The Future of Radiation Protection

Refresher Course / Workshop – 13 February 2019 – Utrecht

Final Report

Adopted by NVS Board, 11 March 2019

Contents

Introduction

On February 13th, NVS organized a refresher course on the Future of Radiation Protection. The refresher course was based on the report "Radiation Protection today – success, problems and recommendations for the future' by Rolf Michel, Bernd Lorenz, Hansruedi Völkle. In 2018 the Fachverband für Strahlenschutz (FS) adopted this report as a position paper. The FS has invited other IRPA Associate Societies to comment on the recommendations formulated in this report. The NVS gratefully acknowledges this opportunity and especially owes many thanks to Rolf Michel for lecturing on this topic during the refresher course.

The refresher course was attended by 42 participants, including eight members of the NVS Board and/or NVS-Refresher committee. All recommendations were discussed in four fall-out groups where every participant contributed to the discussion. The list of participants is given at the end of this report. All suggestions, comments and amendments have been collected. They are summarized below together with some general remarks.

NVS has adopted this report as a NVS position paper in her Board Meeting of March 11, 2019.

General Remarks

NVS greatly appreciates the work of the FS club of philosophers which resulted in the FS position paper on the future perspectives on radiation protection. The position paper attempts to redefine the role and the position of the radiation protection discipline. This redefinition is characterised by

- a shift of emphasis from hazard and risk to safety and benefits associated with intended use of manmade sources of radiation *c.q.* unwillingly exposure to natural radiation;
- a plea for better dose definition and use, optimised and simplified safety communication, improved implementation of the optimisation principle with regard to social and economic accounting;
- a plea to refrain from further tightening the current dose limits and a proposal to even increase the current eye lens dose limit;
- a call against unnecessarily conservative assumptions for dose estimates, a call to emphasise the principle of justice, to adopt a lower limit with regard to dose reduction, to improve the disclosure of the limitations of epidemiological research, a call for reasonableness to prevail and for a correct interpretation (and precision) of measurements;
- a need for a better preparedness for emergencies, a need to improve communication with the public during an emergency and the definition of an a priori strategy to deal with fear of radiation;
- the promotion of the overall professionalization of communication with the public, greater visibility in the media and during education, making radiation protection known and more attractive through multiple levels of training, and developing a strategy to undermine self-proclaimed experts.

NVS recognizes many of the problems identified in the position paper.

In general, the position paper seems to focus on the complexity of the system of radiation protection and the fact that communication about radiation and radiation safety between radiation protection professionals and non-professionals is often difficult. Simplifying for the sake of communication is however not seen as the ultimate solution to this problem. The solution might be found in the

radiation protection professionals learning how to communicate in a more appropriate way. A major switch in communicating radiation protection is to emphasize safety rather than risk. NVS fully supports this change that will certainly be a change for many radiation protection professionals.

The position paper advocates a holistic approach towards radiation protection. This is generally supported by NVS. Whereas the paper states that in the final assessment of radiation protection risks and/or safety all other hazards have to be taken into account, NVS is of the opinion that the paper is written rather unilaterally from a radiation protection point of view. NVS stresses the necessity to involve other hazards than ionizing radiation in a holistic approach towards radiation protection. In case of *e.g*. exposure to chemical and/or carcinogenic substances, by Dutch legislation on safe working conditions, safety experts have to comply with much more stringent limits. It is therefore entitled to wonder whether the hazard aspect of exposure to radioactive substances and/or ionising radiation may deviate significantly from the protective measures against other carcinogenic substances. A restriction to ionizing radiation only, seems not be justified. Risk assessments for various toxic agents should at least to some extent be in line. Extending the holistic approach offers the unique opportunity to promote the successes achieved by radiation protection.

The paper strongly focuses on (variations in) the natural background as the base-line for optimization. NVS appreciates this discussion – especially in an era where there seems to be an unnecessary drive to exclude every risk from our lives through ever lower limits – but we also recognize that this strong focus might lead to discomfort, especially when the wider holistic approach as described above, is adopted, but also when individual dose contributions are explicitly trivialised.

Statements and recommendations

1. Whenever possible, total doses instead of individual dose components should be considered, taking into account the natural radiation exposure and its variations in space and time.

   NVS interprets the goal of this statement to be risk communication. There are somewhat varying opinions on this statement, but some consistency is observed. The total dose

   - should preferably not be used to set the dose limits;
   - seems to be a useful tool for dose optimisation (ALARA) purposes;
   - seems to be a useful tool for risk communication, but it should be envisaged with whom one is communicating (transparent context framing):
     - occupationally exposed persons have got training and basic knowledge. Total dose should be mentioned, but also the contributing components to this dose;
     - the general public has got no training and hardly any or no basic knowledge. Added dose relative to the natural background dose upon communication with (high school educated) layman/patient is recommended.

   NVS notes that

   - the 'total dose' is actually a dose rate averaged over one year. The actual damage caused is a matter of 'total dose' delivered over a (short) time period, which becomes cumbersome when more (or unrepairable) damage is done than the human body is able to repair. The repair rate is stemming from cell biology studies and should be taken into account to set a limit for the 'total dose' delivered in a short period of time rate as well;
   - an assessment taking into account *all* risks (*e.g.* including household, traffic accidents) is not preferable, but NVS considers this beneficial provided that there is a uniform way to compare risks. This is to some extent the case for chemical / carcinogenic agents, but is lacking for other situations:
     - dose components like ingestion and inhalation may build on chemical ingestion and inhalation models (only distinct parameters will be DCC vs. [say] LD_{50}). The special issue for radiation doses is the risk of becoming irradiated from a distance, which – once chemical ingestion/inhalation measures are in place - is often the major contributing dose component;
   - a radiation dose from exposure to artificial sources should not disappear in the fluctuation of the background radiation. A radiation dose simply represents a certain additional risk of cancer according to the Linear No-Threshold theorem and should be the basis for (not) taking measures.

2. The system of limits, reference levels, constraints etc. is too complex for the various stakeholders in our society.

   NVS does not fully agree with this statement. We do however share the feeling that the system is too complex for communication with the public.

   Some members agree with the statement, they consider the system of limits and reference values being too complex (even for experts) and not suitable for every target group. The

system should, in their opinion, provide a tool for simplification to be able to communicate with non-expert professionals. Specifically, it was pointed out that the current system is not suitable for informing the public. The point was also raised that specific skills and competences are required (which are not always the key competencies of an expert). Therefore, the system should supply means and methods for simplifying the communication to the public and also to prevent probable misuse by pressure groups or commercial entities). It might be feasible to use a (adjusted) traffic light system for this specific purpose (see also 3). Finally, it was noted that, due to lack of harmonization, cross border activities are (unnecessary) complex; simplification and harmonization of the system is therefore required.
Other members, however, pointed out that one should not call the system complex, but well developed and thought out and thus providing good tools to use in practice by radiation protection experts. They deem the current system to be sufficiently developed with good nuances and useful, even though not specifically meant for communication to the public.

3. A traffic light scheme is a good a tool for communicating radiation protection / radiation risk.

The predominant opinion is that the traffic light scheme can be useful as a tool in risk communication with the public. It is a well-known signal.

A traffic light of just two colours (red - unacceptable and green - acceptable) is proposed to overcome confusing the public. The (un)acceptable risks have to be shown in perspective by using well-known risks. A more in-depth discussion is needed about the value of the threshold level between red and green when the proposed system of three colours is changed to two colours.

In order for the tool to be successful, the public will have to get used to the different traffic light schemes in non-emergency times. In these public information campaigns the transition from green to red and back should be explained. Naturally transition from green to red or vice versa should be based on solid scientific arguments. It is recommended to use as few schemes as possible (maybe only in case of emergency and existing exposures). We recommend to start with explaining a traffic light system in communication with the public in emergency situations. It is important not to use dose rates or cumulative dose in communication with the public. The symbol of the traffic light should be enough.

A traffic light scheme is not needed in communication with radiation workers in case of an emergency, since all workers are trained in radiation protection and are thus knowledgeable in dose units. Personnel not normally involved in the use of radioactive materials or radiation should be approached as members of the public. The traffic light scheme with two colours can be successful in the following occupational situations:

- At the entrance of area's with high active sources, like used in brachytherapy or NDO, to communicate whether the source is in position or not.
- In annual reports or as a tool in spreadsheets where dose limits or emission limits are exceeded

ALARA should be explained to workers in their training and not as a colour in the traffic light symbol.

Some propose to learn from the way risks of chemical substances are defined in three areas:

- Exceeding the Maximum Tolerable Risk (MTR) for chemical substances – defined as the chronical exposure that leads to a lifetime risk of cancer of one to ten thousand
- Exposures between the MTR and the negligible risk – defined as 1% of the MTR.
- Lower than the negligible risk.

4. Current limits in radiation protection should not be lowered anymore.

Within NVS, this recommendation is generally endorsed. The process for setting limits is complex and involves not only scientific knowledge but also political and societal viewpoints. Science must provide information about risks to society in a neutral and objective manner. Authorities must decide on appropriate levels of protection for their citizens. When relevant scientific developments give cause to do so, it must be possible to make limits - based on the current risk model - more or less restrictive. When setting limits, it should be remembered that a certain degree of conservatism is already in the system through a downward spiral of tightening ICRP, EU, Dutch Nuclear Energy Act to ultimately local regulations. Therefore a realistic assessment of risks in relation to the practical use of these limits is necessary.

5. RP Professionals should be very clear about the (contributions to the) total dose and the corresponding uncertainties

NVS considers this statement too general because of a lack of framework. It is unclear with which stakeholders radiation protection professionals are communicating. NVS interprets the term '*clear*' more as '*aware*'.

NVS notes that

- communication about uncertainties is particularly difficult, especially in communication with the public at large, which in general does not accept any uncertainties. In communication with the public, uncertainties may be incorporated in the explanation without explicitly mentioning them. Scientists and radiation protection professionals should exchange views on uncertainties;
- when doses (risks) have to be estimated, a worst-case scenario is adapted to counteract uncertainties. Next to this, the reality is often too complex to include in a realistic model. To explain such a scenario and associated outcomes, any sources of uncertainty should clearly be identified;
- the indication of uncertainties may appear relevant upon submitting a risk analysis in the context of an application for a license.

6. RP Professionals should be very careful in using ‘collective dose’.

Although the value and the limitations of collective dose are known, several scientists and/or radiation protection professionals occasionally use this term outside its scope. Unfortunately this type of data feeds self-proclaimed experts, who at best just misinterpret what has been read, or more often (ab)use it for their own agenda. Do not apply ‘collective dose’ for larger populations and do not link the manSv’s to potential detriment. The best defence against such “fake news” is not creating the data in the first place.

NVS suggests that

- once applied correctly, 'collective dose' can be a good tool, but the term 'collective dose' is not (or no longer) used in Dutch legislation;
- as a parameter 'collective dose' should only be used inside a facility to check if its local radiation protection programme operates well.

NVS recommends all scientists and radiation protection professionals also acting as peer-reviewers for (scientific) papers/articles: do not endorse articles in which you see this happening.

7. The LNT hypothesis and the multiplicative risk model should be explained better.

NVS has no clear opinion on this statement. The reactions are varying from total agreement (sufficient explanation available) to total disagreement (do not explain to the public at large). Again it is not clear if the explanation is directed to radiation protection professionals/officers or to the public at large. The uncertainties that exist now, will remain in the future. Furthermore the statement appears to abrade with the traffic light model (in *e.g.* public communication: "What does a double dose/double risk mean in the green area?", "How to explain a yellow dose?" – see also statement 5).

NVS therefore concludes that

- where radiation protection scientists need to have excellent knowledge of the LNT hypothesis and multiplicative risk model, the understanding of the hypothesis and model is fit for purpose among radiation protection professionals;
- the only non-professional body that should be informed of this in an appropriate way is the legislator;
- the general public is not a suitable stakeholder to be confronted with this statement giving rise to introducing more fear of radiation within society, to exposing one of the most fundamental sources of uncertainty and, potentially, to affecting the sense of security. So, NVS questions what the benefit of such an explanation would be and even recommends to leave out the explanation where necessary or desirable.

8. With respect to Radon, there is a large need for consistency in the way international and national organisations develop dosimetry and regulations. These concepts should allow simple communication with the general public.

The radiation protection system with regard to exposure to radon and its progeny is separate from the rest. The need for consistency may be agreed, but the radon risk factor from epidemiological studies (UNSCEAR) and from body models (ICRP) is varying by a factor of two. However, this factor of two is actually not so bad as these two risk factors are stemming from totally different approaches. Next to this, radiation protection professionals are very often implementing conservatism factors of ten or more into any dose assessment. For the time being, the best solution seems to be simply comparing the measured radon concentration with the national mean radon concentration, in which the expected variation in the measurement results is communicated in advance.

Varying opinions popped up. Given the overall presence of ^{222}Rn (radon), the high level of its geographical fluctuations, uncertainties regarding the dose conversion coefficients *etc*., there is not much sense to excessively draw the attention of the general public to radon issues. The public at large does not take the radon issue seriously.

NVS suggests that any inconsistencies have to remain within the radiation protection professional society. Providing to the general public an exaggerated feeling of the Radon-associated risks would lead to unreasonable fears and undesired financial burdens to the building industry.

9. The current dose limit for the lens of the eye should be withdrawn.

NVS strongly disagrees that treatment options could be a starting point for the determination of safety measures and therefore does not support the statement "*Cataract of the lens of the eye can be successfully treated*" (given during the lecture) as an argument to withdraw the current dose limit.

Within NVS opinions about the eye lens dose limit vary:

- the dose limit to the eye lens was changed because there were reasons to believe the limit was not prudent anymore. Maybe the value was badly chosen, but as it has been implemented there is no way back unless solid scientific evidence is available: progressive insight applies, so the current dose limit for the lens of the eye should be maintained;
- the introduction of the eye lens seems to have been a premature decision. The boundary between the population and worker dose limit (15 mSv/a) and the radiological worker dose limit (20 mSv/a) is too small to substantiate. In case there is no 'hard' argument to maintain the 20 mSv/a dose limit, it is proposed to set this to 50 mSv/a, a sufficiently large difference with the 15 mSv/a limit.

It was suggested that, as the eye lens dose is difficult to monitor, it should be recommended to wear so-called "lead glasses" in the relevant situations (*cf*. recommendation to wear gloves upon working with open radioactivity).

10. The 'social and economic' maxim in the ALARA principle should be followed consequently in all exposure situations.

This statement provoked an interesting discussion on what exactly ALARA is and what is contained in the term "social aspects". It was stated that the ALARA methodology should be the same for natural and artificial sources. Justification of measurements to be taken should be part of the application of ALARA. Public perception was discussed as an important parameter to be considered. NVS concludes that, basically, social, economic and some additional aspects should always be part of applying the ALARA principal. A possible method for the application of ALARA was put forward, using the cost per avoided µSv as a mere method for assessing whether further measures should be taken. An amount of 1 €/µSv was suggested.

11. Conservative assumptions in dose calculations should be avoided as far as possible.

This statement let to discussions and provoked partially contraire opinions. One group pointed out that the current system has several draw backs of using overly conservative estimations. Although conservatism in itself is found worthwhile, stacking of conservatism should be avoided. Using conservative scenarios in combination with conservative coefficients leads to extreme overestimation of exposures. Others noted that conservatism should always be applied to take into account unknown uncertainties thus preventing under-estimation of the dose.

12. Optimization must have a lower dose limit, in the order of the variations in the background.

NVS draws no definitive conclusion with respect to this statement, although the discussion provided useful suggestions how to proceed. The statement separated the attendees in two, quite distinctive, groups.

A large group agreed with the statement. It was stated that the current system enhances the costs without reasonable gain. In this group several suggestions were made regarding the lower dose limit which could be applied:

- A fixed amount (in euro) per avoided µSv (however, situations may occur where simple (cheap) measures should be applied anyhow).
- A lower dose limit of a fraction of 0.1 to 1 percent of the yearly unavoidable dose from man-made or man-manipulated sources of ionizing radiation (both for a single dose as well as a recurring yearly dose).
- The Dutch system of Secondary (risk) Level.

One participant pointed out that optimization is always about “reasonable” and “taking economic and social factors into account”. Therefore, there always is a lower limit, just because the benefit of further optimization is not justifying the financial and social efforts. Following this line of reasoning the lower limit is situation dependent (which one attendee used as argument against a lower limit).

Some attendees did disagree with the statement. They stated that if one accepts the LNT model in combination with the optimization principle, there can in principle be no lower limit to optimization. The graded approach therefore remains the right solution to proportionate measures.

Last, but not least, some suggested (being neither fully pro nor contra) an alternative approach by which the suggested lower limit should not be regarded as a 'limit' but rather as a lower dose constraint.

13. RP Professionals should not follow regulations in a formalistic way. Their experience should be taken into account when establishing regulations and guidelines, thus allowing reason to prevail.

NVS fully agrees with this statement. The radiation protection expert must have sufficient opportunities to interpret legislation in order to establish both a safe and pragmatic

approach to the radiation protection needed. Depending on a wider or stricter interpretation of the ALARA approach it should be welcomed to overrule some ALARA aspects in case of a (too) strict ALARA interpretation which could lead to unnecessary and partially even counterproductive measures. This would *e.g.* be the case if on one hand, a measure increases the dose (within the given limits), while on the other hand the same measure has significant (health and safety) advantages in other fields. A too strict emphasis on following regulations would imply that these measures would be regarded as "filling the threshold" and therefore even being forbidden.

14. There is a need for preparedness of informing the public in emergency situations, especially with respect to the system of flexible reference values and intervention levels.

NVS agrees that during an emergency adequate information must be provided quick and reliable. The two colour traffic light system as indicated above (see 3) would be very useful. This system should be clarified during general public information campaigns.

Basic information about ionising radiation and radiation protection should be part of secondary education. Media should be trained in using proper terminology. Reliable information channels from authorities via media to the public should be established in times of normal daily operation. New information channels (social media) should be considered and used to provide reliable information.

15. A strategy to deal with radiation fear in case of emergencies should be developed.

Perception of risks of ionising radiation should on the shortest possible term be changed from the risk to die to the probability to develop cancer. Experts in risk communication are necessary to make the public more familiar with risks or rather the safety of ionising radiation in comparison to familiar risks. Independent authorities (like RIVM[1]) are needed to provide this information. Information campaigns from publicly perceived high risk companies should be used on a larger scale in the Netherlands (*e.g.* COVRA[2] information for the local community).

16. RP Professionals should be prepared to inform media on behalf of their professional organizations. There should be a crosslink between NVS and other relevant bodies like the competent authorities.

NVS agrees that adequate information should be provided in a clear and understandable way. Either the communication experts need training in communicating radiation safety or the radiation experts need training in communication. This process should be an integral part of emergency preparedness and possibly also as part of a more general communication on radiation and radiation protection.

Authorities, NVS and companies/institutes should cooperate in an open way with common goals. All information should be available to all parties involved and processes on

[1] National Institute for Public Health and the Environment
[2] Central Organisation for Radioactive Waste

information exchanges should be ready up front. ANVS has a statutory task to communicate about emergencies. NVS can possibly play a role in training either the radiation protection professional or the communication expert. All channels of information must be used to inform the public. This concerns both classic media (TV/radio/newspaper) as well as social media.

17. A strategy how to cope with 'self-appointed' experts is needed.

NVS endorses this statement. A good communication strategy is needed to deal with self-appointed experts, some politicians and environmental action groups. They can have a great influence on public opinion. A number of members have indicated that NVS should play a role in dealing with self-appointed experts. As an organisation, NVS considers taking its professional responsibility in the event of incorrect statements in the media. Training, the availability of Q&A's and information material are matters that might be developed.

18. Radiation protection should be more visible in media and education. Basic education in radiation (protection) at school is necessary.

NVS supports this recommendation. Media and influencers should be educated/informed by radiation protection experts in regular situations and not only during radiological emergencies.

As society, NVS encounters the broader problem of an often irrational thinking and acting population (see e.g. vaccination problems, abuse of alternative medicine, and false information about healthy food). This is enforced by popular magazines, television programs and influential social media. Increasing the visibility of radiation protection information could be a starting point of changing this attitude. It is important that NVS takes effort to direct the media to NVS for trustworthy knowledge and perception on radiation and radiation protection. NVS, as a professional society can operate independently.

As far as education in radiation and radiation protection is concerned, NVS is of the opinion that physics teachers should provide correct information, NVS is willing to provide or check information available. Secondary schools seem to be the more obvious places for education on radiation and radiation protection. Consideration should be given to explaining the applications of radiation in daily life and the benefit radiation holds for society.

Organizing a school event by a RP-society can increase understanding of radiation and its applications.

19. There is a large need to make the profession more attractive. Opportunities for education have to be extended/improved. Chairs should be installed at universities.

In the Netherlands, the profession of radiation protection expert is mainly considered as an attractive profession. However, there is scarcity. It seems possible that a lack of proper payment (salaries are considered low) constitutes this problem. A lack of knowledge of radiation protection as a field of employment also plays a role. A way to improve the attractiveness of the profession might be to have the profession contribute more to occupational (field) research. NVS sees no need for further expansion of study programmes

or educational opportunities. The current programmes seem to meet the demand. However, education and training for continuous professional development seems to be lacking.

There is no university chair in radiation protection in the Netherlands; discussion on the need for a university chair has been going on for years. Even though the Netherlands is a small country, having one chair would stimulate radiation protection as a field of study and improve its visibility. Consideration should be given to dividing this chair into a few part-time chairs.

20. RP Professionals care for safety when dealing with ionizing radiation. They are experienced and keep their knowledge up to date. They strive for neutrality and objectivity. They advocate for transparency and understandability by laypersons of the system of RP and of the associated protective measures.

With the amendment of replacing neutrality and objectivity by integrity, NVS fully supports this statement. In our opinion integrity reflects much better the intention of this statement, whereas neutrality and objectivity are not in all situations achievable - most radiation protection professionals ultimately work for an employer. It was also noted that any professional should know and keep to his or her limits.

It would help the radiation protection field if radiation protection professionals are reasonably aware about other safety aspects in their field of work. So as that they can relate radiation safety to exposures to *e.g.* biological of chemical agents. This would fit into a holistic approach of risk and safety as mentioned before in the position paper.

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