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Fukushima: consequences and lessons learnt

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Fukushima: consequences and lessons learnt

This document provides the minutes of the webinar organised on 9 March 2021 by the Belgian Society for Radiation Protection and the Belgian Nuclear Society, in commemoration of the Fukushima-Daiichi nuclear accident.

The text summarizes the highlights of the lectures, followed by a transcript of the video-exchanges of the panel debate. The written answers by the lecturers to some questions raised by e-mail are also included.

The slides from the lectures can be found on the BVSABR website: https://www.bvsabr.be/events

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Fukushima: consequences and lessons learnt

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Fukushima: consequences and lessons learnt - Tuesday 9 March 2021

9 :15	**Welcome** *Mrs. Michèle Auglaire, vice-chair Belgian Nuclear Society*
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10:00	**Situation in Japan today, latest results of the radiological health effects assessments** *Mr. Johan Camps, Belgian nuclear research centre (SCK CEN)*
10:30	**Consequences and lessons learnt for Europe** *Mr. Massimo Garribba, deputy DG for Energy, European Commission*
11:00	**Debate on lessons learnt in Europe** Moderator: Mr. Robbe Geysmans, *SCK CEN* Panellists: *Mrs. Anne Bergmans, Faculty of Social Sciences, University of Antwerp* *Mrs. Cécile Laugier, EDF, France* *Mr. Hans De Neef, National Crisis Centre (NCCN)* *Mr. Massimo Garribba, European Commission* *Mr. S*imon *C*oenen, *Federal Agency for Nuclear Control (FANC)* *Mr. Augustin Janssens, Belgian Society for Radiation Protection* Consolidation of chat box questions: *Mr. Tom Clarijs, BVSABR*
12:15	**Conclusion** *Mrs. Tanja Perko, Belgian Society for Radiation Protection*

Welcome and introduction

Mrs. Michèle Auglaire, BNS

Michèle Auglaire welcomes the participants to the conference dedicated to 'Fukushima, consequences and lessons learnt', which has the objective to present up-to-date information on the situation is Japan, particularly in the prefecture of Fukushima.

The conference is organised ten years after the dramatic tsunami which submerged large portions of the territory and directly caused the death of thousands of people. Many remember this day and the terrible images from the broadcasting in Japan. It is important first to remind that and to have a thought to all the victims of the tsunami.

On March 11, a major earthquake afflicted Japan. Eleven nuclear plants were operating at that moment; all shut down automatically, the cool-down of the reactors remained ensured, without major anomaly. Unfortunately, the earthquake provoked a tsunami, and a 15-meter wave was at the origin of major destructions on the nuclear site of Fukushima Daiichi. The induced flooding of the site caused a loss of all power supplies and the related safety equipment, leading after some days to core meltdowns and releases of radioactivity to the environment. To protect the population from the direct radiation effects, evacuations were ordered progressively; more than 100 000 people left their homes.

In the immediate aftermath and over the ten years following the accident, Japanese Authorities have undertaken very challenging work to address the on-site and off-site consequences in the areas impacted by the earthquake and tsunami and the resulting nuclear accident.

So, ten years after, it is appropriate to take time to understand the situation today - in particular from a radiological point of view - and what has still to be done to manage the consequences of the accident.

Just after the accident, several international initiatives were taken to analyse the event and draw lessons in terms of nuclear safety and radiation protection. Very early, on 24-25 March 2011, a comprehensive and transparent safety assessment

called ‘stress tests’ was launched for all nuclear power plants in the European Union, and also in Switzerland and Ukraine, with the objective to undertake a review in the light of what happened in Fukushima. The stress tests included a comprehensive analysis of the design and an assessment of the robustness against earthquakes, flooding, and other extreme natural hazards. The results of the stress tests conducted by the European utilities were reviewed by the association of European regulators ENSREG. They were published in full transparency. Based on the conclusions of this assessment, several modifications were implemented in the field of nuclear safety, radiation protection and emergency planning. So today, ten years after, the objective is also to look on what has been accomplished for the improvement of the safety and radiation protection of the nuclear installations.

The present conference tries to give an answer to the following questions: What happened in Fukushima and what were the consequences of the accident in Japan, in Europe and in the world? Which lessons were learnt on radiation protection, on nuclear safety and on emergency planning? Is there any remaining gap in this domain? What are the current challenges?

In order to answer these questions, the Belgian Society for Radiation Protection and the Belgian Nuclear Society have invited Belgian and international experts for lectures and a panel discussion. In the first part of the conference, three different lectures provide an outline on the consequences of the accident, on the situation today in Japan and on the resulting EU stress tests and adapted safety standards. In the second part of the conference, a panel discussion is organised with invited experts from Belgian an international companies and institutions, to answer questions on the consequences and lessons learnt.

Highlights from the lectures[1]

The accident and the situation of the TEPCO's Fukushima-Daiichi site today (9.11.2021)

Mr. Toshimitsu Homma, Nuclear Regulation Authority, Japan

About the evolution of the situation of the Daiichi site:

- On 17 April 2011 TEPCO issued a roadmap on the restoration of the situation from the accident. Many recovery actions were undertaken to stabilize and restore the situation and on 16 December of that year a first stage was achieved; it could be declared that the releases were under control.
- Besides the further protection works and the decontamination and dismantling, special attention was given to prepare the removal of the spent fuel. In November 2013 the removal of the undamaged fuel started This is today completed for units 4 and 3 (over 2000 fuel elements were removed from the pools) and shall be continued in the next years for units 2 and 1. In parallel investigations and preparatory work are currently on-going for the removal of the residual fuel debris of the reactors. This should be completed within 10 years. The full decommissioning is expected to take 30-40 years.
- Impermeable underground walls were built to stop the flow of contaminated groundwater to the sea. The management of contaminated water from the cooling and decontamination creates an acute problem, given the large amounts of treated water that has to be stored on the site (over 1 million m^3). The release of the most cleaned water to the sea is under investigation; an iterative decision process goes on, involving the concerned parties.

About the situation in the surroundings of the Daiichi site:

- On 11 May 2011, a roadmap was issued for the assistance of the residents of the Fukushima prefecture, particularly the residents suffering from the evacuation. The different evacuated areas were gradually redelineated, in

[1] The slides from the lectures can be found on https://www.bvsabr.be/events.asp?ID=223. For the answers to the questions to the lecturers, see the Q/A section below.

function of the exposure risks and the progress of the decontamination works. There are still 37 000 people evacuated (situation as of July 2020).

- The casualties in the Fukushima prefecture accounted for 60% or 2147 of all 3591 'Disaster Related Deaths' in Japan. 'Disaster Related Deaths' are defined as deaths which occurred due to aggravation of injury as a result of the Great East Japan Earthquake and which are qualified for condolence money pursuant to the national legislation. It appeared that the mortality risk was significantly higher in the first month of the triple disaster. This excess risk of death is attributed to the indirect health impacts[2].
- The decontamination of the affected areas has been undertaken (around the site, in the Fukushima prefecture but also in some municipalities of surrounding prefectures). The decontamination has been completed in 2018 (in 100 municipalities). Average dose rate reductions between 30 and 60% are achieved by the decontamination.
- A waste treatment and interim storage area has been created in the immediate vicinity of the accident site, where the waste arising from the decontamination works is processed and stored. A timeline has been established for studying and investigating the final disposal of the waste.
- The accident had huge economic consequences for the area. A reconstruction and revitalisation basis has been developed with priority areas around decommissioning (remote technologies), robotics (robot test facility), energy (hydrogen research) and agriculture.

About the evolution of nuclear safety in Japan:

- A new Nuclear Regulatory Authority has been created, linked only to the Ministry of Environment (the previous agency NISA was under the Ministry of Economic Affairs and Industry).
- The new nuclear safety regulation imposes reinforced design requirements as well as new requirements, including the prevention of core damage, the

[2] See also: LESSONS LEARNT IN PROTECTION OF THE PUBLIC FOR THE ACCIDENT AT THE FUKUSHIMA DAIICHI NUCLEAR POWER PLANT, Jessica Callen and Toshimitsu Homma, © 2017 Health Physics Society

prevention of equipment failure, the suppression of the dispersal of radioactive materials and the introduction of a specialised safety facility. The emergency planning has also been improved with the definition of predefined protective actions.

- Currently 9 reactors are again in operation in Japan (all PWRs) and the restart has been approved for another 7 reactors (4 BWRs and 3 PWRs). The restart of another 17 reactors is anticipated, 3 are under construction, while 24 have been definitively shut down.

Situation in Japan today, latest results of the radiological health assessments

Mr. Johan Camps, SCK CEN, Belgium

Pm: The lecture is largely based on the latest report published by UNSCEAR[3] on 9th March 2021: 'Levels and effects of radiation exposure due to the nuclear accident at the Fukushima Daiichi Nuclear Power Station (FDNPS): Implications of information published since the UNSCEAR 2013 Report'. https://www.unscear.org/unscear/en/fukushima.html

About the releases to the environment and the radiation levels:

- The estimated atmospheric releases during the different phases of the accident were for most radionuclides lower than the releases from Chernobyl and significantly lower than the releases from the atmospheric nuclear weapons testing. About 20% was released over land and 80% over the Pacific Ocean.
- The estimated direct liquid releases from leakages to the Ocean are an order of magnitude lower.
- The resulting contamination levels on land are comparable to those from Chernobyl but the affected area is significantly smaller.
- The contamination levels in the environment decreased at a rate which is faster than what is expected from the radioactive decay only, except for forest areas.

[3] United Nations Scientific Committee on the Effects of Atomic Radiation

About the doses to workers and public:

- From the 21 000 workers on-site, 174 were exposed to effective doses higher that 100 mSv, with a maximum individual dose of 680 mSv; 13 workers had thyroid doses higher that 2 Gy, with a maximum thyroid dose of 32 Gy.
- The doses to the public are difficult to calculate due to the uncertainties linked to the countermeasures taken, the individual habits of the concerned people and the effect of the remediation measures. For people from the most affected evacuated districts the average effective dose is lower than 8 mSv and the thyroid dose lower than 0.03 Gy.

About the health implications:

- No immediate health effects (acute radiation effects) have been observed among workers and public.
- More than 50 patients were reported to have died either during or soon after the evacuation, as a result of non-radiation related effects.
- The assessment of longer-term health effects is complex due the baseline ('normal') cancer incidence in the population. Even among the highest exposed group of workers, it is unlikely that an increase in cancer incidence will be discernible.
- Over 200 cases of thyroid cancer were detected among 800 000 screened infants, which is a higher incidence than would be expected, but this is mostly attributed to the extensive screening that was undertaken.
- The most important health effect is the impact of the accident on the social well-being and mental health.

Consequences and lessons learnt for Europe

Mr. Massimo Garribba, deputy DG for Energy, European Commission

About the consequences on public awareness:

- The Fukushima nuclear disaster changed the international debate over energy policy almost overnight. The disaster caused deep public anxiety throughout the world and damaged confidence in nuclear power.
- Globally, the disaster generated uneven outcomes, including in the EU, where it shaped in a different way the nuclear energy policy depending on the Member States (Germany, France, Belgium, etc.).

About the actions undertaken at EU level:

- Nearly immediately after the accident, on 24-26 March 2011, the EU Council provided two mandates: (1) to perform risk and safety assessments of the nuclear power plants (the stress tests) and (2) to review the legal and regulatory framework for the safety of the nuclear installations.
- The stress tests have reassessed the safety margins and the robustness of the plants, beyond (supplementary to) the existing safety evaluations performed in the licensing process. They were conducted in full transparency; all reports were published, and stakeholders have been closely involved. They showed that the safety standards in Europe were generally high, but further improvements were recommended.
- The review of the regulatory basis led to an amendment of the Nuclear Safety Directive with strengthened requirements on the independence of the regulatory authority and on the transparency, and new requirements with respect to the safety objectives, the nuclear safety culture, the emergency preparedness and response and the necessity for periodic peer reviews. Topical peer reviews on 'ageing of the plants' and on 'fire prevention' are respectively on-going and scheduled.
- The Basic Safety Standards (radiation protection) Directive, which was already under revision, integrated a more explicit requirement on the collaboration between countries in emergency management. A study is

currently on-going to assess how this aspect is practically implemented in the EU Member States.

- The EU is also supporting the strengthening of nuclear safety through the Euratom Research and Training programme, international cooperation agreements and the Instrument for International Nuclear Safety Cooperation, the latter providing EU assistance to third countries.

About the future of nuclear energy in the context of the European Green Deal:

- The European Commission recognises the role of nuclear energy and its contribution to the security of the energy supply and to the decarbonisation targets in those countries that decide to use nuclear energy.

Panel discussion on lessons learnt in Europe

Panel Moderator: *Mr. Robbe Geysmans, SCK CEN*

Panellists:

Mrs. Anne Bergmans, Faculty of Social Sciences, University of Antwerp

Mrs. Cécile Laugier, EDF, France

Mr. Hans De Neef, National Crisis Centre (NCCN)

Mr. Massimo Garribba, European Commission

Mr. Simon Coenen, Federal Agency for Nuclear Control (FANC)

Mr. Augustin Janssens, Belgian Society for Radiation Protection

Consolidation of chat box questions: *Mr. Tom Clarijs, BVSABR*

Robbe Geysmans introduces the panel discussion and encourages attendees to raise questions via de chat-box[4]. The panel consists of six panellists, representing a broad range of expertise, from the policy and regulatory field, to the industry, the science and beyond. This will allow answering questions about several fields of interest. The focus will go on the *lessons learnt* from the accident, in Belgium and in Europe.

Introduction

To start the discussion, Robbe Geysmans requests each panellist to introduce her-/him-self and explain where she/he worked ten years ago in 2011 and how she/he experienced the accident.

- Massimo Garribba, today at the European Commission Deputy Director General for Energy, was at the time of the accident Head of the Unit

[4] Complementarily, specific questions to the presenters of the previous session are answered afterwards by e-mail (see in the Q/A section below).

responsible for Nuclear Safety. He works since more than 25 years in the nuclear field, first in fusion research, then on the policy and legislative aspects of nuclear fission. He has a background as engineer.

- Simon Coenen works as expert in nuclear safety at the Belgian Federal Agency for Nuclear Control (FANC). He has more than 30 years experience in the nuclear field, first at SCK CEN, where he was at the end responsible for two of the research reactors, and from 2004 on at FANC. The Fukushima accident happened at a moment that he was on an intensive care hospital bed, which gave him incidentally more time to closely follow the developments on media and as such advise colleagues who had to reply to numerous questions.

- Anne Bergmans is social scientist; she is senior researcher and guest professor at the University of Antwerp. Her field of study is sociology of safety and risk. As such, she is involved in some dedicated EU and national projects which target to support public engagement and dialogue in this field. She follows the nuclear issues with an 'interested, outsider perspective'. At the time of the accident, she had small children, so she could not really focus deeply on what happened. But since then she is interested - as social scientist - to follow how we learn from such accidents and how societal resilience can be enhanced, by improving e.g. the emergency preparedness and response in a prospect of risk dialogue.

- Augustin Janssens is radiation protection expert since about 50 years, starting his career with research in dosimetry at the University of Ghent, then moving to the European Commission where he was head of unit for radiation protection. From the early moment that the accident was notified in Europe he was deeply involved. As such he could experience all difficulties to manage the information flow on the accident in the days and nights after the occurrence, and later on with regard to the food imported from Japan. Although he and his colleagues had to focus on the consequences for the EU, they remained concerned about the impact of the accident on the local Japanese population. He was directly involved in the integration of the emergency preparedness and response requirements in the revised Basic Safety Standards Directive, which were fostered by the occurrence of the accident.

- Hans De Neef works at the Belgian National Crisis Centre (NCCN) and is coordinator for the CBRNE expertise centre. Before, he was coordinator for the National Nuclear Emergency Plan. He remembers the alert related to the tsunami and its devastating consequences. Related to that, he wants to express his respect to his Japanese colleagues who had to deal with three major catastrophes at the same time. He also remembers having been involved with the crisis centre in assessing the consequences for Belgium. In the days following the accident, the crisis centre launched a media campaign to familiarise the public on the distribution of iodine tablets. This sensitisation campaign - scheduled long beforehand - was obviously extra effective in this context.
- Cécile Laugier is since 25 years active in the nuclear industry and works at Electricité De France (EDF). She is Vice-Director of the Nuclear Power Plant Operation Division of the company, in charge of the environment. At the time of the Fukushima accident, she was running the technical support centre, providing - amongst others - expertise on seismic hazards. The accident triggered questions related to the design criteria. She however reminds that, with regard to flooding risks, much was already learnt from the flooding incident at the Nuclear Power Plant of Le Blayais in 1999. Following the Fukushima accident, stress tests were performed, with the need to look beyond the design basis of the facilities. Amongst several improvements, the approaches related to emergency preparedness were changed, including the creation of the 'Nuclear Rapid Action Forces[5] (FARN)'.

[5] Rapid Action Forces – Forces d'Action Rapide Nucléaire: regional intervention teams created by EDF to support the on-site nuclear emergency response in case of accident

Questions to the panel

About public communication: ***"To what extent can the information extracted from the previous presentations be used to raise the understanding of non-experts, of the public in general? And beyond this, to what extent should we really raise the understanding of the public about an accident such as Fukushima?"***

- Augustin Janssens: The communication to the public on accidents is essential in the management and follow-up of emergencies. But the issues are very complex and difficult to translate, to 'digest' in key messages which can be easily understood. So it is important that we learn from what happened and from the related experiences, to better explain to the public the reasons of the protection measures taken. An analogy exists with the current COVID crisis, which is - in a global context - a much bigger health crisis than Fukushima was in Japan.

- Simon Coenen: Communication is important, but it has to be done carefully. Communication science is very different from the nuclear sciences. So it is important not to stick to mere numerical and technical figures, but to accompany these figures with the right messages for the public.

- Massimo Garribba: Before communication, one should address the issue of transparency. If a decision is taken which is sound, it should be taken in a transparent way. Only this will allow building trust with the population. This shall also include 'what is *not* going well' to be explained in a transparent way. This need for transparency is addressed in the EU legislation as well as in the entire process of the stress tests.

  However, in the longer term, when an issue is not anymore felt in an emotional way, contrarily to what would be the case just after an accident, the interest of the public may be really modest. This is e.g. what was experienced during the first topical peer review performed under the Nuclear Safety Directive performed on the ageing of the installations. So also raising the interest of the community of stakeholders is essential.

- Anne Bergmans: The question on raising the interest 'of the public' is rather broad. It is important to start with defining the type of public, i.e. which stakeholders we want to address and what message we want to convey them. Considering that, some information from the previous expert presentations may be useful, other will probably not work. By knowing well our stakeholders we may understand better which messages are important to them, how we shall present them in a meaningful way, and how we could raise their interest.
- Cécile Laugier: Concepts as 'nuclear safety' or 'defence in depth' are rather theoretical and as such very difficult to communicate. Despite many technical improvements made on the reactors, they are hard to explain to the public in general. On the other hand, pictures from e.g. the Rapid Action Forces, or from people acting in related exercises, are much stronger and better allow conveying messages.
- Hans the Neef: A distinction should be made between providing information in the 'cold phase' (i.e. proactively) or in the 'warm phase' (i.e. during an emergency). In the cold phase there is obviously more room to build on the interaction between all parties. In the warm phase, it is really important that messages are trust-worthy, by showing clearly that the required protective actions are supported by scientific assessments, which must be presented in an understandable way for the general public.

About safeguarding the nuclear expertise in Belgium: *"With the phase-out of nuclear energy in Belgium, are we sure that the expertise on dealing with possible accidents will remain, considering that the territory may still be affected by nuclear accidents that might happen on installations abroad or on Belgian nuclear decommissioning and waste management sites?"*

- Hans de Neef: The National Crisis Centre has a multidisciplinary approach that must consider all risks on the Belgian territory. As long as nuclear or radiological risks exist, it will be necessary to have preparedness and response measures in place, in the same way as for many other types of hazards.

- Simon Coenen: Nuclear safety is a never-ending story, it has to be considered from the design phase, over the whole lifetime, up to the final decommissioning of each facility. As result of the Fukushima accident, the collaboration and exchange of information with neighbour countries on emergency measures has been enhanced. As long as these risks remain, the regulatory body will have to deal with it.
- Augustin Janssens: Maintaining expertise will not only be needed to deal with potential accidents from abroad, but also with possible terrorist attacks or even nuclear war. These situations cannot be fully excluded. A huge expertise is available in Belgium, e.g. in radioecology for the identification of contamination in foodstuffs. It is essential that this expertise remains ensured by a new generation of scientists.

About the nuclear safety systems in place: *"Could* passive *safety systems have mitigated the effects of the accident?"*

- Massimo Garribba: The question is specific and can only be answered in a speculative way. However, it shall be noted - when you visit the site - that the affected units 1 to 4 were constructed in front of the seaside, while the unit 5 and 6 were built on a higher location and were not damaged by the tsunami. It is rather clear from the assessments after the accident that the tsunami risk had been underestimated. Building an effective seawall could have been better considered in the design of the nuclear power plants.
- Cécile Laugier: There were indeed passive features installed in the form of a protective wall in the sea, but it was designed too low and as such insufficient. What is however more important than passive safety features is that the nuclear facility has the right necessary *autonomy and resilience*. That is what has been strengthened: autonomy and resilience in terms of availability of water and electricity, provided by different redundant systems. In France, an autonomy and a resilience for three days have to be guaranteed. Thereafter, extra support from outside must be ensured. A lesson from the Fukushima accident is that the damages on-site and in the vicinity can be considerable. So the possibility must exist to rely on external rescue teams, providing water and electricity

supply, in whatever condition. The support must be well-equipped and staffed with skilled forces, able to face all possible scenarios. To enhance this autonomy and resilience is probably more important than passive features.

- Anne Bergmans: It is a good approach to focus on what we can learn from the accident and on how we can enhance as such the safety level. But we shall nonetheless not keep a sort of 'blind-spot' on these improvements. We shall consider - without overreaction - that accidents may always occur at a certain time and that we shall anyway be prepared. So we have also to focus on dealing with that, not only on a demonstration that the installation is safe.

About the evacuation decision: ***"From the presentation it appears that the emergency measures at Fukushima could protect against radiological effects, but caused on the other hand about fifty evacuation casualties and also led to significant psychological effects. How can we balance the radiological benefits and the drawbacks from protective measures?"***

- Augustin Janssens: Related to the evacuation risks, we indeed did not consider sufficiently (in Japan but also in Europe) that transferring vulnerable people could be dangerous and even cause deaths. This is clearly a lesson that we need to take from the Fukushima experiences and include in our emergency response planning.

  The psychological stress due to relocation of people from affected areas is another issue. We understand today that the doses for the population are rather low, at a level that will probably cause health effects that are not discernible at epidemiological level, but on the other hand, the 'non-radiological effects' are very clear. From an outsiders' view, the circumstances of the relocation of people appear to have been very difficult, creating significant stress. But we can obviously not assess what would have been the stress for the people would they have been staying in the affected areas. What is anyway clear is that a decision for relocation is not an urgent decision. So there must be time to talk to the people, explain them the situation, the risks would they remain, and the consequences of relocation. The approach should allow coming to a

shared decision within the community. Such a decision-making process takes time, is not easy and shall not be based on dose numbers only.

- Hans De Neef: After the Fukushima accident the extreme complexity and possible adverse effects of the evacuation measure became very clear, not only for the coordination on a national level but also on a local level. As such, evacuation shall be seen as the last possible reaction, only to be implemented once there is evidence that the radiological consequences would be larger than all the other collateral consequences.

  The potential evacuation should be well-defined in the emergency preparedness phase, proactively, so that it can be undertaken in the most efficient way would it be needed. Consideration shall be given to the blocks (zones) at stake for a potential evacuation and within these blocks the vulnerable groups. Currently a socio-economic vulnerability assessment is on-going in Belgium for all emergency planning areas around facilities at risk. Aside of the national emergency plan for the overall coordination, a good preparation at local level is indispensable.

- Massimo Garribba: When the stress tests were presented to representatives of the civil society, there has been a strong request to deepen the 'cross-border' understanding of the emergency preparedness and response measures. A study performed at European level in 2012 found major differences in the applicable measures in neighbouring countries. Since many nuclear facilities are close to country borders - and considering also the inevitable psychological impact of some of the measures - the question of harmonisation and coordination between countries is an absolute necessity. In 2015 the EU Council adapted a set of conclusions that highlighted the importance of coherent tools across the country borders. Now that the BSS Directive emergency requirements are implemented in the national legislations, the European Commission started an overall re-analysis of the cross-border arrangements.

About the protective measures in general: *"When addressing the protective measures to the population, what are the errors to avoid? What should not be done?"*

- Hans De Neef: In a real emergency situation there is typically a four-cycle process in the management of the crisis: the creation of a situation awareness, the preparation of protective actions, the decision-making, and the follow-up of the execution. In this context there are different influential factors that will impact the evaluation and decision-making, which are obviously the technical radiological aspects, but also the operational feasibility, socio-economic aspects, communication and - as highlighted above - the international cooperation. It is however not possible to fix in advance all suitable and non-suitable measures that shall be taken. The Crisis Centre has for that reason prepared a 'toolbox' with the set of protective measures that may be taken (including sheltering, evacuation, iodine prophylaxis, and also indirect measures like the protection of the food chain, drinking water, etc.). There is not such thing as 'one measure shall not be taken' or 'one will be better in all circumstances'. Each emergency situation is unique, and in function of the situation one or another set of measures may be the most opportune to be taken.

- Augustin Janssens: The BSS Directive requires that EU Member States have to cooperate in emergency planning, and it is essential that this is actually implemented. In order to stimulate the common understanding of what shall be done, the collaboration between the Technical Support Organisations on this matter has been stimulated, so that at least at the level of the expert support to the crisis management some coherence is put in place. A trivial example is the use of the same colours for the maps that illustrate the accident consequences.

  An example on what should probably not have been done are the changes in the permissible food contamination levels in Japan after the Fukushima accident, which were reduced significantly in comparison with international standards, without firm scientific grounds. There may have been good reasons for proceeding like that, but the measure appeared from an outsiders' perspective rather confusing. The

experience showed that it was also not necessary from a radiological point of view, considering the very low exposure levels.

The panel discussion concludes with a final question of Robbe Geysmans to all participating experts: ***"If you would have to take* one *main lesson that you learnt or what the world learnt from the Fukushima accident, what would it be?"***

- Anne Bergmans: We should not be blind for accidents which may have a low probability but serious consequences, on the contrary we need to be prepared to face them, as good as we can.

  Also, in crisis management, we will have to deal with uncertainties, the situations are complex, so it will be impossible to have all scientists in full agreement before taking a decision. But nevertheless, when the situation becomes less 'hot' and allows it, it is important thinking quickly on broadening the basis of the further decision-making, looking not only on the radiological risks but all other related issues.

- Simon Coenen: The Fukushima accident confirmed that 'nuclear safety' deserves attention at all times. Keeping a questioning attitude, having a critical attitude, is one of the fundamentals of nuclear safety.

- Massimo Garribba: 'Continuous improvement' is a basis of nuclear safety. Applying this means that we have to verify our hypotheses every time, and as such discover new issues not considered before. This approach conducts towards what is called 'safety culture'.

  It is also very important to highlight two points that were taken up in the EU legislations: i.e. (1) the independence of the regulatory authorities in their decision making and (2) the transparency of the decision making towards the public. These two elements, taken together, provide a guarantee for the citizens that work is done based on technical competence only and that the decision-making process is understandable and available to external scrutiny.

- Céline Laugier: We all need to be humble and keep our eyes open and acknowledge the unpredictability of such events. But it is also our

responsibility to learn lessons from this kind of accidents and enhance the safety. This shall rely on both human, organisational factors as on technical equipment.

- Hans De Neef: Aside of the safety culture there is also a need for an 'emergency preparedness culture', learning continuously and being critical towards own ideas, being open for every possible improvement of the emergency preparedness and response.
- Augustin Janssens: 'Solidarity' is essential, particularly in crisis circumstances, to manage the situation, to the benefit of the whole society, from an ethical point of view.

  This may be illustrated with the experience in the context of the food contamination. On the one hand doses were negligible, certainly in Europe, for food imported from Japan, but decisions were taken looking at the own interest, without considering the impact of these decisions on the farmers' community.

  And there are many examples showing the importance of solidarity in case of other emergencies, like natural disasters and epidemics.

Concluding words

by Mrs. Tanja Perko, BVSABR

Mrs. Tanja Perko concludes the meeting by reminding that the purpose of the event was to commemorate the Fukushima-Daiichi nuclear accident and to identify the lessons learnt for radiation protection, nuclear safety and emergency preparedness and response. Both the Belgian Nuclear Society and the Belgian Society for Radiation Protection are 'learnt societies', and the collaboration allowed bringing together several disciplines, experiences, responsibilities and enlarging the discussion during the panel. Although the vision and mission of the two societies are to some extent different, it is great that the event could be created in a dialogue. It was an opportunity to critically reflect on how to improve the governance of nuclear technology in Belgium and in Europe, how to be prepared to nuclear or radiological accidents, and to reflect on the radiological challenges in case of such event, also from a societal point of view.

Based on the presentations and the highlights of the panel discussion, it may be concluded that the Fukushima-Daiichi nuclear accident had large psychological, sociological, political, environmental, economic and technological consequences; it showed the need to question and improve the safety of the nuclear installations; it gave a 'kick' to improve emergency preparedness and response. It also gave an opportunity to critically reflect on radiation protection principles and recognise that those principles are often 'value-based', not only based on facts. These issues are opportunities to have a dialogue, to openly discuss and to learn from each other.

There are obviously many other topics to be discussed about the accident, but the conference was limited in its duration as it had to be organised online. But the societies will continue learning and create opportunities to stimulate dialogue.

Finally, both societies thank all panellists for the vivid discussion as well as the presenters for the informative presentations introducing the panel. In name of these societies, Tanja Perko thanks also to panel moderator Robbe Geysmans, Tom Clarijs and the people behind the screens organising the event, as well as all attendees who followed the webinar.

Questions and answers by e-mail

The questions below were raised via the chat-box to the lectures[6] during the event; they were answered by the lecturers after the event.

Questions to Mr. Toshimitsu Homma, Nuclear Regulation Authority:

1) On which basis would you qualify the entrance into a 'long-term' management and what delay would you consider acceptable for existing nuclear power plants? (In view of the approximate nine months it took to recover the control of the cold shutdown at Fukushima, would you qualify that the long-term management started after these 9 months or not?)

Answer: From the perspective of radiation protection, the long-term phase of an accident, often called the 'recovery phase', begins on-site when the radiation source is considered to be sufficiently secured, and the exposure situation is adequately characterised to enable work to begin on dismantling the damaged installation. Off-site, the long-term phase begins when radiological conditions in affected areas are sufficiently characterised to support decisions by the authorities about the future of these areas, and also when long-term protective actions have been implemented to accompany the rehabilitation of living conditions in areas where people are allowed to stay or expected to return. Those are described in ICRP Pub. 146[7].

In the Fukushima Daiichi case, the long-term phase on-site can be considered as starting on 16 December 2011 when the Japanese Government announced 'the re-establishment of control and the attainment of cold shutdown status regained in Units 1 to 3', meaning that the radiation source was considered to be sufficiently secure. You can also see the Chernobyl case in the Annex of ICRP Pub. 146.

[6] The slides from the lectures can be found on *https://www.bvsabr.be/events*

[7] ICRP publication 146: Radiological protection of people and the environment in the event of a large nuclear accident: update of ICRP Publications 109 and 111.

2) Do you have an idea of the energy needed (per year, month, ...) to ensure the freezing of the soil?

Answer: Unfortunately, I have no idea of the energy needed to ensure the freezing of the soil in the Fukushima Daiichi site. I tried to search for that information from TEPCO's website and METI's website but could not get it.

Editor's note: some related information is now available on:
https://www.tepco.co.jp/en/decommision/planaction/landwardwall/index-e.html

3) Is the system for 'disaster related deaths' still in place for health effects associated with the Fukushima triple disaster and is there still increase of deaths?

M. Homma mentioned the existence of the 'disaster related death system' in Japan. This system allows the recognition of excess deaths among the affected population in the years following the accident. This system leads to compensation for deaths related to the disaster (including earthquake, tsunami, and nuclear accident). In the first years after the accident a significant number of excess deaths has been recognised. My question is how long this system will consider disaster related death from March 11, 2011, disaster? Is there a decrease in the number of deaths recognised or even an end planned for this system?

Answer: Yes, it does. Please find attached the most recent data by the Reconstruction Agency, unfortunately in Japanese[8].

In the Great Hanshin-Awaji Earthquake of 1995, deaths due to medical causes of death, such as deaths from illness caused by overwork or environmental deterioration associated with the earthquake, were officially recognized as eligible for disaster condolence payments under the Act on Disaster Condolence

[8] Document reference: Reconstruction Agency - Number of deaths related to earthquakes in the Great East Japan Earthquake (Survey results as of September 30, 2nd year of Reiwa). With the cooperation of each local public body, the death toll related to the earthquake in the Great East Japan Earthquake – only available in the Japanese language

Payment enacted in 1973. For this reason, disaster-related deaths covered by this Act are said to be a concept that first emerged after the Great Hanshin-Awaji Earthquake.

The Reconstruction Agency has still published the number of people killed in disaster-related deaths by prefecture, municipality, age, and period, that it has been able to ascertain to date (the most recent figures are as of September 2020). In announcing the number of disaster-related deaths by prefecture, the Reconstruction Agency defines 'disaster-related deaths' as 'those who died due to the aggravation of injuries caused by the Great East Japan Earthquake and who were eligible for the payment of disaster condolence money based on the Act on the Disaster Condolence Payment'. This means that the analysis of disaster-related deaths is based on the fact that each municipality decides to pay condolence money and disability payments based on the Act by their own criteria, and not on the question of whether the deaths are related to the disaster.

In May 2012, the Reconstruction Agency established the 'Working Group on Disaster-Related Deaths' and compiled a 'Report on Disaster-Related Deaths in the Great East Japan Earthquake'. In the report, among the 1,632 related deaths that the Reconstruction Agency was able to ascertain by March 31, 2012, the Working Group investigated the causes of 1,263 deaths in municipalities with the highest number of earthquake-related deaths and in municipalities where evacuation orders were issued due to the nuclear power plant accident, and published the results of the analysis. In addition, opinions from local governments and experts were obtained on the causes and measures to be taken, and finally, future measures are summarized.

If you remembered, the figure of 1,700 disaster-related deaths presented by the president of the American Nuclear Society at the NEA workshop in Lisbon in January 2020 may have been a reference to this number. So at that time, I questioned the basis for that figure. At least, the Japanese government has not officially announced the number of disaster-related deaths attributed to the Fukushima Daiichi accident. This is because the decision to certify is left to committees at the municipal level, and there are no definite criteria. Since there are no criteria for determining when a death occurs after a disaster has occurred, the absolute number of deaths is extremely uncertain.

In the case of the Niigata Chuetsu Earthquake, Nagaoka City, referring to the rules prepared by Kobe City for the Great Hanshin-Awaji Earthquake, said, 'Deaths within a week of the earthquake are related deaths, and if within a month, the possibility is high. If it is after that, it is unlikely, and if it is after six months,

it is not a related death.' The MHLW[9] has also endorsed this as the 'Nagaoka standard' and introduced it to other local governments as a 'reference example' when the Great East Japan Earthquake occurred.

In fact, in a survey of disaster-affected municipalities conducted by the Japan Federation of Bar Associations about two years after the Great East Japan Earthquake, the rate of recognition of disaster condolence money for applications made by the concerned people showed a gap among 86% in Fukushima Prefecture, 76% in Miyagi Prefecture, and 60% in Iwate Prefecture. In some cases, the families of the deceased who did not receive condolence money filed lawsuits, and the local governments voiced their desire for the government to establish criteria for approval.

This is the situation concerning disaster-related deaths, and I believe that the absolute number of disaster-related deaths in the Great East Japan Earthquake is not very meaningful. So, in my presentation, I introduced a paper on excess relative mortality risk by Morita et al[8].

4) How were the 62 radionuclide concentrations assessed? By calculation codes or measurements? (or a combination of both?)

Answer: TEPCO assessed the 62 radionuclide concentrations by measurements. For gamma-ray emitting radionuclides they used a gamma-ray nuclide analysis method with a germanium semiconductor detector, other nuclides such as H-3 (separation by distillation followed by beta-ray measurement with a liquid scintillation counter), C-14, Sr-90, Sr-89, Cd-113m, Ni-63 (chemical separation followed by beta-ray measurement), and TC-99, I-129 (ICP-MS measurement).

You can see further information at TEPCO and METI site.
https://www.tepco.co.jp/en/decommission/progress/watertreatment/index-e.html
https://www.meti.go.jp/english/earthquake/nuclear/decommissioning/atw.html

5) What about the analysis of the protective measures to the population? What has been done well? What are the errors to avoid?

[9] MHLW: Ministry of Health, Labour and Welfare of Japan

Answer: I think that the implementation of precautionary urgent protective actions such as evacuation decided by the government on 11, 12 March before the large releases from Unit 2 based upon plant conditions and restrictions of food and water on 17 March were quite effective to reduce both external and internal exposures. However, the urgent evacuation and long-term temporary relocation of patients from hospitals and elderly people from nursing facilities encountered difficulties as I emphasised in my presentation. I think this was mainly due to the lack of preparedness and even siting issues.

Please find attached[10] to our paper related to lessons learnt on protection of people at the Fukushima Daiichi accident.

6) Concerning the strategy for water treatment: why was 'dilute & disperse' chosen over 'concentrate & contain' (e.g. evaporation and conditioning of concentrates)

Answer: Basically the 'Tritiated Water Task Force' assessed five options for the ALPS treated water disposition in 2016:

– Geosphere injection;
– Controlled discharge into the sea;
– Controlled vapor release;
– Hydrogen release; and
– Underground burial.

The Task Force assessed each option against several criteria: technical feasibility, regulatory feasibility, duration, cost, scale, secondary waste, radiation exposure to workers. In 2020 the ALPS Subcommittee considered that there was no precedent for deployment of three of the options (i.e., geosphere injection, hydrogen release and underground burial) in their assessment of the five options. In addition, for each of these first-of-a-kind options, there are significant unresolved technical and regulatory uncertainties and risks that will need addressing. That is the situation now.

[10] Document reference: LESSONS LEARNT IN PROTECTION OF THE PUBLIC FOR THE ACCIDENT AT THE FUKUSHIMA DAIICHI NUCLEAR POWER PLANT, Jessica Callen and Toshimitsu Homma, © 2017 Health Physics Society

Please find the reference[11] to a Review Report by IAEA for further information.

You can also find information at the METI site:
https://www.meti.go.jp/english/earthquake/nuclear/decommissioning/atw.html

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Questions to Mr. Johan Camps, SCK CEN:

1) In the total dose to the workers, do you have the respective weights of internal contamination and external exposure?

Answer: I think this cannot be found in detail in the UNSCEAR 2020 document although doses have been reviewed (some information is given in the text, but somewhat scattered). But in earlier presentations we gave about the topic we collected the table below which gives number of workers receiving a certain dose in the early phase (March 2011) and split between internal and external exposure and TEPCO employee or contractor. These numbers give a good idea (some numbers will be later somewhat fine-tuned, but not much) of the respective importance of internal and external exposure.

Exposure (in mSv)		< 10	10-20	20-50	50-100	100-150	150-200	200-250	>250	**Total (mSv)**	**Max. (mSv)**	**Avg. (mSv)**
External	**TEPCO**	673	598	292	105	20	6	0	0	1694	182	19
	Contr.	1697	331	182	58	8	3	0	0	2279	199	9
	Total	2370	929	474	163	28	9	0	0	3973	199	13
Internal	**TEPCO**	1038	398	186	37	6	1	1	5	1672	590	12
	Contr.	1837	249	99	21	0	0	0	0	2206	99	5
	Total	2875	647	285	58	6	1	1	5	3878	590	8

[11] IAEA Follow-up Review of Progress Made on Management of APLS Treated Water and the Report of the Subcommittee on Handling of APLS treated Water at TEPCO's Fukushima Daiichi Nuclear power Station, IAEA, 2 April 2020

Exposure (in mSv)		< 10	10-20	20-50	50-100	100-150	150-200	200-250	>250	Total (mSv)	Max. (mSv)	Avg. (mSv)
Total Ext+Int	**TEPCO**	346	530	539	195	63	15	0	6	1694	670	31
	Contr.	1337	461	361	99	17	2	2	0	2279	238	14
	Total	1683	991	900	294	80	17	2	6	3973	670	21

2) Was iodine prophylaxis included in the countermeasures for the public? What is your opinion about this measure in general?

Answer: Iodine prophylaxis was in principle included in the totality of countermeasures taken (it is important to realize that these countermeasures are largely depending on time and location) but for sure in general tablets have not been taken. Based on the experience from Chernobyl we know very well that an important increase in thyroid cancer incidence in (young) children from an absorbed thyroid doses of 100 mGy on (or even a little bit below) was observed (this was also largely due to contaminated food, because food bans were taken late in Chernobyl), while an increase in thyroid cancer incidence was not observed in adults. In general we know that children are most vulnerable in relation to exposure, in this respect my personal opinion is as a first option to evacuate children if time allows and possible from the operational perspective. Emergency plans in Belgium do not consider the option to date to evacuate only children (this can be of course together with their parents). However, avoiding that children become exposed avoids in the aftermath (even if doses are limited as in Japan) a long-term medical follow-up with screening procedures such as we have seen in Fukushima. If evacuation is not possible, iodine prophylaxis is of course a good option (again mainly for children, young persons and in combination with sheltering, not for age 40-50+).

3) I agree that LNT is a simple a fast approach to give a rough estimate / boundary value of the health impact. I nonetheless thought UNSCEAR acknowledged it should not be used for the estimation of health impact (as it

would lead to over-conservative results) but only for radio-protection / preventive purposes. Isn't that so and, if yes, what are their recommendations for the estimation of health effects?

Answer: Fully correct, if doses are high enough, for example workers with doses >100 mSv health implications are made quantitatively by UNSCEAR: they give 2 to 3 excess cancers in this group as I presented. For low doses however (LNT), UNSCEAR is not quantifying the potential health implications based on these doses. They calculate a collective effective dose (32 000 manSv first 10 years whole population of Japan), but this should also not be used to estimate health implications (cf. ICRP recommendation). They further refer to follow-up studies (e.g. thyroid) and conclude "no discernible increase in risk to be expected". This statement is sometimes confused with no impact at all from radiation, but that is of course not exactly the same: some health impact is possible but it is not discernible.

4) In your presentation, it is not clear what 'average dose < 8mSv with 90% in factor 3' means. Is it: 2.66 mSv on average with 90% < 8mSv (= 3 x 2.66) or is it 8 mSv on average with 90% <24mSv?

Answer: Very relevant question; there was little time to explain in detail during a short presentation, but I wanted to give at least some quantitative numbers. Effective dose (but also absorbed thyroid) dose has been estimated in the UNSCEAR study on district level (for non-evacuees) and for different evacuation scenarios for evacuees. For all the different districts and scenario's a different average dose was found. However the results have been grouped: evacuees, non-evacuees from the Fukushima prefecture (different districts), non-evacuees from specific districts neighbouring the Fukushima prefecture, … What I presented during the talk was the maximum averaged dose for these different "groups".

As an example (referring to the slides): The average effective doses in non-evacuated districts (Fukushima) were ≤ 5 mSv, the absorbed thyroid dose: ≤ 20 mGy first year. The maximum average effective dose in a district within the Fukushima prefecture was estimated to be 5 mSv, the average effective dose in other districts < 5 mSv.

The factor 3 indicates that in general on district level (also for the district with the maximum averaged dose), it has been estimated that 90% of the people get doses in the range of 3 times lower to 3 times higher than the average value, which gives some view on the dose distribution the people received. The UNSCEAR report includes some related dose distribution graphs, which I could not yet show during the presentation.

5) The conclusion is that it is difficult to assess the health effect from radioactive releases. Did we try to assess this health effect from the observations from the Chernobyl accident (empirical approach)?

Answer: Interesting question, probably most difficult is to communicate the (potential) health effects. My view on this (for the stochastic effects, as for deterministic effects if acute radiation syndromes are observed it is relatively clear): assessing the health effects can be done mainly in two ways:

- the dose can be calculated (eventually including an uncertainty) and based on this the increase in incidence of health effects due to radiation exposure can be estimated: somewhat difficult because for low doses you need assumptions like LNT. A lot of data is needed to do this correctly, but retroactively - when time is available - you can get an idea of potential health effects using combinations of models and data
- epidemiological studies or screenings: the first is a blunt instrument because of the high baseline incidence of stochastic effects such as cancer, the second (screenings) especially when new, advanced techniques are introduced (such as was done for thyroid screening) you get an increased incidence independent of radiation exposure …

For Fukushima both ways are in agreement, resulting in the UNSCEAR statement: “no discernible increase in risk to be expected”. However this statement is often not well interpreted and quoted as no health effect. This is not exactly the same, some limited number of stochastic effects are expected (for example in the group of workers exposed to doses > 100 mSv, 2-3 cases are assumed but not discernible above the baseline cases of around 70 …, for the public it is even more tricky, below 100 mSv increase in cancer incidence has

never been demonstrated in epidemiological studies, but this is because, even if they exist, it has been statistically impossible to demonstrate this).

This is a very balanced message and indeed difficult to bring. The fact that no health effects have been observed and that no discernible increase in risk has to be expected means that radiation protection has worked in Japan (some will say that it worked too good: too low food levels …), in contrast to the Chernobyl accident in which you had around 134 acute radiation syndromes and a clear increase in thyroid cancer among young children.

6) In your presentation you emphasize the use of individual monitoring devices following the Fukushima accident. What is planned in Belgium concerning the promotion of the use of such devices and what is envisaged by the public expert body and the authorities to collect and discuss the results of the measurements performed by citizens?

Answer: A very relevant question in context of preparedness. We performed - in the context of the Measurement cell (the working group of partners under presidency of FANC-AFCN contributing to measurements in the context of a nuclear and/or radiological emergency) - a screening of existing citizen initiatives in Belgium (in fact mainly international initiatives with Belgian participants) including the number of measurement points, also somewhat the quality of the data was investigated. We also looked how we could obtain the data (download options, web scraping, …). This was done some two years ago and the conclusion at that moment was that for the early phase (data directly available if an accident would happen tomorrow) those data are interesting to monitor within the crisis response organization but would bring little additional information for decision making if compared to the early warning network TELERAD and the mobile teams.

For the later phases, the amount of measurements will of course increase rapidly, and also just for radiation measurements in normal situations we have considered to set-up some projects but till now none has started. The main work in Belgium on this in my knowledge is the PhD work of Joke Kenens in the unit of Catrinel Turcanu at SCK CEN.

7) Some graphs/figures from Mr Camps' presentation that compare values such as doses, dose rates or activity contents should be more exploited for communication (by the authorities, the media...) to the public to try giving them a better-balanced view and knowledge of radiation risks.

Answer: I fully agree that graphical representations say often more than "thousand words". Balanced views are indeed not often encountered in media communication, especially if it relates to radiation risks and making available such graphs/figures can help. I made part of the graphs myself, but a lot of the material was taken from different sources, such as UNSCEAR, IAEA. It has to be noted that following the accident some European projects in nuclear and radiological emergency management have been funded in which lessons learnt from Fukushima were part of the project. In one of these projects (CONFIDENCE) a study was made on data visualization, i.e. how to visualize for instance contamination maps, different lay-outs/colour schemes using the same data were used and people were asked to give their interpretation.

Questions to Mr. Massimo Garribba, European Commission:

1) There are already so many peer reviews and audits in nuclear industry, especially from IAEA (OSART missions) and WANO. What is the added value of an additional peer review at European level?

Answer:

- The peer reviews and audits performed through the IAEA and WANO are valuable mechanisms to enable teams of experts to review a relevant area of nuclear safety at a plant to assess its alignment with the relevant international safety standards, and to aid mutual learning amongst licensees and regulators.
- The post-Fukushima stress tests were the first coordinated set of peer reviews conducted at the same time in 17 countries on key technical areas arising from the lessons of the accident in Japan. As a result of this exercise, important safety improvements were identified in all participating countries

through the findings and recommendations of the peer reviewers. The safety levels were clearly enhanced through the implementation of measures identified through this European peer review. Stress tests have subsequently been carried out in neighbouring countries in view of the benefits of such cooperation.

- Furthermore, the findings, recommendations and the national action plans were all transparently published to share information about the measures taken to enhance nuclear safety at nuclear power plants in Europe. The process was fully transparent and included public meetings for stakeholders to express their views and pose questions.
- The topical peer review under the Nuclear Safety Directive similarly builds on the experience and benefits of greater cooperation amongst countries with nuclear installations, through a coordinated exercise every six years to review how an important topic in nuclear safety is dealt with. The national assessment reports, peer review findings and recommendations and national actions plans are published to enable full sharing of lessons and improve public understanding, which is not always the case with other peer review mechanisms.

2) Do you see / foresee a possible target for a kind of 'sufficient nuclear safety level' to be reached in the future - so in conjunction with an 'acceptable level of risk'? Or would you foresee more a continuous / non-bounded improvement target for nuclear safety even if this could lead to unaffordable solutions?

Answer:

- Member States that decide to use nuclear energy need to apply the highest standards of safety, security, waste management and non-proliferation.
- In this respect, the EU has also developed the most advanced legal framework for nuclear energy, ensuring that those MS who chose nuclear are complying with the highest standards.
- Moreover, WENRA safety objectives and reference levels as well as the IAEA standards provide additional guidance to Member States in their efforts to meet the objectives of the EU legislative framework

- We must make sure that safety related actions at European, regional, and national level all contribute to this objective in a cohesive manner, mutually reinforcing nuclear safety.

3) Germany decided to phase out nuclear energy on the so-called 'findings' of an 'ethics commission' conjured up after the Fukushima accident. This commission mainly consisted of individuals from NGOs, churches and other non-technical individuals known for their fundamental opposition to nuclear energy. There were no real scientific or technical reasons supplied but instead and ethical/political conclusion was reached to phase out nuclear energy. We could say that Germany has a new state religion now: 'Greenism' tightly coupled to anti-nuclear activism. How is it justified that energy policy in a secular institution like the EU is so strongly influenced by this irrational behaviour just because it is the economically strongest country. Can we nevertheless expect that nuclear energy, in particular Generation IV reactors and closed fuel cycles will be named in the green taxonomy?

Answer:

- According to Article 194 of the Treaty on the Functioning of the European Union (TFEU), the choice between different energy sources is within the competence of the Member States. Therefore, the exploitation of nuclear energy is solely a national choice and Germany is fully competent in deciding to phase out nuclear energy.
- At the same time, other Member States (e.g., France, Finland, Hungary, Poland, Romania, Czech Republic, Bulgaria, Slovakia, Slovenia etc.) explicitly refer to nuclear energy for meeting their climate targets and for ensuring energy security in their National Energy and Climate Plans adopted last year.
- The European Commission's (EC) role in this context is to ensure that Member States deciding to use nuclear energy fully comply not only with the TFEU, but also with the Treaty establishing the European Atomic Energy Community (the Euratom Treaty) and its secondary legislation on nuclear safety, radiation protection, radioactive waste management, investments, security of supply and safeguards.

- The EU Taxonomy Regulation has excluded only solid fossil fuels in its definition of environmentally sustainable activities.
- Like all other activities, any nuclear investment needs to show, besides its contribution to achieving climate mitigation objectives, that it complies with the 'do no significant harm' principle.
- The assessment of nuclear energy in the context of EU Taxonomy has not yet been completed. This assessment is ongoing, in particular to determine whether nuclear energy, irrespective of the generation design, complies with the criteria of not doing significant harm to the other environmental objectives and whether it can therefore qualify as environmentally sustainable under the EU Taxonomy Regulation.
- The Commission's Joint Research Centre will soon finalise an in-depth report assessing the 'do-no-significant-harm' aspects of nuclear energy.
- This report will be reviewed by experts on radiation protection and waste management, as well as by environmental experts - the Euratom Article 31 expert group, and SCHEER Committee of DG SANTE.
- The assessment process is set to be scientifically rigorous, transparent and to bring together a balanced set of views. It will follow the principle of technological neutrality, as established in the Taxonomy Regulation.
- Once the assessment process is completed and if all conditions are met, the Commission can amend the delegated act on the climate objectives by the end of 2021, in order to ensure that all the relevant sectors that lack complete assessment at this stage (e.g., nuclear) can then be included.