

A plan that is designed to ensure that an organization has the right skills at the right time and at the right cost. The plan is a standardized and consistent methodology for overall human resources planning, driven by strategic and business objectives.

intellectual assets

An alternative, more commonly used term for knowledge assets. See *knowledge assets*.

intellectual assets management

A part of knowledge management that focuses on issues relating to intellectual property such as organizing and exploiting patents, copyrights, trademarks and other intellectual property rights.

intellectual capital

The intellectual material, such as knowledge, information, intellectual property, experience, that can be put to use to create wealth.

Comment: In the nuclear industry, the large investment in intellectual capital is perhaps most visible by the high financial outlay required to get control room personnel authorized (licensed) and to maintain the knowledge base that warrants continuation of those individual operating permits. See *intellectual property* and see also *knowledge assets*.

intellectual property

Explicit knowledge assets that is protected by law. Intellectual property includes items such as patents, trademarks, copyrights, licenses etc. See *knowledge* and *knowledge assets*.

intranet

A computer network that functions similarly to the internet, but the information and web pages are located on computers within an organization rather than being accessible to the general public. See also *extranet*.

know-how

Competence derived from knowledge and experience.

knowledge

The acquiring, understanding and interpreting of information. Knowledge is often used to refer to a body of facts and principles accumulated by humankind over the course of time. Explicit knowledge is knowledge that can be easily expressed in documents. Implicit knowledge and tacit knowledge represent knowledge that people carry in their heads.

Comment: Knowledge is distinct from information as knowledge is information that has a purpose or use. Data leads to information and information leads to knowledge. Knowledge confers a capacity for effective action.

Knowledge may be applied to such purposes as problem solving and learning, forming judgments and opinions; decision making, forecasting and strategic planning; generating feasible options for action and taking actions to achieve desired results. Knowledge also protects intellectual assets from decay, augments intelligence and provides increased flexibility.

Explicit knowledge is contained in documents, drawings, calculations, designs, databases, procedures and manuals. *Explicit knowledge* implies declared knowledge (i.e., knowledge that is conscious to the knowledge bearer). *Explicit knowledge* is why it is not a problem for the employee to tell about rules and obviously learned facts. Very often this knowledge is already

written down in books. Examples that contain explicit knowledge include NPP documentation and databases such as a website, an operational manual, records or a report of research findings.

Implicit knowledge and *tacit knowledge* are held in a person's mind and have typically not been captured or transferred in any form (if they had, they would then become *explicit knowledge*). Compared with *explicit knowledge*, such knowledge is more difficult to articulate or write down and so it tends to be shared between people through discussion, stories and personal interactions. It includes skills, experiences, insight, intuition and judgment.

Implicit knowledge is difficult to reveal, but it is still possible to be recorded. Usually knowledge bearers cannot recall this knowledge by themselves, because the information is too obvious to them. Some authorities draw a distinction between *tacit* and *implicit knowledge*, defining *tacit knowledge* as that which cannot be written down, and *implicit knowledge* as that which can be written down but has not been written down yet. In this context, *explicit knowledge* is defined as that which has already been written down.

Tacit knowledge has been called "what we know but don't know we know." It is the most difficult type of knowledge to recall and, thus, to transfer. However, every individual possesses a lot of *tacit knowledge*. Employees, for example, tacitly know how they persuade other people, how to behave in different situations, or how to organize a meeting. Such knowledge cannot be completely explained, since it is wholly embodied in the individual, rooted in practice and experience, expressed through skillful execution, and transmitted by apprenticeship and training through watching and doing forms of learning.

Sometimes *tacit knowledge* is used as alternative terminology for *implicit knowledge;* however, technically, the two identify different categories of knowledge.

See *exit interview, information*, *intellectual assets, critical knowledge* and *know-how*

NOTE: The term knowledge is defined and used somewhat differently in the sphere of personnel training. For detail on this specialised application, see the Terms in the Field of NPP Personnel Training incorporated into IAEA-TECDOC-1358, Means of Evaluating and Improving the Effectiveness of Training of NPP Personnel, (2003).

knowledge assets

Those parts of an organization's *intangible assets* that relate specifically to knowledge, such as *know-how*, *best practices*, and *intellectual property*. Knowledge assets are often divided into human (people, teams, networks and communities), structural (the codified knowledge that can be found in processes and procedures) and technological (the technologies that support knowledge sharing such as databases and intranets). Knowledge assets are more commonly known as intellectual assets See *best practices*, *intangible assets*, *intellectual property*, and *know-how*.

Comment: By understanding the knowledge assets an organization possesses, the organization can improve its ability to use them to best effect and also identify any gaps that may exist.

knowledge audit

A method of reviewing and mapping knowledge in an organization, including an analysis of its knowledge needs, resources, flows, gaps, users and uses.

Comment: A knowledge audit generally includes aspects of an information audit but is broader in its scope. See *information audit*.

knowledge base

A collection of knowledge in the form of subject-problem-solution information that pertains to a specific topic or subject of interest.

Comment: A knowledge base is a special kind of database for knowledge management. It is the base for the collection of knowledge. Normally, the knowledge base consists of explicit knowledge of an organization, including trouble shooting, articles, white papers, user manuals and others. A knowledge base should have a carefully designed classification structure, content format and search engine. An organization may also build subject-specific knowledge bases to collate information on key topics or processes.

knowledge broker

A person or body who facilitates the creation, sharing and use of knowledge within an organization.

Comment: Many organizations have created knowledge broker roles such as a 'knowledge coordinator'. 'Knowledge broker' is also used to describe a company or individual that operates commercially as a knowledge trader or provides knowledge-related services.

knowledge capture

A process of capturing the knowledge available within an individual or organization and making it available.

Comment: More than ever before, organizations need to find ways to capture employee knowledge and best practices and ensure that they are shared and used throughout the workplace. To achieve this, organizations must uncover and address the gaps between their goals and their current knowledge-transfer practices. New tools and technologies must be supported with process and cultural changes and populated with high-quality structured content. A complete solution requires:

- effective architectures, techniques, and standards for organizing and presenting content effectively;
- new skills to help personnel understand what knowledge to capture, and how to document it, in order to maximize its usefulness to others;
- revised goals and expectations that make knowledge capture a high-priority in everyone's job;
- efficient systems and tools that centralize knowledge content and make it easy to store, access, and maintain.

In the nuclear industry a process of capturing of the available knowledge is an important part of knowledge preservation process for successful carrying out future decommissioning work. See *knowledge sharing* and *knowledge transfer*.

knowledge centre

A place where knowledge is gathered and stored and can be accessed and used.

Comment: A knowledge centre may be a physical place such as a library, a virtual place (a knowledge portal), such as a knowledge portal, interactive website or online discussion board, or a place where people gather, such as a café, or an informal meeting room or a discussion area created to encourage knowledge sharing. See *knowledge portal* and *virtual*.

knowledge creation

A process that results in new knowledge, or organizes current knowledge in new ways making use of existing knowledge.

Comment: Once knowledge is created the organization has a knowledge flow**.** Knowledge flow is the way knowledge travels, grows, is stored and retrieved. Knowledge flows are: up and down from management; within circles of sharing (such as shared interests between staff performing similar or complementary roles); through planning, investigation, and training; or through common sources such as books, reports, data bases or knowledge bases.

knowledge economy

An economy in which knowledge plays a predominant part in the creation of wealth.

knowledge flows

The ways in which knowledge moves within, into and out of an organization.

knowledge harvesting

A set of methodologies and technologies for efficiently capturing the implicit knowledge of experienced experts and converting it into explicit knowledge – incorporating people's knowledge into documents, to enable it to be more easily shared with others. See *knowledge* and *codification*.

knowledge loss risk assessment

A process used to determine the potential business impact of the loss of critical knowledge from an organization.

Comment: This process is a part of organization's overall strategy to address the challenges created by an ageing workforce. The process is designed to:

- identify expert incumbents who possess critical knowledge and skills;
- conduct a risk assessment based on two factors: time until retirement and position criticality;
- determine the most appropriate method(s) for addressing potential knowledge loss through attrition;
- establish knowledge retention plans that meet continuously changing business needs;
- provide a process to review results and ensure knowledge retention plans are monitored and evaluated.

See *attrition, critical knowledge, exit interview*, *knowledge retention plan* and *position criticality*.

knowledge management

An integrated, systematic approach to identifying, acquiring, transforming, developing, disseminating, using, sharing, and preserving knowledge, relevant to achieving specified objectives. Knowledge management helps an organization to gain insight and understanding from its own experience. Specific activities in knowledge management help the organization to better acquire, store and utilize knowledge.

Note: Knowledge management consists of three fundamental components: people, processes and technology. Knowledge management focuses on people 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 and make knowledge

accessible which will allow people to work together without being located together. People are the most important component. Managing knowledge depends upon people's willingness to share and reuse knowledge.

knowledge management solution

A solution to a knowledge management problem or the use of knowledge management techniques to solve an organizational problem.

Comment: Examples of knowledge management solutions include upgrades of plant procedure systems to provide additional detail, mentoring assignments for employees soon to retire, and more structured on-job training programmes.

knowledge management strategy

A detailed plan outlining how an organization intends to implement knowledge management principles and practices in order to achieve organizational objectives.

Comment: There are many strategies used to preserve knowledge. Primarily, the activities to be deployed largely depend on the nature of knowledge: tacit knowledge requires greater efforts to preserve knowledge than explicit knowledge. While tacit knowledge can be preserved only by transferring it to successors or simply other people (a so-called personalization strategy), explicit knowledge benefits from the possibility of articulation or codification and being stored, with the help of advanced information and communication technologies. Preserving tacit knowledge is equal to transferring tacit knowledge to other employees or to engage in a knowledge transformation process that transforms tacit knowledge to explicit knowledge. Such endeavors are highly time-consuming.

Generally, two categories of knowledge preservation strategies (activities) can be discerned: personalization strategies (knowledge transfer) and codification strategies (knowledge articulation/elicitation). See *articulation, codification,* and *knowledge*.

knowledge mapping

A process to determine where knowledge assets are in an organization and how knowledge flows operate within the organization. Evaluating relationships between holders of knowledge will then illustrate the sources, flows, limitations, and loss of knowledge that can be expected to occur. See *knowledge assets* and *knowledge flows* and see also *concept maps*.

Comment: Knowledge mapping normally results in a knowledge map (K-Map), which is a tangible representation or catalogue of the concepts and relationships of knowledge. The catalogue is a navigational aid that enables a user to find the desired concept, and then retrieve relevant knowledge sources. A number of IT solutions is available to support and effectively apply knowledge mapping process into an organizational practice.

knowledge package

A knowledge base which brings together related components of knowledge, often extracted during the exit interview process. A knowledge package is a collection of linkages, often to websites or information repositories. It will be structured using taxonomy, linking together people and documents on a particular topic. Within the nuclear industry it has been used successfully in relation to technologies and NPP operations.

knowledge officer

A role with responsibility for implementing knowledge management principles and practices. See also *chief knowledge officer*.

knowledge portal

A comprehensive access structure to resources (a Web "supersite") that provides a single, often personalized interface point for accessing and consolidating information from disparate sources.

Comment: Knowledge portals are suitable to support the fundamental activities of knowledge management in a given knowledge domain to communicate, study and do research. Knowledge portals can be used to access knowledge repositories and communities of practice. Typical resources that should be accessible via a knowledge portal are information items about places of learning, opportunities for learning and research, experts, meeting opportunities, factual data and informative texts. See *communities of practice* and *knowledge repositories*.

knowledge preservation

A process of maintaining an organisational system of knowledge and capabilities that preserves and stores perceptions, actions and experiences over time and secures the possibility of recall for the future.

Comment: The preservation of knowledge is an important building block within the knowledge management field. Organisations that intentionally manage their experiences for them to be available for the future have to master three basic processes of knowledge management:

- select, from the large number of organisational events, persons or experts and processes, only those that are worth preserving;
- store their experience in a suitable form;
- ensure the setting up and operation of the organisational memory.

knowledge repository

A place to store and from which to retrieve explicit knowledge.

Comment: An example of a low-technology knowledge repository is a set of file folders. A high-technology knowledge repository might be a database.

knowledge sharing

A process that leads to knowledge capture and transfer.

knowledge retention plan

A plan that identifies the critical knowledge and positions in an organization, and methods to be used for addressing potential knowledge loss through attrition, and the process that will ensure that the plan is continually updated to meet changing business needs. See *attrition* and *critical knowledge*.

knowledge transfer

The transfer of knowledge in a broad array of settings: between individuals, groups of individuals, communities, organizations, industries, or even nations.

Comment: Several "levels of transfer" can be distinguished, depending on complexity. At *level I*, the objects of transfer are data and materials (materials, components, intermediate and end products, etc.). Such knowledge transfer will not enable the recipient to recreate the sender's knowledge. At *level II* the sender transfers documentation and blueprints and the necessary information to manufacture products based on documentation and blueprints. Documentation and blueprints correspond to the explicit knowledge of the original

technology developer. At *level III* the recipient is able to reproduce the knowledge and change it, adapting it to different conditions. Such transfers have to be accompanied by elements of *level I* and *II* transfers for the recipient to fully understand the sender's knowledge. See *knowledge sharing*.

knowledge worker

An employee whose role relies on an ability to find and use knowledge. Often acts as a gatekeeper or conduit within an organization.

learning

See *adaptive learning*, *e-learning*, *double-loop learning*, *generative learning*, *learning histories*, *learning organization*, *organizational learning*, and *single-loop learning*.

learning histories

Explicit knowledge that has been developed from storytelling by individuals who are familiar with activities and events, in order to record their observations, perspectives and interpretations for analysis and use by others in performance-improvement initiatives.

Comment: Such documenting processes typically involve small groups of people familiar with the topic and can be in formats varying from simple narratives to elaborate compilations. The development processes themselves have the potential of increasing involvement and trust, raising sensitive issues that otherwise might not be put forward, transferring knowledge beyond the immediate source environment, and building a body of management knowledge about what works and what does not work (and, in some cases, why). In the nuclear industry, developing learning histories can serve not only the above purposes but also enhance the enjoyment and effectiveness of training exercises that are designed to convey operating experience and lessons learned. See *knowledge* and *storytelling*.

learning organization

An organization whose key personnel view its future success as being based on continuous learning and adaptive behavior. The organization, therefore, becomes renowned for creating, acquiring, interpreting and retaining knowledge and then modifying its behavior to reflect new knowledge and insights. See *organizational culture.*

lessons learned

Concise descriptions of knowledge derived from experiences that can be communicated through mechanisms such as storytelling, debriefing etc, or summarized in databases. See *database* and *storytelling*.

Comment: Such lessons often reflect on "what was done right," "what should be done differently," and "how to improve the process and product to be more effective in the future." In the nuclear industry, operating experience feedback is an example of an applied lessons learned programme.

leverage

The realization of the inherent value of an asset – physical or knowledge-based – beyond what is currently being realized. In short, to get more value out of it. See *knowledge assets*.

mentoring

A relationship between an experienced individual and a less experienced individual that exists in a one-on-one fashion, designed to enhance understanding of, and ability to put into practice, knowledge and skills possessed by the mentor. Such relationships are usually

established for extended periods of time and typically have general rather than specific objectives.

Comment: The role of a mentor is to transfer from the mentor to the menthe ideas and thought processes that are designed to foster critical thinking skills, self-confidence, and role maturity rather than to teach physical capabilities to perform specific tasks. In the nuclear industry, mentoring is often used to pair more senior personnel with junior personnel to assist the latter with professional and career development. See also *coaching* and *reverse coaching* and *mentoring*.

multi-skill assistance

A process in which an individual or team arranges a meeting or a workshop in order to make use of the knowledge and experience of others before embarking on a project or activity.

Comment: In the nuclear industry some organizations have established multi-skilled teams for maintenance work, where each team has the collective skills needed to complete their assigned work. Often team members provide cross-training for other team members on simpler tasks in their discipline for team members to be individually assigned to a broader range of tasks. Also termed *peer assistance*.

network

(a) A connection of two or more institutions that enables them to share information resources.

(b) A wide variety of systems of interconnected components. Specific examples include:

- social networks, business networks and entrepreneurial networks;

- computer networks, which transfer information between computers. Specific configurations include star networks and grid networks. The entire World Wide Web are also networks.

Comment: The Asian Network for Education in Nuclear Technology (ANENT) supported by the IAEA is a new partnership for co-operation in human resource development and research in nuclear technology as a key strategy for capacity building, nuclear infrastructure development and better use of available information resources. ANENT was established in February 2004, to promote, manage and preserve nuclear knowledge; to ensure the continued availability of talented and qualified manpower in the nuclear field in the Asian region; and to enhance the quality of the human resources for the sustainability of nuclear technology. Universities, research centres, government agencies and other institutions involved in nuclear education and training in the region, are accepted as participating members of ANENT, whilst international or regional networks are collaborating members. Currently there are 28 participating institutions from 12 countries (Australia, China, India, Indonesia, Malaysia, Mongolia, Pakistan, Republic of Korea, Sri Lanka, Thailand, Philippines and Vietnam) and six networks as collaborating members. See also *extranet* and *intranet*.

nuclear knowledge portal

A knowledge portal that focuses on resources in the domain of nuclear knowledge. See *knowledge portal*.

organizational culture

A mixture of an organization's traditions, values, attitudes and behaviors.

Comment: In knowledge management, an organization's culture is extremely important – if it is not based on qualities such as trust and openness, then knowledge management initiatives are unlikely to succeed. In the nuclear industry some organizations use organizational culture

surveys, which help managers to know the extent to which the organizational climate supports the sharing of knowledge. See *culture*.

organizational learning

The ability of an organization to gain knowledge from experience through experimentation, observation, analysis and a willingness to examine both successes and failures, and to then use that knowledge to do things differently.

Comment: While organizational learning cannot take place without individual learning, individual learning does not necessarily produce organizational learning. Organizational learning occurs when an organization becomes collectively more knowledgeable and skillful in pursuing a set of goals.

organizational memory

An alternative term for corporate memory. See *corporate memory* and *institutional knowledge.*

peer assistance

An alternative term for multi-skill assistance. See *multi-skill assistance*.

peer review

A process used for checking the work performed by one's equals (peers) to ensure it meets specific criteria.

Comment: Peer review is used in working groups for many professional occupations because it is thought that peers can identify each other's errors quickly and easily, speeding up the time that it takes for mistakes to be identified and corrected., The goal of all peer review processes is to verify whether the work satisfies the specifications for review, identify any deviations from the standards, and provide suggestions for improvements.

portal

A special web page that organizes access to all of the online resources relating to a topic, similar to providing a "one-stop shop".

position criticality

The importance of a particular position relative to all positions being considered in an assessment of available qualified staff to perform the functions necessary to assure safe, reliable, cost-effective operation.

Comment: In the operation of a nuclear power plant, it is obvious that the positions occupied by those persons who operate the control room are more critical those that of nuclear engineers whose work will be checked and re-checked by peers and responsible managers before being accepted for action. Both roles are important to power plant operation; however, the former can influence the reactor's operation directly and immediately, whereas the latter's impact is indirect and subject to intermediate assurances of correctness.

post-job briefing

An alternative term for after-action review. See *after-action review*.

pre-job briefing

A process that involves conducting a structured and facilitated discussion before a task or project is performed to explain what should happen. See also *after-action review*.

records management

Processes relating to the generation, receipt, processing, storage, retrieval, distribution, usage and retirement of organization's records.

Comment: A means of helping an organization to make sure it is creating and maintaining an adequate documentary record of its functions, policies, decisions, procedures, and essential transactions, whether in paper, film, electronic record, or some other medium. Records management thus helps the organization to decide which records to keep and which to destroy and how best to organize them all. See also *document management*.

reverse coaching and mentoring

A relationship by which senior individuals in an organization can learn from junior personnel whose experiences, skills and thought perspectives differ from their own.

Comment: Even where formal 'reverse relationships' are not established within an organization, this is a critical strategic consideration as the demographic profiles of the work force and social dynamics change from traditional patterns to ones that tend to create generation gaps. In the nuclear industry, such relationships hold the potential to improve new employees' feelings of contributing and being valued for what they bring to the organization; to enhance diversity initiatives; to facilitate the learning by more senior personnel of new skills from less senior personnel (such as computer utilization and understanding the jargon of younger employees and their peer groups).

review

See *after-action review*, *after-event review,* and *peer review.*

root cause analysis (RCA)

A generic problem-solving methodology employed to determine the fundamental causes (root causes) of events that have an impact on safety, health, environment, quality, reliability, or production. Such systematic investigations help identify "why, what and how" something happened so that recurrence might be prevented.

Comment: Events rarely have a single root cause. Thus, it is critical that a Root Cause Analysis (RCA) team does not "jump to judgment" and that a sufficiently thorough investigation is made to be reasonably certain that all underlying causes have been identified and that relevant, but non-causal factors, have been filtered out during the RCA process.

search engine

A software program that searches a database and gathers and reports information that contains or is related to specified terms.

Comment: The term search engine is most commonly used to refer to Web search engines, although other types of search engines exist. Web search engines attempt to index a large portion of pages on the World Wide Web. Other search engines are topic-specific, region-specific, and even site-specific.

single-loop learning

An alternative term for adaptive learning. See *adaptive learning* and *double-loop learning*.

skills directory

See *yellow pages*.

socialization

The process of sharing tacit knowledge by bringing people together to facilitate observation, discussion, imitation and practice.

Comment: One way of implementing socialization is by storytelling. However, the transfer of tacit knowledge through socialization, without the creation of explicit knowledge in the process, is a rather limited form of knowledge creation. Because of this, the nuclear industry has structured training programmes to achieve not just tacit-to-tacit knowledge creation, but also explicit-to-explicit, tacit-to-explicit, and explicit-to-tacit knowledge transfer. See *storytelling* and *exit interview*.

social network

A way of describing systems composed of multiple elements that are related in some way. Each element, or node, may or may not have a relationship with the other nodes. In an organizational context "nodes" are people and "relationships" might be a subject (e.g. "customer needs") that the "nodes" discuss, or might be a physical activity (e.g. "are in contact with as part of normal work"). Often, the "relationship" between two people is further described by a frequency, indicating how often the relationship is active.

Comment. Effective knowledge-sharing is a key to success in most organizations. Social network analysis can document how knowledge is currently shared within the organization and help identify simple initiatives that often lead to a dramatic increase in knowledge sharing. Social network analysis can also help managers to understand how knowledge enters and flows within an organization. It can also identify pools of knowledge within the organization and can document how accessible it is to others. See *knowledge*.

storytelling

The practice of relating personal recollections, impressions, perspectives, observations, and interpretations, typically with the aim of conveying a particular series of events that collectively convey a message that is of use to the listeners.

Comment: Civilization has spread and advanced through the gathering of people to orally share perspectives and interpretations of events in their lives and in the lives of others. From such activities, "stories" have emerged that have been transferred beyond the original gathering in both oral and written forms. This practice is used in business and industry to transmit tacit knowledge orally and to develop learning histories that can then be utilized extensively for a variety of purposes. Often metaphors are efficiently used within the storytelling process. See *learning histories*.

succession planning

A methodology for identifying and developing employees to ensure that key organizational positions can be filled with qualified internal candidates, in advance of actual need, and to assist in managing diversity and workforce planning.

Comment: In the nuclear industry succession planning is often used for management and senior scientific and technical positions.

tacit knowledge

See *knowledge*.

taxonomy

A hierarchical structure in which a body of information or knowledge is categorized, allowing an understanding of how that body of knowledge can be broken down into parts and how its

various parts relate to each other. Taxonomies are used to organize information in systems, thereby helping users to find it.

thesaurus

A hierarchical arrangement of related words and phrases often displayed in systematized lists of synonyms.

undocumented knowledge

Knowledge in an organization that has not been documented in such a way that it is accessible to those who may need it.

Comment: Undocumented knowledge can be tacit knowledge which may be very difficult to elicit, such as clues that an experienced field operator uses to anticipate problems at an NPP, or knowledge that can easily be externalized, such as an engineer's informal calculation of the basis for the minimum required feed water flow that has never been included in the appropriate plant system description document. See *knowledge*.

virtual

Something that exists or is brought together via electronic networks, rather than existing in a single physical place. See also *portal* and *virtual team*.

virtual team

A team whose members are not located together but who utilize electronic networks for communication, collaboration and work processes.

work force planning

The process that identifies or anticipates vacant positions and the required staffing levels and skills to ensure the retention of institutional knowledge and critical skills and competences to support future business strategies.

Comment: This information addresses potential gaps between current and projected work force needs. It takes into account diversity and labour costs and so becomes a part of the staffing plan in an organization's business plan. It includes attrition data, planned retirements, vacant positions, development plans, succession plans, and current work force requirements. See *attrition*, *institutional knowledge* and *succession planning*.

yellow pages

A directory in the form of a database that includes details of people's skills, knowledge, experience and expertise so that users can search for people with specific knowledge. See *skills directory*.

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