Gerhard Proehl:

Now, I will talk a little bit about international system of radiation protection. First of all, I will give an overview about the international organizations which are involved in the development of radiation protection. First of all, there is the ICRP, the International Commission on Radiological Protection. The ICRP was founded in 1928. The work was initiated because of the application of ionizing radiation ___ effects were observed. At that time, x-rays were used for many things and the technique was not so far developed to really control all the radiation fields. The ICRP is a charity, which means it is more or less a braided organization. At the beginning it was mainly a collaboration of medical doctors who were working with ionizing radiation and with x-rays. The tasks of ICRP are to estimate exposure levels from applications of x-rays and radionuclides in Medicine, this means the total dose and also the dose rates; provide information about the age and gender of the doses, and also looking whether the pathway, external or internal, has an effect on health. Finally, ICRP also developed a system to be able to convert the exposure to radiation dose. This means to convert activity intake into a dose. Finally, and this is also a very important point of the ICRP is to provide recommendations for radiation protection. This means to give recommendations about dose limits, about reference levels for specific applications, and to provide the basis for developing radiological protection standards worldwide.

However, ICRP is not working alone. It is working hand in hand for more than 60 years with UNSCEAR, which is the United Nations Scientific Committee on the Effect of Atomic Radiation. UNSCEAR was founded in 1957. It was a consequence of the increasing application of nuclear techniques in the ’50s. Therefore, it was founded to systematically study the effects of ionizing radiation. This includes radiation from x-ray sources, from medical sources, also from the application of ionizing radiation in science and industry and, importantly, also to estimate the levels and the trends of radiation doses to people worldwide for a lot of these applications. UNSCEAR publishes, regularly, reports in which those estimations are given. In addition to that, UNSCEAR works on studies (0:05:00) on ionizing radiation, in particular on the effects on humans and also since about 20 years, on the effects on wildlife. UNSCEAR directly reports to the United Nations General Assembly. So since in UNSCEAR many member states of the United Nations are participating, this represents a kind of consensus of the UN member states on the effects of ionizing radiation.

The third player in this is the IAEA, the International Atomic Energy Agency. Again, the IAEA was also founded in 1957. It was founded also to support member states in the

application of nuclear techniques. You may know that in the ’50s and ’60s many states of the world had established nuclear programs for both generation of electricity and also for the application of nuclear techniques in science and industry, and to have some standardization and some common goals, the IAEA was founded and in one of the articles it is said the IAEA should establish safety standards or safety for protection of health and minimization of danger to life and property and provide for the application of these standards. So, the task of the IAEA was to elaborate a set of standards to ensure the safe application of nuclear techniques.

Here we have a slide which shows how these three institutions work together. First of all, we have the UNSCEAR and they provide scientific reports on the radiation effects and also scientific report on radiation levels from different applications. These reports from UNSCEAR are digested by the ICRP and from this, ICRP elaborates recommendations on dose limits and on reference levels, say in which situation which doses are acceptable and which would be tolerable. From all of these, the IAEA produces safety standards for protecting people and the environment. However, the IAEA does not do it on their own, but in cooperation with its member states. IAEA has meanwhile about 170 member states, this means nearly any country on the planet is a member of the IAEA. So, the IAEA safety standards have different categories. First of all, very high level document is fundamental safety principles. This is so to say it gives 10 main overarching objectives for (0:10:00) safety with regard to the use and application of ionizing radiation. This is a very ___ same document. It has 20 or 30 pages. However, to elaborate what does it mean in practice, we have safety requirements and there is safety requirement for a range of different applications. Here is the safety requirement for the management of radioactive waste. Once they have the requirements, they define what is the role of the government, what are roles of the regulator, what are roles of operators, etc. Then we have still more information on what does these requirements mean in practice. So, whereas the requirement says what to do, what shall we do, the safety guides provide information on how to do it.

Coming back to the safety fundamentals. There are 10 fundamentals that defines the responsibility for safety, who is responsible, what are the role of the government? Then leadership for the management of safety is necessary. And then we have the 3 principles of justification of facilities and activities, which means whenever nuclear techniques or nuclear applications are applied, it needs to be justified. It means has it really enough benefit and

does it do more good than harm. And only if this is the case, it is justified to have a specific application.

Then we have the optimization of protection. It is obvious that the application of nuclear techniques may cause rotation exposure to people, so protection measures have to be in place to protect people. However, optimization means that the protection measures and the doses avoided due to the protection measures should be balanced.

Number 6 is the limitation of risks and this means it is necessary to put a limit for the risk of individuals. They should also protect future generations. This is also important for construction and operation of facilities for nuclear waste, for the disposal of nuclear waste, and action should be taken to prevent accidents and should accidents occur, emergency preparedness measures and an appropriate emergency response should be in place.

Number 10 is, there may be some radiation risk which cannot be regulated. Nevertheless, also, if possible, there are protection (0:15:00) actions to reduce existing or unregulated radiation risks should be in place. For radiation protection, the IAEA basic safety standards is a key document. Again, all these standards represent international consensus on radiation protection and in the international consensus because all these standards have been developed by the IAEA in collaboration with other international organizations, in this case it is the European Union, Food and Agricultural Organization, ILO – the International Labor Organization, WHO – World Health Organization. So, all these international organizations contribute to the development of such standards, that's important. By the end of the day, the IAEA is represented by the board of governors, as well as these organizations have to approve, have to agree to these international standards. So, this represents really an international consensus. To develop such a document is a very long process because you may imagine if you have to ask these organizations, ask for input, assimilate the input, and find a consensus in all the opinions which are around, this takes time. Nevertheless, I think due to this procedure of development, these standards have a very high weight. ___ in particular defines responsibilities for the government and the regulatory body as well as for the operator of a nuclear installation. Then it defines exposure situations and we have the radiation protection principles and the radiological criteria. And I will go into a little bit more detail into this.

So, the system of radiation protection, those three exposure groups, first is the workers, this means those people who are occupationally exposed during their work. So, this can be workers in nuclear power plants, but also people who work in laboratories, dealing with radionuclides, but also people in the medical area. Then we have the patients, people who are undergoing treatment and the general public. And we have three exposure situations, planned exposures, emergency exposures, and exposures from existing contamination, and we have also the three radiation protection principles - justification, limitation, optimization. The exposure groups - occupational exposure is exposure of people during their work. Public exposure is exposure to members of the public, I mean this is all people who are not dealing with radioactivity (0:20:00) as a consequence of their work, this is anyone due to planned existing exposure situations and emergency situations, and this excludes any occupational exposure or medical exposure. So, this is medical, is not including public exposure. Medical exposure is patients undergoing medical or general diagnosis or treatment and carers or comforters of patients undergoing radiological procedures and also volunteers subject to exposure as a part of the program of biomedical research.

So the planned exposure is all radiation involving the planned introduction and operation of new sources. It means whenever an activity is planned that may expose people living outside the planned facility, there is a limit for the people outside the facility shall not be exposed above a certain limit. However, we have also emergency exposure situations which are unexpected. This may occur during the operation of a planned exposure which is a nuclear accident for example or any other accident. However, also from malicious act, which requires urgent attention. And finally we have existing exposure situations. These are situations that already exists when a decision on control has to be taken. Typical example for that is a situation near Fukushima, after the accident, the contamination exists and it has to be checked whether actions need to be taken to reduce levels of those in this area.

This also includes natural background radiation, for example from radon. There are some areas in the world, on the globe, with very background level of radon and radon levels in houses may be very high and may cause exposures to people, which may cause health effect. Also residues from past practices, which operated in the past, and which were not controlled by the current system of radiation protection. We all know that in the beginning of the nuclear age, radiation protection measures were not fully in place and in some places environmental contamination still exists, which may cause enhanced levels to people living in this area. We have also, for example, residuals from incidents and accidents. One

example is, accidents in Chernobyl and Fukushima, for example soil was removed or areas were decontaminated, and a lot of waste was generated. Also, those residuals may cause enhanced levels of exposure to people and this has to be also covered within this existing exposure situations.

Let's come again to radiation protection principles. (0:25:00) – We have justification, which means any action should be adequate to the risk, and by the end of the day you should do more good than harm. This sounds easy, but in practice may be not so easy. It always requires a case by case consideration. Optimization – an important principle is the ALARA principle which means that any additional radiation exposure should be as low as reasonably achievable, economic and social factors being taken into account. So, this means as good as you can, but any optimization measure should be adequate to the risk. And then we have the Limitation, to make sure that individuals are not exposed at levels higher than the dose limits or the reference levels. These are two different things. The dose limit is for planned exposures, so this means when something a facility has planned and will be constructed and go into operation. At this stage, the exposure is still under control. The facility can be designed as such that dose limits will not exceed. And the dose limits from all planned activities must not exceed an effective dose of 1 mSv per year from all doses. And if you have several sources in an area, the total dose to an individual living in such area should not be higher than 1 mSv. So, if you have two installations, simple case would be depending on local circumstances that each of the two facilities has to be designed as such that the maximum dose from one facility is 0.5 mSv per year. In practice it's a bit more complex, it's just an example. But, yes, a limit because we plan something and we have to plan it such that there is compliance with the limit. And if you go for emergency situations or existing exposure situations, I mean in an emergency you cannot plan and in this case it does not make sense to give a limit because you don't know what happens. However, for emergency situations they are giving reference levels. Reference level is not a limit, but it's a target. Government or whoever is responsible should take measures that the exposures to people complies with this reference levels. Here, what you see, is here we have a fixed value for the limit. For the reference level a range is recommended. Let's start with the emergency, for emergency it ranges from 20 to 100 mSv. So, measures should be taken that people are not exposed to levels higher than 100 mSv. However, depending on the situation, it might be simple or easy to take measures that people don't get 100, (0:30:00) but may be 50 or 20. So, this also means that people should not get more than 100, but nevertheless you should do as good as you can, and if you can achieve 20 mSv with a justifiable effort, 20

mSv should be tried to achieve. And the same is for existing exposure situations. The upper bound of reference is 20 mSv, but the lower bound is 1 mSv per year. The existing exposure situation is a classical for post-accident situation as we have it in Chernobyl or also in Fukushima and you may remember that Japanese government for Fukushima has recommended in 2011, a long term goal for existing exposure of 1 mSv per year, so going towards the lower end of this range. There is this flexibility to also be able to check the feasibility of measures and also to take into account the experience which has to be made so far in the management of emergency situations or of existing exposure situations.

So, what you see here is called the Wheel of IAEA safety standards. This wheel also indicates hierarchical structure of the safety standards. In the middle, we have the safety fundamentals, then in the red ring we have the safety requirements and here we have a number of different safety guides which provide guidance for a wide range of applications. This includes, for example, monitoring of environmental radioactivity, disposal of waste in deep geological formations, disposal of waste for low level waste for a number of medical applications. So, for many applications you can find guidance on how to ensure safety for specific application. It is important to remember, as safety standards are approved by the IAEA board of governors, which represent all IAEA member states. Currently the safety series of standards consists of about 130 to 140 standards. Safety guides which deal with the safety of applications of ionizing radiation are reevaluated every 5 years. So, every 5 years it is checked whether this material which has been collected is still actual or whether some revision is needed due to different technological developments, etc.

So, safety requirements is a more high level document that is reevaluated every 10 years. (0:35:00). And safety fundamentals which are very general overarching objectives, are reevaluated – they are not given a fixed period, but they will also be regularly checked.

In addition to that, there is a number of international conventions for safety of nuclear applications. I mean conventions are agreements between states for regulation of matters affecting all of them. This includes agreement about basic principles or procedures, define common goals, and also define duties of participating member states. And finally it provides a system of exchange of information. This sounds a bit abstract, however, it’s important if you look at neighboring member states, both of them are applying nuclear applications, may be nuclear power plants or other things. Therefore, it is necessary or might be useful for them to exchange to have common views on the goal and also to exchange information

on the specific nuclear facilities. There's a number of conventions which are coordinated by the IAEA. They are coordinated by IAEA, but not run by the IAEA. They are run by the member states who are members of the joint convention, for example, for nuclear safety or for the management of spent fuel and radioactive waste. For example, this convention on the management of spent fuel and radioactive waste, member states meet every three years and then every member state has report about the amount of radioactive waste in their country, how this radioactive waste is stored, whether the storage is in compliance with the IAEA safety standards. If not, they have to report why it is not in compliance, what they are going to do to ensure compliance in the long term. So, there is a mutual exchange of information and pushing or encouraging all the member states to comply with the safety standards of the IAEA.

International convention is on early notification of nuclear accident. This means if there is a nuclear accident in country A, country A has to inform the member states and in particular the neighboring member states about these accidents, about the severity of the accident and the current status of the facility. And there is also convention on assistance in case of nuclear accidents or radiological emergency. Furthermore, we have the ESPOO Convention. This means it is a convention on environmental impact assessment in a trans-boundary context. This environmental impact assessment includes also radiological impact assessment. The London Convention is on the prevention of marine pollution, of dumping of waste and other matters, in particular radioactive waste. The OSPAR Convention particularly deals with the protection (0:40:00) of marine environment of the North-East Atlantic.

London Convention came up in 1972, until then it was still a practice of some member states that low level and intermediate level radioactive waste has been dumped in the ocean in the North Atlantic, but also in the Pacific and other places. Within this convention, it was agreed that such practice should stop and finally it stopped, not in 1972, but I think in 1990 something.

Okay, Summary – IAEA safety standard defines the radiation protection system. It is important to note that this has been internationally agreed. It is based on science, based on knowledge on effects of ionizing radiation, and it includes all relevant exposure situations as planned exposure emergencies or existing exposure situations. And very important, IAEA standards are established by IAEA in consensus with all member states and also with other international organizations. The application of the safety standards is within the national

responsibility, so each member state is responsible to implement it, to apply it, and if necessary, IAEA provides support for the application of safety standards. Some countries which have not a long history in the application of nuclear techniques, might need in the beginning some assistance and some support to implement the standards into regulations. And as we have seen, the safety standards are complemented by international conventions.

Thank you very much.