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CURRENT STATUS IN E&T IN RADIOLOGICAL PROTECTION

RADIATION AND WASTE SAFETY TRAINING: TOWARD SUSTAINABILITY AND SELF-RELIANCE – A MALAYSIAN EXPERIENCE

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ABSTRACT

The growing trend and increasing use of ionizing radiation in various economic activities demand effective radiation safety practices and regulatory control. In this respect, Education and Training (E&T) plays a vital role and as a tool in capacity building and molding personnel with suitable technical competency and good safety habits towards achieving continuous safety and quality improvement in organization.

Various types of training were developed, designed and introduced into the market by Malaysian Nuclear Agency (Nuclear Malaysia) to meet different needs of customers taking into consideration product susceptibility and customer behavior in order to gain endorsement and market acceptance hence ensures product sustainability. In this context, training modalities have been carefully planned starting from product design and marketing to the adoption of synergetic approach in teaching and learning activities to provoke interest and acceptance. Attractive training packages that are customer-centric, relevant products and market-driven training modules have been successfully introduced to address the market needs resulting in sustainable training programmes. Together with incentives offered, it serves as a catalyst to stimulate participants' interest in term of benefits derived: financial, professional and personal gains.

This paper examined critically the experience of Nuclear Malaysia in executing radiation and waste safety training for the improvement of safety performance and quality in an organization contributing to product sustainability and self-reliance. The training programme had been implemented in accordance with the needs of organizations apart from fulfilling regulatory requirements as well as towards achieving the National visions for knowledge generation, wealth creation and societal well-being.

1. Introduction

The success of an entity is normally linked to the capability of its workforce in executing the assigned job functions. They are movers and catalysts contributing to the effectiveness and efficiency that spur organizational growth and achieve set targets and objectives. The introduction of Atomic Energy Licensing Act in 1984 marked the new dawn of national nuclear technology development in Malaysia. The Act governs all activities related to radiation technology so that they are carried out in accordance with standard and stipulated procedures. Malaysian industries recognized the importance and usefulness of nuclear technology for development and upgrading quality but take cognizance that nuclear technology has its downsides and controversial if not handle properly. In view of this, the government had initiated measures and implement strategies towards regulating the use of the technology to ensure safety and security; and activities using nuclear materials follow the national and international standard practices.

The functions of promotion and technology development are under the purview of Malaysian Nuclear Agency (Nuclear Malaysia), while the aspects of monitoring and regulation are under auspices of Malaysian Atomic Energy Licensing Board (AELB). Even though both organizations are under the same Ministry, the separation of power is critical to avoid conflict of interest and assuring activities are carried out with high integrity and in ethical manner.

2. The Landscape of Radiation Training in Malaysia

The dire need for effective and encompassing radiation training in Malaysia arises due to the widespread utilization of radiation technology in various economic sectors. There are intense demands for radiation training as a result of high safety awareness among the users as well as strict monitoring and inspection by the authority especially the AELB.

Nuclear Malaysia is the first and premier agency in the country that organized training for industries and other stake-holders. The main challenges facing the agency include **firstly**, to enhance the capacity of human capital to reach a performance level where nuclear technology activities can be operated in an efficient, effective and ethical manners; and **secondly**, to achieve income target of 30% of the operational budget with ultimate goal towards self reliance. The Training Centre is one of the major contributors in Nuclear Malaysia to meet this target.

As such, it is necessary to urgently address those needs to improve performance and to position training activities for better growth and profit. Recently there are numbers of players making entry into the market offering training in radiation and waste safety. Majority of these players were the products and spin-offs from the Nuclear Malaysia's training activities.

3. Sustainability – It's About Demand

The quest for the marketable products and quality training at an affordable cost to attract customers requires well-thought strategies and thorough planning. We are well aware that customers normally select training program that meet their specifications, offers convenience and provides solution to their problems. Hence, sustainable training products were developed and designed taking account customers' perspective without neglecting 4Ps' marketing mix. Garnering customers' attention in a volatile marketplace and make them commit to attend training programme is an uphill battle especially in the period of economic downturn.

Nuclear Malaysia approaches/strategies to capture customers' attention and penetrate new market include the followings: Firstly, Promoting the culture of creativity and products innovation to complement the traditional approach of business; Secondly, Organizational philosophy of 'Customers are the King' and 'Customers run your businesses'; Thirdly, the understanding of customer behaviors; and Fourthly, adaptation of the Maslow's theory of the Hierarchy of Needs. Customer-centric training was designed to maintain competitiveness and acquire customers' endorsement, recognition and acceptance (Fig. 1).

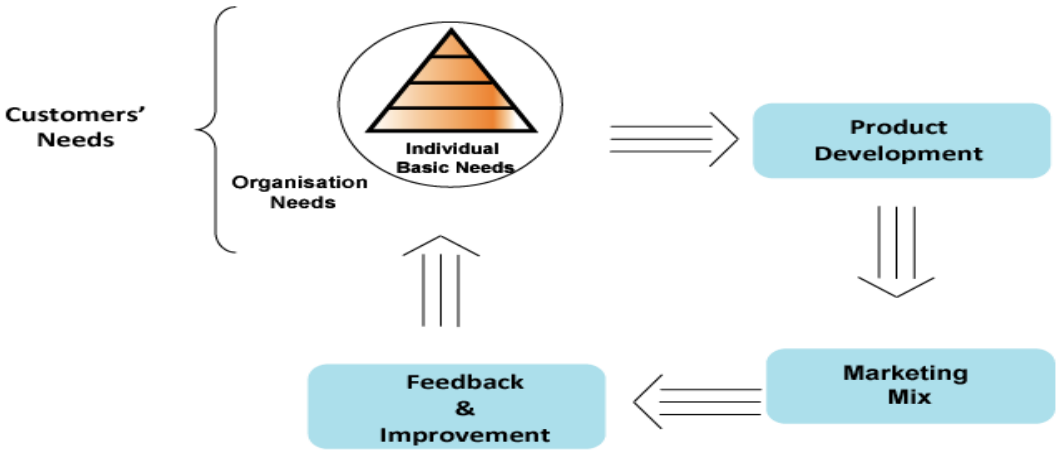

Fig. 1 Customer-Centric Training Cycle to Ensure Sustainability

To ensure the success of training programmes/products, Nuclear Malaysia performed periodic market survey to gauge customers' satisfaction improvement of infrastructure such

as classrooms and laboratories that are necessary to fulfill customers' requirement and satisfaction.

Our experience shows, the 'pull and push' factor has been the decisive factor determining the success of training products developed (Fig. 2). Customer concerned or individual benefits such as 'What is it at me (WIIAM)' and 'What is it for me (WIIFM)' are also taken into consideration.

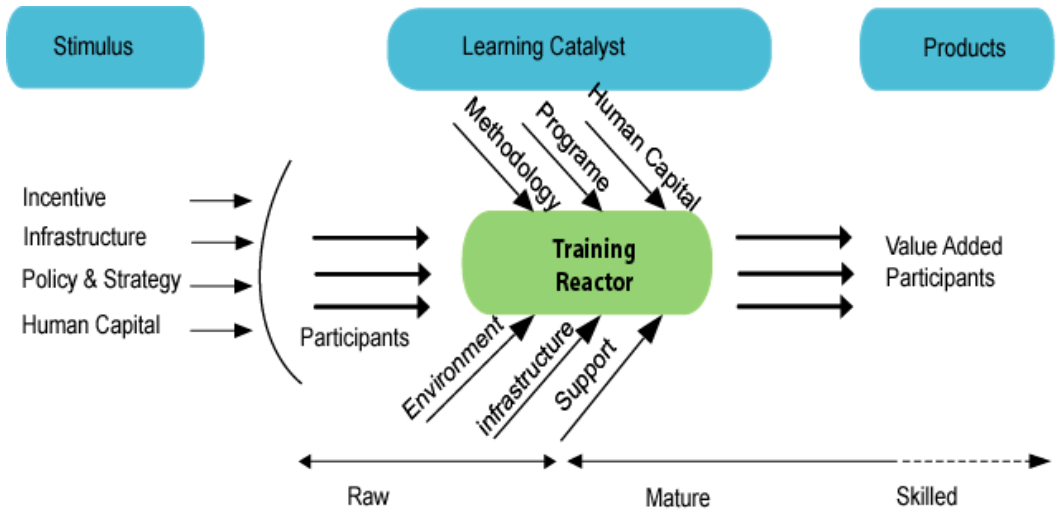

Fig. 2 The 'Pull and Push' Factors for Attractive Products and Sustainability

4. Approach using Stimulus Package

Malaysian government is very committed in human capital development. The stimulus package introduced recently by the government to assist economic recovery and minimize the impact of economic downturn had also included element of training. Nuclear Malaysia had benefitted from this package via provision of training through a programme called 'Training & Placement'. They are trainings for X-ray operators, non-destructive testing (NDT) personnel and Radiation Protection Officer. Under this package personnel undergoing the courses are fully paid by the Government and received allowances. Qualified and certified persons after attending the course shall easily be absorbed into the market. Companies/individuals participating in the training programme also gained some benefits in the form of tax rebates, financial rewards and professional enhancement.

In a volatile and competitive marketplace, every player had to embark with strategic approach to win customers' confidence and product endorsement. Wider customer acceptance of our training products are among others due to the vigorous and focused marketing initiatives and attractive products; right pricing strategies; listening to and satisfying the customers; and adoption of logos, pathos and ethos concept into business model.

Some of our products – Training for 'Radiation Protection for Officer', 'Industrial Radiography' and 'Medical X-ray Operator' – have gained the status of *'Iconic Products'* and generates considerable amount of revenues.

In order to become a market leader in the business of training, the support of strong leadership is a pre-requisite. Strong leadership provides direction and makes available resources for the Training Centre to run efficiently and effectively.

The Training Centre has recently been diversified into 'soft-skill' training programmes not really related to our core business of radiation, but corresponds to the job functions. They are management courses (Human Resource Development, Communication, Quality and Productivity, Research management, Research Methodology etc.) for personnel involved in

scientific fields. Such activities enable us to venture and capture new markets thus widen our earning base.

5. Reaching the Customers

Nuclear Malaysia's training products had been successful in capturing its target customers especially personnel at supervisory level of industrial sectors: manufacturing, oil and gas etc; and medicals. However, market segment for the masses involved at operational level are largely untapped. These segments comprise front-line workers which made up of personnel from the Military, Custom and Excise, Fire and Rescue etc, could become the future potential source of revenues.

Nuclear Malaysia in the quest to maintain status quo; and penetrate and break ground into the largely untapped and potentially lucrative market employs the following strategies:

5.1 Cross Border Training

Apart from regular training at our premise, the programmes have also been conducted in selected growth areas that have been proven productive. Through this marketing approach, the cost has been substantially reduced besides having the advantages of tailored-made programme. The mechanism employed included Regional based training, In-company training and smart partnership. Nuclear Malaysia is also taking strides to internationalize its activities especially the Middle East and ASEAN Countries. This exercise had already been fruitful as shown by demand in Kuwait and Brunei Darussalam.

5.2 Consortia

This innovative marketing model is a derivative version of in-company training programme designed for a small group of companies that provide the benefit of customized programme based on cost sharing principles. This opportunity is well suited for the Small and Medium Industries (SMI) that lack the financial resources to organize the course on individual basis.

5.3 Dual Location Approach

Realizing customers' limited resources, shortage of capable trainers and lack of facilities, the 'tailor-made' training is conducted at two different locations capitalizing on the strength of respective organizations and training modality. Practical part of training for instance is conducted at Nuclear Malaysia while the theoretical section is in the customers' premise. Customers comprise mostly the SMI/ small companies offering them the benefit of cost reduction and larger number of staff could be trained on-site compared if it is conducted elsewhere.

5.4 Incentives

Customers are always seeking for some kind of investment return in a short term, i.e., in the form of incentives – financial, professional and personal gain, from the Government or private finance initiatives. The authorities in Malaysia had given due recognition for training programmes that we conducted. The gains that customers received includes training rebates, double tax deduction, certificates of professional achievement and qualified practice, and personal gain.

5.4 Quality Management System (QMS)

Quality Management System is a useful marketing tool to instill customers' confidence in products and delivery system. It also provides assurance for efficient, effective and ethical service. The centre has been awarded the latest version of QMS ISO9001:2008, indicating our commitment for quality which promises continuous improvement in teaching-learning, training materials and facilities, and trainers.

5.5 Tuition on Demand

In line with global trend and extensive use of information and communication technology, on-line training programme was designed with the concept almost similar to 'pay as you learn' 'Anywhere, Anytime', in which customers learn at their own pace, sit for the examination, and get certified from their premises.

6. Challenges and Moving Forward

Like any other business, there is a need for performance appraisal at every stage of the planning process for training programme with the aim of improving quality and bottom-line. Commitment to the endeavor of education and training (E&T) is a primary driver toward increased level of performance and productivity. In the planning of training model, there is an urgent need for us to balance between maintaining financial stability while focusing on strategic objectives (e.g. imparting knowledge to participants) that would preserve our market leadership in radiation E&T.

Any decision to introduce new products should also be based on market needs and pragmatic approaches, rather than intangible criteria and dogma such as feeling, sentiment and emotion. More notable *'Iconic Products'* should be created to generate and sustain customer interest and recognition. Clearly, we are facing the challenge of incorporating sustainability objectives into business approaches and operating models, i.e., to understand how to establish a meaningful, well-developed strategy and business model that have significant impact on customers.

7. Conclusion

Sustainability of training products depends on the market acceptance, endorsement and recognition by stakeholders. Nuclear Malaysia devised some strategies to face the current turbulent environment and competitive marketplace to make the training programme sustainable and self-reliance. The approaches include attractive products packaging; pragmatic marketing strategies; attractive incentives for customers; and effective and efficient delivery system.

In future, Nuclear Malaysia will be introducing 'Customer Royalty Programme' and 'Franchising' to stave off competition and create 'Win-Win' situation with our customers. In order to realize the vision of making Nuclear Malaysia's Training Centre as regional and global player, we need to work on consolidating the leadership position; aggressive marketing; continuous improvement as stipulated in our QMS management system; and nurturing the culture of discipline, dedication and determination workforce.

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RADIATION PROTECTION TRAINING PROGRAM AT THE EU JOINT RESEARCH CENTRE IN ISPRA, ITALY

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ABSTRACT

Training in Radiation Protection in the Joint Research Centre (JRC) of the European Commission, in Ispra, is addressed to Exposed Workers, Radiation Protection Technicians, Emergency Squads and Non-Exposed Workers.
After a major reorganisation of the Radiation Protection Sector, training methods and schemes have also been reorganized, developing new generic and specific training actions for internal and external Workers, aimed at harmonizing different background education and different Radiation Protection practices among Workers of different nationalities.
For the year 2009, the training programmed at JRC-ISPRA has involved almost 400 workers, and has covered most of the needs of the Centre.
Basic Radiation Protection classroom training, specific Controlled Area on-the-job trainings, emergency management and preparedness, radioactive transports, alpha risks and glove-box handling procedures are some of the training actions successfully organised by the Radiation Protection Sector in 2009.

1. Introduction

1.1 Nuclear activities in JRC-ISPRA

The European Commission's Joint Research Centre (JRC) is a Directorate-General of the European Commission, providing independent scientific and technological support for EU policy-making.
JRC-ISPRA has been founded in 1958, after the Treaty of Rome, in order to foster research on nuclear applications and technologies: its mission and roles evolved, throughout the years, and the nuclear research is now only a limited part of its activities.
The Ispra Site, the third biggest Commission site after Brussels and Luxembourg, covers an area of 167 hectares, and has 36 km of roads and 6 km perimeter fencing. There are about 250 buildings hosting some 1.800 staff plus, typically, 500 staff of external companies and up to 200 daily visitors.
The Site also hosts some nuclear facilities awaiting decommissioning (two research reactors, hot cells, radioactive liquids treatment station, etc.), some facilities in the decommissioning process (radiochemistry laboratory, etc.), some waste management facilities in operation (solid waste station, new radioactive liquids treatment station, characterisation facilities, decontamination facility, etc.), and some research facility in operation (Cyclotron Laboratory, Performance Laboratory (PERLA), PUNITA Laboratory, SETRAC, etc.).
Nuclear activities in JRC-ISPRA, although heavily reduced after 1987, when a referendum stopped all power plants (and all major nuclear activities) in Italy, have been expanded since 1999, with the adoption of the "*Nuclear Decommissioning and Waste Management Programme*", a process which will span over a few decades.
JRC-ISPRA is committed to progressively reduce its nuclear liabilities, releasing from regulatory control all classified areas which were subject to nuclear activities in the past, and

eventually assigning them to conventional research activities, without any radiological constraint.

1.2 Radiation Protection in JRC-ISPRA

JRC-ISPRA accounts for 21 nuclear licences, 14 Controlled Zones and 12 main Surveilled Zones. The number of Exposed Workers operating in JRC-ISPRA is around 180 internal staff and around 180-200 external staff (depending on specific projects), employed by 25-30 external Companies. A minor number of Non-Exposed Workers (30 in 2006, 34 in 2007, 77 in 2008) operate in Controlled Areas, being specifically authorized for limited-time working activities presenting no radiological risk.

Internal JRC Personnel operates under JRC Qualified Expert (QE) control: the QE is also responsible, among many other duties according to Italian Law [1], for Exposed Workers' classification, their monitoring (either for external and internal doses), and the effectiveness of the global radiological protection programme in force under his/her competence.
Outside Workers (according to [2] and [1]), are classified and operate under the surveillance of their Company's QE, who usually collaborates with JRC-ISPRA's QE in order to implement the most suitable Radiation Protection programme in the JRC.

Radiation Protection (RP) assistance is a task assigned, for all JRC-ISPRA nuclear activities, to the **Nuclear Decommissioning Unit**'s "***Radiation Protection Sector***", to which the JRC's QE belongs: some 15 RP internal Technicians manage JRC-ISPRA's 26 classified areas, and coordinate RP assistance given by some other 25 external RP Technicians, who operate under a JRC-ISPRA Framework Contract for RP Assistance.
The Sector is also responsible for the operation of four internal Laboratories: the External Dosimetry Laboratory, the Whole Body Count Laboratory, the Nuclear Instruments' Calibration (accredited) Laboratory, the Electronics Laboratory.

Operational Radiation Protection activities in JRC-ISPRA are mainly structured over three pillars:

1. Support to safe custody of those facilities awaiting the decommissioning process
2. Support and assistance in the management of radioactive waste
3. Support to operating facilities

2. Training for JRC-ISPRA specific needs

2.1 Training Internal Exposed Workers

JRC-ISPRA, as License-Holder, is responsible, according to Italian applicable nuclear legislation [1], for education and training (about radiological risks) of its Internal Workers [6].

JRC-ISPRA has been a relevant Training Centre on Radiation and Radiation Protection, in the past ("*Ispra Courses*"), and delivered high-level training to Professionals and Scientists.

Today, current RP training has been tailored to JRC-ISPRA's needs, that is to face future huge decommissioning works, in the context of a Country in which all major industrial nuclear activities are suspended since 22 years. Indeed, while Italy has developed since long time a clear legal framework for the profession of Qualified Expert, there is no such framework for RP Technicians (in the industrial domain), nor any officially recognized training scheme. This implies that License Holders should develop their internal RP training programmes, in order to compensate for the absence of an official national training (or education) certification.

Basic RP training is therefore administered to JRC Exposed Workers, followed by specific courses on radiological risks on JRC-ISPRA's facilities, and advanced training on dosimetry, transports, HASS, and other more advanced topics.

Wherever necessary, in order to tackle highly specific risks for which JRC-ISPRA does not possess anymore adequate competences (as alpha works in glove-boxes, during the year 2009), selected JRC Personnel is asked to follow external training sessions, and subsequent internal informative training sessions are then organized in the Centre.

2.2 Training External Exposed Workers

JRC-ISPRA is also responsible, according to Italian Law [1], for specific information and training of External Workers (operating in the Centre) about radiological risks in its facilities.

Specific training on radiological risks on JRC-ISPRA's facilities is therefore administered to External Exposed Workers: this means showing detailed radiological status (doses, contaminations, peculiarities) of each one of JRC-ISPRA's facilities, and implies the existence of un updated system of recording of dose and contamination maps throughout the JRC-ISPRA.

2.3 Training Exposed Workers for harmonization

A significant turnover among Staff is experienced in JRC-ISPRA in these last years: while this surely represents an opportunity, opening exciting possibilities of knowledge exchange between Workers -and therefore of improvement-, it also corresponds to an issue, regarding proper training on correct behaviour in Controlled Areas and JRC shared and approved work practices.

The issue is two-fold: continuous Personnel's turnover implies devoting Personnel for continuous training and, on the other hand, harmonization within, e.g., RP assistance practices -during experimental work, during RP assistance, or during decommissioning and waste management operations- is essential.

Individuals normally tend to operate according to their previous work experience and practice, usually gained in other countries, with different regulations and rules, which may significantly differ from the ones in force in Italy[1]. Harmonization is therefore needed, especially among RP Technicians, who check and supervise all radiological risks.

Specific training sessions are therefore devoted to the diffusion of good practices (in the use of radiation sources, for example, or in workplace monitoring, or in laboratory set-up and management, etc.) among Workers.

2.4 Training Non-Exposed Workers

Many JRC-ISPRA internal and external workers (around 1800 people) are classified as NON-Exposed Workers, and are actually not exposed to any radiological risk during their work activities in the JRC (Scientific, Technical and Administrative Personnel operating outside classified areas).

However, since a few years, an urgent need for more comprehensive information to Non-Exposed Workers clearly emerged: specific divulgation sessions, aimed at helping Workers to better understand the risks to which they are exposed (or not exposed) to, at their workplace, have been successfully organized.

[1] A significant example, in this regard, is the use of specific radiation hazard zone signals. While in many Countries (France, Spain, etc.), the use of coloured trefoils is standardised, as an additional indication of dose and contamination levels –and forms, therefore, part of the radiological culture of Exposed Workers-, those symbols are not allowed in the Italian regulation, resulting in many non-Italian Workers being at first confused and asking either for clarification or for their introduction in JRC-ISPRA!

2.5 Training new Radiation Protection Technicians

Newcomers usually need to be trained on Radiation Protection: some RP assistance services require deep knowledge of JRC-ISPRA's facilities and interfaces, therefore on-the-job training has been successfully applied.
Individual training passports are prepared, specifically tailored to the candidates' previous experience and skills, in order to familiarize them with places, practices, risks.

Tutoring by a more experienced Colleague is the standard practice in training new RP Technicians in JRC-ISPRA.

2.6 Training Radiation Protection Technicians on radiation software

A few radiation software packages are currently being used in the Radiation Protection Sector for RP purposes: these include a JRC-ISPRA-customised specific version of SAFE AIR® [4] (for contamination release and dose to the public evaluations, in accidental conditions); MICROSHIELD®, for many different dose rate calculations; IMBA PROFESSIONAL PLUS®, for internal dosimetry evaluations.

Specific training on the use of these codes, addressed to selected RP Technicians, is necessary and regularly performed.

2.7 Training Radiation Protection Technicians on technical procedures

RP Technicians, and mostly those belonging to the External Companies offering their services to JRC-ISPRA, need to be continuously trained on specific work instructions in force in JRC-ISPRA.

Specific training sessions for RP Technicians, either classroom-based and on-the-job, are organized, with the scope of reviewing basic procedures most encountered in practice (smear test sampling, dose and contamination mapping, incident reports, clearance of material, entry/exit from controlled zones, assignment of EPDs, etc.).

2.8 Training Radiation Protection Technicians on radiation instruments

Many contamination meters and dose rate meters (with a plethora of external probes) are being used in JRC-ISPRA by RP Technicians[2].
This variety of instruments represents a major issue, either in terms of training to the newcomers, and of continuous training to permanent RP Technicians. Moreover, training RP Technicians, due to their daily assistance tasks to other Workers, is difficult to organize and to perform.

A specific training session on the use of one (or more) instrument(s) is repeated every week for one month, in order to facilitate the participation of the majority of RP Technicians (the subject changes every month): closure sessions at the end of the year (*rattrapage*) are also programmed.

2.9 Training Emergency Squads

Emergency Squads are available 24/7 in JRC-ISPRA: they are composed of permanent JRC Fire Brigade Staff and a variable number of voluntary JRC Staff, working on a shift basis every day. The Emergency Squads are required by Law, due to JRC-ISPRA Nuclear

[2] Personal dose-meters, electronic personal dosimeters, air samplers, smear test measuring equipment, neutron monitors, neutron dose-meters, direct air contamination monitors, tritium monitors, bubblers, portable gamma spectrometry devices, laboratory NaI and HPGe detectors, and some hundreds of ambient monitors are available and are currently used in daily RP assistance

Licenses, and intervene in Controlled Areas in case of incidents of any nature. Moreover, they are also assigned the duty of radiation monitoring and sampling around the Site during a nuclear emergency.
Emergency, due to the nature of the Site, which is dispersed over a vast territory and over a big number of buildings, is locally managed by specifically trained JRC Staff (Building Delegates), who act as a link between the Emergency Director and the Staff during an emergency, and locally coordinate actions on Staff gathered at assembly points, including evacuation to a safe place, if necessary.

Continuous training to Emergency Squads, Building Delegates and Emergency Directors is also provided, on a quarterly basis.

3. Training effectiveness evaluation and feedback

The evaluation of the effectiveness of a training action is part of its execution: a database of questions and answers has been collectively developed within the Sector, and is used to generate set of questions (different for each session and for each course) to be submitted to the candidates. Evaluation is usually directly communicated to candidates and significant questions/answers are publicly discussed.

Feedback from the Candidates is requested and appreciated, and is treated *via* the existing system at the European Commission (SYSLOG TRAINING evaluation).
Very interesting suggestions have come from candidates in the years, especially concerning on-the-job training and the balance between theory and practice during the courses.
In 2009, a mock-up glove-box, equipped with ventilation and filtration, to be used in training Personnel for work activities with alpha risks, has been put in operation, and candidates have been successfully trained in operations (glove changes, insertion/extraction of material, emergencies, etc.) of this kind.

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RADIATION PROTECTION TRAINING IN LOVIISA NPP, LEGISLATIVE GUIDANCE AND DEVELOPMENT OF TRAINING PROCESS

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ABSTRACT

Radiation protection training has been the framework for site induction training throughout the history of Loviisa NPP. Legislation and regulations have set requirements for the content of radiation protection training but also the development in safety culture and aspiration to improve the prerequisites for good working conditions have motivated ameliorating the training process. This paper will give an overview to the regulatory requirements for radiation protection training in Finland and on the other hand, a survey to the development of the training process in Loviisa NPP. By 2009, the process has shaped into a sound form but some tools that would improve the training results are still to be studied and applied into action. Future changes in human resources due to change of generation and possible new plant installation projects will keep the training process in progress. Implementation of radiation protection and -safety training into covering the project management and contractor chains in designing will be a challenge.

1. Introduction

From the beginning of the production of nuclear energy in Finland, the nuclear safety guides (YVL guides) of Radiation and Nuclear Safety Authority (STUK) have directed the development of radiation protection training given by nuclear energy operators. YVL guides set requirements for training when the first Finnish nuclear power station unit was pressed into service. As times have progressed, requirements for training have changed and affected to the areas of focus in the ensemble of contractor and staff training at Loviisa NPP.

In addition to regulatory requirements, the ambition to develop the safety culture has directed the plant to pay increasingly attention to training. On the other hand, the whole industry is facing change of generation when experienced experts are retiring and young employees beginning their working careers. These factors have challenged Loviisa NPP to strengthen its training processes

In this paper, the most important milestones of YVL guides and other national regulation that have affected to training will be viewed. Furthermore, the starting point and development of training through the history of Loviisa NPP will be briefly presented. Moreover, present training process of contractor or staff member arriving into the plant will be described. Finally, the future challenges and possibilities will be discussed

2. Regulatory requirements for radiation protection training in Finland

The Industrial Safety Act [1, 2] has from the mid-1950's given general requirements for employers to give sufficient training in regard to working environment circumstances, right working procedures and possible health risks related to work. It treats training in a general level, not paying attention to a certain industry or work.

The nuclear safety guides (YVL guides), instead, have guided the development of radiation protection training throughout the history of the plant operation. In 1981, guide YVL 7.9, *Radiation Protection of workers at nuclear facilities* [3] gave requirements for the radiation

protection training about the topics that were expected to educate to the workers. The content was expected to include at least the applicable parts of radiation legislation and regulations, fundamentals of radiation and radiation risk.
The first revision of YVL 7.9 [4] required from the beginning of 1993 emphasized the significance of an examination in which the workers were required to show their understanding of the radiation protection aspects. On the other hand, offering a deeper level of radiation protection training to workers whose work affects particularly to the radiation protection objectives was highlighted.
The approach in the second revision of YVL 7.9 [5], published 2002, is enlarged to make radiation protection training to provide workers with preconditions to act consistently if unpredictable situations occur at the workplace. It encourages in using mock-up facilities in training for personnel who work in demanding workplaces as regards radiation or contamination circumstances. Also highlighting worker's own responsibility in taking care of him/her own and other person's radiation safety is emphasized. Approving site induction trainings given in other Finnish and Swedish nuclear power plants was made possible.
Requirements for training and qualification of plant staff is described in YVL 1.7 [6]. It defines general demands for site induction training, for basic, further and recapitulative education for plant staff and administrative

3. Training process in Loviisa NPP

3.1 History of radiation protection training

Radiation protection training was begun in late 1970's when the first unit of Loviisa NPP was pressed into service. Radiation protection training was the framework of site induction training; other fields of education were deepened later. Material consisted of hand-written and -drawn overhead projector slides and it was trained by radiation protection personnel.
In 1980's, the training methods were similar to the ones in the previous decade but an examination where learning was shown after the lecture was introduced. Visualization was based upon transparencies and film slides.
1990's were the decade of relatively strong development in site induction training. In addition to radiation protection matters, more attention was paid to industrial safety and general procedures on site. The first VHS training film was introduced. Each training session was divided into radiation protection and industrial safety section. The first of these was held by radiation protection personnel and the latter by training organization which by then had concentrated on training operators.
In mid-1990's co-operation between two Finnish nuclear power companies began in site induction training. First radiation protection training video was a product of co-operation between the two power companies. Site induction training material and content was formed into consistent form at both sites.
In the beginning of the new millennium, the co-operation was enlarged to cover all nuclear power companies in Finland and Sweden. Training methods and exams were standardized as far as practicable and site induction training performed in any Finnish or Swedish nuclear power plant was approved at other sites. In Finland, co-operation in producing training videos and DVDs was continued. Means offered by digital technology has applied in visualizing e.g. radiation and contamination in training DVDs.
Within the three decades of producing nuclear energy in Finland, training processes have been modified due to changing regulations, working culture, and developing technical means. The most important milestones in regulations and in radiation protection training are presented in Figure 1.

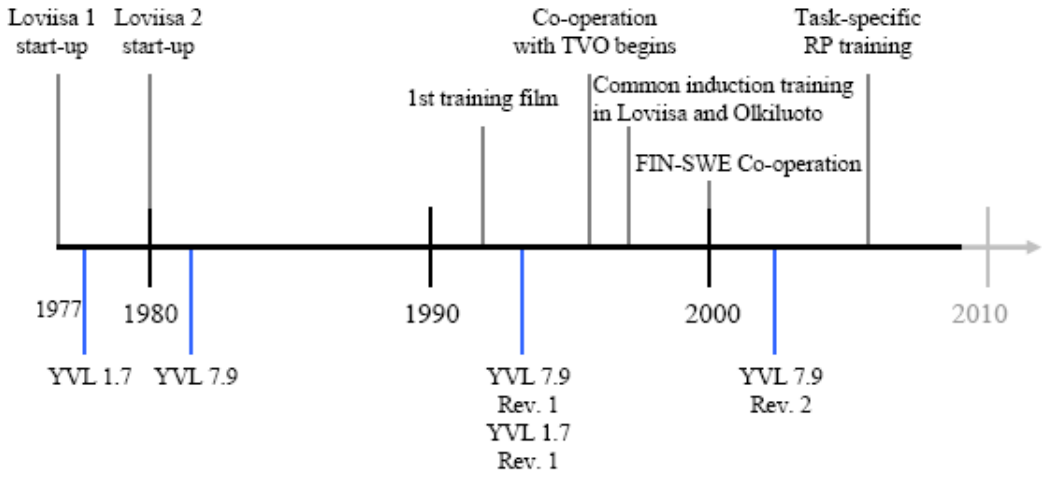

Figure 1. The most important milestones and requirements in radiation protection training.

3.2 Current training process in Loviisa NPP

During the last three years the site induction training has continued in its Nordic form but in addition, more and more attention has been paid in offering new employees and contractors site- and task-specific training including industrial safety training, education on plant working procedures and radiation protection. The training process for a worker arriving to Loviisa NPP is outlined in Figure 2.

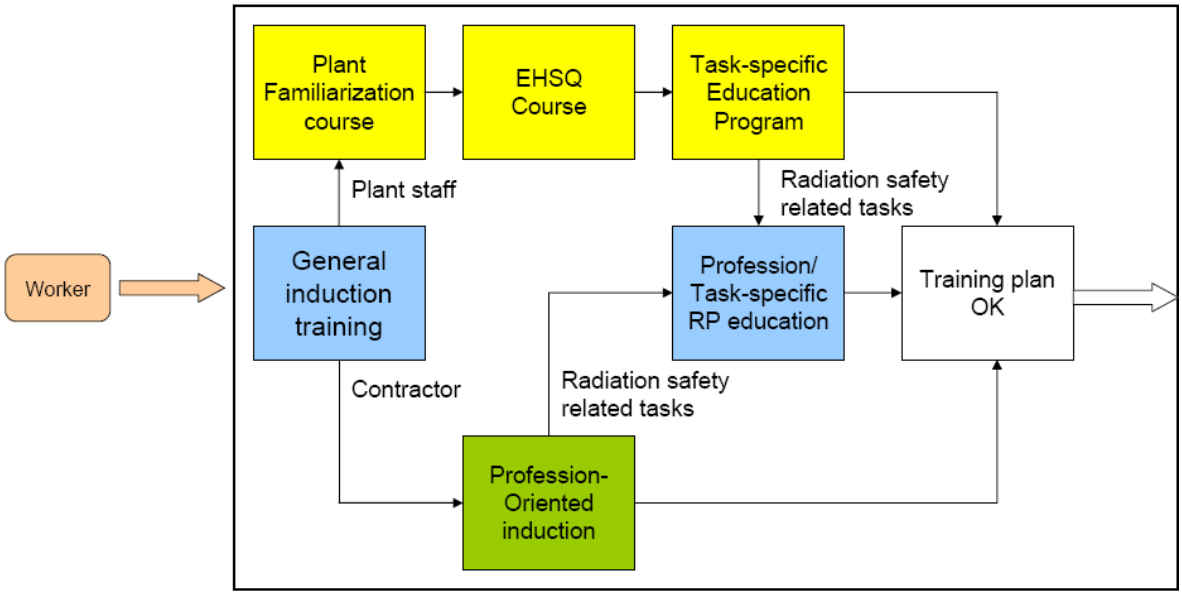

Figure 2. Training process in Loviisa NPP.

General radiation protection training is offered first in the general site induction training. The approach in this is in offering the worker a sufficient knowledge in order to operating correctly in radiologically controlled area. A basic knowledge on radiation, dose, health effects, dosimetry, means for minimizing doses and controlling radioactive contamination is given. Learning is tested with an examination in the end of the training session.
For a plant staff member, a personal training program is established in where the task-specific requirements are set for knowledge in different professional fields. Each plant member goes through plant familiarization course and EHSQ course. Both of these are roughly one-week courses. In EHSQ course, one day is reserved for radiation protection training. Viewpoint in the course is on the other hand, linking the topics learnt in General induction training more closely to the plant RP actions and on the other hand, illustrating the

most general radiation protection procedures in guided workshops. These can include measurement tasks with small radioactive sources, demonstrating different shielding materials, effect of distance etc.
If the work affects particularly to the radiation protection objectives, the person is guided to profession- or task-specific radiation protection training. The objective is to give sufficient knowledge on what radiation and contamination is, how it builds up, how does it affect to a human, how the risks can be minimized, which are the most essential radiation sources in the plant regarding to the specific occupational group and what are the correct actions if unpredictable situations occur at the workplace.
For a contractor, the training procedure is somewhat simplified compared to what it is to a plant staff member. However, the most significant elements of the EHSQ and plant familiarization course topics are discussed in profession-oriented induction lead by the foreperson or contact person of the contractor. Again, if the task has a clear relation in radiation safety objectives, the person attends to an advanced RP training with a relevant work group. Somewhat the same content is discussed as for plant staff members but the weight is more on radiological circumstances at the working area, radiation protection procedures in the specific job and actions in possible unpredictable situations.

4. Future challenges and opportunities

As if the radiation protection training has taken steps forward within the last few years, there are still some challengers that will have to be surpassed. One of them is managing radiation safety as a process in designing and realizing of plant modification projects and maintenance. Figure 3 illustrates this.
Traditionally the focus in e.g. plant modifications has been in following them through cost-efficiently, maximizing the plant safety and efficiency. Focus in radiation protection training has been in offering the employees an adequate level of knowledge about radiation and radiation protection means in tasks they are expected to perform in the plant.
Good training for employees does not appear to be enough to ensure the long-term realization of radiation protection targets if the knowledge of the project management and designers is not sufficient in radiation safety issues. Good implementation of work does not correct deficiencies in design and project management: Mistakes in these cause unnecessary exposure to radiation during the installation, operation, maintenance and decommissioning of the system. As a time scale, this can mean a time period of years or even decades.

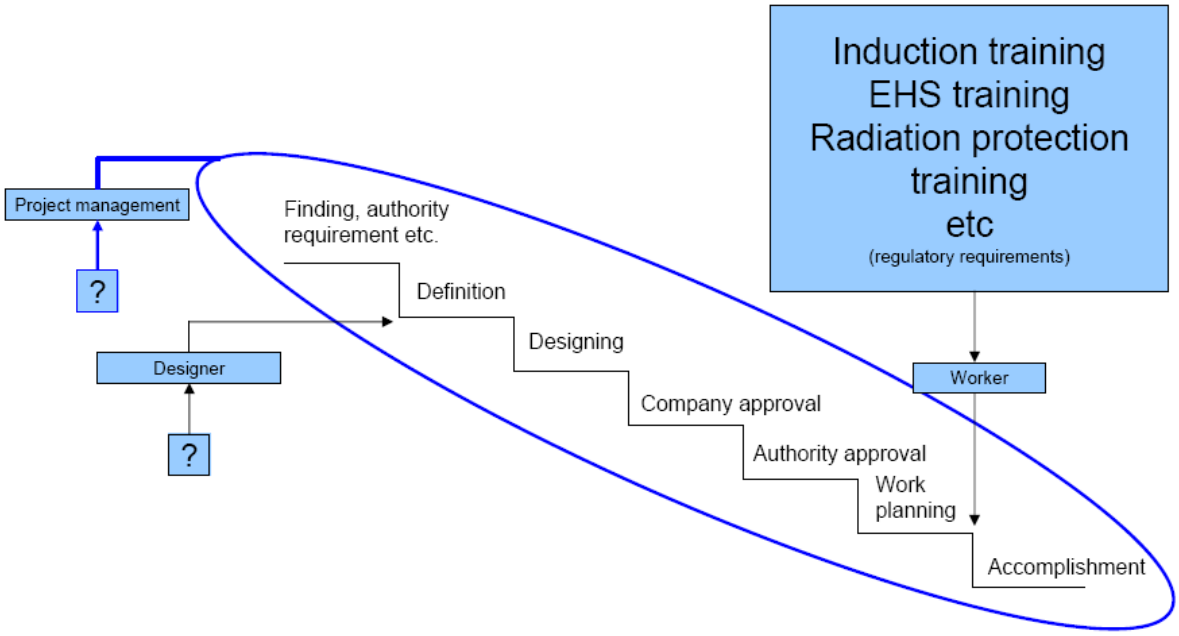

Figure 3. Radiation protection training in different project phases.

Best results in long-term radiation safety management would be achieved by concentrating in offering enough radiation safety training for people who make decisions about system layouts, modification schedules, component selection etc., naturally together with ensuring good radiation protection knowledge for plant workers and contractors. Steps have been taken into this direction in Fortum Company.
But there are still lots to be done even better in the current approach of radiation protection training in Loviisa power plant. Mock-up facilities where the practices of radiologically controlled area could be demonstrated and practiced have been discussed. This would improve the possibilities for practicing use of protective equipment and contamination monitors, decontamination methods etc.
Other field that can offer development is using modern training tools that information technology offers. Computer aided and internet-based training has not been exploited efficiently in Loviisa so far. Instructor-conducted training shall not be entirely closed down but computer aided training might be used for learning foreknowledge and on the other hand, for recapitulation training where already learned information needs to be summoned up.
Nuclear power producing companies in Finland are in the middle of change of generation. During the past and following few years, tens of per cent of plant staff will be replaced by incomers due to retirement of the most experienced workers. This will continue the pressure for strengthening the training processes in the following years.
Finland will be in a situation where choices are soon made whether new nuclear installations will be built or not. If the decision will be positive, demand for facilities and training personnel will increase. Along this there will be a need and room for further developing methods for improving the results of radiation protection training.

5. References

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