Report from workshop on Radiation Protection during NPP Decommissioning, 16-19 June 2014, IAEA Vienna

1. Introduction

In the end of 2013 the IAEA initiated a project to develop guidance in occupational radiation protection and risk management for decommissioning of nuclear power plants (NPP) and research reactors.

Decommissioning of nuclear power is a growing business in the world. Work tasks during decommissioning (demolition etc.) will largely be conducted in a different type of work environment, compared with the work carried out during normal operation, both in terms of radiation exposure and industrial hazards to workers. The aim of this project is to provide for practical guidance on relevant issues in occupational radiation protection taking into account management of other industrial hazards to workers, in order to support the use of the existing safety guides on occupational radiation protection. The plan is to publish this guidance material in an IAEA Tecdoc. The project will include the planned activities during decommissioning (e.g. planned exposure situation), including potential exposures and hazards. Management of emergency situations is however not included.

2. The workshop

A workshop on occupational radiation protection during nuclear power plant decommissioning was held at IAEA 16-19 June 2014, as part of the IAEA's approved Programme and Budget for 2014–15 and is included under IAEA Project 3.3.1.003 on "Occupational Radiation Protection, with funding from the European Union.

The workshop, which was aimed at operators, service providers and radiation protection professionals involved in decommissioning activities, was attended by 15 experts from Belgium, Bulgaria, Canada, Denmark, France, Germany, India, Japan, Lithuania, Slovakia, Spain, Sweden, United Kingdom and United States of America [Annex 2 gives the list of participants]. The purpose was to exchange experiences in managing the protection of workers from ionizing radiation and other industrial hazards during the decommissioning of nuclear power plants.

The workshop consisted of the following technical sessions [Annex 1 gives the agenda]:

- Session 1 Occupational radiation protection experiences in decommissioning
- Session 2 Case studies
- Session 3 Occupational radiation protection challenges in decommissioning activities
- Session 4 Radiation Protection Management
- Session 5 Management of radiological and non-radiological occupational hazards

There were a variety of presentations (see Appendix 2) at the meeting, covering experiences from previously conducted, on-going and from planning of future decommissioning activities. The presentations showed both good examples and lessons learned with respect to occupational radiation protection. Also several interesting discussions took place during the meeting, covering a wide range of occupational radiation protection issues, such as:

Occupational radiological risk assessments, radiological characterization, radiation protection program, strategy and organizational issues, work planning, itinerant workers, radiation protection experts in the organization, monitoring of internal intake and of exposure to the lens of the eye, management of radiological and non-radiological occupational hazards, optimization of protection, role and use of dose constraints, engineered control versus using people and safety culture.

It is envisaged that the documentation from the workshop, together with documentation from a planned Technical Meeting, will feed into the development of the Tecdoc. The Tecdoc is not intended to be a comprehensive manual regarding radiation protection programmes for decommissioning of NPPs, but is intended to provide useful information on the various issues including good practices and possible pitfalls and how to avoid them. Recommendations or guidance that may arise from this project will need to fit into the overall radiation protection framework (requirements and guidance).

3. Workshop documentation

The documented output from the workshop consists of the following:

- A summary of the highlights (views and statements from participants) from the discussions taken place during the sessions presented in Appendix 1;
- Power-Points, and (with a few exceptions) written summaries of the technical presentations. A list of all the technical presentations is given in Appendix 2.

Appendices

1. Highlights from the workshop
2. List of technical presentations

Annexes

1. Agenda for workshop
2. List of participants

Appendix 1: Highlights from the workshop

Highlights in a chronological order from the discussions taken place during the workshop:

Monday 16 June

Session 1 Occupational radiation protection experiences in decommissioning

ws 1. Availability of RP resource to support decommissioning can be a significant issue - and it is likely that a bigger resource is needed than during operations.

ws 2. Decommissioning is more dynamic than operations and "surprises" e.g. with respect to non-documented radiological situations or non-planned radiological conditions are likely, demanding an increased flexibility of the RP personnel.

ws 3. Care is needed on deciding how much characterisation is needed initially - on the one hand to inform the methodology to be used and on the other hand to minimise the radiation dose.

ws 4. Although ALARA is seen as important in decommissioning there was little or no mention of dose constraints.

ws 5. There is considerable decommissioning experience on a variety of plants and using various techniques including the consequences for RP matters (e.g. generation of aerosols, secondary waste) in some countries, while there is little or no decommissioning experience in other countries.

ws 6. Additional engineering protection for decommissioning may include steel or other shielding. Note: the expected dose reduction gained from shielding should be compared with the exposure incurred by installing the shielding.

ws 7. There is not a generically preferred decommissioning strategy from an RP viewpoint - both immediate dismantling and safe enclosure are candidates. However, there may well be an advantage to dismantle ASAP because knowledge of the operating history is still accessible, and so is equipment. While it is true that external dose rates decrease for NPPs, transuranics will still be present, and with easy to detect nuclides gone or considerably reduced (e.g. Co-60 & Cs-137), monitoring and control of RP risk becomes more difficult.

Tuesday 17 June

Session 2: Case studies

Session 3: Round table on occupational radiation protection challenges in decommissioning activities

ws 8. It is likely that both the people doing decommissioning [managers, safety professionals and technicians] and those regulating it will need a different skill set than they needed during the operating phase of the NPP; in particular formal qualification and operational experience may be insufficient; some account of decommissioning experience is likely to be needed.

ws 9. There is not a "Golden Way" to achieve RP optimization in decommissioning – many ways are possible.

ws 10. The legal requirements vary considerably from country to country, for example some require a licence for each specific task within a decommissioning programme whereas others have a single licence; some countries require considerable detail at the task level whereas others require more of an overview leaving some flexibility; however it seems to be important that there is a clear adoption of procedures, documents and organisation that are fit for decommissioning (i.e. changed from operations) – authorization (if any) of RP programme follows these different approaches.

ws 11. There needs to be an evolution of documents and procedures from operations to decommissioning.

ws 12. Characterisation is helped by knowledge about the operation phase – plant operational records and interviews with staff (and maybe retirees) are useful.

ws 13. Nuclide vectors need careful derivation and consideration. For different purposes (inhalation protection, surface contamination, clearance etc.) different nuclide vectors characterising the same material might be bounding.

ws 14. ALARA implicitly includes the need to consider both radiation risks and conventional health risks.

ws 15. Dose constraints are sometimes used but the derivation of them is not always clear.

ws 16. Where contractors are used it is important to not only brief them on site safety requirements and provide any necessary radiation protection training, but also consider their safety culture and how it might need to be changed.

ws 17. Nuclides that are of minor significance during operations may well become important during decommissioning NPPs – notably alpha emitters; the possibility that leaking fuel has been present in an NPP should always be anticipated.

ws 18. There would be advantages in having RP input to both the decommissioning strategy and processes, and also to any contractual arrangements – this might be influenced by where the most senior RP person is in the organisation.

ws 19. The person in charge for RP in the decommissioning should be on an adequate level within the organisation that allows participation also in the high level decision making process.

ws 20. The system for OPEX doesn’t adequately cover decommissioning.

Wednesday 18 June

Session 4: Radiation protection management

Session 5: Round table on management of radiological and non-radiological occupational hazards

ws 21. Surprises during decommissioning include: finding that in the past people were allowed to take items away from the site after self-frisking it [either poorly or perhaps lower standards used historically for monitoring compared with current practices] so contamination ended up in people’s homes; unrecorded contaminated soil not detectable by routine surveys because it was covered with lead sheet and then concrete; previously unreported Sr-90 in the ground-water.

ws 22. Different cutting options are liable to have different benefits and drawbacks – these can include secondary waste production.

ws 23. Many decommissioning tasks are one-shot operations; that is they have never been done before in quite the same circumstances, and often will not be repeated.

ws 24. The End State for the decommissioning needs to be clearly defined; any changes to the required end state as decommissioning proceeds can have significant time and cost implications.

ws 25. Care is needed over using radionuclide fingerprints relevant to operations as they may no longer be relevant when decommissioning starts.

ws 26. A way to manage decommissioning on the operational level from an RP viewpoint is to adapt the system used for operational work, for example having a system of radiation work permits supported by radiological safety reviews that looks in detail at the specifics of the proposed work; the permit specifies any Hold Points & Contingency Plans and who is permitted to approve the go-ahead of the work.

ws 27. Pre-job briefings are important to understand the Scope of Work, and then initial briefs can be used to ensure the "leaders" understand and agree upon overall plan and controls, with subsequent Routine Briefs focussing on plan and controls for what is to be accomplished on that shift.

ws 28. During decommissioning there is a continually changing environment as infrastructures are dismantled, shielding removed etc. and temporary storage raw or processed radioactive waste increases.

ws 29. It may be helpful to have an ALARA and Safety Committee and set up ALARA Task Forces for specific jobs that are expected to be radiological significant.

ws 30. 3-D simulation of plant may be used to plan the work such as VISIPLAN, VRdose etc.

ws 31. A study in relation to decommissioning of a BWR looked at occasions when people could receive significant eye doses, to what extent a body TLD measuring Hp(10) is representative of Hp(3) eye dose, and how effective protective equipment is. The study showed that no routine measurement of dose to the lens of the eye needs to be done given the current plant status. Also it was found that photon radiation (rather than beta radiation) dominates at the plant and that the TLD registers a dose value that is representative for the dose to the eye lens. Relatively large distances to the potential sources as well as beta radiation shielding in the eye protection seem to be the reasons.

ws 32. Tecdoc 1731 "Implications for Occupational Radiation Protection of the New Dose Limit for the Lens of the Eye" has recently been published.

ws 33. It is important to note that ALARA implies a need to consider what can be done to reduce doses, but there is no obligation to arrive at a particular result – it should be the optimum given all the circumstances.

ws 34. The ALARA approach takes into account such things as Human Factors and the organizational context, workplace situations (changes may occur), culture, etc. as well as issues such as 'trade-offs' where a number of factors need to be balanced bearing in mind both radiation protection and socio-economic issues.

ws 35. Occupational safety is not only a matter of procedures and equipment; safety by design also has a role. This includes considering ergonomic/sociological aspects from the workers point of view. Thus occupational safety should be considered in the early phases of a decommissioning project, as well as radiation protection.

ws 36. Historical cladding failures should be anticipated which would give rise to: Americium-241, Curium- 242, 243, 244, Plutonium- 238, 239, 240 [Note Pu-241 (pure beta), decays to Am-241] Neptunium- 237; during decommissioning the ratio of hazard from alpha to beta emitters is often in range from 50:1 to 500:1 but can even be 1:1.

ws 37. Source term characterisation potentially impacts on many aspects of decommissioning including:

a) Effluent Sampling
b) Waste Management
c) Routine Surveys
d) Personnel Contamination Monitoring
e) Free Release of Materials (Clearance)
f) Air Sampling
g) Training
h) Instrumentation

ws 38. Radon Interference causes challenges to alpha-in-air monitoring.

ws 39. Personal Air Sampling (PAS) may be needed for dosimetry purposes, but should not be relied upon for categorizing the radiological hazard in areas, or for operational control of work. There can be differences from country to country on how to allow for the protection provided by respiratory protective equipment.

ws 40. If PAS is not used then it may be necessary to carry out extensive smoke tests to ensure general air samplers are in appropriate locations. Additionally local air monitors at the work places can be helpful.

ws 41. It may be necessary to develop a programme for Bioassay Intake Assessment of decommissioning workers [there may well not have been one during the operational phase of the NPP].

ws 42. There was general agreement that optimisation of radiological risks should take into account non-radiological occupational hazards, but a number of issues were identified.

ws 43. Although conventional industrial safety needs to be addressed there are liable to be aspects that are in harmony with radiation safety requirements and others that clash. For example there are both radiation protection and conventional safety reasons to avoid cutting techniques that are liable to injure the worker, or cause a fire; there is a clash when a potential radiation protection measure could give rise to an occupational safety hazard, for example protecting against a H-3 intake could lead to a loss of air and therefore asphyxiation, or to minimise secondary radioactive waste generation rubber covers for the feet of a ladder were removed.

ws 44. It can be difficult to quantify the magnitude of conventional safety risks; in the first instance a way to deal with this is simply to decide if the hazard is present or not – e.g. asbestos, toxic chemicals, falls from height, electrocution, etc. conventional hazard risk assessment methods can be used for risk quantifications.

ws 45. In some countries the regulatory body deals with both radiological risks and conventional safety risks, in other these regulatory functions are separate.

ws 46. Pre-job briefings should include not only radiation protection issues but also conventional safety issues.

ws 47. In addition to conventional industrial risks it is necessary to also consider other factors such as radioactive waste management, and transport requirements.

Thursday 19 June

Round table session on dose constraints (DC)

ws 48. The conceptual basis and IAEA Requirements for DC were outlined.

ws 49. The approach to DC both by decommissioning operators and regulators varies considerably from site to site and country to country.

ws 50. Some sites use a self-imposed administrative limit – not really a DC.

ws 51. In hospitals there is a lot of data on similar work so a DC would have a good evidential basis, but decommissioning tends to be a one of a kind activity so it would be very difficult to set a proper dose constraint unless there is a fleet of NPP that will be decommissioned in a similar way.

ws 52. In order to set annual prospective doses you need to know in detail what decommissioning jobs individuals will do for the following year.

ws 53. Dose estimates are often used as an aid to planning, and these estimates are reviewed and improved as decommissioning proceeds and it becomes clearer what the radiological conditions will be and what the nature of the tasks will be. The dose estimate (often collective dose rather than individual dose) may end up being either an over or under estimate – particularly if the quantity of work is not what was expected.

ws 54. There was some discussion on whether it was best to have constraints on a task by task basis or on an annual basis – both could in theory be used. Practical examples exist in different countries.

ws 55. There was some concern that doses within the dose limit as a result of an unplanned event during decommissioning could exceed a DC and therefore bring regulatory action.

ws 56. When decommissioning it is necessary to deal with what is there – often reality does not match drawings and plant records – so DCs are liable to be of less value than in other contexts. DCs are a planning tool in decommissioning rather than an operational tool.

Round table session on engineered protection versus using people

ws 57. Simpler solutions to engineering needs can sometimes be better than purpose designed equipment – more reliable, shorter timescales, cheaper, but perhaps larger doses; for example use of a remote controlled toy car to take measurements in high dose areas, use of robot arms from the car manufacturing industry.

ws 58. Procurement of equipment can be an issue – the licensee is still responsible so needs to be an intelligent customer for off the shelf equipment that has not been designed with nuclear use in mind.

ws 59. If the use of purpose built equipment is foreseen then time will be needed design, build, & commissioning – so long lead times to be expected. It is important for the engineering and radiation protection staff to have early engagement to avoid engineering a perceived problem out that in fact is not really a radiological problem and also to identify workable RP solutions.

ws 60. Decommissioning contractors with little or no nuclear experience may not necessarily use dose efficient techniques or equipment – so may need advice from the licensee; for example dismantling and deconstruction may need to be carried out within a ventilated tent to prevent the spread of contamination.

ws 61. While engineering solutions should always be considered when planning decommissioning operations, there can be sound reasons for rejecting them and relying on safe systems of work and personal protective equipment.

ws 62. It is good practise to require a decommissioning contractor to have to explain to the licensee the ALARA programme and to say why the method proposed was chosen and other options rejected.

Round table session on safety culture

ws 63. Some experience shows that it can beneficial to clean and paint areas to be decommissioned – not only will this make cleaning and decontamination easier as decommissioning progresses but it will have a valuable effect on worker attitudes. However other experience shows that by fixing contamination with paint, it makes clearance measurements extremely difficult. It becomes necessary to eventually remove the paint carefully as alpha contamination may be hidden behind the paint.

ws 64. Often contractors used in decommissioning projects will not have worked on a nuclear site before so may well need to have nuclear safety culture not only explained but also enforced by the licensees staff. The need for any auditing is minimised where the contractor’s staff are part of a team with experienced licensee staff.

ws 65. Provision of on-site training and understanding help acceptance of the need for rules.

ws 66. Sometimes experienced workers think they know enough to ignore procedures and take shortcuts. Empowering experienced staff to make suggestions for improvements to procedures may reduce non-compliance.

ws 67. While inexperienced people are liable to want detailed instructions regarding decommissioning work, experienced people are more likely to want some flexibility.

ws 68. It can be helpful to engage Trade Union Safety Representatives so they understand the reasons for procedures.

ws 69. Contractors from a different country may well have a different safety culture, and may well be used to different regulatory requirements.

ws 70. ISOE members have access to the names and contact details of RP Managers for various sites around the world – so queries could be addressed to them.

Appendix 2: List of the Technical Presentations

Occupational radiation protection experiences in decommissioning

- Radiological Protection within Magnox Ltd, UK
- Main challenges and gained experience in the field of radiation protection during implementation of decommissioning projects at Ignalina NPP, Lithuania
- Experience and analysis on radiation protection in decommissioning the Japan Power Demonstration Reactor, Japan
- Occupational Radiation Protection In The Environment of The Long- Term Storage, Slovakia
- Radiological Safety Aspects of Nuclear Power Plant Decommissioning – Indian Perspective, India
- German Experiences in RP during Decommissioning – Overview and Legal System, Germany

Case studies

- German Experiences in RP during Decommissioning – Example cases, Germany
- Radiation Protection Measures During the Decommissioning of DR 2, Denmark
- Dismantling of the PWR BR3 at the SCK, with, in particular, the removal of asbestos, Belgium
- Case Study – Bradwell Ponds Centre Bay Clearance, UK
- Lessons about alpha contamination in CANDU reactors, Canada
- José Cabrera NPP dismantling and decommissioning project, Spain

Radiation Protection Management

- Implementing a Radiological Work Control Program during decommissioning, US
- Implementation of the ALARA principle in the decommissioning project of the BR3, Belgium
- Implications of the new dose limit for the lens of the eye at service operation of Barsebäck NPP, Sweden
- Occupational safety: how to improve results with prevention through design, France
- Managing alpha contamination from Actinides (transuranics) during NPP decommissioning, US
- Bugey 1 project (movie), France