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Decommissioning of Nuclear Facilities: Training and Human Resource Considerations

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DECOMMISSIONING OF NUCLEAR FACILITIES: TRAINING AND HUMAN RESOURCE CONSIDERATIONS

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FOREWORD

In 2006 the IAEA published Safety Requirements No. WS-R-5 *Decommissioning of Facilities Using Radioactive Material*. This publication includes the important requirements regarding the personnel involved in a decommissioning project, including competence, training, qualification, and retaining of the personnel.

In 1996 the IAEA published Technical Report Series No. 380 *Nuclear Power Plant Personnel Training and its Evaluation: A Guidebook*, which provides guidance with respect to development, implementation, and evaluation of training programmes. This guidebook recommends the Systematic Approach to Training (SAT) as the best practice for attaining and maintaining the competence and qualification of personnel. The SAT has subsequently been adopted by Member States; and the methodology is being applied to all types of nuclear facilities for various phases of a nuclear facility life cycle including the operational phase and decommissioning phase. The IAEA Technical Working Group on Training and Qualification of NPP Personnel recommended that a report be prepared to provide practical information and specific examples of good practices in the training of personnel for the decommissioning phase of nuclear facilities, including guidance on the application of the SAT methodology to decommissioning training.

Decommissioning of nuclear facilities is a process involving activities such as radiological characterization, decontamination, dismantling of facility systems and equipment, and the handling of waste and other materials. Many organizational and management needs arise during the course of decommissioning projects. While a significant amount of attention has been focused on the technical aspects of decommissioning and many IAEA publications have been developed to address technical aspects, human resource considerations — particularly the training and qualification of decommissioning personnel — are becoming more paramount with the growing number of nuclear facilities of all types that are reaching or approaching the decommissioning phase. Training alone can not ensure the required competence. Change management, human performance improvement and knowledge preservation polices and practices also need to be implemented to promote adequate performance of the personnel involved in decommissioning. Training of personnel for undertaking the decommissioning project should be viewed as the integral part of the human resource management process. This report is intended to supplement and support other IAEA technical publications on decommissioning and personnel training.

This publication provides information and examples on decommissioning training and other human resource considerations based upon experience in a variety of Member States. The body of the report provides general information that represents practices of the Member States that contributed to the development of the publication. The information was obtained from a request that was sent to the Member States for examples of decommissioning training practices. In addition to the examples included in the printed report, an accompanying CD-ROM contains more comprehensive examples.

Appreciation is expressed to all Member States for their valuable contributions and to all of the participants listed at the end of this publication, who contributed. Particular appreciation is expressed to M. Rodriguez (Spain), A. Scott (United Kingdom) and J. Yoder (United States of America) for their assistance in the development and compilation of this publication. Particular thanks are due to J. Yoder (United States of America) for his editorial work. The IAEA officer responsible for this publication was A. Kazennov of the Division of Nuclear Power.

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1. INTRODUCTION

1.1. Background

With the growing number of nuclear power plants and other types of nuclear facilities reaching or approaching the decommissioning phase, it is timely to gather and disseminate lessons learned and good practices in one of the key activities for the success of decommissioning — assuring the competence of personnel involved in decommissioning activities. The operating organizations of nuclear facilities normally possess limited expertise in decommissioning and consequently rely on a number of specialized organizations and companies that provide the services related to the decommissioning activities. Because of this there is a need to address the issue of assisting the operating organizations in the development and implementation of human resource management policies and training programmes for the facility personnel and contractor personnel involved in various phases of decommissioning activities.

In some decommissioning projects, attention has largely focused on the technical aspects of decommissioning, with relatively little attention being given to personnel-related issues. One of the keys to success is the training of the various personnel involved in decommissioning in order to develop the necessary knowledge and skills required for specific decommissioning tasks. The appropriate use of operating personnel knowledge of the facility and its systems is invaluable for successful performance of decommissioning activities.

Adequate numbers of competent and motivated personnel must be available during any phase of a nuclear facilities life cycle. From the regulatory perspective, the licensing requirements define that the licensee needs to be able to demonstrate that adequate numbers of competent personnel are available until the facility is finally removed from regulatory control. The licensee should consider the options to fulfill the licensing requirements and select the option best suited to satisfy its needs. These needs are satisfied, in particular, through the appropriate management of human resources and personnel training.

The IAEA Safety Requirements No. WS-R-5 *Decommissioning of Facilities Using Radioactive Material* [1] include the important requirements regarding the personnel involved in a decommissioning project. In particular, item 3.8 of these requirements defines that the responsibilities of the operating organization include ‘Ensuring that properly trained, qualified and competent staff are available for the decommissioning project’. Item 5.9 defines that ‘Provision shall be made, as far as possible, to ensure that key staff are retained and that institutional knowledge about the facility is maintained and is accessible’. Item 7.3 defines that ‘The skills needed for decommissioning shall be evaluated and the minimum requirements for qualifications of staff in each position shall be established. It shall be ensured that an individual responsible for performing an activity during the decommissioning process has the necessary skills, expertise and training to complete the decommissioning process safely’. Item 8.4 of these requirements defines that ‘In order to provide an adequate level of safety, the operating organization shall, inter alia, prepare and implement appropriate safety procedures; apply good engineering practice; ensure that staff are properly trained and qualified and are competent; and keep and submit records and reports as required by the regulatory body.’

This report was recommended by the IAEA International Working Group on Training and Qualification of NPP Personnel (IWG-T&Q) in 2000 and supported by a number of the IAEA meetings on NPP personnel training. The need for Agency involvement in this area was

reinforced during the biennial meetings of the Technical Working Group on Training and Qualification of NPP Personnel (TWG-T&Q) in March 2002 and March 2004.

To obtain more detailed information on current practices related to decommissioning training a list of required examples on training for the decommissioning phase of nuclear facilities was developed and sent out to Member States to collect examples for use in the printed form of this report and also for including on an accompanying CD.

1.2. Purpose

The purpose of this report is to disseminate good practices and provide recommendations in training and other human resource aspects such as human resource management and human performance improvement for the personnel performing decommissioning activities, in order to assist the nuclear facility operating organizations in Member States in:

— enhancing safety of the facility personnel, contractor personnel, and the public;
— decreasing the collective and individual radiological doses;
— decreasing the time to complete the particular decommissioning operations;
— decreasing the risk levels associated with both radiological and industrial hazards;
— reducing the financial resources necessary for performing the particular tasks; and
— establishing a nuclear facility integrated management system for safe and efficient undertaking a decommissioning project; the system which human resources management, training and human performance improvement are the important processes in.

1.3. Scope

This publication considers many aspects related to assuring the competence of personnel involved in the decommissioning phase of nuclear facilities. The information in the text of this publication and the examples used are representative of the experience of decommissioning a wide variety of nuclear facilities. The use of the systematic methodology and techniques described in the publication may be tailored and applied to the development of training for all types of nuclear facilities undergoing decommissioning.

The report is not intended to address project management topics such as cost estimation, budgeting and scheduling, but rather provides an overview of training requirements, objectives, and practices for all categories of personnel involved in decommissioning with a concentration on the needs of training the workers who will be performing the system isolation, decontamination, dismantling, and decommissioning tasks.

Section 2 provides general information related to human resources management. Section 3 discusses some of the key differences and issues in transitioning from the operational phase to decommissioning activities. Section 4 contains information and resources on knowledge management useful for the decommissioning phase. Section 5 addresses the various personnel involved in decommissioning activities who may need training, and the applicability of the systematic approach to training methodology for the development and implementation of training. Sections 6 and 7 then provide an overview of training needs for management and professional staff, with an emphasis on the training of the workers who perform the hands-on decommissioning activities. Section 8 identifies several ongoing programmes that can be utilized to improve the efficiency and effectiveness of decommissioning training. Sections 9 and 10 then conclude with a discussion of instructor training, training facilities and equipment. Section 11 summarizes in the conclusion of this report, for the nuclear facility

operating organization managers, a strategic vision for the use and competence of human resources needed for successful underrating a decommissioning project.

One appendix lists decommissioning-related publications published by the IAEA that provide technical information that may be useful for the development of training. The twenty-three appendices are specific examples provided by Member States that expand upon, and support, each of the main sections of this publication. The last appendix serves as an executive summary of the report for the operating organization managers and supports a development of a management vision for the use and competence of human resources in the decommissioning projects. The eleven sections and twenty-five appendices are followed by a list of publications that are referred to in the preceding sections. Annex I contains the list of the examples requested from Member States, followed by an index of the contents of the accompanying CD in Annex II. The CD that accompanies this report contains over 80 documents.

An executive summary of this report — that may be especially useful for the nuclear industry managers — may be found in Appendix 25.

1.4. Intended users of this publication

This report is intended to be used by:

— managers of the nuclear facility operating organizations;

— managers of the decommissioning projects;

— personnel involved in human resource management in the nuclear facilities;

— nuclear facility training staff;

— regulatory body personnel;

— staff of the training organizations;

— developers of training programmes, training material and training tools in support of the decommissioning projects;

— managers and personnel involved in improvement of human performance within the decommissioning projects;

— personnel involved in the establishment of integrated management systems for the nuclear facilities preparing for or undertaking the decommissioning.

1.5. Relationship to other IAEA publications

In using this report the reader should be aware of other key IAEA publications on nuclear facility decommissioning such as provided in the references [1–9].

A list of the IAEA decommissioning-related publications that may be useful references for the development of decommissioning training is included in Appendix I.

In addition the reader should also be aware of the IAEA publications on the training, qualification, human resource management, human performance improvement and knowledge management of NPP and site personnel such as provided in the references [10–22].

This report draws on the preceding reports and is intended to provide practical information along with Member State examples of actual decommissioning training requirements, objectives, and materials.

1.6. Definitions

The following are definition of terms used in this report. These terms unless otherwise noted are taken from references [1] and [6].

Decommissioning - Administrative and technical actions taken to allow the removal of some or all of the regulatory controls from a facility (except for a repository which is closed and not decommissioned).

Decommissioning plan - A document containing detailed information on the proposed decommissioning of a facility.

Deferred dismantling (sometimes called safe storage, safe store or safe enclosure) - the strategy in which parts of a facility containing radioactive contaminants are either processed or placed in such a condition that they can be safely stored and maintained until they can subsequently be decontaminated and/or dismantled to levels that permit the facility to be released for unrestricted use or with restrictions imposed by the regulatory body.

Entombment - the strategy by which radioactive contaminants are encased in a structurally long lived material until radioactivity decays to a level permitting the unrestricted release of the facility, or release with restrictions imposed by the regulatory body.

Immediate dismantling - the strategy by which the equipment, structures and parts of a facility containing radioactive contaminants are removed or decontaminated to a level that permits the facility to be released for unrestricted use, or with restrictions imposed by the regulatory body. In this case decommissioning implementation activities begin shortly after the permanent cessation of operations. This strategy implies prompt completion of the decommissioning project and involves the removal of all radioactive material from the facility to another new or existing licensed facility and its processing for either long term storage or disposal.

Nuclear facility - A facility and its associated land, buildings and equipment in which radioactive materials are produced, processed, used, handled, stored or disposed of on such a scale that safety must be considered.

Operation - All activities performed to achieve the purpose for which a facility was constructed.

Operational period (operating period) - The period through which a facility is being used for its intended purpose until decommissioning or closure.

Operator (operating organization) - Any organization or person applying for authorisation or authorized and/or responsible for nuclear, radiation, radioactive waste or transport safety when undertaking activities or in relation to any nuclear facilities or sources of ionizing radiation. This includes, inter alia, private individuals, governmental bodies, consignors or carries, licensees, hospitals, self-employed persons, etc. (IAEA provided definition)

Permanent shutdown - That point in the life of a plant when it reaches the end of the operational period, at which point there is no intent to restart operations.

Safe enclosure (SE, during decommissioning) - A condition of a nuclear facility during the decommissioning process in which only surveillance and maintenance of the facility takes place.

Transition period - The period through which the administrative and technical activities to take the plant from the operational period to placement in a safe, stable and known condition in preparation for SE and/or dismantling are planned and implemented.

2. MANAGEMENT OF HUMAN RESOURCES

2.1. Influences of decommissioning strategies

Training is one of the essential tools required to achieve a successful transition from the operating phase of a nuclear facility to the decommissioning phase and to implement the decommissioning strategy. The training requirements will, however, depend, to a large extent, on the factors that are summarised below.

Role of the plant operator in decommissioning

If the plant operator is responsible for decommissioning of the facility and carries out the decommissioning using his own personnel, the training should be aimed at training personnel in the specific aspects of decommissioning. As the existing staff is familiar with the facility systems, configuration, and operating history of the facility; less attention needs to be given to training in these areas.

If the responsibility for decommissioning is the plant operator, but the decommissioning is performed with the support of specialist contractors, then it is necessary to ensure that the contractor personnel are adequately trained in decommissioning. The contractor personnel also need to be provided with sufficient information and/or training in relation to the facility systems, configuration and operating history. Reference [12] provides guidance on assuring the competence of contractor personnel.

Period elapsing between plant shutdown and the initiation of decommissioning

The longer the time between plant shutdown and the start of decommissioning, the greater is the risk of the plant operator losing employees through retirement or through their leaving the company. In this situation, there is greater need for an active policy of retention of the know-how and of training, in order to capture the experience and knowledge of the outgoing personnel and to transfer the captured knowledge to the newly involved personnel.

Similarly, if the waiting period is very long, there is also a risk of documentation of value for the decommissioning being lost, through deterioration or through being lost or misplaced. In order to mitigate this potential problem, it is necessary to apply rigorous document management and record keeping policies, including correct classification, indexing, and digitisation of the relevant documents.

Decommissioning option selected

The “entombment” option is obviously the one requiring least effort from the point of view of training and retaining know-how.

The “deferred dismantling” option requires little initial effort in training, since the initial responsibility for plant surveillance is normally with the operator; however may require a significant effort in training at later stages for the training of newcomers. It is advisable to make efforts in knowledge preservation, such that the existence of appropriate information and documentation and availability of preserved knowledge are ensured when decommissioning is carried out.

The “immediate dismantling” option requires early development of training for the personnel that are to be involved in decommissioning. The availability of the documentary records generated during construction and operation is considered necessary for decommissioning.

Foreseen duration of decommissioning

An excessively lengthy decommissioning process may have the same effects as a decommissioning deferred in time; that is to say, the loss of human resources, information and valuable documentation. In order to mitigate these effects, it is considered appropriate to maintain a continuous policy of training, retention and the transfer of knowledge throughout decommissioning.

In general, the aforementioned factors may be reduced to the following:

— **Factor 1**: Time elapsing between the shutdown of the plant and the foreseen completion of decommissioning (“Elapsed time until decommissioning completion”).
— **Factor 2**: Number of new workers entering the decommissioning process (“Percentage of new personnel”).

The behaviour of these factors (high or low values) determines the effort required in the following areas:

— **TD**: Training on specific aspects of decommissioning.
— **TP**: Training on aspects relating to the configuration and operating history of the plant.
— **KM:** Retention of knowledge (including its documenting).

These factors are shown qualitatively in Figure 1.

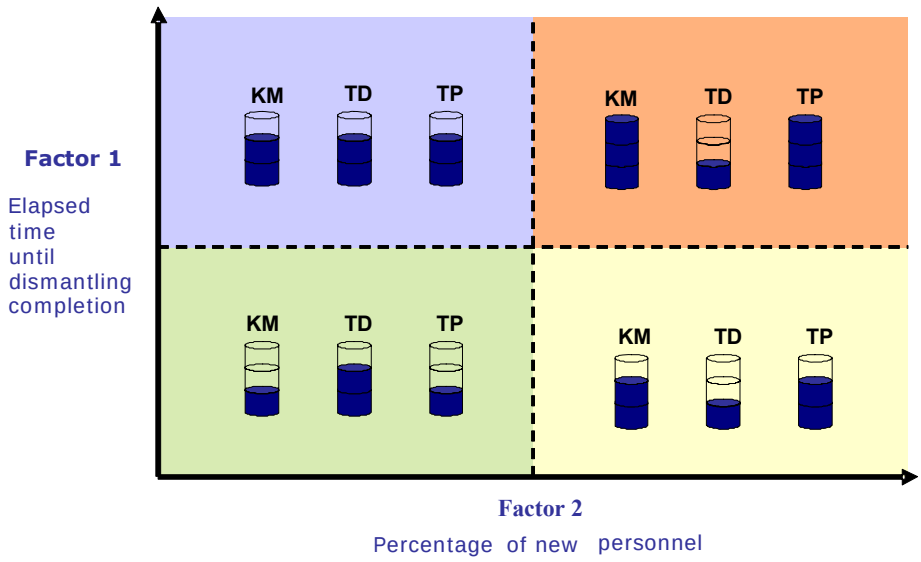


Fig. 1. Relative training needs of personnel as a function of elapsed time for decommissioning.

The following may be observed in the figure:

(a) Decommissioning processes deferred in time and to be performed by personnel other than the plant operators (upper right-hand quadrant) require very successful management of knowledge before decommissioning commences, and require a significant amount of training on the characteristics of the facility. It is assumed that the decommissioning will be performed by personnel having expert knowledge in this area, for which reason this aspect will not be as relevant from the point of view of the necessary training.

(b) At the other end of the scale, decommissioning processes initiated immediately following plant shutdown and performed fundamentally by the operating personnel (lower left-hand quadrant) require training on decommissioning aspects, the other two aspects not being as significant.

(c) The two remaining options require significant effort in knowledge management and specific training on the plant, since decommissioning is either prolonged considerably over time or is performed by personnel with no knowledge of its operating history. Likewise, both require training on decommissioning, this being more intensive if the work is to be performed by the personnel of the plant operator.

Other factors which influence the training needs in decommissioning include:

— the influence of new technologies related to specific decommissioning activities;
— the necessity to re-train the personnel in relatively short periods of time in accordance with the decommissioning plan;
— the existence of many one-of-a-kind unique activities;
— the relatively small number of people in the training groups for specific activities;
— the involvement of contractors;
— potential lack of experience in working in a radioactive environment (especially in the later stages);
— increased proportion of non-radioactive risks; and
— possible changes in legislation or regulations reflecting new requirements.

2.2. Worker transition

Adaptation of the Organization

The transition from the operating phase to the decommissioning phase implies a very relevant change, not only with respect to the nature of the activities to be performed but also with respect to the context in which they are performed (see section 3). It is common for this transition to be accompanied by a modification to the organization, in order to adapt it to the new activities and objectives. By way of an example, the following two organization charts (Figures 2 and 3) show the organization in force at a plant during the operating and decommissioning phases.

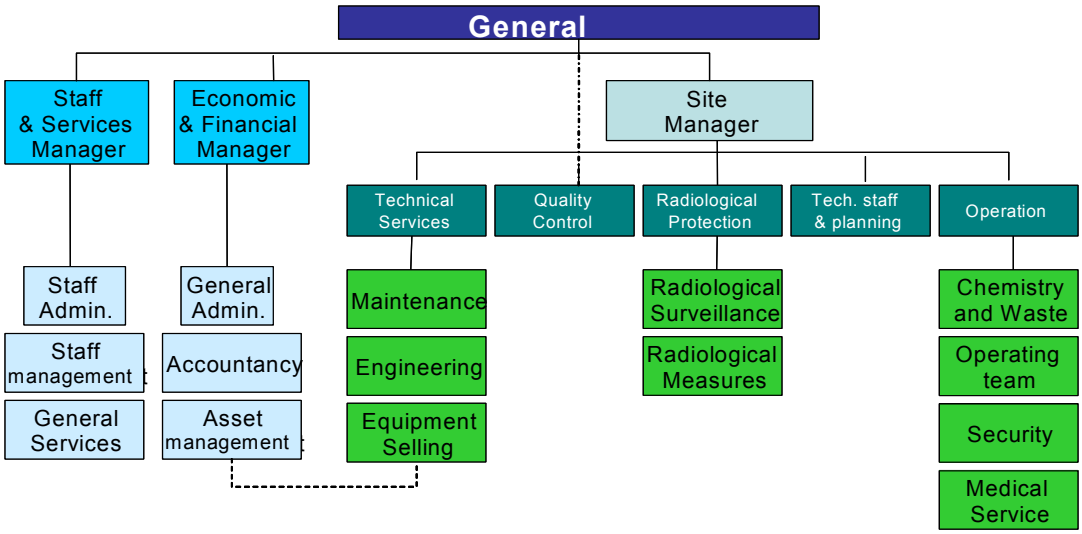


Fig. 2. Operating Organizational Chart.

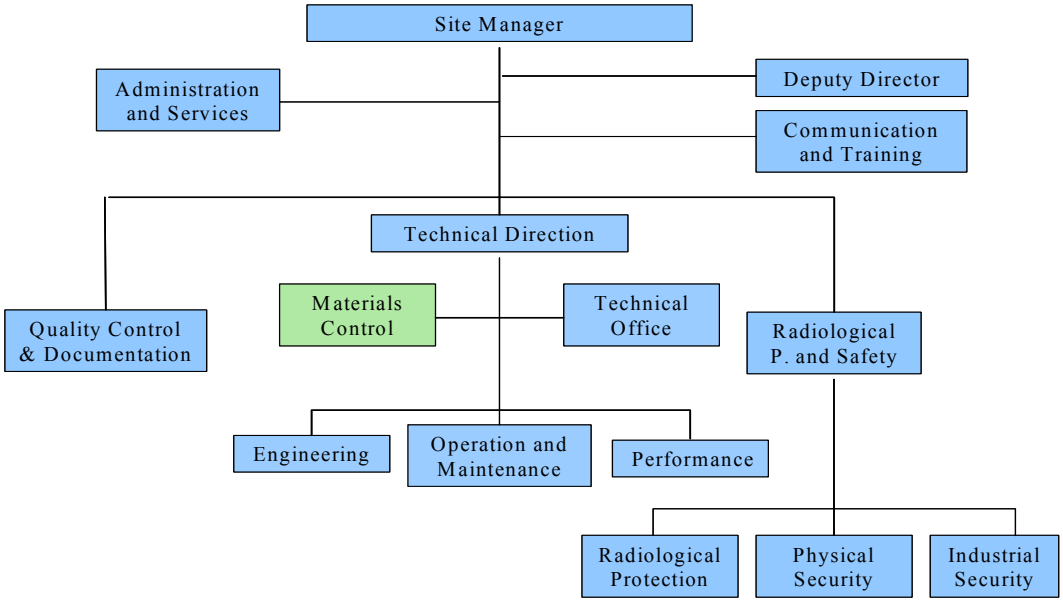


Fig. 3. Decommissioning organizational chart.

In addition to the organizational changes, there may be reassignments of personnel to new job positions/posts, some of them not previously existing during the operating phase; and also the incorporation of external personnel belonging to subcontracted companies. The modifications to the organization should be suitably planned and managed, such that the best possible organization and assignment of personnel to job positions/posts is achieved. In this respect, it is important to know the following:

— the time at which the new organization will be required;
— the necessary job posts, with special attention to newly created posts;
— the number of persons required for each job post;
— the profiles of the available personnel, with their qualifications;
— the dates foreseen for the exit / withdrawal of available personnel;
— the subcontracting policy to be applied;
— the expectations of the plant operator's personnel.

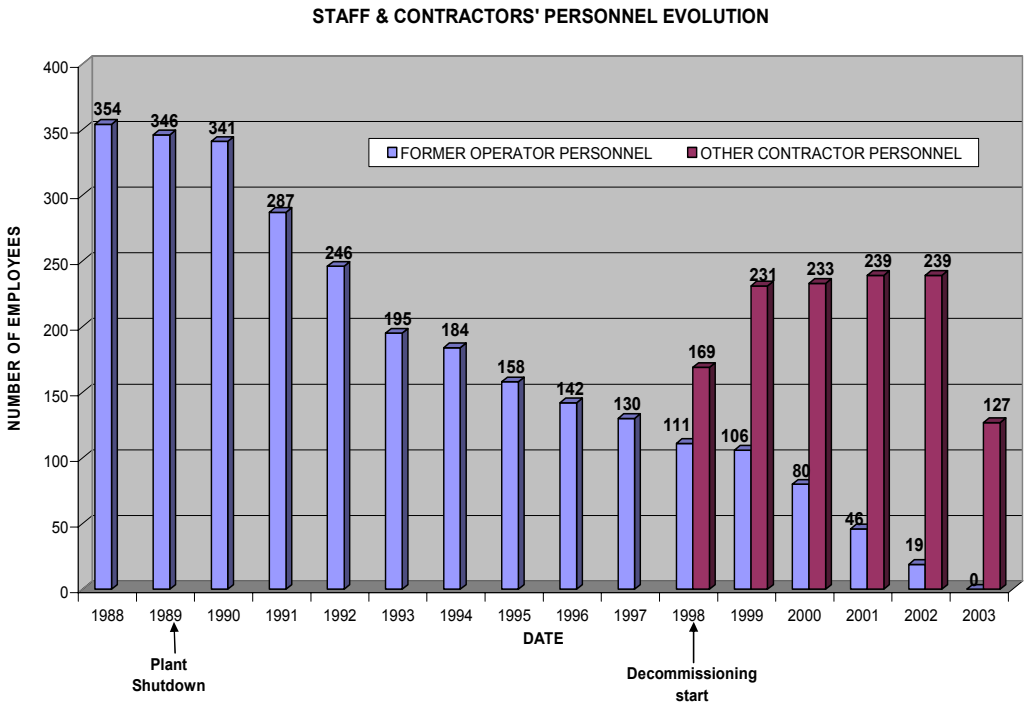
Once these details are known, it will be possible to make an adequate selection of the best profiles for each job post, from among either the operator's personnel or those of third-party companies; and also to identify the overall training needs of the personnel.

Appendix III shows the approach followed by Enresa to design the organization required for the decommissioning of Vandellós I NPP, and the training requirements ("Building up a new organization for decommissioning purposes and training associated"). This Appendix is complemented by a detailed description of the organization established for a department, included in Annex II, item 5 ("Organizational guide" used to build up a new organization for the decommissioning of Vandellos I NPP). Item 54 of Annex II provides another example of a decommissioning organization for the Connecticut Yankee decommissioning project (USA).

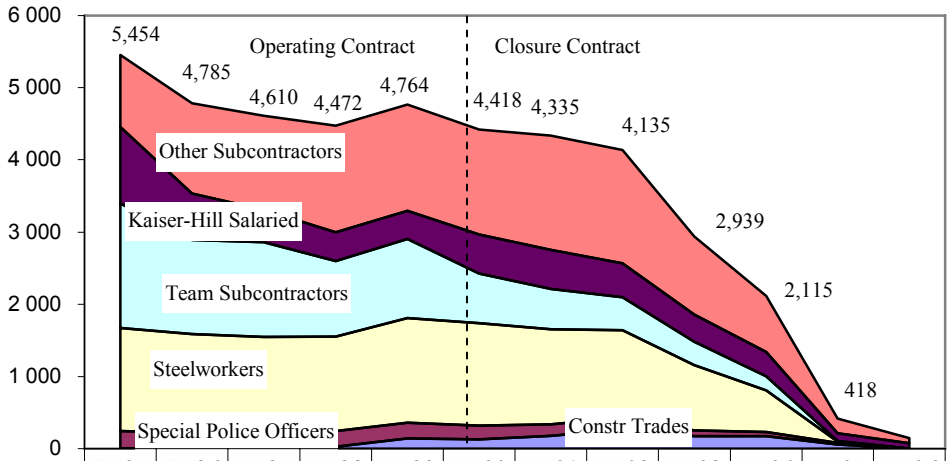
Workforce management

It is particularly important to have insight beforehand of the expectations of the personnel, especially with regard to their interest in possible early retirement options, changing companies, or changing their job post within the company. Active involvement and communication between the company and employees in considering these options may contribute to a better working environment and a more efficient organization.

The following examples (Figures 4 and 5), corresponding to nuclear power plants decommissioned in Europe and the United States, show the evolution of the plant operator's workforce from the time of definitive shutdown to the beginning of decommissioning; and also the different personnel management options adopted.



Site Staff Reduction



	FY95	FY96	FY97	FY98	FY99	FY00	FY01	FY02	FY03	FY04	FY05	FY06
Other Subcontractors	1 000	1 250	1 300	1 475	1 469	1 451	1 583	1 570	1 081	779	204	69
Kaiser-Hill Salaried	1 055	642	451	400	389	540	540	470	379	331	109	76
Team Subcontractors	1 728	1 308	1 312	1 049	1 097	691	560	455	323	195	6	0
Steelworkers	1 425	1 361	1 329	1 305	1 449	1 416	1 315	1 208	901	577	17	0
Special Police Officers	246	224	218	218	216	190	161	165	80	59	23	0
Constr Trades	0	0	0	25	144	130	176	267	175	174	59	0

Fig. 4. Evolution of the plant operator's personnel from definitive shutdown to the completion of decommissioning.

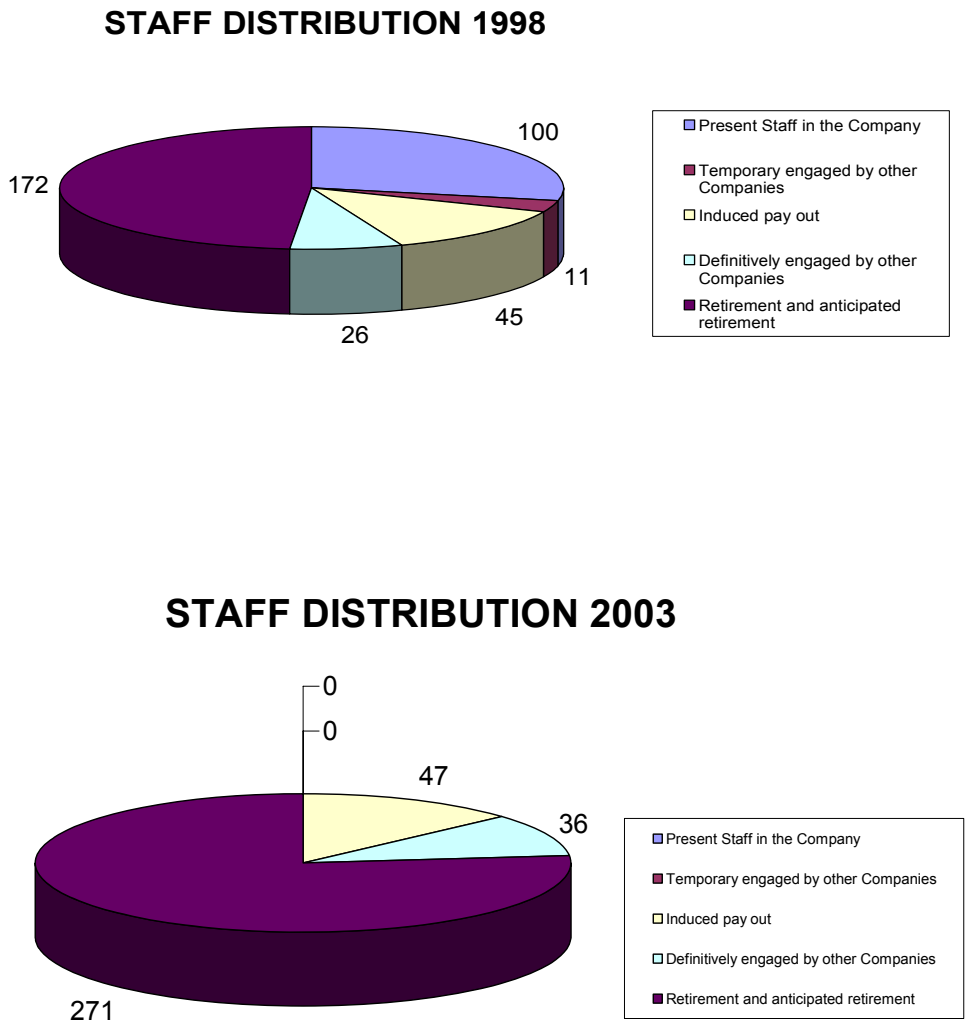


Fig. 5. Management of Plant operator's human resources at the initiation and at the completions of decommissioning.

These graphs show the important impact of the early retirement that was due to the advanced age of the workforce and the support received from the organization. These graphs also reflect a delay of eight years before the initiation of decommissioning. As a result, a significant number of personnel needed to be replaced by personnel from other companies and an ambitious policy of knowledge retention and training are to be implemented.

Some examples on how training may help during the transition to decommissioning are included in Annex II, items 37 and 38.

Selection of the Management Team

It is advisable to pay special attention to the selection of the management team for this new - decommissioning - phase, in order to ensure the availability of the necessary number of qualified individuals, because of the magnitude of the changes implied by decommissioning (see section 3). In the selection of the management team the following factors should, among others, be considered:

- The decommissioning needs to be managed in the same way as an engineering project, with objectives that are clearly identified and mapped out in terms of time.
- The activities to be managed are very dynamic and require rapid and creative decision-making.
- Processes will need to be established that allow for the rapid dissemination of information, and that facilitate coordination between the different disciplines involved (multidisciplinary work performance and control groups).
- Decision-making may require the participation, debate and consensus of a management team representing different points of view and specialities (technical, organizational and communicative skills).

The competence of a senior management team plays the outstanding role in safe and efficient performance of a decommissioning project. Appendix II suggests the core competencies for a senior management team, to be ensured through the appropriate selection, training and development of the decommissioning managers. Importance to possess these core competences may vary for different management functions; however, the senior managers should initiate the analysis in order to identify specific requirements for the knowledge and skills of each member of the senior management team and also the management team group competence. The competencies suggested in Appendix II were identified using a job competency analysis method [15], and reviewed by the managers having 'hands-on' and successful experience in undertaking nuclear facility decommissioning projects in various countries and by the training specialists involved in the area of training for decommissioning. Various nuclear facilities preparing for decommissioning may use the list of these competencies for designing their selection, recruitment, training and development programmes.

An interesting example of a structured management team selection and enabling process is the so-called "DECOTRAIN" project, developed jointly by Sogin, Enresa and BNFL within the framework of the "Leonardo da Vinci Programme", carried out under the auspices of the EC. Item 8 in Annex II is a paper that describes the project "DECOTRAIN".

2.3. Resource management

Once the organization that will undertake the decommissioning has been defined and the decommissioning itself has been initiated, the management team needs to provide supervision of the personnel that occupy relevant job positions in the organization. This is necessary so that maximum personnel performance may be obtained regardless of whether the personnel belong to the plant operator or other companies.

The motivation of subcontracted personnel does not normally represent a problem (it can be "demanded" by contract); although this does not mean that no attention needs to be paid to this issue. It is far from true that subcontracted resources may be perfectly replaced with

others having similar characteristics; there may be profiles that are especially important for the organization and that warrant a treatment similar to that given to the operator's personnel.

It is common for the personnel belonging to the plant operator, with regard to their attitudes and mindsets, to be encountered:

- uncertainty of their professional future;
- lack of stimulus or motivation, because of approaching retirement, or the possible elimination or changes to job functions;
- insecurity, on changing from performance of a well known activity to a new one;
- interest in prolonging the duration of the work packages;
- underutilization of experienced personnel and their "know-how" not being made use of;
- scepticism of the ability of the organization to perform the work.

In order to mitigate the possible negative effects of such attitudes, it is advisable to plan and implement change management policies and practices aimed at motivating the personnel, among which the following are examples:

- Spread the vision of a new stage / new project as important and as much in need of qualified personnel as the previous one (personal and collective challenge).
- Whenever the circumstances allow, offer professional opportunities in the field of decommissioning (emerging activity).
- Train and qualify personnel to new conditions.
- Facilitate mobility between job positions, allowing people to find the best fit position.
- Award new responsibilities such as supervisory responsibilities for other workers.
- Promote employment or the performance of practical interventions among the direct family of the employees (children).
- Facilitate integration into multidisciplinary teams (including contractors) where personal experience is appreciated.
- Link the departure of personnel wishing to leave the organization to the achievement of specific project objectives.
- Implement a policy of evaluation (remuneration, performance awards) based on meeting project objectives.

These change management policies and practices may be applied individually or in combination depending on each specific case. It is important, however, that people having positions of responsibility in the organization have a suitable level of motivation and be capable of transmitting this to the rest of the workforce. In this respect, it may be appropriate to provide them with specific training on motivation techniques.

In addition to the policies mentioned above, the following are considered good practices in management:

- Establishment, from the management team, of an open door policy throughout the organization, allowing personnel concerns to be acquired first hand.
- Systematic dissemination to the organization of information relating to the progress of decommissioning (on-going activities, scheduled activities, difficulties, need for coordination), as an essential requirement for the achievement of adequate performance.
- Delegation of responsibility, promotion, and valuing of personal initiative.

Some examples on handling human resources issues during transition to decommissioning are included in Annex II, items 1 and 2.

2.4. Human performance

Experience in different Member States' decommissioning projects shows a great interaction between training and human performance. The number of accidents or incidents directly attributable to inadequate human performance rapidly decreases when training is strengthened. References [17] and [21] should be consulted for methods and practices for improving human performance.

As part of change management policies listed in section 2.3, some Member States also implement training or worker practices such as:

- Training on Human Performance Fundamentals;
- Peer and Self Checking;
- Observation and Coaching;
- Interactive Approach to Pre-Job Briefings and Project Review (see Sections 5.3 and 7.2.2).

Such training and work practices are effective tools to combat the attitudes and mindsets discussed in Section 2.3.

Items 39 and 40 of Annex II describe how human performance factors were incorporated with training programmes for nuclear decommissioning. Item 41 of Annex II describes an example of how human factors are considered in training to mitigate risks.

An interesting example of a pilot initiative to implement Human Performance Improvement (HPI) tools and techniques — which is useful for the decommissioning projects — is described in item 84 of Annex II. After the senior managers received initial training at the Nuclear Executive Leadership Training Course, HPI appeared to be a process that had high potential to cause a step change improvement in Integrated Safety Management (ISM). HPI is considered as a tool that provides additional insights not evident by just using existing, traditional tools such as root cause analysis or event investigations. It became evident during the pilot how important it was to establish a "just culture" in order to ensure open communication of event circumstances. Example benefits identified during the pilot included:

- reduced events with consequences;
- increased identification of lower significance problems with resulting improvement in continuous improvement and development of a learning culture;
- realization that people make mistakes, and the role of the organization in causing individual errors, resulting in improved identification and correction of organizational weaknesses that contribute to human error;
- simpler procedures and work packages;
- improved identification and control of critical steps;
- improved event investigation;
- consistent and fair disciplinary process that emphasizes HPI principals and encourages reporting;
- reduced numbers of documented Employee Safety Concerns; and
- improved Employee Feedback (via documented surveys).

A report included in item 84 of Annex II not only explains the process and management of pilot HPI implementation but also provides an access to the actual training material used for the training on the HPI.

3. OPERATIONAL VERSUS DECOMMISSIONING ACTIVITIES

As a nuclear installation — whether it is a reactor, processing facility, laboratory, or R&D facility — approaches the end of its operational phase, and the planning for the decommissioning begins, it is very important to understand how the nature of the activities undertaken will change. With respect to training issues, and the requirement to ensure that personnel are suitably qualified and experienced before their services being called upon, it is particularly important to have an understanding of the likely change in emphasis in the skills required.

During the operational phase of the installation the operations are generally likely to have been routine and repetitive in nature. Any abnormal non-routine situations encountered are likely to have occurred several times in the operating life of the facility with the facility working environment fully understood and predictable. The exception to this is nuclear R&D facilities, where over the operational lifetime of the facility different programmes of testing, experimentation and evaluation have been completed. In such facilities, decommissioning likely represents a series of unique challenges to deal with different plant areas which were generally used and abandoned sequentially during the facilities operational history.

The activities undertaken during decommissioning, following any routine programmes of de-fuelling or facility system flushing, generally comprise a formal sequence of non-routine, one-of-a-kind tasks. To ensure that these tasks are completed with respect to safety, programme, quality, and cost considerations, it is important to identify the change of emphasis in the training requirements as the transition from operations to decommissioning occurs. Table 1 shows how the emphasis in training is typically influenced for a selection of activities relating to operations and decommissioning.

TABLE 1. COMPARISON: OPERATIONAL AND DECOMMISSIONING TRAINING REQUIREMENTS

Operations [1]	Decommissioning [1]	Change In Training Emphasis	Example
Reliance on permanent structures for operational life of facility	Use of temporary structures to assist dismantling	More focus on individual tasks and achieving "fitness for purpose"	1. Requirement to work in custom-made containment structures. 2. Permanent fire protections systems, containment, and confinement systems during operations; temporary fire protection measures (i.e., fire watches, hoses) breached confinement/containment systems during D&D requiring pre-planning for individual tasks.
Safety management based on operational nuclear facility requirements	Safety management systems based on individual decommissioning tasks	More focus on individual tasks and their interrelationships	1. Hazard assessments based on several tasks being completed simultaneously, by different groups of workers. 2. Established system of validated normal and emergency operating procedures during operations; one-of-a kind dismantling activities during D&D with minimal possibility to fully validate procedures.
Production orientated management objectives	Project completion orientated management objectives	More focus on project management skills and "completion culture"	Working to an agreed project completion cost and programme.
Permanent employment with routine objectives	Visible end of employment, with uncertainty of retention	More focus on human factor issues and associated safety management issues	1. Requirement to retain motivation and enthusiasm without sacrificing safety culture. 2. Long-term employment (i.e., 40 years during operation); short-term employment leads to large turnover of personnel during D&D.
Stable Resource pool of known ability to match relatively stable / predictable requirements	Much smaller stable resource pool topped up as/when required using highly mobile contractors	More focus on ensuring and maintaining a reliable supply of fully competent workers, and contractor management	Use of contractors; and development of common transferable standards of competence.
Established and developed operating regulations	Change of regulatory focus	More focus on change management issues and multiple simultaneous tasks	Long history of regulations and specificity for operations; only general requirements for D&D due to unique nature of activities.
Predominant radiological risk	Changed nature of radiological risk, industrial risk more significant	More focus to ensure correct blend of training to cater for both industrial and radiological risk issues	1. Training of technicians in radiological / disassembly skills, to create a multi-skilled decommissioning operative. 2. Stable design, and stable maintenance activities during operation; cutting, rigging, scaffolding, fire safety risks during D&D.
Focus on functioning of systems	Focus on management of materials and radiological inventory	More focus on waste categorization and minimization issues	1. Training in waste segregation, waste management, and environmental assessments. 2. Routine preventive and corrective maintenance, and waste generation during operations; large amounts of liquid and solid wastes to remove and handle during D&D.
Repetitive Activities	One-off activities	More focus on one-off tasks	Use of custom built mockups. Routine operations controlled by procedures during operating phase; unique one of a kind tasks with new procedures each time during D&D.
Familiar with working environment	Working environment can be uncertain	More focus on pre-job preparations, job hazard analysis & risk assessment	1. Interactive approach to safety management, with emphasis on coping with 'worst case' scenarios. 2. Stable design and confinement/containment systems during operations; system integrity breached during D&D requiring hazards analysis for each activity.
Access to high radiation & contamination levels unlikely, or for short time	Access to high radiation & contamination levels on more routine basis	More focus on dose management issues	1. Routine long-term use of PVC airline suits. Requirement for radiological monitoring /assessment skills. 2. Steam generator tube repair during an outage; complete removal of steam generator during D&D requiring more emphasis on dose assessment.

Operations [1]	Decommissioning [1]	Change In Training Emphasis	Example
Routine levels of materials shipped off-site	Much larger amounts of materials shipped off-site	Focus on hazardous material handling, and materials management skills	1. Environmental assessment training. Transfer systems for radioactive materials. 2. Low level waste shipped during operation; during D&D Pu residues in glove boxes and ventilation systems, large quantities of liquid waste from system flushing, etc., to be processed, handled and shipped.
Relatively stable isotopic composition	Isotopic composition changes with time	More focus on non-routine radiological issues	Increased scope, content and intensity of radiological safety training.
Training programs designed for 30-40 years of use	Training programs designed for a few years of use	Emphasis changed to radiological and industrial safety training	Tailored and personalized training programmes during D&D..
Initial training programs that are months to years long with extensive continuing training	Initial training programs that are a few days to weeks long with as needed continuing training	Emphasis on one-time, unique tasks versus routine operations	Development of 'refresher' training tailored to suit individual tasks/durations during D&D.

(1) This table is derived in part from Reference [6]

To further illustrate the changes in emphasis, which occur in training requirements, several individual areas are discussed briefly below.

Project management

The decommissioning process is generally one of deconstruction, where construction management skills are utilised. It is not different from construction in that a series of individual tasks are required to be managed simultaneously such that the project can achieve its objectives in terms of cost, programme, and quality. The need for effective planning and preparation is however emphasised due to the unique challenges encountered because of the hazardous and radiological (and often unpredictable) environments, in which the work is completed. Whereas it may be relatively straightforward for a worker to cut into a masonry wall during construction, to repeat this task during decommissioning, where radiological and operating constraints exist, offers a completely different challenge.

Decommissioning projects often use many subcontractors for specific dismantling tasks. Hence there is a need to provide project management training including detailed planning, risk assessment, and resource management in order to ensure that managers and supervisors have the knowledge and skills necessary to safely and efficiently manage these subcontracts and achieve project objectives. In addition, it is also necessary to ensure subcontractors have, or are provided with, the necessary task specific training to safely and effectively complete work packages.

Safety management

Due to the hazardous nature of the work undertaken, a greater emphasis on safety management for all parties involved in the decommissioning tasks is required. Whereas the project management team can consider the task requirements and environment, and specify the working procedures, it is essential that the personnel supervising and completing the tasks are fully competent to complete the works in a safe manner. The control of radiation exposure during decommissioning operations is particularly important, and relies on health physics personnel fully conversant with the likely exposures to be encountered and the exact nature of the work planned, and who are trained to specify the required protection measures. As well as the requirements to work routinely in both high contamination and radiation areas, there is also more emphasis in decommissioning on standard industrial safety training, associated largely with the construction industry. The requirement essentially is to train personnel such that they are able to apply specialist radiological safety skills alongside standard industrial safety practice.

The change in emphasis is applicable not only to the workers but also to the personnel who manage facility and personnel safety issues. In decommissioning, managers require training to produce safety cases/analyses that are applicable to situations where many different tasks may be completed simultaneously by different workgroups.

With the increasing use of transferable groups of workers (contractors), there also is a need to ensure that all workers involved in decommissioning activities have attained and maintain the relevant levels of competence required (see section 7).

Environmental management

As facilities are progressively dismantled, there is a large increase in the physical amount of material (in solid, liquid and gaseous form) being handled. This in turn leads to issues associated with environmental management. At every stage of decommissioning - where facility systems are being dismantled and material transferred both on-site and off-site - there is increased risk for uncontrolled releases to the environment. As facility systems are breached and more materials are handled, personnel require training to ensure that the environmental impacts of the decommissioning are carefully managed and minimised. As facility systems are breached, there is also an increased requirement to introduce temporary ventilation systems, and to train workers in the use of personnel protective equipment, to safeguard their own operating environment.

Materials handling including radioactive waste management

Within the decommissioning process, hazardous materials are generated and should be handled. In particular, conventional hazardous materials such as asbestos, acids, lead, etc., and also with irradiated materials/waste that presents a radiological hazard, should be handled. In decommissioning, it is important that personnel are trained to work with a wide range of such hazardous materials; often materials hazardous in their own right, and also radioactively contaminated. It is important that personnel understand the requirements for radioactive waste management, and can apply radioactive waste management requirements, techniques and good practices to waste categorization, segregation, treatment, storage, disposition, and minimisation of waste. For example, training in areas such as the safe operation of waste treatment systems and their associated quality assurance requirements should be provided. This training should include the acceptance criteria for such wastes in the particular disposal/storage facility concerned.

Programme management

It has been found in some member states (see, for example, a reference [30]) that it is unwise to decouple the planning of the decommissioning programme from the plans to deal with the social and economic implications of the decommissioning programme.

The early experience with the re-deployment of staff as a result of the decommissioning of the Dounreay site in the United Kingdom is summarised in Annex II, item 59. In this case, the influence of the UK Government through the Nuclear Decommissioning Authority required the site operator, the United Kingdom Atomic Energy Authority, to take account of the social and economic implications of the decommissioning of the site. This is an important issue in the specification of training at other nuclear sites.

Many of the nuclear sites in the world are located in remote areas. One of the consequences of the decision to move from operation phase to decommissioning is to make it clear to the local population that the future of the plant is limited. This can bring about an immediate movement of staff from the area and with it, the expertise gained over decades.

If, however, the staff are able to see that the future of the community in which they are located is being considered, they will be more inclined to stay, be re-trained and support the decommissioning programme.

In the preparation of the decommissioning programme for the site, it is important to recognise the resource requirements in the same way as the financial and other requirements of the

programme and in the integrated Programme Management. The resource profile required for the decommissioning are derived from the programme in the same way as the costs.

Experience in the United Kingdom shows, however, that even with the preparation of a detailed social and economic plan for a site, inaccuracies in the early decommissioning programmes, in terms of activities and timescales, can have a very significant impact on the ability to plan for the resource requirements and hence for the training necessary to support the decommissioning.

4. KNOWLEDGE MANAGEMENT FOR TRAINING PURPOSES

4.1. Knowledge management during operation

In general, loss or misuse of the knowledge accumulated by a company may have negative consequences on the business, such as the lack of quality, the slowdown of work, and an increase in costs.

The risk of losing knowledge, both explicit and tacit, increases with the time passed (from the time it was generated to the time it is needed). Information may be lost due to its deterioration or outdated electronic supports (paper documents, old electronic formats, etc.). Information may also be lost due to the retirement of qualified and knowledgeable facility staff, or because of the losses or errors produced during the transmission of information from one person to another. This problem directly affects the decommissioning of a nuclear facility that, as has been stated in section 2, may become greater the longer the time between shutdown of the facility and the beginning of decommissioning. The problem is compounded by the fact that efforts to identify the information requirements for decommissioning are not usually an organized and consolidated activity and may not be appreciated by organizations operating the nuclear facility.

Due to these reasons, it is important to consider decommissioning as a phase in the life cycle of a nuclear facility and to preserve during operation the records and information that might be useful after shutdown.

In order to preserve records, discipline and commitment are required, taking into account that some of the information to be recorded does not have an immediate use, and this activity might be seen as time consuming and non-productive. Some of the knowledge management areas of interest from a decommissioning training perspective are as follows:

— Updated configuration of the facility, paying especial attention to:
  - Non-visible systems (pipes, wires, etc., below ground level or embedded into walls)
  - The characteristics of the thermal insulation products (asbestos)
  - The structural details of the buildings to be dismounted or demolished
— Installation operational history
  - Incidents and operation failures producing permanent radiological consequences (e.g. soil and walls contamination)
  - Abnormal operation of auxiliary equipment needed for dismantling activities (ventilation systems, cranes, etc.)
  - Power history and outage records (for reactors)
  - Modifications to facility and equipment made during operations

- Inventory of radioactive wastes
  - Packaged operational radwaste
    - Categories
    - Volumes
    - Conditioning (e.g., physical, chemical, and radiological) status
  - Operational radioactive waste not retrieved yet
    - Radiological characterization data
    - Volumes
- Inventory of non-radioactive hazardous wastes
  - Classification
  - Quantities / volumes
  - Proposed treatment route
- Updated radiological characterization of the facility
  - After shutdown
  - After de-fuelling, first decontaminations and retrieval of operational waste
- Human resources:
  - Qualification
  - Experience

Documentation typically collected and archived for decommissioning includes ([9]):

The following design, construction and modification documentation are typically collected and archived:

- Site characterization, geological and background baseline
- radiological data;
- Complete drawings and technical descriptions of the facility as built, including design calculations;
- Construction photographs with detailed captions;
- Schedules of any construction modifications and their drawings;
- Procurement records that identify the types and quantities of the materials used in construction;
- Engineering codes;
- Equipment and component specifications, including pertinent information (i.e. the supplier, weight, size, materials of construction, etc.);
- Facility construction material samples;
- Facility design inventories of chemical and radiological material flow sheets;
- Quality certifications;
- Safety cases for the operation of the facility;
- Environmental impact statements;
- Pre-operational facility testing and commissioning records;
- Licensing documentation and operating requirements;
- Preliminary decommissioning plans.

The following documentation should be collected and archived during the operation, shutdown and post-shutdown of a facility:

- The licence and licensing requirements;
- Safety analysis reports;
- Technical manuals;

— Details of environmental releases;
— Facility logbooks;
— Facility and/or site radiological survey reports;
— Operating and maintenance procedures and records;
— Abnormal occurrence reports;
— Decontamination plans and reports;
— Technical specifications (limits and conditions);
— Design change reports and updated drawings;
— Hazardous material inventories;
— Process and service interfaces with other facilities;
— Process flow-sheets, including for services;
— System, structure and component inspection records;
— On-facility waste management records;
— Site hydrology and groundwater contamination records;
— Records of equipment terminations (e.g. piping and cables) during operation and at shutdown;
— Records of staff leaving debriefings;
— QA records;
— Fuel geometry, performance (i.e. damage) and accounting records;
— Records of neutron fluxes and distributions;
— Records of waste management strategies and locations of waste;
— Records of radiation sources and their locations;
— Samples of irradiated and embrittled materials;
— Relevant laboratory test reports.

The knowledge and documents to be preserved have to be identified as early as possible during the operation of the nuclear facility, so that continuous mechanisms for recording and storing of relevant information for use in the decommissioning phase can be established.

Information has to be stored in such a way that integrity can be guaranteed as time goes by, and that knowledge can be easily accessed in the future. Accordingly, it is crucial to have a sound management system that provides for the identification, storage and easy retrieval of both paper and electronic documents.

Training has an important role during the transition to decommissioning, when the detailed design of the decommissioning project and its organization are being developed. Training can be an effective tool to transmit information stored during the operation of the facility to the decommissioning organization and its personnel. In the same way, training is also essential during the planning and performance of specific decommissioning tasks, particularly during the detailed planning of each work package, which usually relies on a sound knowledge of the configuration and the operational history of the systems to be dismantled. Thus, in this phase, the training of work supervisors, health physics personnel, ALARA technicians and industrial safety personnel, and other personnel, can be accomplished. (See section 7 for information on the examples of training programme content).

In both cases training effectiveness can be greatly enhanced with the participation of personnel familiar with the operation of the facility. Nevertheless, to rely on training without the benefits of proper knowledge management can significantly reduce the ability to safely and effectively accomplish decommissioning tasks.

As an example, a typical list of aspects subject to knowledge management treatment for the decommissioning of a Member State (ES) nuclear power plant is shown below:

Operational knowledge

- Selection, copying, and reclassification of operational documents applicable to decommissioning (construction details, operating events, design modifications, operating instructions).
- Selection, copying, and creation of a new archive for useful photos, videos and presentations generated during the operation of the plant.
- Retention of personnel with knowledge of especially important aspects: operators, key maintenance technicians, etc.
- Programme for the transfer of know-how to other workers, based on on-the-job training: maintenance, waste management, auxiliary operators, safety engineers.

4.2. Knowledge management during decommissioning

In addition to the use of knowledge generated during the operation of the facility for decommissioning, the knowledge generated during decommissioning has to be preserved, stored and made available, with the following main objectives:

- To serve as a reference for repetitive activities, or for activities with a common baseline within decommissioning. Taking into account that personnel rotation is higher in this phase than during operation, it is particularly important to generate training material that eases the transmission of useful knowledge, increases the performance of the workers and minimizes the risks, such as:

  - lessons learned in previous similar activities;
  - updated situation of the facility or area of activity;
  - industrial and radiological risks;
  - basic rules to access / exit radiological areas;
  - basic rules to dress in protective clothes and undress;
  - generic rules on use of equipment and tools;
  - emergency plans and procedures;
  - conduct of operations, such as adherence to procedures and instructions, log keeping practices, three way communication, shift turnover practices, required reading, etc.

- To show stakeholders and interested institutions how the project is progressing. Transparency is an important element to make decommissioning acceptable; and training and communication constitute useful helping tools. From this viewpoint, it is important to videotape, photograph and document relevant activities, and to identify and store technical, economical or social information that might be interesting for the stakeholders and public in general.

- To help consolidate and standardize decommissioning methods, by means of documenting best practices and lesson learned, so that they can be used in future similar projects, whether by the same operator or by other interested companies.

Training is a key tool for the transmission of knowledge, whether to the workers that directly participate in the project (internal training), to the interested organizations (training and communication), or to personnel involved in other similar activities (external training).

Some generic tools for knowledge management include the following:

- Paper Documents
  - Construction documentation
  - Procedures / tasks descriptions
  - Incident reports
  - Periodic operational reports
  - Lessons learned and best practice compilations
  - Safety analysis and related reports
  - Reports on relevant activities
- Videos
- Photographs
- Presentations
- Information systems (data bases)
  - Wastes inventories
  - Radiological Characterization data
  - Data on human resources, personnel records, and organization structures
  - Documents' classification and archive
  - Configuration
  - Operation, maintenance, and facility modification records
- 3-D tools
  - Updated configuration of the facility
  - Radiological characterization data
- Management of critical knowledge possessed by the retired personnel
  - Preservation of tacit and implicit knowledge, and related data and information
  - Documented critical tasks and knowledge

Options and examples to retain knowledge from implementation of decommissioning projects and activities, and to mitigate knowledge loss, are included in Table 2. The options selected are based on an analysis of the knowledge to be preserved, the risk of loss, and available tools. Section 4.3 identifies several Internet sites that have additional information on the selection of options.

TABLE 2. OPTIONS TO RETAIN KNOWLEDGE AND TO MITIGATE KNOWLEDGE LOSS

Option to retain knowledge	Examples of Implementation
Cataloguing of: ▪ Documentation & Procedures ▪ Checklists, Inventories ▪ Data from Performance Support Systems ▪ Video and photo records	- Digitisation of old construction related documents necessary to carry out a delayed level 3 decommissioning, and inventory of all the records (approximately documents 1500). - Documentation of the final status of underground facilities, after being decontaminated and filled up with clean debris (documents potentially necessary for future land release activities). - Accurate documentation of systems and facilities in use during the dormancy / care and maintenance phase. - Detailed specification of surveillance activities performed every five years during the dormancy phase (risk of losing skills because of the low frequency). - Videotaping of activities related to graphite retrieval projects, valid for the decommissioning of the facilities and workshops used in these tasks. - Photos on construction details, very useful for dismantling purposes. - Implementation of management information systems as a way to handle and preserve useful information regarding waste, work programming and control.
Education and Training ▪ Classroom and mock-up training ▪ Computer-based training (CBT), video-based, and alternative delivery ▪ On-job training (OJT) ▪ Coaching ▪ Vocational training ▪ Apprenticeship programmes	- Use of the mock-up of a huge reactor building to select, and provide training on, the safest dismantling sequence. - Simulation of the transference of activated materials, as part of an ALARA training programme. - Training on basic Radiological Protection aspects using video (use of PPE, dressing and undressing, etc.) - Vocational training to assure nationally recognised standards (e.g., National Vocational Qualification (NVQ) in UK). - Programme on teaching nuclear and decommissioning fundamentals to young professionals (apprentice programmes in UK).

Option to retain knowledge	Examples of Implementation
Technology Improvement and Process Re-Engineering ▪ Process improvement ▪ Update equipment ▪ "Smart" tools and technology ▪ Eliminate task	- Elimination of a surveillance activity requiring the interpretation of the noise produced by equipment vibration (historically performed by a specific single person). - Implementation of a new document management information system, as a way to gain independence from the person historically responsible for the operator's archive management.
Alternative Resources ▪ Subject matter experts ▪ Rotating Staff ▪ Multi-skilling or cross-training ▪ Use of contractors	- Integration of new and old professionals into the same team, as a way to facilitate the transfer of tacit knowledge. - Integration of professionals belonging to different departments but collaborating on activities. - Involvement, on a contractual basis, of the individuals with 'hands-on' experience in management of decommissioning projects as the advisors.

A comprehensive list of examples on record keeping for decommissioning can be found in reference [9]. Annex II, item 6, Mestral technological centre brochure, describes the Spanish initiative launched to preserve, enhance and share the knowledge generated during the decommissioning of Vandellos I NPP.

4.3. Sources of information on knowledge management practices

The IAEA maintains a web site on knowledge management http://www.iaea.org/inisnkm/nekr/index.html where useful information may be obtained. The U.S. Tennessee Valley Authority maintains a web site http://tva.gov/knowledgeretention that contains useful information and a methodology for capturing knowledge of individuals; this methodology would be also useful for future decommissioning activities.

5. TARGET GROUPS, TRAINING NEEDS AND APPLICATION OF THE SYSTEMATIC APPROACH TO TRAINING (SAT)

5.1. Target groups

The personnel who may need some form of training may generally be divided into two target groups: Stakeholders (i.e. regulatory authorities, senior management, the public) and decommissioning personnel.

5.1.1. Stakeholders

In the first group — Stakeholders — are those personnel who may influence decommissioning strategies and requirements. In this group are: senior management, licensing authorities, the public, members of the press (mass media), and other stakeholders. This group is important for every phase of the decommissioning process since it has a significant influence on the strategies and processes chosen. It is necessary to provide them with suitable information or, in some cases, training, to understand the decommissioning process as a

whole. This information or training is focused on a general overview since most of these personnel are not experts in a decommissioning subject matter area (except licensing authorities).

Senior management
Senior management personnel are typically qualified through a combination of professional qualifications and their extensive previous experience. Information and training for these personnel provide general overview of decommissioning, focused on actual phases of the process. They are provided with information about technical aspects of decommissioning from nuclear facility shutdown through the transition period and decommissioning option selection until decommissioning commences. The level of detail and content of training depends on the managers' experiences in decommissioning, the period of decommissioning of a particular facility, and technical specifics of the particular facility. (See also Section 2.2 and Appendix II.)

Licensing authorities
Training in the decommissioning area required for regulatory body personnel depends upon the competence and experience of the particular regulatory body personnel, and may significantly vary from one country to another. There are some common training needs, such as specific training needed for competent granting of a licence for decommissioning, or specialized training in the field of safety assessment in respect to decommissioning. However, even if personnel of the regulatory body are knowledgeable and experienced in a wide spectrum of nuclear industry areas, including familiarity with decommissioning, training is normally provided before the start of decommissioning, to develop the competence of the relevant regulatory body personnel in the specific decommissioning processes chosen.

Public
This group is provided with information about decommissioning processes, especially about possible safety implications and potential impacts on the environment. Every decommissioning project normally includes the development of an environmental study, which is fundamental for communication with the public. The public is usually informed through mass media, visitor centres, Internet web sites for the activity; and formal training is usually not developed. In some instances local special interest groups may emerge that may require educational or training programmes tailored to address their interests.

Press (mass media)
This group receives information in the same manner as the public. Some members of the press may attend seminars and training courses provided for managers.

Training for this target group — Stakeholders — is not specifically addressed in this publication, since a very wide variation of possible education, training, or information dissemination techniques may be applied. However, some of the managerial and professional training courses and seminars discussed in Section 6 may be useful for this target group. Appendix IV is one example of a training course provided to journalists, in order to acquaint them with the terminology and methods of decommissioning activities and to enable them to provide accurate information to the general public.

5.1.2. Decommissioning personnel

Decommissioning personnel can be categorized into three groups: managers, professional staff, and workers. Training requirements for these groups are addressed in Sections 6 and 7 of this publication. All these personnel require formal training.

Managers
Managers in this group can be divided into two subgroups: technical and non-technical. Training is adapted accordingly. The training of managers is addressed in Section 6.

Professional staff
Training is provided in the overall aspects of decommissioning and according to individual job positions and duties. Training for this group of personnel is addressed in Section 6.

Workers
Training is provided according to their job positions and duties. Section 7 addresses worker training.

In all of the above groups, the work can be undertaken using personnel employed directly by the organization tasked with the decommissioning or by contractors. Contractors are used more in the 'worker' group to provide specialist support and to satisfy peak labour demands. The training for contractors is no less onerous than that for the client organization workers, and in many cases may be greater due to the non-familiarity of the contractor worker with the working environment.

5.2. Regulations and standards

Decommissioning projects have increased the scope of regulatory control performed by regulatory bodies in the Member States. However, many of the existing regulations contain only general requirements for assuring that personnel involved in decommissioning are adequately trained and qualified. The regulations and standards that are applied to decommissioning can be grouped into three areas:

Regulations for the operational phase: Regulations and standards for operation generally contain much more specific requirements for training and qualification of personnel. These regulations and standards typically continue to be applicable to the earlier stages of decommissioning. For example, at a reactor, until such time as the reactor fuel is removed from the reactor vessel and then subsequently removed from on-site spent fuel storage facilities. The presence of spent fuel is considered in the safety analysis for a facility, and personnel involved in spent fuel management are regularly trained and qualified. Training is usually the same as that provided during the operational phase of the nuclear facility.

Regulations for radiation protection: Regulations and standards for radiation protection are usually equally applicable to the operating and decommissioning phases as long as radioactive material or contamination is present on-site and the potential for personnel exposure to radiation is present. These regulations require training on radiation safety with particular emphasis on radiation worker training and qualification.

Regulations for industrial and occupational safety: Regulations and standards for industrial safety and occupational safety generally provide specific training and qualification requirements to assure the safety of workers. These regulations tend to be the primary "drivers" for the training of personnel involved in decommissioning. Regulations and

standards typically address the training needed for fire safety, industrial safety, working in confined spaces, hoisting and rigging, working with hazardous (non-radioactive) material and chemicals, and many other occupational related training needed for decommissioning activities.

In most Member States regulations and national standards for decommissioning currently do not contain detailed decommissioning training requirements, relying instead on other regulations such as those discussed above to address training. This is due, partly, because of possible decommissioning options and the widely varying nature of decommissioning activities. However, this requires careful application of appropriate training requirements — from these other regulations and standards — to the training needed for the decommissioning phase. The lack of specific regulations or national standards for decommissioning training was one of the primary reasons why the IAEA Technical Working Group on Training and Qualification of NPP Personnel requested that this publication be prepared to present information on current practices. As an example, in one of the Member States (UK), national standards on competency for decommissioning workers have been developed, and are used as the basis for vocational training programmes (see Section 7.2.1). Items 13, 18, 19, 20, 21, 22, and 23 in Annex II are other examples of regulations and supporting standards, and also examples of guidelines that have been adapted and applied to decommissioning training.

5.3. Analysis of training needs

Following the above identification of the target groups, the next logical step is to identify what the exact training requirement is for each group of personnel. In decommissioning, along with the routine tasks, there are many one-of-a-kind tasks which offer unique challenges in terms of the hazards likely to be encountered, and in terms of technical difficulties. Although several different techniques are used to determine the exact training needs for various target groups, the way the training programmes are structured in all cases is similar, as depicted in the Figure 6.

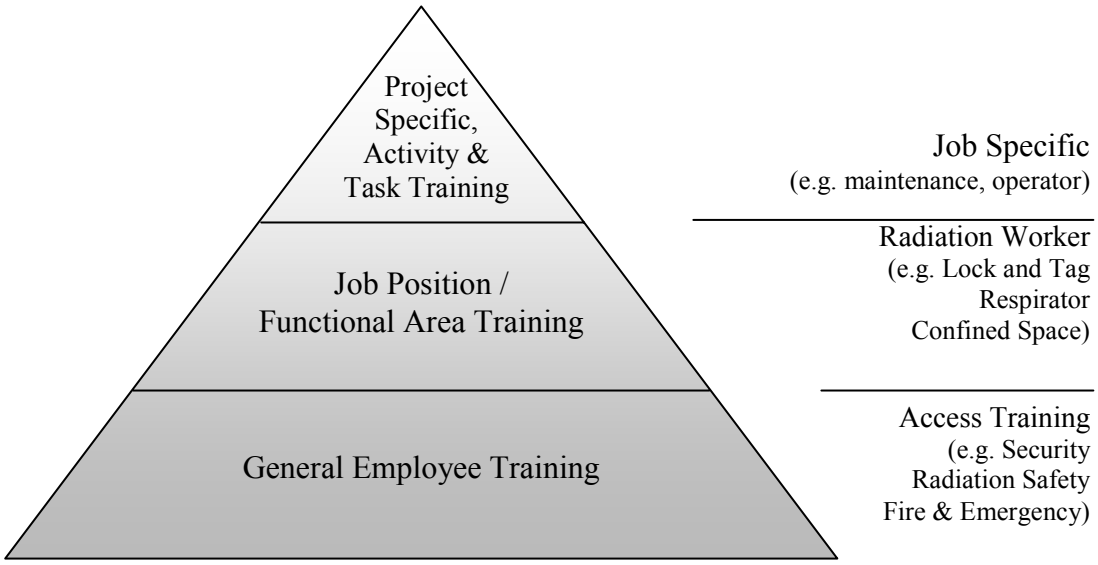


Fig. 6. Training pyramid.

The pyramid comprises a base of general site safety and regulatory requirements applicable to most individuals; on which is built training packages tailored to suit the type of skills required

by specific job positions. On top of this, project specific training packages for specific decommissioning activities are required.

Two techniques often used as the basis for determining training needs in general are Job and Task Analysis (JTA) and Job Competency Analysis (JCA). In these techniques discussed further in Sections 5.4 and 7.2.2, the component parts of the work to be undertaken are analysed, and the requirements — in terms of the actual tasks to be completed and the competencies required to undertake these tasks respectively — are listed. Annex II, item 1, gives an example of another approach to needs analysis. When completing a needs analysis concerning decommissioning activities, and considering the potential hazards which can exist, the overriding requirement is to complete the work in a safe manner. Hence, regardless of which technique is used, a needs analysis to examine all factors which are known, or may potentially influence the safety of the personnel and of the facility, or may potentially have negative impact on the environment, is essential.

A description of the methods used to determine the risks which need to be mitigated, and hence the work methods and competence requirements for the personnel involved in both planning and implementing the work, is included in Section 7.2.2 and in the Appendices XV, XVI, XVII, and XVIII. These appendices provide examples of Job Hazard Analysis and Risk Assessment. Examples of a general approach to establishing Safe Systems Of Work (SSOW) with respect to decommissioning tasks, and therefore identifying competency requirements and training needs for specific tasks, are included in Annex II, items 9 and 45.

Another technique used by some Member States (UK, USA) to accomplish a training needs analysis, associated with individual decommissioning tasks, is a Project Review. A Project Review is a high-level proactive, systematic, and facilitated review of a high risk job, work package, independent hazard review package, procedure, experiment, critical step or any other activity where the likelihood of error is potentially high and the consequence of error unacceptable. A Project Preview identifies potential events, examines their most likely causes, points to critical steps, and evaluates error precursors and error likely situations. The goals of the Project Preview are:

- to identify actions that will lessen the severity of an event or eliminate the likelihood of a specifically identified event altogether;
- to obtain direct worker input;
- to establish workers' support of the approach, process and documentation;
- to achieve workers' understanding what and where hazards exist.

Examples of material generated during such a Project Review are included in Annex II, items 41, 44, and 45.

When identifying potential problems with respect to both safety and technical issues, which may lead to the identification of training needs, it is important that a proactive approach is used, with as many people — who influence the outcomes of the tasks — involved as possible. This particularly refers to involvement of the workers who will be completing the 'hands-on' work. Another example of this type of activity is the use of briefing sessions described in Section 7.2.2 for workers, both before and following the completion of work packages. Such exercises are referred to typically as Pre- Job Briefings (see Appendix XX) or Toolbox Talks. (See Annex II, item 10.)

5.4. Applicability of the systematic approach to training methodology

One of the essential requirements for assuring safety of the public and the workers during the decommissioning phase is the availability of competent personnel. A systematic approach to training (SAT) is recognized world wide as the international best practice for attaining and maintaining the qualification and competence of nuclear facility personnel. The IAEA publication [11] provides information on the reasons why the systematic approach to training is now the international best practice for the training and qualification of NPP personnel, and also provides a detailed description of SAT methodology.

With a systematic approach to training, the competence requirements for personnel involved in decommissioning activities can be established, validated, and met in an objective manner. An overview of the SAT process is given in Figure 7.

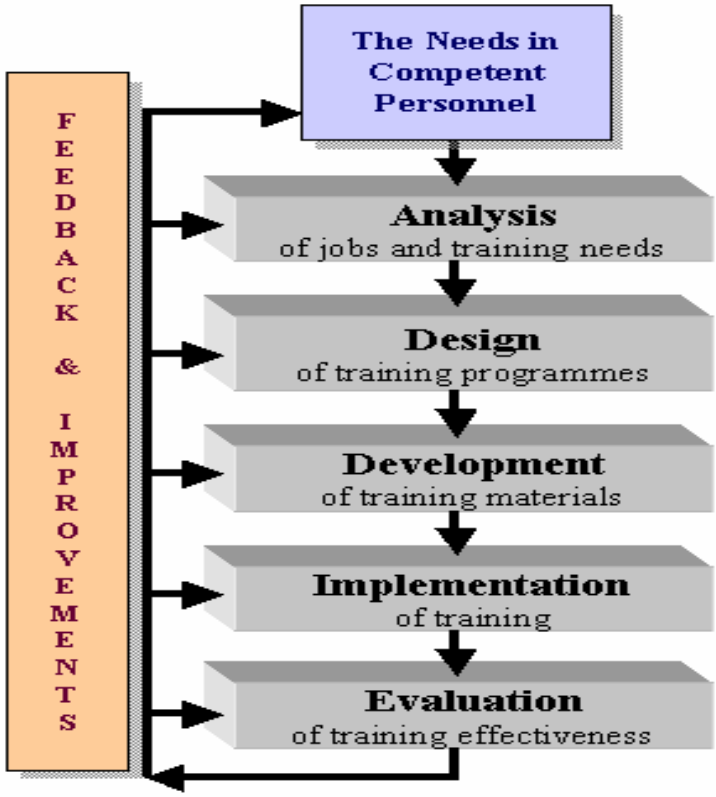


Fig.7. Overview of the SAT process.

SAT consists of five interrelated phases, which are:

ANALYSIS — This phase comprises the identification of training needs and the competencies (knowledge, skills, and attitudes) required to perform a particular job.

DESIGN — In this phase, competencies are converted into measurable training objectives. These objectives are organized into a training plan.

DEVELOPMENT — This phase comprises preparation of all training materials so that the training objectives can be achieved.

IMPLEMENTATION — In this phase, training is conducted by using the training materials developed.

EVALUATION — During this phase, all aspects of training programmes are evaluated on the basis of the data collected during each of the other phases. This is followed by suitable feedback leading to training programme and facility improvements.

While the guidance in the IAEA publication [11] was primarily intended for full application to the operational phase of nuclear power plants, the basic elements of the SAT methodology apply equally to the decommissioning phase of any nuclear facility. However, full application of traditional techniques of SAT, without reasonable limiting the scope of Analysis to the tasks involving the potential risks and hazards associated with decommissioning activities, may result in significant expense and effort. Training programmes for the operational phase are designed and developed to assure public and worker safety over a 30–40 year operational phase, whereas training needed for many decommissioning activities is of very short duration. Many tasks are performed only one time. Additionally, once the fuel is removed from a nuclear power plant, the risk to the public is significantly reduced. Accordingly, some Member States use a graded approach to the application of SAT. The graded approach is a process where the level of Analysis, and documentation associated with the SAT phases, are tailored to the magnitude of the hazards involved. A graded approach to training encourages application of techniques that allow the most efficient use of personnel and resources in training activities. Under no circumstances should health or safety concerns be compromised in the name of cost savings or expediency. Significant hazards during the decommissioning phase still pose a risk to the safety of workers, so grading of training development efforts should not be misconstrued to mean reduction in the quality of training. Rather, the level of detail and formality are tempered by factors such as hazard and risk, cost-benefit, and the use of other methods to control the hazards of a decommissioning activity or task. Appendix V contains one example of a list of the minimum elements considered necessary to substantiate a systematic approach to training and provide an adequate level of assurance that training is consistent and job related. References [15] and [23] also contain guidance and information on various methods to grade the SAT process. The graded approach should only be implemented with the concurrence of management of the decommissioning project.

6. TRAINING NEEDS AND THE CONTENT OF TRAINING FOR DECOMMISSIONING MANAGEMENT AND PROFESSIONAL STAFF

The training needed for decommissioning managers and professional staff (e.g. engineering personnel, health physics, chemistry, environmental, industrial safety personnel - sometimes referred to as technical support staff) is dependent upon whether they have previous experience in decommissioning.

The types of courses and seminars that are typically required for managers and professional staff can be divided into four categories.

- **Management and supervisory skills:** In particular courses on motivational techniques and methods to promote human performance improvement within the organization. These types of courses are necessary to address some of the human resource management issues discussed in Section 2.3. Reference [16] contains detailed information on the selection and competency development of managers. References [17] and [21] contain detailed information on approaches to human performance improvement.
- **Project Management including planning:** It is essential that the management and professional staff have training in project management and planning since careful planning of decommissioning activities is essential to both public and worker safety. In

many Member States such courses are readily available and certifications in project management are provided based on successful completion of training. In other Member States these types of courses may need to be developed with assistance from IAEA and other organizations formed to promote sharing of information and methodology for decommissioning (see Section 8).

— **Decommissioning methods:** Many of the managers and professional staff may not have any experience in decommissioning. They typically need to attend courses that address regulatory aspects, decommission planning, decommissioning technology, and other topics such as those identified in Table 6.1 below. These types of training courses are also provided by organizations such as those identified in Section 8.

— **Facility/Job specific training:** Depending on the job function, managers and professional staff may need to participate in the same training identified for workers in Section 7, such as courses on radiation safety and industrial safety. Annex II, items 29, 30 and 43 are examples of qualification standards for three professional staff job positions. Annex II, items 49 and 50 are examples of qualification standards for a first line decommissioning and decontamination (D&D) manager job position.

Within the nuclear industry, there is also a widespread recognition of an ageing process, where generally a low proportion of the personnel employed are younger people. Recruitment and the associated training are therefore needed over the next decade to replace retirements, with predicted shortages in all roles including those management and professional staff required to undertake decommissioning activities. This problem was identified in the publication [26] which contained the recommendation that "Governments should engage in strategic planning of education and manpower, integrated with human resource planning, to encourage young students into the industry". As an example, in one of the Member States (UK), a recent initiative to address the need for more industry recruits has involved the formation of the Nuclear Technology Education Consortium (NTEC). NTEC represents the majority of nuclear teaching expertise skills in the UK; one of its aims being to meet the countries' projected post-graduate nuclear skills requirements in decommissioning. (See also www.ntec.ac.uk)

Appendix VI ("Training on decommissioning for students" — programme and mock-up photo) illustrates the training activities launched at Vandellos to train secondary and university students on decommissioning practices. Appendix VII is an example of the training needs identified for the Greifswald (KRG) project in Germany. Appendix VIII describes the training objectives for a typical course for personnel involved in decommissioning and radwaste management. Annex II, item 11 describes further education courses now available in one Member State (UK), designed to facilitate progression from technician to an advanced degree. Item 60 of Annex II provides information on training of the management and professional staff by the external contractor. Item 66 of Annex II gives a practical example of training conducted for the managers who should acquire new knowledge and skills during a transition from operation to decommissioning phases.

Table 3 is an outline of the contents of a typical training course that would be applicable to both managers and professional staff. Table 4 is a list of typical courses for managers and professional staff. These courses are typically provided by organizations such as IAEA, by contract with private companies, or by the decommissioning organization. Annex II, items 57 and 58 are additional examples of the prospectus and syllabus of training courses for decommissioning and decontamination. The reference [25] (a technical report on research reactors) also provides information on training needs for management and professional staff, and also for workers.

TABLE 3 EXAMPLE OF THE TYPICAL DECOMMISSIONING TRAINING COURSE TOPICS FOR MANAGEMENT AND PROFESSIONAL STAFF

IAEA REGIONAL TRAINING COURSE ON DECOMMISSIONING
The course content is adjusted to match the interest of participants (for example in this case a significant number of attending Member States having nuclear power plants but little experience in decommissioning). The sessions offered in this course reflect a recent model. Day 1 • Opening of the Meeting. Administrative / Logistic Information. Outline of the Course • Brief Introduction of the Participants. Presentation of Their Countries' Activities Related to Decommissioning of Nuclear Power Plants and Trainees' Involvement • Regulatory Process for Decommissioning • Regulatory Issues and Licensing of Decommissioning in the Host Country Day 2 • Preliminary and Detailed Planning Process for Decommissioning • Preparation of Decommissioning Plan and Related Documents, Record keeping • Pre-decommissioning Radiological Characterization of Shutdown NPPs • Characterization, Strategy, Infrastructure and Practical Experience for Decommissioning of NPPs: Description of Case Studies Day 3 • IAEA Safety Guidance on Decommissioning of NPPs • Cost Estimates for Decommissioning of NPPs, Examples • Assessment of Decommissioning Strategies and Selection of Preferred Strategy • The Decommissioning of NPPs in Host Country: Case Study I • Funding Mechanisms for the Decommissioning of NPPs Day 4 • IAEA Safety Guidance on Waste Management, Criteria for Removal from Regulatory Control, Health and Safety Aspects of Decommissioning • D&D Practical Problem Day 5 • Technical Tour at NPP • The decommissioning of NPPs in Host Country: case study II • Round Table Discussion • Technical Tour to the Nuclear Research Center Day 6 • Half a day will be given to national presentations regarding decommissioning experience and prospects for nuclear power plants in each country • De-fueling and Associated Issues • Organization and Management of Decommissioning Projects

IAEA REGIONAL TRAINING COURSE ON DECOMMISSIONING
• Technical videos e.g. (i) Dismantling a Nuclear Power Plant- Gundremmingen Block (ii) BR-3 Dismantling, Mol, Belgium (iii) other videos to be made available by host institution Day 7 • The Transition from Operation to Decommissioning • Remote Operation and Robotics in NPP Decommissioning • Decontamination Technologies as Part of Decommissioning • Assessment of Amounts and Characteristics of Decommissioning Waste Day 8 • Dismantling Technologies • Waste Management and Disposal in Decommissioning • Current and Anticipated Problems in Decommissioning of NPPs in the Host Country, Release of Materials from Nuclear Regulatory Control • Safe Enclosure During the Decommissioning Process Including Maintenance Requirements Day 9 • Training Requirements in Preparation To and During Decommissioning • Release of Building and Sites, Final Status Surveys, Project Final Report, Licence Termination • Technical Tour to Host Country's Facilities Being Decommissioned Day 10 • Communications for Decommissioning – Host Country's Experience • Round Table Discussion • Evaluation of the Course, Brainstorming Discussions and Concluding Remarks. • Closing of the course

TABLE 4. TYPICAL COURSES FOR MANAGERS AND PROFESSIONAL STAFF

COURSE	TYPE
Project management / planning / contingencies analysis*	General management skills
Time management	General management skills
Negotiation	General management skills
Specification and contracting of activities	Technical
Motivation / leadership	General management skills
Configuration / operation of the facility	Technical
Facility technical specifications and surveillance requirements	Technical
Response in emergency	Technical
Human Performance Fundamentals	General management skills
Observation and Coaching	General management skills
Conduct of Project Reviews and Pre-Job Briefings	General management skills
Communication skills	General management skills
"Crisis" management	Technical
Management of records and documents*	Technical
Human Resources Performance Management	General management skills
Legislation/regulations applicable to decommissioning activities*	Technical
Materials management*: categories, requirements, alternative treatment options, etc	Technical
High level RP, ALARA and JHA concepts	Technical
Decommissioning technologies*	Technical
Spent fuel management as precursor to decommissioning*	Technical
Radiological characterisation*	Technical
Project Risk Management*	Technical
Safety Assessment*	Technical
Costs and Funding*	General management skills

* Courses provided routinely by IAEA. Other courses or seminars are typically provided by national organizations, by contract with private companies, or by the decommissioning organization.

7. TRAINING NEEDS AND THE CONTENT OF TRAINING FOR DECOMMISSIONING WORKERS

7.1. Categories of workers

This section addresses the following categories of workers:

- Operators;
- Technicans such as radiological protection technicans and chemistry technicans;
- Maintenance personnel such as electricans, mechanical maintenance, and instrumentation and control technicans;
- Craft personnel such as welders, pipefitters, carpenters; and
- Supervisors of the above categories.

The training discussed in this section may also be adapted and used for other personnel who support decommissioning such as administrative personnel (e.g., procurement, public

relations, personnel management, etc.), quality assurance and quality control personnel, and security and physical protection personnel.

To complete the safe and efficient decommissioning of a facility, a wide range of disciplines and skills' levels are required. In determining the training needs of these workers, it is important to look at the typical functions which are required to be performed in the process of decommissioning. The main functions requiring to be serviced - along with the associated categories of workers - are shown in the Table 5 below. The workers providing the direct effort, or core functions, to de-fuel and dismantle the facility, and the support functions are shown.

TABLE 5. CATEGORIES OF PERSONNEL SUPPORTING THE CORE FUNCTIONS

Supervisory/Management Staff				
Core Functions During Decommissioning				
De-fuelling	Dismantling	Decontamination	Waste Processing and Handling	Engineering Support
Services Provided By				
Operators	Operators/ Technicians	Operators	Operators/ Technicians	Skilled Crafts Technicians
Supported By				
Engineering, Maintenance	Analytical Services	Radiological Safety Services	Specialist Services	Safety Support
Services Provided By				
Skilled Crafts Technicians	Technicians/ Scientists	Health Physics Technicians	Technicians (various)	Technicians (various)

In Table 5, which depicts categories of workers who are required to undertake the practical 'hands on' implementation phase of the decommissioning projects, workers are divided into five main categories for descriptive purposes:

(1) **Operators.** The type of facility operations required to be completed is dependent on the phase of decommissioning underway. There is an obvious advantage in using the operators who were engaged during the production phase of the facility, and who are fully familiar with the facility and the operational procedures. This is particularly relevant for the de-fuelling phase of a reactor facility and the initial post-operations clean-out work associated with waste processing /reprocessing facilities. The operators performing this work will generally be qualified to complete the work by virtue of their previous operational experience and knowledge gained in a nuclear facility environment. Typical tasks undertaken include de-fuelling, facility systems washout, safety surveillance, waste handling, waste processing, decontamination, and process facility operations.

(2) **Technicians**. This category typically includes technicians who provide essential radiological monitoring and protection support services, and those who provide analytical and testing services, (e.g., chemical, bioassay, facility inspection). The technicians completing this work will generally be qualified to complete the work by virtue of their discipline competence. In the case of radiological safety support, previous experience in a nuclear facility environment is essential.

(3) **Skilled Crafts**. This category includes workers with engineering or construction craft skills, who provide both engineering maintenance and technical support. This category also includes the standard mechanical, electrical, instrumentation and control technicians, and also welders, pipe fitters, fabricators, etc. There is also a requirement on occasions to deploy technicians from the building trades such as bricklayers and carpenters. The technicians performing this work will generally be qualified to complete the work by virtue of their trade competence coupled with previous experience in a nuclear facility environment. Typical tasks undertaken include facility maintenance, facility construction and facility dismantling.

(4) **Specialist support**. This category includes workers servicing the various and miscellaneous support requirements that arise during the decommissioning process. Examples of the typical services required include scaffolding, lagging, concrete cutting and drilling specialists, remote handling equipment operators, underwater specialists, lift technician specialists, demolition specialists (including explosive demolition). These workers are deployed on an ‘as required’ basis essentially to utilize their specialist skills.

(5) **Supervisors**. To ensure that all decommissioning work is completed in a safe and efficient manner, the presence of supervisors to oversee the workers is essential. Supervisors representing all of the above categories of workers are typically required. Having a well trained, fully qualified and experienced supervisor is considered essential, although deploying such supervisors does not remove any of the obligations to ensure that the workers being supervised are suitably trained and experienced. There is an advantage in using supervisors with technical backgrounds related to the activity being supervised. However, the most important attribute a supervisor requires is the ability to manage the work such that it is completed in the manner intended, and to the required standards of safety and quality assurance.

Throughout the Member States, the skills groups listed above are generally common, well understood, and in most instances the subject of various trade union agreements. It is also recognised however, that there is a requirement for some overlap between the groups. The most common requirement in this respect is for a worker to undertake some waste handling / processing operations as part of a dismantling or decontamination, i.e., for a worker to undertake both technical and operational activities. This hybrid, which has been developed or

has evolved in several Member States, fulfills a job position referred to as a decommissioning operator or decommissioning technician. Appendices X and XIII are two examples of the training courses provided for such a job position.

7.2. Types and content of training

7.2.1. General, vocational, or generic training

Many of the personnel identified in the categories listed in section 7.1 will have been trained and qualified during the operational phase; and a significant portion of their previous training is directly applicable to the decommissioning phase. In addition, a significant portion of existing training programme material is normally used for continuing training and for training new employees. It is also recognised that as the decommissioning process progresses, generally an increasing percentage of the total workers are contractor personnel (see also Figure 4). Whereas these contractors may not possess specific knowledge of the facility being decommissioned, they may well have been selected due to their previous experience of similar work at other facilities or their specialist skills. Alternatively they may have been employed simply to satisfy resource requirement peaks, with little or no previous relevant training.

Hence, it is important that training programmes are designed such that they can be used to train both workers who possess significant previous relevant experience and those who have little or no previous experience. In the case of the former, the task is effectively to confirm existing knowledge, and to identify and address any shortfalls by 'top-up' or refresher training. When forming training programmes, there is a need to consider accommodating trainees of varying abilities and also addressing the identified training needs.

In addition, when designing training programmes, there is a need to determine the frequency of delivery for certain course materials to individuals. Such 'refresher' training may not necessarily be as intensive as the initial training for the subject matter, but should be delivered such that the levels of understanding and knowledge are maintained. This is equally applicable for workers who may only use certain skills on an intermittent basis, and for workers who may develop bad habits during continuous repetition of tasks.

The operator (control room operators, field operators), technician, and maintenance training programme material from the operational phase can be readily used 'as-is' or adapted for use particularly during the early stages of decommissioning. Particularly, when many facility systems and equipment are still operational or need to be used for decontamination tasks (such as flushing and cleaning piping systems before dismantling).

Safety, in terms of both personnel and the facility, being the main consideration during any part of the decommissioning processes, the requirement and standard for training in this area, is particularly relevant for workers. It is found however that the standard training material used for general industrial / construction site safety supplemented by material relating to radiological safety can form a sound basis for general decommissioning worker training.

There are also a large number of generic courses that are applicable. Typical subject matter for such generic safety and other training are listed below. This training can be delivered either by formal lectures, in the workplace, in a laboratory, or on the job. The examples of generic courses are as follows:

- General employees training in radiation safety, industrial safety, fire safety, emergency planning
- Radiation worker safety training
- Respirator (full face, half face, self contained breathing apparatus) training
- Airline suit training
- Electrical safety training
- Confined space training
- Crane, hoisting, and rigging training
- Lockout and tagout training (safe system of work)
- Fire Watch training
- Forklift safety training
- Human performance awareness fundamentals training
- Peer and Self Checking
- Project Reviews and Pre-Job Briefings
- Use of Power Tools
- Manual Handling
- Basic First Aid
- Working at Height
- Chemical/hazardous material handling

Even though training courses from the operating phase may already exist for radiation safety training, it is usually necessary to place much more emphasis on radiation worker training due to the more significant radiological challenges encountered during decommissioning activities and the greater potential for exposure of personnel during specific decommissioning tasks. The radiological surveillance completed during the operational phases of the facilities would have been based largely on routine surveys confirming steady state known conditions. In decommissioning, the requirements are to supplement this routine monitoring with task specific radiological monitoring of constantly changing conditions where the radiological hazards can, to a lesser or greater extent, be unpredictable. It is important to provide this enhanced training so that the workers and supervisors recognize this change, and will be better prepared to perform the radiological work.

Appendix IX contains an example of an extensive list of additional courses that various categories of workers may need depending on the specific decommissioning activities and tasks they are assigned to perform. Appendix X is an example of a list of courses that have been developed for a newly developed decontamination and decommissioning (D&D) technician job position. Appendix XI (Specific training program for the internal transference of activated graphite at Vandellos - tracking sheet and course contents) illustrates the characteristics of a course specifically designed for the transference of activated graphite. Annex II, item 12 and 56, include examples of a training matrix used to show the various training requirements for different posts within a decommissioning project.

In one of the Member States (USA), all workers at government owned decommissioning sites are required to take a hazardous waste operations training course. The length of this course varies from 24 hours to 40 hours depending on its applicability to various categories of workers. Periodic refresher training is also required. Appendix XII is an outline of the topics covered in the course. Annex II, items 19 and 20, contain the U.S. Occupational Safety and

Health Administration (OSHA) regulations and standards for this training. This information is also available on the OHSA internet site at http://www.osha.gov

During the transition from the operational phase to the decommissioning phase, it has also been found necessary to provide emphasis on team building and human performance improvement training. This is partly due to the uncertainty in long-term employment and partly due to the change in the workforce. IAEA publications, references [17] and [21] on human performance improvement, have examples of these types of courses.

In some Member States vocational and appenticeship programs have been established to provide for a career building potential in the field of environmental cleanup and decommissioning. These are described briefly below.

The vocational programs were established in recognition of the growing use of a mobile contractor workforce, which migrates to different nuclear facilities as they enter their decommissioning phase; and in recognition of the requirement to ensure common standards across the industry. When considering the typical different backgrounds of the workers (e.g., previous facility operators, technicians, semi-skilled operatives, etc.), the need to establish common occupational standards is also recognised. Appendix XIII describes a modular approach by one Member State (UK) to establishing common national occupational standards in nuclear decommissioning. In vocational programmes the workplace is essentially the classroom. In this approach a worker is required to achieve nationally accepted standards of competence in various aspects of nuclear decommissioning in order to satisfy the vocational training requirement. The worker's competence is assessed while observing the worker's performance of various standard tasks, by assessing knowledge and understanding (typically by using oral and written questions), and by collecting evidence to support these attributes. From these various tests of performance, knowledge and understanding, a portfolio of evidence for each candidate is collated. This is then submitted to an independent external examiner who decides whether the worker has achieved the desired level of competence in the module being completed. The worker is then awarded a National Vocational Qualification (NVQ) in Nuclear Decommissioning. An example of one module from the NVQ system in UK is contained within Appendix XIII. An overview of the system is included in Annex II, item 13.

A problem in many of the Member States is that of predicted future shortages of trained skilled labour in the nuclear industry in general and nuclear decommissioning in particular. This is due to demographics and the well-documented decline over recent years in the number of young persons entering the industry. This, in turn, has a bearing on the type of personnel available for training. To address this problem, one of the Member States (United Kingdom) has developed an apprenticeship programme at Dounreay, tailored to train young persons in the skills required for nuclear decommissioning, and to provide a base for career development. It is believed that by encouraging young persons to pursue a career in nuclear decommissioning by providing a structured course of formal training, the apprentices of today are better equipped to be the supervisors and /or managers of tomorrow. In this programme young persons leaving secondary education participate in a three-year period of work experience, academic training and vocational training leading to an apprenticeship in Nuclear Decommissioning and Operations. The emphasis throughout this three-year training period is on exposing the apprentice to as many of the different facets of nuclear decommissioning as possible, while ensuring that the learning process is fully supervised with respect to the young persons health and safety. While set standards are required to be met in order for the young person to successfully achieve a formal apprenticeship qualification, the emphasis is also

firmly on human resource development, using this qualification as the first step in the process of building a successful career in the industry. A description of this apprenticeship scheme can be found at Annex II, Item 14.

Appendix XIV provides a list of lessons learned in the training of decommissioning project personnel from the Connecticut Yankee and Connecticut Rowe nuclear power plants (United States of America).

7.2.2. Training based on specific activities and tasks

During decommissioning many of the activities and tasks undertaken are very unique and only performed one time. In such situations, extensive job and task analysis, or job competency analysis, and training programme course development are usually not undertaken. Instead more detailed work planning is conducted by the operating organization to identify all of the steps involved in a particular decommissioning task. As part of this activity planning process, several Member States (CA, UK, USA) have developed processes referred to as a Job Safety Analysis (JSA), Job Hazards Analysis (JHA), Risk Assessment, and Hazard and Operability (HAZOP) Analysis. In this latter approach - used in UK to identify potential hazards - a team of individuals with varying backgrounds and expertise is brought together during HAZOP sessions, and through a collective brainstorming effort which stimulates creativity and new ideas, a thorough review of the activity under consideration is completed.

These processes form the basis for the identification of the hazards involved in each step of an activity, the generic training prerequisites that must be completed by workers assigned to the activity (radiation safety training, etc.), and the task specific training required. Much of the specific task training is then provided by Subject Matter Experts (SMEs) either in the classroom, by walking down the job site, conducting “dry runs” in the facility or on mock-ups, and discussing each step in the activity. Section 10.2 describes the use of mock-ups.

A job hazard analysis is a technique that focuses on job tasks as a way to identify hazards before they occur. It focuses on the relationship between the worker, the task, the tools, and the work environment. Ideally, after one identifies uncontrolled hazards, the steps to eliminate or reduce the hazards to an acceptable risk level are taken. One of the most important elements of controlling the risks and making sure that the controls identified are used properly is the provision of information, instruction, and training to those doing the work. The control or elimination of hazards through measures other than training is normally the preferred option. When this is not completely possible, training of workers must be provided. Appendices XV, XVI, and XVII are examples of forms provided by two Member States (CA, USA), that are used to conduct a Job Hazards Analysis or Job Safety Analysis. Appendix XVIII is an example of a risk assessment format used in one Member State (UK). In another Member State (USA) an automated Job Hazardous Analysis tool has been developed including the use of a Pocket Personal Data Assistant (PDA). Appendix XIX provides a brief description of the Pocket JHA tool. Annex II, item 31 includes a description of the automated job hazards analysis tool. Annex II, item 32 is the U.S. Occupational Safety and Health Administration guide on JHA.

In order for the JHA process to work effectively, subject matter experts, training personnel and workers must all be involved in the Job Hazards Analysis process working together as a team.

After training is provided, pre-job briefings are typically conducted immediately before conducting the task associated with the decommissioning activity. To improve the pre-job briefings, it is important for the supervisor to actively involve the workers in the discussion of the work to be performed. The briefings typically include a "walk-down" of the job site and an interactive discussion of the tasks to be performed. Table 6 is an example of an interactive approach to pre-job briefings. Appendix XX is an example of a Pre-Job Briefing form. Annex II, Item 10 also provides a short example of an approach to pre-job briefings known as Toolbox Talks. Annex II, item 53 is an example lesson plan for a work package 'walk-down"; and item 55 is an example of an on-job training guide.

TABLE 6. INTERACTIVE APPROACH TO PRE-JOB BRIEFINGS

- Supervisors facilitate the pre-job brief and cover five (5) critical questions:
  1. Have we performed this task before?
  2. What are the critical steps or phases of this task?
  3. How can we make a mistake at this point?
  4. What is the worst thing that can go wrong?
  5. What barriers or defences are needed?
- Workers provide information for the pre-job briefing
  - Gives worker ownership of their personal safety
  - Workers are involved in how the job is to be performed

8. PRACTICES TO IMPROVE THE EFFICIENCY AND EFFECTIVENESS OF DECOMMISSIONING TRAINING

ENTRAC: The IAEA has developed the Electronic Nuclear Training Catalogue (ENTRAC) that provides a method for gathering, sharing, and maintaining training information and materials. This Internet site (http://entrac.iaea.org) provides an access to information and documents on personnel training, including training for decommissioning activities, to the related IAEA technical documents, and also to the documents and data the Member States provide to IAEA for information exchange and sharing.

IAEA pilot project: The IAEA is establishing an international demonstration project to demonstrate the safe decommissioning of research reactors. There are over 200 research reactors that have either not operated for a considerable period of time, and may never return to operation, or are close to permanent shutdown. The objective of the project is to facilitate the exchange of information and experience, education and training, and serve as a model for other such projects. The intent is to use the selected facility as a training facility for decommissioning activities and allow for hands-on application of procedures for project participants. Workshops and training courses would also be held at the facility. It is also anticipated that during major evolutions of the decommissioning process, groups of individuals from other Member States would be cycled through the facility to obtain practical experience. Technical reports would also be published to share lessons learned. Information on the status of this project can be found on the IAEA web site.

OECD-NEA-CPD: Organization for Economic Co-Operation and Development, Nuclear Energy Agency, International Co-operative Programme on Decommissioning. This programme provides a forum for ensuring the safe, economic and best environmental options for decommissioning are employed.

RADWASTE: The web site http://www.radwaste.org maintains an extensive list of publications related to all phases of decommissioning. Many of these publications provide information, not only on decommissioning methods and technology, but lessons learned and other information that can be useful when planning for the training of managers, professional staff, and workers for specific decommissioning projects.

EUNDETRAF: The objectives of the European Nuclear Decommissioning Training Facility (EUNDETRAF) are to disseminate and share European decommissioning knowledge with those who are faced with the challenge of decommissioning nuclear facilities, by holding annual training courses. Each training course consists of a one-week theoretical and a one-week practical part. The target audience for these training courses include personnel who are or will be involved in decommissioning projects, such as manager, engineers, health physicists. The courses may also be of interest to the entities and individuals desiring to know more about decommissioning; such as government and regulatory bodies, industry representatives and contractors. Information on EUNDETRAF courses and schedule can be found on their web page at http://www.eundetraf.be/html/eundetrafintro.html

Sharing of training materials: For many job positions, a common core of training material can be used. For example, for job positions such as radiation protection technicians and maintenance crafts, a significant portion of training is the same even across different NPP types. In some Member States this training material is made available through the Internet, either openly or through password controlled sites. The use of this material can significantly reduce the costs of development of new material. One example of such training material for radiation protection technicians is provided by the U.S. Department of Energy at http://www.eh.doe.gov/radiation/RST/rst.htm. This site also contains training material for radiation worker training and general employee training on radiation safety. Training courses on decontamination and decommissioning may be also found at the Argonne National Laboratory (USA) web site http://www.td.anl.gov/D&D. The IAEA has also established a programme to support the development of standardized training packages and distance learning tools in the field of nuclear safety. Information on this programme and the training materials available can be found at http://www-ns.iaea.org.

Reciprocity agreements: This is a process that allows an organization to accept previous training and qualification of personnel from another similar organization. It can be used for almost any job position, but it is mostly widely used for general employee training, including such training required for decommissioning and outage support contractors, who may move from one facility to another for decommissioning or outage work. These agreements are used typically to establish that workers have attained a recognized level of safety awareness. Such levels of knowledge and understanding of safe working practices are not necessarily restricted to the nuclear industry. For example, records of previous training provided in the construction industry can be used as building blocks for training required for nuclear decommissioning workers.

9. SELECTION AND TRAINING OF INSTRUCTORS

The IAEA publication *Development of instructors for nuclear power plant personnel training*, IAEA-TECDOC-1392 [13], provides detailed guidance on the selection, qualification, and training of instructors. This publication is fully applicable to the development of instructors for the decommissioning phase. In addition to the guidance provided in reference [13] for the selection of instructors, previous experience in decommissioning activities would be desirable, if such personnel are available. The use and reliance on part-time or occasional

instructors and subject matter experts as instructors is common in decommissioning activities. Such personnel are typically supported by the training organization and may receive coaching and limited instructor training depending on their capabilities. Most instructors are also subject matters experts and should receive some general training on decommissioning. Such training is identified in Section 6, Tables 3 and 4. Annex II, items 33 and 34, provide specific examples on the selection and qualification of instructors for decommissioning activities. Instructors who have no decommissioning experience should also participate in courses and seminars such as the example provided in Table 3.

The training provided for many decommissioning tasks is also performed through structured pre-job briefings, "walk downs", and on-the-job (OJT) training. Instructors typically prepare pre-job briefing materials or assist in their preparation, including materials of pre-job briefings and "walk downs" conducted by first line supervisors. It is desirable to provide first line supervisors with training on how to correctly conduct pre-job briefings. The personnel who provide OJT material are also typically trained in the proper conduct of OJT (see Annex II, item 34).

10. TRAINING FACILITIES

10.1. Special training facilities

In order that the training needs for personnel involved in nuclear decommissioning can be adequately addressed, it must be recognized that due to the unique and 'one off' challenges which arise, there is a requirement for specialized training. Much of the training associated with the techniques and related industrial and radiological safety issues are available as standard learning courses/modules and are indeed common to the training required by the nuclear facility operators. The use of existing facilities set up to train personnel during nuclear facility operation, usually local to the nuclear facility, is simply extended to cover the decommissioning requirement. There is however a need in facilities that are dedicated to provide training for either highly specialized tasks or for tasks which are unique to the nuclear decommissioning process.

Such facilities are usually in the form of mockups (see section 10.2) that simulate the plant layouts. Other uses for such centres include training associated with remote handling equipment, specialist decontamination equipment, and the application of specialized coatings and chemicals. The mockups are usually located close to the actual decommissioning site, whereas the established national training organizations supply more specialized decommissioning training at these centres.

Appendix XXI (Mobile information centre for training on decommissioning and radioactive waste management — photos) shows the mobile information centre used at Vandellos to train and communicate the decommissioning goals, methods and progress to students, population of the local municipalities and stakeholders.

An example of a typical layout of a decommissioning training facility from one of the Member States (United States of America) is included in Annex II, item 46.

10.2. Use of mockups and other techniques

In the training of personnel involved in nuclear decommissioning, the prime considerations are those associated with both radiological and industrial safety. This is particularly important in terms of the requirement to minimize potential exposure of workers to ionizing radiation

and to minimize the spread of radioactive contamination. Generally, the ideal situation is for a typical dismantling or waste packaging operation to be completed according to the pre-planned course of action, such that the work is completed successfully and that the radiation doses are kept to an absolute minimum, i.e. the 'time at risk' is controlled. Hence, it is extremely important that the working procedures are well understood and, wherever possible, practiced by the workers before the work being undertaken.

One of the most powerful tools to develop the working procedures and to train the personnel is the use of a mockup. For the dismantling of highly active equipment in particular, the training of workers using full-scale mockups is invaluable. Mockups are also used extensively in training centres to simulate typical working environments found in the industry. An example of this is the simulation of standard dismantling/cutting operations in cramped areas to permit training in the use of full plastic suits and the associated breathing air arrangement. Further authenticity can be gained in such situations with the use of invisible agents to simulate contamination.

Much can be gained from the simulation of facility conditions and rehearsing operations in the comfort of an inactive facility. Examples of where the use of mockups can assist the training process are:

- To develop tooling and equipment, such that potential problems with the use of tooling can be foreseen and the limitation of its use is fully understood. This is particularly true where the use of remote disassembly equipment is being considered.
- To train in the use of Personnel Protective Equipment (PPE) which is utilized in active conditions.
- To identify any element of risk, and to trial potential methods of mitigation.
- To develop disassembly techniques, and to train workers in the execution of such procedures.
- To establish the duration of individual activities and, hence, to acqire an aid to controlling any dose considerations.
- To minimize the spread of both radiological and chemical (e.g. asbestos) contamination, hence, reducing the risk to both workers and the environment.
- To establish team working arrangements.
- To simulate fault or emergency situations, and to train in the associated recovery procedures (e.g. sudden collapse of worker, building evacuation).
- To assist in the planning of waste minimization.

Other simulation techniques used both in support of decommissioning and training include the use of three-dimensional models that are generated using computer aided design (CAD) systems; or 3-D modeling using such hardware as gamma camera, gamma spectrometer, laser scanners and associated software; interactive graphics robotic software; or other software techniques. Such models are used to accurately simulate the relative spatial positions of components, access ways, potential exposures, personnel and tooling on a screen. Software tools provide the advantage over mockups that they are of the multiple re-use. As well as tools for the development of technical solutions, they can be used by personnel to familiarize themselves with facility layouts and gain familiarity with the equipment operating envelopes prior to exposure to a live working environment. Item 80 of Annex II provides the examples of the hardware and software used for characterization, decommissioning planning and training.

The use of mockups and simulation aids is particularly useful due to the nature of typical decommissioning work undertaken. When considering the many different facilities throughout the Member States currently being decommissioned, it is indeed very rare for this decommissioning requirement to have been considered during the original design and construction stage. Hence, the development of dismantling techniques (in terms of equipment and personnel training) using mockups or similar as discussed above, before executing the work, is often essential.

It is often the case that work is required in areas that were inaccessible during operations due to dose considerations and were sealed behind many layers of shielding. In such cases the only way to develop methods of disassembly is by the use of mockups constructed from original as-built drawings and data. Work in such areas also creates challenges regarding the prediction of radiation dose uptake for workers. In situations where it is not always possible to obtain radiation survey data, mockups, where personnel can train to develop techniques and tooling such that the 'time at risk' for the workers is kept to an absolute minimum, are invaluable.

Appendix XXII provides several photographs of typical mockups used for training. Further examples of the use of mockups as training aids for decommissioning activities are included in Annex II, items 12, 36, and 47. Annex II, item 17 is an example of a three-dimensional computer aided design (3D-CAD) tool that is used as a dismantling planning tool.

10.3. Computer based or web-based training

Although the most effective type of training in nuclear decommissioning is that which is undertaken either in a live working environment or with mockups (particularly for workers), there is a definite place and requirement for classroom or self-study type training. Within the overriding 'safety awareness' part of the training requirement there is a specific need for personnel to learn about safety issues relevant to nuclear decommissioning, and to keep abreast of such issues. There is also a requirement for personnel, especially contractors, to produce proof that the training has been successful and that the subject matter has been fully understood, i.e. to obtain evidence that specific and prior agreed levels of competence have been attained.

Increasingly such safety training is undertaken using computers (computer-based training — CBT), and using the Internet (web-based training — WBT). As interactive technology develops, and with the increasing use of multi-media and virtual reality, a new term Technology-Based Training (TBT) is being used. There are many companies within the Member States who provide such services including educational entities, i.e. universities and colleges, as well as companies specializing is such products.

The training is usually either delivered via CD-ROMs or via Internet, whilst in some instances a mixture of both is used. The training courses can last from ten minutes for an introductory style course, through to two hours for a full topic training session. More extensive courses are also available that cover material equivalent to a full-time five-day classroom based course. The training is usually presented as a modular series of individual topics that can be called from a menu with extra information offered which may be accessed if required. Questions are used throughout the material to assess the trainees understanding, and may be used to control the route taken through the course material and rate of progress in line with the trainee's understanding of the subject. There is often an assessment or test module with questions designed to assess the trainee's overall understanding of the material.

Where WBT is used, it often includes direct access to an instructor or mentor who can provide advice on the training material and also analyze the results of tests to determine the level and delivery pace of the training material to suit the individual trainee's competence level.

In looking at training associated with nuclear decommissioning, CBT or WBT is a useful tool as it:

- Is suited for the delivery of standard multi-repetitive safety training modules that form the basis of the worker training requirement, i.e., it can lead to more efficient use of instructor time.
- Can be used to deliver refresher type courses.
- Can be used to deliver training to personnel of differing prior levels of competence.
- Can be used by personnel who do not feel confident or comfortable with a classroom type situation, i.e., they can work at their own pace.
- Usually includes an assessment module, the successful completion of which can be used as evidence of competence.
- Can introduce an element of interaction between the trainee and the course material that is not always possible in a classroom environment. (This can make it a more interesting and fulfilling experience.)

Typical subject matter relating to nuclear decommissioning that is taught using CBT or WBT includes:

- Asbestos in the workplace
- Basic radiation safety
- Radiation safety for radiation workers
- Chemical safety
- Confined space awareness
- Electrical safety
- Electricity at work regulations
- Environmental management
- Fire fighting (emergency)
- First aid at work
- Introduction to Control of Substance Hazardous to Health (COSHH)
- Introduction to radiation safety
- Manual handling
- Management of health and safety
- Noise at work
- Radiation safety (for radiation workers)
- Reporting of incidents
- Risk Assessment
- Safe manual handling
- Safe working at heights
- Safety signs and signals regulations

— Use of Personnel Protection equipment (PPE)
— Working safely with flammable liquids and powders
— Workstation assessment
— Workplace induction

10.4. Training information management systems

During decommissioning, there are many unique tasks performed for which specialized training (respirator, confined space training, hoisting and rigging, etc.) may be required. A large amount of flexibility is also usually necessary in assigning workers to perform tasks. It can become difficult to track the training of individual workers to assure they have the prerequisite training required for the type of task to be performed. To help manage the training and assignment of personnel to specific operating tasks, many Member States have already developed or purchased Training Information Management Systems for use during the operational phase. These systems can be readily used or modified to meet the needs of decommissioning activities. Numerous vendors provide Training Information Management Systems. These systems are referred also to as Learning Content Management Systems. They are valuable tools for tracking training by job category and by an individual. Appendix XXIII contains an example of the features of a typical Training Information Management System.

Some details of the Training Information Management System in use during the decommissioning of Vandellos I NPP is shown in Appendix XXIV (Training Information System at Vandellos; and photographs of computer screens are included in Annex II, item 7).

11. CONCLUSIONS — THE NEED FOR A STRATEGIC VISION FOR THE USE AND COMPETENCE OF HUMAN RESOURCES

Adequate numbers of competent and motivated personnel must be available during any phase of a nuclear facilities life cycle including decommissioning. .One of the critical prerequisites for successfully carrying-out a decommissioning project is the considered management vision and long-term strategic plan for the use of human resources and for the assurance of the adequate competence of all personnel (the employees and contractors) involved at all stages in the decommissioning project activities.

Attention should be paid to the training of all categories of personnel including management and professional staff and workers. Training of personnel — being an important mean to achieve the required organizational and human performance — alone can not ensure the required competence. Particularly, change management polices and practices also need to be implemented to achieve adequate performance of the personnel involved in decommissioning. Training of personnel for undertaking the decommissioning project should be viewed as the integral part of the human resource management process. In order to perform the decommissioning project in a safe and efficient manner, the operating organization and decommissioning project managers should develop and communicate to the staff the vision for the integrated management of human resources including personnel training.

Adequate resources should be allocated by the operating organization and decommissioning project managers to ensure competence of all personnel (the employees and contractors) involved at all stages of the decommissioning project, and to preserve knowledge for future generations. It is needed to define the management vision for the integrated management of human resources — including personnel training — at an early stage of a decommissioning project. The integrated process involving human resources strategic planning, recruitment,

selection, training, qualification, motivation, performance evaluation, development, and knowledge preservation should be established for safe and efficient conducting the decommissioning activities.

APPENDIX I
LIST OF IAEA PUBLICATIONS ON DECOMMISSIONING AND DECONTAMINATION

Safety Series (SS)	
Predisposal Management of Radioactive Waste, Including Decommissioning	SR No. WS-R 2 (2000)
Decommissioning of Nuclear Power Plants and Research Reactors., Safety Guide	SS No. WS-G-2.1 (1999)
Decommissioning of Medical, Industrial and Research Facilities, Safety Guide	SS No. WS-G-2.2 (1999)
Decommissioning of Nuclear Fuel Cycle Facilities, Safety Guide	SS No WS-G-2.4 (2001)
Safe Enclosure of Nuclear Facilities During Deferred Dismantling	Safety Reports Series No.26 (2002)
Managing the Early Termination of Operation of Nuclear Power Plants	Safety Reports Series No. 31 (2003)
Safety Considerations in the Transition from Operation to Decommissioning of Nuclear Facilities	Safety Reports Series No. 36 (2004)
Application of the Concepts of Exclusion, Exemption and Clearance, Safety Guide	SS No. RS-G-1.7 (2004)
Derivation of Activity Concentration Values for Exclusion, Exemption and Clearance	Safety Reports Series No. 44 (2005)
Standard Format and Content for Safety Related Decommissioning Documents	Safety Reports Series No. 45 (2005)
Decommissioning of Facilities Using Radioactive Material	Safety Requirements No. WS-R-5 (2006)
Technical Reports Series (TRS)	
Decontamination of Nuclear Facilities to Permit Operation, Inspection, Maintenance, Modification or Plant Decommissioning	TRS No. 249 (1985)
Methodology and Technology of Decommissioning Nuclear Facilities	TRS No. 267 (1986)
Methods for Reducing Occupational Exposure During the Decommissioning of Nuclear Facilities	TRS No. 278 (1987)
Decontamination and Demolition of Concrete and Metal Structures During the Decom. of Nuclear Installations	TRS No. 286 (1987)
Factors Relevant to the Recycling or Reuse of Components Arising from the Decommissioning and Refurbishment of Nuclear Facilities	TRS No. 293 (1988)
Monitoring Programmes for Unrestricted Release Related to Decommissioning of Nuclear Facilities	TRS No. 334 (1992)
Cleanup and Decommissioning of a Nuclear Reactor After a Severe Accident	TRS No. 346 (1992)
Application of Remotely Operated Handling Equipment in the Decommissioning of Nuclear Facilities	TRS No. 348 (1993)
Planning and Management for the Decommissioning of Research Reactors and Other Small Nuclear Facilities	TRS No. 351 (1993)
Decontamination of Water Cooled Reactors	TRS No. 365 (1994)
Decommissioning Techniques for Research Reactors	TRS No. 373 (1994)
Safe Enclosure of Shutdown Nuclear Installations	TRS No. 375 (1995)
Design and Construction of Nuclear Power Plants to Facilitate Decommissioning	TRS No. 382 (1997)
Decommissioning of Nuclear Facilities Other than Reactors	TRS No. 386 (1998)
Radiological Characterisation of Shutdown Nuclear Reactors for Decommissioning Purposes	TRS No. 389 (1998)
State-of-the-art Technology for Decontamination and Dismantling of Nuclear Facilities	TRS No.395 (1999)
Organization and Management for the Decommissioning of Large Nuclear Facilities	TRS No. 399 (2000)
Minimisation of Radioactive Waste from Decontamination and Decommissioning of Nuclear Facilities	TRS No. 401 (2001)
Record keeping for the Decommissioning of Nuclear Facilities: Guidelines and Experience	TRS No. 411 (2002)
Decommissioning of Small Medical, Industrial and Research Facilities	TRS No. 414 (2003)
The Transition from Operation to Decommissioning of Nuclear Installations	TRS No. 420 (2004)
The Power Reactor Information System (PRIS) and its Extension to Non-Electrical Applications, Decommissioning and Delayed Projects Information	TRS No. 428 (2005)
Dismantling of Contaminated Stacks at Nuclear Facilities	TRS No. 440 (2005)
Management of Problematic Waste and Material Generated During the Decommissioning of Nuclear Facilities	TRS No. 441 (2006)
The Decommissioning of Underground Structures, Systems and Components	TRS No. 439 (2006)
Redevelopment of Nuclear Facilities after Decommissioning	TRS No. 444 (2006)
The Decommissioning of Research Reactors; Evolution, State-of-the-art, Open Issues	TRS No.446 (2006)
Technical Documents (TECDOC)	
Decontamination and Decommissioning of Nuclear Facilities: Final Report of Three Research Meetings (1984-87)	IAEA-TECDOC 511 (1989)
Decontamination of Transport Casks and of Spent Fuel Storage Facilities	IAEA-TECDOC-556 (1990)
Factors Relevant to the Sealing of Nuclear Facilities	IAEA-TECDOC-603 (1991)
Considerations in the Safety Assessment of Sealed Nuclear Facilities	IAEA-TECDOC-606 (1991)
National Policies and Regulations for Decommissioning Nuclear Facilities	IAEA-TECDOC-714 (1993)
Decontamination and Decommissioning of Nuclear Facilities - Results of a CRP, ,Phase II: 1989-1993	IAEA-TECDOC-716 (1993)
New Methods and Techniques for Decontamination in Maintenance or Decommissioning Operations - Results of a Co-ordination Research Programme, 1994-1998	IAEA-TECDOC-1022 (1998)
Technologies for Gas Cooled Reactor Decom, Fuel Storage and Waste Disposal, TCM Juelich, Germany, Sep 1997	IAEA-TECDOC-1043 (1998)
On-site Disposal as a Decommissioning Strategy	IAEA-TECDOC-1124 (1999)
The Decommissioning of WWER-Type Nuclear Power Plants	IAEA-TECDOC-1133 (2000)

Nuclear Graphite Waste Management -Technical Committee Meeting , Manchester, United Kingdom, 18-20 Oct 1999	CD-ROM (2001)
Decommissioning Techniques for Research Reactors- Final report of a Co-ordinated Research Project 1997-2001	IAEA-TECDOC-1273 (2002)
Safe and Effective Nuclear Power Plant Life Cycle Management Towards Decommissioning	IAEA-TECDOC-1305 (2002)
Decommissioning Costs of WWER-440 Nuclear Power Plants. Interim Report: Data Collection and Preliminary Evaluations	IAEA-TECDOC-1322 (2002)
Planning, Organizational and Management Aspects of Decommissioning: Lessons Learned	IAEA-TECDOC-1394 (2004)
Operational and Decommissioning Experience with Fast Reactors	IAEA-TECDOC-1405 (2004)
Financial Aspects of Decommissioning	IAEA-TECDOC- 1476 (2005)
Selection of Decommissioning Strategies: Issues and Factors	IAEA-TECDOC-1478 (2005)
Characterization, Treatment and Conditioning of Radioactive Graphite from Decommissioning of Nuclear Reactors	IAEA-TECDOC-1521 (2006)
Other	
Nuclear Data Requirements for Fission Reactor Decommissioning	INDC (NDS)-269 (1993)
International Benchmark Calculations of Radioactive Inventory for Fission Reactor Decommissioning	INDC (NDS)-355 (1996)
A Proposed Standardised List of Items for Costing Purposes in the Decommissioning of Nuclear Installations	OECD/NEA, Paris 1999
Safe Decommissioning for Nuclear Activities, Proc. of an Int. Conf. Berlin, 14-18 Oct. 2002	IAEA, Vienna, 2003
Joint NEA/IAEA/EC Workshop on the Regulatory Aspects of Decommissioning, 19-21 May, 1999, Rome	ANPA, Rome, 2000
Status of the Decommissioning of Nuclear Facilities Around the World	IAEA, Vienna. 2004

APPENDIX II
SENIOR MANAGEMENT COMPETENCIES

The list of suggested competencies for the members of a senior management team may be used to design the selection, recruitment, training and development programmes for a decommissioning project.

No	Competencies
	General management and technical competencies
1	Vision for the overall management and policies of a comprehensive decommissioning project
2	Strategic vision and main aspects of transferring the organization from Operational to Decommissioning
3	Establishing the appropriate Organizational Culture. Organization's values. Establishing and adhering to the Code of professional ethics: role of managers
4	Management of change
5	Effective Management of Human Resource
6	Reassignments of personnel; motivation; maintaining the appropriate safety and organizational culture
7	Management ownership for Personnel Training, Re-training and Qualification; Basics of a systematic approach to training (SAT): manager role and responsibilities
8	Establishment of integrated Management System
9	Quality Management (how to integrate it into a coherent Management System)
10	Knowledge of main elements of management of a decommissioning project (processes, activities, interface arrangements)
11	Understanding the need for, objective and key issues of the characterization of radiologically and chemically hazardous materials
12	Basics of decontamination and dismantling; and key issues for the site
13	Basics of waste management; and key issues for the site
14	Key issues of spent fuel management (including SF Storage) impacting the decommissioning project
15	Basics of Risk Assessment, Risk Management and Risk-Informed Decision-Making
16	Basics of Project Management (all important aspects, including project risk management)
17	Ability to identify key stages and deliverables and to drive achieving the results
18	Fundamentals of Programme Management (work breakdown structures, earned value reporting, etc.)
19	Basics of planning for decommissioning. Key issues and current status of the Decommissioning Plan (DP)
20	Site Closure competencies associated with the site End State and Closure Plans.
21	Main aspects of cost estimates and cost reduction for the decommissioning project
22	Main aspects of procurement. Purchasing and spares policy
23	Evaluation of tenders
24	Contractors' management. Ensuring competence of the contractors
25	Assessments (self –assessment, independent assessments, Management System review)
26	Basics of Safety Management (policy, organizational issues, planning, measuring, review and audit); and establishing Safety Culture
27	Key issue of Health Physics and Radiation Protection. Personnel and industrial safety. Establishment of safe work environment; decreasing personnel dozes and injuries. Exposure reduction – ALARA
28	Basics of job hazard analysis
29	Accident and error-free performance tools
30	Basics of Environmental Safety
31	Knowledge of policies and key issues of facilities' maintenance, surveillance and inspection. Facility modifications; basics of configuration management
32	Improving workplace, human and organizational performance: role of managers. Establishing measurable expectations; performance standards; monitoring performance; identification of performance gaps; corrective actions. Implementation of effective Corrective Action Programme
33	Knowledge of plant (site, units') history
34	Basics of Knowledge Management for decommissioning (including Knowledge Retention and Transfer). Knowledge of main issues of Information Management and Record keeping
35	Basic knowledge of Information Technologies in support of decommissioning projects

No	Competencies
36	Key issues of Security and Safeguards. Role of managers in verification and ensuring the appropriate security and safeguard measures
	Regulatory requirement related competencies
37	Knowledge of main applicable Regulatory requirements
38	Knowledge of key issues of Licensing (including the final decommissioning license termination)
39	Safety Analysis Report (SAR) purpose and main issues
40	Basics of Emergency Preparedness (basics of Emergency Planning, Managers' responsibilities during various emergencies and accidents including personnel injury, radiation, fire, evacuation; on-site and off-site systems and organizational arrangements supporting Emergency Preparedness, event assessment and reporting)
	Administrative, financial and social issues
41	Labour regulations and issues. Handling disciplinary problems. Handling conflicts within a work group
42	Basics (relevant to all senior managers) of business planning, financial management (including budgeting) & accounting
43	Knowledge of key issues related to minimizing the social impact
	Interpersonal / soft skills, and overall management competencies
44	Leadership
45	Strategic thinking
46	Achieving Results
47	Communication skills (including promoting unity of purpose in the organization through the sharing of ideas, information, policy, and procedures; verbal and listening skills, communication with employees; encouraging discussion of the views, ideas, thoughts, and opinions of others; encouraging everyone in the organization to express opinions freely; giving and receiving feedback; conducting effective meetings; asking for input from others)
48	Decision-making and problem solving skills
49	Time management
50	Negotiating and Influencing
51	Facilitation techniques & Effective Presentation skills
52	Stakeholder focus. Interaction with the stakeholders
53	Business focus (including prioritizing expenditures across the organization to reduce costs while investing in safety and efficiency)
54	Developing People
55	Basics of developing effective incentive programmes for fulfilling safety requirements, achieving the decommissioning project goals, and retention of personnel
56	Basics of coaching employees to better performance
57	Personal characteristics (such as intelligence, honesty, loyalty. ethics, self-control, sense of humour, creativity, ability to handle stress, invite dissension, empathy, assess ones self, flexible/adaptable, ability to say 'no', continuous learner, proactive, fair minded, broad minded, courage, perseverance, enthusiasm, role model)
58	Specific technical competencies such as: — Operational and decommissioning waste streams characterization and conditioning — Radiological inventory — Classification and selection of the Segmentation Techniques. Application of dismantling techniques and equipment — Basics of nuclear criticality safety
	Language skills
59	Foreign language skills adequate to effectively participate in the management of the projects that involve the overseas contractors and consultants; and to effectively learn through the communicating with the overseas colleagues, reading relevant material, participating in the international meetings, conferences and visits to the overseas enterprises

APPENDIX III
BUILDING UP A NEW ORGANIZATION FOR DECOMMISSIONING PURPOSES AND TRAINING ASSOCIATED (VANDELLOS I D&D PROJECT)

Introduction

The Vandellós 1 Nuclear Power Plant was a 500-MWe gas-graphite reactor that was shut down in 1989, after 17 years of operation, due to a fire in the turbines.

Enresa, the Spanish public company responsible for radioactive waste management, took charge of the decommissioning of this installation, firstly to design and license the technical aspects of the project and, subsequently, to assume responsibility for operation of the plant.

After studying three decommissioning alternatives, a stage 2 for the de-fuelled reactor vessel and contents and decontamination of most of the rest of the site was chosen.

Simultaneously to the technical studies, design and licensing, and previous to the initiation of the works, Enresa carried out what we thought was a very important planning task for decommissioning: the design of a new organization led by Enresa but mainly integrated by personnel belonging to the former operator of the plant.

The following paragraphs will describe the results of this design and how training helped to its implementation.

Design of the organization

Before undertaking the detailed design of the organization to be involved in the project, the following criteria were established:

- Enresa needs to operate as a management company that:
  - Has minimal in-house resources at Vandellós, placed in key positions
  - Obtains maximum support from the head office
  - Applies its own methods and management systems
- Enresa has to make optimal use of the resources and know-how of the former operator and its workers.
- Enresa will hire specialist companies for specialised activities
- Enresa has to take advantage of this first decommissioning experience and obtain a reusable model, valid for future similar projects.

Taking these guidelines into account, Enresa drew up what were thought to be the key points to establish a new organization:

- A new general organization chart, in which performance services (engineering, performance, waste management), and controlling services (quality assurance, radiological protection) are clearly separated and report to different heads.
- Organization guides for each department, consisting of volumes describing the positions, duties and assignments of people, mainly from the former operator. These guides also described the training needed in order to adapt personal profiles to the new duties and responsibilities.

- New basic documents, such as a new security plan, a new dose calculation plan, new technical specifications, etc, and new detailed procedures, classified into three main groups:
- Operation, maintenance and security procedures, based on procedures of the previous operator (validated or adapted)
- Administrative and quality assurance procedures, based on Enresa procedures (revised).
- Engineering and performance procedures, completely new because they describe completely new activities at the plant: decommissioning activities.
- Management information systems, such as the documentary, financial, human resources and safety systems and the especially important waste management information system. This includes a newly developed software that allows us to identify and control the routes followed by all materials arising from decommissioning.

Organization guides and generic training needs

Organization guides were considered a powerful tool to document and disseminate the new structure applicable to decommissioning.

In these guides, generic training needs were detected after identifying the following:

- Responsibilities for each department
- Jobs required
- Tasks assigned to each job
- Procedures applicable to each department
- Information Systems / technology required
- People assigned to each job (number and names)

In order to complete the design for the new phase, this information was complemented with the equipment and the budget needed for each department.

The skills and competences needed for each job and offered by the different candidates were not included in these books, but were considered during the selection process.

An example of a complete organization guide is provided as an annex. As a partial example, a list of generic training applicable to the “Operation and Maintenance” department is shown below.

Generic Training Courses for the "Operation and Maintenance Department"

SUBJECT TYPE	SAFETY	RADIOLOGICAL PROTECTION	QUALITY ASSURANCE	OCCUPATIONAL HEALTH	GENERAL AND ADMINISTRATIVE
A (Preliminary)	Handbook on the prevention of occupational risk. Protection against fires.	Emergency Plan. Basic RP course for P.E. personnel		Basic first-aid course.	Presentation of ENRESA and Vandellós 1.
B Necessary to: - guarantee the required levels of quality and safety - acquire behaviour patterns in situations of risk	Specific safety course. Specific training on fire-fighting (I). Basic safety course.	Training on the emergency plan (detailed). ALARA training (Management level). ALARA training (Performance level)	Basic quality assurance course.	Basic RCP and first-aid course. Generic health promotion campaigns. Specific health promotion campaigns.	
C Necessary for the performance of fundamental and job post-specific tasks	Specific courses on the identification and control of risks. Specific training on fire-fighting (II). Specific training on fire-fighting (III).	Training on operative RP Specific training for RP personnel (I, II and III). Training for RP laboratory personnel (I and II).	QA procedures Training for QA personnel	Attention to contaminated / irradiated wounded personnel. Evacuation and rescue of accident victims. Basic treatment of polytraumatised, electrocuted or intoxicated personnel.	Corporate Systems (general) Corporate Systems (specific) Corporate Systems (management support). Office computer tools. Training of Information Centre personnel.

Applicability criteria:

Courses	Trainees
Type A	
Presentation of ENRESA and Vandellós	All the personnel of the service
Handbook on the prevention of occupational risk	All the personnel of the service
Protection against fires	All the personnel of the service
Emergency plan	All the personnel of the service
Basic RP course for P.E.	Service P.E. personnel
Basic first-aid course	All the personnel of the service
Type B	
Specific Safety course	All the personnel of the service
Training on emergency plan (detailed)	Personnel with responsibilities in resolving emergency situations
Basic Safety course	Performers of work entailing risk and other personnel involved
Specific training on fire-fighting (I)	All the personnel of the service
ALARA training (Management level)	Persons responsible for work entailing exposure to ionising radiations
ALARA training (Performance level)	Performers of work entailing exposure to ionising radiations
Basic course on quality assurance	Personnel with management or administrative profiles
Basic RCP and first-aid course	Performers of work entailing risk
Type C	
Specific courses on the identification and control of risk	Personnel subject to the risks dealt with in each course
Operative RP training	Service licensed personnel
Quality Assurance procedures	Personnel with management or administrative profile and using QA procedures
Attention to contaminated / irradiated wounded personnel.	Performers of work entailing risk
Evacuation and rescue of accident victims	Performers of work entailing risk
Treatment of polytraumatised, electrocuted, etc. personnel	Performers of work entailing risk
Corporate systems (general)	Personnel needing to access Management Systems

Courses	Trainees
Corporate systems (specific)	Personnel updating information in corporate systems
Corporate systems (management support)	Personnel with management profile using information from corporate systems
Office computer tools	Users of office computer tools

Personnel evolution during decommissioning

The development of an initial organizational design is important in decommissioning. However, the organization is a dynamic entity that is modified continuously depending on the progress of the works.

For this reason, all the basic organizational aspects mentioned above should be continuously monitored and updated where necessary.

The distribution by departments of both the former operator's personnel and the personnel of contractors and their evolution during the works are shown below by way of an example.

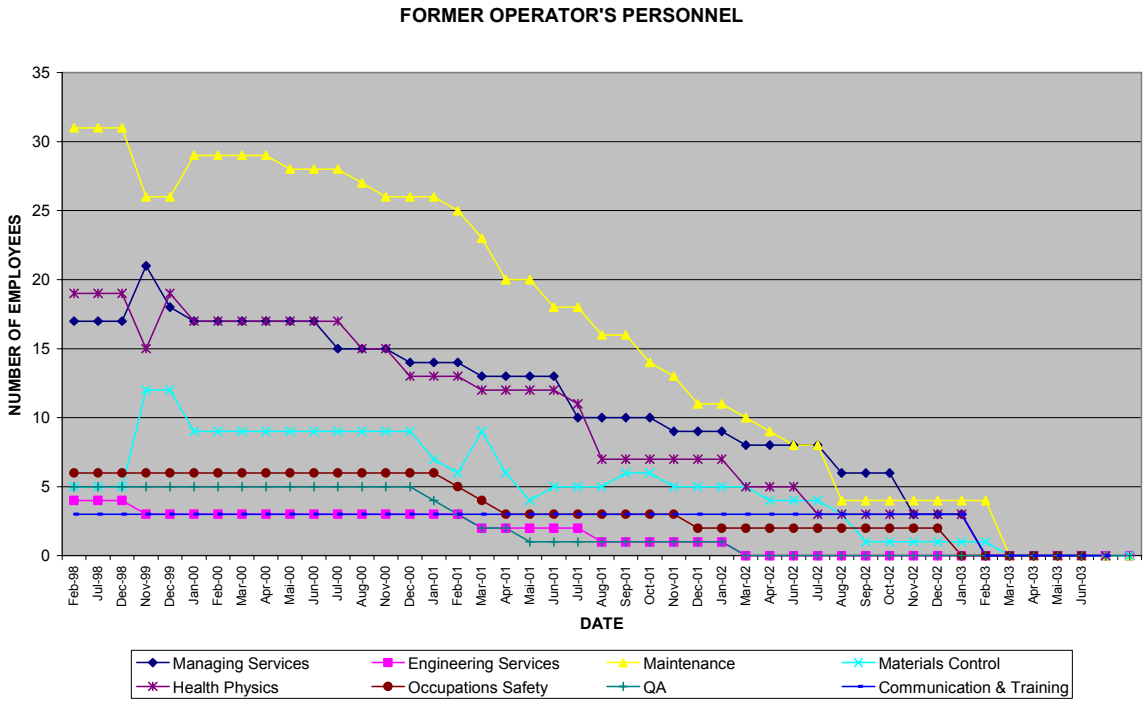


Fig. 1. Evolution of former operator's personnel, broken down by departments.

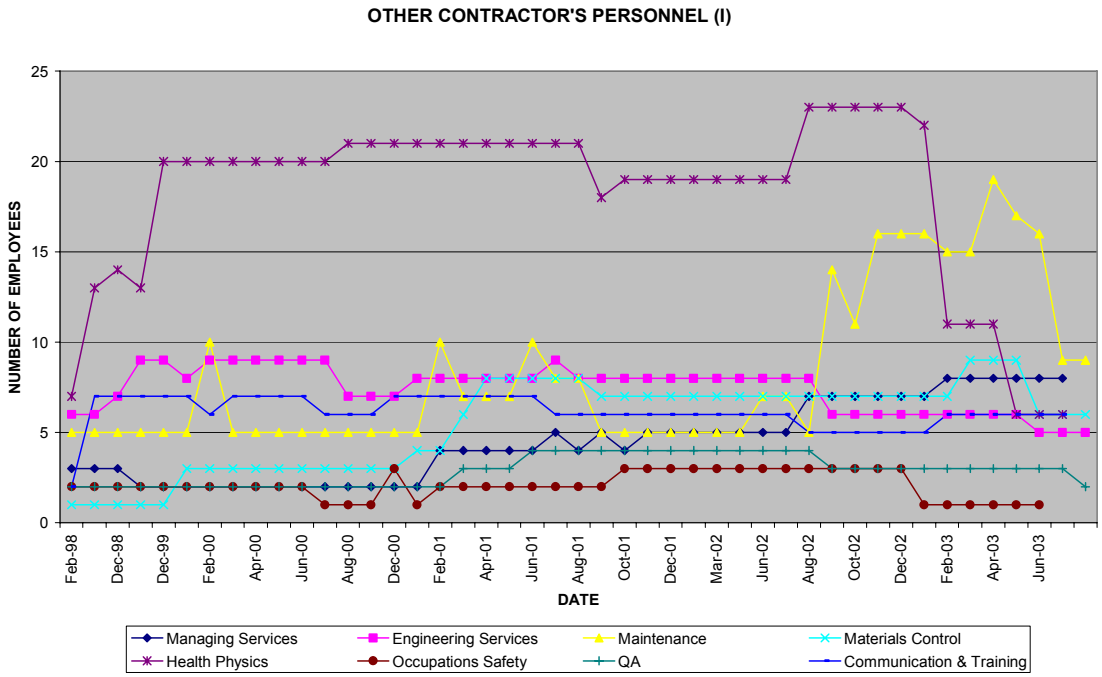


Fig. 2. Evolution of other contractors' personnel (I).

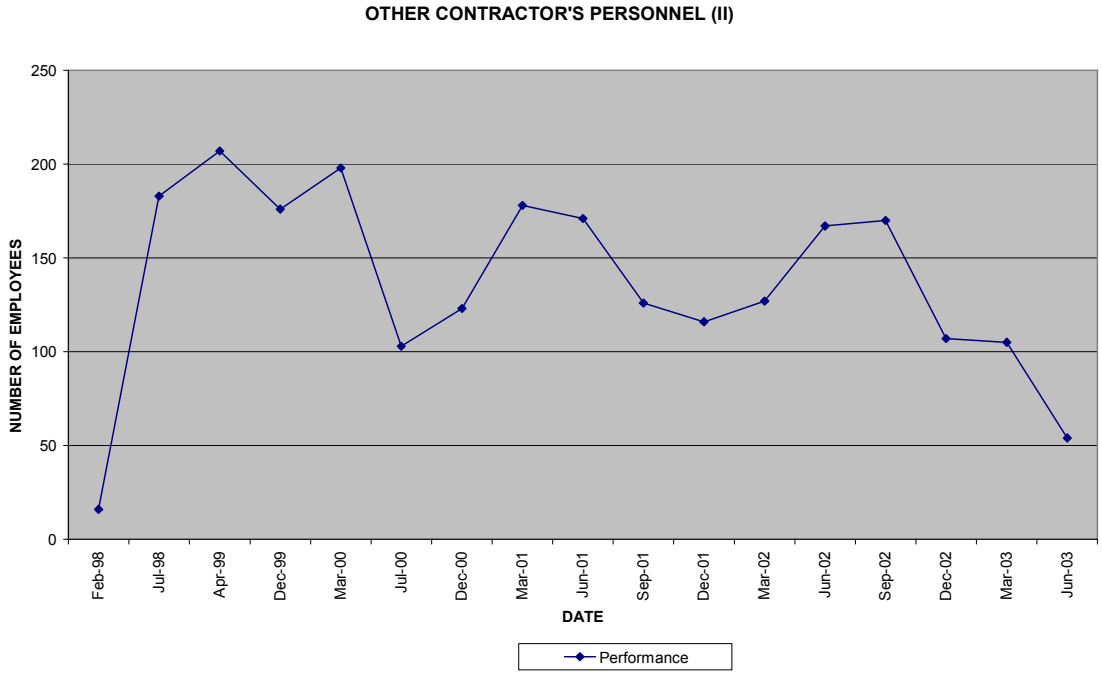


Fig. 3. Evolution of other contractors' personnel (II).

Catalogue of training courses

The aforementioned generic training courses were provided just after decommissioning began.

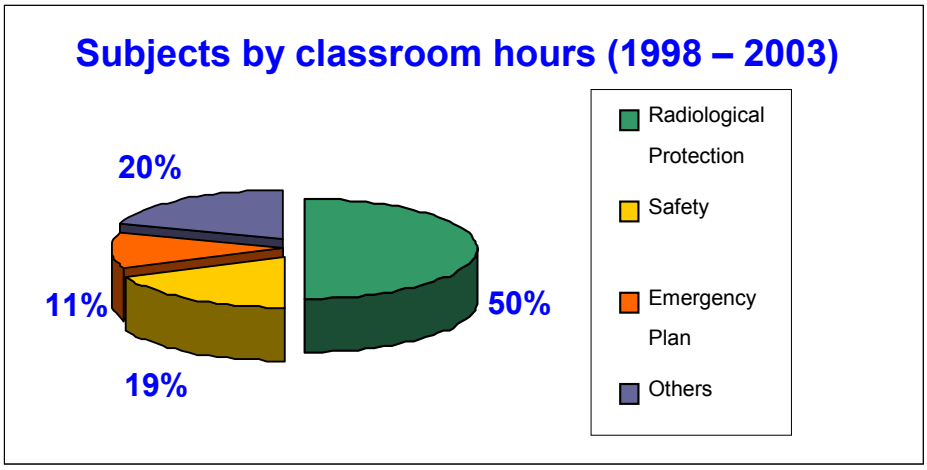
They were completed, during the project, with the following training courses, delivered to the different groups of staff involved in the decommissioning:

(1) Specific course on the Vandellós I NPP Dismantling and Decommissioning Plan
(2) Course for entry / incorporation in the job post.
(3) Basic course to obtain the professionally exposed worker permit
(4) Course on use of the facility supervision and control system
(5) Interpretation of reportable events
(6) Operation of the vehicle exit gate monitor
(7) Training plan to obtain surveillance plan operator licence
(8) Operative Surveillance of the facility outside working hours
(9) Course on radiological protection applied to dismantling
(10) Course on radiological protection laboratory and instrumentation
(11) Course on specific RP instructions
(12) RP training course for licensed personnel
(13) ALARA training
(14) Use of measuring instruments for declassification
(15) Course on radioactive waste management
(16) Application of new Regulation on the transport of radioactive wastes
(17) Declassification of materials and surfaces
(18) Characterisation of surfaces
(19) Transport / movement of graphite
(20) Basic course on quality assurance
(21) Activities classified as QA class
(22) Application of quality assurance procedures
(23) Course on the prevention of occupational risk
(24) Course on safety and hygiene
(25) Course on the identification of specific risks
(26) Practical safety courses for different machinery
(27) Course on safety for operations and maintenance personnel
(28) Rescue and intervention at heights
(29) Emergency plan
(30) Training course on fire-fighting
(31) First-aid and resuscitation
(32) Medical Services personnel training: decontamination and biological controls
(33) Training of information centre monitors
(34) Techniques for public speaking and communication media
(35) Training of Interns
(36) Course on office computer systems
(37) Documentary management during decommissioning.

The following diagram shows the distribution of the different courses delivered by subject areas.

Internal training

Courses delivered:	1.537
Attendance:	7.834
Classroom hours:	3.955
Hours-person:	21.394



APPENDIX IV
DECOMMISSIONING COURSE FOR JOURNALISTS AT VANDELLOS

CONTENTS OF THE COURSE ON DECOMMISSIONING OF VANDELLOS I NUCLEAR POWER PLANT

Elaborated from a course on
Decommissioning and Radioactive Waste Management
Tarragona, November 18, 1997

CONTENTS

I. CONTEXTUAL INFORMATION

II. PROCESS APPLIED TO OBTAIN THE DISMANTLING PERMIT

1. Alternatives for dismantling
2. Environmental impact statement
3. Works permit

III. DESCRIPTION OF ACCEPTED DISMANTLING PROJECT

1. Site preparation phase
2. Dismantling performance phase
3. Final phase
4. Relevant project data

IV. NATIONAL AND INTERNATIONAL EXPERIENCE OF DISMANTLING

1. Decommissioning activities performed in Spain

- JEN-1 reactor
- ARGOS and ARBI reactors
- AUM decommissioning and dismantling

2. INTERNATIONAL EXPERIENCE

(a) United States
(b) Germany
(c) France
(d) Japan

GLOSSARY

APPENDIX V
MINIMUM ELEMENTS FOR A SYSTEMATIC APPROACH TO TRAINING (FROM REFERENCE [23])

A systematic approach to training requires certain minimum activities, products, and elements. In order to substantiate a systematic approach and to provide an adequate level of assurance the training is consistent and job related, specific products, documentation, and processes must exist.

This appendix identifies minimum products and documentation for formal systematic training and discusses the content of these minimum needs. The minimums identified in this appendix apply only to development and implementation of a systematic approach to training. Other regulations or standards may contain minimum prescriptive requirements that may exceed the requirements that result from systematically established training programs. The following information does not reflect all these other possible requirements. Users of this appendix must ensure that other applicable requirements are identified and implemented.

PROCEDURES AND ADMINISTRATIVE GUIDANCE

A level of consistency and guidance is necessary for the development and conduct of any formal training program. Even the facilities with minimum risk and hazard potential should have guidance that provides management with assurance of formality, quality, and consistency. Procedural or administrative guidance should be available in the following areas. A separate procedure is not required for each of these areas.

(1) Roles and responsibilities

It is essential that persons involved in the development, presentation, and approval of training and training materials be clearly identified and understands the responsibilities, authority, and expected interface activities associated with their position. This may be accomplished with a simple designation of responsibility and authority by line management. The use of position descriptions is acceptable, provided these documents are current and adequately reflect the information necessary, commensurate with the organizational structure and need for formal definition.

(2) Training development process

Training activities should be guided by formal requirements. This guidance need not be lengthy or detailed for many facilities and organizations. If a description of the process is endorsed by management and the level of detail is sufficient for participants to understand and follow, the guidance is acceptable.

(3) Conduct of training

There should be an organizational definition of the local requirements for conduct of training. This may include on-the-job training guidance, classroom training guidance, structured self-study guidance, or guidance in other areas that are important for the student and instructional staff to understand. A level that defines basic requirements (for example, qualified classroom instructors will use an approved lesson plan) is sufficient.

(4) Training program evaluation

All training programs should have some level of evaluation to assess the effectiveness of the training. This level will vary, but clear guidance is necessary regardless of the activities that are needed. Adequate evaluation guidance may consist only of documentation which designates areas subject to evaluation and required periodicity of evaluations.

(5) Feedback and corrective actions

Maintenance of the training materials and program activities is essential. Formal guidance should be available to ensure changes are identified and incorporated in the training in a timely manner. This guidance should also define application and use of industry and facility lessons learned information.

(6) Records and recordkeeping

Any training program requires the maintenance of some records. To ensure consistency and credibility of records and recordkeeping systems, administrative or procedural guidance should be available. The guidance does not need to be complex or lengthy as long as it ensures compliance with requirements. Identification of retention, storage, disposition, and access/change authority should be sufficient for many programs.

MINIMUM PRODUCTS AND DOCUMENTATION

The products and documentation necessary to maintain a systematic approach are dependent on the techniques that are selected and applied in the program development and implementation. The traditional approach to SAT identifies efforts in distinct phases that are sequential. Alternative approaches integrate activities associated with phases and do not specifically require activities and phases to match the traditional approach. For ease of understanding, the following minimum products and documentation reflect products by specific phases. The minimum should be met, but the products do not necessarily have to be developed in the order described.

1. Analysis

1.1. Minimum Products

— An approved, verified task list (or equivalent) which identifies train, no-train, and over-train tasks.

Equivalent is used to allow for the inclusion of regulatory or other requirements that may not necessarily be identified as job-specific in analysis.

1.2. Minimum documentation

— A description of techniques and participants.

A short memorandum that simply states the technique(s) used and the function and name of the participants is sufficient for low-hazard level efforts.

2. Design

2.1. Minimum products

- An approved training summary or plan.
- Learning objectives (or equivalent).
- Examination, evaluation, and test-out requirements (may be included in the training summary or plan).
- A task to training matrix (or equivalent).

The training summary or plan reflects the decisions made regarding the content, structure, and implementation of the training based on the train or over-train tasks. This summary need only be at a level of detail and comprehension that assures line management that the needs for training will be met for this program.

Equivalents for learning objectives are included for regulatory or local requirements that are content-specific or do not allow clear objectives to be developed.

A task-to-training matrix to ensure that all tasks are included in the training program and for modification purposes when changes occur. An equivalent may be any system that tracks the training of tasks and allows identification of the impact changes have on the program elements.

2.2. Minimum documentation

- Approved summary or plan.
- Evidence of subject matter expert involvement.
  Evidence of subject matter expert involvement may only require an SME signature on the plan submittal or some other method of identifying involvement.

3. Development

3.1. Minimum products

- Approved training materials.

3.2. Minimum documentation

- Evidence of subject matter expert involvement and line management involvement.

4. Implementation

4.1. Minimum product

- Trained employees.

4.2. Minimum documentation

— Attendance records.
— Student evaluation results.
— Evidence of appropriate instructor qualification.
— Individual training records.

5. Evaluation

5.1. Minimum products

— Revised and current training materials, strategies, or settings.

5.2. Minimum documentation

— Records of evaluation results.
— Records of approved changes made to training and a description of the considerations or drivers for the changes.

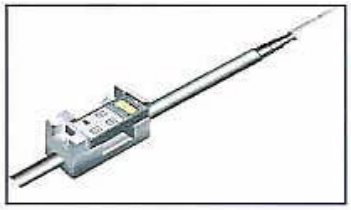
The information must be sufficient to assure management that the proper revisions are being made for appropriate reasons.

APPENDIX VI
PROGRAM OF TRAINING ACTIVITIES FOR UNDERGRADUATE STUDENTS (VANDELLOS)

TEACHING UNIT 1

RADIOACTIVITY AND RADIOLOGICAL PROTECTION

The trainee acquires knowledge of the nature of radioactivity, its effects and methods for protection against ionising radiation.



The unit consists of two parts:

The first consists of a **description** backed by audiovisual means of radioactivity: discovery, origins, nature, applications, measuring equipment and units, the biological effects of ionising radiations and protection against them.

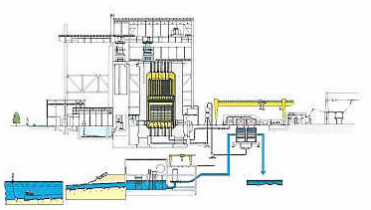
Subsequently, in the **workshop**, the radiological protection standards and controls used are explained: classification of areas, use of the radiological work licence, personal dosimetry, differences between irradiation and contamination and the conditions required to work in radiological zones.

The trainees handle and perform **practical** exercises with measuring equipment, TLD and DLD dosimeters, warning signs, area signposting, decontamination and different items of personal protective equipment.

TEACHING UNIT 2

NUCLEAR POWER PLANT OPERATION AND DISMANTLING

The trainee acquires knowledge of the operation and dismantling of nuclear power plants.



In the workshop, groups of 6 trainees use the explanatory pocket guide to construct a mock-up of the Vandellós I nuclear power plant, including explanations of the main components of this type of facilities.

Subsequently, a visit is made to the facility, where the dismantling process is explained, and finally — once again in the workshop — the plant dismantling process is reproduced in an ordered and sequential manner using the previously constructed mock-up.

TEACHING UNIT 3

RADIOACTIVE WASTE MANAGEMENT

The trainees acquire knowledge of the nature of radioactive wastes, their origins, classification, handling, control, transport and storage or disposal.

The different radioactive waste management strategies are analysed, along with the solutions adopted in the specific case of the dismantling of Vandellós I and technical solutions for the management of low, intermediate and high level wastes.

DISMANTLING WORKSHOP AT VANDELLOS

APPENDIX VII
EXAMPLE TRAINING NEEDS FOR THE GREIFSWALD (KGR) DECOMMISSIONING PROJECT

This example is derived from the experience gained within the project on decommissioning of four VVER 440 reactors at Greifswald, Germany

Training and skills development

In preparing the decommissioning, one of the very first actions will be focused on the set-up of the future project management unit (PMU). Several questions immediately come to mind: Which associates are available to perform needed functions of project management? Do those available posses the right skills and experience? What training they will require? Will externals need to be hired? To what extent external contractors will be employed?

The initial approach should involve a review of available candidates within the company who are performing a project management-like function or have demonstrated multidisciplinary orientation. While the number of those candidates may be limited, there are advantages associated with the utilization of own resources. They are already familiar with the company structure, processes, and clients. They should be able to assemble a management team quickly because they have already an understanding of the various departments. Internal moral will not be as negatively impacted as it might be, should external contractor resources be acquired.

If candidates selected properly, most will be found to have some suitable experience, but will be probably lacking in formal project management training and the application of a project management process. This can be partly addressed through education and training seminars like this one you attending right now. Some more potential areas of training were listed in Chapter 1.3.2.

From the experience made in preparing KGR decommissioning, the following survey illustrates selected training needs faced within the KGR project, including skills needed for proper management.

Completion and extension of knowledge in:

(1) Decommissioning planning
- Quality management
- Project management/tendering procedures
- Risk management
- Project management
- MS-Project for Windows
- Auto-CAD 2000
- Oracle training courses

(2) Radiation protection
- refresher/cyclical courses for radiation protection
- emergency protection of nuclear facilities
- radiation measurement technique

- transport of radioactive material
- tightness tests/leak detection

(3) Remote dismantling
- operation of manipulators
- acetylene- oxygen supply systems
- CNC-programming (Sinumerik 840D)

(4) Waste management
- environmental assessment/environmental impact studies
- environmental monitoring
- handling of artificial mineral fibres
- removal of asbestos
- waste management concepts
- handling of spent fuel
- conditioning of radioactive material
- training for handling hazardous material
- continuation courses for waste management (introduction of new waste catalogue, declaration of waste and waste analytic, prevention of water pollution etc.)

In addition to these measures, it was also concentrated on the retraining of personnel and qualification for new jobs as for example:

- Decontamination specialist
- Radiation protection specialist
- Dismantling specialist
- Master qualification

Leading personnel, engineers and commercial/office staff was prepared on the new conditions of market economy.

It should be also mentioned that the KGR top management was completely replaced by managers partly experienced in decommissioning projects.

During the decommissioning performance it may be difficult to maintain all necessary skills as the work changes. Specialized training would be provided to those who perform unique activities or operate certain equipment (remote dismantling operators)
.
Where operating staff are retrained in decommissioning tasks then this can be provided under contract from specialists who may go on to supervise the work. In some countries specialist qualifications are being produced for decommissioning workers.

Finally, it is important to recognize that managers may also need retraining if they are to operate as effective project managers rather than operating plant managers. Because of the potential for the decommissioning to be performed over a long time period, refresher and retraining will be required at established intervals or in view of important activities.

APPENDIX VIII
EXAMPLE TRAINING COURSE ON DECOMMISSIONING AND RADWASTE MANAGEMENT (UNITED KINGDOM)

INTRODUCTION

This training course on decommissioning and radwaste management is structured into three separate but largely inter-related sections and these sections are:

(i) Radiological protection
(ii) Decommissioning of nuclear facilities
(iii) Radioactive waste management

The first section i.e. radiological protection is primarily a foundation course designed to enable students to understand and appreciate safety aspects of decommissioning and radwaste management.

The second section i.e. decommissioning of nuclear facilities is the crux of the course. A large part of the time is devoted to this section.

The last section addresses the management of radwaste which arises as a result of decommissioning activities.

TRAINING OBJECTIVES

On completion of this course, students would be able to:

On radiological protection

- clearly describe various types of radiation and their effects on biological systems
- define relevant dosimetric quantities and the associated parameters such as the radiation weighting factors and tissue weighting factors
- differentiate between deterministic and stochastic effects and their implications on risk assessment
- understand radiological protection principles and practices
- understand biological effects of radiation from cellular considerations – somatic and genetic effects

On decommissioning of nuclear facilities

- define various stages of decommissioning of nuclear reactors, non-reactor facilities, nuclear submarines
- demonstrate awareness of national, European and international regulatory standards and practices and state the existing Government Policy
- carry out Environmental Impact Assessment (EIA) and produce Environmental Impact Statement (EIS)
- describe the need for site/facility characterisation for decommissioning work and the need for progressively detailed development using various techniques like radiometric and sampling techniques
- understand and demonstrate the implementation strategy of the ALARP principle to satisfy regulatory requirements

- understand the methodology and implications of BPEO/BPM and the identification of best practicable decommissioning option
- describe and appreciate safety aspects on radiological and non-radiological activities involved in decommissioning work
- prepare decommissioning plan
- describe decontamination techniques for various items of interest
- identify dismantling techniques within the regulatory, financial and environmental constraints

On Radwaste management

- state the British and the IAEA waste categories and their usefulness in waste management
- demonstrate full comprehension of national regulations concerning radioactive wastes – RSA 93, EPA 95, discharge authorisation, exemption and clearance criteria etc. as well as international treaties, protocols and conventions (the Joint Convention)
- describe the significance and methods of treatment and conditioning of wastes
- describe storage and transportation of radioactive waste and demonstrate awareness of radiological safety aspects
- understand waste disposal methods for different waste categories and Nirex's proposal for ILW disposal (phased disposal)
- be aware of Government initiatives in the management of legacy wastes and the setting up of NDA

APPENDIX IX
EXAMPLE LIST OF GENERAL SAFETY COURSES FOR WORKERS

From a U.S. National Laboratory with operating facilities and facilities undergoing decommissioning

#	COURSE TITLE	LENGTH IN HOURS
TRN1	Fall Protection Competent Person	8.0
TRN3	Portable Breathing Air Compressor Units	0.5
TRN4	Basic Respirator with Fit	2.5
TRN5	Self-contained Breathing Apparatus (SCBA)	1.0
TRN6	Airline Hood	1.0
TRN7	Respirator Issuer	1.0
TRN8	Basic Respirator, Classroom Only	2.0
TRN9	Airline Suit Training	0.75
TRN10	General Hazard Communication Training	1.0
TRN11	Overhead Cranes & Hoists Refresher	2.0
TRN12	Incidental Overhead Crane/Hoist & Rigging Initial	16.0
TRN13	Chemical Hygiene Plan (WB)	1.0
TRN14	Lockout/Tagout for Authorized Employees	7.0
TRN16	Forklift Operator Initial	8.0
TRN17	Mobile Crane Operator Initial	20.0
TRN18	Airline Respirator Training	1.0
TRN20	Scaffold User Course (WB)	1.0
TRN21	Aerial Lift Operator Initial	8.0
TRN22	Incidental Overhead Crane/Hoist & Rigging Refresher	4.5
TRN24	Aerial Lift Operator Refresher (CBT)	1.0
TRN25	Forklift Operator Refresher (CBT)	1.0
TRN26	Mobile Crane Operator Refresher	8.0
TRN27	Hazwoper 40 hour	40.0
TRN28	Hazwoper 24 hour	24.0
TRN29	Hazwoper 8 hour Refresher	8.0
TRN30	Overhead Cranes & Hoists Initial	15.0
TRN31	Hazwoper Supervisor 8 Hour	8.0
TRN32	Hearing Conservation (WB)	0.5
TRN33	Rigging Practices Initial	20.0
TRN34	Rigging Practices Refresher	2.0
TRN35	Lead Worker	1.3
TRN37	Asbestos Worker Initial	32.0
TRN43	Asbestos Contractor Supervisor Initial	40.0
TRN46	Asbestos Awareness	2.0
TRN47	Asbestos 16 Hour Operation & Maintenance Initial	16.0
TRN48	Respirator Fit Test	0.5
TRN49	Asbestos Inspector Initial	24.0
TRN50	Scaffolding Competent Person/Builder/User	6.0
TRN59	Higher Than Normal Risk Electrical Safety	3.0
TRN61	Overview of PRD-5099 & NFPA 70E (Rev. 2000)	4.0
TRN68	Storm Water Pollution Prevention (WB)	0.5

#	COURSE TITLE	LENGTH IN HOURS
TRN70	RAD Worker II Initial	20.0
TRN72	RAD Worker I Initial	10.0
TRN74	General Employee RAD Training (WB)	0.75
TRN76	Monitor Radiography	2.0
TRN77	Source Custodian Refresher	0.5
TRN78	Source User (WB)	0.5
TRN79	Asbestos Contractor/Supervisor Refresher	8.0
TRN80	Asbestos Worker Refresher	8.0
TRN83	Asbestos 4 Hour Operations & Maintenance	4.0
TRN85	Asbestos Inspector Refresher	4.0
TRN87	Medic First Aid (W/CPR) Basic	8.0
TRN88	Medic First Aid (W/CPR) Retraining	4.0
TRN92	Laser Safety for Class 3B and 4 Lasers (WB)	4.0
TRN100	Phase 1 Fundamental Academic Training	2.0
TRN101	Phase 1 Site Academic Training	2.0
TRN102	Respond to Injured Person in a Radiological Area	1.0
TRN146	RCT Continuing Training	10.0
TRN146	Radiological Engineering Continuing Training	10.0
TRN147	Respiratory Training Practical	1.0
TRN150	Basic Respirator Refresher (CBT)	1.0
TRN152	Asbestos Awareness (CBT)	1.5
TRN166	ALARA Committee Member Training	3.0
TRN167	RAD Worker 1 Site Specific	2.5
TRN168	RAD Worker II Site Specific	3.5
TRN171	Source Custodian Initial	2.0
TRN181	Radiography Refresher	3.0
TRN184	Hazmat Carrier/Driver	10.0
TRN185	RAD Worker I Practical (WB)	1.0
TRN186	RAD Worker II Practical (WB)	1.0
TRN188	Glovebag Installation, Use, & Removal	8.0
TRN189	Criticality Safety	3.0
TRN191	Radiography Initial	20.0
TRN192	Glovebag Use	1.0
TRN195	Site Access	1.0
TRN202	Site Access Training (WB)	1.0
TRN211	RAD Worker II Refresher	5.0
TRN213	RAD Worker I Refresher	4.0
TRN216	Hazmat Employee Packaging Operations	5.0
TRN217	Hazmat Employee F.S. Radioactive Materials Transportation	6.0
TRN219	Eberline AMS-4 CAM	2.0
TRN225	Lead Awareness (WB)	0.5
TRN232	Fire Extinguishers	1.0
TRN246	Site Access Training For Construction (WB)	1.0
TRN260	American Red Cross Emergency First Responder CPR	28.0
TRN269	TAA Requirements	4.0
TRN276	Cross Connection Control	4.0
TRN277	Backflow Prevention Device Maintenance and Repair	4.0
TRN280	Railroad Operations	12.0

#	COURSE TITLE	LENGTH IN HOURS
TRN288	Personal Protective Equipment (WB)	0.75
TRN290	Hazwoper Core Part A	17.0
TRN291	Hazwoper Core Part B	7.0
TRN301	Basic Mathematics & Algebra	2.0
TRN302	Unit Analysis & Conversion	2.0
TRN303	Physical Sciences	2.0
TRN304	Nuclear Physics	2.0
TRN305	Sources of Radiation	2.0
TRN306	Radioactivity & Radioactive Decay	2.0
TRN307	Interaction of Radiation with Matter	2.0
TRN308	Biological Effects of Radiation	2.0
TRN309	Radiological Protection Standards	2.0
TRN310	ALARA	2.0
TRN311	External Exposure Controls	2.0
TRN312	Internal Exposure Controls	2.0
TRN313	Radiation Detector Theory	2.0
TRN314	Radiological Documentation	2.0
TRN315	Communication Systems	2.0
TRN316	Counting Errors & Statistics	8.0
TRN317	Dosimetry	3.0
TRN318	Contamination Control	4.0
TRN319	Air Sampling Program/Methods	4.0
TRN320	Respiratory Protection	4.0
TRN321	Radiological Source Controls	2.0
TRN322	Environmental Monitoring	4.0
TRN323	Access Control & Work Area Setup	8.0
TRN324	Radiological Work Coverage	4.0
TRN325	Shipment & Receipt of Radioactive Materials	2.0
TRN326	Radiological Incidents & Emergencies	4.0
TRN327	Personnel Decontamination	4.0
TRN328	Radiological Considerations for First Aid	2.0
TRN329	Radiation Survey Instrumentation	4.0
TRN330	Contamination Monitoring Instrumentation	4.0
TRN331	Air Sampling Equipment	4.0
TRN332	Counting Room Equipment	4.0
TRN358	Radiological Work Control Process	5.0
TRN359	Sample Management	1.0
TRN360	Suspect/Counterfeit Parts Awareness	2.0
TRN364	Toxic Substance Control Act	1.0
TRN365	Monthly SCBA Inspections	2.0
TRN367	Chemical Protective Clothing Level A and B	2.0
TRN370	Laboratory Safety Refresher (CBT)	2.0
TRN382	Substation Access	0.5
TRN391	Cadmium Worker	1.0
TRN397	Advanced Instructor Training	16.0
TRN398	Basic Instructor Training	35.0
TRN399	OJT Instructor Training	4.0
TRN400	Program Evaluation and Corrective Action	24.0

#	COURSE TITLE	LENGTH IN HOURS
TRN401	Table Top Job Analysis	10.0
TRN402	Table Top Needs Assessment	10.0
TRN404	Team Approach to Training Development Seminar	24.0
TRN406	Instructor Development	40.0
TRN426	Affiliate Instructor Training	10.0
TRN427	Research & Electronic Worker Electrical Safety	3.0
TRN432	Ethics Overview	1.0
TRN443	OJT Instructor Evaluation	1.0
TRN444	The OJT Process	1.0
TRN445	Materials Used to Conduct OJT	1.0
TRN446	Effective OJT Training Process	2.0
TRN448	Confined Space Atmospheric Testing	1.5
TRN471	Carbon Dioxide Hazard Training	2.0
TRN474	Powder Actuated Tools	1.0
TRN477	Introduction to STD-101	3.0
TRN482	Work Control Process for Planners	30.0
TRN484	Inspect a Tent	2.0
TRN485	Pressure Demand Airline Respirator	1.0
TRN486	Halon Extinguishing Systems Awareness (WB)	0.5
TRN487	TAA User (WB)	0.3
TRN498	Lockout/Tagout for Affected Employees	0.5
TRN592	Safety Basis Training	2.0
TRN593	Price-Anderson Amendment Act	4.0
TRN595	DOT Drug and Alcohol Supervisor Training	2.5
TRN596	Emergency Escape Breathing Apparatus	0.5
TRN601	Opacity (Visible Emissions) Awareness Training	1.0
TRN604	Stop Work Authority (WB)	0.5
TRN606	Heat Stress (WB)	0.5
TRN608	Design Control (WB)	0.5
TRN616	Lessons Learned System (WB)	0.5
TRN618	Criticality Safety For Nuclear Managers	1.5
TRN622	ISMS Training For Managers (WB)	1.0
TRN623	Conduct of Operations Awareness	7.0
TRN628	Quality Assurance Program (WB)	0.5
TRN631	Davis-Bacon Awareness Training	1.0
TRN635	Clean Agent Extinguishing Systems Awareness (WB)	0.5
TRN636	Manual 8 Environmental Protection and Compliance Overview	4.0
TRN638	Configuration Management Overview (WB)	1.0
TRN641	MCP-3562, Hazard Identification, Analysis & Conduct of Operations Activities	4.0
TRN649	Airborne Hazards Determinations	1.0
TRN650	Requirements Management (WB)	0.5
TRN652	Operational Safety Boards Training	2.0
TRN661	Chemical Management System	16.0
TRN663	Lockout/Tagout for Authorized Employee Limited	5.0
TRN664	Facility Hazards List Training (WB)	0.5
TRN666	ISMS Overview (WB)	0.5
TRN668	RADCON Design Review	1.5

#	COURSE TITLE	LENGTH IN HOURS
TRN671	Dose Determination & Shielding Calculations	2.0
TRN686	Gas Cylinder Safety and Handling (WB)	0.5
TRN688	Fundamental Applications Training – Electrical Theory	10.0
TRN691	Hood Extinguishing Systems	1.5
TRN70F	Radiological Worker II For Fire Fighters	20.0
TRN711	Suspect/Counterfeit Items Training (WB)	0.5
TRN722	Laboratory Protective Equipment (WB)	0.5
TRN723	Authorization Agreements (WB)	0.5
TRN732	Performing Pre-Job Briefings & Documenting Feedback (WB)	0.3
TRN733	Basic Planning and Scheduling	8.0
TRN738	Power Management Clearances & Work Permits	1.0
TRN755	Soldering For Industrial Electricians	10.0
TRN756	Oscilloscopes	10.0
TRN759	RadCon Manual Training for Managers & Supervisors	2.0
TRN764	Project Management System (WB)	0.5
TRN776	Calibration Program Training	2.0
TRN777	Calibration Program Overview (WB)	1.0
TRN779	Cause Analysis & Corrective Action Development (WB)	1.5
TRN780	Fundamentals of Cause Analysis	24.0
TRN783	Basics of Self-Assessment (WB)	0.75
TRN786	General Safety Analysis Training (WB)	0.5
TRN791	OSHA Awareness	10.0
TRN792	Employee Safety Team Trending Analysis (WB)	0.5
TRN793	Employee Safety Team Training for Goals & Objectives (WB)	0.5
TRN794	Employee Safety Team Investigation Training (WB)	0.5
TRN795	Employee Safety Team Inspection Training (WB)	0.5
TRN796	Company Approach to Cause Analysis	24.0
TRN799	Audits, Surveillance and Assessments	2.0
TRN804	Beryllium Safety Training (WB)	0.5
TRN805	Manual 8, Environmental Compliance & Protection Refresher Training (WB)	1.0
TRN814	Phase 1 Site Academics	2.0
TRN815	Hazard Communication Core Lesson Plan	2.0
TRN816	Foundations of Measurement Instrumentation and Calibration	30.0
TRN819	Control of Quality Significant Material Storage	1.0
TRN840	Baseline Change Control (BCP) Training	8.0
TRN843	Avalanche Training	16.0
TRN845	Quality Assurance Program	1.0
TRN847	Affiliate Instructor Using Computers	4.0
TRN869	Conduct of Operations Core Training	20.0
TRN870	Need To Know Security Training (WB)	0.5
TRN871	Hosting Foreign Nationals (WB)	0.5
TRN872	Troubleshooting Electrical Circuits	10.0
TRN896	Supervisory Skills Training (WB)	4.0
TRN907	Chapter 6, STD 101 Project Work Order Process	3.0
TRN909	Supervisory Skills Training	20.0
TRN910	Work Control Process for WCAC	10.0
TRN911	Work Control Process for SSC Engineers	10.0

#	COURSE TITLE	LENGTH IN HOURS
TRN914	Laser Safety Refresher for Class 3B and 4 Lasers (WB)	1.5
TRN934	Excellence in Human Performance	12.0
TRN937	Electrical Energy Awareness Training	20.0
TRN996	Test Control & Inspection, Testing, & Operating Status	2.0
TRN997	Control of Special Processes	2.0
TRN998	Handling, Shipping, and Storage	2.0
TRN999	Software Quality Assurance	2.0
TRN1001	Design and Change Control	2.0
TRN1002	Inspection and Inspection Planning	2.0
TRN1003	Work Control/Material Control	2.0
TRN1004	PAPR Using 3M SNAPCAP	1.5
TRN1005	American Heart Association/CPR	8.0
TRN1006	Plutonium Training	2.5
TRN1007	Conduct of Operations Refresher Training	7.0
TRN1008	ARCPRO Flash Boundary Calculator	3.0
TRN1009	Hoisting & Rigging Supervisor Awareness	1.5
TRN1010	MSA Mask Mounted PAPR	1.5
TRN1012	Storm Water Construction Inspection Training	1.5
TRN1014	Bloodborne Pathogens Training for Medical & Fire Department	0.5
TRN1016	Hoisting & Rigging Critical Lift Person-in-Charge (WB)	1.0
TRN1017	General Ergonomics Awareness (WB)	0.5
TRN1018	Basic Maintenance Blueprint Reading	9.0
TRN1022	INPO Human Performance	10.0
TRN1025	Portable Automotive Lifting Device	2.0
TRN1033	Advanced Supervisory Skills Training	9.0
TRN1041	Compressed Gas Safety Training (WB)	1.0
TRN1057	Drill Controller and Evaluator Training (WB)	1.0
TRN1058	Mobile Crane Mechanics Initial	15.0
TRN1059	Mobile Crane Mechanics Refresher	8.0
TRN1066	Performing Assessments	8.0
TRN1074	Corrective Action System	3.0
TRN1075	Pressure System Assembler	4.0
TRN1077	Radiation Monitoring Equipment	7.0
TRN1079	Global Positioning Systems (GPS) Refresher	1.5
TRN1082	Use of Commercial Grade Items in Safety SSC (WB)	0.5
TRN1083	Heat Stress Stay Time (WB)	0.5
TRN1084	Subcontractor Technical Representative Handbook Overview	9.0
TRN1089	Hazwoper 8 Hour Scope/Application of Hazwoper Standard (WB)	1.0
TRN1092	Hazwoper 8 Hour Toxicology, Monitor & Medical Surveillance (WB)	1.0
TRN1093	Hazwoper 8 Hour Hazard & Risk Assessment Tech & Hazard Identification (WB)	1.0
TRN1094	Hazwoper 8 Hour Respiratory Protection & PPE (WB)	1.0
TRN1095	Hazwoper 8 Hour Confined Spaces & Handling Drums & Containers (WB)	1.0
TRN1096	Hazwoper 8 Hour Site Control & Decontamination (WB)	1.0
TRN1097	Hazwoper 8 Hour Emergency Response & Spill Prevention	1.0

#	COURSE TITLE	LENGTH IN HOURS
TRN1098	Hazwoper 8 Hour Refresher INEEL Site Specific (WB)	1.0
TRN1099	Oversize Load Transportation Training	1.0
MTR970	Battery Maintenance and Testing	4.0

APPENDIX X
EXAMPLE OF COURSES FOR A D&D TECHNICIAN

From a U.S. production facility site with facilities undergoing decommissioning

D&D Technician Training Requirements Matrix				
Course No.	Course Title	Length (hr)	Freq.	Setting
Position Specific Training				
CAT00000	Consolidated Annual Training	2	1Y	QQ
TREG0013	First Aid/CPR/Bloodborne	4	2Y	CR
TREG0014	First Aid/CPR/Bloodborne Alternate year	1	2Y	SP
E5200010	SRS Lead Compliance Program	1	1Y	CR
QRIS5007	Behavioural Based Safety	8	0	CR
QRIS5008	BBS Observer Training	8	0	CR
UDC00064	Waste Verifier Training	2	1Y	BR
UDCO0050	SDD Waste Certification	4	2Y	BR
UDCO0029	SDD Annual RCRA	1	1Y	RS
UFDGO908	SDD Annual Spill Control	1	1Y	RS
TMAMHAZ1	Hazmat (Initial and Recurring (CBT))	4	3Y	CR
MEDHCP00	Medical Hearing Conservation Program Clearance (Medical Exam)	4	2Y	QQ
QRIH6085	Hearing Conservation	1	1Y	SP
TREGFW01	Fire watch/Patrol	3	0	CR
UDCO0038	Asbestos Awareness	TBD	TBD	TBD
TBD	Heat Stress Training	TBD	TBD	TBD
TBD	Fall Protection/ Ladder Safety	TBD	TBD	TBD
UDCO0052	Stop Work	1	0	BR
TBD	SDD New Employee Orientation Training	TBD	TBD	TBD
QHRG0000	Rad Worker Level II	4	2Y	QQ
TBD	SIRIM Reporting Criteria	1	0	BR
NSJGCON1	Conduct of Operations	2	0	CR
FESHAHAO	AHA Orientation	1	0	SP
UDCO0018	PAPR Training	2	0	JP
TRPG8000	Dust Mask Training	0	0	RS
TRWG5100	Glovebag Installation and Removal	16	0	CR
QHRG5000	Radiological Containments	12	0	CR
QRRP7000	Respiratory Protection Issuance	2	2Y	SP
QRRP4000	General Respiratory Protection	2	1Y	QQ

D&D Technician Training Requirements Matrix				
Course No.	Course Title	Length (hr)	Freq.	Setting
QRRP1000	Negative Pressure Respirator	1	1Y	QQ
QRRP2000	Plastic Suit Training	2	1Y	QQ
QREPHAZW	24 Hr Hazardous Waste Safety & Health Training	24	1Y	QQ
NSJGOCH1	Occupational Health	1	0	SP
QIHI9618	B&K Sound Level Meter 2232	4	2Y	OM
UDCO0042	Asbestos AHERA Worker Training	32	1Y	CR
QRIS6300	Confined Space Entry	4	0	CR
TREGHEC0	Initial Hazardous Energy Control	8	0	CR
USMO0014	Inspect Radiological Materials Areas	1	0	BS
UDCO0020	Waste Shipment Training	4	0	JP
UDCO0022	Low Level Waste Staging Areas (LLWSA) Mgmt Training	4	0	JP
UDCO0023	RCRA Satellite Accumulation Areas Management	4	0	JP
UDCO0024	RCRA Staging Areas Management	4	0	JP
UDCO0025	Non-Rad Liquid Waste Staging Areas – Operator Rounds	4	0	JP
NSJGLUW1	Lamps as Universal Waste	1	0	RS
NSMGWCOT	247-F Low Level Waste	2	0	CR
NSJGWH02	247-F Low Level Waste Verifier	1	0	BR
TMAD0007	Perform Pre and Post Trip Inspection	40	0	OM
TMAD0009	Perform Drivers Road Test	4	0	JP
TMAR2500	Full Body Safety Harness Training	2	0	LW
TMAR4400	Scaffolding and Fall Protection	3	0	CR
TMAM0100	OXY/Fuel Equipment Operations	24	0	CL
TMAM2901	Perform Plasma Arc Cutting	8	0	OM
TVCE3200	Oxy/Gasoline Cutting	8	0	CR
TMAMWLD3	Welding Safety Read & Sign	2	0	RS
UDCO0003	Operate Polyurea Coating System	2	0	JP
UDCO0011	Operate Pentek Vac-Pac & Associated Scabbling Equip.	8	0	JP
UDCO0004	Shrouded Tools	4	0	OM
UDCO0017	Keibler-Thompson Shear Training	4	0	JP
UDCO0021	Foam Application Training	4	0	BR
UDCO0037	Operation of the Marcrist MFS250 Diamond Floor Shaver	4	0	JP
UWMIFI01	Vacuum Stripper Operations Using the Grit Blaster	1	0	OM
UDCO0002	Operate Portable Breathing Air Compressor	2	0	JP
TMEE0300	Safe Practices on or Near Electrical Conductors	5	1Y	CR
TMEE2800	Electrical System Safety	6	3Y	CL
TMEE0400	Grounding in Addition to Electrical Lockouts	4	1Y	CL
TMAR0601	Incidental Rigging	10	3Y	QQ
TMAM0601	Forklift Operations	4	1Y	QQ
TMAM0608	Operate Telescoping Forklift	4	0	JP
TMAM2302	Operate Manlift (66’ or Less)	8	0	JP
TMAM2304	Operate Manlift (66’ or Greater)	3	0	JP
TMAM2303	Operator Scissor Lift	8	0	JP
TMAM2300	Aerial Lift Operations	4	0	CR

D&D Technician Training Requirements Matrix				
Course No.	Course Title	Length (hr)	Freq.	Setting
NSJGFSNS	247-F Facility Specific Nuclear Criticality Safety	1	0	BR
NSJGFET1	247-F Facility Entrance Training	1	0	BR
TICTS003	OJT Trainer Evaluator	4	0	CR
TBD	Be Compliance Training	TBD	TBD	TBD
TMAMO610	Operate Duct Lift	4	0	JP
TBD	System Draining/Working with Acids and Bases	TBD	TBD	TBD
UDCO0053	Material Size Reduction/Use of Hand Tools	1	0	BR
UDCO0054	Hoisting and Rigging/ Handling Heavy Loads	1	0	BR
UDCO0055	Stored Energy	1	0	BR
UDCO0056	Asbestos Work Lessons Learned	1	0	BR
UDCO0067	Fire Monitor Training	1	0	BR
UDCO0069	D&D Improvement Initiatives	1	0	BR
UDCO0070	Site D&D ConOp's Back to Basics	1	0	BR
UDCO0063	Hazards Identification (Structures, Systems etc)	TBD	TBD	TBD
NSJGPHTB	247-F Project Power Hand Tool Training	1	0	BR
TBD	Chemical Storage	TBD	TBD	TBD
TBD	System Isolation	TBD	TBD	TBD

APPENDIX XI
COURSE DESCRIPTION SHEET (GRAPHITE TRANSFERENCE COURSE)

COMMUNICATIONS/TRAINING SERVICES VANDELLOS I NPP

Reference: 60/2 ***Subject Area:*** SE ***Level:*** E

Title: **Transport of graphite ATOC / DTG (Safety)**

Addressed to: Personnel involved in container transport operations.

No of courses: 1 ***Duration of each course:*** 2 hours

Persons attending: 20 ***Credit:***

Start date: 27/01/03 ***End date:*** 27/02/03

Classroom hours: 2 ***Hours-person:*** 40

Course Programme:

Line management and forklift truck drivers involved in the process of transferring containers of graphite from the ATOC to the DTG.

Safety measures in the driving of forklift trucks.

Safety measures in work for the transfer of graphite containers from the ATOC to the DTG.

Occupational stress.

Shift work.

TRAINING COURSE ON SAFETY IN THE OPERATION OF
GANTRY AND MOBILE CRANES

Name:
Company:

1. May the crane operator use the crane to hoist persons?

   □ At any time □ It depends on the circumstances

   □ Never □ Sometimes

2. The obligatory protective equipment to be used by the crane operator is:

   □ Helmet

   □ Helmet and safety footwear

   □ Helmet, safety footwear and belt

   □ Helmet, safety footwear, belt and glasses

3. The main risks involved in operating are:

   □ Inhalation of harmful substances

   □ Falls between different levels, trapping, electrical contacts, dropping of loads, adverse weather conditions.

   □ Falls on one same level, trapping, electrical contacts, dropping of loads

   □ Excess strain, fire, noise

4. The wind speed as from which cranes should not be operated is:

   □ 20 km/h □ 80 km/h

   □ 60 km/h □ 100 km/h

5. May the reverse mode be used during operation?

   □ Yes □ At times

   □ No □ If requested by the foreman

6. To what extent is checking the brake the obligation of the crane operator?

   □ Daily □ It is not the obligation of the operator

   □ Weekly □ It depends on the type of crane

APPENDIX XII
HAZARDOUS WASTE OPERATIONS COURSE TOPICS
(UNITED STATES OF AMERICA)

40-Hour and 24-Hour Core Hazardous Waste Operations Course Learning Objectives

(1) HAZWOPER elements and safety program (40, 24W, 24T)

Describe:

The HAZWOPER Standard

- (29 CFR 1910.120/1926.65) and the three main applications of the Standard (hazardous waste site, TSD, emergency response).

Identify:

- Applicable paragraphs of 29 CFR 1910.120;
- Primary elements of an employer's effective OSH program; and
- Responsible personnel in TSD operations.

(2) Effects of chemical exposures

(40, 24W, 24T, 16)

Describe:

- Sources of chemical hazards;
- Signs and symptoms of exposure to hazardous substances; and
- Various chemicals that may have different effects on the body.

Identify:

- Four routes of entry into the body.

Explain:

- Acute and chronic effects of chemical exposure.

(3) Effects of biological & radiological exposures (40, 24T,16)

Describe:

- Biological and radiological hazards;
- Sources of biological and radiological hazards; and
- Probable effects from exposure to biological hazards.

Explain:

- Acute and chronic effects of radiological exposure; and
- Four routes of entry for contaminants into the body.

(4) Fire and explosion hazards

(40, 24W, 24T)

Identify:

- Local fire and explosion hazards; and
- Components of the fire triangle and provide examples of each component.

Define and explain:

- Flashpoint, flammable/combustible limits, chemical incompatibility, and catalyst.

(5) General safety hazards (40, 24W, 24T, 16)

Describe:

- General safety hazards, including noise;
- Construction hazards, where applicable;
- Electrical hazards;
- Powered equipment hazards;
- Walking hazards;
- Heat stress and cold stress hazards; and
- The responsibility of employers and employees to identify and control these general safety hazards.

(6) Confined space, tank, and vault hazards (40, 24T, 16)

Define:

- A confined space.

Identify:

- Requirements and general precautions for confined space work;
- The primary hazards associated with confined spaces; and
- The ways a confined space presents hazardous occupational conditions.

(7) Persons responsible for site safety and health (40, 16)

Describe:

- Positions (or their equivalents) and their alternates who are responsible for safety and health at the site.

(8) (Specific) health and safety hazards (40, 24W, 16)

Identify:

- Significant site hazards in the HASP but not covered under General safety hazards, Fire and explosion hazards, Effects of chemical exposures, or Effects of biological and radiological exposure.

(9) PPE program and use of PPE for full protection (40, 16)

Identify:

- Elements of a personal protective equipment (PPE) program; and
- Four levels of PPE as prescribed by OSHA.

Explain:

- Selection criteria of PPE and their protective limitations; and
- Methods of inspection, use, maintenance, repair, and storage of PPE.

Demonstrate:

- Correct method for inspecting, maintaining, donning, and removing of an appropriate level of protection, based on a scenario provided by the instructor.

(10) PPE program and use of PPE (24W, 24T)

Identify:

- The elements of PPE program;
- Requirements for the four levels of PPE as prescribed by the OSHA Standard; and
- Three atmospheric hazards requiring respiratory protection. (additionally for 24T)
- The selection criteria of chemical protective clothing based on its protective limitations;
- The methods of inspection, use, maintenance and repair, and storage of PPE;
- Atmospheric hazards requiring respiratory protection;
- Approved fit tests for respirator wearers; and
- Limitations of air-purifying respirators (APRs) and their associated cartridges.

(11) Work practices for risk reduction (40, 24W, 24T)

Describe:

- Principles of as low as reasonably achievable (ALARA); and
- Work practices used to reduce exposures to hazards, including applicable SOPs relating to operations/construction.

(12) Engineering controls, risk reduction (40, 24W, 24T)

Describe:

- The concept of hierarchy of hazard controls;
- Applicable hazard controls and equipment;
- How to determine whether required hazard controls are in use; and
- Relevant new hazard control technology or procedures.

List:

- At least three examples (each) of engineering and administrative controls.

(13) Medical surveillance program (40, 24W, 24T)

Describe:

- The basic elements of a medical surveillance program;
- The signs and symptoms of overexposure to hazardous substances;
- Availability of, and a method for, obtaining medical records;
- Rights of employees as patients in terms of confidentiality, access to records, and reporting of examination results; and
- Responsibilities of employees to report incidents, accidents, and illnesses.

(14) Site health and safety plan (HASP) (40, 24W)

Identify:

- Known and potential hazards at worksites.

Describe:

- Key elements of a complete site HASP;
- Methods to contact personnel, and alternates, responsible for site health and safety; and
- The right and responsibility of employees to have access to, and input to change, the site HASP.

Explain:

- Purpose of the site HASP.

(15) Use of monitoring equipment (40,24W)

Identify:

- Different types of monitoring instruments; and
- General limitations of field-monitoring instruments.

Explain:

- Purposes of monitoring instruments; and
- Factors involved in proper selection and use of monitoring instruments.

Demonstrate:

- Operation of applicable monitoring equipment in accordance with the appropriate procedures and instrument technical manuals.

(16) Site informational program (40, 16)

Describe:

- Employer responsibilities to communicate likely exposure(s) to hazards encountered at a waste site; and
- Methods used for that communication.

(17) Drum and container handling/spill containment (40, 24T, 16)

Identify:

- Potential hazards of drum handling (equipment specifically to be addressed in site-specific training); and
- Safe spill handling practices.

(18) Material handling equipment (40, 24T, 16)

Identify:

- Examples of local material handling equipment; and
- Hazards and limitations of specific handling equipment.

(19) Risks from handling radioactive wastes (40, 16)

Identify:

- The following for each of the four types of ionizing radiation: physical characteristics, range/shielding, and biological hazard(s);
- The units used to measure radiation and contamination;
- The colors and symbols used on radiological postings, signs, and labels, and;
- The need to notify supervisor if employee does not have specialized radiation training.

Define:

- Ionizing radiation and radioactive contamination.

(20) Handling of shock-sensitive wastes (40, 16)

Describe:

- Situations when shock-sensitive wastes may be encountered and need for special training.

(21) Laboratory waste pack handling procedures (40, 16)

Explain:

- Hazards of lab packs.

Describe:

- Situations when lab packs are, or may be, encountered and need for special training.

(22) Container sampling (40, 16)

Identify:

- Why an unknown material must be sampled and characterized;
- Steps and precautions when taking samples from drums, tanks, or other containers;
- Hazards associated with obtaining samples from various containers;
- Hazards associated with obtaining samples from bulk containers; and
- Steps and precautions when taking samples from bulk containers.

(23) Procedures for shipping and transport (40, 16)

Identify:

- Requirements of labels, markings, and placards.

(24) Decontamination program and procedures (40, 24W, 24T,16)

Identify:

- Work practices for contamination avoidance;
- Methods of decontamination;
- Primary ways to determine the effectiveness of decontamination;
- Limits to the effectiveness of decontamination; and
- Emergency decontamination procedures.

Demonstrate:

• Student can perform decontamination processes for personnel and equipment.

(25) Emergency response plan and first aid (40, 24W, 24T)

Explain:

- The purpose for emergency planning;
- Primary elements of an emergency plan;
- Worker responsibilities based on level of training;
- Methods to notify workers of emergency conditions;
- Emergency medical treatment and first aid components of the emergency plan;
- Components of the emergency plan for control and containment of hazardous substance spills; and
- Worker limitations based on level of training.

(26) Safe illumination levels (40, 16)

Describe:

- The need for adequate lighting levels for working safely.

(27) Site sanitation procedures and equipment (40,16)

Describe:

- The need for adequate sanitation facilities.

(28) Review HAZWOPER appendixes (40, 24T, 16)

Identify:

- The applicable appendixes to 29 CFR 1910.120.

(29) Overview of hazard communication standard (40, 24T, 16)

Explain:

- The OSHA requirements for a hazard communication program.

Demonstrate:

- Given Material Safety Data Sheet (MSDS), identify health hazards information and protective measures.

(30) Use of reference materials (40, 24W, 24T, 16)

Identify:

- Advantages of using reference materials;
- Common sources of reference providing additional health and safety information (can include the National Institute for Occupational Safety and Health (NIOSH) Pocket Guide, DOT Handbook, Emergency Response (ER) Guide, 4-Agency Manual, and CHRIS Manual); and
- Personnel resources who can answer questions and/or issues regarding HAZWOPER.

(31) Toxicology principles and biological monitoring (40, 24T, 16)

Explain:

- The principles of toxicology and biological monitoring.

(32) Employee rights and responsibilities (40, 24T, 16)

List:

- The rights and responsibilities given to the employee by the Occupational Safety and Health Act of 1970 as well as DOE policies and the steps necessary to exercise these rights and fulfill these responsibilities;
- Responsibilities of the employer under the Occupational Safety and Health Act of 1970 as well as DOE policies;
- The steps you may take if you believe you have been prevented from exercising your rights under OSHA and DOE policies and procedures; and
- The steps you may take if you believe you have been punished for exercising your rights under OSHA and DOE policies and procedures.

(33) "Hands-on" exercises and student demonstrations (40, 24T, 16)

Demonstrate:

- PPE usage, especially respirators;
- Drum and container handling;
- Use of monitoring equipment;
- Decontamination procedures;
- Use of hazard communication tools (e.g., labels, MSDSs);
- Actions in an emergency scenario; and
- Use of reference materials.

(34) Employee training program (24T)

Identify:

- Elements of the hazardous waste operations training program; and
- Personnel responsible for the training program.

(35) Site simulations (24W)

Demonstrate:

- Use of hazard communication tools;
- Elementary decontamination; and
- PPE usage.

Footnotes:

40 = 40-hour initial hazardous waste operation core training
24W = 24-hour initial hazardous waste operation core training
16 = 16-hours of additional training to supplement 24-hour initial hazardous waste operation core training to equal 40-hour core training
24T = 24-hour initial treatment, storage, and disposal (TSD) core training

From DOE: EH/EM, Hazardous Waste Activities Handbook (June 1996).

APPENDIX XIII
EXAMPLE OF NATIONAL STANDARDS OF COMPETENCE FOR NUCLEAR DECOMMISSIONING WORKERS (UNITED KINGDOM)

This Appendix is a sample extract from a compilation of national standards of competence in nuclear decommissioning which are used as the basis for vocational qualifications for decommissioning workers in the United Kingdom. It comprises a list of the units (competence areas) which make up the qualification, and an example of one of the units (No 411). This example is reproduced with kind permission of The City and Guilds of London Institute. City and Guilds is the organization who have developed the full set of standards in the United Kingdom and who arrange delivery of the qualification through approved centres.

Nuclear Technology Decommissioning Level 2

	Unit Title and Code
Mandatory Units	411: Dismantle contaminated plant, structures and equipment used within nuclear facilities
	412: Minimise radioactive waste
	413: Package radioactive waste
	414: Prepare for the decontamination of radioactive items
	415: Achieve required levels of decontamination
	416: Monitor personal dose uptake
	417: Control personal dose uptake
	418: Provide operational monitoring assistance
	419: Identify and deal with hazards in supervised and controlled areas
	420: Deal with risks arising from contingencies in supervised and controlled areas
	421: Implement safe access systems in a radiation/contamination controlled environment
Optional Units - A (Select one)	422: Prepare alpha radiation/contamination controlled work areas for engineering activities
	423: Prepare beta/gamma radiation/contamination controlled work areas for engineering activities
Optional Units - B (Select three)	424: Position and construct equipment to aid nuclear decommissioning
	425: Dismantle equipment used in nuclear decommissioning
	426: Carry out planned preventative maintenance procedures on equipment used in nuclear decommissioning
	427: Adjust equipment used in nuclear decommissioning to meet operational requirements
	428: Operate remote controlled nuclear decommissioning equipment
	429: Minimise risks to life, property and the environment in supervised and controlled areas
	430: Monitor operational radiological conditions
	431: Keep radiological monitoring instruments and equipment in good order
	432: Prepare loads for moving
	433: Movements of loads
	434: Contribute to technical leadership on nuclear decommissioning activities

	435: Prepare equipment for engineering activity in a radiation/contamination controlled environment
Optional Units - C (Select one)	436: Identify and suggest improvements to working practices and procedures
	437: Develop yourself in the work role
	438: Contribute to effective working relationships

Commentary for Unit 411: *Dismantle contaminated plant, structures and equipment used within nuclear facilities*

This Unit covers the competence required to dismantle contaminated plant, structures and equipment used within nuclear facilities (assets) in accordance with specifications. This may be done as a precursor to any number of engineering maintenance or modification activities but is generally to be applied to the act of removal and disposal of the asset. The Unit may also be applied to removal or disposal of legacy waste items, contaminated plant and equipment. The candidate's responsibility is limited to working within detailed specifications and following clearly defined procedures. In some cases, the candidate may still be expected to refer to others for final authorisations, even though responsibility for identifying and implementing decisions remains with the candidate.

This Unit is the core function associated with nuclear decommissioning and is, therefore, essential in defining the candidate's understanding of nuclear decommissioning processes. The Unit covers procedures followed by the candidate which result in the removal of an asset. Typical scenarios which arise naturally in the workplace may include: use of hand tools to dismantle part of the asset prior to disposal; the use of hydraulic or electrically powered tools to remove part or all of the asset; the use of hydraulic or electrically powered tools to dig or abrade contaminated or irradiated surfaces; or any size reduction activity, soil remediation or process which results in disposal of an asset using approved nuclear decommissioning procedures. This Unit does not cover the operation of remote controlled equipment which is covered in Unit 427.

Key words/terms

Key words/terms used in this Unit and their meaning:-

Plant, structures and equipment

The plant, structures and equipment covered by this Unit are as found within a nuclear facility. They may be irradiated and/or contaminated and would include full assemblies such as the reactor, processing plant, experimental plant, glove boxes, and pond structures. They would also cover sub-assemblies such as reactor components, fuel assemblies, pipe work, vessels, mixers and pond furniture.

Dismantling methods and techniques

Typical disconnections would include unfastening of bolts and studs, burning, un-plugging of male/female connections, use of quick release hydraulic couplings, stripping out of electric cables, size reduction, grinding, shearing and cutting.

The methods and techniques to be applied and the procedures to be followed would be clearly specified in the work instructions. The person carrying out this work is responsible for working to those instructions. The items to be dismantled are readily accessed meaning that dismantling is generally straightforward in engineering terms, but is made complex by the need to rigorously adhere to the protective systems in place within a radiation/contamination controlled environment as defined within the Ionising Radiations Regulations (IRRs).

Work area protection and safety requirements

Following As Low As Reasonably Practical (ALARP) principles at all times, accurately establish radiation and contamination levels. Restrict and minimise contamination through use of specific equipment. Maintain high levels of house keeping.

Unit 411: Dismantle contaminated plant, structures and equipment used within nuclear facilities

The National Standard

Performance statements	**Knowledge and understanding**
You must:	You must have knowledge and understanding of:
(1) Work safely at all times, complying with health and safety and other relevant regulations and guidelines. (2) Establish and where appropriate mark component for re-assembly. (3) Ensure that any stored energy or substances are released safely and correctly. (4) Make all isolations and disconnections to the equipment in line with approved procedures. (5) Carry out the dismantling to the agreed level using correct tools and techniques. (6) Store components for re-use in approved locations. (7) Dispose of unwanted components and substances in accordance with approved procedures. (8) Deal promptly and effectively with problems within your control and report those that cannot be solved. ***Key Words/Terms*** — Plant, structures and equipment — Dismantling methods and techniques — Work area protection and safety requirements	(1) Health and safety legislation, regulations and safe working practices and procedures. (2) Engineering drawings and related specifications. (3) Dismantling methods and techniques. (4) Handling equipment methods and techniques. (5)\ Tools and equipment used to carry out dismantling and size reduction. (6) Tool and equipment care and control procedures. (7) How to shield from radiation sources. (8) How to prevent the spread of contamination (9) The properties and types of radiation present in the facility. (10) Storage arrangements for radioactive/contaminated items. (11) Waste disposal procedures (12) Reporting lines and procedures.

Unit 411: Dismantle contaminated plant, structures and equipment used within nuclear facilities

NVQ and SVQ Assessment

Evidence requirements:

You need to provide evidence to show that the way you work matches the National Standard. To do this you will need to cover the requirements below:

You must provide at least 3 different examples of performance evidence relating to dismantling.

Taken as a whole, the performance evidence must cover:

- the dismantling of both full and sub-assemblies in line with the specifications given
- at least 2 of the asset characteristics specified in the Key Words/Terms for plant, structures and equipment
- at least 2 different dismantling techniques as described in the Key Words/Terms
- at least 1 example of the work area protection and safety requirements detailed in the Key Words/Terms.

Assessment guidance:

Simulation as a method for generating evidence is not acceptable.

Questioning will be needed to establish knowledge and understanding in relation to those aspects of the Key Words/Terms not dealt with through performance evidence.

Typical types of performance evidence would include dismantled assets, procedures followed and organizational records. Oral questioning or written tests would be the preferred means of assessing knowledge and understanding. Observation and examination of outcomes and records will probably provide the most effective methods of assessment.

Unit 411: Dismantle contaminated plant, structures and equipment used within nuclear facilities

Knowledge and understanding

The table below indicates the depth and breadth of Knowledge and Understanding needed for this Unit:

Knowledge and understanding	**Key points statement**
Knowledge statement on National Standard page:	*Key points to be covered by a candidate:*
(1) Health and safety legislation, regulations and safe working practices and procedures.	• manual handling • lifting and moving legislation and procedures • HASAWA • COSHH • workplace risk assessments • permits to work

(2) Engineering drawings and related specifications.	• reading simple line drawings/diagrams • job cards/work instructions • scaling • symbols • conventions
(3) Dismantling methods and techniques.	• unfastening of bolts • unfastening of studs • burning/plasma cutting • unplugging of male/female connections • quick release hydraulic couplings • stripping out of electric cables • size reduction • grinding • shearing • cutting
(4) Handling equipment methods and techniques.	• hoists • cranes • drum handlers • jigs • lifting frames • slings
(5) Tools and equipment used to carry out dismantling and size reduction.	• plasma arc equipment • oxyacetylene • nibblers • shears • saws • grinders • wire cutters • drills

Knowledge and understanding	**Key points statement**
Knowledge statement on National Standard page:	*Key points to be covered by a candidate:*
(6) Tool and equipment care and control procedures.	• essential maintenance, inspection and testing • calibration • oiling/greasing • electrical testing • care of drills, blades, discs etc
(7) How to shield from radiation sources.	• time, distance, shielding • lead and other radiation shields • semi-remote working
(8) How to prevent the spread of contamination.	• containment • local exhaust ventilation • tie down coatings • damp swabs • area demarcation

(9) The properties and types of radiation present in the facility.	• alpha, beta, gamma • sources of radiation • contamination and radiation • ventilation • containment • shielding
(10) Storage arrangements for radioactive/contaminated items.	• site layout and asset configuration • orientation of containers • container types • labelling/identification • stacking • pallets • drum handlers • safety signs
(11) Waste disposal procedures.	• packaging • monitoring • waste records • waste handling
(12) Reporting lines and procedures.	• supervisor • project engineer • Radiation Protection Advisor (RPA) • safety officer • workplace representatives • colleagues • record keeping • positive feedback • negative feedback

APPENDIX XIV
TRAINING LESSONS LEARNED FROM CONNECTICUT YANKEE AND YANKEE ROWE

The Training Process for decommissioning has several key elements which impact the type of training needed and the process by which the training is provided. These key elements also change significantly as each of the phases of decommissioning progress from the transition from operations to the decommissioning though the final site closure and long-term fuel storage, if required. It is important to understand the basis for the training being provided and apply a reasonable approach to that training. Managing the changes to personnel and administrative controls, based on the status of the facility, is challenging. Ensuring tracking of qualifications, documentation and records management, are critical to the Training Programmes' success during the dynamic conditions of decommissioning.

The following is a list of lessons learned through the decommissioning of Connecticut Yankee and Yankee Rowe (United States of America):

Lessons learned

(1) Training Database development and management are critical to ensuring an effective Training Programme. The operational Training Database was used to track qualifications as the site entered decommissioning. It quickly became evident that this tool was too costly and difficult to maintain. The numbers and types of new lessons increase significantly and the workforces changes regularly. An efficient and streamlined approach to tracking Decommissioning Training/Qualifications is essential. The site learned this after having several problems in this area during decommissioning.

(2) Do not treat all training the same way. It is critical to group training requirements together based on similar topics. In many cases the training needed is general informational (i.e. informal) training, and training classes can be combined. For example there were approximately 8 different training classes (Lesson Plans included) that addressed general site safety, site access, hazardous material packaging and hazardous materials awareness (Asbestos, PCB, Lead and Silica) after starting decommissioning. All personnel had to attend these classes. This took substantial time for the workers, trainers and for database management. All of these classes were combined into the General Site Access Training, which can be a classroom or Computer Based. This approach has ensured the training is performed as needed, but has made it much more efficient for providing the training and tracking the results. Funding for decommissioning is limited, which limits resources. It is critical to find efficiencies.

(3) Records management was a problem with decommissioning training. On several occasions problems were identified with records not being completed and managed appropriately. Historical records were not dispositioned in a timely fashion all the time. One reason identified for this was because training became less of a requirement and fewer resources were applied. If these areas are not effectively managed as changes occur (Change Management), it is likely that this will continue to occur.

(4) Identify and use more efficient training techniques for some types of training. There are a number of efficiencies that can be gained by utilizing simplified training techniques that have worked well at the site. The reasons for these changes are important because of the types of individuals that require the general training. On many occasions "on demand" training is needed for specialty contractors performing unique, short duration tasks (days to weeks). It is difficult to manage this type of training efficiently and effectively. As a

result, simple techniques can be used, such as video taping training, computer-based training and bypass exams for experienced individuals, rather than having to provide classroom training in these cases. This type of training needs to be evaluated on risk-based approach.

(5) Improved Radiation Protection Training is important during decommissioning due to the type of work that will be performed by the individuals. During operations, the type of work is generally routine; and during outages there is substantial time to prepare the work packages. During decommissioning, many more radiological challenges are encountered. It is important to provide this enhanced training so that the workers and supervisors recognize this change and will be better prepared to perform the radiological work.

(6) Understand the regulatory basis for the training that is being performed. It is important to allow flexibility in the Training Programme. Those tasks which require a Systematic Approach to Training (SAT) should be well understood, and those, which do not, should also be recognized. The SAT is good, but in many instances is much more than is needed for decommissioning activities. There are many one-time evolutions and changes are occurring often. It becomes hard to manage the administrative portions of the SAT process and can impact training quality and compliance. The Training Programme should have the flexibility to use the SAT, and to be simple, depending on the predetermined analysis.

(7) Training Personnel Management is important. During decommission, training personnel reported to many different organizations. It was not always effective based on training reporting chain in the decommissioning organization. When it reported to production, it was given the same attention as to when it reported to an independent organization other than production. As the regulatory basis and requirements for training decrease, the emphasis and support seam to decrease. Problems with the Training Programme usually occurred as changes to personnel were made in the training area. There have been 4–5 different personnel directly responsible for training during decommissioning.

(8) Understand the training facilities that have been dedicated during decommissioning. Preparing a long-term facility plan, based on the approach to decommissioning, can be beneficial and can minimize any impacts on the training during the entire project. Relocating training on many different occasions can impact the quality of training and its efficiency. It is important to have training and in-processing in an area that is close in proximity to allow efficiencies in processing workers (usually contractors) on to the site. If planned appropriately as part of a site resource and facilities management plan, it can limit any impacts on training during the project.

(9) Ensure a good plan is in place for managing the training records. During decommissioning, the area that does not get the attention needed — if training resources become challenged — is records management. Problems in this area were identified several times during decommissioning due to the higher priority of getting individuals trained. Managing key Training Programme activities through the site schedule can ensure that the important elements like records will not be missed or compromised.

APPENDIX XV
EXAMPLE JOB HAZARDS ANALYSIS FORMS (CANADA)

Sample form for Job Hazard Analysis Worksheet		
Job:		
Analysis By:	Reviewed By:	Approved By:
Date:	Date:	Date:
Sequence of Steps	**Potential Accidents or Hazards**	**Preventative Measures**

Sample forms for Tasks and Job Inventory for Tasks with Potential Exposure to Hazardous Materials or Physical Agents		
Analysis By:	Reviewed By:	Approved By:
Date:	Date:	Date:
Tasks	Name of Material or Physical Agent	Location

Job Inventory of Hazardous Chemicals		
Analysis By:	Reviewed By:	Approved By:
Date:	Date:	Date:
Name of Chemical	Route of Entry and Physical State	Controls

APPENDIX XVI
EXAMPLE JOB HAZARDS ANALYSIS FORM (UNITED STATES OF AMERICA)

Work Task Steps Identify sequence of each step.	**Hazards, Concerns, and Potential Accidents** Identify hazards for each step. Identify hazards that could affect workers.	**Controls, Preventative Measures** Specify controls for each hazard (e.g., lockout, tag out points, specific PPE, etc.)	**Supplemental Documents** List permits, operating manuals, and other reference procedures.	**Training** List training requirements.
1.				
2.				
3.				
4.				
5.				
Etc.				

APPENDIX XVII
EXAMPLE JOB SAFETY ANALYSIS FORM (UNITED STATES OF AMERICA)

442.17 09/01/2000 Rev. 08	**JOB SAFETY ANALYSIS**

INSTRUCTIONS

JOB/TITLE:	Identify the activity being analyzed.
JSA NUMBER & REVISION:	May be used for a facility/project-specific numbering system.
FACILITY/PROJECT & LOCATION:	Specifically identify facility or project and location where the job will occur.
EFFECTIVE DATE:	List the date the analysis becomes effective, ready to use.
EXPIRATION DATE:	Expiration dates can not be greater than 5 years past the effective date for standard JSAs. They can not be greater than 1 year past the effective date for JSAs governing highly hazardous activities.
APPROVED BY/DATE:	The signature and date indicate approval by the facility/project manager/supervisor.
SME APPROVAL:	The signature and date indicate approval by the SMEs who developed the JSA.
BRIEFLY DESCRIBE THE JOB & EXPECTED RESULT:	Give a summary description of the activity and its purpose.
REQUIRED JOB TRAINING/REQUIRED PERSONAL PROTECTIVE EQUIPMENT (PPE):	List training required for access to the work location, to operate equipment/vehicles, to work at heights, etc. List PPE required to protect against hazards of performing the job in the specified location. **Note:** In addition to listing here, PPE for specific steps is called out in those steps.
SEQUENCE OF BASIC JOB STEPS:	Describe the job, step by step, from beginning to end. (Before examining the job for potential hazards, define the job as a series of tasks or steps. Use judgment to avoid either excessive or insufficient detail. Each step should begin with an action, such as lift, place, remove, position, install, etc.) Verify the recorded steps with the performer to ensure completeness and accuracy.
POTENTIAL HAZARDS:	List the hazards associated with each step. (To ensure that all hazards associated with a step are identified, examine hazards produced by both work environment and the activity being performed. For guidance, as a minimum, consider the following: * Is there danger of striking against, being struck by, or otherwise making harmful contact with an object? * Can the worker be caught in, by, or between objects? * Is there potential for a slip or trip? * Can the employee fall from one level to another or even on the same level? * Can pushing, pulling, lifting, bending, or twisting cause strain? * Is the environment hazardous to safety or health? * Are there concentrations of toxic gas, vapor, fumes, or dust? * Are there potential exposures to heat, cold, noise, or ionizing radiation? * Are there flammable, explosive, or electrical hazards?)
HAZARD CONTROL/PPE:	List the methods to control the identified hazards. (Engineering or administrative controls to isolate workers from hazards are preferred over the use of PPE. For guidance, as a minimum, consider the following: * Find a new way to do the job. * Change the physical conditions that create the hazard. * Revise the work procedure or process. * Reduce the frequency of the job. * Enhance training before performing the job. * Increase monitoring or supervision during the job. * Implement administrative controls when the hazard cannot be eliminated by engineering controls. * Prescribe PPE when appropriate. **Note:** Recognize the potential for creating additional hazards when modifying the initial process.)

Job/Title		JSA Number	Revision
Facility/Project & Location	**Effective Date** **Expiration Date**	**Facility/Project Management/Supervisor Approval** / **Date**	

SME APPROVAL (A "Yes" response requires a signature and date.)

No	Yes	SME	Signature	Date	No	Yes	SME	Signature	Date
☐	☐	Industrial Safety			☐	☐	Env. Protection		
☐	☐	Industrial Hygiene			☐	☐	Quality Assurance		
☐	☐	Fire Protection			☐	☐	Engineering		
☐	☐	RCT/RAD Eng.			☐	☐	Other:		
☐	☐	Other:			☐	☐	Other:		

Briefly Describe The Job and Expected Result

Required Job Training/Required Personal Protective Equipment

Sequence Of Basic Job Steps	Potential Hazards	Hazard Control/PPE

APPENDIX XVIII
EXAMPLE RISK ASSESSMENT/METHOD STATEMENT (UK)

RWE NUKEM RISK ASSESSMENT/METHOD STATEMENT N^{O} D009489/OPS/03/230

TITLE: DECONTAMINATION VESSEL.

TO PUMP LIQUOR FROM LIQUOR TRANSFER PUMP PIT TO VESSEL PIT.

NAME	PRINT	SIGNATURE	DATE
AUTHOR:			
CHECKED:			
APPROVED:			

CLIENT	PRINT	SIGNATURE	DATE
ACCEPTANCE:			

METHOD STATEMENT REVISIONS ARE INDICATED BY A VERTICAL LINE IN THE NUMBER BOX OF THE METHOD STATEMENT OR AT THE LEFT HAND EDGE OF A SECTION OF TEXT.

INTRODUCTION

During an incident, water entered the Fan 6 extract duct. The water then exited the duct on the first floor of the decontamination vessel galleries, cascaded down through the two lower galleries and ended up contained in the vessel sump pit. A smaller quantity found its way into the vessel liquor transfer pump sump pit (adjacent to the vessel sump pit). Contamination, which was washed out of the duct, has been cleaned up from the floors and walls of the gallery levels and the area declassified to Contamination Low.

The vessel sump pit (P74) and the vessel liquor transfer pump sump pit (P152) are both rated R high/C moderate and will be treated as “confined spaces” due to their location.

The intention is to transfer the liquor in the vessel liquor transfer pump sump pit to the vessel sump pit, which will allow entry to the vessel liquor transfer pump sump pit for maintenance/repairs to the transfer pump. Meantime, the liquor in the vessel sump pit will be transferred into the decontamination vessel, were it can be pumped to the AETP via the transfer pump following repairs. The liquor would then be recirculated through the AETP filters and discharged to receipt area

SCOPE

This method statement/risk assessment refers to the transfer of liquor from the vessel liquor transfer pump sump pit to the vessel sump pit using a portable sump pump.

EQUIPMENT

110V sump pump and hose
110V electrical extension lead
Approx. 35 ft rope to lower pump into sump
Keys to access both pit hatches (from PTW office)
PVC or chemical suits
Face shields
Rubber boots and gloves
Roll of “Kim wipe”
Plastic bags and a roll of black tape
Torch

PERSONNEL

Suitably experienced General workers
Health physics surveyor

HAZARDS

(1) Radiation
(2) Contamination
(3) Falling from height
(4) Confined space
(5) Use of electrical equipment

RISK ASSESSMENT ACTION

CAN THE FOLLOWING PROTECTIVE MEASURES BE APPLIED TO THE IDENTIFIED TASK HAZARDS							
PROTECTIVE MEASURE	TASK HAZARD						
	1	2	3	4	5	6	7
CAN THE RISK BE AVOIDED ALTOGETHER	N	N	N	Y	N		
CAN THE RISK BE REDUCED BY SUBSTITUTION	N	N	N	N	N		
CAN THE RISK BE IMPROVED TECHNICALLY	N	Y	Y	Y	Y		
DO EMPLOYEES REQUIRE INSTRUCTION/INFORMATION/TRAININ G	Y	Y	Y	Y	Y		
IS PERSONAL PROTECTIVE CLOTHING REQUIRED	N	Y	Y	N	N		
ARE SAFETY SIGNS REQUIRED	Y	Y	N	Y	N		

JOB RISK ASSESSMENT

FREQUENCY FACTOR **(FF)**	SEVERITY FACTOR (**SF**)
1=Improbable occurrence	0=No hazard
2=Possible occurrence	1=Trivial hazard
3=Occasional occurrence	2=Minor injury
4=Frequent occurrence	4=Major injury to one person
5=Regular occurrence	6=Major injury to several people
	7=Death of one person
	8=Multiple deaths

RISK RATING (**RR**)=FREQUENCY (**FF**) X SEVERITY (**SF**)

IF RISK RATING > 4 - CONSIDER NEED FOR ACTION
IF RISK RATING > 8 - ACTION MUST BE TAKEN

HAZARD ACTION SCHEDULE

HAZARD	RISK	INITIAL RATING			SAFEGUARD	FINAL RATING		
		FF	SF	RR		FF	SF	RR
Radiation	External Dose.	2	2	4	Personal electronic dosimeter. HP Surveys	2	1	2
Contamination	Internal Dose. Personal Contamination.	2	2	4	HP Surveys- PVC or chemical suit, face shield, rubber boots and gloves during pumping ops. See H187 for details.	2	1	2
Falling from height	Personal injury	2	8	16	Wear safety harness and lanyard whilst working over open hatches. Lanyard to be clipped to steelwork to give least fall distance.	2	2	4
Confined space	Asphyxiation	2	8	16	**No entry to pits**. Pump to be lowered in on a rope. Ensure Fan 6 is extracting from vessel galleries prior to ascent to galleries.	1	0	0
Use of electrical equipment	Electrocution	2	8	16	Use of 110V equipment should prevent death. Pump will be within electrical test date.	2	2	4

STEP NO	INSTRUCTION	HAZARD/ CONTROL METHOD	RESPONSIBLE PERSON	TASK COMPLETION SIGNATURE
1	Sign onto safety documentation for task and carry out toolbox talk with all parties involved.	N/A	PTW receiver	
2	Collect tools and equipment (inc. keys for pit hatches) at bottom of vessel gallery levels.	1	Persons carrying out task	
3	Open both pit hatches and make assessment of length of hose required to reach between the floor levels of both pits. (**ADD A FUTHER 3 METRES** to hose length to allow connection to the fixed effluent pump for the following stage of recovery)	1, 2, 3 & 4	Persons carrying out task	
4	Once hose is secured to the portable sump pump, lower the pump by rope, into the pump pit. **Wear safety harness during this operation.**	1, 2, 3 & 4	PTW receiver Persons carrying out task	

STEP NO	INSTRUCTION	HAZARD/ CONTROL METHOD	RESPONSIBLE PERSON	TASK COMPLETION SIGNATURE
5	Lower the open end of the hose into the vessel pit so that the end is restrained by the cat ladder rungs and is below the surface of the water to prevent splashes. **Wear safety harness during this operation.**	1, 2, 3 & 4	PTW receiver Persons carrying out task	
6	Personnel carrying out pumping ops should now don the PVC or chemical suits, rubber boots, rubber gloves and face shield.	1	PTW receiver Persons carrying out task	
7	Start the transfer of liquor from the pump pit to the vessel pit.	1, 2, 3, 4 & 5	Persons carrying out task	
8	Once as much liquor as possible has been transferred, remove the sump pump from the pump pit and allow it to drain for 10 mins. Allow HPS surveyor to survey pump and then double bag it.	1, 2, 3 & 4		
9	Lift the hose so as to drain any liquor in it over into the vessel pit. Then lift the open end clear of the liquor surface and allow to drain for 10 mins. Allow HPS surveyor to survey the hose and then double bag the end.	1, 2, 3 & 4	Persons carrying out task HPS surveyor	
10	The pump and hose can be stored next to the vessel as it will be required for the following stage of the recovery.	1 & 2	Persons carrying out task	
11	Make an estimate of the levels in both pits (approx. 10 ins between ladder rungs) then lock both pit hatches shut.	1, 2, 3 & 4	PTW receiver Persons carrying out task	Pump pit level: Vessel pit level:
12	HPS survey of area, tidy up tools and equipment and store next to pump as they will be needed again. Remove waste and laundry as appropriate.	1 & 2	Persons carrying out task HPS surveyor	
13	Sign off PTW and return it to PTW office along with keys for pit hatch locks.	N/A	PTW receiver	
14	End of task.			

Review/Reassessment

ORIGINATION DATE	

REVIEW	COMMENTS
1ST	
2ND	
3RD	
4TH	
5TH	

REVIEW	DATE	NAME	SIGN	CLIENT ENDORSEMENT
1ST				
2ND				
3RD				
4TH				
5TH				

APPENDIX XIX
EXAMPLE OF AN AUTOMATED JOB HAZARDS ANALYSIS TOOL (UNITED STATES OF AMERICA)

A job hazard analysis is an essential component of work planning. In performing the analysis, the work is defined, the conditions at the work site are evaluated, all potential hazards are identified, and the measures needed to control the hazards are determined. The most effective way to evaluate the job site is to walk through the area where the work will be performed and note any conditions that could pose a hazard.

Until now, planners had to remember the list of possible hazards and take notes as they performed their work-site walkdowns. Their decisions about each possible hazard could not be entered into the Automated Job Hazard Analysis system until they returned to a workstation. But, with programming support from Lockheed Martin Information Technology, the AJHA software has been adapted to the pocket PC, sometimes referred to as a personal data assistant or PDA.

The program that enables a user to process an AJHA record on a PDA is called "Pocket AJHA." It's available for installation through Software Distribution under "Hanford Site Applications." Any AJHA user can install this feature on his or her PDA — provided it uses Microsoft Pocket PC 2002 as the operating system. The PDA must be "synchronized" with the user's workstation to complete this installation.

There are several different brands and models of PDAs commercially available that will work. However, the Palm line of PDAs does not use Microsoft's operating system and therefore won't fully integrate with the Hanford Local Area Network.

Once the PDA is set up, the user simply logs onto "Pocket AJHA" while the PDA is in its cradle and synchronized, and selects the desired AJHA to take into the field. In the field the user can display the hazard questions and indicate which ones may apply to the job being planned. When the job-site walkdown is done, the user simply returns the PDA to the cradle and uploads the AJHA record to the central AJHA database.

These PDA devices offer a host of other capabilities that will help speed up the planning and administrative processes. For example, copies of procedures can be stored and retrieved in the field for review. A user can review his or her e-mail, record voice messages, electronically jot down notes or make sketches. Some PDA models are equipped with cell phones and digital cameras.

APPENDIX XX
PRE-JOB BRIEFING CHECKLIST (UNITED STATES OF AMERICA)

Job Title: _____ **Procedure or Tracking No.:** _____

Name/Title of Person Conducting Briefing: _____ **Date/Time:** ____ / ____

The objective of a good pre-job briefing is to communicate an understanding of scope, hazards, and mitigation to enable the safe completion of work. Follow MCP-3003 for requirements. **Additional Radiological Work Permit requirements found in box 11, page 2.**	
Initial each box upon completion of the section during the pre- job briefing. Mark N/A in the comments box if this section is not applicable to this job.	**Initials**
1. Discuss Scope of Work to be Performed and Limiting Conditions.	
Comments:	
2. Review Hazards of the Job and Mitigation of those Hazards. **(Including JSA's, Permits, LO/TO, FHL, etc.)**	
Comments:	
3. Review Work Procedures and Initial Conditions Involved.	
Comments:	
4. Discuss Stop Work, Emergency Escape Routes, Contingencies, and Recovery Options for Potential Problems and Errors.	
Comments:	
5. Discuss Roles and Responsibilities, Handoffs, Stop Work, Training, and Work Restrictions. Identify job supervisor/person in charge.	
Comments:	
6. Discuss Needed Tools and Equipment	
Comments:	
7. Discuss Safety, Radiological (see box 11), Environmental Requirements/Wastes	
Comments:	
8. Discuss Error Likely/Feedback, /Lessons Learned, and Previous Experience with Similar Tasks	
Comments:	
9. Review 4 Key Questions (**Everyone actively participates when conducting a pre-job briefing.)**	

Job Title: **Procedure or Tracking No.:**

What are the critical steps or phases of this task? **(Important parts of the task that must go right)** How can we make a mistake at this point? **(Review Error Precursors)** What is the worst thing that can go wrong? **(A review of potential consequences and contingencies)** What barriers or defenses are needed? **(Also discuss how to use the following when performing work:** **STAR, 3-way Communication, Place Keeping, Peer Check)**	**STAR** **Stop – clear mind of other thoughts** **Think – about task details and surrounding situation** **Act – deliberate and safe actions** **Review – for expected results**
Comments:	

10. Minimum Radiological Work Permit (RWP) Requirements	**Additional Notes and Comments and other Building/Equipment/Process specific pre-job checklists covered. Mark N/A in the comment box if this section is not applicable to this job.**
Scope of work **Radiological conditions of the workplace** **Procedural and RWP requirements** **Special radiological control requirements** **Radiologically limiting conditions (may void RWP)** **Radiological control hold points** **Communication & coordination with other groups** **Housekeeping and final cleanup provisions** **Emergency response provisions**	

Print Names of Workers	Training (1)	Badge No.	Craft or Job Title	Company Name (If not INEEL)	Briefing Date	Worker's Initials (2)

(1) Supervisor initials to verify employee's required training for planned work is current. Mark N/A for not applicable.
(2) Worker's initials indicate attendance at the pre-job briefing and satisfactory understanding of all items discussed.

By my signature, I indicate that I have conducted the pre-job briefing covering all items indicated above concerning the requirements specified for the work to be performed.

Person Conducting Briefing: **Date/Time:** **/**

APPENDIX XXI
MOBILE INFORMATION CENTRE AND VISITORS MAP AT VANDELLOS

enresa

Visita al desmantelamiento de Vandellòs I

APPENDIX XXII
EXAMPLE OF MOCKUPS

ROCKY FLATS — UNITED STATES

Size reduction tent showing exhaust ducting and waste receptacles.

Workers wearing breathing air system and performing size reduction using a "nibbler" in the tent.

Simple mockup of an entry barrier used to simulate restricted access and develop dressing/undressing procedures (Dounreay, United Kingdom).

Waste Processing and Handling Mockup (COVE, United Kingdom).

APPENDIX XXIII
EXAMPLE OF FEATURES INCLUDED IN A TRAINING INFORMATION MANAGEMENT SYSTEM (UNITED STATES OF AMERICA)

TRAINING RECORDS AND INFORMATION NETWORK (TRAIN)

TRAIN is a 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.

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.

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 programs.

Job information – Jobs 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.

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.

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 programs 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 company
- Based 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.

APPENDIX XXIV
EXAMPLE TRAINING INFORMATION SYSTEM AT VANDELLOS

Management of training information during the decommissioning of Vandellos I NPP was based on a simple ad-hoc application. Annex I, item XX contains pictures of the main screens of the system.

The main features of the application are:

— **Maintenance of courses details:**
  - Item (thematic internal classification)
  - Level
  - Target personnel
  - Duration
  - Contents
  - Etc.

— **Maintenance of employees / personnel data**
  - Name
  - Department
  - Job
  - Company
  - Role in emergency
  - Licence holder / Type
  - Etc.

— **Assignation of courses to employees/personnel**
  - Course code
  - Personnel code
  - Date
  - Duration
  - Results
  - Etc.

— **Queries / Reports**
  - List of courses performed by employee
  - List of employees assigned to a course
  - Courses delivered by periods, departments, item (theme).
  - Others

APPENDIX XXV
EXECUTIVE SUMMARY FOR THE MANAGERS: LESSONS LEARNED AND MANAGEMENT VISION FOR THE HUMAN RESOURCES AND TRAINING

(This appendix is elaborated from Reference [31].)

Introduction

Adequate numbers of competent personnel must be available during any phase of a nuclear facility life cycle, including the decommissioning phase. While a significant amount of attention has been focused on the technical aspects of decommissioning and many publications have been developed to address technical aspects, human resource management issues, particularly the training and qualification of decommissioning personnel, are becoming more paramount with the growing number of nuclear facilities of all types that are reaching or approaching the decommissioning phase.

Lesson learned 1 – Training is one of the keys to success

The operating organizations of nuclear facilities normally possess limited expertise in decommissioning and consequently rely on a number of specialized organizations and companies that provide the services related to the decommissioning activities. In some decommissioning projects, attention has largely focused on the technical aspects of decommissioning, with relatively little attention being given to personnel-related issues. One of the keys to success is the training of the various personnel involved in decommissioning in order to develop the necessary knowledge and skills required for specific decommissioning tasks.

Lesson learned 2 – Factors requiring consideration, which influence training requirements

Training is one of the essential tools required to achieve a successful transition from the operating phase of a nuclear facility to the decommissioning phase and to implement the decommissioning strategy. The training requirements will, however, depend, to a large extent, on a number of factors:

— decommissioning strategy selected;
— role of the plant operator in decommissioning;
— period elapsing between plant shutdown and the initiation of decommissioning;
— foreseen duration of decommissioning;
— new technologies related to specific decommissioning activities;
— necessity to re-train the personnel in relatively short periods of time in accordance with the decommissioning plan;
— existence of many one-of-a-kind unique activities;
— relatively small number of people in the training groups for specific activities;
— involvement of contractors;
— potential lack of experience in working in a radioactive environment;
— increased proportion of non-radioactive risks;
— possible changes in legislation/regulations reflecting in new requirements;
— loss of confidence in job security and future stable work opportunities compared with operational phase.

Lesson learned 3 – Prepare staff for reassignments

The transition from the operating phase to the decommissioning phase implies a very relevant change, not only with respect to the nature of the activities to be performed but also with respect to the context in which they are performed. It is common for this transition to be accompanied by a modification to the organization, in order to adapt it to the new activities and objectives. In addition to the organizational changes, there may be reassignments of personnel to new job positions, some of them not previously existing during the operating phase; and also the incorporation of external personnel belonging to subcontracted companies. The changes to the organization should be suitably planned and managed, such that the best possible organization and assignment of personnel to job positions is achieved. Operating staff – working previously for a long time in their positions during the operating phase – may experience significant difficulties in this transition. Operating organization management should implement a set of measures to communicate policies to the staff; to make an adequate selection of the best profiles for each job post, from among either the operator's personnel or those of third-party companies; to maintain positive attitudes of the personnel; and to identify the training needs of the personnel.

Lesson learned 4 – Planning for knowledge retention and training while managing the workforce

The appropriate use of operating personnel knowledge of the facility and its systems is invaluable for successful performance of decommissioning activities. It is particularly important to have insight beforehand of the expectations of the personnel, especially with regard to their interest in possible early retirement options, changing companies, or changing their job post within the company. Active involvement and communication between the company and employees in considering these options may contribute to a better working environment and a more efficient organization. As a result of early retirement due to the advanced age of the workforce and the support received from the organization, and of a delay before the initiation of decommissioning, a significant number of personnel may be replaced by personnel from other companies. This leads to the need for an ambitious policy of know-how retention and to an increased amount of training that will need to be provided.

Lesson learned 5 – Special attention to the competence of the Management Team

Special attention should be paid to the selection and competence building of the management team for this new — decommissioning — phase, in order to ensure the availability of the necessary number of qualified individuals, because of the magnitude of the changes implied by decommissioning. The following factors should be considered:

— The decommissioning project needs to be managed in the same way as an engineering project, with risks identified and objectives that are clearly identified and mapped out in terms of time, safety, cost, and quality. Good project management is the cornerstone for a successful decommissioning project.
— The activities to be managed are very dynamic and require rapid and creative decision-making.
— Processes will need to be established that allow for the efficient and rapid dissemination of information, and that facilitate coordination between the different disciplines involved (multidisciplinary work performance and control groups).
— Decision-making may require the participation, debate and consensus of a management team representing different points of view and specialities (technical, organizational and communication skills).

Lessons learned 6 – Essential relationships between resource management, attitudes, motivation, training, change management, and human performance

Once the organization undertaking the decommissioning has been defined and the decommissioning itself has been initiated, the management team needs to provide supervision of the personnel who occupy relevant job positions in the organization. This is necessary so that maximum personnel performance may be obtained regardless of whether the personnel belong to the plant operator or other companies.

It is common for the personnel belonging to the plant operator, to typically experience the following conditions which affect their general attitude to the decommissioning work:

— uncertainty of their professional future;
— lack of stimulus or motivation, because of approaching retirement, or the possible elimination or changes to job functions;
— insecurity, on changing from performance of a well known activity to a new one;
— interest in prolonging the duration of the work packages;
— underutilization of experienced personnel and their "know-how" not being made use of;
— scepticism of the ability of the organization to perform the work.

In order to mitigate the possible negative effects of such attitudes, it is advisable to plan and implement change management policies and practices aimed at motivating the personnel, among which the following are examples:

— Spread the vision of a new stage / new project as important and as much in need of qualified personnel as the previous one (personal and collective challenge).
— Whenever the circumstances allow, offer professional opportunities in the field of decommissioning (emerging activity).
— Train and qualify personnel to respond to the fresh challenges presented.
— Facilitate mobility between job positions, allowing people to find the best fit position.
— Award new responsibilities such as supervisory responsibilities for other workers.
— Promote employment or the performance of practical interventions among the direct family of the employees (children).
— Facilitate integration into multidisciplinary teams promoting the development of new skills (including contractors) where personal experience is appreciated.
— Link the departure of personnel wishing to leave the organization to the achievement of specific project objectives.
— Implement a policy of evaluation (remuneration, performance awards) based on meeting project objectives.

It is important that people having positions of responsibility in the organization have a suitable level of motivation and be capable of transmitting this to the rest of the work force. In this respect, it is necessary to provide them with specific training on motivation techniques.

The following are considered good practices in change management (that, in turn, may also require formal or informal training to be provided):

— Establishment, by the management team, of an open door policy throughout the organization, allowing personnel concerns to be discussed openly.
— Systematic dissemination to the organization of information relating to the progress of decommissioning (on-going activities, scheduled activities, difficulties, need for coordination), as an essential requirement for the achievement of adequate performance.
— Delegation of responsibility, promotion, and valuing of personal initiative.

Experience in decommissioning projects shows a great interaction between training and human performance. The number of accidents or incidents directly attributable to inadequate human performance rapidly decreases when training is strengthened.

As part of change management policies, the following training or worker practices are implemented:

— Training on Human Performance Fundamentals;
— Peer and Self Checking;
— Observation and Coaching;
— Interactive Approach to Pre-Job Briefings and Project Review.

Such training and worker practices are effective tools to combat the compromised attitudes and mindsets.

Lesson learned 7 – Operational versus decommissioning activities: changes of emphasis in the training requirements

During the operational phase of the facility the operations are generally likely to have been routine and repetitive in nature (with the exception of nuclear research facilities). Any abnormal non-routine situations encountered are likely to have occurred several times in the operating life of the facility with the facility working environment fully understood and predictable. The activities undertaken during decommissioning, following any routine programmes of de-fuelling or facility system flushing, generally comprise a formal sequence of non-routine, one-of-a-kind tasks. To ensure that these tasks are completed with respect to safety, programme, quality, and cost considerations, it is important to identify the change of emphasis in the training requirements as the transition from operations to decommissioning occurs. Project management; safety management; environmental management; material handling and radioactive waste management are the examples of areas in which the training emphasis will change.

Lesson learned 8 – The need in Knowledge Management, and training as a key tool for the transfer of knowledge

Loss or misuse of the knowledge accumulated by a company may have negative consequences on the business, such as the lack of quality, the slowdown of work, and an increase in costs. Preservation of knowledge during all phases of a nuclear facility life cycle is important for the success of the decommissioning project, especially the historical operational information. Preservation of knowledge gained during the progress of decommissioning projects is also important for undertaking future decommissioning projects.

The risk of losing knowledge, both explicit and tacit, increases with the time passed (from the time it was generated to the time it is needed). Information may be lost due to its deterioration

or outdated electronic supports (paper documents, old electronic formats, etc.). Information may also be lost due to the retirement of qualified and knowledgeable facility staff, or because of the losses or errors produced during the transmission of information from one person to another. This problem directly affects the decommissioning of a nuclear facility that may become greater the longer the time between shutdown of the facility and the beginning of decommissioning. The problem is compounded by the fact that efforts to identify the information requirements for decommissioning are not usually an organized and consolidated activity and may not be appreciated by organizations operating the nuclear facility.

Areas of knowledge to be preserved have to be identified as early as possible during the operation of the nuclear facility, so that continuous mechanisms for recording and storing of relevant information for use in the decommissioning phase can be established.

Training is an effective and key tool to transmit information stored during the operation of the facility to the decommissioning organization and its personnel. In the same way, training is also essential during the planning and performance of specific decommissioning tasks, particularly during the detailed planning of each work package, which usually relies on a sound knowledge of the configuration and the operational history of the systems to be dismantled. Training effectiveness can be greatly enhanced with the participation of personnel familiar with the operation of the facility. Nevertheless, to rely on training without the benefits of proper knowledge management can significantly reduce the ability to safely and effectively accomplish decommissioning tasks.

Lesson learned 9 – The need to consider all target groups requiring training

The personnel who require some form of training may generally be divided into two target groups:

— Stakeholders - those personnel who may influence decommissioning strategies and requirements. This group includes senior management, licensing authorities, the public, members of the press (mass media). This group may require either formal or informal training.
— Decommissioning personnel including managers, professional staff, and workers. This group of personnel requires a structured and disciplined approach to training, which will largely be of a formal nature.

Lesson learned 10 – Lack of regulations with specific decommissioning training requirements

In most countries regulations and national standards for decommissioning currently do not contain detailed decommissioning training requirements, relying instead on other regulations such as regulations for the operational phase; and statutory and local regulations for radiation protection, industrial safety, environmental protection and occupational standards to address training. There is a tendency to adapt and apply the existing standards and guidelines to decommissioning training. In some countries, national standards on competency for decommissioning workers have been developed, and are used as the basis for vocational training programmes.

Lesson learned 11 – Regardless of which technique is used — Training Needs Analysis is essential

In decommissioning, along with the routine tasks, there are many one-of-a-kind tasks which offer unique challenges in terms of the hazards likely to be encountered, and in terms of technical difficulties. Although several different techniques are used to determine the exact training needs for various target groups, the way the training programmes are structured is similar and can be represented by a pyramid. This pyramid comprises a base of general site safety and regulatory requirements applicable to most individuals such as radiation safety training, fire safety training, and access training. The next level consists of training packages tailored to suit the type of skills required by specific job positions such as confined space training, respirator training, radiation worker training, and lock and tag training. On top of this, project specific training packages for specific decommissioning activities are required.

Job task analysis and job competency analysis are often used as the basis for determining training needs. When completing a needs analysis concerning decommissioning activities, and considering the potential hazards which can exist, the overriding requirement is to complete the work in a safe manner. Regardless of which technique is used, a needs analysis to examine all factors which are known, or may potentially influence the safety of the personnel and of the facility, or may potentially have negative impact on the environment, is essential. Various methods are used to determine the risks which need to be mitigated, and hence the work methods and competence requirements for the personnel involved in both planning and implementing the work (e.g. Job Safety Analysis (JSA); Job Hazard Analysis (JHA); Risk Assessment; general approach to establishing Safe Systems Of Work (SSOW); Project Review; Hazard and Operability (HAZOP) Analysis).

A job hazard analysis is a technique that focuses on job tasks as a way to identify hazards before they occur. It focuses on the relationship between the worker, the task, the tools, and the work environment. After one identifies uncontrolled hazards, the steps to eliminate or reduce the hazards to an acceptable risk level are taken. One of the most important elements of controlling the risks and making sure that the controls identified are used properly is the provision of information, instruction, and training to those doing the work. The control or elimination of hazards through measures other than training is normally the preferred option. When this is not completely possible, training of workers must be provided. In order for the JHA process to work effectively, subject matter experts, training personnel and job incumbents must all be involved working together as a team. The benefits of an interactive approach to identify the exact training and development needs associated with decommissioning tasks cannot be overstressed.

Lesson learned 12 – Graded approach to application of SAT to decommissioning training

A systematic approach to training (SAT) – promulgated by the IAEA - is recognized world wide as the international best practice for attaining and maintaining the qualification and competence of nuclear facility personnel. The basic elements of the SAT methodology (primarily intended for full application to the operational phase of nuclear power plants) apply equally to the decommissioning phase. However, full application of traditional techniques of SAT, without reasonable limiting the scope of SAT Analysis phase to the tasks involving the potential risks and hazards associated with decommissioning activities, may result in significant expense and effort. It is worthwhile to employ a graded approach to the application of SAT to decommissioning training. The level of Analysis, and documentation

associated with the SAT phases, are tailored to the magnitude of the hazards involved. A graded approach to training encourages application of techniques that allow the most efficient use of personnel and resources in training activities. Under no circumstances should health or safety concerns be compromised in the name of cost savings or expediency. Significant hazards, both known and potential, during the decommissioning phase still pose a risk to the safety of workers, so grading of training development efforts should not be misconstrued to mean reduction in the quality of training. Rather, the level of detail and formality are tempered by factors such as hazard and risk, cost-benefit, and the use of other methods to control the hazards of a decommissioning activity or task.

Lesson learned 13 – Four main areas of management and professional staff training

The training needed for decommissioning managers and professional staff is dependent upon whether they have previous experience in decommissioning; however, training typically is required in the following four areas: Management and supervisory skills; Project Management (including Planning); Decommissioning methods; and Facility / job specific training.

Lesson learned 14 – Decommissioning workers: general training plus training for unique and hazardous tasks

To complete the safe and efficient decommissioning of a facility, a wide range of disciplines and skills' levels of the workers are required. In determining the training needs, the workers may be categorized into two groups according to their functions: the workers providing the direct effort, or fulfilling core functions (including de-fuelling, dismantling, decontamination, waste processing and handling); and the workers fulfilling support functions (including engineering, maintenance, analytical services, radiological safety services, specialists services, safety support). It is common for a worker to undertake some waste handling / processing operations as part of a dismantling or decontamination, i.e. for a worker to undertake both technical and operational activities. This hybrid fulfils a job position referred to as a decommissioning operator or decommissioning technician. Two types of training are being provided: the first type is general, vocational, or generic training; and the second type is training based on specific activities and tasks.

For the general training, it is important that training programmes are designed such that they can be used to train both workers who possess significant previous relevant experience and those who have little or no previous experience. In the case of the former, the task is effectively to confirm existing knowledge, and to identify and address any shortfalls by 'top-up' or refresher training. When forming training programmes, there is a need to consider accommodating trainees of varying abilities and also addressing the identified training needs. Safety, in terms of both personnel and the facility, being the main consideration during any part of the decommissioning processes, the requirement and standard for training in this area, is particularly relevant for workers. It is found however that the standard training material used for general industrial / construction site safety supplemented by material relating to radiological safety can form a sound basis for general decommissioning worker training. Even though a large number of training courses from the operating phase are applicable, including those for radiation safety training, it is usually necessary to place much more emphasis on radiation worker training due to the more significant radiological challenges encountered during decommissioning activities and the greater potential for exposure of personnel during specific decommissioning tasks. The radiological surveillance completed during the operational phases of the facilities would have been based largely on routine

surveys confirming steady state known conditions. In decommissioning, the requirements are to supplement this routine monitoring with task specific radiological monitoring of constantly changing conditions where the radiological hazards can be unpredictable. It is important to provide this enhanced training so that the workers and supervisors recognize this change, and will be better prepared to perform the radiological work.

Future shortage of trained skilled workforce in the nuclear industry in general, and nuclear decommissioning in particular, is predicted. This is due to demographics and the well-documented decline over recent years in the number of young persons entering the industry. This, in turn, has a bearing on the type of personnel available for training. To address this problem, it is recommended to develop an apprenticeship programme, tailored to train young persons in the skills required for nuclear decommissioning, and to provide a base for career development. Encouraging young persons to pursue a career in nuclear decommissioning by the provision of structured training courses ensures that the apprentices of today are better equipped to be the supervisors and /or managers of tomorrow.

The second type of the workers' training is based on specific activities and tasks. During decommissioning many of the activities and tasks undertaken are very unique and only performed one time. In such situations, extensive job and task analysis, or job competency analysis, and training programme course development are usually not undertaken. Instead more detailed work planning is conducted by the operating organization to identify all of the steps involved in a particular decommissioning task. A team of individuals with varying backgrounds and expertise is brought together during the table-top analysis sessions, and through a collective brainstorming effort which stimulates creativity and new ideas, to complete thorough review of the activity under consideration. The hazards involved in each step of an activity, the generic training prerequisites that must be completed by workers assigned to the activity (radiation safety training, etc.), and the task specific training required are identified. Much of the specific task training is then provided by Subject Matter Experts (SMEs) either in the classroom, by walking down the job site, conducting "dry runs" in the facility or on mock-ups, and discussing each step in the activity.

After training is provided, pre-job briefings are typically conducted immediately before conducting the task associated with the decommissioning activity. In addition, it is also a common practice in some countries to provide for informal training on lessons learned and recent issues arising from corrective action programs or from other industry events.

Lesson learned 15 – Training delivery: balanced involvement of full-time, part-time and occasional instructors, and first line supervisors

Guidance for the selection, qualification, and training of instructors for the nuclear power industry is at the mature stage. This guidance is fully applicable to the development of instructors for the decommissioning phase. In addition, the following lessons learned and experience should be mentioned:

— Previous experience in decommissioning activities is desirable for an instructor, if such personnel are available.
— The use and reliance on part-time or occasional instructors and subject matter experts as instructors is common in decommissioning activities. Such personnel are typically supported by the training organization and may receive coaching and limited instructor training depending on their capabilities.

— Most instructors are also subject matters experts and should receive general training on decommissioning.
— Instructors who have no decommissioning experience should also participate in the decommissioning training courses and seminars designed for the management and professional staff.
— Informal training methods may be particularly useful to ensure managers and workers have a clear understanding of the Project Mission, Goals and Objectives, and to allow timely feedback on important information and lessons learned. As unforeseen situations often arise during decommissioning tasks, it is very important that information is shared and communicated effectively within all levels within workgroups; such that a safe and effective way forward can be identified. Various tools exist for implementing this very important communication exercise including project preview, pre-job briefs and, toolbox talks.
— The training provided for many decommissioning tasks is performed through structured pre-job briefings, "walk downs", and on-the-job (OJT) training. Instructors typically prepare pre-job briefing materials or assist in their preparation, including materials of pre-job briefings and "walk downs" conducted by first line supervisors. It is desirable to provide first line supervisors with training on how to correctly conduct pre-job briefings. The personnel who provide OJT material are also typically trained in the proper conduct of OJT. When informal training is used, pre-planned outlines of material to be covered are normally prepared as an aid to the supervisor or other personnel who may be presenting the informal training.

Lesson learned 16 – The need in considered management of training

Training departments and instructors involved in the training for the operational phase should be effectively used to prepare and conduct training for the decommissioning activities, in conjunction with the decommissioning project line supervisors. If the operating organization has a centralized or on-site training department, a balance between centralization and decentralization of training has been found to achieve effectiveness and efficiency of training. For all major projects, work packages and departments involved in the decommissioning, regardless of who is performing the work – operating organization personnel or contractors – it is a good practice to assign training coordinators. These coordinators work in close cooperation with the training department, if the latter is available. In addition, establishing a Site Training Review Committee to provide oversight of training by review of training needs, training plans and material, and also lessons learned, and to coordinate training activities, has been found to be an effective way to help manage training. These oversight functions may be performed by a Site Safety Committee. Deficiencies in personnel performance, incidents and safety related issues should be reported and promptly analyzed. It should be ensured that the needed training is a part of the Corrective Action Programme.

Lesson learned 17 – The need for specialized training facilities and tools for decommissioning training

In order that the training needs for personnel involved in nuclear decommissioning can be adequately addressed, it must be recognized that due to the unique and 'one off' challenges which arise, there is a requirement for specialized training. Much of the training associated with the techniques and related industrial and radiological safety issues are available as standard learning courses/modules and are indeed common to the training required by NPP operators. The use of existing facilities set up to train personnel during NPP operation is simply extended to cover the decommissioning requirement. There is however a need in

facilities that are dedicated to provide training for either highly specialized tasks or for tasks which are unique to the nuclear decommissioning process. Such facilities are usually in the form of mock-ups that simulate the plant layouts. Other uses for such centres include training associated with remote handling equipment, specialist decontamination equipment, and the application of specialized coatings and chemicals.

In the training of personnel involved in nuclear decommissioning, the prime considerations are those associated with both radiological and industrial safety. This is particularly important in terms of the requirement to minimize potential exposure of workers to ionizing radiation and to minimize the spread of radioactive contamination. One of the most powerful tools to develop the working procedures and to train the personnel is the use of a mock-up. For the dismantling of highly active equipment in particular, the training of workers using full-scale mock-ups is invaluable. Mock-ups are also used extensively in training centres to simulate typical working environments found in the industry. An example of this is the simulation of standard dismantling/cutting operations in cramped areas to permit training in the use of full plastic suits and the associated breathing air arrangement. Further authenticity can be gained in such situations with the use of invisible agents to simulate contamination.
Computerized tools are also used in the training for decommissioning activities, such as:

— three-dimensional models that are generated using computer aided design (CAD) systems;
— computer-based training (CBT) systems;
— web-based training (WBT) tools;
— technology-based training (TBT) tools (multimedia, virtual reality);
— learning content management systems (LCMS) for managing the training including scheduling training, tracking training of individuals, and managing the content of training programmes and courses.

Lesson learned 18 – The need for a strategic vision for the use and competence of human resources

One of the critical prerequisites for successfully carrying-out a decommissioning project is the considered and clear management vision for the use of human resources and for the assurance of the adequate competence of all personnel (the employees and contractors) involved at all stages in the decommissioning project activities. Training alone can not ensure the required competence, change management polices and practices also need to be implemented to promote adequate performance of the personnel involved in decommissioning. Training of personnel for undertaking the decommissioning project should be viewed as the integral part of the human resource management process. In order to perform the decommissioning project in a safe and efficient manner, the decommissioning project managers should develop and communicate to the staff the vision for the integrated management of human resources including personnel training. Adequate resources should be allocated by the decommissioning project managers to ensure competence of all personnel (the employees and contractors) involved at all stages of the decommissioning project, and to preserve knowledge for future generations. It is worthwhile to define the management vision for the integrated management of human resources — including personnel training — at an early stage of a decommissioning project. Example contents of the document for defining this management vision are included below. The purpose of the document is to establish strategy of and approaches to effective management of human resources — including employees and contractor personnel — in terms of an integrated process of human resource strategic planning, recruitment, selection, training, qualification, motivation, performance evaluation,

development, and knowledge preservation; for safe and efficient conducting the decommissioning activities.

Example Contents of Conceptual Document on Ensuring Competent Personnel for an NPP Decommissioning, through an Integrated Process of Training and Management of Human Resources:

1. Introduction
   - 1.1. Background
   - 1.2. Purpose of the document
   - 1.3. Scope of the document
   - 1.4. Definitions
2. Overall scope of the NPP decommissioning activities requiring consideration of human resources
3. Senior management vision and expectations
4. Factors influencing identification of the human resources strategy
5. Key considerations of the human resources strategy
6. Integrated process for management of human resources within the decommissioning project
7. Operational versus decommissioning activities
8. Approach to ensuring and estimates of required human resources
9. Establishment of safe systems of work
10. Target groups for training
11. Key issues of quality training for decommissioning
12. Types of training and use of a systematic approach to training methodology
13. Training needs and general content of training for management and professional staff
14. Training needs and the content of training for workers
15. Assurance of contractor competence
16. Selection and training of instructors
17. Training facilities
18. Strategy for human performance improvement
19. Retention, reassignments and motivation of personnel
20. Recruitment and training of future generations of workers
21. Knowledge management
22. Structure of human resources management and training documentation
23. Phases in development of integrated management of human resources and training
24. Review, improvement and further development of human resources strategy
25. Roles and responsibilities of senior managers, line managers, project managers and personnel in implementation of the strategy
26. Communication of human resources and training strategy and policies to all site personnel and to all stakeholders.

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ANNEX I
LIST OF EXAMPLES FOR AN IAEA REPORT ON TRAINING AND HUMAN RESOURCE CONSIDERATIONS FOR THE DECOMMISSIONING PHASE OF NUCLEAR FACILITIES

Management of human resources/Maintaining human performance

(1) Examples of methods used to address human performance issues such as loss of personnel motivation and poor attitudes that are caused by the uncertainties in job security arising as a result of the transition from operations to decommissioning. These may be seminars, training, committees established to address personnel employment and transitional planning, or other methods used.

(2) Examples of methods used to retrain workers for decommissioning, and examples of programs that focus on multi-tasking or craft consolidation or cross training and how these issues are influenced by trade unions, if necessary.

(3) Examples of methods used to systematically assess work force skill needs for decommissioning and matching and placement of operating personnel to meet these needs.

(4) Examples of organizational charts for the decommissioning phase (with functions and responsibilities, if readily available)

(5) Examples of staffing profiles (number of personnel) showing how staffing levels changed from operational phase to various standby phases to decommissioning.

(6) Examples of job categories and/or job descriptions for various decommissioning job positions for technical staff and workers (operators, maintenance, technicians) that Iidentify major functions and tasks of the new job positions.

Training Requirements

(1) Examples of regulations, standards, or guides that address training requirements for decommissioning.

(2) Examples of the above that address the selection requirements (education and experience) for decommissioning managers, technical staff, and workers.

(3) Examples of methods used to review the training and qualification of contractors.

Knowledge management

(1) Examples of methods used to assure the availability of operational expertise, data, and documentation (procedures, training materials, technical manuals, etc.) for use in the decommissioning phase.

(2) Examples of methods used to retain knowledge, data, and documentation during the Decommissioning phase for future projects and lessons learned information.

(3) Examples of methods used to capture and transfer knowledge of personnel from the operational phase, and during the decommissioning.

Training objectives, training courses, and their content for managers, technical staff, and workers (operators, maintenance personnel, and technicians such as radiation protection technicians, chemistry technicians, etc.)

(1) Examples of training plans or lists of training courses and tables of contents for training courses for all three categories of personnel. These may include classroom, laboratory, and on-the job training.

(2) Examples of methods used to identify training needs for individual decommissioning activities (such as job hazard analysis)

(3) Examples of actual job and task or job competency analyses that were conducted for jobs or activities involved in decommissioning.

Selection and qualification of instructors

(1) Examples of requirements or practices for the selection and qualification of instructors.

Training facilities and training tools

(1) Examples of special training facilities, mock-ups, simulations, computer or web based training, or other special techniques used for training for decommissioning activities.

(2) Examples of training information management systems used to manage the training and track training by job category and by individuals.

ANNEX II
CONTENTS OF THE ACCOMPANYING CD-ROM
DOCUMENTS PROVIDED BY MEMBER STATES AND IAEA

CODE ELEMENTS FOR COUNTRY NAMES – Abstracted from ISO-3166 Part I (1997)

BG	Bulgaria
CA	Canada
ES	Spain
UK	United Kingdom
IT	Italy
JP	Japan
LT	Lithuania
SK	Slovakia
US	United States of America

No.	Material Origin	Title	Section
1	BG	* Training Needs Analysis — Kozloduy NPP Approach	2.3
2	BG	*Social Impact of Decommissioning Kozloduy NPP	2.3
3	CA	Canada's National Occupational Health & Safety Resources (CCOHS)" Job Hazards Analysis	7.2
4	CA	Job Safety Analysis Made Simple	7.2
5	ES	"Organizational guide" used to build up a new organization for the decommissioning of Vandellos I NPP	2.2
6	ES	MESTRAL technological centre at Vandellos: Sharing international decommissioning experience (Mestral brochure).	4.2
7	ES	Training information system at Vandellos (including screens)	10.4
8	ES, UK, IT	Leonardo Da Vinci Programme- New Professions in Decommissioning of Nuclear Power Plants— 'DECOTRAIN'	2.2
9	UK	* Training To Ensure A Safe Working Environment. ** Establishing Safe Working Environment – training and performance improvement.	5.3
10	UK	*Pre Job Briefing –Example Approach-Tool-Box	5.3
11	UK	* Examples of typical training courses- Decommissioning and environmental remediation- North Highland College)	6.1.
12	UK	* Example Training programs and Training Matrix for a typical decommissioning project	7.2.1, 10.2
13	UK	* Standards of Competence and Vocational Training programmes ** Setting Standards of Competence and the Training of the Next Generation of Workers for Decommissioning	7.2.1
14	UK	*Training The Next Generation — The development of an apprentice programme for Nuclear Decommissioning	7.2.1

No.	Material Origin	Title	Section
15	UK	Training Practices to Support Decommissioning of Nuclear facilities (P. McCurrie, British Nuclear Group) - Management of Human Resources - Training Requirements - Knowledge Management - Training Objectives- Management Training Technical and Professional Staff - Training Objectives & Content - Training Facilities & Training Tools	2.0, 4.2, 6.1, 6.2, 7.0, 7.2.1, 10.1
16	UK	Training & Human Performance Practices To Support Decommissioning of Nuclear Facilities (Mr Stuart Harrison, R. Starkey-UKAEA) - Training Requirements - Knowledge Management - Training Objectives & Courses - Qualification of Instructors - Training Facilities *Index of Examples* - Job Description & Training Programme - Decommissioning Project Organization Chart - Job Descriptions: Decommissioning Project Manager Safety Advisor Radiation Protection Advisor - License Conditions Governing Training - Procedure Relating to Management of Competence - Examples of Technical Competencies (3 posts) - Procedure Relating to Contractor Competency - Training Plans (3 posts) - Technical Competency Examples(3 posts) - Course Outline for Instructor Training	2.3, 4.0, 5.2, 5.4, 6.0, 6.1.1, 6.2.1, 7.0, 9.0, 10.1
17	JP	Development of Decommissioning Engineering Support System (DEXUS), Japan	10.2
18	US	DOE training standards for radiation protection for various types of nuclear facilities	5.2
19	US	Training Requirements in OSHA Standards and Training Guidelines, OSHA-2254	5.2
20	US	OSHA's Hazardous Waste Operations Regulatory Requirements for Training (10 CFR 1910.120)	5.3
21	US	DOE Regulation for Radiation Protection (training section of 10 CFR 835)	5.2
22	US	Radiation Safety Training Guide, DOE G-441.1-12	7
23	US	DOE HDBK-1143-2001 Radiological Control Training for Supervisors	6.2
24	US	DOE Handbook for Occupational Health and Safety during Hazardous Waste Activities, Chapter 4, Training (30 pages)	5.2
25	US	Life Cycle Training Requirements for DOE nuclear facilities	5.2
26	US	DOE-HDBK-1074-95, Alternative Systematic Approaches to Training	5.3
27	US	ANL D&D Training Course for Managers and Technical Staff	6.1, 6.2
28	US	ORISE Decommissioning and Environmental Restoration Training Courses	6.1, 6.2
29	US	DOE-STD-1166-2003. Decontamination and Decommissioning Functional Area Qualification Standard	6.2

No.	Material Origin	Title	Section
30	US	DOE-STD-1157-2002. Environmental Restoration Functional Area Qualification Standard	6.2
31	US	Hanford- Automated Job Hazard Analysis Overview ** Introduction Demonstration	7.2
32	US	Occupational Safety and Health Administration- Job Hazard Analysis, OSHA-3071	7.2
33	US	* Instructor Qualification and Training for Decommissioning — Rocky Flats	9
34	US	*Instructor Qualification and Training for Decommissioning — INL	9
35	US	Oak Ridge Institute for Science and Education, Decommissioning and Environmental Restoration Training Courses; and, The Decontamination and Decommissioning Science Consortium material	6
36	US	*Hammer Facility Description	10.1
37	US	* Projects , Interaction and Cooperation-Rocky Flats	2.2
38	US	* Training Organization Evolution during Decommissioning- Rocky Flats	2.2
39	US	*Human performance in the D&D Environment- INL	2.4
40	US	*Maintaining Human Performance- Rocky Flats	2.4
41	US	*Project Preview-An INL Approach To Risk Mitigation-INL	2.4
42	US	*Integrating The Results of Hazard Analysis into the Work Management Process-INL	5.3
43	US	Waste Management Qualification Standard; On-the Job Training guide	6.2
44	US	*Project Preview Process Facilitation Guide- INEEL Training Directorate	5.3
45	US	*Risk Mitigation/Design Plan- INL	5.3
46	US	*Layout of Decommissioning Training Facility	10.1
47	US	*The Rocky Flats Mock Up Facility- Rocky Flats	10.2
48	US	DOE Handbook, DOE-HDBK-1131-98, General Employee Radiological Training	7
49	US	Qualification Standard D&D First Line Manager, Basic Qualification-Rocky Flats	6
50	US	Qualification Standard- D&D First Line Manager, Tear Off Sheets (JPM)-Rocky Flats	6
51	US	Qualification Standard D&D Worker Basic Qualification-Rocky Flats	7
52	US	Qualification Standard- D&D Worker Task Tear Off Sheets (JPM)-Rocky Flats	7
53	US	Lesson Plan- D&D Scenario Guide-Work package Walkdown	7
54	US	Connecticut Yankee Decommissioning Project Organization Chart	
55	US	Connecticut Yankee On the Job training Guide and Job Performance Measure on Operation of the APEX Genie Gamma Spectroscopy System	7
56	US	Connecticut Yankee Training Matrix for the ISC FSS Group, Site Closure	7
57	IAEA	Examples of prospecti and syllabi for the IAEA training courses, seminars and workshops on decommissioning	6
58	IAEA	Examples of IAEA workshop programmes on training, human resource management and human performance improvement for decommissioning projects	6

No.	Material Origin	Title	Section
59	UK	Summary of experience with the preparation of the first socio economic plan at the Dounreay Site in the United Kingdom	3
60	LT	* Training of Ignalina NPP staff by the external contractor	6
61	IAEA	** IAEA presentation (B. Batandjieva) 'Safety Requirements for Decommissioning of Nuclear Facilities'	3, 5.2
62	LT	** Ignalina NPP decommissioning project and approach to personnel training	2, 3, 5.3
63	UK	** Operation vs. Decommissioning: change to the focus of training (the Dounreay site experience)	3
64	US	** Strategic planning for decommissioning and human resources (Connecticut Yankee Atomic Power Company)	2
65	IAEA	** IAEA presentation (B. Batandjieva) 'Analyzing Hazards and Risks and Defining Objectives and Scope of Decommissioning Training'	5.3
66	US	** Project Management, Corrective Action and Human Performance Enhancement (Connecticut Yankee Atomic Power Company)	2.3, 2.4
67	UK	** Project Management skills (the Dounreay site experience)	6
68	US	** Training transition from Operation to Decommissioning (Connecticut Yankee Atomic Power Company)	3, 6
69	US	** Staff training selection using the AJHA	5.3, 7.2.2
70	IAEA	** IAEA presentation (A. Kazennov) 'Decommissioning: changes to personnel training'	3
71	IAEA	A series of IAEA presentations on Decommissioning (M. Laraia): - Organization and management issues - Transition from operation to decommissioning - Management of decommissioning projects - Recordkeeping for decommissioning	2, 3, 4
72	US	** Human Resources Management for Decommissioning – Lessons Learned (Connecticut Yankee Atomic Power Company)	2
73	UK	** Human Resources Management for Decommissioning – Lessons Learned (the Dounreay site experience)	2
74	US	** Contractors — Ensuring Competence and Safety	5
75	UK	** Contractors — Ensuring Competence and Safety	5
76	US	** Lessons Learned From Use Of Major Contractors	2, 3
77	US	** Training for decommissioning: approach, focus, analysis of hazards, design of training, training facilities and use of mock-ups (Hanford Site)	5.3, 7, 10
78	UK	** Training Facilities and Mock ups to support nuclear decommissioning	10
79	SK	** Training modules for the personnel training at the Regional Decommissioning Training Centre	5, 6, 7
80	SK	** Advanced tools for support of decommissioning and training, including 3D laser scanning and modelling (methods and practical experiences)	10
81	SK	** Dismantling and demolition decommissioning tasks	3
82	SK	** Pilot training course on decommissioning technology	5.4, 6

No.	Material Origin	Title	Section
83	BG, SK	** Examples of training material for the pilot training course on decommissioning for Kozloduy NPP	6, 7
84	US	Hanford Human Performance Improvement Lessons Learned	2.4, 6

* Denotes item is extracted from material presented during the IAEA workshop 'Training for Decommissioning Activities' at the Ignalina NPP, Visaginas, Lithuania, 23–27 May 2005.

** Denotes item is extracted from material presented during the IAEA workshop 'Training and Human Resource Management for Decommissioning' at the Chernobyl NPP, Ukraine, 17-21 July 2006.

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