Technical Meeting on Radiation Protection during NPP Decommissioning, 29 Sep – 2 Oct 2014, IAEA Vienna

Meeting Report

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.

The background to the project is that decommissioning of nuclear power is a growing business in the world. Work tasks during decommissioning (e.g. demolition etc.) will largely be conducted in work environments that differ from normal operation, both in terms of radiation exposure and industrial hazards to workers. Although the IAEA has published safety standards in occupational radiation protection and in decommissioning, there is a need for practical technical guidance to support these standards. Therefore the aim of this project is to develop guidance on relevant issues in occupational radiation protection in decommissioning, taking also into account management of other industrial hazards to workers. The plan is to publish the guidance material in an IAEA Tecdoc. It will include the planned activities during decommissioning, but however not the management of emergency situations.

The first part of the project involved a workshop, which was organised for operators, service providers and other radiation protection experts experienced and engaged in occupational radiation protection in decommissioning of nuclear power plants or other nuclear facilities. The workshop was held in Vienna, 16 – 19 June 2014, with participants from different utilities and member states. The highlights from the workshop were presented during this Technical Meeting and will be used in the further development of guidance material.

2. The Technical Meeting

This Technical Meeting on Occupational Radiation Protection during the Decommissioning of Nuclear Power Plants and Research Reactors was held at IAEA, 29 September to 2 October 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 meeting, which was aimed at representatives of the relevant authority that holds responsibility for regulatory control of occupational radiation protection at nuclear facilities, was attended by 9 experts from Bulgaria, Canada, China, Finland, Germany, Hungary, Lithuania, Russian Federation, Sweden and three observers from OECD/NEA, ILO and EU. The list of participants is given in Annex 1. The purpose of the meeting was to identify and propose additional guidance that may be needed in managing the protection of workers against ionizing radiation, taking into account also non-radiological hazards, during the decommissioning of nuclear power plants and research reactors.

The meeting agenda (Annex 2) consisted of the following technical sessions:

- Session 1 Introduction and member states presentations;
- Session 2 Member states presentations;
- Session 3 Round table discussions on: Safety assessment of radiological and industrial hazards of workers;
- Session 4 Round table discussion on: Occupational radiation protection programme;
- Session 5 Round table discussion: Optimization of protection;
- Session 6 Round table discussion: Management of radiological and non-radiological occupational hazards.

All the member states participants were asked to give presentations on their experiences and/or views with regard to occupational radiation protection in decommissioning. These presentations are documented in power-point files, and are part of the documentation from this meeting. Appendix 1 gives a list of the presentations from the Member States. All participants were also provided with electronic copies of the presentations. Presentations were also held by the IAEA, NEA and ILO.

The discussions that took place during all the sessions have been documented in a summary (see Appendix 2). A first draft of this summary was discussed in closing session of the meeting and has also been circulated among the participants for comments after the meeting.

At the end of the meeting he participants were asked to give their view on what issues they consider to be of specific importance or interest in the preparation of guidance material. In brief, these views can be summarized as follows:

- The use of graded approach in legal requirements and/or license conditions, in transfer from operation to decommissioning, and along the decommissioning process were recommended as well as a use of graded approach within the regulatory authorities (e.g. management, inspection, and training);
- implementation of optimization of protection including the possible use of ALARA-program and appropriate use of dose constraints;
- characterization and control of the work environment (which will be continuously changing during decommissioning), considering both radiation and industrial hazards;
- contamination control and specifically an awareness of potential alpha- contamination;
- education and training of workforce, including also professionals and regulators;
- experience feedback, transfer of knowledge records and documentation;

The documentation from this Technical Meeting, together with documentation from the previous workshop, will be a major part of the input material in the development of the guidance material. This 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).

Appendices

1. List of member states presentations
2. Summary from discussions

Annexes

1. List of participants
2. Agenda of TM

Appendix 1 List of presentations from Members States

1. Regulatory requirements on ORP in Bulgaria and their implementation in the planning for decommissioning of KNPP units 1&2;
2. Radiation Protection during Decommissioning of Nuclear Facilities in Canada;
3. Overview of Occupational Radiation Protection in Decommissioning of Nuclear Power Plants and Research Reactors in China;
4. Radiation Safety at the Decommissioning - regulatory perspective; (Finland)
5. Radiation Protection in Decommissioning Projects in Baden-Württemberg (Germany)
6. Regulatory requirements in occupational radiation protection in Hungary;
7. Regulatory aspects of occupational radiation protection in decommissioning of Ignalina NPP; (Lithuania)
8. Regulatory control of radiation safety of staff during the decommissioning of Russian nuclear facilities;
9. Occupational Radiation Protection during Decommissioning of Swedish Nuclear Facilities.

Appendix 2: Summary from the discussions during the meeting

These summary notes are the documented output from the discussions that took place at the meeting.

General aspects

1. It is important for regulators to have a graded approach towards occupational radiation protection (ORP) during decommissioning and a systematic graded approach to all the hazards in the plant during decommissioning may be needed.

2. A graded approach by the regulator might include adjusting the qualifications that some people need for decommissioning (compared to that needed for operations).

3. It can be useful for regulatory requirements for decommissioning to have some flexibility to enable standards to be adjusted to the nature of the hazard.

4. The period between final shut down and start of decommissioning is not defined. The allowed activities in this period are different in each country. A clarification may be helpful.

5. A smooth change from operation to decommissioning should be possible.

Optimization of protection

6. The IAEA Safety Report "Optimization of Radiation Protection in the Control of Occupational Exposure" published in 2002 includes guidance on optimization of protection.

7. Keeping radiation exposure to the staff as low as reasonable achievable (ALARA) is the responsibility of the operator. ALARA programs may be established in a plant in order to fulfil this responsibility

Dose constraints – risk constraints

8. Dose constraints (DC) may be a useful tool in the planning of decommissioning activities, e.g. if an estimated expected dose for a work task does not exceed the selected dose constraint, the planned work task should be considered as justified and be subject to optimization of protection. This is mainly the responsibility of the operator.

9. In relation to operations and decommissioning on nuclear sites, use is made of Action Levels, Investigation Levels, and dose budgets but minimal use of DCs.

10. Estimation of expected doses and comparison of these doses to criteria for the decision (e.g. DC) may help to decide whether the planned work is acceptable or not.

11. No use is made of risk constraints in relation to ORP for decommissioning.

Collective doses – individual doses

12. Sometimes collective dose estimates can be used to choose between different options for decommissioning procedures or as an indicator for the need to optimize a decommissioning method.

13. Few countries have collective dose written into licences or requirements on collective dose in regulation or guides.

14. There is some use of collective dose to check the effectiveness of the radiation protection programme, but care is needed in relation to considering the scope of work. It can be of

regulatory interest if the outcome is either well above or well below the collective dose estimate.

15. In decommissioning the situation is liable to be continually changing so comparison to other decommissioning work is difficult unless similar work on similar NPPs is done (e.g. when there is a fleet of NPPs of the same design to decommission).

16. Databases can be useful, e.g. doses incurred and decontamination factors (DFs) achieved for primary loop decontamination

17. Individual dose is important for planning purposes, in particular the estimated maximum dose to any person.

Responsibilities and management

Management of radiological and non-radiological hazards

18. In some countries conflicts between radiation protection regulations and occupational health regulations exist and need to be decided by the (often different) competent authorities.

19. Decision about the precedent between radiation protection and occupational health should be carefully weighed and should be agreed upon by the (different) competent authorities.

20. Before start of a planned work, not only the radiation protection has to be assessed but the conventional hazards as well. The protection measures need to be agreed upon between radiation protection manager and occupational health manager.

Radiation protection organization and availability of resources in radiation protection

21. In all countries, operational charts for the plant exist and changes of the organization need an approval of the authority. The number of needed staff is not regulated and only in one country the needed staffs for the safety related work is laid down in the operational chart. The authorities have no legal basis for the approval of the number of persons in a unit, unless there has been an incident related to the number of the staff.

22. The determination of the number of persons needed for the safe operation of a plant is the responsibility of the operator.

23. There are no rules for the examination of a radiation protection organization, except the recognized rules of management. Only if there are indications, that work is not done properly, the authorities may intervene.

24. For decommissioning projects, the operators see the need for more staff in certain areas of their organization (radiation protection, waste management, occupational health), but also wish for more staff in the authorities and the expert organization for licensing, approvals and inspections during decommissioning.

25. It is likely that more radiation protection resource will be needed by the licensee for decommissioning because of the increase in work with significant radiological hazards. The on-site resource (employees and contractors) is the responsibility of the licensee. There are cost pressures to reduce staff numbers. It may be difficult for the regulator to influence this, but if something goes wrong there will be the inevitable question ‘why didn’t you do something about it?’

26. The radiation protection resource within the regulatory authority may well not be increased during decommissioning; indeed it may be reduced because the potential impact on the public is much lower during decommissioning than during the operation of the NPP.

27. It should be noted that there could be a few years lead time to get the necessary radiation protection resource because of the need for both theoretical and practical training for decommissioning work.

Safety culture

28. It was agreed that safety culture is important, for radiation and industrial safety.

29. There may well be a challenge getting contractors (particularly those who have never worked on a nuclear site before) to adopt the appropriate safety culture.

30. No examples were given of regulations specifically focused on safety culture, although it is recognised that various requirements indirectly impact on safety culture – so it can be difficult to regulate safety culture.

31. It is hard to inspect safety culture, as it is an attitude of the management and the staff. An attitude can however be observed with help of indicators for a good or a bad attitude. Various indicators were discussed; house-keeping, information transfer in the plant, decisions, interactions between the staff or between staff and inspectors. Observances of such indicators could be evaluated regularly and discussed with the management of the plant.

32. In June 2014 IRPA issued the final version of "Guiding Principles for Establishing a Radiation Protection Culture".

33. It was noted that while the IAEA BSS (GSR Part 3) includes a requirement to promote and maintain a safety culture, there is no equivalent requirement in the Euratom BSS, (but it is noted in the Euratom nuclear safety directive[1]).

Safety assessments of radiological and industrial occupational hazards

Prior radiological evaluation and characterisation

34. The licence holder needs to keep documents that will be needed for prior radiological evaluation and characterisation up to at least the end of the operational life of the NPP, and when decommissioning is deferred then the documents need to be preserved until at least decommissioning begins. Documents may be paper or electronic; in either case arrangements should be in place to ensure the documents are readable when they are needed.

35. It was noted that various documentation would be helpful such as operational records, results of surveys, design drawings, modification records, records of incidents etc.

36. The knowledge of long term workers is a valuable source of information, however well managed documentation is very important and could be a better source of information than the knowledge of long term workers.

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[1] COUNCIL DIRECTIVE 2009/71/EURATOM of 25 June 2009 establishing a Community framework for the nuclear safety of nuclear installations amended by Council Directive 2014/87/Euratom of 8 July 2014

(19) The establishment of a strong safety culture within a nuclear installation is one of the fundamental safety management principles necessary for achieving its safe operation.

37. The range of radio-nuclides important for decommissioning may well be different to those important during operations

38. Extensive radiological characterisation surveys may result in unnecessary (high) exposure to the workers doing the characterization, and it is necessary to be clear on the purpose of any such surveys. The operator and the regulatory body should agree on the aim of the survey and decide where data are needed, in which depth and when.

39. There may well be areas of the plant that are inaccessible or very hazardous before the decommissioning begins. Such areas can be surveyed as the decommissioning progresses but before any decommissioning work starts in the area.

40. In the absence of good characterisation information a conservative approach to worker protection is needed.

41. No matter how good the characterisation has been there are likely to be surprises such as finding a discarded door in the bottom of a fuel pond, or contamination from unrecorded incidents. Procedures for reaction in case of surprises may be helpful.

42. Workers should stop work if something unexpected is discovered during decommissioning so the significance of this can be considered and if necessary a new plan of work can be developed.

43. Characterisation should anticipate the possibility of alpha contamination arising from fuel cladding failures.

Identification of non-radiological hazards

44. There is liable to be a range of non-radiological hazards during decommissioning that were not significant during operations - this may include: asbestos, chemicals (e.g. PCBs), fire, working at height, confined spaces working, heat stress, electrical shock etc. Plant walk-downs can reveal some of these hazards but others will not be obvious.

45. In many countries there are different regulatory bodies for conventional safety and radiation safety, so it is important that there is cooperation between such regulators.

46. In some counties the licensee reports annually on conventional health and safety performance.

47. OECD/NEA published in 2013 a report[2], EGOE Case study 3, including the section “integration of risk management at nuclear power plants”.

Risk analysis and assessments

48. Both the expected doses and those from incidents should be considered; for incidents both the probability of events and their consequences in terms of dose need to be considered.

49. A database for lessons learnt during decommissioning could be valuable.

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[2] NEA/CRPPH/R(2013)3

50. From an information availability viewpoint immediate dismantlement would be preferred, but there can be safety (and radioactive waste management) advantages in deferment to take advantage of radioactive decay.

51. A good understanding of the hazards at a NPP helps to with the risk analysis prior to decommissioning.

52. Hazards during operation may be different to hazards during decommissioning, as parts of buildings and systems are touched, modified or dismantled, that were left alone during operation. For decommissioning each workplace needs to be examined and the hazards need to be identified.

Radiation Protection Programme

Controlled and supervised areas

53. All countries have requirements and/or guides to set up controlled and supervised areas. Although there are similarities in the use of these areas (and of zones within areas) by various countries, the terminology and detailed criteria may differ. Some countries only use the expected dose of the individual workers, e.g. 6 mSv/h for closed zones, > 6 mSv/year in controlled areas, > 1 mSv/year in supervised areas. Some countries use additional criteria for the definition of controlled/supervised areas for decommissioning, e.g. contamination, aerosol concentration, H-3- or alpha-contamination.

54. All countries have means of contamination control at least for persons at the exits of the controlled areas or at latest at the exits of the plants. Contamination control ranges from hand-feet-monitors to whole body controls, some with, some without physical barrier. Systematic contamination control of material does not exist in some countries.

55. The controlled and supervised areas, established and used during operation, may need to be changed when entering into decommissioning; e.g. when contaminated systems are opened in areas where during operation no open contamination existed or if nuclides not usually expected during operation have to be considered, e.g. transuranic elements or H-3.

56. The controlled and supervised areas may change during decommissioning as well, e.g. when systems of closed zones have been dismantled and the dose-rates in these zones have dropped. Procedures for changes are therefore needed.

57. At the boundary of different radiological areas the necessary monitoring may be linked to a physical barrier or left to administrative requirements (these might not be followed – could be an issue for inspection); monitoring should cover both people and equipment.

58. During decommissioning, staff will need to move between zones to a greater extent than during normal operation. It may be necessary to put up physical barriers at the exits from controlled and supervised areas to force staff to use the contamination monitors and to prevent the spread of contamination. (Problem: measuring time needs to be reasonable short, as staff increases during decommissioning and therefore queue up at the exits in the evenings). If other means are used, a sanction and gratification system may help to ensure obedience to the rules, although inspection of implementation of administrative contamination control means could be a challenge. The management (and the inspectors) have to lead by example.

59. There is a definite need for contamination control of the material and tools leaving the controlled and supervised zones. Nuclide specific criteria may be needed. Where hardware is not available, radiation protection staff may be needed to enforce measurements.

60. The background radiation should be considered when siting monitoring equipment.

61. Intervention by regulators may include: requiring the licensee to extend the size of their controlled and supervised areas, downgrading the radiological qualification of people that skip required monitoring.

62. The protection measures for the workers needed in a controlled or supervised zone may change from operation to decommissioning. Procedures for changes are therefore needed.

Work planning and work permits

63. Work permits for decommissioning should be an adaption of the permits used for operations, and should take account of the prior safety assessment of the planned work.

64. In all countries work permit systems are used. They cover either specified work without time limit or specified work with a time limit ranging from one day to several weeks.

65. Work permits include at least the radiation protection measures.

66. It was noted that in addition to radiological permits there may well be a need for permits covering a range of other hazards. In some countries different work permits exist, e.g. an additional fire permit, or a permit for work in hazardous surroundings. In other countries the work permits contain all hazards and protection measures, fire and other hazards included.

Workplace monitoring

67. All countries have requirements and/or guides for workplace monitoring. In some countries monitoring is prescribed in detail, in some countries only general requirements exist.

68. Monitoring should be designed not only to measure the expected normal radiological situation but also to indicate any breakdowns in controls leading to changes in radiation or contamination levels.

69. A program for workplace monitoring needs to be provided for decommissioning activities according to the hazard at each workplace (including occupational hazards e.g. PCB). This program may be part of the licensing procedure or of a safety assessment prior to the start of decommissioning activities.

70. Hazards at the workplace may change during decommissioning. A procedure for the assessment of needed changes may be necessary.

71. Records of workplace monitoring need to be provided in a way, that allow their examination at all times and their storage over a long time.

72. It was noted that EPRI had published a report in 2013 “Alpha Monitoring and Control Guidelines for Operating Nuclear Power Stations, Revision 2” which may well be helpful for decommissioning.

73. WENRA published in 2012 “Decommissioning Safety Reference Levels Report” which includes On-site and off-site monitoring.

Assessment of individual exposure

74. Characterization of the radiological hazard is a crucial input to the decision on what dosimetry is needed for decommissioning.

75. Dosimetry used for operations may well need to be adapted to suit decommissioning (e.g. regarding bioassay).

76. During operation, monitoring of internal contamination is usually done by the use of whole body counters. During decommissioning activities other methods need also to be considered, e.g. samples of urine or of faeces from a selection of workers in environments where alpha or tritium contamination cannot be excluded.

77. All countries have regulations concerning dosimetry for workers. Most countries have both ‘official’ and operational dosimetry - for the legal dose record and operational day to day dose control respectively. Officially approved dosimeters are used for the official recording of the individual doses of workers and electronic dosimeters for the assessment of operation or decommissioning activities at the site;

78. The ‘official’ dosimetry has to be provided by a licensed/approved dosimetry service (how to carry out inspection of such services may be an issue).

79. The assessment of operational doses is part of the operator´s responsibilities in most countries. Some countries have authorities that do the assessment of individual doses on a regular basis, using the official dosimeters. In some countries the frequency of assessment depends on the workplace.

80. There is no difference in any country in the assessment of doses to staff or itinerant workers at the plants. In some countries the doses of the itinerant workers, which they have received in other plants, are examined by the authorities before start of work in the next plant.

81. Assessment of individual doses need to include all exposure types in a given situation (internal, external) and to use the relevant assessment method (dosimetry program, bio-assay program, workplace monitoring).

82. Assessment of individual doses may be used as an operational tool for the planning of decommissioning work. This is mainly the responsibility of the operator. However; this might be a difficult task, as the radiation work environment and the scope of work are continuously changing during decommissioning. In order to achieve this aim, new measurements, where possible, and data of the radiological characterization are important. Operational records, e.g. reports on incidents during operation, and knowledge of the former operational staff may be helpful.

83. A comparison of the estimated expected doses with actual doses after completing the work may be used in order to examine the work planning process. This is mainly the responsibility of the operator.

84. Assessment of individual doses may be used for the control of work, (e.g. setting guidance levels for doses with the obligation of revised planning if guidance levels are reached). This procedure may be a provision of the licence or a provision in the operational/decommissioning handbook.

85. Assessment of individual doses may also be used to compare decommissioning methods, e.g. comparison of different types of decontamination methods for primary systems. But: Comparisons are only possible, if plants and methods are similar.

86. Exposure of workers employed by the operator is normally well controlled, and doses are kept ALARA and below national dose limits. However the control of exposure of itinerant workers, especially specialists, is more difficult if they work in different plants. In specific situations, itinerant workers may even be exposed to annual doses close to 20 mSv. And if there is a need in a specific case for a worker to exceed 20 mSv, this might need an approval from the regulatory authority depending on the national regulations. The annual dose limit for occupational exposure differs between countries. Some countries apply an annual limit of 20 mSv, while other countries use 50 mSv as a limit in a single year, which in most cases is complemented by a 20 mSv averaged over five consecutive years.

Education and training

87. All countries have regulations for the education and the training of the staff for operation, which could be adapted to the needed qualifications for decommissioning.

88. It is important that the people involved in decommissioning are trained (and re-trained) according to the risks to which they will be exposed (radiological and industrial) – this includes not just task related hazards but also those relating to the use of personal protective equipment, such a dressing and undressing routines.

89. For decommissioning special training for hazardous surroundings may be needed. Use of ‘mock-ups’ or a ‘cold’ surrounding simulating the hazardous work place can help the licensee optimise decommissioning work activities – these can range from multi-million dollar facilities down to a simple pipe.

90. Experience exchange can be useful whereby visits are made to a reference facility to see how decommissioning and the associated training is done and in some countries the operators send personal to external decommissioning sites for training.

91. Qualification in occupational health may prove more important during decommissioning than operation, as fewer safety relevant systems need to be protected and less accuracy during work is needed. Additional education and training in occupational health and protection measures are therefore needed, for the responsible personal and the dismantling staff, but also for the authorities.

92. For decommissioning the focus of qualification may change e.g. waste management has a higher priority than during operation. The programs for qualifications need to be adapted accordingly.

93. In the course of decommissioning the radiation related hazards are getting smaller. The need to allow a decrease of qualification for some of the staff is recognized by the authorities, but the means to do so, is not sufficiently laid down in the regulations.

94. The Canadian Nuclear Safety Commission published in 2006 “Radiation Safety Training Programs for Workers Involved in Licensed Activities with Nuclear Substances and Radiation Devices, and with Class II Nuclear Facilities and Prescribed Equipment”.

Information and knowledge transfer

95. Record storage and retrieval is important particularly if there is to be a few decades deferment of decommissioning

96. Information between the dismantling staff and the responsible staff of a plant on radiological and occupational hazards is no obligation laid down in laws or ordinances, but is recognized by the operators and the authorities as an important tool for the protection of workers. The same applies for knowledge transfer, especially between new and experienced staff and between generations, e.g. in case of deferred dismantling or safe enclosure of a plant.

97. Information transfer between the operator’s own staff and itinerant workers may be achieved during training programs (new staff), during scheduled daily or weekly meetings, and during meetings for planning of measures in ‘pre-job briefings’ and assessment of work already completed in ‘post-job briefings’.

98. Regulations for the recording and storage of records exist in several countries. However there seem to be a lack of regulations with regard to management of aging records.

99. Operational records are an important tool for knowledge transfer between generations. They need to take into account the aging of paper (storage and regular control accordingly) or the development of the electronic storage mediums (from floppy to cloud). The control of stored documents needs the attention of the authorities.

100. Regular reports may be used for knowledge keeping and transfer, for example yearly reports including the description of decommissioning work, the doses of the workers for certain measures, problems and their solutions. In case of deferred dismantling or safe enclosure a listing of the problematic points of the plant (e.g. hidden contaminations) may be used for later planning.