Radiation protection in selected EU Member States
Evaluation of the answers to the Joint Project questionnaire on radiation protection

Joint Project – Nuclear Risk & Public Control, June 2019, update August 2019

In the Joint Project, European NGOs and research institutions cooperate since 2003 on safe and sustainable energy issues with a focus on anti-nuclear activities in Central and Eastern Europe. For more information: see http://www.joint-project.org/.

In 2018, the Joint Project sent a questionnaire to the national authorities responsible for radiation protection in our countries. We asked about the implementation of the BSS-Directive 2013/59/Euratom, the implementation and interpretation of Council Regulation (Euratom) 2016/52 and about Intervention levels and countermeasures in case of a radiological accident.

We received answers from Romania, Czech Republic, Hungary, Austria and Poland. However, not all questions were answered, and some answers would have needed further clarification that we did not receive.

In some cases, we complemented the answers with information from laws and ordinances.

In this report all questions and answers are listed and evaluated.

Answering authorities:

Country	**Authority which answered our questionnaire**
Austria	Ministry of Sustainability and Tourism (BMNT)
Czech Republic	State Office for Nuclear Safety (SONS)
Hungary	Hungarian Atomic Energy Authority (HAEA)
Poland	Head of the Department of Social Communication and Quality, President's Office
Romania	National Commission for Nuclear Activities Control (CNCAN)

1. Status of implementation/transposition

Question: What is the status of implementation of the BSS Directive (Directive 2013/59/Euratom)?

The BSS Directive had to be implemented / transpositioned into national law by 06 February 2018.

Country	Answer
Austria	Parts of the BSS Directive were implemented by amending the Intervention Ordinance (IntV 2017) and the Medical Radiation Protection Ordinance (MedStrSchV). The Radiation Protection Law is being amended in 2019, the related ordinances will be amended afterwards.
Czech Republic	The BSS has been fully implemented in Czech legislation.
Hungary	The BSS has been implemented in the Hungarian domestic legal system in 2018.
Poland	The draft Act amending the Nuclear Law and the Fire Protection Act (No. UC68 in the List of Legislative Works of the Council of Ministers) has been submitted for approval to the Council of Ministers. Update 17 June 2019: The major legal act (pl. 'ustawa') to implement the BSS directive was passed by the Sejm (PL Parliament). Now it will be proceeded by the Senate.
Romania	The regulation projects for transposing and implementing Directive 2013/59/Euratom are being prepared (May 2018).

Evaluation:

The BSS Directive had to be transpositioned in national law by 06 February 2018, but only in the Czech Republic and Hungary it has been implemented until June 2019.

Some legal proceedings on non-transposition have been launched by the European Commission in 2018 and 2019. According to the EU infringement database[1], EU Member States Cyprus, Finland, Greece, Ireland, Italy, Luxembourg, Malta, Portugal and Sweden have not notified their transposition measures correctly. Italy has even been referred to Court in July 2019.

According to information from the Art. 31 Group's Meeting in November 2018[2], after the transposition deadline has passed in February 2018, the Commission is currently preparing another project to check compliance of Member States transposition measures with the Basic Safety Standards Directive.

[1] https://ec.europa.eu/atwork/applying-eu-law/infringements-proceedings/infringement_decisions/index.cfm?lang_code=EN&typeOfSearch=false&active_only=0&noncom=0&r_dossier=&decision_date_from=&decision_date_to=&DG=ENER&title=2013%2F59%2FEuratom&submit=Search

[2] https://ec.europa.eu/energy/sites/ener/files/summary_report_goe_meeting_november_2018_as_approved_12_-_13_june_2019.pdf

2. Changes in comparison to BSS

Question: Have there been any changes with regard to content in comparison to the BSS original document?

The Member States can introduce more severe protection measures than In the BSS Directive, if not stated else. This and the following questions should show if the Joint Project countries did introduce lower dose limits or reference levels, or if they implemented the requirements of the BSS Directive unchanged.

Country	Answer
Austria	No changes are planned, only supplements for Austria-specific needs of regulation.
Czech Republic	No changes to the Directive contents.
Hungary	The Hungarian framework on radiation protection contains several legal documents (laws, governmental decrees, ministerial decree), so the BSS Directive has not been simply translated but transpositioned into the existing regulatory environment. Where the BSS Directive prescribes requirements in general or allows choice between options, the same safety level of standards was applied to the Hungarian situation during the transposition.
Poland	The draft laws have been changed due to comments (only available in Polish language). No answer if changes compared to the BSS Directive were made.
Romania	No relevant answer.

Evaluation:

Most answers of the authorities are very vague. Without analysing the legal texts in detail, it is not possible to find out if the Member States implemented other, especially lower, dose limits or reference values.

Austria as the only country that decided not to use nuclear energy has lower intervention levels as other countries. During the participation process of the new radiation protection law (still ongoing), the Austrian Institute of Ecology has demanded lower dose limits and reference values.

See also answers to next questions.

3. Dose limits for the public

Question: EU Member States are allowed to introduce dose limits and reference levels that are lower than in the BSS Directive. Will your country do so? / Has your country done so? If yes, which dose limits/levels are in use and why?

Question: What is the effective dose limit for members of the public? Are there specific dose limits for the foetus, children, young adults, pregnant and breastfeeding women?

Art. 12 (1): Member States shall ensure that the dose limits for public exposure shall apply to the sum of annual exposures of a member of the public resulting from all authorised practices.

(2): Member States shall set the limit on the effective dose for public exposure at 1 mSv in a year.

Country	Answer
Austria	The effective dose limit for individual members of the public is 1 mSv/year. No specific dose limits are required for foetuses, children, adolescents, pregnant and lactating women.
Czech Republic	The effective dose limit for individual members of the public is 1 mSv/year.
Hungary	The dose limits for public of BSS Directive has been implemented in Governmental Decree No. 487/2015. (XII.30.) on the protection against the ionization radiation.
Poland	The possibility for lower dose limits and reference levels has not been used. Dose limits are introduced in Art 1(24) and Annex 3 to the draft Act.
Romania	The dose limits are established through The Fundamental Norms of Radiological Security (NSR - 01), approved through Order of CNCAN President, no 14, from January 24, 2000. The project for modifying the Norms for basic requirements regarding the radiological security is in final approval stage, and the version resulted after the public consultation phase can be found on CNCAN website. Both are only available in Romanian

Question: What are the equivalent dose limits to single organs, e.g. the thyroid?

Art. 12 Dose limits for public exposure

(3): In addition to the dose limit referred to in Art. 12 (2), the following limits on the equivalent dose shall apply:

> *(a) the limit on the equivalent dose for the lens of the eye shall be 15 mSv in a year;*
>
> *(b) the limit on the equivalent dose for the skin shall be 50 mSv in a year, averaged over any 1 cm^2 area of skin, regardless of the area exposed.*

Country	Answer
Austria	Same as in BSS Directive
Czech Republic	Same as in BSS Directive
Hungary	The equivalent dose limits (if any) to single organs of BSS Directive has been implemented in Governmental Decree No. 487/2015. (XII.30.) on the protection against the ionization radiation.
Poland	See Annex 3
Romania	The equivalent dose limits to single organs are calculated based on the recommendations of ICRP.

Evaluation – dose limits for the public:

The dose limits of the BSS Directive have been implemented in the JP countries.

Critical studies argue for lower dose limits for effective dose, but also for equivalent doses. New scientific knowledge is discussed in Mraz & Becker (2017). Main critics are:

The ICRP relies mostly on study data from the LSS (Lifespan Study) of the survivors of Hiroshima and Nagasaki, even though the survivors were exposed to high radiation delivered in short time. This radiation pattern is not the same as f. e. after the accidents of Chernobyl and Fukushima, where people received low protracting doses. But ICRP believes the atomic bomb radiation to be twofold stronger in effect than chronical long-term exposure. Therefore, a factor DDREF (dose and dose-rate effectiveness factor) of 2 is used by ICRP resulting in two-times lower risk coefficients for description of health risks. This can no longer be considered as up to date, amongst others due to the INWORKS study (Richardson et al. 2015) which has been able to proof that there is no reduction in excess relative risk for chronic low dose exposure compared to risk resulting from radiation of atomic bombs. The DDREF has to be reduced to 1 due to this new scientific evidence. The WHO and the German Commission on Radiological Protection (SSK) already both recommend a DDREF of 1. (WHO 2013, p.32, SSK 2014)

Of uttermost importance is the reduction of dose limits and levels, and of inclusion of single organ doses for gonads and thyroid.

The protection of the embryo/foetus and the genetic integrity of future generations have to be given highest priority. Radiation protection must therefore supplement adult based models and take into consideration the increased vulnerability of the embryo and the young child.

There is scientific evidence of genetic and teratogenic effects like genetically induced malformations, cancers, and numerous other health effects in the children of father and/or mothers who were exposed to low doses of ionising radiation. The current radiation risk model of ICRP fails to predict or explain the many observations and should be revised.

According to BUND (2016) dose limits for single organs additional should be included in the BSS-directive, especially for gonads. But also thyroid doses would be of relevance.

The dose limit for skin in the BSS-Directive is set to 500 mSv for occupational exposure and 50 mSv for members of the public. New studies show skin cancer in workers and after X-ray diagnostics, mostly with doubling doses below 100 mSv (Mathews et al. 2013; Schmitz-Feuerhake 2014; Mämpel et al. 2015) Therefore in BUND (2016) a dose limit for skin dose for workers of 10 mSv/a and for members of the public of 1 mSv/a is recommended.

Also the equivalent dose for the eye lens is regarded as too high. Cataracts are now seen as stochastic effects. Children are more sensitive (Worgul et al. 1996). Dose limit recommendations of BUND (2016) for the eye lens are 10 mSv/a for workers and 1 mSv for members of the public.

4. Reference levels

Question: What are the reference dose levels for existing exposure situations and for emergency exposure situations?

ANNEX I: Reference levels for public exposure as referred to in Articles 7 and 101

(1): Without prejudice to reference levels set for equivalent doses, reference levels expressed in effective doses shall be set in the range of 1 to 20 mSv per year for existing exposure situations and 20 to 100 mSv (acute or annual) for emergency exposure situations.

Art. 53: Emergency occupational exposure

(1)(b): in exceptional situations, in order to save life, prevent severe radiation-induced health effects, or prevent the development of catastrophic conditions, a reference level for an effective dose from external radiation of emergency workers may be set above 100 mSv, but not exceeding 500 mSv.

Country	Answer
Austria	Emergency exposure situation for members of the public: reference level of effective dose 100 mSv/year; existing exposition situation: 20 mSv/year According to IntV 2017: 250 mSv maximum for lifetime emergency exposure; emergency exposures over 20 mSv effective dose are only allowed if they are voluntary.
Czech Republic	Emergency exposure situation for members of the public: reference value of effective dose 100 mSv/year; 500 mSv/year in case of protection of human lives; existing exposition situation: 20 mSv/year
Hungary	The reference levels of existing and emergency exposure situations prescribed in Governmental Decree No. 487/2015. (XII.30.) on the protection against the ionization radiation, as follows: a) in emergency exposure situation the reference level is should be 20-100 mSv effective dose, annual or acute. The exact value of reference levels – depending on the category of emergency and the its circumstances – are determined in the National Nuclear Emergency Response Plan. (Presently 100 mSv reference level (effective dose or equivalent dose for embryo) is applied in the first 7 day in case of a category I and II emergency situation inside the urgent protective action zone. All the other cases (category III-V events, or after the first 7 days) the reference level is 20 mSv annually. These values are based on the guidance of International Atomic Energy Authority.) b) in existing exposure situations, the general value of reference level is 6 mSv effective dose annually. However, the exact value of reference level between 1 - 6 mSv should be determined case by case by the Hungarian Atomic Energy Authority taking into account the social and economy factors and the opinion of interested parties.
Poland	See Art. 1(29) in a radiological event, and Art 1(32) for existing exposure situations
Romania	No answer.

Evaluation – reference values for the public:

First, it has to be explained that reference levels are not identical with intervention levels or protective measures or general criteria derived from reference values. Important is what pathways are included in the dose assessments for these levels. The reference levels from the BSS-Directive include all pathways (ground-shine, cloud-shine, inhalation, ingestion). Protective levels or general criteria for protective measures include not necessarily all pathways, f. e. only the ground-shine dose as a decision base for relocation measures.

In general, the Joint Project countries use the same reference values for the public as are provided in the BSS Directive.

(Hungary answered that it uses 6 mSv per year as reference level for existing exposure situations. This is the level given in the BSS-Directive not for members of the public, but for existing occupational exposure situations. It still has to be verified if the 6 mSv/year also apply to members of the public.)

The reference value for lifesaving activities is in many countries up to 500 mSv. This will also be relevant for members of the public engaging for example in a voluntary fire brigade or other activities – which makes them emergency workers per definition. In Austria, a lower reference value of 250 mSv once in a lifetime is set for all emergency workers (IntV 2017).

A reference level is not the same as a dose limit:

It has to be kept in mind that reference values are not dose limits. Therefore, in case of emergency, the dose that is received by members of the public could even be higher than the reference value:

BSS Directive Art. 4 (84): "reference level" means in an emergency exposure situation or in an existing exposure situation, the level of effective dose or equivalent dose or activity concentration above which it is judged inappropriate to allow exposures to occur as a result of that exposure situation, even though it is not a limit that may not be exceeded;

Read more in chapter 12.

5. Occupational dose limits

Question: What are the dose limits for workers, including pregnant women, breastfeeding women, apprentices and students up to 18?

Art. 9 Dose limits for occupational exposure

(2): The limit on the effective dose for occupational exposure shall be 20 mSv in any single year. However, in special circumstances or for certain exposure situations specified in national legislation, a higher effective dose of up to 50 mSv may be authorised by the competent authority in a single year, provided that the average annual dose over any five consecutive years, including the years for which the limit has been exceeded, does not exceed 20 mSv.

(3): In addition to the limits on effective dose laid down in Art. 9 (2), the following limits on equivalent dose shall apply:

> *(a) the limit on the equivalent dose for the lens of the eye shall be 20 mSv in a single year or 100 mSv in any five consecutive years subject to a maximum dose of 50 mSv in a single year, as specified in national legislation.*
>
> *(b) the limit on the equivalent dose for the skin shall be 500 mSv in a year, this limit shall apply to the dose averaged over any area of 1 cm^2, regardless of the area exposed;*
>
> *(c) the limit on the equivalent dose for the extremities shall be 500 mSv in a year.*

Art. 10: Protection of pregnant and breastfeeding workers

(1): Member States shall ensure that the protection of the unborn child is comparable with that provided for members of the public. As soon as a pregnant worker informs the undertaking or, in the case of an outside worker, the employer, of the pregnancy, in accordance with national legislation the undertaking, and the employer, shall ensure that the employment conditions for the pregnant worker are such that the equivalent dose to the unborn child is as low as reasonably achievable and unlikely to exceed 1 mSv during at least the remainder of the pregnancy.

(2): As soon as workers inform the undertaking, or in case of outside workers, the employer, that they are breastfeeding an infant, they shall not be employed in work involving a significant risk of intake of radionuclides or of bodily contamination.

Art. 11 Dose limits for apprentices and students

(2): Member States shall ensure that the limit on the effective dose for apprentices aged between 16 and 18 years and for students aged between 16 and 18 years who, in the course of their studies, are obliged to work with radiation sources, shall be 6 mSv in a year.

(3): In addition to the limits on effective dose laid down in paragraph 2, the following limits on equivalent dose shall apply:

> *(a) the limit on the equivalent dose for the lens of the eye shall be 15 mSv in a year;*
>
> *(b) the limit on the equivalent dose for the skin shall be 150 mSv in a year, averaged over any area of 1 cm^2, regardless of the area exposed;*
>
> *(c) the limit on the equivalent dose for the extremities shall be 150 mSv in a year.*

Country	**Answer**
Austria	Same as in the BSS Directive Equivalent doses for workers: eye lens 100 mSv/5 consecutive years and 50 mSv/year (in the radiation protection law in force the equivalent dose for the eye lens is 150 mSv/5 consecutive years; this dose limit will be reduced in the new law.) In the radiation protection law in force it is not allowed for people under age 18 to be exposed to radiation at their workplace. In the new law occupational exposure will be allowed if necessary for their training. In the radiation protection law in force it is not allowed for pregnant women to be exposed to radiation at their workplace. In the new law occupational exposure for pregnant women will be allowed if the dose for the unborn child will not exceed 1 mSv.
Czech Republic	Same as in the BSS Directive Equivalent doses for workers: eye lens 100 mSv/5 years and 50 mSv/year
Hungary	The dose limits for workers, including pregnant women, breastfeeding women, apprentices and students up to 18 of BSS Directive has been implemented in Governmental Decree No. 487/2015. (XII.30.) on the protection against the ionization radiation. Additional requirements: - pregnant women, breastfeeding women and women were born recently should not be exposed to ionization radiation - women providing breast milk for others should not be exposed to situation where intake of radionuclides or radioactive contamination could be happened
Poland	See Art. 1(24) and Annex 3. The new Act provides for a ban on employing breastfeeding women to exposure of ionising radiation.
Romania	The dose limits are established through The Fundamental Norms of Radiological Security (NSR - 01), approved through Order of CNCAN President, no 14, from January 24, 2000.

Country	Answer
	The project for modifying the Norms for basic requirements regarding the radiological security is in final approval stage, and the version resulted after the public consultation phase, can be found on CNCAN website. Both are only available in Romanian

Evaluation:

There is scientific evidence of genetic and teratogenic effects like genetically induced malformations, cancers, and numerous other health effects in the children of father and/or mothers who were exposed to low doses of ionising radiation. The current radiation risk model of ICRP fails to predict or explain the many observations and should be revised.

The working conditions of a pregnant worker, after declaration of pregnancy, should be such as to ensure that the additional dose to the embryo/foetus would not exceed about 1 mSv during the remainder of the pregnancy. (ICRP 103 2007, p. 85) This dose seems to be too high, esp. according to results of the effects of natural background on childhood cancer where external dose rates of ≥200 nSv/h (1.75 mSv/a) compared to those exposed to <100 nSv/h (0.88 mSv/a) already show effects. (Spycher et al. 2015)

According to BUND (2016) dose limits for single organs additional should be included in the BSS-directive, especially for gonads. But also thyroid doses would be of relevance – so reference levels for food limits could be derived (see chapter 4.2.1.8)

The dose limit for skin in the BSS-Directive is set to 500 mSv for occupational exposure and 50 mSv for members of the public. New studies show skin cancer in workers and after X-ray diagnostics, mostly with doubling doses below 100 mSv (Mathews et al. 2013; Schmitz-Feuerhake 2014; Mämpel et al. 2015) Therefore in BUND (2016) a dose limit for skin dose for workers of 10 mSv/a and for members of the public of 1 mSv/a is recommended.

Also the equivalent dose for the eye lens is regarded as too high. Cataracts are now seen as stochastic effects. Children are more sensitive (Worgul et al. 1996a). Dose limit recommendations of BUND (2016) for the eye lens are 10 mSv/a for workers and 1 mSv for members of the public.

According to a personal information from a member of the Red Cross, the personnel of Japanese Red Cross had to take measurements of people after Fukushima. The personnel saw themselves as civilians (1mSv dose limit), but the authorities saw them as responders (20 mSv), this was a problem. Such unclear situations need to be avoided.

6. Collective dose limits

Question: Are collective dose limits used? If yes, for which situations and what limits?

Country	Answer
Austria	No collective doses are used.
Czech Republic	
Hungary	
Poland	No.
Romania	Collective dose limits are not used. Collective dose is an indicator used in the radiation protection system.

Evaluation:

The ICRP has the opinion that collective effective dose is not intended as a tool for epidemiological risk assessment, and it is inappropriate to use it in risk projections. The aggregation of very low individual doses over extended time periods is inappropriate, and, in particular, the calculation of the number of cancer deaths based on collective effective doses from trivial individual doses should be avoided. (ICRP 103 2007, p. 11)

The experts of the Ulm Meeting (IPPNW 2014) have a completely different opinion. They argue that the concept of collective dose is the current evidence-bases school of scientific thought for quantitatively predicting stochastic radiation risk. Due to the LNT model also very low doses can have health effects (as was already proved by several studies, see chapter 3). Also in BUND (2016) it is recommended that besides the effective individual dose and single organ doses also the collective dose should be used. Levels for the collective dose should be determined esp. in planned radiation situations.

7. Radon

Question: What dose limits are set for radon exposure in the workplace and in buildings for the public?

Art. 74: Indoor exposure to radon

(1): Member States shall establish national reference levels for indoor radon concentrations. The reference levels for the annual average activity concentration in air shall not be higher than 300 Bq/m^3.

Art. 54: Radon in workplaces

(1): Member States shall establish national reference levels for indoor radon concentrations in workplaces. The reference level for the annual average activity concentration in air shall not be higher than 300 Bq/m^3, unless it is warranted by national prevailing circumstances.

Country	Answer
Austria	Reference level of radon in average per year is 300 Bq/m^3 for residential buildings and workplaces. No limit is set.
Czech Republic	No limits are set for irradiation from natural emitters in residential buildings. The reference level for natural irradiation inside buildings with residential or living rooms is a) 300 Bq/m^3 for volume activity of radon in the interior air of a residential or living room; this value is related to the average value with air exchange that is normal during use; or b) 1 µSv/h for the maximum spatial dose equivalent rate in a residential or living room at a height of 1 m above the floor and at 0.5 m from a wall. The value of annual average volume activity of radon in the air at which the owner of the building with a residential or living room has to take measures to reduce the irradiation is 3,000 Bq/m^3.

Country	Answer
Hungary	The reference levels limits for radon exposure of BSS Directive has been implemented in Governmental Decree No. 487/2015. (XII.30.) on the protection against the ionization radiation.
Poland	See Art. 23b: reference level for the annual average airborne radon concentration of 300 Bq/m3
Romania	Exposure to radon is considered existing exposure situation for which CNCAN has established reference levels and not dose limits. The reference level for exposure to Radon is established by CNCAN at 300 Bq m3. This reference level is applicable both for public exposure and for workplaces. The workplaces where it is probable that exposure of workers exceed the effective dose of 6 mSv per year of a corresponding value integrated in time (concentration converted in dose), these are managed as planned exposure situations where dose limits apply. For these workplaces, CNCAN establishes which operational protection requirements apply.

Evaluation:

The JP countries want to adopt the BSS radon reference levels.

In Germany, a radon level of 250 Bq/m^3 was in force before the BSS Directive, in Austria 200 Bq/m^3 for new buildings and 400 for old buildings.

The World Health Organisation WHO informs on its website[3] that the risk of lung cancer increases by 16% per 100 Bq/m^3 increase in long time average radon concentration with linear dose-response relation. In 2009, WHO recommended in its "WHO handbook on indoor radon: A public health perspective", to establish a national annual average concentration reference level of 100 Bq/m^3, but if this level cannot be reached under the prevailing country-specific conditions, the reference level should not exceed 300 Bq/m^3.

Due to the high lung cancer risk the radon level of 300 Bq/m^3 is too high and should be reduced as far as possible.

8. Expertise

Question: On what scientific expertise is radiation protection in your country based on (ICRP-recommendations, Euratom Art. 31 group)? Is independent experts' expertise taken into account? From whom and in which way?

Country	Answer
Austria	European and international requirements, recommendations and standards are the basis for radiation protection. These include EU Directives, publications of IAEA, ICRP etc. External expertise is used when necessary. Involved in the transposition of the BSS Directive are experts from the State and the Federal States, from scientific and other institutions.
Czech Republic	Radiation protection is currently based on ICRP Recommendations no. 101 and 103, IAEA BSS, Council Directives, and conclusions of the expert group at Euratom Art. 31, HERCA and others

[3] https://www.who.int/news-room/fact-sheets/detail/radon-and-health, seen 21 Aug 2019

Country	Answer
Hungary	The Hungarian Atomic Energy Authority is in contact and cooperate with the National Research Institute for Radiobiology and Radiohygiene, the Hungarian Academy of Sciences Centre for Energy Research, the Institute of Nuclear Techniques of Budapest University of Technology and Economics, and other scientific and research institutions. Implementing the requirements for radiation safety, the Hungarian Atomic Energy Authority takes into account the ICRP recommendations, the IAEA safety requirements and guides, the EU directives and regulations, as well as the recommendations of WENRA, HERCA, IPRA, UNSCEAR and OECD NEA. The Hungarian Atomic Energy Authority has been delegated members for Group of Experts referred to in Article 31 of the Euratom Treaty, and for HERCA, WENRA and OECD NEA working groups. The Hungarian scientific and research institutions mentioned above has been participating as well in several working groups for radiation safety.
Poland	The Polish nuclear law takes into account the EU legislation in force and the recommendations of the IAEA.
Romania	Radiation protection requirements applicable in Romania are based on the ICRP recommendations, especially those mentioned in publication no 103 of ICRP.

Evaluation:

ICRP and the Article-31-Group of Experts are the only expert groups who can at the time-being influence radiation protection legislation, though the ICRP has no democratic legitimation. And the Article-31-Group which is staffed by the member states does also not consult with the public. It would be preferable to have also independently staffed expert groups with public participation who work more transparently.

9. Public participation

Question: Are there any options for public participation in radiation protection in your country?

Country	Answer
Austria	Stakeholders' opinions have to be included in exposition situations.
Czech Republic	Involvement of the public in processes relating to radiation protection is welcome. SONS employees strive to examine each suggestion, work with it, and if it is contributive, apply it in practice. Suggestions were debated and consulted with many concerned parties during the preparation of the new atomic legislation, both in formal comment procedures and at informal meetings and seminars
Hungary	There are radiation safety relevant professional associations, such as the Health Physics Section of the Roland Eötvös Physical Society or the Hungarian Radiotherapy Society. The Hungarian Atomic Energy Authority is open for any comments improving the level of radiation safety from radiation experts, civil organizations performing radon survey, etc.
Poland	The public has opportunity to participate in consultations of legislative acts. Information of the public is regulated in Art. 39m, n, o. See also Art. 110(6) for

	the tasks of the President of the State Atomic Energy Agency in the field of communication.
Romania	In Romania, general public can participate in the process of preparation of regulation as pe chapter II of Law 25/2003 regarding decision transparency in public administration, where procedures for participation are provided. Also, the public may get involved at the time measurements of radon levels in houses take place, through granting access and making measurements in their own houses (where the case).

Evaluation:

The possibilities for public participation are in some countries during preparation of laws, but in other countries there are none at all.

The answers also show that participation of other stakeholders is more welcomed but is no substitution for the participation of the public.

When there is no national law involved, like it is the case with Council Regulation (Euratom) 2016/52, the public also has no say at all.

10.Dietary data

Question concerning Council Regulation (Euratom) 2016/52:
Euratom Art.-31-Group recommends that member states should establish regularly the typical dietary habits for different regions so that in the case of an accident no underestimations of actual consumption rates occur: What dietary data does your country use in case of implementing the Regulation?

- On which sources (food basket etc.) are the consumption data based on?
- How up to date are the consumption data?
- Are the data adapted to local consumption patterns?
- Do the data include so-called minor-food according to Council Regulation Euratom 2016/52?
- Are there consumption data for different gender and age groups?

Country	Answer
Austria	BMASGK is responsible which did not answer our questions.
Czech Republic	In the event of a radiation incident or radiation accident that would result in contamination of areas around the Czech nuclear power plants, the SONS will proceed in accordance with Section 102, Para. 1 of the Atomic Act (AA). The measures will relate primarily to: - A preventive ban on consumption of food and water and use of fodders that might have been contaminated. This applies primarily to agricultural products grown in open areas. - Revocation of the ban on consumption of food and water and use of fodders in which the maximum permissible levels defined by Regulation

Country	Answer
	(Euratom) 2016/52 are not exceeded, unless the Commission sets other levels for the specific event. That said, the SONS will simultaneously monitor adherence to Section 102, Para. 2 of the AA while taking into consideration the actual market basket of the affected inhabitants, including consumption of less important foods. - Prioritisation of importation of uncontaminated foods and fodder to the affected area.
Hungary	In case of the region around Paks Nuclear Power Plant, the food consumption data are based on the study made in 1990. For radioactive waste repositories the survey made in the design phase of the facility are used. Regarding the changes of dietary habits (e.g. the consumption of local foods produced in the backyards suppressed) these earlier surveys give a conservative estimation. For distant areas from the facilities the Hungarian Central Statistical Office's statistics on regional and settlement-type pattern of consumption are taken into account. The Hungarian Central Statistical Office's statistics are yearly updated. The data do not include the so-called minor-foods. There are different consumption data used for the critical group (children) and the adults.
Poland	This is under the competency of the Chief Sanitary Inspector – not answered here.
Romania	Ministry of Agriculture is responsible – no answers.

Evaluation:

Only Hungarian authorities answered the question partly. The questionnaires were also sent to the responsible authorities that were named in the first answers, but they did not answer.

The problem of the underlying dietary data was discussed in detail in Mraz & Becker (2017): "These data on dietary habits and food consumption are outdated by more than 25 years. Moreover, for only 10 EU member states out of 28, food data have been researched and used in calculations. Dietary habits have changed in the meantime, this can lead to much higher ingestion dose than assumed in the food level regulation. For example, if 200g (adult) or 120g (child) of the new "superfood" sweet potatoes are consumed per month, an ingestion dose of 2.5 mSv (adult) and 4 mSv (child) would result, because sweet potatoes are classified as minor food and therefore have a very high food level."

11.Food levels

Question: Council Regulation (Euratom) 2016/52: Member states are allowed to derogate from the food levels and introduce food levels that are best for ensuring their people's health – will your country do that? Which levels will be used and why?

Country	Answer
Austria	BMASGK is responsible which did not answer our questions.
Czech Republic	No answer
Hungary	In Hungary the values listed in Council Regulation (Euratom) 2016/52 are applied for the maximum permitted levels of radioactive contamination to be applied following a nuclear accident or any other case of radiological emergency. Those maximum permitted levels are still in line with the latest scientific advice as presently available internationally.
Poland	There are currently no plans to derogate from the levels.
Romania	No answer.

Evaluation:

Only Hungary and Poland answered the question.

The maximum permitted food levels from Council Regulation (Euratom) 2016/52 have been criticised as too high in Mraz & Becker (2017) not only because the underlying dietary data are outdated (see chapter 10), but also due to the following reasons:

- For dose calculations in the food level regulation an assumption is used that only 10% of all food is contaminated up to the maximum, and 1% of liquid food, respectively. This will not be true in a worst case of a severe nuclear accident in one of the EU Member States and under unfavourable meteorological conditions. Therefore, the maximum food levels should be conservatively calculated without using these two factors.
- 1 mSv as reference dose for the effective ingestion dose is as such too high. Following recommendations by the ECRR (ECRR 2010) and the German BUND for the reduction of the dose limit in the BSS-Directive from 1 mSv to 0.1 mSv/year for members of the public, such a reduction can also be demanded for the reference ingestion dose underlying the maximum food levels. Taking into account that the ingestion dose contributes to a large extent to the total dose, the reference dose in the food level regulation should also be reduced substantially to 0.1 mSv. Such lower food levels would provide better protection than the food levels from the recent Euratom regulation.

When comparing the former Austrian food levels to those of today's legislation, it becomes clear that not only scientific evidence is underlying such levels, but political motives:

	Nuclides	Council Regulation Euratom 2016/52; implementing regulation 297/2001 (first after Fukushima)	EU: Second Implementing regulation 351/2011 after Fukushima	Japan 2011 after Fukushima	Austria until accession to EU (BKA 1991)	EC/EU for food imports affected by Chernobyl Council Regulation 1048/2009
Infant food	Caesium	400	200		11.1	370
	Iodine	150	100			
Milk	Caesium	1,000	200	200	185	370
	Iodine	500	300	300	185	
Vegetables	Caesium	1,250	500	500	111	600
	Iodine	2,000	2,000	2,000	74	
Drinking water	Caesium	1,000	200	200	1.85	
	Iodine	500	300	300 (100 for infants, pregnant and breastfeeding women)	3.7	

This topic needs to be followed up.

12.Intervention measures: levels and general criteria

Question: What intervention levels are used in case of a radiological accident, each for children and adults: (please define dose level, pathways included and integration time)

- iodine prophylaxis
- sheltering
- evacuation
- temporary relocation
- permanent or long-term relocation

Country	Answer
Austria	No answer, but the intervention levels can be found in the Interventionsverordnung (IntV 2017): • Sheltering: 1 mSv projected dose (cloud-shine, ground-shine, inhalation, 2 days) for people < 18 years and pregnant women; for all others 10 mSv • Iodine tablets: 10 mGy projected thyroid dose (inhalation, 2 days) for people < 18a and pregnant women; for all others 100 mGy

Country	Answer
	• Evacuation: 50 mSv avertable dose (cloud-shine, ground-shine, inhalation, 2 days) • Temporary relocation: 30 mSv projected dose (ground-shine, 1 month) • Long-term relocation: 100 mSv projected dose (ground-shine, 1 year) Due to the BSS Directive the calculations of the expected dose for temporary and long-term relocation have been changed: While in IntV (2007) no other intervention measures (like sheltering) were considered, in IntV (2017) the effects of countermeasures have to be taken into account. In the explanations to the amended IntV (Erläuterungen IntV 2017) it is explained that the reference level of 100 mSv effective dose for emergency exposure situation for members of the public is even lower than the intervention level for long-term relocation, because not only ground-shine but also all other pathways have to be considered.
Czech Republic	In the event of a nuclear accident, irradiation of natural persons will be reduced by applying individual protection, restriction on entry and presence of natural persons in the affected area, and as needed, urgent protection measures will be adopted and implemented (hiding, iodine prophylaxis, evacuation) as well as follow-up protective measures (resettlement, restriction on use of food and water contaminated by radioactive substances, restriction on use of fodders contaminated by radioactive substances); see Section 104 of the Atomic Act and Section 107 of D 422. The iodine prophylaxis dosage is specified in the information leaflet for the pills. In addition, it is specified in the 2018-2019 Basic Information for the Event of a Radiation Accident at the Dukovany NPP and the 2018-2019 Basic Information for the Event of a Radiation Accident at the Temelín NPP (hereinafter, the "Manual"). The Manual is a part of a calendar that is published by the Dukovany and Temelín NPP every two years and distributed to the inhabitants in the accident planning zone (hereinafter, the APZ). The Manual is free for download on the websites of both the NPP under the tab "Manual for Population Protection". The evacuation routes are specified, among others, in the Manuals for each APZ in the form of a route description and depiction on a map. The capacity of the shelters at the NPP is sufficient for hiding everyone working at the NPP. No special shelters for inhabitants have been built outside the NPP. Hiding in existing buildings is assumed (houses, schools, etc.).
Hungary	Based on the BSS Directive 2013/59/Euratom and on the relevant international recommendation (ICRP Publication No. 103, ICRP Publication No. 109, Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards - General Safety Requirements, IAEA Safety Standards Series No. GSR Part No. 3., Preparedness and Response for a Nuclear or Radiological Emergency - General Safety Requirements, IAEA Safety Standards Series No. GSR Part 7.) the so called „intervention levels" for independent protective measures should not be used any more. Instead of those reference levels and generic criteria derivated from the reference levels should be used in frame of protective strategy. In this viewpoint the question could not be answered properly. Emergency reference levels (based on expected doses): • Effective dose in the first 7 days in Emergency Planning Zones I and II, PAZ, UPZ: 100 mSv; in all other areas 20 mSv • Fetal equivalent dose in the first 7 days in Emergency Planning Zones I and II, PAZ, UPZ: 100 mSv; in all other areas 20 mSv

Country	Answer
	General Criteria: • Effective dose in the first 7 days: 100 mSv • Fetal equivalent dose in the first 7 days: 100 mSv • Thyroid dose in the first 7 days: 50 mSv • 20 mSv/a effective dose: precautions for late period • 20 mSv/a fetal dose: precautions for late period • 100 mSv effective dose/1 month: monitoring, consultancy • 100 mSv fetal dose/entire period of pregnancy: advice to make a decision based on individual circumstances • 10 mSv effective dose in the first year from ingestion: food and water restrictions, monitoring etc. • 10 mSv fetal dose for the whole pregnancy period from ingestion: food and water restrictions, monitoring etc. • 10 mSv effective dose in the first year from using contaminated vehicles: restricting use • 10 mSv fetal dose for the whole pregnancy period from using contaminated vehicles: restricting use • 1 mSv effective dose in the first year: restriction in food trade • 1 mSv fetal dose for the whole pregnancy period: restriction in food trade Optimized intervention levels (based on avoidable doses): • Iodine prophylaxis: >= 50 mSv thyroid dose • Sheltering: >= 10 mSv effective dose in 2 days (external, internal, inhalation) • Evacuation: >= 50 mSv/7 days (external, internal) • Relocation: >= 30 mSv/1 month; >= 100 mSv in the first year; >= 1 Sv for lifetime (all pathways)
Poland	Regulation of the Council of Ministers of 27 April 2004: • Iodine blocking: >= 100 mGy thyroid dose • Sheltering: 10 mSv for the following 2 days • Evacuation: 100 mSv for the following 7 days • Temporary resettlement: 30 mSv for 30 days • Permanent resettlement: 1 Sv lifetime dose (50 years for adults, 70 years for children); if the dose does not decrease to 10 mSv during the following 2 years Also OILs will be implemented by the new law.
Romania	Operational Intervention Level (OIL) Definition – the ambient doses resulted from soil deposits resulted after a nuclear accident. These are used only after the radioactive cloud has passed and the mobile teams start measurements (at 1 m above the ground). When the OILs are exceeded, the Authorities recommend protection actions as per the following tables. OIL 1γ = 1000 µSv/h: The flow of OIL in an inhabited or frequented area, without vegetation or with little vegetation and far from roads, trees and buildings. Protection measures: population evacuation, information of public OIL 2γ = 100 µSv/h: Agricultural area or pastures, without vegetation or with little vegetation and far from roads, trees and buildings.

Country	Answer
	Protection measures: population evacuation, information of public, interdiction of food and water consumption from the respective area. OIL 3γ = 1 µSv/h above ground: Agricultural area or pastures, without vegetation or with little vegetation and far from roads, trees and buildings. Iodine prophylaxis: 50 mSv thyroid dose in the first 7 days Sheltering and evacuation: 100 mSv in the first 7 days (effective dose, fetal dose) Temporary relocation: 100 mSv in the first year (effective, fetal) Permanent relocation: 1-20 mSv for more than 5 consecutive years

Evaluation:

The dose levels for intervention measures are not the same in the questioned Member States, some are not comparable due to different assessment methods.

For example, in Austria this measures starts for people < 18 years and pregnant women at a projected thyroid dose of 10 mGy (inhalation) in the first two days; in Hungary and Romania at 50 mSv in the first seven days, in Poland at 100 mGy (not known in how many days).

Another example is evacuation: In Austria, the intervention level is 50 mSv avertable dose (from cloud-shine, ground-shine and inhalation, 2 days). In Hungary, the general criteria for evacuation is a dose >= 50 mSv/7 days (external, internal). Poland has a level for evacuation of 100 mSv for the following 7 days, and Romania has 100 mSv in the first 7 days (effective dose, fetal dose), too.

The projected dose is defined by the International Commission on Radiological Protection (ICRP) as the dose that would be expected to be incurred if no protective measure(s) were to be taken. (ICRP Publication No. 103, 2007)

For Austria, the changes due to the BSS directive can be reviewed in more detail:

In Austria, due to the transposition of the BSS Directive two intervention levels were made less conservative. For the calculation of the expected effective dose for the intervention measures temporary and long-term relocation the effects of countermeasures now have to be taken into account. In the earlier version of the Interventionsverordnung, it was assumed conservatively that people stay outdoor all the time. This can be problematic because perhaps not all people profit from countermeasures, a conservative approach would be more on the safe side.

On the other hand, Austria has kept its low intervention levels for young people and pregnant women for sheltering, and even introduced a lower level for pregnant women for iodine prophylaxis (IntV 2007: 100 mGy, IntV 2017: 10 mGy).

The integration time for exposure was reduced from 7 days to 2 days with the argument that international experience has shown that sheltering can only be recommended for 2 days. (Erläuterungen IntV 2017, p. 9)

Iodine tablets for adults > 40 years are no longer recommended, therefore no intervention level is given in IntV (2017):

The transposition of the BSS Directive can be used for strengthening, but also for loosening emergency planning.

13.Agricultural countermeasures

Question: Which agricultural countermeasures are planned in your country in case of radioactive contamination? At which levels of contamination will they be started? In which regulations are they defined?

Country	Answer
Austria	No answer, but countermeasures are listed in the Maßnahmenkatalog (BMLFUW 2014)
Czech Republic	In the event of a nuclear accident, measures in the area of agriculture will depend on many circumstances. One of the fundamental measures is: restriction on the use of fodders contaminated by radioactive substances. In the event of a release of radioactive substances causing contamination, this may mean, e.g., hiding of grazing animals in stables. It is obvious that there may not always be enough time or suitable facilities for such measures. It will be critical for each measure in what period of the year (thus, was stage of plant development) the nuclear accident would occur. Further handling of the crops would then be specified based on the degree of contamination. At present, no country has in place detailed procedures and measures for agriculture for each specific case. Research work is in progress, involving, among other things, experience of Japan, searching for solutions to specific problems. Our country too is doing research into this, e.g., outcomes of the project “Research into advanced methods of detection, determination and coping with radioactive contamination” are published on the web page: https://suro.cz/cz/vyzkum/vysledky/vyzkum-pokrocilych-metod-detekce-stanoveni-a-nasledneho-zvladnuti-radioaktivni-kontaminace. (available only in Czech language) Levels of contamination for implementing these measures are not set. Everything will proceed according to the principle of optimisation in radiation protection – based on the effective dose for a representative person. As for acts of law and decrees, the atomic legislation defines reference levels, not implementation of different measures. The Office may ordain a general provision setting the reference level applicable to a situation and specific circumstances.
Hungary	The agricultural countermeasures in case of radioactive contamination are the follows: (i) to prohibit the consumption of local and wild food, (ii) to prohibit those locally produced consumption products (food, milk and drinking water), which are not essential (iii) to restrict the trade in goods (including forage, animals). The agricultural countermeasures should be implemented if the surface dose rate is 1 µSv/h or higher or the activity concentration of food, milk and

Country	Answer
	drinking water is 1,000 Bq/kg of I-131 or 200 Bq/kg of Cs-137 in case of a reactor accident. The agricultural countermeasures planned for an emergency and the trigger levels are in line with the recommendation of the IAEA (Preparedness and Response for a Nuclear or Radiological Emergency - General Safety Requirements, IAEA Safety Standards Series No. GSR Part 7) The countermeasures for restriction on the trade in goods based on the levels prescribed Council Regulation (Euratom) 2016/52. The agricultural countermeasures are defined in the National Nuclear Emergency Response Plan.
Poland	Are specified in Regulation of the Council of Ministers of 27 April 2004: Annex 1 and 2 Atomic Law Art 97: after an accident, food and feed are controlled to comply with Council Regulation (Euratom) 2016/52 OILs according to IAEA GSR 7 will be implemented within emergency planning zones around the NPPs.
Romania	Ministry of Agriculture is responsible – no answer

Evaluation:

In Austria and Germany, a catalogue of agricultural countermeasures in case of a severe nuclear accident defines decision bases for the start of certain agricultural countermeasures in the pre-release phase of a nuclear accident. If the following values are exceeded, food products could be contaminated above the maximum food levels of Regulation Euratom 2016/52. (BMLFUW 2014, p. 29)

Soil contamination:

- Iodine: 700 Bq/m^2
- Caesium: 650 Bq/m^2

There are also values for wet and dry air contamination, see BMLFUW (2014, p. 29)

These values can be exceeded in case of a nuclear accident. During the Environmental Impact Assessment (EIA) Bohunice III (WUA et al 2015), data from the Slovak authorities showed that in case of a severe accident a small part of Austrian territory could be contaminated with about 2,460 Bq Cs-137/m^2 and 10,000 Bq I-131/m^2. It has to be kept in mind that it was not the worst-case accident scenario that was used for calculation in the EIA:

According to the Austrian countermeasure catalogue, f. e. the following agricultural measurements should start immediately if soil contaminations higher than the above mentioned values are expected:

- Immediate harvesting of marketable products
- Putting livestock into stables

Both measures will lead to a variety of consequences for farmers and consumers, most of them can be argued to cause negative impacts.

In future EIA procedures neighbouring countries should control contamination data in case of nuclear accidents to review if its food production could be impacted with food reaching the maximum food levels according to Regulation Euratom 2016/52.

The answers from Hungary imply that the agricultural countermeasures should be implemented if the activity concentration of food, milk and drinking water is 1,000 Bq/kg of I-131 or 200 Bq/kg of Cs-137 in case of a reactor accident. This has to be verified, because 1,000 Bq/kg I-131 is far above the food level of 500 Bq I-131/kg for milk and drinking water.

Question: Did your country take part in the EURANOS project (European approach to nuclear and radiological emergency management and rehabilitation strategies)? If yes: What part of the EURANOS results are in use in your country?

Country	Answer
Austria	No answer.
Czech Republic	No involvement.
Hungary	Hungary participated in the part of the EURANOS RODOS demonstration activities. These demonstration activities provided useful support for implementation of the RODOS (Real-time, On-line DecisiOn Support system) operational application in Hungary.
Poland	Yes, the Institute of Atomic Energy in Świerk (=NCBJ) and the State Atomic Energy Agency participated. The project included work on RODOS and ARGOS, new models to analyse effectiveness of decontamination strategies, models for forecasting in aquatic environments. The State Atomic Energy Agency uses both RODOS and ARGOS, NCBJ uses RODOS. Both systems are still being developed for which funds are currently raised.
Romania	No answer.

Evaluation:

EURANOS had the goal to assist Member States in making decisions in emergency situations: "Differences, for example, in climate, terrain, agricultural production, infrastructure and culture, make it unlikely that individual member states will adopt all countermeasure options in their emergency response plans. To assist decision makers in their choice of options for addressing future nuclear and radiological incidents, a handbook for use in Europe will be developed.“ (Forschungszentrum Karlsruhe 2005) This handbook has been published in its second edition in 2010.

In the EURANOS project, a wide set of agricultural countermeasures were discussed, and it would have been interested to see what countermeasures of the EURANOS project were implemented in the national criteria or countermeasure catalogues and in systems like RODOS which are used for decision making in case of an emergency.

14.Conclusions

The BSS-Directive (Directive 2013/59/Euratom) is implementing new radiation protection basic norms for the EU Member States.

Does the BSS Directive help to improve EP&R (Emergency Preparedness and Response) in the EU or not? Yes and no. Member States have to re-assess their EP&R regimes, but on the other hand formerly lower reference levels or dose limits could be increased.

It is necessary to get prepared for a severe nuclear accident by harmonizing radiation protection and EP&R in the EU – differences in countermeasures and dose limits will result in disturbance of the public. People will not understand if contaminated food is allowed to be put on the market in one country, but forbidden in another one, or if some people are advised for sheltering and taking iodine tablets, and other people receiving the same dose are not.

A basic problem is that the maximum dose limits and reference levels are too high. The questioned Member States mostly do not prefer to deviate from the values and limits of the BSS Directive.

Children, embryos, pregnant and breastfeeding women have to be protected better because they are especially vulnerable to radiation. Radon levels have to be reduced to lower the lung cancer risk. These topic needs to be followed up in NGOs' work.

Therefore, for NGOs it will be necessary to inform people not only about existing limits and levels, but also on critics of these limits and levels. Helpful are positive examples of countries which have lower levels, f. e. Austria with its lower reference levels for countermeasures sheltering and iodine prophylaxis.

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16.Glossary and Abbreviations

Bq	Becquerel
BSS	Basic safety standard
Committed effective dose, committed equivalent dose	Dose commitment means that the effect of radiation is integrated over a time interval. For children, committed doses are calculated up to the age of 70, for adults a period of 50 years following the contamination is used. For each year in this time interval, equivalent or effective doses are calculated and summed up.
DDREF	Dose and dose-rate effectiveness factor; a factor introduced by ICRP that generalises the suspected lower biological effectiveness of low dose radiation exposures as compared with exposures at high doses and high dose rates. ICRP uses a DDREF of 2.
Effective dose	The effective dose (E) is the sum of weighted equivalent doses in all tissues or organs of the body from internal and external exposure. For this purpose, the equivalent doses are multiplied with tissue weighing factors (w_T). The unit of the effective dose is the Sievert (Sv). $E = \sum_T w_T \sum_R w_R D_{T,R} \quad \text{or} \quad E = \sum_T w_T H_T$
Equivalent dose	The equivalent dose (H_T) is used to assess how much biological damage is expected from the absorbed dose in a tissue or an organ (T). For calculation, the absorbed dose is multiplied with the radiation weighing factor (R). For different types of radiation different factors R are used. R is highest for alpha radiation and lowest for gamma radiation, depending on their possible biological damage. The equivalent dose can be calculated for single tissues or organs; if these are summarized, the total equivalent dose is resulting. The unit of equivalent dose is the Sievert (Sv). $H_T = \sum_R w_R D_{T,R}$
Gray, Gy	Unit of absorbed radiation, defined as the absorption of one joule of radiation energy per kilogram of matter

	1 Gy = 1 J kg^{-1}
Gy	Gray
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiological Protection
IPPNW	International Physicists Against Nuclear War
LSS, Lifespan Study	Long-term study on health effects on survivors of the atomic bombs in Hiroshima and Nagasaki
m	milli
NGO	Non-governmental organization
Reference level	A reference level is not a dose limit, but represents a dose above which it is strongly recommended to reduce contamination
Sievert, Sv	Unit of radiation dose
WHO	World Health Organization