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Memorandum

Conclusions and recommendations from the 17th Workshop of the European ALARA Network 'ALARA in emergency exposure situations'

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Abstract

The European ALARA Network regularly organises workshops on topical issues in radiation protection. In light of the Fukushima accident, the most recent workshop questioned the application of the ALARA principle in emergency exposure situations. This memorandum presents the conclusions and recommendations of this workshop. One of the outcomes is that the process of optimisation in emergency exposure situations should be flexible enough to be able to modify or refine decisions over the course of an accident. In the urgent phase, decisions must be made in a very time-constrained environment, based on scarce, uncertain and sometimes unreliable information. In this phase, optimisation and protection strategies are therefore developed and applied on the basis of conservative assumptions or 'reasonably foreseeable worst-case scenario' which could lead to an overestimation of the consequences. In the intermediate phase, knowledge of the situation improves, and more time is available to make the decision. This is reflected by adopting a less conservative approach, and transitioning to a more appropriate optimisation adapted as effectively as possible to the various exposure situations. When the situation is eventually stabilized (transition phase), there is time to shape the measures taken previously to reflect local conditions in the affected territories. In every phase, consideration should be given to the stakeholders, so that their needs and requirements can be incorporated as effectively as possible.

Keywords: emergency exposure situations, reference level, ALARA principle, radiation protection culture

The European ALARA network

The European ALARA Network (EAN[4]) is a non-profit organisation which was founded 20 years ago. Its objective is to promote a wider and more uniform implementation of the optimisation principle (ALARA) in all exposure situations. As part of its activities, the EAN regularly organises workshops on topical radiation protection issues where, in addition to plenary presentations, participants are engaged in working groups.

Workshop objectives

As stated in the recommendations of the International Committee for Radiological Protection (ICRP) (Publication 103 [1]), and in the European Basic Safety Standards (Euratom Directive 2013/59 [2]), the ALARA principle applies in emergency exposure situations (abbreviated here to 'EmES'). For the purpose of radiological protection, the practical implementation of the optimisation principle is supported by the use of reference levels. These are not dose limits, and represent indicators of the level of exposure considered tolerable for the exposed population (e.g. emergency workers, members of the public) given the circumstances. In addition, emergency plans should be based on an optimum protection strategy (defining what needs to be achieved and how to do it), i.e. resulting in more good than harm for the exposed persons and affected territories.

The objectives of the workshop were:

- To show the challenges posed by the optimisation of occupational and public exposures in emergency situations, as illustrated by some of the lessons learnt from the Fukushima accident.
- To review the national arrangements for assessing, monitoring and mitigating the radiological consequences of a nuclear accident.
- To review the arrangements for providing ALARA-based training and awareness for the various types of stakeholders engaged in the emergency response and long-term recovery actions.

The workshop was organised in conjunction with a NERIS[5] workshop on the 'State of the art and needs for further research for emergency and recovery preparedness and response'. The EAN workshop took place at the *Instituto Superior Technico* in Lisbon, Portugal, 15–17 May 2017. This memorandum provides a synopsis of the presentations and working groups discussions. All the presentations are available on the EAN website.

[4] www.eu-alara.net.

[5] The European platform on preparedness for nuclear and radiological emergency response and recovery, http://www.eu-neris.net.

Themes and issues arising

Guidance on emergency preparedness

The latest recommendations and guidance from key international organisations (namely ICRP, International Atomic Energy Agency, World Health Organisation, European Commission and the Nuclear Energy Agency) on the management of EmES were presented. The importance of the concepts of '*justification*' and '*optimisation*' in the development of protection strategies was commonly emphasised. Another element appears to be the use of preset '*dose criteria*' (referred to as reference levels, action levels etc) as tools to support the practical implementation of optimisation. The importance of the '*involvement and consultation with interested parties*' (stakeholders) were also commonly acknowledged and advocated.

However, some organisations (e.g. ICRP, Nuclear Energy Agency) recognise that the number of factors (radiological factors plus economical, societal, ethical etc) to be considered in a protection strategy is large, and their relative importance will vary with time and according to the circumstances.

Terminology

While the distinction between the various phases of an accident was globally accepted, there was a lack of consensus between the organisations with regard to their exact definition and the criteria to move from one phase to another.

Even when the emergency situation is over, environmental contamination may persist for a long period of time. Management of this long-term exposure is considered an 'existing exposure situation' (abbreviated here EES and already dealt with in the 14th EAN Workshop at Dublin in 2012). The decision to transition from EmES to EES is made by the relevant authorities based on the situation, but there is no pre-determined set of criteria to delineate this transition. Several presentations at the workshop showed that this transition phase was indeed blurred, both geographically and temporally, and that in practice both EmES and EES could occur concurrently at different locations. 'ALARA in the case of a radiological accident' could have been a more suitable title for the workshop.

Protection strategies

National arrangements. Examples of several protection strategies were presented by representatives from France, Germany and Austria. The development of these protection strategies was well planned, and illustrated a common methodology. Initially, there is consideration of the different nuclear accident scenarios that are reasonably foreseeable for a country, followed by an evaluation of dose assessments and possible outcomes, and lastly mitigation measures are selected with regard to 'dose criteria'. It appears that in planning, the application of mitigation measures is mainly driven by radiological criteria, although it is recognised that these criteria may not necessarily be applicable in practice. Furthermore, national arrangements generally consider only the urgent phase of the accident.

Discussions emphasised that, given the urgency and uncertainty of the situation, a robust emergency plan incorporating safety margins should be established in advance. The emergency plan should be based on the 'reasonably foreseeable worst-case scenario'. The concerns and needs of stakeholders should also be better considered when justifying the application of some measures (notably evacuation). However, because the urgent phase is inherently complex and unpredictable, and radiation exposures are highly variable in space

and time, it was acknowledged that the protection strategy must be flexible, to allow for the prevailing circumstances when applying ALARA (cf the dairy management strategy in Ireland, which is customised to the season).

Later—when the situation has become stable, and radiological conditions have been characterised—the conservative approach should be replaced by a more appropriate one, because there is more time to shape and adapt the protection strategy, with input from relevant stakeholders (health professionals, authorities, food sector, population etc). The 'optimum' approach will be achieved by taking economical and societal factors into consideration. In fact, it is possible that at some point in time (recovery phase, or beginning of EES) these factors will be considered more important than radiological ones. The establishment of forums to facilitate stakeholders' dialogue and information exchange, with the support of radiation protection experts, is key to successful outcomes at this stage.

Local arrangements. At this level, the approaches presented (from a French nuclear utility and Finnish and English nuclear regulatory bodies) were of a more practical nature. Some common issues were identified:

- the need for mobile and field equipment;
- the need for effective radiation monitoring—a strong focus on individual exposure measurements (dosimeters, dose alarm settings etc) was given;
- ensuring adequate communications during the emergency phase;
- the decontamination of personnel.

Technical developments on these issues are currently ongoing, arising from experiences following the Fukushima accident.

Reference levels (RL). Formally defined by ICRP as '*the level of dose or risk, above which it is judged to be inappropriate to plan to allow exposures to occur, and below which optimisation of protection should be implemented*' (cf §237 [1]), RL are used in selecting and benchmarking mitigation measures, and driving optimisation. There is still a large variation in the interpretation, application and values given to RL, especially when it comes to:

- their use in practice (action level, ceiling vs. floor value etc);
- the people exposed (RL can be set for (emergency) workers, responders or the public);
- the affected environment or medium (foodstuff, ground contamination etc)
- the unit of measurement (RL for the whole body (mSv) or a single organ (mGy); derived RL expressed in μSv h^{-1}, Bq kg^{-1} etc);
- the time frame (RL set for one event, for a month, for a year etc);
- their use in determining the applicability of emergency mitigation measures, such as sheltering, iodine intake, evacuation, relocation, resettlement etc.

From all the presentations at the workshop, it is remarkable that no two identical RL were presented (the use of different terminologies and concepts being complicating factors for comparison). This presents potential difficulties in applying RL in the accident phase, particularly in terms of communication and perception by non-radiation specialists. Furthermore, practical experiences from Japan and Belarus showed that RL are regarded as a demarcation between safe and dangerous. This is reinforced by the fact that RL are often put into regulation. Considering that RL are expected to be revised (when changing from EmES to EES), flexible and adaptable to the changing situation (e.g. decreasing with time, as in Belarus), this adds another layer of complexity to the situation.

In addition, participants agreed that derived reference levels might lead to over-conservatism, due to inherently large uncertainties in dose assessments. The example of RL derived from an annual effective dose and expressed in ambient dose equivalent rate in Japan was particularly relevant.

Dose assessment and monitoring

Software models are used with the objective of assessing the consequences of an emergency situation and providing support to the decision-making process. Speakers—mainly coming from NERIS—explained that evaluations can be performed at all stages: in preparedness (e.g. MOIRA software to assess consequences to fresh water), during an accident (by evaluating radiological consequences (e.g. PAN-EPR software) and assisting with decision-making (e.g. J-RODOS software)) and also in the recovery phase (e.g. ERMIN software). These models are an invaluable aid to the decision-making process, but care must be given to the interpretation of results which may be subject to multiple assumptions in the source term—resulting in conservative dose values, which also carry significant uncertainties. Furthermore, modelling should not be considered as a substitute for measurements in the field.

The output from the software models referred to above is a rich area for research and further development, with new themes currently under scrutiny—such as including a probabilistic approach (statistical distribution of the results) to help quantify the potential uncertainties associated with these assessments.

Stakeholders

The importance of 'stakeholders' was an overriding feature of the workshop. The presentations highlighted the fact that the stakeholders are very numerous and heterogeneous. It was recognised that the relative importance of the different stakeholders in the optimisation process will vary with time, and concluded that the (potentially) exposed members of the public and also specific individuals (health professionals, leaders of opinion, …) should be given more consideration in the decision-making process. This applies potentially to all the stage of the EmES. But the question of how to achieve this in practice remains unclear, and will be specific to the particular circumstances that prevail at the local level.

Radiation protection culture, information and training

Considering the large number of stakeholders and their diverse backgrounds, a large variation in the initial information, education, training etc regarding radiation protection has been noted.

Reported experiences of exercises, rehearsals and associated training showed good results for the preparation of emergency and first-response workers. Joint training sessions and multi-agency exercises, to stimulate the sharing of experience and encourage collaboration, were proposed. The very specific case of on-site workers in the late phase after an accident[6] was put under the microscope, and the application of ALARA for these individuals explored.

Information given to the public by the authorities should be clear, precise, understandable, unambiguous and creditable. If not, there is a strong risk that the public will lose confidence and trust with the authorities, and once this is lost it can be very difficult to rebuild —as was the case with the Chernobyl and Fukushima accidents. The workshop was an

[6] Precisely at the end of the 'intermediate phase' and the beginning of the 'recovery phase'.

opportunity to show successful examples of public communication campaigns carried out in Japan, Belarus and Portugal.

- **Planning**: Heightening public awareness (e.g. iodine intake, evacuation route) and radiation protection culture 'in peace-time' was recognised as necessary to assist in allaying fears of radiation, and for clarity and common understanding.
- **Urgent/intermediate phases**: Discussions agreed that communication to the public should be clear and concise, with careful coordination between the authorities, utility providers, scientific organisations etc, to avoid overlap and confusion. Key messages can be made in advance, using multiple media platforms (lectures, meetings, radio, television, social media etc).

In the longer term (recovery, beginning of EES), people in affected territories should not purely be lectured about the situation, but should instead be provided with awareness and support. Forums for discussing and sharing information with input from radiation protection experts should be set up. Tools (e.g. measurement devices like the D-Shuttle used in Japan) should be provided to help individuals understand the nature of the radiological situation, and support given to aid the development of 'daily-life radiation protection culture'.

Only when people feel involved and empowered in a situation will they begin to take responsibility for improving and adapting to the situation. Education and continuing support will enable communities to make informed decisions with regard to their living situation, and develop a sense of their own responsibilities for managing the situation and going forward.

References

[1] ICRP 2007 The 2007 recommendations of the International Commission on Radiological Protection. ICRP Publication 103 *Ann. ICRP* **37** 2–4

[2] European Union Council Directive 2013/59/Euratom of 5 December 2013 laying down basic safety standards forprotection against the dangers arising from exposure to ionising radiation, and repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/Q2 122/Euratom *Official Journal of the European Union* **L13** 1–73