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Editorial: Applying ALARA for decommissioning and site remediation

A large portfolio of case studies was presented at the EAN 18th Workshop on the application of ALARA in decommissioning and site remediation that took place last month at CEA-Marcoule Nuclear Centre, France. This issue of the EAN Newsletter will be devoted to these themes.

First, you will find 3 articles based on presentations given at the workshop. The articles have been selected to provide you with an overview – a 'flavour' – of the topics covered during the workshop.
CIEMAT has undergone the decommissioning and dismantling of many of its research installations and some feedback is provided of this experience.
Decontamination of circuits and systems can be an asset for radiation protection purposes as well as for waste management and TÜV Nord (Germany)'s article explains what a Full System Decontamination is and its pros and cons for ALARA.
ALARA shall not forget the "non-nuclear" sector and Applus+RTD (The Netherlands) has experience in decommissioning NORM installations, such as oil and gas production installations and coal-fired power plants, and present an insight into the process.

In total, there were 22 presentations! Note that all are available on the EAN website: www.eu-alara.net. Large time was also devoted to working group discussions and the Conclusions and Recommendations, written by the EAN Bureau, (try to) captures and summarizes the main topics from all of these elements.

Next workshop. 2019 is a busy year for the EAN. EAN Workshop n°19 is planned in November 2019 (exact dates to be decided) and will discuss the use and development of innovative ALARA Tools. The workshop will be hosted by the Greek Atomic Energy Commission (EEAE) at Athens and is jointly organised with the PODIUM project, part of the CONCERT projects.

The EAN Newsletter Editorial Board. –
Sylvain Andresz, Julie Gilchrist, Fernand Vermeersch and Pascal Croüail

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The Decommissioning of Research Installations at CIEMAT Madrid

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The CIEMAT (Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas) is a public research body, focusing on energy and environment and the technologies related to them. It has offices in several different regions of Spain, and its activity is structured around projects which form a bridge between Research & Development & Industrialisation (R&D&I)and social interest goals.

The CIEMAT took over from the old Junta de Energía Nuclear (JEN), which since 1951 had led research in nuclear fission energy production and control in Spain. In the decade of the eighties, it opened to new energy alternatives and to applied study of the environmental impact of energy. At present, the main lines of action are the study, development, promotion and optimisation of various sources such as: renewable energies, nuclear fusion, nuclear fission and fossil fuels; the study of their impact on the environment, development of new technologies; not forgetting areas of basic research such as high-energy physics and molecular and cellular biology.

For the regulatory aspects, CIEMAT remains as a unique group of nuclear facilities including a research reactor (JEN-I), U-processing plants, hot cells, …, (all dismantled nowadays) and about 20 radioactive facilities in operation.

Integrated plan for CIEMAT facility improvement

The Integrated Plan for Facilities Refurbishment (PIMIC, acronym from Spanish Plan Integrado para la Mejora de las Instalaciones del CIEMAT)) was started up in 2000 for decommissioning old radioactive and nuclear facilities that were shut down for a long time, remediation of zones and grounds with residual contamination, modernizing buildings and facilities, and improving the general infrastructures of the site.

The Nuclear Safety Council (Consejo de Seguridad Nuclear, CSN) is the body in charge of supervising and inspecting PIMIC actions, including documents (manual, functional regulations, procedures, records, etc.), operation and dosimetry for workers and public.

The PIMIC is divided into two projects led by the CIEMAT Subdirectorate General of Safety and Facilities Refurbishment: The general Rehabilitation Project is being implemented by CIEMAT as nuclear operator, while the Dismantling Plan and restoration of contaminated areas was entrusted to Enresa and has been carried out between 2006 and 2018.

Since its beginning, the most significant remediation and cleaning PIMIC operations already performed in facilities and spaces have been the following:

- JEN-1 experimental reactor (IN-01), under refurbishment in order to become a relevant facility for fusion research (double-triple ion beam for material characterization).
- Radioactive liquid waste storage plant (IN-07), currently a temporary VLLW storage facility.
- Radioactive liquid waste conditioning plant (IR-16), currently at final stage for re-use as a conventional building.
- Solidification of radioactive aqueous waste in concrete drums
- Research reactor fuel element development plant (IN-03), currently the CIEMAT neutron metrology laboratory.
- Hot metallurgical cells (IN-04), currently at final stage for re-use as conventional building.
- M-1 irradiated fuel reprocessing pilot plant (IR-18), pending a final decision on the remaining buried contamination.
- Radionuclide alpha metrology laboratory (IR-13A), cleaned and remediated.
- Cleaning and rehabilitation of buildings where activities related to the first part of the nuclear fuel cycle were carried out.
- Remediation on the uranium tailings contaminated soil in 'Montecillo' area, currently waiting for final restoration.

- Remediation on the accidental contaminated soil (^{137}Cs and ^{90}Sr) in 'Lenteja' area, currently a temporary VLLW storage facility.

The activities of PIMIC are being performed with alongside the normal operation of CIEMAT. While PIMIC-Dismantling is protected with a fenced area and specific security access points, PIMIC-Rehabilitation is performed in buildings near to conventional workplaces that must be informed about PIMIC progress. Obviously, all the conventional risks and hazards like dust production and noise reduction have been considered.

The Radiation Protection program consists of: education and training of exposed workers, classification of working areas, definition of local rules, procedures in controlled areas, administrative record (radiation Work Permit), workplace monitoring and individual external radiation monitoring (official TLD, operational DED) and internal dosimetry (Whole Body Counting and BioAssay).

The ALARA approach has been applied in order to optimize the received doses based on an annual collective dose objective and keeping the individual doses well below the dose limits for workers.

In the period 2006-2018 the number of radiation workers per year in PIMIC ranged from 20 to 100 people and the mean annual dose ranged from 0 to 1.4 mSv/y. The maximum annual individual dose ranged from 0.1 to 4.7 mSv/y. The annual collective dose ranged from 0.1 to 38.1 man.mSv in a year. The collective dose for the whole project at the moment is 86 man.mSv.

An important task concerning D&D projects is the waste management. Each PIMIC project have developed Clearance Plans that have been approved by the CSN, allowing the free release of about 50% of the PIMIC-Dismantling waste (total about 12,000 t) and 80% of the PIMIC-Rehabilitation waste (total about 2,000 t). No HLW was produced in PIMIC because fuel bars and some activated parts were previously extracted in the 1990s.

The total budget for the PIMIC project during the last 18 years is about 60 M€, from which approximately 80% corresponds to PIMIC-Dismantling and the remaining 20% correspond to PIMIC-Rehabilitation which is still in progress.

Acknowledgements

Authors want to express their gratitude to Dr. Javier Quiñones (previous PIMIC Director) and Esther Garcia (ENRESA manager for PIMIC-Dismantling project) for the information provided to write this paper. ■

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Full System Decontamination under ALARA Point of View

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In the life cycle of nuclear power plants, oxide layers on the inner surface grow up and are a main source of radiation dose in the facility. To reduce this radiation exposure a decontamination process can be performed. Main drivers for decontamination are radiation protection and waste management. Decontamination is carried out to protect staff during maintenance or dismantling work. Decontamination also supports the management of waste. The range of decontamination varies from single parts or small dismounted components cleaned in baths up to the Full System Decontamination methods discussed here that cover the complete primary circuit in a pressurized water reactor (PWR), or the reactor pressure vessel (RPV) with internals in a boiling water reactor (BWR), and includes in both cases the auxiliary systems.

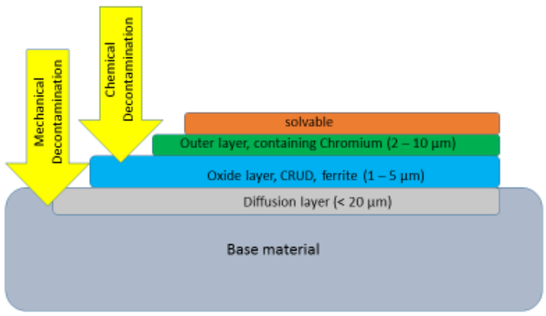
Full System Decontamination (FSD) principle

There are different kinds of decontamination methods like mechanical and chemical processes [1, 2, 3, 7, 8]. To remove the contamination, which is embedded in the structure of the oxide layers on the inner surface of pipes and components, chemical decontamination methods have been used since the 1960s. Parts and components are decontaminated in baths where the chemicals dissolve the oxide layers. The main goal for these decontamination methods was the reuse of components and a decrease inf radiation levels. Nowadays in the case of decommissioning the problems of waste and material management have increased. With a FSD big components could be more easily handled, the dismantling and cutting work could be done in a decreased dose environment and the recycling of materials is simpler.

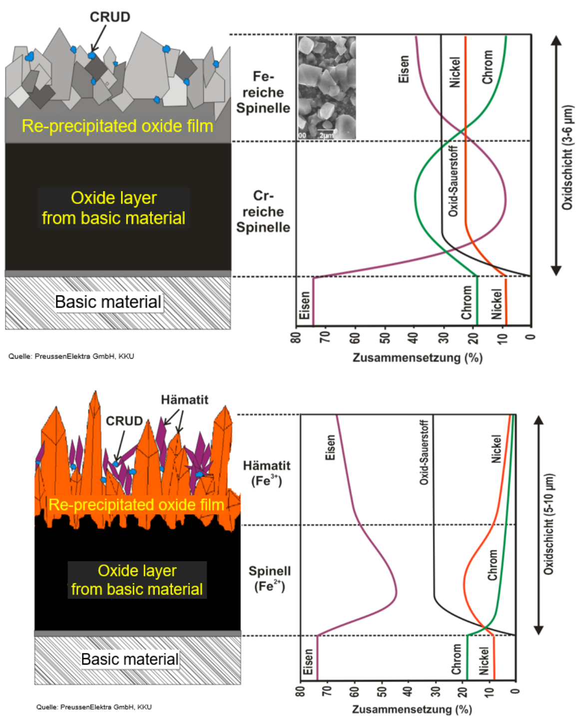
The chemicals that were used in former times are mostly the same as those used now. The variety of chemicals available leads to many different decontamination processes. Some established processes are *LOMI* developed by Central Electricity Generating Board (CEGB) for Electric Power Research Institute (EPRI), *CANDECON* developed by Atomic Energy of Canada Limited (AECL), *HP/CORD UV* originally developed by Siemens KWU, *NITROX-E* by Westinghouse and the new *ASDOC_D-MOD* (Advanced System Decontamination by Oxidizing Chemistry) by NIS Siempelkamp [8]. The last three were applied in German NPP and are the subjects of this discussion.

is the common aim for all the processes is that the contamination would be removed from the surface. The structure of the contamination varies between BWR and PWR and has substantial influence on the success of the decontamination. Whilst slight adhered nuclides can be removed more effectively than strongly sticking nuclides by other methods, the oxide layers remains. Chemical decontamination in baths up to Full System Decontaminations (FSD) can remove these oxide layers. Electrochemical and mechanical processes like milling remove not only contamination but also a part of the surface. After the treatment, only deeply penetrated nuclides are still measurable. That means for the radiological characterization that a new estimation of the amount and composition of contamination has to be made. In particular, the relationship between α-ray nuclides and β/γ-ray nuclides must be newly determined.

Picture 1 shows the principle of the different oxide layers in a PWR. The difference of the structure of the oxide layers between a PWR and a BWR Is shown below in Picture 2.



Picture 1. Oxide layers and decontamination methods.



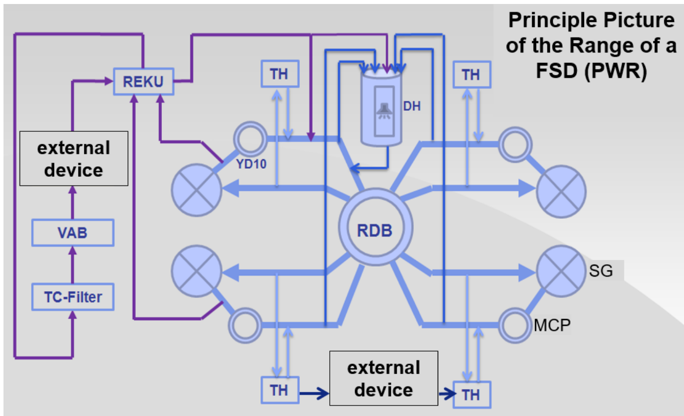
Picture 2 [4]. Oxide layers in PWR and BWR.

A single decontamination is done, for the decontamination of main coolant pumps for maintenance, using a chemical bath. With external equipment like pumps and filters, the next step is the decontamination of single loops or components. A FSD decontaminates all loops, pumps, steam generators (in the case of pressurized water reactors (PWR)), the RPV and auxiliary systems as shown in picture 3. All power plant installations are used with some external devices. Filtering systems and ion-exchangers remove particles and dissolved ions from the decontamination medium. A lot of additional pipes and hoses are arranged separately to form the decontamination circuit and to avoid dead ends, where the risk of recontamination or deposition particles is high.

Here we find differences between the FSD processes:

- HP CORD UV uses an external filter and ion exchanger to decontaminate the medium,
- ASDOC_D-MOD uses the filter systems of the NPP.

Common for all processes are an external pump for the supply of seal water for the coolant pump of the NPP. Additional pumps are also necessary in both cases for the filtering loop (external or internal filters and ion exchangers); they replace the high-pressure pumps of the NPP. NPP pumps (ASDOC_D-MOD) do chemical metering or external pumps (HP CORD UV) are used.



Picture 3. The ranges of the FSD.

First step of FSD

Different kinds of chemistry is used which leads to many different procedures within the FSD. The chemistry dissolves the oxide layers on the inner surface. Most used chemicals are:

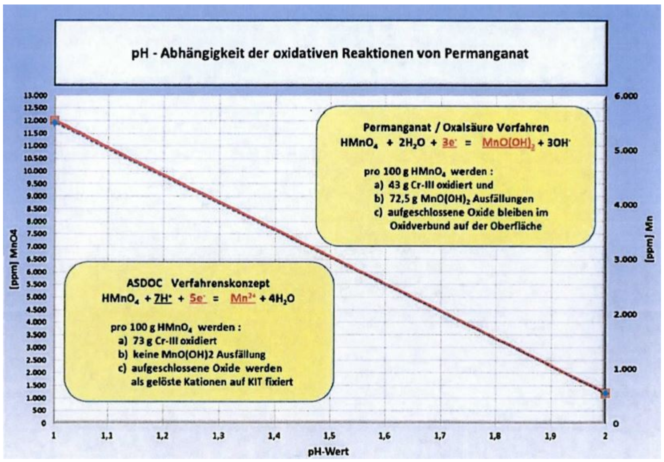
- Permanganate acid
- Oxalic acid (tests for Tartaric acid and Ascorbic acid has been made)
- Methyl sulfonic acid (Sulfonic acid tested)
- Nitric acid
- Ni-Carrier (if necessary)
- Hydrogen peroxide
- Cationic exchange resins
- Anionic exchange resins
- α-Carrier (if necessary)
- Chelating agents like EDTA

Common for all the processes discussed here is the first step of decontaminating a PWR with an oxidation process using permanganic acid, which dissolves the hardly soluble oxide layers containing chromium. In this step the formation of manganese dioxide occurs. Formation of manganese dioxide depends strongly on the pH-value of the medium as shown in picture 4 [5].

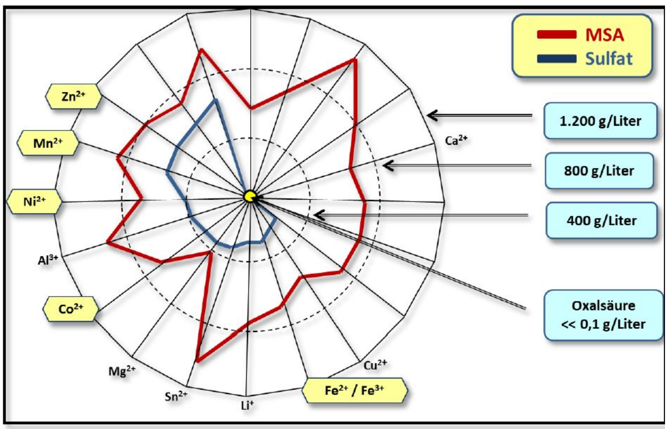
This leads onto a main difference in the processes. In NITROX-E and ASDOC_D-MOD the pH-value of the decontamination medium will be lowered by a bias acidic solution, in case of NITROX-E with nitric acid, in case of ASDOC_D-MOD with MSA (Methyl sulfonic acid). The acidic solution has an additional advantage: the solubility of metal-ions is higher than in a more basic decontamination medium. This is shown in picture 5 [5], [6].

As an advantage of these chemical properties, the concentration of the chemicals that were used for the treatment with oxidative and reductive reagents could be lower. This means a reduction of necessary chemicals. For example, the concentration in the HP CORD UV process for the permanganate acid is about 200 ppm and for the oxalic acid up to 2000 ppm. This is lowered in the ASDOC_D-MOD process to 50-70 ppm permanganate acid and up to 50 ppm oxalic acid.

High concentrations of the chemical reagents could lead to high decontamination factors in a limited number of steps, but the possibility for the breakup of the oxide layers are high. This means, that a part of the layers is not dissolved and particles are floating in the decontamination medium. Especially in dead ends of the FSD circuit, this is a risk for recontamination and together with the formation of manganese dioxide; this leads to hard to solve recontamination layers, which could reduce the effect of the decontamination. The HP CORD UV-process uses a particle filter to remove these particles from the decontamination medium while with the ASDOC_D-MOD process the resins and the resin catcher are used to remove the particles.



Picture 4. pH-dependence of oxidative reactions of permanganate



Picture 5. Solubility of metal ions.

Second step of FSD

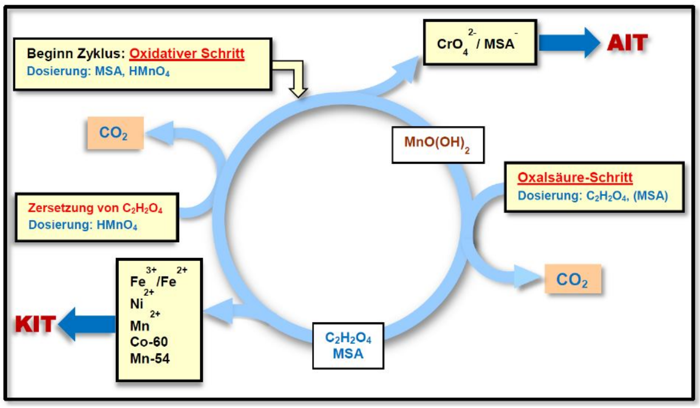
The second step in a decontamination cycle is the reductive step with oxalic acid, which is commonly used, but the concentration varies for the different processes. The whole cycle is shown in picture 6 for the ASDOC_D-MOD process. It is the same as for the other processes where HP CORD UV don´t need MSA, but NITROX-E uses nitric acid.

Common for the FSD processes are the repetition of these cycles but the number of repetitions and the duration of the cycles varies. HP CORD UV process and NITROX-E process uses 3 to 5 cycles with a duration about a week while the ASDOC_D-MOD process uses up to 20 cycles with a duration of some days each. In picture 6 the residues from the reactions are recognizable. This is carbon dioxide gas from the reaction of oxalic acid with permanganate acid. In the case of the HP CORD UV process the remaining oxalic acid will be destroyed by UV-light before starting the next cycle. In both cases, it is necessary to obtain the gas flow to prevent a hazard. Not specified is the production of hydrogen gas, which is an unwanted reaction. The radionuclide waste and the metal ions are fixed on the resins. The mass of needed resins varies in the range of some cubic meters of ion exchangers. With the ASDOC_D-MOD process, the mass of dissolved and fixed on resins metal ions could reduce to a value of about 120 kg. In the other processes, this mass varies from 400 kg to 750 kg. The dissolved and removed activity is in the range from 1E13 Bq to 1E14 Bq. This depends on the amount of activity at the start of the decontamination. Picture 7 shows the symbolic progression of a FSD. A complete FSD in 19 steps with ASDOC_D-MOD process is shown in picture 8.

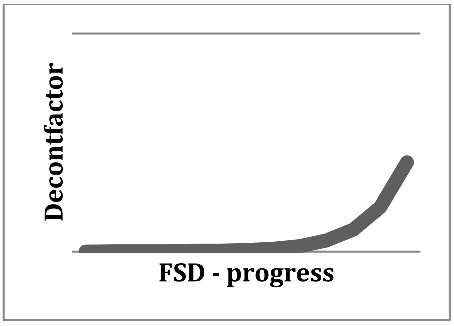
The success of the Full System Decontamination is measured with the "decontfactor". The decontfactor is dose rate before decontamination divided by dose rate after decontamination. It is necessary to locate good measuring points in the system to obtain representative information of the changes during the different steps of the decontamination.

The contamination that could be dissolved and removed is in the order of 1E 14 Bq. A decontfactor of 10 means, that 90% of the contamination is washed out. An average value for the decontfactor of a PWR is about 75.

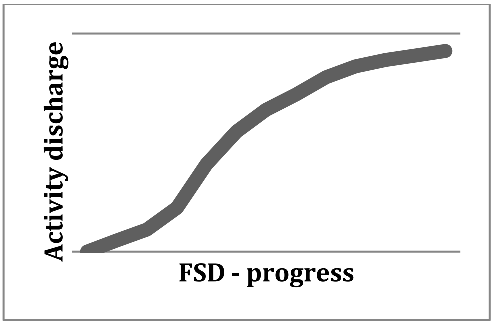
From this it follows that in case of dismantling work in the controlled area the radiation field could decrease e.g. from 120 µGy/h to 20 µGy/h and that means a saving in collective dose for a 10.000 h work of 1000 mSv. The next picture show results of the decontamination of a steam dryer in a BWR and shows clearly the meaning of the decontfactor.



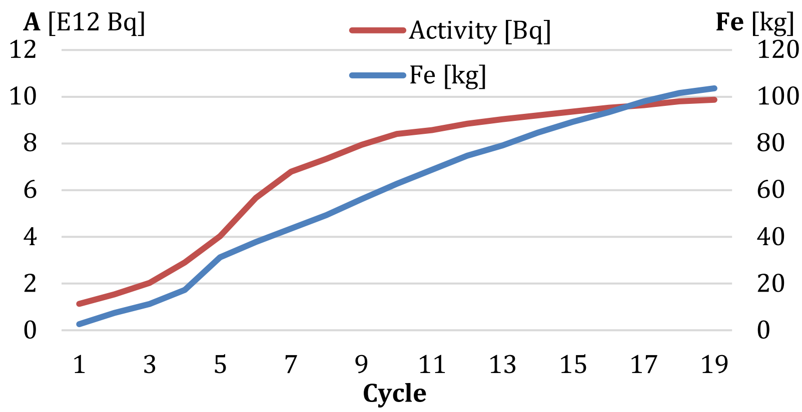
Picture 6. Cycle of ASDOC_D-MOD process.



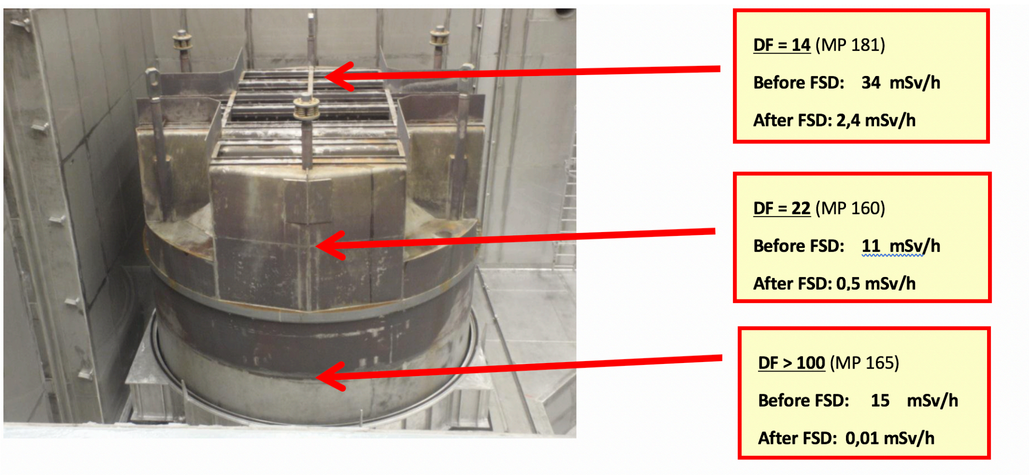
Picture 7. Deconfactor with the progression of FSD.



Picture 7. Discharge Activity with the progression of FSD.



Picture 8. Complete ASDOC_D-MOD FSD.



Picture 9. Decontfactor and decreasing dose rates in a BWR.

What to be aware of about FSD in the context of optimisation analysis?

During the FSD it is necessary to consider the possibilities for unwanted reactions or pitfalls. Before each FSD it is necessary to check the materials for sustainability against corrosive attacks. Sustainability is not given for carbon steel but also for some kind of austenite with low enrichment of Chromium. Common for these processes are the reactions of protons with iron. These are two reactions, which leads to Hydrogen gas:

$$2Fe^{2+} + 2H^{+} \rightarrow 2Fe^{3+} + H_2$$
$$Fe^{\circ} + 2H^{+} \rightarrow Fe^{2+} + H_2$$

This situation arises by the corrosive attack of uncoated, not passivated base material and the corrosive attack on carbon steel or low chromium enriched austenite. The first one is common for BWR, because there are areas in the main steam pipe and the feed water pipe that are constructed from carbon steel. Therefore, the control of hydrogen is necessary because in isometric high points the hydrogen could concentrate and reach the ignition limit. Control parameters during the FSD are hydrogen in the decontamination medium, Fe^{2+} concentration and the redox potential. The redox potential should be positive; otherwise uncontrollable reactions with the base material could occur. A possibility to regulate the process is the add-on of H_2O_2. This will increase the redox potential and passivate uncoated base material.

Due to the activity and the chemicals in the decontamination medium, it is required, that no medium could reach other systems, which are not in the defined decontamination circuit. The separation between decontamination circuit and other systems must be ensured especially with a FSD during maintenance period of the NPP or short after shut down with nuclear fuel in the pool.

Another area for corrosive attacks are the water treatment systems. They are not in the decontamination circuit of a FSD. But the excess water resulting from chemical metering, seal water and water to exchange loaded resins is not free from chemicals and could start corrosive attack on valves and accessories in the water treatment area. Therefore, it is necessary to look for material sustainability even in this region.

These are main advantages and disadvantages of chemical decontamination like they are listed in [3]:

Summary: advantages and disadvantages

Advantages

- Chemical decontamination is relatively simple and similar to classical cleaning in the conventional industry for which a lot of experience exists. It may also be relatively inexpensive where additional equipment is not required.
- Chemical decontamination is a known practice in many nuclear plants and facilities.
- With proper selection of chemicals, almost all radionuclides may be removed from contaminated surfaces.
- With strong mineral acids, a decontamination factor of more than 100 may be achieved, and in many cases, the item may be decontaminated up to releasable levels.
- Chemical decontamination may also remove radioactivity from internal and hidden surfaces. However, in this case, its effectiveness may be low, and measurement at release levels will be a problem.
- The dose rate in the controlled area is decreased. Therefore, radiation protection is easier and always the collective dose decreased.
- Waste management is easier because a lot of dismantling work can be done without shielding. That means less remote controlled work is necessary which results in a decreased processing time: good for economics and radiation protection.

Disadvantages

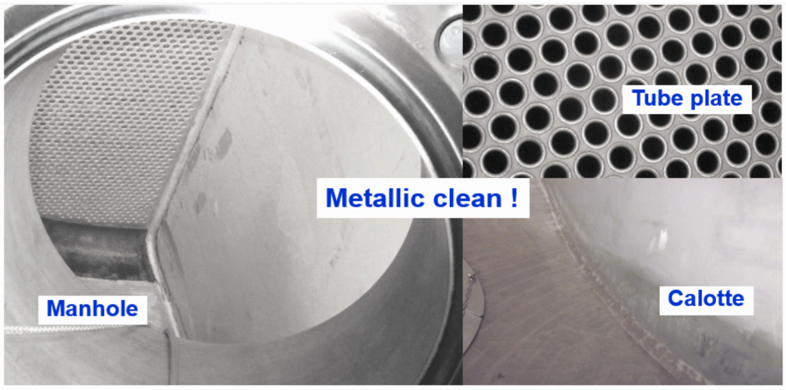
- The main disadvantage of chemical decontamination is the generation of secondary liquid waste, resulting in relatively high volumes compared to other processes. The treatment and conditioning of this secondary waste requires appropriate processes to be considered when selecting the decontamination option. Moreover, in some cases (e.g. internal and hidden surfaces), the effectiveness of the decontamination may be relatively low.
- Usually the solution must be heated up to 70 to 90°C in order to increase the rate of the decontamination process.
- A further disadvantage in obtaining high decontamination factors is that corrosive and toxic reagents may need to be handled.
- Chemical decontamination is mostly ineffective on porous surfaces.

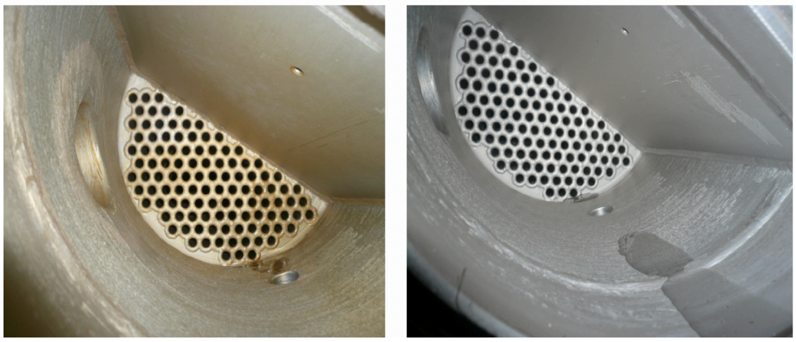
Conclusion

The main drivers for a FSD are radiological protection, waste and material management and economics. All of these three different kinds of Full System Decontamination with their own specific advantages reached these goals. Common is the use of permanganate acid and oxalic acid for the oxidative and reductive processes to disolve the oxide layers on the inner surface. The metal ions will be fixed on ion exchange resins – in the NPP´s own filters or external filter devices. Due to the bias acidic solution, it is possible to decontaminate with lower concentrations of the chemical reagents. A lower number of external components helps to save space in the integration of the FSD components in the system.

To avoid a high particle portion in the decontamination medium it is useful to start with lower concentration and stepwise metering of the chemical regents. This leads to a smooth decontamination with low risk of recontamination and deposition of particles in dead ends.

The good results of different procedures of FSD (illustrated in picture 9) helps to save dose for the dismantling workers, support the waste management and the recycling of materials. ■





Picture 10 (top). Steam generator primary chamber hot leg in a PWR, before: 150 mGy/h → after: 3 mGy/h [4]. Pictures 11 (down). Last rinsing cycle: before (left): 200 Bq/cm² and after (right): 20 Bq/cm² [4].

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Decommissioning of Non-nuclear Facilities; Insight into the Process

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This article provides an overview of issues encountered prior to, and during, the process of decommissioning. It is important to acknowledge that the decommissioning project team must work alongside the daily operations business. Of course, the decommissioning team can make use of the facilities and resources of the daily operations business, but decommissioning must be managed as a project to meet the scope, the timelines and delivery dates. The focus is on the implementation of the optimization principle (ALARA) during the whole process.

Scientific particle accelerators produce particles with high energy; in these situations construction materials can be activated. At specific industrial sites, natural radioactivity (NORM) is now a well-known issue due to the use of raw material from the earth crust like ores, gas, oil and water. In oil- and gas production plants and geothermic installations, NORM in the produced water or gas can result in an accumulation of radioactive material in the process installation. Also during combustion of coal in coal fired power plants the natural spikes of uranium and thorium in the coal can generate higher levels of radioactivity inside the installation.

In these facilities there can be relatively large volumes of NORM waste with relatively low activity concentrations. During the dismantling of a NORM process installation 10,000 tons of contaminated steel can be removed. The scale of work and the amounts of NORM waste can be enormous. A lot of this NORM cannot be recycled or added as a raw material for other further processing due to chemical components. The decommissioning of non-nuclear facilities can generate huge amounts of materials that are above the scope clearance levels. Taking this into account means the costs for waste can be big issue.
The main hazard for workers during decommissioning of a NORM contaminated installation is the risk of dust inhalation during the demolition work. For a demolition worker dust in the air is a common phenomenon and the work environment during NORM decommissioning is like regular demolition work. However, the level of specific NORM education of these workers is not high and an , understanding of radiation protection (PPE) can be hard to convey. Working with low level personal protection equipment (a simple cap or hood) is not comfortable, and if it is not comfortable to wear they will not use it. So for instance during the decommissioning of a NORM plant the workers did not use the simple P-3 filter caps but used an airflow helmet with P-3 filter. This form of PPE gives the workers more comfort and protection. Comfort of the PPE is therefore a good worker protection strategy.

During the inventory at site surprises will be encountered. For example, the wall thickness or reinforcement steel on the drawing could be adjusted during the construction phase and not adjusted in the final drawing. Also adjustments afterwards, during operation of the facility, are not always recorded, especially in old buildings. These hidden adjustments can have consequences for the waste costs, but also the costs of demolition. The amount of reinforcement (activated steel) in concrete construction at acceleration facilities can change the approach of demolition.

The diversity and number of stakeholders can be very complex during a decommissioning process in the Netherlands and can be a challenge. It is therefore important to inform the stakeholders, this depends of course on the complexity of the project. In an accelerator decommissioning project for instance, the residents of the local district and local press were invited by the facility owner to visit the site in advance of the decommissioning. These meetings can give the residents a better feeling "what is going on there". We should bear in mind that some projects also can be (locally) politically sensitive, especially for those facilities which in the past were subject of incidents.

In the inventory phase of several decommissioning projects a management advisory group (MAG) was put together. Due to the scale of the project, the management needed more understanding of the decommissioning techniques. The MAG was formed by specialists of the specific facility, cleaning specialists, waste management and radiation protection. Choice of technique needs a graded approach on costs of technique, the exposure of the workers and the generated waste. In the MAG alternative decontamination techniques were investigated like high pressure water cleaning, abrasive blasting and chemical decontamination. The costs of labour, exposure, environmental impact and waste costs can be in conflict. For example: less sampling of the materials can generate large costs of waste or uncontrolled wastes above the clearance criteria. On the other hand, the sampling and analyses costs a lot of money, and the processing time of the samples at the lab can temporarily halt the decommissioning process.

One of the ongoing decommissioning projects is the dismantling of a former phosphorus production plant at Vlissingen in the Netherlands where there is combined contamination risk at specific parts of the installation. The former furnaces are phosphorus, asbestos & NORM contaminated. NORM is therefore not the only issue in this decommissioning: phosphorus is the main acute risk. Phosphorus reacts with oxygen and is highly flammable at low temperatures. Also, applications using asbestos gaskets are NORM contaminated. For this reason the decision was made to treat the contaminated parts of the installation in separate ways; NORM and phosphorus contaminated parts were first cleaned with high pressure water, in this way the phosphorus /NORM sludge will be separated from the steel and is a part of the phosphorus /NORM sludge waste stream. The phosphorus/NORM sludge will be subsequently incinerated in a special rotary incinerator.

Large volume of sludges in the installation contain elementary phosphorus and NORM nuclides. If the sludges are simply dried for waste treatment, the phosphorus will ignite and an uncontrolled fire is the result. This is not the right solution.
In order to neutralize the elementary phosphorus, a mini plant was built by the facility owner and specialized contractor. The sludge containing the phosphorus was filtered, so a large amount of the phosphorus was recovered. The next step of this process was the incineration of the sludge in order to oxidize the elementary phosphorus and to generate a residual solid waste fraction that no longer has an ignition (fire) risk. The gases from the oxidised products and NORM residuals from the rotary incinerator were cleaned by a gas scrubber (phosphorus acid).

This is a process installation by itself (24/7 operation) to manage this waste problem with combined risks. It is a very delicate process with a lot of process variations like the concentration of phosphorus, solid fraction and water content of the sludges. To manage the NORM emissions in air and water and the NORM activity in the residual sludge waste, a monitoring program was set up to include air sampling, water sampling and measurements of the solid waste. ■

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EAN Workshop 18: ALARA for Decommissioning and Site Remediation

Conclusions and Recommendations

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Workshop objectives

During the past 50 years, more than 400 nuclear power plants (NPP) and research facilities have been shut down and decommissioned, or are undergoing decommissioning. It is expected a significant increase in the number of decommissioning projects given that 60% of the current NPP will be subject to decommissioning in the next 10-15 years. The 1st EAN workshop (Saclay, 1997) already considered the implementation of the optimisation principle (ALARA[1] principle) for decommissioning. Recommendations regarding dose assessment evaluation, the importance of encompassing all risks (not just radiological ones) and the need for guidance addressed to the non-nuclear sector were formulated. The topic was revisited at the 7th EAN workshop (Arnhem, 2006) where these recommendations were reiterated.

More than a decade later, the EAN decided to see if the status of its former recommendations has changed. In addition, since ICRP Publication 103[2], the approach to radiological protection is now based on the characteristics of the radiation exposure situation (rather than the previous process-based approach) and a consequence is that the ALARA principle potentially applies to all sources of exposure. As such, the 18th EAN workshop "ALARA for Decommissioning and Site Remediation"[3] was planned with the intention to provide a look at the "non-nuclear" sector.

The objectives of the workshop were:

1. To present the regulatory background and latest guidance and standards regarding radiation protection for decommissioning and site remediation; both in the nuclear and the non-nuclear sectors.
2. To examine the conceptual and the practical aspects of the optimisation (ALARA) principle in these fields for workers and the public with the aim of gathering an array of experience and feedback from work performed in nuclear and non-nuclear installations and legacy sites.

[1] As Low As Reasonably Achievable (ALARA) – The International Commission for Radiological Protection (ICRP) states that "*all exposures should be kept as low as reasonably achievable, taking into account economic and societal factors*". Since 1980 the ALARA principle has been part of the European Basic Safety Standards, has been progressively introduced into national regulations and organisations radiation protection programme. The ALARA principle is emphasised as the cornerstone of radiation protection. The European ALARA Network has been created by the European Commission in 1996 to further specific research topics on the theme. The EAN is a self-sustainable network since 2005 acting to promote a wider and more uniform implementation of the ALARA principle for the management of worker, public and patient exposures in all exposure situations and provide a focus and a mechanism for the exchange and dissemination of information from practical ALARA experiences, notably via topical workshops.

[2] ICRP, 2007. Recommendations of the International Commission on Radiological Protection. ICRP Publication 103. Ann. ICRP 37 (2-4), 2007.

[3] The terms "decommissioning" and "remediation" can have different meaning across different publication and audience. The International Atomic Energy Agency Safety Glossary (IAEA, 2007) defines decommissioning as "*administrative and technical actions taken to allow the removal of some or all of the regulatory control from a facility.*" and remediation as the "*measures carried out to reduce the radiation exposure from existing contamination of land areas through actions applied to the contamination it-self or the pathways to humans*". IAEA restrict the term "clean-up" for "*actions taken to reduce the impact of site that are undergoing decommissioning*", hence installation under regulatory control. During the workshop, remediation was used broadly to encompass remediation actions at nuclear facilities, non-nuclear facilities and legacy site.

3. To discuss and investigate selected key themes with regard to ALARA: the holistic approach and waste management were selected as areas for discussion.
4. And finally, to identify remaining needs and perspectives.

The workshop was organized in collaboration with the Information System on Occupational Exposure Working Group on Decommissioning (ISOE WG-DECOM[4]).

PROGRAMME AND SETTING THE SCENE

The Workshop was hosted by the Marcoule Institute for Separation Chemistry at CEA-Marcoule, France. CEA-Marcoule has a long experience of decommissioning and dismantling of experimental reactors and laboratories and in nuclear waste management.

There were 46 participants from 12 countries. Half the programme was devoted to presentations[5], and half to working group discussions.

The first session was the opportunity for several organisations to present their activities on the topics of the workshop. First, the ISOE WG-DECOM presented several dosimetric results extracted from the ISOE database with regard to decommissioning work and activities. Strategic considerations coming from the gathering of operational experience between utilities and nuclear safety authorities were also provided. The Nuclear Energy Agency presented the scope and future areas for work of the recently created Committee on Decommissioning and Legacy Management (CDLM) whilst the IAEA presented its standards and guidance (some under update) on decommissioning and remediation. The outputs of several international cooperation projects were also presented. The German-specific regulatory framework for radiation protection during decommissioning concluded the session.

The presentations given in the following sessions provided a wealth of experiences from decommissioning and remediation projects undertaken in the nuclear sector[6] (session 2), the non-nuclear sector and for legacy sites (session 3). A special emphasis on the management of mixed-risk situations and the challenges in the management of wastes was given in session 4.

Strategy

Three basic strategies were highlighted for the decommissioning of nuclear installations: immediate, deferred (safe enclosure) and entombment – each having associated advantages and disadvantages. Immediate dismantling has fewer uncertainties and can often utilise most of the systems that ran during operation, and there is also easier retention and transfer of knowledge. Deferred dismantling is more convenient from a radiation protection point of view (short-lived radionuclides have decayed) but costs more (because of the surveillance and maintenance costs) and detailed knowledge of systems may no longer be available. Entombment is specific and its requirements are comparable to those with a waste disposal and this was not discussed further during the workshop. Based on the presentations given, immediate decommissioning is generally the preferred option. Remediation is also typically carried out without delay.

Interestingly, a general scheme for applying ALARA in both decommissioning and remediation (D&R) can be drawn from all the presentations of the workshop and this includes (a) a starting point, (b) the planning and implementation of the D&R strategy (ALARA analysis included) and (c) an end-state.

These three elements are described below, as well as other key themes and issues that emerged from the workshop presentations and discussions. On the final day, the conclusions and recommendations from the working groups were presented and discussed, and these are also summarised below.

Starting point and the need for initial characterisation

An initial characterisation of the site is always performed as a pre-requisite to understand the situation. It has been recommended to start characterisation early if possible – an example was provided from the Mühlberg NPP where

[4] ISOE stands for Information System on Occupational Exposure: http://www.isoe-network.net. The ISOE Working Group on Decommissioning is a network of RP experts from utilities and authorities who are involved in NPP decommissioning projects. The working group has been set up beginning of the 2000 and since that date, its work has been based on a comprehensive understanding of national contexts and operational experiences trough exchanges and gathering. ISOE WGDECOM notably brought the views if nuclear utilities and NPPs to the workshop.

[5] All the presentations are available at the EAN website: http://www.eu-alara.net/.

[6] Meaning: installations under nuclear regulatory control e.g. nuclear power plant, nuclear fuel related installations, low flux reactor, research installations etc. Installations from "outside the nuclear sector" are not subject to nuclear regulatory control *a priori* e.g. thorium gas mantle factory, NORM installations etc.

measurements have started several years before the planned end of operations.

Reported experience from characterisation includes:

- The radiological characterisation of the radionuclides, their activity and distribution, etc. with the help of in-situ survey and mapping (dose rate, gamma spectroscopy etc.), sampling and laboratory measurements. Models and software have also been used (e.g. for activation evaluation).
- Characterisation also includes the search for contaminants and chemicals substances because these can have a strong impact on the overall D&R strategy (see below for details).
- Characterisation takes time and is expensive [8, 19]. Advanced sampling techniques have been presented [12] and new technologies have been judged beneficial for ALARA, notably non-destructive techniques and for alpha measurement.
- The characterisation should also include the context of the site: location and setting, neighbourhood, presence of other installations – in operation or not, the natural environment etc. To this regard, the workshop presented a large panel of cases: nuclear power plant [10], nuclear installation surrounded by other nuclear installations in operation [11, 20], remote site [17, 20], NORM site located in a city [15] and even radioactive material inside dwellings [14, 16].

The characterisation is also informed by the operational history of the installation, but these elements are not always available and/or are limited and can easily be lost, especially for legacy sites because of the elapsed time and the loss of contact with persons previously in charge.

The importance of the knowledge of the former workers was highlighted several times and this also applied to installations outside the nuclear sector. It was recommended that importance was given to (a) the retention of knowledge from the former workers (with good record keeping of radiological data and events) and (b) the transfer of this knowledge to the decommissioning workers. Furthermore, a lack of radiation-experienced workers in decommissioning was highlighted. The creation of specific modules on decommissioning (initial training, in-house training) was suggested to address this issue.

Overall, a transfer between operators of lessons-learnt and experience – even 'bad experience' – of D&R performed has been advocated. The use of a centralised tool/database collecting this type of information from decommissioning projects has been proposed.

Decision-making and the need for a holistic approach

It has been repeatedly stated that the outputs from the characterisation will strongly influence the planning and implementation of the strategy (or as it was put: "*lay down the foundation of ALARA*" [10]).

But besides the traditional elements of radiation protection generally considered for the ALARA analysis (collective and individual doses, dose constraint etc.), the workshop clearly showed that these are not enough and that the choice of the strategy will depend on a large array of items, *inter alia*:

- the economic environment and the resources available (this item being generally one of the most important);
- the regulatory requirements (for workers, for the public, etc.);
- technical aspects and notably safety and security (because D&R are multi-risk and multi-contaminant situations);
- the stakeholders such as the nuclear regulatory authority, other governmental agencies, workers and contractors, residents and public, media etc;
- the waste strategy;
- the end-state.

The time dimension should also be taken into account when deciding the strategy because it adds uncertainties (*e.g.* the evaluation of exposure in the future) and gives room for changes in circumstances during the D&R. In this regard, changes to regulation (*e.g.* clearance criteria for waste) has proven to be very challenging and should be anticipated at best.

Experiences also show that the abovementioned items are all inter-connected, at various levels. As a consequence of this, the D&R plan should consider "all" of these items in an integrated way – in particular the risks associated with the D&R should be addressed together utilising a holistic approach rather than separately.

Proposal for a holistic approach for risks management. This was a particular focus of the workshop and experiences in the management of mixed risks were presented: for example, radioactivity and conventional and industrial risks [15, 22], chemicals [22], heavy metals [21], asbestos [8, 18], beryllium [20] or phosphorus [21].

A general methodology for a holistic approach was drafted by the participants:

1. First, identify all the relevant hazards (within pre-determined boundaries because "all" risks cannot be considered). Lack of funding has been clearly identified *per se* as a risk.
2. Perform a risk assessment and rank the risks to ensure a graded approach to risk management. Some risks can be quantitatively evaluated whilst others will rely on professional judgement. Uncertainties should be recognised and ascertained.
3. A multidisciplinary team (*i.e.* not limited to radiation protection) is better placed to perform the assessment and consider the different scenarios to select the optimum one, given the prevailing circumstances. Attention should be given to avoid dose transfer between the workers (*e.g.* to the decontamination or the waste personnel). The practical management of some risks may be contradictory (*e.g.* radioactivity and asbestos) and this remains a challenge.
   The team can also act as advisor (for the higher decision makers).
4. Decision-aiding tools such as logi-gramme and Multi-Attribute Analysis [9, 20] can help to choose the optimum variant between the scenarios. But it has been pointed out that these tools cannot be exhaustive (especially for considering aspects that require a judgement and relate to social and ethical issues) and should only guide the decision.

Still, there is no generic recipe for a holistic approach and the general methodology should be adapted to each case. Nevertheless, collecting the information, discussing the different scenarios with a formalised and documented process within the multidisciplinary team and with other stakeholders will provide objectivity and transparency to the decision and may also favour its agreement and implementation.

Decommissioning and remediation in practice

The practical examples and lessons-learnt from the presentations raised some transversal topics that can be seen as key elements for the practical implementation of ALARA in D&R.

Techniques. D&R technical actions seem industrially matured and these include the use of laser for cutting of elements, remote operation with robotic arm [9] etc. The decontamination and especially the full system decontamination [13] help minimize the dose rate field and facilitate the dismantling of big components (made *ex-situ*) and the volume of radioactive waste.

Phased operations. Radiation protection in D&R is different from operation: continuous changes in the installation, access to places not accessed before, with unknown radiological situation (referred to as "*opening the lid*" [20]). A good practice is to break down the ALARA plan into sub-activities and sequences (*e.g.* up to 23 activities in [8]). Phasing the ALARA plan should be based on the initial characterisation and this will allow a stepwise planning that supports the coordination of the work, hence the optimisation of the exposure, lower costs and less waste produced. Hold-points decided in advance can separate the different phases (e.g. dose rate in [7]).

Flexibility and re-adaptation along the way. Occurrence of deviations in the plan, discrepancies between expected and actual working conditions (discovery of stored waste [9] or buried contamination [15]) and other unexpected event (presence of bats [8]) have been experienced. Characterisation and monitoring of the situation should be performed regularly/continuously to identify these elements. Because of these deviations, the ALARA plan should be flexible enough to allow several iterations and updates (*e.g.* up to 12 for [9]). The phased operations approach will also assist in limiting the impact of such deviations and cope with them.

Timescales. It was confirmed that the preparation and the conduct of decommissioning operations is performed over long-time scales, often several years (operation took 9 years at [8], started in 2010 at [9] and 2012 at [12]). Remediation takes less time, but the radiation protection challenges and the complexity of the site are also much lower.

Globally, the available data suggests that collective and individual radiation doses have been well controlled. This is supported by the results presented by ISOE WG-DECOM [3]. The actual exposure of the workers is generally far below the initial optimised dose objectives, which have been recognised as conservative, especially for situations outside the nuclear sector.

The challenges in the management of wastes

Choosing a D&R strategy also means choosing a waste management strategy. The latter is also informed by the initial characterisation that is used to evaluate the type and the amount of wastes that will be generated. It has been pointed out that the data from the radiological characterisation of waste are not suitable for occupational radiation protection purposes.

The workshop also showed that a combination of factors should be considered in the management of waste and the following have been cited *inter alia*:

- the regulatory context and notably waste clearance policy and waste acceptance criteria;
- the disposal routes - sometimes there is no route available due to the absence of a national repository [19] or a lack of specific regulation [18];
- the volume of waste - from the presentations of the workshop, the total volume of waste produced by D&R operation can be (very) important and there is consensus to consider that as a big challenge which has a strong factor on the cost;
- the type of radioactive waste: "non-radioactive" (clearance criteria apply), low level or intermediary;
- and also, non-radioactive properties of the waste and notably hazardous/chemical properties. Chemical contaminants can be a great challenge because it will limit or prevent the management of waste (*e.g.* asbestos [18], PAHs [22]).

Several segregation protocols and techniques were presented for sorting the wastes: the volume of waste generally requires the implementation of automated methods, such as the FREMES system in [12] and/or a graded approach: simple measurement for rough segregation, then more complex measurement for a finer segregation [15]. Decontamination/cleaning or other specific treatment on the waste to meet the clearance criteria has been used and are recommended [7, 13, 19].

End-state

The site end-state is the objective of the D&R strategy. The end-state is defined by the future use of the site in combination with dosimetric criteria (that can be expressed in terms of activity concentration (Bq/g), or dose rate (nSv/h). The end-state shall be decided in the planning phase, with consideration to the site-specific factors, which in turn requires a dialogue with the concerned individuals. This is particularly important when the general public is living and working nearby (e.g. legacy sites).

It has been clearly stated that the optimum end-state is the one that reaches the overall best solution considering comprehensively radiation protection/safety (workers, public), the available resources and also environmental and ethical aspects. Indeed, remedial actions such as dismantling and decontamination performed to the extreme can be very detrimental to the site and the natural environment and examples of deep digging for removal of thousands of tons of soil [12] or cutting down living trees [11] has been presented. A balance between remediation and its consequences should be found to remove "*as much as contamination as reasonably achievable*" and achieving a 'sustainable D&R'. Sometimes it can be more reasonable to leave some contamination on the site; with restrictions placed on use or a surveillance plan being implemented.

Nuclear sector vs. non-nuclear sector

The workshop was the opportunity to compare and contrast experiences in the nuclear sector and in the non-nuclear sector. A key output is that the remediation plans are very similar between the two sectors from a technical point of view. The process starts with the (initial) characterisation survey and mapping, and the remediation techniques employed are broadly the same; as well as the protective equipment used and the personnel involved are classified as radiation workers etc. However, the radiation protection challenges are generally far lower in the non-nuclear sector and it was admitted that the approach can be over-cautious. Incidentally, it was pointed out that the industrial or chemical risks could be more challenging in the non-nuclear sector (*e.g.* phosphorus, mercury [21]) compared to the radiation risks. Managing these multiple risks is part of the holistic approach and it has been recognised as reasonable to accept a certain level of exposure in the management of another risk.

The management of waste – and the associated challenges – are also very similar. This is logical given that national regulation applies to the characteristics of the waste, irrespective of the type of installation who produced it. The decommissioning of a NORM site can generate very large volumes of radioactive waste (mainly low-level).

There are real differences in the context surrounding a nuclear installation, a non-nuclear installation and a legacy site. Stakeholders (public) are, literally, much closer to radiation in the non-nuclear sector and this can explain the aforementioned over-cautious approach. Also economy is very much at stake, acting as a factor of limitation (remediation in dwelling at the expense of the owner [13]) or as motivation (disposing of site approved for development in city centre [15], restarting the installation as soon as possible [19]).

Working groups recommendations

The working groups considered many of the issues already described above. The full working group presentations are available on the EAN website; a summary of the main recommendations is given below.

Working Group 1A. How to apply ALARA for workers during decommissioning and site remediation?

- The selection of appropriate personal protective equipment (PPE) should be made with care, taking into account the multi-risk situations, based on reliable characterisation, and also the comfort of the workers. A catalogue of protective equipment can be created and shared between operators and their Health Physics departments.
- The retention of the knowledge of the installation is very important to optimise exposure during decommissioning. Operators and regulators are to be involved.
- Creation of a centralised tool to capitalise all the data necessary in the planning, then the follow-up of D&R.
- Given the multi-risk situation, the decision on the techniques to be utilised for decommissioning should be agreed in collaboration with stakeholders in several fields (not limited to radiation protection).
- Training of the workers has to address all the aspects of safety, including the differences between operation and decommissioning. Refresher training sessions should be planned.

Working Group 1B. How to apply ALARA for workers during decommissioning and site remediation?

- It is important to display to top management the benefits in all areas of an ALARA analysis such as the reduction of waste amount, delays and cost.
- Top management (who decide the whole strategy of decommissioning) radiation protection culture should be increased.
- The better the characterisation and the accuracy of the data, the better the ALARA, and this is profitable to other fields. Using new technologies can be profitable to ALARA. Characterisation for waste management purposes is different from characterisation for radiation protection purposes. Conservatism should be avoided.
- Initial characterisation should be started early enough to avoid losing information. Collecting all the data is not necessary. The level of confidence in the data should be considered.
- The management of multi-risk situations is a challenge if radiation protection personnel and industrial safety professionals do not communicate. Technical experience in decommissioning is a rare resource and specific modules about radiation protection in D&R should be created.
- The ALARA plan is designed and implemented to reach the end-state. The end-state is mainly a political decision so attention should be given to the balance of forecast dose between the workers and the public. Changes in the regulation impacting D&R are minimized in the case immediate dismantling and can be anticipated if communication channel with the Authority are found.

Working Group 3. The holistic approach: how to be ALARA in the context of other risks?

- Decommissioning and remediation are multi-risk situations: deconstruction/remediation work risks along with radioactivity and chemical – and the sustainability of the strategy should also be taken into account as well as the views of the operator, the regulator and the public. All of this requires a holistic approach.
- A general methodology is to start with a hazards identification (HAZID), then a risk assessment to rank the hazard and then to implement controls to mitigate the risks in a graded (i.e. proportionate) manner. So in the end, It can be more reasonable to accept an exposure so to reduce the occurrence from another risk. The management of some risks may be in contradiction and this should be dealt with using the graded approach.
- Team working, not limited to radiation protection specialist personnel, is needed in the identification of the hazard and the completion of risks assessments. The view of other stakeholders (public) may be looked for.
- Each case is specific and the methodology for the holistic approach could be adapted to the circumstances. In addition, it shall be expected several iterations and adjustments during the implementation of the strategy.

Working Group 4. The challenges raised by waste and how to overcome?

From a strategic point of view.

- Choosing a decommissioning strategy means choosing a waste management strategy. Mixtures of strategies, like decay storage of large components, can be advantageous in view of ALARA.
- Consider using rooms and facility areas inside the facility under decommissioning as storage facilities in order to minimise transports.
- When setting up criteria for evaluation of the strategy it is important to clarify the weighting of the criteria between technical, environmental, economic, societal etc.
- Framework conditions for residual materials management in different countries should be compared in view of ALARA and improved international cooperation regarding use of existing waste management facilities can be considered to increase flexibility.
- Waste acceptance criteria for a repository should be in place before conditioning of waste. If not available, packaging should be done in a way that allows easy re-packaging with low dose for the workers.

From a technical point of view

- Good documentation of waste packages, information and knowledge keeping are part of the ALARA procedure.
- Lowering doses below ALARA can increase other (conventional) risks. The ALARA principle should be applied for individual doses instead of collective doses. How to compare real short-term doses with potential long-term doses when choosing a strategy?
- Use of remote techniques for inspections and maintenance in storage facilities might have a high potential for dose reduction in the long-term. Evaluate the possibility for self-shielding of waste packages in storage facilities.

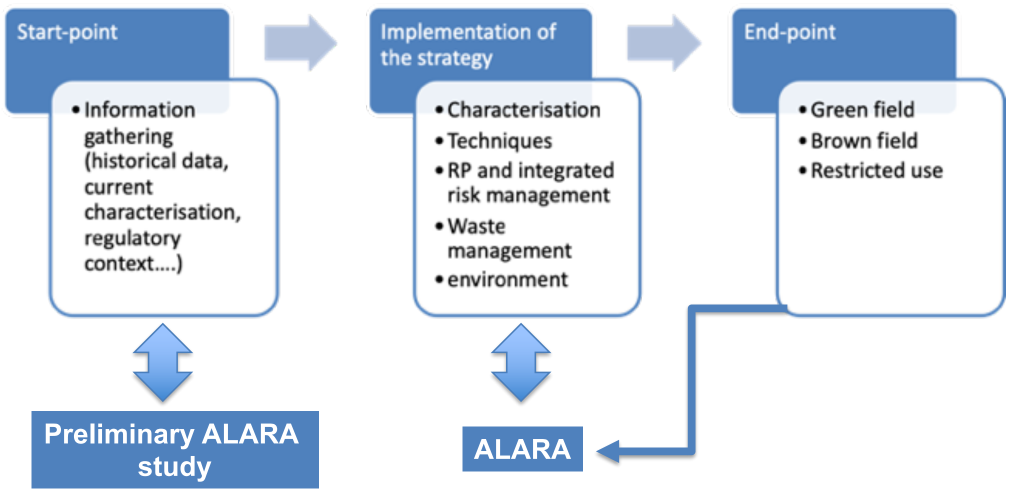

Figure 1. General scheme and key elements with regard to ALARA in a decommissioning and remediation strategy

WORKSHOP PRESENTATIONS AND REFERENCE

1. *Introduction*, Mr. J-M. Carrere, Direction of CEA-Marcoule Centre, France
2. *Presentation* of former EAN workshops on the theme and the reasons to organize a new workshop, Mr. F. Vermeersch, EAN Chairman, SCK•CEN, Belgium
3. *ALARA issues in decommissioning: the point of view of the ISOE WG-DECOM*, Mr. L. Vaillant, CEPN, France.
4. *IAEA recommendations and guidance with regard to radiation protection for decommissioning and site remediation,* Mr. J. Rowat, IAEA.
5. *Creation of NEA Committee on Decommissioning and Legacy Management*, Mrs. G. Kwong, NEA, France.
6. *Regulatory Requirements for Radiation Protection in Decommissioning in Germany*, Dr. B. Rehs, BfE, Germany.
7. *Scenarios and strategy for dismantling hot cell M2 at LHMA installation*, Mol, Mr. Ph. Antoine, SCK•CEN, Belgium.
8. *Dose estimation and optimisation during the decommissioning of the Low Flux Reactor in Petten, the Netherlands,* Mr. F. Draaisma, NRG, The Netherlands.
9. *ALARA Approach – Dismantling PIT7 Decladding Build*, Mr. F. Petitot, CEA Marcoule, France; Mr. C. Durain Orano, France.
10. *Radiological characterization to lay the foundation of ALARA. Experience from Mühleberg NPP,* Mr. E. Neukäter, BKW Energie, Switzerland
11. *The decommissioning of research installations at CIEMAT in Madrid*, Mr. J. C. S. Vergara, CIEMAT, Spain.
12. *The site remediation of the FBFC fuel cycle facility in Dessel, Belgium*, Mrs. C. Mommaert, Bel V, Belgium.
13. F*ull system decontamination, under ALARA point of view*, Dr. M. Knaack, TÜV Nord, Germany
14. *The Radium Action Plan in Switzerland*, Mrs. M. Palacios, SFOPH, Switzerland
15. *Remediation of a former gas mantle factory contaminated with radioactive 232Th*, Mr. A. Lowe, PHE, United Kingdom
16. *Radiation protection in the management of radioactive geological material in private buildings*, Mr. J. Amoudruz, IRSN, France
17. *Remediation and release of the Randstad uranium mining and milling site*, Mr. H. Efraimsson, SSM, Sweden
18. *Radioactivity and Asbestos at EDF/DP2D*, Mr. G. Ranchoux, EDF/DP2D, France
19. *Choosing a strategy for waste: recycling? disposal? Experience from an Italian Agency*, Mrs. M. R. Rosella, ARPA Lombardie, Italie
20. *Risk Management at Legacy Sites and Facilities: Implications for Proportionate Risk Management and a Graded Approach to Risk Assessment*, Mr G. Smith, United Kingdom
21. *Decommissioning of non-nuclear facilities: insight into the process*, Mr. A. Bloot, Applus RTD, The Netherland
22. *Restricted Clearance - PAHs leading to challenge in dismantling*, Mrs. S. Fleck, VKTA Rossendorf, Germany.

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ALARA News

EUTERP 8th Workshop: Optimizing Radiation Protection Training

The last EUTERP workshop just took place (10-12 April 2019) at Malta. This EUTERP Workshop considered how training can be optimized to make the best use of resources to improve radiation protection in practice and promote a clear radiation safety culture.

The following topics were part of the programme and the discussions:

- New developments and innovation in RP training;
- Needs analysis;
- Design of training;
- Evaluation of training;
- Trainer standards and competencies;
- Outreach and networking

A significant part of the programme was given specifically to discussions in working groups. The recommendations on education and training issues, will be addressed to relevant local, national and international stakeholders.

Workshop website:
http://academy.sckcen.be/en/Events/EUTERP-workshop--Optimising-Radiation-Protection-Training-20190410-20190412-99fa493d0868e81180cbecf4?leftmainmenu=1

EAN 19th workshop

The EAN will organise it's 19th workshop on the topic of **Innovative ALARA Tools**. Provisional objectives are:

- To present recent and emerging innovative ALARA "tools" that can be used in the different steps of the ALARA process.
- In particular, help in the dissemination of the **PODIUM** project's ALARA tools on the optimization of occupational exposure via personal dosimetry using computational methods.
- To investigate the benefits of these innovative tools for ALARA, and also identify potential limits and obstacles.
- Explore more broadly how innovative ALARA tools and the innovation may (re)shape the ALARA process for future years: ALARA, toward a (r)evolution?

The local organisation is taken care of by the Greek Atomic Energy Commission (EEAC, Member of EAN). The workshop will be hosted at the Congress Centre of the National Centre for Scientific Research "*Demokritos*", 15341 Agia Paraskevi (Athens' suburb) in November.

We will keep our Readers updated about the exact dates and the development of the programme. ■


Next EAN Workshop?
ALARA Tools
Athens, Greece
November 2019 *
* provisional date

* *
*

FAQ ALARA

Focus on decommissioning

How should we take timescales into account in determining optimized objectives for dismantling projects?

As in the case of facilities in operation, the optimized objectives will be collective and individual dose objectives. It is crucial not to make use of the fact that there is more time available to artificially reduce the annual doses. The objectives must therefore be overall objectives covering the entire dismantling project (or each technical stage), and only then should they be set with regard to target dates.

Can a dismantling strategy be modified solely for the purposes of radiation protection?

Of course, and this has happened many times. Some strategies would result in exposures in excess of the limits or produce dose profiles that are not at all reasonable. It is recommended that every eventuality be planned for, rather than waiting for a strategy to be underway before becoming aware that it has to be stopped for reasons related to radiation protection. Experience has shown that it is much less expensive to be well prepared in advance.

How important is the maintenance of the collective knowledge of a facility?

Often there are differences between the original specifications or detailed plans for a facility and how the facility is actually built. Often this is due to the building process identifying practical difficulties and overcoming them with minor modifications. Similarly over the life-time of a facility much can change in its physical structure, fittings, services and how the facility is used. It is important that plans are accurately updated and logs maintained of maintenance, what operations have been undertaken in the facility, successful approaches, lessons learned and the range of radionuclides that have been used.

This knowledge base is particularly important in taking an ALARA approach to routine maintenance work, refurbishment, rarely carried out operations and decommissioning. The knowledge of those that have been involved with the facility needs to be captured in an accessible form and where appropriate included in training. In some older facilities this enlightened approach to maintaining a collective knowledge base may have only recently started. Here it may be necessary to introduce processes to capture knowledge from long serving staff and those leaving / retiring or even by contracting former staff members.

What is the best way to motivate workers to take the ALARA approach on board when "their" facility is to be shut down?

In this case, it is important to remind them that they remain responsible for preparing for dismantling. The facility must be clean so that dismantling can take place in the best possible conditions. In many cases the groundwork for the motivation to take this professional approach, will need to have been made during the preceding years of normal operation, with an ALARA approach as integral part of the attitude of management and workers.

Text coming from ***Frequently Asked Questions on ALARA***, discussed at IAEA consultancy meeting, March 2010

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