EUROPEAN ALARA NETWORK

NEWSLETTER

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Editorial

You may have noticed this Newsletter has something new. What's the change?

The EAN logo!

We tried to choose something more modern in style but, of course, still illustrating the founding principle of the Network.

In the same vein, we have also changed the layout of the website: you can have a look and comment.

But what does not change is the spirit of the Network. The Newsletter, the website, the **workshops**, – and all the EAN Members behind them continue to be the core components of the EAN. We recently organised a workshop on the application of the ALARA principle in 'emergency exposures situations' and you will find down below some of its outcomes (pp. 2 - 16).

Surveys are also an effective way to share experience and you will find the results of a survey regarding radiation protection practices in dental radiography (p. 17).

The young generation is not forgotten; the Youth Club of the French Society for Radiation Protection and the Rising Generation Group of United Kingdom Society for Radiation Protection have drafted a survey intended for the young generation in radiation protection (p. 19).

Please share this survey to the young RP you know.

The EAN is not a closed network. **If you are interested we cordially invite you to join**.

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

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17th European ALARA Network Workshop “ALARA in emergency exposure situations” Conclusions and recommendations

EAN Newsletter Editorial Board

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WORKSHOP OBJECTIVES AND PROGRAMME

Emergency exposure situations can arise as a result of a nuclear accident, a malicious or terrorist act, or any other unexpected radiological event. They require a quick response and also potentially long-term sustainable countermeasures and remedial actions in order to avoid tissue reactions (deterministic effects) and reduce the stochastic risks of induced cancer and heritable effects. On-site workers, first responders, volunteers, etc. as well as the public can be exposed to ionising radiation – the magnitude of exposures will vary greatly and are generally complex to evaluate. The affected environment can be contaminated for decades.

The current ICRP recommendations (chapter 6.2 of ICRP Publication 103 [1]) and European Basic Safety Standards (EU-BSS, article 69 of Euratom Directive 2013/59 [2]) emphasise the requirement to apply the principle of optimisation (ALARA) in emergency exposure situations (abbreviated here to “EmES”). However, these situations are very complex, so it was decided to investigate the challenges posed by the application of ALARA in these situations, especially in the light of the Fukushima accident.

The workshop on “ALARA in emergency exposure situations” was organized by the European ALARA Network (EAN), in conjunction with a NERIS[1] – the European platform on preparedness for nuclear and radiological emergency response and recovery [3] – 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 *Instituto Superior Technico* in Lisbon, Portugal, 15-17 May 2017. There were more than 60 participants from 17 countries and almost half of the programme was devoted to working group discussions.

Several key themes and issues emerged from the workshop presentations and working groups and these are described below. On the final day, the conclusions and recommendations that reflected the content of the presentations and the working group discussions were presented and discussed. These are also summarised below. All the presentations are available on the EAN website[2].

THEMES AND ISSUES ARISING

Guidance on emergency preparedness

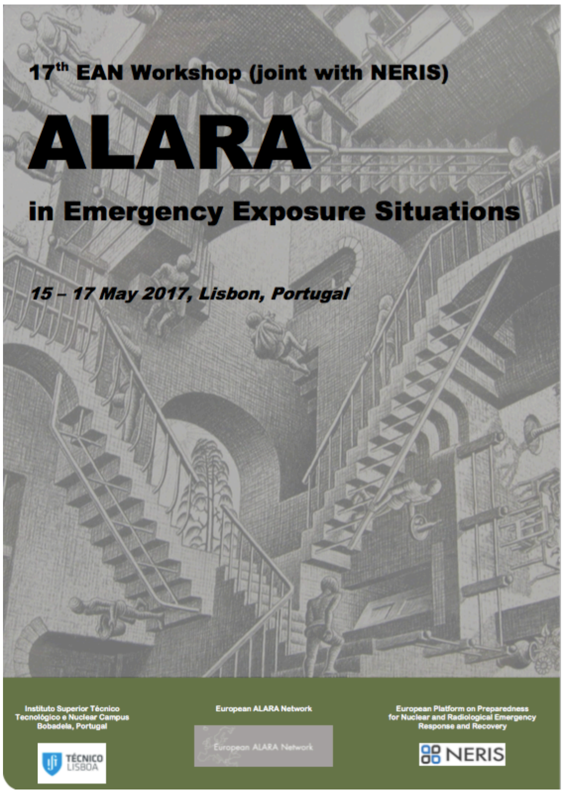
The workshop was used as a forum to present the latest recommendations and guidance from key international organisations (namely IAEA [4], ICRP [5], WHO [6], EC [7] and NEA/CRPPH [8]) with regard to the management of EmES. There are many common aspects and notably an emphasis on the concepts of “justification” and “optimisation” of the radiological protection strategy. Exposures shall be maintained below “dose criterion” set in advance (different labels may exist: reference level, action levels etc.). The importance of the “involvement and consultation with interested parties” (stakeholders) is also commonly identified and advocated.

But some organisations recognise that the amount of factors to be considered in a protection strategy is huge (radiological factors plus economical, societal, ethical etc.) and their relative importance will vary with time and according to the circumstan

[1] http://www.eu-neris.net

[2] www.eu-alara.net

[2] www.eu-alara.net



Terminology

It is also noticeable that there is no consensus between the organisations in the definition of the different phases of an accident (timeline) and the criteria for the transition from one phase to another. Still, we can globally distinguish between the "planning", "urgent", "intermediate" and "recovery" phases.

At some point in the time, the emergency situation will end but contamination of the environment may persist for a long period of time. Management of long-term exposure from emergency are considered as "Existing Exposure Situations" (abbreviated to EES and already analysed at 14th EAN Workshop at Dublin in 2012). The change from EmES to EES will be based on a decision by the relevant authorities, but there are no pre-determined boundaries that delineate the transition. Several presentations of the workshops showed that the transition phase is indeed blurred, both geographically and temporally, and that in practice the two situations may occur concurrently at different location. Finally, "ALARA in the case of a radiological accident" may have been a more suitable title.

Mitigating measures

Mitigation strategies generally encompass measures such as stable iodine intake; sheltering; evacuation/relocation; restriction on food, water and comodities; or some combination of these measures. In the EU-BSS [2], their implementation, in accordance with an optimised 'protection strategy', is part of the 'emergency response plan'.

National arrangements. The developments of several protection strategies were presented by representatives from France [9], Germany [10] and Austria [11]. The elaboration of these protection strategies was well planned and illustrated a common approach. For example, initially there is consideration of the different nuclear accident scenarios that are reasonably foreseeable for a country, then an evaluation of dose assessments and possible outcomes, and lastly mitigation measures are selected with regard to dose criterion. It appears that in planning, the application of mitigation measures are mainly driven by radiological criteria, altough it is recognised that these criteria may not necessary be applicable in practice. Furthermore, national arrangements generally consider only the urgent phase of the accident.

Discussions confirmed that, given the uncertainties and the urgency of the situation and for the sake of protection, a robust and resilient emergency plan should be established in advance. The emergency plan should be based on the most 'reasonably foreseeable worst-case scenario'. The potential concerns of stakeholders should also be better considered when justifying the application of some protective 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 (see notably the dairy management strategy in Ireland which is customised to the season [12]).

Later, when the situation has become stable and is characterised (intermediate phase), an overly conservative approach should be avoided because there is more time to shape and calibrate the protection strategy with inputs from relevant stakeholders (health professionnals, authorities, food sector, population etc. were identified [13]). The 'optimum' approach will be obtained by taking also economical and societal factors into account.

In fact, it is possible that at some point in the timeline (recovery phase, or beginning of EES) these factors will be considered more important than radiological criteria. The establishement of dialogue forums – gathering public, national/local authorities and radiation protection experts, where topics of concerns can be addressed and transparent information exchanged, will help in achieving trust and agreement.

Local arrangements (utility and organisation). At this level, the approaches presented were of a more practical nature and issues related to application in the field were discussed. Some topics common across the presentations (from EDF-FARN [14], STUCK [15] and PHE [16]) were identified:

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

Technical developments on these issues are currently on-going, fuelled by the experiences from Fukushima accident.

Reference levels (RLs)

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]), RLs are to be used for selecting and benchmarking mitigation measures, and driving optimisation. There is still a large variation in the interpretation, application and values are given to RLs, especially when it comes to:

- their use in practice (benchmark vs. action level, ceiling vs. floor value etc.);
- the people exposed (e.g. RL can be set for (emergency) workers, responders or the public);
- the affected environment or medium (foodstuff, ground contamination etc.)
- the unit of measurement (e.g. RL for the whole body (mSv) or a single organ mGy; derived RL expressed in µSv/h, Bq/kg etc.) ;
- the time frame (e.g. 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 of the workshop, it is remarkable that no two identical RLs were presented (the use of different terminologies and concepts being complicating factors for comparison). This presents potential difficulties in applying RLs in the accident phase, particularly in terms of communication and perception by non-radiation specialists. Furthermore, practical experiences from Japan [17] and Belarus [18] showed that RLs are regarded as a demarcation between 'safe' and 'dangerous'. This is reinforced by the fact that RLs are often put into regulation. Considering that RLs are expected to be revised (when changing from EmES to EES), flexible and adaptable to the changing situation (e.g. decrease with time like in Belarus [18]), 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 derived RLs expressed in ambient dose equivalent rate in Japan (µSv/h) was particularly relevant [17].

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. Orators – mainly coming from NERIS – explained that evaluations can be performed at all stages: in preparedness (e.g. MOIRA to assess consequences to fresh water [19]), during an accident (by evaluating radiological consequences (e.g. PAN-EPR [20]) and assisting with decision-making (e.g. J-RODOS [21])) and also in the recovery phase (e.g. ERMIN [22]). 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 carry also significant uncertainties. These models are an invaluable aid to the decision-making process but are not the only factors for consideration. Furthermore modelling should not be considered as a replacement for in-the-field measurements.

The assessment of predicted outcomes is a rich area for research and developments 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

'Stakeholders' was a transversal topic during the entire workshop. The presentations given highlighted the fact that the stakeholders are very (very) numerous. This is quite a peculiar situation. It has been 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 involvement and room . This applies potentially to all the stage of the EmES. But the question of how to practically achieve this remains globally unclear and it will probably be made on a case-by-case basis, at local level.

Radiation protection culture, information and training

Considering the large number of stakeholders, it has been noted a large variation in the initial information, education, training, etc. when it comes to radiation protection. Reported experiences of exercises, rehearsals, and associated training showed good results for the preparation of emergency and first-responders workers [23]. The need for joint training sessions and multi-agency exercises was advocated to stimulate the sharing of experience and encourage collaboration. The very specific case of on-site workers in the late phase after an accident[3] was put under the microscope and the application of ALARA for these individuals questioned [24].

The public does not require training but will need and ask for information: so strong attention should be given by the authorities because confidence is quick and easy to lose and difficult to rebuild (as epitomised during Chernobyl and Fukushima accidents). The workshop was the opportunity to show successful examples of public communication campaigns carried out in Japan [25], Belarus [18], and Portugal [26].

- Planning: Heightening public awareness (e.g. iodine intake, evacuation route) and RP culture 'in peace-time' was recognised 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, concise, with careful coordination between the authorities, utility, scientific organisations etc. to avoid overlap and confusion. Key messages can be made in advance and using multiple media platforms (lectures, meeting, radio, TV, social media etc.).

In the longer term (recovery, beginning of EES), people in affected territories should not purely be lectured about the situation but, instead, educated to enable them to understand it for themselves. Tools should be provided to allow them to assess the situation. Forums for discussing and sharing information with input from radiation protection experts should be set up. Tools (e.g. measurement devices [27]) 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'.

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

Only when people feel involved and empowered in a situation, will they begin to take ownership 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 going forward.

WORKING GROUP RECOMMENDATIONS

The working groups considered many of the above issues and a summary of their discussions and recommendations is given below. The working group's presentations are available on the EAN website.

1. Can the ALARA principle be fully applied in Emergency Exposures Situations for members of the public?

- ALARA can apply, but with added complexity and with the need for flexibility and evolution with time.
- In the planning phase, more effort should be done to define ALARA, especially in terms of relevant dose criteria, their use and understanding. The need to consider the justification, and feasibility, of proposed protective actions has been emphasised.
- It is also recommended to adopt an 'holistic' approach, that is to say taking into account all hazards (including non-radiological) and consider the extent of possible economic, social, psychological etc. consequences of the accident and the associated mitigation measures (e.g. hospital evacuation).
- Preparation of the public should be considered more (because an unprepared community will not react optimally).
- In the urgent phase, pre-planned protective strategies will apply and precautionary evacuation based on accident presumed conditions can be achieved (especially if dose projections are not available, like in Fukushima).
- For the transition phase, economic and societal aspects may override the radiological aspects, especially for the relocation and return of affected communities.
- The working group also identified specific topics to be addressed: the management of external vs. internal doses, the case of malicious acts, and co-operation between neighbouring countries.

2. Can the ALARA principle be fully applied in Emergency Exposures Situations for occupational exposed individuals?

- Due to the urgency and the need for quick action, scenarios of exposure should be planned for in advance and knowledge/experience from training and past accidents should be used to inform initial optimisation steps. Training has been re-emphasised as a necessity, and in particular the emergency services (e.g. fire, ambulance) should receive radiation-specific training.
- In the emergency phase, it is recognised there may be a need to work under higher dose reference levels and also to increase the number of exposed workers. Radiation monitoring should be continuous (to the extent possible) and internal exposures assessed (to the extent possible).
- In the intermediate phase, there is a necessity to ensure that radiation protection arrangements are in place for all workers. These arrangements should fit with the task. Radiation protection specialists should be integrated in the working team. In all cases, workers should be considered as occupationally exposed and optimisation driven to a reference level of 20 mSv.

3. Predict the unpredictable. How to ensure that emergency plans are optimal from a radiation protection point of view? (2 groups)

- Both groups advocated for the need of detailed and robust emergency plans to be set in advance and the need for training and exercise of workers and responders. The two groups recognised that the situation can go beyond that predicted and this leads to the need for adaptation of the emergency response (according to the situation).
- The potential for escalation of the incident should be formally taken into account prior to the accident, notably to identify what further resources (logistics) may be needed and the role of international co-operation and co-ordination (assistance, border crossing etc). It was recommended by one working group that, during an accident, a specific task group should forecast the "worst of the worst" scenario.
- Communication and trust will be key if an accident goes beyond prediction. Both groups concluded that more efforts should be made to improve the radiation protection culture prior to the accident; local authorities, health professionals and the public were mentioned. But serious difficulties in communicating about radiation protection were spotted, and notably the concept of RLs (judged to complex). So it is recommended to strengthen and harmonize communication in advance. ❑

Interestingly, the recommendations of the 2 groups are quite comparable.

References

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

[2] Council Directive 2013/59/Euratom of 5 December 2013 laying down basic safety standards for protection 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 2003/122/Euratom.

The references below are linked to presentations made during the workshop.

[3] Presentation of the NERIS platform, T. Schneider, CEPN (France).

[4] Considerations for the Development of a Protection Strategy for a Nuclear or Radiological Emergency? C. Robinson, International Atomic Energy Agency.

[5] Justification, Optimization and Management of Emergency Exposure Situations - an ICRP perspective, A. Nisbet, Public Health England.

[6] World Health Organization Recommendations on Iodine Potassium Intake, Z. Carr, World Health Organization.

[7] Euratom Directive 2013/59 - Elements to be Included in a Emergency Management System, B. Patel, European Commission.

[8] CRPPH Working Party on Nuclear Emergency Matters, C. McMahon, Environmental Protection Agency (Ireland).

[9] The French Doctrine for Nuclear Post-Accident Management: The Work of the CODIRPA, N. Tchilian, French Nuclear Safety Authority (ASN) (France).

[10] Optimised Protection Strategies in Nuclear and Radiological Emergencies – the German Example, F. Gering, German Nuclear Safety Authority (BfS) (Germany).

[11] Emergency Preparedness In Austria in the light of the new European Basic Safety Directive including also the ALARA Approach, M. Dauke, AGES GmbH (Austria).

[12] Strategy for the Management of Contaminated Food: the EURANOS Handbook, C. Organo, Environmental Protection Agency (EPA) (Ireland).

[13] Optimization and Robustness of Intervention Strategies ,C. Murith, Swiss Federal Office of Public Health (OFSP) (Switzerland).

[14] The EDF First Response Team (EDF FARN): Management of Radiological Risk in Emergency Exposure Situation, P. M. Eymond, Électricité de France (France).

[15] Finnish Experience in Emergency Preparedness - Experience of Cooperation Results, J. Sovijärvi, Finnish Radiation and Nuclear Safety Authority (STUK) (Finland).

[16] Setting Dose Reference Level for Emergency Responders in the United Kingdom, S. Ely, Public Health England (United Kingdom).

[17] Implementing Optimisation in Post-Accident Situation: Some Lessons from Fukushima, T. Shogo, Japan Atomic Energy Agency (Japan).

[18] Post-Chernobyl Countermeasures and Management in Belarus, V. Averin, Institute of Radiology (RIR), (Belarus).

[19] Modelling of Nuclear Accident Consequences on Freshwater Bodies, E. Gallego, University of Madrid (Spain).

[20] Using Modelisation of On-Site Consequences: the Example of Fluidyn-PANEPR Software, C. Souprayen, Fluidyn co. (France).

[21] RODOS: Real Time Online Decision Support System for nuclear emergency management, W. Raskob, Karlsruhe Institute of Technology (KIT) (Germany).

[22] ERMIN: European Model for Inhabited Areas: Use within a Wider Decision Making Framework, T. Charnock, Public Health England (United Kingdom).

[23] A Framework for Training of First Responders and Intervention Teams, L. Portugal, Portuguese Environmental Agency (APA) (Portugal).

[24] Responders On-Site in the Late Phase after an Accident - The ALARA Approach, J. F. Lecomte, French Radiation Protection and Safety Institute (IRSN) (France).

[25] The Experience of Activities of Q&A about Radiation in Daily Life after Fukushima Daiichi Nuclear Power Plant Accident, T. Kono, Japan Atomic Energy Agency & Young Researcher Association, Japan Health Society (Japan)

[26] Radioactivity from Fukushima Nuclear Accident Detected in Lisbon: Concerns of and Communication with the Public, M. Capucho dos Reis, University of Lisbon, Technologic and Nuclear Campus (IST CTN) (Portugal).

[27] The Use of Electronic Dosimeter for Individual Exposure Assessment and Management after a Nuclear Accident: the Example of the D-Shuttle in the Fukushima Prefecture, W. Naito, National Institute of Advanced Science and Technology (AIST) (Japan).

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Justification, optimisation and dose limitation following nuclear accidents – an ICRP perspective

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The ICRP system of radiological protection is a fundamental framework for dealing with any exposure situation in a systematic and coherent manner. At the centre, the system relies on the three principles of justification, optimisation and dose limitation. These principles are applied in the three exposure situations: planned, existing and emergency. ICRP Publications 109 and 111 (ICRP 2009a,b) focussed on emergency and existing exposure situations resulting from nuclear accidents, and were built on the experience of managing the Chernobyl accident in Europe in 1986, but were published before the events at Fukushima Daiichi nuclear power plant in 2011. An ICRP Task Group (TG93) was established in 2013 to update Publications 109 and 111 in light of the lessons learned from the management of Fukushima and from the series of dialogue meetings organised by ICRP in co-operation with national and local stakeholders starting in 2011. This short abstract aims to provide the current ICRP perspective on justification, optimization and dose limitation in emergency and existing exposure situations following a large scale nuclear accident.

The principle of justification ensures that any decision that alters the radiation exposure should do more good than harm. It is important to recognise that justification should be applied at different levels/scales and over different timeframes: situations evolve and prevailing circumstances change. For example, when planning for, or responding to an emergency exposure situation, justification should consider whether or not the overall protection strategy, will do more good than harm, taking into account the balance of harms and benefits associated with, for example, evacuation, sheltering and stable iodine prophylaxis. In the case of an existing exposure situation, justification applies initially to the fundamental decision to be taken by the authorities to allow people to live permanently in the long-term contaminated areas. Justification should then be applied on a smaller scale, where decisions on protection need to be taken at the local level. Here the implementation of strategies to improve the radiological situation must also do more good than harm in the broadest sense taking into account overall dose reduction and impact of the strategy on people and the environment in the affected area; specific needs of the individual should also be considered.

The principle of optimisation is intended for application to those situations for which the implementation of protection strategies has been justified i.e. at all levels and for all timeframes. Optimisation of the protection strategy ensures that the likelihood of incurring exposures, the numbers of people exposed and the magnitude of their individual doses should be kept as low as reasonably achievable, taking into account societal and economic factors. This means that the level of protection should be the best under the prevailing circumstances, maximising the benefit over harm. Optimisation is an iterative process. In order to avoid severely inequitable outcomes of the optimisation process, there should be restrictions on the doses to individuals from a particular source, through the application of reference levels.

The reference level can be taken as an indicator of the level of exposure considered tolerable, given the prevailing circumstances. Reference levels are values to inform decisions on protection strategies in existing and emergency exposure situations. Reference levels are tools to support the practical implementation of the optimisation principle firstly by identifying exposures that require more specific attention and then by reviewing the exposure scenario to further improve protection. Reference levels can be specified in measurable quantities (such as ambient dose rates, maximum permissible levels in foodstuffs) to facilitate their application in specific circumstances. These derived reference levels, must be realistic i.e. not too conservative.

In planning for and responding to wide scale nuclear accidents, ICRP TG93 is considering an update to its recommendations on reference levels to simplify their application (Table 1).

Table 1: Reference levels for optimising protection for members of the public in case of nuclear accidents

Emergency exposure situation	Existing exposure situation
100 mSv or lower [A]	10 mSv/y or lower [B]

[A] Either in a short period or over a year
[B] The long-term goal is to reduce exposures to the range of 1 mSv/y or less

Publication 109 recommended selection of reference levels in the band 20 – 100 mSv for emergency exposure situations. TG93 recognises that under some circumstances it may be appropriate to select a reference level lower than 20 mSv, hence its new recommendation of selecting a reference level of 100 mSv or lower. Publication 111 recommended selection of reference levels from the lower part of the 1 – 20 mSv/y band. For clarity, TG93 now recommends selecting an initial reference level of 10 mSv/y or below, with a long-term goal of reducing exposures to the range of 1 mSv/y or less. Following an accident, annual doses will decrease progressively over time due to natural processes as well as remediation and other actions that are taken. Depending on the circumstances (i.e. presence of long-lived radionuclides) this could take years or decades, during which authorities may use intermediate reference levels to help identify exposures that require attention and stimulate continued improvements in the situation. ❑

References

ICRP (2009a) Application of the Commission's Recommendations for the Protection of People in Emergency Exposure Situations. ICRP Publication 109. Ann. ICRP 39 (1)

ICRP (2009b) Application of the Commission's Recommendations for the Protection of People living in Long-term Contaminated Areas after a Nuclear Accident or a radiation Emergency. ICRP Publication 111. Ann. ICRP 39 (3).

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Development of a Justified and Optimised Protection Strategy for a Nuclear or Radiological Emergency

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Introduction

IAEA safety standards require Member States to "ensure that protection strategies are developed, justified and optimised, at the preparedness stage, for taking protective actions and other response actions effectively in a nuclear or radiological emergency" [1].

The concept of the protection strategy, comprising a suite of justified and optimised protective actions and other response actions, has evolved from the previously recommended approach in which interventions were individually justified on the basis of the dose that is avertable by that action, using the concept of intervention levels. The concept of protection strategy involves consideration of protective actions and other response actions, individually and in combination, on the basis of the reference level and generic criteria, expressed in terms of residual and projected doses, respectively. Such actions are justified and optimised taking account of these criteria and a range of non-radiological factors and impacts.

The new protection strategy concept has a potential impact on the national emergency preparedness and response (EPR) frameworks that have been in place for many years, particularly due to introduction of the new concept of reference level and the use of residual dose. Its application at the national level poses a challenge that can only be faced once all concerned parties have clear understanding of the implications of the new concepts and their possible effects on the existing EPR arrangements. Although the revised approach may seem to complicate the decision-making process, it is intended to enhance the protection of the public following a nuclear or radiological emergency, most notably by helping to ensure that the protection strategy is justified, i.e. it delivers more good than harm on a continuing basis.

Step-wise approach to developing a protection strategy

Recognising this challenge, the IAEA has been supporting Member States with the aim to increase awareness on how the new concepts introduced in the IAEA Safety Standards [1, 2] are intended to be applied. In addition, IAEA is developing technical guidance [3] on how to develop a protection strategy for nuclear or radiological emergencies, which includes detailed guidance on setting and applying reference levels and generic criteria and taking account of non-radiological factors and impacts in decision-making for a justified and optimised strategy. This technical guidance will include a stepwise approach for developing a protection strategy; a simplified version is illustrated in Fig. 1.

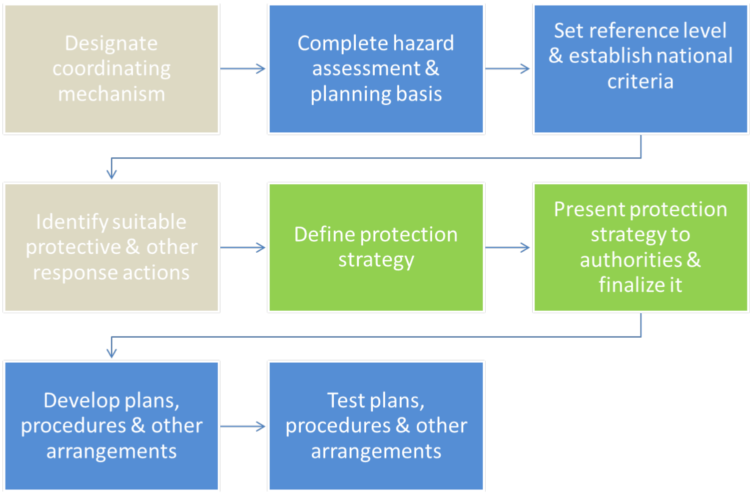

Fig. 1. Simplified illustration of a step wise process for development of a protection strategy for a nuclear or radiological emergency.

Some steps of this approach are likely to have been addressed in the development of existing plans, procedures and other arrangements in countries, and thus only need to be updated, while others may need to be developed from first principles. The definition of the protection strategy is the key stage in this process together with its validation and finalisation, following presentation to the relevant authorities. Defining the strategy involves multiple steps, including justification and optimisation, which may take place in an iterative manner.

A simplified illustration of justification in the overall process of developing and implementing a protection strategy is illustrated in Fig. 1

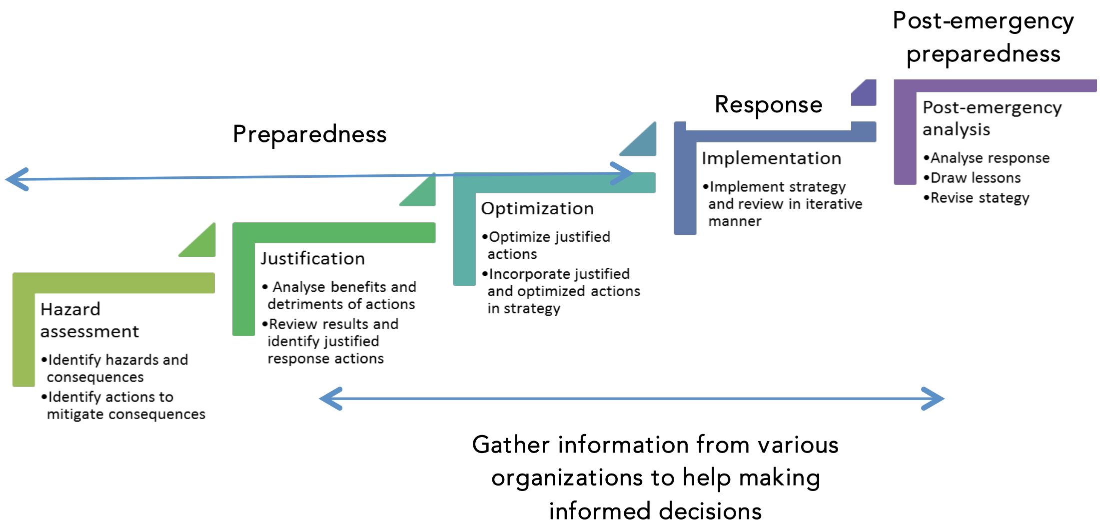

Fig. 2. Simplified illustration of deriving justified and optimised protection strategy.

Processes for justification and optimisation of the protection strategy

The principles of justification and optimisation are easily understood and there appears to be a general consensus on the considerations involved in justifying and optimising the protection strategy. However, there is less agreement and clarity on the processes deployed to derive justified and optimised protective actions. Member States generally apply informal processes during which emergency or crisis management organisations tend to demonstrate a greater ability to consider non-radiological factors and practical aspects in optimisation than radiological protection professionals. This is linked to their experience associated with the more frequent conventional emergencies for which they are responsible for managing.

In order to help Member States apply more formal processes for justification and optimisation and to identify the information that needs to be gathered, the way this information needs to be used, and the organisations to be involved for providing adequate input, the technical guidance [3] under development elaborates a process for justifying and optimising the protection strategy and identifies the main factors likely to influence justification and optimisation decisions. Such factors relate to, for example, the necessity to prevent severe deterministic effects and to reduce the risk of stochastic effects; the time frames in which doses might be incurred and timing that allows for effective implementation of protective actions; the impacts these actions may cause (e.g. on radioactive waste to be produced); and other environmental, economic, social and ethical aspects. For each of these factors relevant questions and considerations are being developed in the form of easy-to-reference tables, of which Table I is an example extract.

TABLE I: EXAMPLE OF FACTORS AND CONSIDERATIONS FOR THE PROCESS OF JUSTIFICATION

Factors	Relevant questions	Examples of relevant considerations
…		
Timing	• Are there timing constraints on decision making for the action and on its implementation? • How does the evolution of the emergency affect implementation of the action?	• At what stage does the action need to be taken in order to be effective? • How long will it take to implement this action and how does this timing relate to the timescale over which doses are received?
…	…	…

A similar table is being developed for factors and other considerations influencing optimisation, which includes additional factors associated with the nature of the emergency and available resources. The questions and considerations associated with optimisation are focused on the practicalities of implementing different options for protective actions. For example, some of the optimisation considerations associated with the direct and indirect economic aspects include:

- The direct costs directly associated with the implementation of the option, including:
  - Salaries of workers, costs associated with equipment and additional use of infrastructure, consumables (fuel, food, heating etc.), ongoing sampling and measurement costs, waste management costs.
- The indirect costs are those that are indirectly associated with the implementation of the option and may include:
  - The loss of revenue from businesses in affected areas (for example during evacuation); losses of use of other facilities (e.g. tourist sites arising during any access restrictions); and costs associated with loss of confidence in goods, e.g. foods subject to restrictions, and the consequent drop in sales;
  - Costs arising from interruptions in international trade that may occur if an area associated with

major trade routes, such as a major port, is affected. It may be possible to consider implementation of options that reduce the impact on international trade (e.g. by providing alternative routes for supplies).

The technical guidance under development [3] recognizes that different justification and optimisation approaches need to be applied at the preparedness stage and during the different phases of response to a nuclear or radiological emergency. The different approaches are driven not only by the assumptions made at the preparedness stage (e.g. on the possible evolution of the emergency) in contrast to the actual circumstances of a given emergency, but also by considerations of timing to allow effective public protection and the amount of information available to support decision-making. Immediately following the declaration of an emergency, the focus will be on implementation of precautionary and urgent protective actions based on observable or plant conditions. There is little or no time for optimisation or stakeholder engagement during this period and actions will be implemented according to pre-justified and optimised plans. Once urgent protective actions have been implemented, the focus will shift to characterisation of the situation and expansion or withdrawal of urgent protective actions and implementation of early protective actions, based on limited justification and optimisation processes. In the transition phase, once the situation has been brought under control, the emphasis will be on the detailed characterisation of the radiological situation and preparations for termination of the emergency and, when appropriate, for long term recovery operations. These processes are less urgent and allow for more detailed planning on the basis of the more reliable information that will become available during this phase. Thus, full justification and optimisation processes (as at the preparedness stage) are a necessary part of the overall response effort during the transition phase, including consultation with stakeholders.

Conclusion

The development of a justified and optimised protection strategy at the preparedness stage will facilitate effective and efficient emergency response should a nuclear or radiological emergency occur. This process requires involvement of various organisations with relevant responsibilities and relevant information and data to inform decision-making. Involving these organisations as early as possible and consulting all relevant stakeholders will help to promote common understanding, acceptability in the proposed strategy and the associated practical plans and arrangements. The IAEA is developing technical guidance to support Member States in developing protection strategies, recognising that many elements of such a strategy may already have been addressed in developing existing plans, procedures and other arrangements.
Justification and optimisation are key processes in the development of a protection strategy. However, there is a lack of practical guidance on what these processes involve. The IAEA is therefore addressing this need taking into account the new concepts introduced in the international standards [1, 2]

References

[1] Food and Agriculture Organization of the United Nations, International Atomic Energy Agency, International Civil Aviation Organization, International Labour Organization, International Maritime Organization, Interpol, Oecd Nuclear Energy Agency, Pan American Health Organization, Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization, United Nations Environment Programme, United Nations Office for The Coordination Of Humanitarian Affairs, World Health Organization, World Meteorological Organization, Preparedness and Response for a Nuclear or Radiological Emergency, IAEA Safety Standards Series No. GSR Part 7, IAEA, Vienna (2015).

[2] Food and Agriculture Organization of the United Nations, International Atomic Energy Agency, International Labour Office, Pan American Health Organization, World Health Organization, Criteria for Use in Preparedness and Response for a Nuclear or Radiological Emergency, IAEA Safety Standards Series No. GSG-2, IAEA, Vienna (2011).

[3] International Atomic Energy Agency, Considerations for the Development of a Protection Strategy for a Nuclear or Radiological Emergency, Emergency Preparedness and Response Series, EPR-Protection Strategy, IAEA, Vienna (in preparation).

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Optimisation and robustness of intervention strategies in emergency exposure situations

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According to the International Commission on Radiological Protection (ICRP), the intervention strategy in emergency exposure situations is based on the principles of justification and optimisation. The first means that intervention measures must be justified, in other words “do more good than harm”. With regard to optimisation, a reference level - “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. The chosen value for a reference level will depend upon the prevailing circumstances of the exposure under consideration” – is set.

As part of the intervention preparation phase, the intervention is divided up into phases and zones to facilitate application of the protection measures.

For each intervention measure selected, a trigger for the measure is established in the form of an intervention level (IL), a level that is usually set based on the effective dose received by members of the public. To facilitate its practical application in stressful situations, an operational intervention level (OIL) is also set, which is based on an easily measurable quantity.

This paper takes an accident at a nuclear reactor as an example of an emergency exposure situation.

Optimisation during the acute phase

During the acute phase, in other words before the radioactivity has been released into the environment, the basis for decision-making is provisional. At this point, we do not know whether it will be released, on what scale and what the immediate weather conditions will be. The measures to be taken, which cover both the risk of external and internal exposure, would be sheltering or evacuation, and simultaneously taking iodine tablets. The intervention level concerns the effective dose received by members of the public during the release phase, while the operational intervention level is a parameter that measures the probability and potential scale of the discharge, for example the temperature of the reactor core and the containment activity.

This situation is marked by the uncertainty regarding what will happen next and the relatively significant consequences of the release. Also, let us not forget that this is a very rare situation, which also has repercussions on the strategy. Consequently, this is no time for procrastination, but for implementing “generous” protection measures. This means that, given the uncertainty, it is sensible to incorporate a safety margin in decisions. This could be described as “optimisation under robustness constraints”.

Optimisation during the intermediate phase

Just after the release, decisions are based on the measurements on the ground to estimate the deposition and its dosimetric impact. By this time, maps would be available, although still rough, showing the ambient dose rate and depositions. The protection measures would be linked to exposure pathways. The protection measure against external exposure would therefore be to limit the time spent outside or to evacuate the site, while to protect against internal exposure, a harvest and grazing ban would be issued in the affected territories, and foodstuffs would be controlled. The operational intervention level concerns the ambient dose rate in the first case and the activity deposited on the ground in the second case. This situation is characterised by an approximate knowledge of the exposure, a potentially high risk to the public and a need to take action quickly. The intervention should be conducted in a calm and composed manner and the response should be calibrated. This means the measures should no longer be "generous", but instead adapted as effectively as possible to the situation. This could be described as "optimisation under efficiency and speed constraints".

Optimisation in the transition phase

During this phase, decisions are based on an examination of the practical situations encountered by inhabitants in their living environments. External exposure would therefore influence whether inhabitants can stay in their homes and the potential associated constraints, while the measures to reduce or avoid internal exposure would mainly involve checks on food contamination and agricultural processes. It should be noted at this point that efforts would no longer be based on the operational intervention levels set during the preparation phase, but on the analyses carried out on the basis of specific situations encountered.

During this phase, the action taken previously would be adapted to changes and local conditions. There is time to reflect and to plan protection measures. The public and stakeholders should participate in decision-making so their needs and requirements are incorporated as effectively as possible. This could be described as "optimisation under social acceptance constraints".

Conclusions

The methods for optimisation in emergency exposure situations evolve over the course of the different phases of the intervention, from a focus on robustness, through to efficiency and speed and finally social acceptance.

Throughout the intervention, the models and arguments used must be simple and transparent, partly because those in charge of applying them are not usually the same people who developed them during the preparation phase, so they need to be able to assimilate them quickly and often in stressful situations; and partly in order to be able to communicate effectively with the public, as this communication is key to the implemented protection measures gaining acceptance. Finally, it should be emphasised that decision-makers have an important and delicate task and that they should refrain at all costs from covering their backs by adapting their strategy to potential backlashes.

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On the Use of Thyroid Shielding in Dental Radiography. Result of a survey

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In order to gather a picture of the different practices in the field of shielding in dental radiography, the Ediorital Board and Mr. J. Holroyd drafted a short survey to gather more information about the regulations and national guidance regarding:

- collimation,
- thyroid shielding,
- paralleling technique
- and lead aprons

in relation to intra-oral, panoramic, cephalometric and dental Cone Beam Computed Tomography (CBCT) radiography.

Results

The survey was available on-line from October 2016 to August 2017 but only gathered 2 responses. Still, the results are presented in the table below.

Question		Answer from		
		United Kingdom (PHE)	Belgium (Univeristy of Leuven)	Sweden (SSM)
Considering intra-oral radiograph	is rectangular collimation ?	recommended *	recommended *	n.a
	are thyroid collars ?	recommended *	recommended*	mandatory (cf. SSMFS 2008:5, §4)
	is paralleling technique ?	not recommended, but used	n.a.	n.a.
	are lead aprons for patients ?	not recommended and not used	not recommended, but used	n.a.
Considering panoramic radiograph	are lead aprons for patients ?	not recommended and not used	n.a.	n.a.
	are thyroid collars ?	not recommended and not used	not recommended and not used	not recommended
Considering cephalometric radiography	are lead aprons for patients ?	not recommended and not used	not recommended and not used	n.a.
	are thyroid collars ?	recommended *	not recommended and not used	n.a.
Considering dental CBCT radiograph	are lead aprons for patients ?	not recommended and not used	not recommended and not used	n.a.
	are thyroid collars ?	not recommended and not used	not recommended and not used	not recommended

* recommended = in guidance. n.a. = not answered

With regard to intra-oral radiography, there is a consensus to recommend the use of:

- **rectangular collimation** (in this case, a collimator is a little metallic barrier with a small aperture so as to reduce the size and shape of the X-ray beam, ideally to the size of the film or detector);
- and **thyroid collars**. Swedish radiation protection authority SSM even makes them mandatory, based on a literature review. Whereas in other countries their use is only recommended in specific circumstances.

Protection can also be achieved by the use of:

- **Paralleling techniques** (to ensure overall alignment, notably because reducing the size of the beam can make aiming more difficult) (recommended in United Kingdom [1]).
- And **lead apron** (recommended in Belgium).

Only in the UK is there a recommendation to use thyroid collars for cephalometric radiography where the thyroid may be in the primary X-ray beam.

When it comes to panoramic X-ray or CBCT, no shielding is recommended or used due to the risk that the shield covers structures that are essential to the diagnostics. Although there is evidence that for large volume CBCT thyroid shields are appropriate to use [2], this is not yet recommended in national guidance.

Conclusion

The ALARA principle applies in dental radiography with the aim of reducing the exposure of patient and staff during diagnoses. Overall, the survey shows that the protection of the thyroid for intra-oral radiography can be effectively achieved with collimator and paralleling techniques. This has almost no cost and will also limit the potential retakes of radiographs. Thyroid shielding is also recommended in certain situations.
Protection is not recommended for panoramic and CBCT radiography.

But it should be noted that patient positioning, the use of fast detectors or film, field of view (projection geometry) and X-ray generator parameter settings also have a strong influence on patient dose.
So besides collimation and thyroid collar that should be implemented where appropriate, ALARA considerations should also include proper patient positioning, beam alignment and imaging system requirements. ❑

References

[1] Guidance Notes for Dental Practitioners on the Safe Use of X-ray Equipment, NRPB, 2001.

[2] The Use of Thyroid Shields In Dental Radiography, John Holroyd (DXPS, Public Health England), EAN Newsletter issue 37, February 2016.

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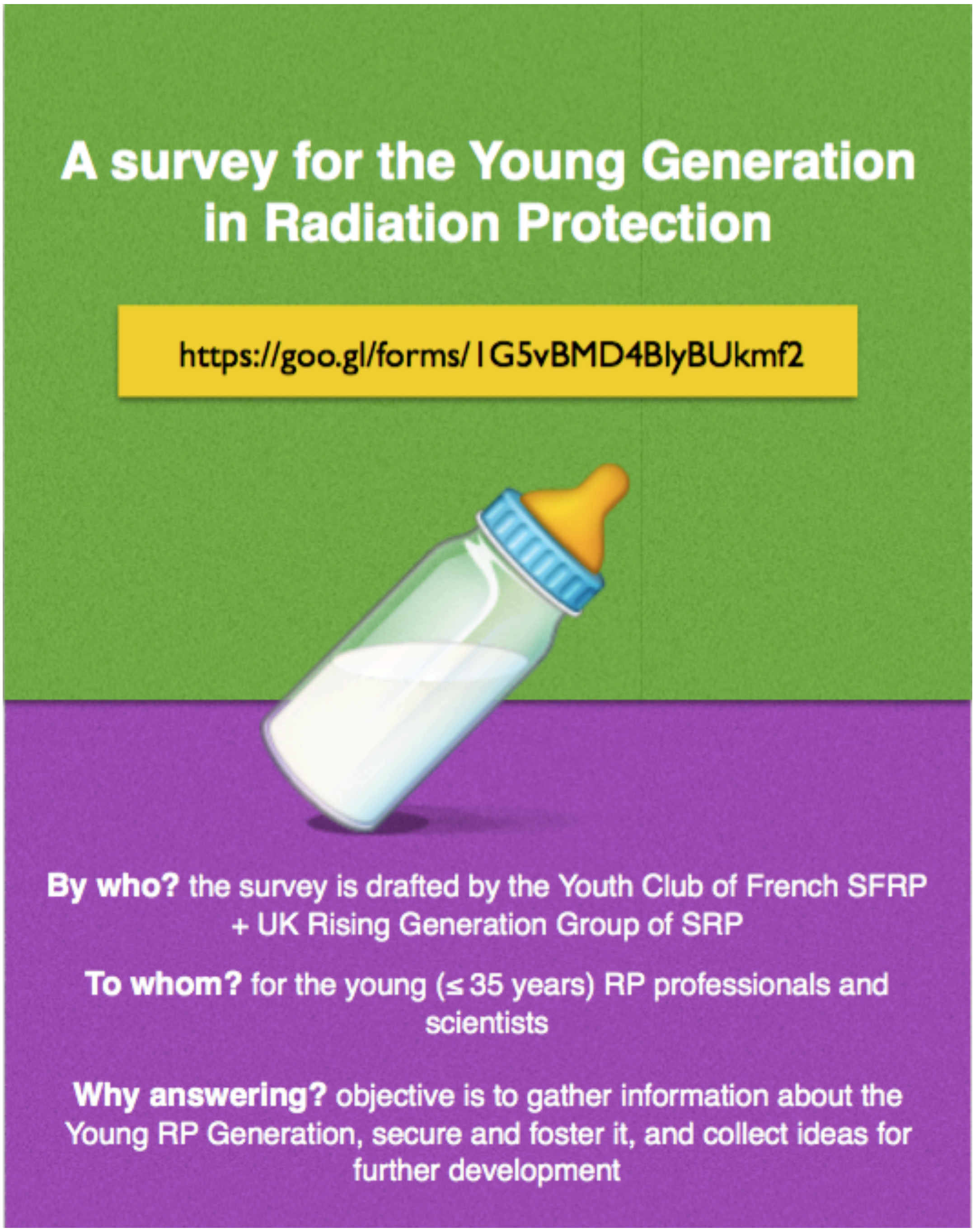
A survey for the Young Generation in Radiation Protection
https://goo.gl/forms/1G5vBMD4BlyBUkmf2
By who? the survey is drafted by the Youth Club of French SFRP + UK Rising Generation Group of SRP
To whom? for the young (≤ 35 years) RP professionals and scientists
Why answering? objective is to gather information about the Young RP Generation, secure and foster it, and collect ideas for further development

ALARA News

EAN at 4th ICRP Symposium / 2nd European Radiation Protection Week

First day at 4th ICRP Symposium / 2nd European Radiation Protection Week

The 4th International Symposium of the International Commission of Radiological Protection and the 2nd European Radiation Protection Research Week of the 5 European research platforms (ALLIANCE, EURADOS, EURAMED, MELODI and NERIS) was held in Marne-la-Vallée, near Paris, France 10-12 October 2017.

This combined event offered the opportunity for almost 500 professionals, experts and researchers worldwide to discuss their respective concerns and the current challenges faced in the areas of radiological protection, new research and better interactions with stakeholders.

The programme can be found at http://www.icrp-erpw2017.com/en/programme/18 and proceedings will be made available on the ICRP website. Some elements of the programme that particularly overlap with the EAN area of interest were:

- Ethics in radiation protection ;
- Optimisation of population evacuation zones following an accident ;
- Benefit vs. Risk in radiology, medicine and radiotherapy ;
- Medical incident/accident.

The symposium was the occasion for the ICRP Main Commission to set up a meeting with the Special Liaison Organisations who have formal links with ICRP. EAN participated in this meeting, which took place on Monday 9th October, and collected several requests for information from ICRP. This will be further discussed at the next meeting with ICRP in Geneva.

It was also an opportunity to meet and discuss with the representatives of the other organisations. ❑

Creation of European NORM Association (ENA)

The European NORM Association (ENA) was founded in Brussels on 27 September 2017. ENA was formed by merging the European NORM networks EAN_{NORM} and EU NORM, and also incorporates activities of the European NORM4Building project. The foundation was officially announced during the EU NORM Symposium 2-5 October 2017 at the National Physical Laboratory, Teddington, UK.

ENA is a platform of experts from NORM industries, radiation protection regulators, research organisations and services providers (e.g. laboratories and consultants) active in the field of NORM. The objective of ENA is to promote radiation protection in the context of exposure to NORM by operating as a European platform and forum for discussion, dissemination and exchange of information, training and by supporting scientific knowledge and new directions of research related to NORM issues.

ENA's activities will include, but may not be limited to, the following:

- Organise working groups on priority topics such as building materials, NORM in various industries and NORM in the environment
- Organise conferences and symposia in a format similar to the EU NORM Symposia, and continue workshops similar to those previously organised by EANNORM
- Maintain and extend the network of specialist throughout EU, possibly continuing the Contact Points known from EANNORM
- Close links to NORM industry associations
- Maintain strong relationship with IRPA, national radiation protection associations and other networks such as the European Radon Association
- Nurturing the close collaboration of EANNORM with the IAEA, especially through the IAEA's ENVIRONET NORM Project.

The new association will be stronger and more efficient, and avoid duplication of efforts of its founding organisations. ENA also aims to become an unbiased counterpart at EU level for the development, review and practical implementation of regulations and guidelines.

Benefits of ENA membership include, but are not limited to, the following:

- Opportunity to join one or more Working Groups (WG) and regular update on developments in the WG
- Access to a contact database of NORM experts from industry, academia, laboratories, consultancies and regulators across Europe (formerly called "Contact points" under EANNORM)
- Discount of 10% on registration fees of Workshops, Symposia and other events
- Free access to conference papers and presentations of the last EANNORM and EU NORM events.

Interested individuals and organisations are invited to become members. A provisional website has been set up at http://ean-norm.eu/ena/. It contains the statutes and Code of Ethics of ENA, membership fee schedules as well as the membership application form.

The Executive Board of ENA consists of Rob Wiegers (IBR Consult, The Netherlands, President), Christian Kunze (IAF-Radioökologie, Germany, Vice President), Stéphane Pepin (FANC, Belgium, Treasurer) and Christian Ahrens (NCC, Germany, Secretary). In autumn 2018, presidency and vice-presidency will be rotated. ❑

Next EAN workshop

The topic of the next EAN workshop will be "Site Clean-Up and Decommissioning" (preliminary title). This workshop will be jointly organised with ISOE network (http://www.isoe-network.net) that can gather the views of electricity generating companies.

The workshop will be held in the first quarter of 2019 at Marcoule premises, France or at Bruges, Belgium

We will keep our readers updated about dates and location. ❑

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FAQ ALARA – QUIZ

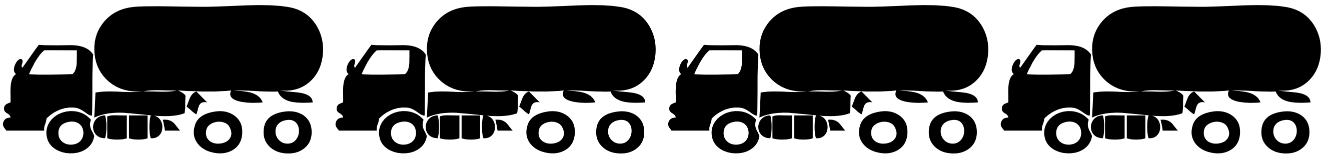
Let's imagine the transport by truck of radioactive material through a tunnel.
The total activity transported is ***X*** Bq and its accidental release could lead to a collective exposure of ***C*** H.Sv.

The probability of an accident occurring in the tunnel for a given truck is ***p***. You can pay to have one truck or two.

In the safety analysis, what is the safest option: one truck or two?

If one truck carries the entire load, the collective risk is: p × C.
This risk remains unchanged if the load is distributed over two trucks (or *n* trucks):
2 × (p × C/2) = pC

Deciding whether a factor should be included in the decision making process depends to the nature of the problem. In this case, even an important factor as the collective dose will be excluded from the safety analysis! ❑



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