April 2016

EUROSAFE TRIBUNE

Towards Convergence of Technical Nuclear Safety Practices in Europe

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2014 nuclear safety directive: a driver for convergence


R O S A F E
Towards Convergence of
Nuclear Safety Practices in Europe
EUROSAFE

To our readers

As the newly elected ETSON president, I want to pay tribute to two leaders – Jacques Repussard and Frank-Peter Weiss – whose involvement in the enhancement of nuclear safety resulted in a strong and active ETSON. This was a real challenge given the particular history and legacy of each member TSO.
Today, we have a clear cooperation pattern based, on the one hand, on the EUROSAFE initiative, which involves independent TSOs as well as organisations that integrate the safety authority and TSO functions, and, on the other hand, on the ETSON network, which involves independent TSOs only.
My predecessors created working groups within ETSON, tasked with producing tangible material such as safety assessment guidance based on technical guides or the prioritisation of research needs. The corresponding documents, which are freely downloadable on ETSON's website, were elaborated based on the involvement of each member TSO, despite the lack of institutional funding. They represent a valuable contribution to the TSO function, which I will endeavour to develop further, drawing notably upon the work performed by ETSON working groups devoted to knowledge management and to waste and decommissioning. In bringing together specialists within the same technical area, such networking activities also contribute to boosting their efficiency within their respective organisations, providing direct, daily access to fellow scientists. I am convinced that these assets contributed, to some extent, to requests by non-European TSOs to join ETSON.
Regarding the EUROSAFE initiative, last November's forum in Brussels focussed on the challenges in terms of nuclear safety and security associated with implementing the 2014/87/Euratom directive, which emphasises the science-based nature of technical safety assessment and the need for a strong and continuously updated knowledge base in this area, thereby acknowledging the importance of TSOs. The EUROSAFE Forum also drew attention to the growing importance of nuclear security issues and their interface with safety issues. Here too, the TSOs are positioned to provide valuable assessments, bearing witness to their irreplaceable role in fostering ever higher levels of nuclear safety, security and radiation protection across the world.

I am glad to share these views with you and wish you pleasant reading.

Benoît De Boeck

A special tribute

As they retire, **Frank-Peter Weiss**, Scientific and Technical Director of GRS, and **Jacques Repussard**, Director General of IRSN, leave a valuable legacy, starting with the creation of ETSON. They share their thoughts on the major developments in nuclear safety and the progress made under their leadership.

Dr. Weiss, what do you regard as the major strides achieved in nuclear safety during the past few years?

If I take the example of Germany, before the Fukushima Daiichi NPP accident, nuclear safety research and assessment were carried out in a context of envisaged lifetime extension of the reactors. Then the accident triggered the phase-out of nuclear energy and the subsequent refocussing of safety research. The resulting new safety requirements systematically incorporate the lessons learned from Fukushima – with a major objective: creating sufficient robustness to prevent cliff-edge effects in case of beyond-design events. As regards emergency management, GRS' collaboration with its ETSON partners and, in particular, with its strategic partner IRSN proved of inestimably high value in acquiring valid information about the progression of the accident and the radiological situation.

What part did GRS play in the reorientation of nuclear safety research in Germany?

In the framework of the German Alliance for Competence in Nuclear Technology, GRS was instrumental in defining the topics to be dealt with in the wake of the Fukushima Daiichi NPP accident. This is, notably, the enhancement of the scope of safety analyses to beyond-design-basis scenarios, the safety of spent fuel long-term storage and, for example, the impact of extreme natural hazards upon the effectiveness of the defence-in-depth concept. Also, in the future, GRS has a part to play in research projects, preferably with our ETSON partners, aimed at assessing and improving the safety of nuclear facilities worldwide.

What were the results of GRS' refocussed R&D programme?

The most significant progress in the GRS' safety knowledge base was achieved in preventive and mitigative accident management, in assessing the consequences of external hazards, and in evaluating human performance under extreme conditions.

Learn more:

ETSON
European Technical Safety Organisation Network > www.etson.eu
ENSTTI
European Nuclear Safety Training and Tutoring Institute > www.enstti.eu

Considerable progress was also achieved in developing new, dynamic PSA techniques, as well as in the reliability assessment of digital instrumentation. Our research benefited a lot from our cooperation, in particular with ETSON partners, in the framework of EURATOM programmes or Nuclear Energy Agency of the Organisation for Economic Co-operation and Development (OECD/NEA) projects. In this respect, the 2014 EU safety directive is key to decisively promoting the international recognition of TSOs and their cooperation.

Mr. Repussard, what were the drivers for TSOs during the past 15 years?

The Fukushima Daiichi NPP accident was certainly a turning point, for it highlighted the usefulness of organisations capable of fulfilling technical safety assessment, as reflected in the 2014 EU safety directive.

Also noteworthy was the shift from a pattern of bilateral relationship – such as our historic partnership with our German counterpart GRS – to a pattern of networked relationship conducive to the creation of ETSON, as well as the shift in the management of research programmes towards a more strategic approach to research & development – conducive to the set-up of European research platforms driven by strategic research agendas.

What were, from your perspective, the main accomplishments during this period?

The consolidation of the TSO concept – despite the differences between the organisations in terms of size, means, status regarding the safety authority, legacies, etc. – was itself an achievement. Another was the dissemination of state-of-the-art knowledge, primarily through the safety assessment guides published by ETSON, as well as through the training and tutoring courses offered by ENSTTI. As regards research, major advances were performed through the networking of European experts in terms of computer codes and better understanding of phenomena such as the source term characterisation, for instance.

What are the challenges ahead?

Hurdles are still to be overcome in domains such as:

- The management of safety, noting that past efforts to consolidate defence in depth have not addressed sufficiently human issues potentially affecting the safety culture performance, and extreme hazards (natural or man made) potentially leading to severe accident conditions,
- Robust and independent assessments that rely upon strong science – or transparency to give citizens a better understanding of the role of TSOs, in accordance notably with the Energy Transition and Green Growth Act in France,
- Radiation protection, to gain better knowledge of the health impact from chronic exposure to low doses of ionising radiation – with a view to updating where the radiation protection system is needed. The work must continue and, at the same time, new avenues should be explored resolutely to meet the expectations of society.

Policies 07
From the provisions of the 2014/87/Euratom directive to the need for increased technical convergence, an overview of the key change drivers for European TSOs.

Prospects 17
To which extent did the outcomes from Fukushima and the provisions of the European nuclear safety directive impact future safety research priorities? Insights are proposed by ETSON and NUGENIA.

Challenges 24
What challenges lie ahead for the TSOs? How do players from the industry reconcile safety and security imperatives to comply with the directive? ETSON members and Engie shine a spotlight on these issues.

- The merit of discussing problems with everybody is to change people from feeling victimised by a disaster to feeling empowered to manage the situation, thereby creating a positive spirit based on self-confidence.

Professor Iossif Bogdevitch
Belarusian Research Institute for Soil Science and Agrochemistry (BRISSA)

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The EUROSAFE Tribune 29

The EUROSAFE Tribune is a periodical from the EUROSAFE Forum *published jointly by GRS and IRSN as a contribution to the EUROSAFE approach.*

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Special Focus
MOVING FORWARD THROUGH DIALOGUE

Rehabilitation of living conditions in territories contaminated by severe nuclear accidents
The merits of stakeholder-centric approaches

April 2016

Front cover:
Symbolising the high nuclear safety levels that the EU expects from its member states, the European flag also epitomises the Instrument for Nuclear Safety Cooperation, which aims at promoting such levels abroad.

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Kaleidoscope

EUROSAFE NEWS

The EUROSAFE Forum 2016 will take place in Munich, Germany, on November 7-8, 2016
The topic of the forum will be announced soon on the EUROSAFE website: www.eurosafe-forum.org

ENSTTI COURSES

April 18-22, 2016
Oversight of safety culture and management systems
Brussels, Belgium

June 20-24, 2016
Human and organisational factors
Fontenay-aux-Roses, France

PUBLICATIONS

ENSREG statement on the progress in the implementation of post-Fukushima National Action Plans
More on: www.ensreg.eu

ETSON Workshop - Overview on the assessments of earthquake/flood and provisions in case of station blackout (SBO) or loss of ultimate heat sink in the light of the Fukushima accident.
More on: www.etson.eu > ETSON > Information Center > Reports & Publications

AWARDS

European Commission Training & Tutoring Award
Maro Aghazarian (Armenia) is tasked with computational fluid dynamic simulations for reactor safety scenarios in the thermal-hydraulic division of the Nuclear & Radiation Safety Centre (NRSC), the technical arm of the Armenian Nuclear Regulatory Authority (ANRA). Her fellow ENSTTI intern, Indah Annisa (Indonesia), is working for BAPETEN, the nuclear energy regulatory agency of Indonesia, conducting safety assessments as part of the licensing process for facilities using radioactive sources for medical applications. During the 2015 EUROSAFE Forum in Brussels, the two women were honoured with the European Commission Training & Tutoring Award for their top performance in the ENSTTI training courses. "*I took four training courses in the past two years at ENSTTI, and I use what I learned there for my daily work at NRSC,*" Aghazarian stresses, echoed by Annisa, who says: "*I can use the best practices learned during the course to enhance the applicable regulations in Indonesia.*"

Adriaan van der Meer, Head of Unit B5, handed over two Merit Awards to the best trainee, Maro Aghazarian, and the best tutee, Indah Annisa, on November 2nd, 2015, during the EUROSAFE Forum 2015 in Brussels.

ETSON Award
The 2015 ETSON Award for collaborative papers written by young engineers from different Technical Safety Organisations went to Klaus Heckmann and Qais Saifi for their paper entitled, "*Comparative Analysis of Deterministic and Probabilistic Fracture Mechanical Assessment Tools*".

Klaus Heckmann (GRS) addressing the floor at the EUROSAFE Forum 2015 in Brussels.

ETSON NEWS

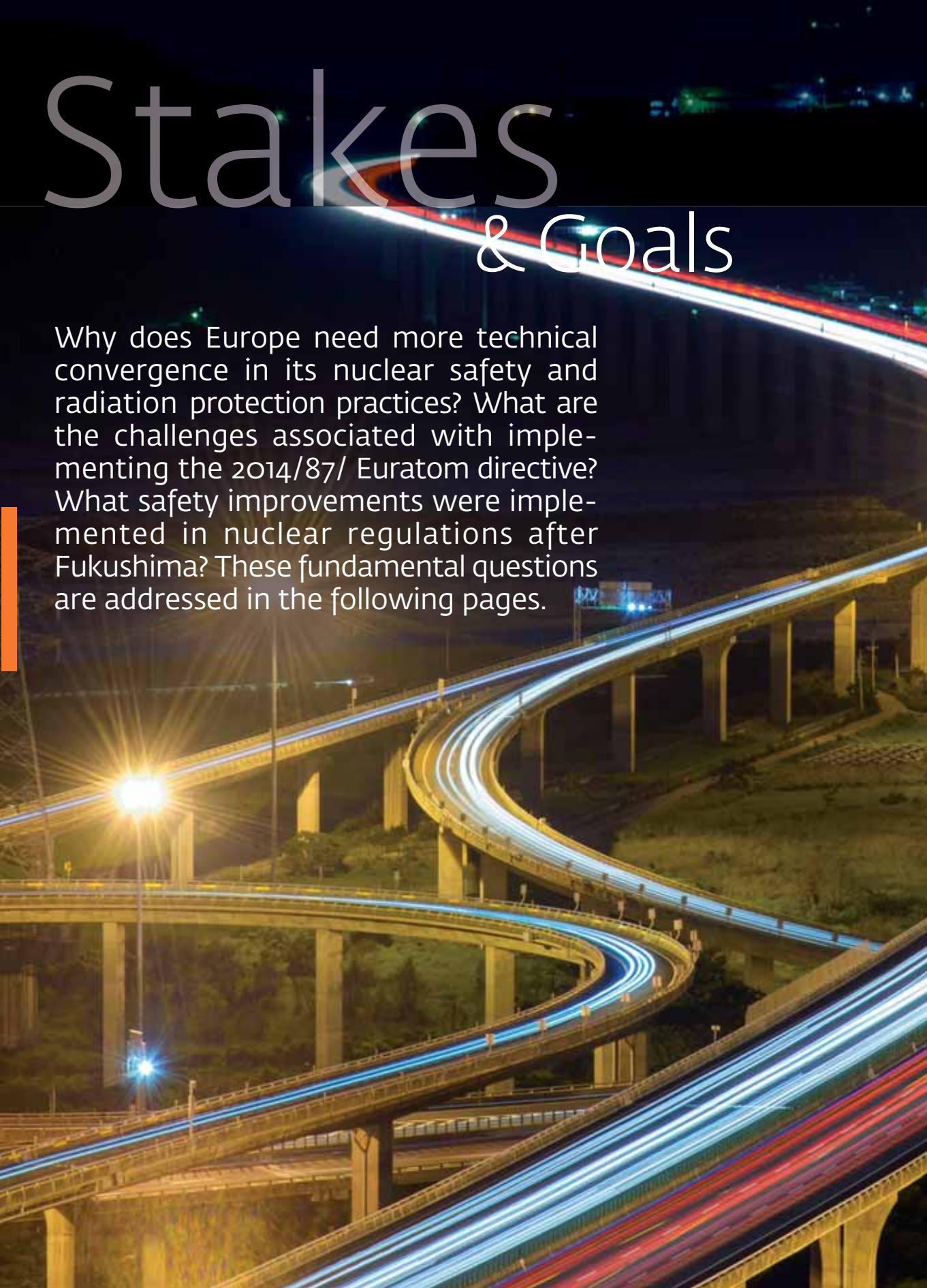
New membership
The network is pleased to welcome a new member: **the Hungarian Centre for Energy Research of the Hungarian Academy of Sciences (MTA-EK)**
More on: www.energia.mta.hu

New chairmanship
Benoît De Boeck, General Manager of Bel V (Belgium), was elected **President of the ETSON Board,** replacing Jacques Repussard, Director General of IRSN (France), at the General Assembly of the Network in Hohenkammer (Germany) on July 10th, 2015.
More on: www.etson.eu

Meetings
The ETSON General Assembly in Brussels on November 4th, 2015, voted to launch **the ETSON Award annually,** with a grant given to the first two winners, and to strengthen its cooperation with the IAEA not only *via* the TSO Forum, but also in connection with other networks, such as the Ibero-American Forum of Radiological and Nuclear Regulators (FORO).
The technical knowledge of the ETSON members should be easily accessible *via* one single website

Stakes & Goals

Why does Europe need more technical convergence in its nuclear safety and radiation protection practices? What are the challenges associated with implementing the 2014/87/ Euratom directive? What safety improvements were implemented in nuclear regulations after Fukushima? These fundamental questions are addressed in the following pages.



IRSN Director-General Jacques Repussard talking to DG ENER Deputy Director-General Gerassimos Thomas, during the *EUROSAFE Forum* on November 2nd in Brussels.

Going further on the convergence issue

The 2014 EU nuclear safety directive acknowledges the TSO function and provides for more technical convergence in nuclear safety practices among the EU member states. IRSN Director General **Jacques Repussard** assesses the progress achieved to date and points out the gaps that remain to be bridged.

WHAT ARE THE PREREQUISITES TO PROVIDING SAFE NUCLEAR POWER?

Besides the competence of the industry – designers, equipment manufacturers and operators – nuclear safety is based on the proficiency of the control system in its two components: regulatory conformity and risk evaluation. This has three main inferences: Firstly, the regulatory process should be adequate in terms of laws, control and sanctions. Secondly, competence is needed to truly assess risks and not just to check the conformance of facilities to regulations, as regulations mainly

reflect lessons learned from experience. This is why TSOs are needed! They are science-driven entities that support the regulatory system by shedding light on unresolved nuclear safety and radiation protection issues. The third paradigm is the need for the control system to be legitimate in the eyes of society, irrespective of existing formal rules. In this regard, let me stress that nuclear safety professionals are always accountable to society, and if society understands that, it helps them achieve their goals.

The convergence of nuclear safety science is no matter for competition, but for European institutions to work together to get the support they deserve.

WHY DOES EUROPE NEED MORE TECHNICAL CONVERGENCE IN ITS PRACTICE?

Nuclear safety is a national responsibility, but it is at the same time a European problem, and some common issues could be better solved by acting together. The industry has long crossed national borders, and so may the consequences of severe accidents. The EU directives regarding nuclear safety, radiation protection and waste management prescribe an appropriate organisation of the regulatory system and provide broad objectives for nuclear safety. This framework thus allows for reasonable competition between nuclear providers, as well as ambitious common objectives for safety and radiation protection.

WHICH MAJOR GAPS MUST BE BRIDGED TODAY?

Science is not implemented enough to support regulators at the national level. If we take reactor licensing for instance, the directive says reactors should be built so that, in case of a core meltdown, there will be no serious consequences outside the reactor building. But the question is how to implement this concretely, at a national level, without harmonising approaches? Today, there is no such harmonised approach, not just to nuclear safety, but also to civil security in the case of an accident. The situation is even worse among stakeholders, with little harmony among the achievements of various countries when it comes to the right of people to be informed and involved in the regulatory process.

WHAT PART CAN BODIES SUCH AS ETSON PLAY TO FOSTER HARMONISATION?

Voluntary bodies such as ETSON can help develop harmonised tools to support the implementation of science to protect people. ETSON, for instance, is developing technical safety assessment guides, but its resources and impact are limited, so far without institutional support at the EU level. The same goes for training! It is a worthwhile goal to employ, throughout Europe, experts in nuclear safety who have been trained in the same principles and curricula. But this requires resources; implementation so far is insufficient to cover future issues.

WHAT DO YOU CONSIDER THE KEY TO FURTHER ADVANCES?

During the past 10 years, ETSON has made a lot of progress, but many challenges remain, and there is little chance of overcoming these challenges in the near future unless we progress with the national governments, the safety authorities, the European Commission and the European Parliament.

Honouring with his presence the EUROSAFE Forum held in Brussels in November 2015, **Gerassimos Thomas**, Deputy Director-General – Directorate-General Energy at the EC, described the challenges and opportunities associated with the implementation of the 2014/87/Euratom directive. In his address, Mr. Thomas clearly distinguished between the short- and long-term challenges associated with implementing the highest nuclear safety standards in Europe.

Implementing the 2014/87/Euratom directive: the EC's view

The member states' energy policy framework

In terms of the legal framework, the 28 member states of the European Union are free to choose their own energy mix. Half of them have chosen nuclear power as part of that mix. In this context, the policy pursued by the European Commission aims at ensuring the greatest possible safety when using nuclear technology. Moreover, the Commission engages with both the international community and the industry to ensure that this priority is shared. The post-Fukushima experience demonstrated clearly that we are all interdependent when it comes to safety and that the industry's image is a global matter. The EUROSAFE initiative plays an important part in achieving these goals by contributing to the convergence of nuclear safety practices.

The intents of the new directive

With its revision of the Nuclear Safety Directive, adopted in 2014 and amending Directive 2009/71/Euratom, the EU has decided to bring its nuclear safety standards to a higher level. Through this new legal framework it sets an ambitious safety objective with the aim to further reduce the risk of nuclear accidents and avoid large radioactive releases in case such accidents happen. It also intro-

duces the requirement for a European system of peer reviews by ENSREG regulators on specific safety issues every six years and an obligation to reassess the safety of the nuclear installations on a regular basis, at least every 10 years. This strengthened legal framework is in the process of being transposed into national law by the member states, just as the efforts continue to effectively implement the Radioactive Waste Directive. The EC is closely following the Member States progress and assisting them in this task through workshops and bilateral contacts. Progress will be closely monitored and all EU law procedures will be used to ensure compliance by all countries. In addition, the new Basic Safety Standards directive, to be transposed by 2017, modernises and consolidates the European radiation protection legislation and takes into account recent international recommendations and standards. For the first time, Member States are now required to establish national emergency response plans and cooperate with one another in addressing emergency situations. This is expected to foster emulation among them in terms of having the best standards. These plans will then be peer-reviewed and tested through international emergency exercises.

Long-term operations: a short-term challenge

There are important short-term challenges within the safety framework described above, one of which is long-term operations. Most nuclear power plants have been operating for 30 years, and now the whole industry has to evolve to a new phase by implementing new legislation, performing safety upgrades and preparing for new build and replacement capacity. This means that the entire structure of the industry will gradually change. In this regard, most countries within the OECD face common challenges. While such change can be managed with the help of the regulatory authorities, it requires effort by the operators, the regulators and the authorities. Sharing experiences and establishing best practice would be a key element in the years to come with a view to creating the conditions for smooth long-term operations.

Enhancing NPP operators' preparedness through solid training is a key aspect of the implementation of nuclear safety directives. Here, trainees are using the simulator for the monitoring of incidents and accidents in operation (SOFIA).

The implementation of the reinforced legal framework is not about changing the primary responsibility or the architecture of the system, but about further improving the already high levels of nuclear safety in Europe by applying a new set of EU-wide safety requirements, including those related to the nuclear safety culture.

Longer-range challenges: the central role of standards

The European Commission stresses the importance of sharing experience and cooperation regarding new build. While the need for building new generation reactors to replace capacity is accelerating, nuclear vendors have not yet given evidence of satisfactory control of costs or schedules. While there are already some coordination efforts on common standards in the industry today, these remain rather general, and it is important that they come closer to the operational situation. At the same time as licensing for new builds will intensify, a significant challenge will be put on the regulators. A more shared approach on safety requirements and standardisation of reactor designs and licensing could contribute not only to bringing down costs but also to further improving safety EU-wide. Based on this observation, the Commission stands ready to facilitate more cooperation among regulators to coordinate new licences and encourage the industry to work even more closely together on standards.

Innovation, important issues remain ...

Research represents a significant share of the budget devoted to Euratom and a major strength for Europe. As the regulatory requirements and industry develops, we need to constantly assess how much of the research should be focussed on safety and safety improvements, how much on the back end of the fuel cycle and how much on future generation technologies such as Generation IV or, for example, SMRs. These are undeniably issues where the dialogue between the scientific community and policymakers will intensify.

Responsibilities and risk: focussing on the implementation of the legal framework

The European Commission has long advocated high safety standards around the globe and has devoted substantive effort to exporting these standards. The Commission will pay much attention to the transposition by member states of the reinforced EU legal framework over the next three years. The implementation of this framework is not about changing the primary responsibility for – or the architecture of – the system. Initiatives have to be taken within this architecture in accordance with the new common EU requirements such as those on nuclear safety objectives, periodic safety reviews or requirements relating to human factors in nuclear safety (nuclear safety culture). A close coordination at both national and European levels will be needed to effectively carry out the peer reviews addressing specific safety topics every six years. Responsibilities must be kept where they are today, whereas risk must be kept where it can be managed. And last but not least, each initiative must be assessed in terms of its contribution.

3 questions to...

Ákos Horváth (MTA-EK)

on the newest ETSON member TSO

The MTA Centre for Energy Research (MTA EK), the leading Hungarian nuclear energy research institute, is the newest member of ETSON. Ákos Horváth, its Director General, introduces MTA EK's aims, stakes and future prospects.

Could you briefly present MTA EK: its purpose, resources and programmes?

MTA EK is part of the network of institutions under the control of the Hungarian Academy of Sciences. As an independent expert body, MTA EK defines itself also as a TSO of the Hungarian Atomic Energy Authority. Its 380 employees are working in three institutes, namely the Research Institute for Atomic Energy, the Institute for Energy Security and Environmental Safety, and the Research Institute for Technical Physics and Material Sciences. The first two institutes are involved in TSO activities.

Relying upon more than 150 scientists and engineers from all disciplines relevant to nuclear safety, radiation protection, non-proliferation and nuclear waste management, MTA EK performs safety assessments in these areas and regularly assists in the elaboration of regulations and guidelines in nuclear safety and radiation protection. In many cases, our centre has been tasked with ensuring compatibility of Hungarian regulations and guides with worldwide, state-of-the-art expectations.

What do you expect from joining ETSON?

As I said before, several institutions serve as a TSO of the Hungarian Atomic Energy Authority. Besides ourselves, it includes the Nuclear Technology Institute of the Budapest University of Technology and Economics, the Geological and Geophysical Institute of Hungary, the Frédéric Joliot-Curie Research Institute for Radiobiology and Radiohygiene, PÖYRY ERŐTERV Co. engineering company, NUBIKI Nuclear Safety Research Institute Ltd., and SOM System Engineering Bureau Ltd.

Our aim at MTA EK is to represent the entire Hungarian TSO network, including the organisations listed above, as a full-fledged member of ETSON and to contribute to the work performed in the relevant expert groups. We believe that, drawing upon our expertise and capabilities, we can effectively collaborate with the other ETSON members. In this framework, we aim at maintaining a high level of safety culture in our institute and in Hungary. We are very interested in the expertise of other partners in efficient knowledge management and best practices to enhance the safety culture.

What are the nuclear safety and radiation protection prospects in Hungary?

Hungary has begun a nationwide nuclear R&D programme, in which MTA EK leads the research consortium. The work aims to adopt the Generation III+ technology and transfer knowledge to the young experts. A major milestone for us will be the construction of new nuclear units. In addition, the research organisations of the other Visegrád Four countries – the Czech Republic, Poland and Slovakia – and CEA in France are our partners in the ALLEGRO project (*), tasked with constructing a high-temperature, helium-cooled, fast-spectrum reactor to demonstrate Generation IV GFR.

(*) Read interview with Peter Líška (VÚJE) on p. 21.

Improving safety from a regulator's perspective

The accident at the Fukushima Daiichi NPP triggered the identification of a series of improvements to be implemented in nuclear regulations. How do they translate in the EU context, where national frameworks must comply with the 2014/87/Euratom directive in both safety fundamentals and conventional nuclear safety, even though safety is the national responsibility of each member state? **Antonio Munuera-Bassols**, Nuclear Safety Director at Consejo de Seguridad Nuclear (CSN), the Spanish regulator, highlights some important considerations.

As a consequence of the Fukushima Daiichi accident, all EU nuclear power plants performed safety assessments ("stress tests") including evaluating their robustness and identifying measures to improve their safety. As a consequence, each national regulator elaborated a National Action Plan (NAcP). "*Immediately after the Fukushima accident,*" Antonio Munuera-Bassols recalls, "*the European Council requested the safety assessment of all EU NPPs. WENRA, a club of regulators with 18 member countries, elaborated the methodology and specifications for the implementation of the stress tests that were approved by ENSREG, the European Nuclear Safety Regulators Group, which acts as an adviser to the European Commission. Those specifications covered three different topics: natural hazards, the loss of safety systems and management.*"

The Nuclear Safety Directive 2009/71/EURATOM prescribes two different peer reviews. The first deals with the national framework and must be performed every 10 years; the second is a topical review performed every six years.

A two-step approach

The stress test was performed in two steps within less than a year. The first step assessed the current situation, i.e. verified the current safety environment. This included the design basis of every plant, with a particular focus on the impacts from earthquakes and flooding. "*A regulatory oversight framework was elaborated in the report, taking into account the safety review to identify grounds for improvement,*" Munuera-Bassols points out. The second step assessed plant robustness, going beyond the design basis to identify the margins for improvement. "*This was done by increasing the severity of the situation,*" he explains, "*taking into consideration not only natural hazards, but also the loss of safety systems, to assess how the plant was able to handle continuous loss of safety systems, heat sink, site degradation, etc.*"

Located in Extremadura, not far from the border with Portugal, the Almaraz nuclear power plant was commissioned in the early eighties. It is the first Spanish plant that was equipped with Generation II reactors.

One intention was to identify the strengths and weaknesses of each nuclear power plant and suggest possible improvements. "*This was done for every plant,*" Munuera-Bassols emphasises. "*The regulator also undertook further assessment to identify additional actions.*"

Action plans and practices

Challenges and common practices were identified based on the stress tests and peer reviews. "*Those practices pertain, for instance, to the use of fixed equipment instead of mobile, particularly in the initial phase of an accident, along with increasing the capacity of the bolt-on systems. Several member states intend to create an alternative on-site emergency management centre, as well as centralised emergency support for rapid intervention,*" Munuera-Bassols says. Among other actions, several member states implemented measures to mitigate the consequences in case large areas of the NPP are damaged due to malicious acts, such as large fires and/or explosions in outdoor areas. For small reactors, the strategy to mitigate the consequences of a severe accident is to maintain the core inside the vessel, but only where cooling is possible from the outside. "*It should be noted that stress tests also have been extended to nuclear facilities other than reactors,*" he says.

Challenges and improvements

Many challenges remain, especially those associated with the installation of passive recombiners, with hydrogen management without containment, with containment integrity and heat removal, and with reactor shutdown without containment integrity. "*The review of extreme natural hazards and the relevant provisions also is a real challenge because it requires the implementation of many measures*," Antonio Munuera-Bassols stresses. Among significant improvements considered in every National Action Plan are the extensive use of mobile equipment – for example to provide cooling water to different locations, containment integrity, and the installation of passive recombiners and containment venting. "*Various accident mitigation guidelines were implemented, including the construction of on-site alternative emergency centres and the management of large volumes of contaminated water. Many of the member states also considered working with external teams offering assistance and rapid intervention,*" Munuera-Bassols concludes.

Science & Technology

The lessons learned from Fukushima and the provisions of the 2014/87/Euratom directive prompted the identification of new research needs. ETSON, the European TSO Network and NUGENIA, the association devoted to the Generation II and III nuclear reactors, give their respective views on future safety research priorities.

What R&D to implement the directive?

Article 8 of the 2014/87/Euratom directive issued in July 2014 addresses issues in accident prevention and mitigation that are closely related to the work performed by the ETSON Research Group (ERG). Do the European TSO network's R&D priorities in these areas meet the requirements of the directive? ERG coordinator **Jean-Pierre Van Dorsselaere** provides insight.

An EU-wide approach to nuclear safety is important because a nuclear accident could have negative consequences for countries across Europe and beyond. The 2014/87/Euratom directive introduces, beyond the regulatory and transparency aspects, a high-level safety objective to prevent accidents and radioactive releases outside a nuclear plant. This should apply to nuclear facilities of any type (nuclear power plant, fuel fabrication plant, spent fuel storage, etc.). For operating plants, this objective should lead to the implementation of 'reasonably practicable' safety improvements. For future plants, Van Dorsselaere foresees significant safety enhancements, based on the state of science and technology.

"*Such objectives are totally consistent with those of the ETSON Research Group,*" Van Dorsselaere explains. "*To provide the highest level of expertise, the TSOs must be well aware of the state of the art in nuclear safety research and thus widely contribute to orienting research and setting priorities in this field.*"

ETSON views on R&D priorities to implement the 2014 directive

Article 8 stipulates that the objective is to prevent accidents and mitigate their consequences, avoiding early releases requiring off-site emergency measures but with insufficient time to implement them and large radioactive releases requiring protective measures that could be limited in area or time. It also addresses defence-in-depth to ensure minimising the impact of extreme natural and unintended man-made hazards, preventing and controlling abnormal operation and failures, controlling design basis accidents and severe conditions, incl. prevention of accident progression and mitigation of severe accident consequences. The ETSON partners work on all of these issues: three of them are described below, with some illustrations of ongoing associated R&D projects with ETSON participation.

Extreme hazards

The lack of an integrated approach to hazard assessments and the dis-

ETSON will continue to participate in all new R&D projects aimed at better meeting the main objectives of the 2014 directive.

tinction between internal and external hazards can be a hindrance to assessments, as an external hazard can cause an internal hazard. Thus, efficient protection requires that the two be considered together. Therefore, future work will focus on, for example, the integration of natural external hazards in the plant safety case and probabilistic safety assessments (PSAs), the development of hazards PSA requirements, hazard combinations, external events modelling, fire propagation modelling, human reliability and simulators. Van Dorsselaere emphasises: "*Several ETSON partners work on most of these issues, for instance in the FP7 project titled 'Advanced Safety Assessment Methodologies: extended PSA', coordinated by IRSN, or in the Working Group on Risk Assessment of the OECD/NEA.*"

Passive safety systems

From a defence-in-depth perspective, passive safety systems have the potential to create options and extra time in accidents characterised, for example, by loss of power and loss of cooling water, as their function is based directly on physical phenomena such as gravity, natural convection, condensation and/or evaporation, that are independent of operator actions. Van Dorsselaere adds: "*New proposals for H2020 involve several ETSON members: NUSMoR on the definition of a generic European Small Modular Reactor design based on currently best available, possibly passive, safety features; and APASS on the investigation and development of passive safety systems for residual heat removal from the reactor coolant system or from spent fuel pools, in particular for retrofitting existing NPPs.*"

The control of severe conditions, a key issue

Large-scale experiments with real materials are extremely difficult to carry out. Moreover, different phases in the progress of a severe accident are linked so tightly that it is not possible to obtain totally reliable information based only on separate-effect tests. Therefore, despite the significant work done in the Severe Accident Research NETwork of excellence (SARNET), uncertainties remain in our understanding of different phenomena related to severe accidents, as well as their management strategies. In line with the ranking done in SARNET, with a strong involvement of ETSON members, this concern recently triggered research programmes such as IVMR, devoted to the feasibility of retaining the molten fuel inside the pressure vessel of a 1000 MWe NPP or above. "*In addition to current FP7 or H2020 research*

CATHARE, advanced simulation for all reactor designs

I am performing R&D in thermal hydraulics, using CATHARE, an integral computer code developed in France by the CEA, EDF, AREVA and IRSN. The objective is to analyse accidental transients and predict their consequences. To validate the code, I participate in international thermal-hydraulic experimental programmes such as PKL and ATLAS, under the aegis of the OECD-NEA. The purpose is to assess the code simulations with respect to the experimental results. The advantages of CATHARE lie in its ability to perform 3-D simulations and to deliver results within a limited calculation timespan. This advantage – compared to, for example, the American code RELAP – is derived from the 'implicit' nature of the code. And last but not least, CATHARE can be applied to most power reactor designs, i.e., water-cooled, gas-cooled, lead-bismuth-cooled reactors. The forthcoming developments aim to extend the application domain of the 3-D capabilities of the code to parts of the reactor other than the pressure vessel, such as the steam generator.

Anis Bousbia-Salah,
Safety Analysis Expert
Bel V

projects, such as the Passive and Active Systems on Severe Accident source term Mitigation (PASSAM) or the improvement of the ASTEC European Code for Severe Accident Management (CESAM)," Van Dorsselaere says, *"other projects are conducted under the aegis of the OECD/NEA/CSNI, such as the benchmark study of the accident at Fukushima (BSAF). Three new projects are beginning in 2016: Source Term Evaluation and Mitigation (STEM2), Thermal-hydraulics, Hydrogen, Aerosols and Iodine (THAI3), and the Behaviour of Iodine Project (BIP3). ETSON members are very active in all of these projects."*

Ensuring further consistency

In October 2011, ETSON published a position paper presenting the prioritisation of the network's safety-research needs, which contributed also to the NUGENIA R&D roadmap published in October 2013 (*see article on pp. 22-23*). The needs they identified met, in large part, the objectives of the 2014/87/Euratom directive on the safety of nuclear facilities. Moreover, ETSON members have been strongly involved for many years in R&D projects related to safety improvements in the European NPPs. *"This situation was even reinforced after the Fukushima Daiichi accident in 2011,"* Van Dorsselaere stresses, adding that *"ETSON will continue to actively participate in all new R&D projects that will contribute to better meeting the main objectives of the 2014 directive."*

Learn more:

"ETSON views on R&D priorities for implementation of the 2014 Euratom directive on safety of nuclear installations" *by J.P. Van Dorsselaere (IRSN) - J. Mustoe and S. Power (AMEC), M. Adorni (BelV), A. Schaffrath (GRS), A. Nieminen (VTT).*
Paper downloadable at:
www.eurosafe-forum.org/eurosafe2015

3 questions to...

Peter Líška of VÚJE

about research on the Generation IV ALLEGRO reactor

Ensuring the safety of Generation IV reactor designs is the purpose of CEA (France), MTA EK (Hungary), NCBJ (Poland), ÚJV Řež (Czech Republic) and VÚJE Trnava (Slovakia), partners in ALLEGRO, a demonstration designed to assess the feasibility of future power reactors. Peter Líška, Vice-Chairman of VÚJE, updates EUROSAFE Tribune readers on the project.

Why is VÚJE involved in a Generation IV demonstration?

The ALLEGRO project aims to demonstrate the feasibility of constructing a high-temperature, helium-cooled, fast-spectrum reactor (GFR) with a closed fuel cycle. From a nuclear safety perspective – which is our primary concern as a TSO – a major intended benefit is passive safety in the event of a loss of the power grid. The reactor is designed to produce sufficient electricity to ensure self-sustained removal of decay heat. Moreover, the great advantage of helium as a coolant is that it is an inert gas, not conducive to fire or explosion. In addition, helium's phase stability makes it a perfect coolant in terms of thermal hydraulics. From an environmental and economic perspective, the expected benefits are several: long-term sustainability of uranium resources, minimisation of waste – through multiple fuel reprocessing and the fission of long-lived actinides – high thermal-cycle efficiency and projected industrial use of the generated heat, to produce hydrogen, for instance. These Generation IV fast-neutron reactors use 60 percent of the energy contained in natural uranium versus just 1 percent for Generation II or III reactors.

What is the aim of the partners involved in the ALLEGRO project?

As I said, we expect GFRs to enable us to produce large quantities of hydrogen – marketable for a variety of applications, such as fuel cells or hydrogen-powered cars – at far lower costs than conventional electrolytic processes. This is of particular interest for some participants in the project, such as our Polish partner Narodowe Centrum Badań Jądrowych (NCBJ), which develops new technology. Furthermore, the high temperatures (between 800° and 900°C) of GFRs and the high-flux neutron irradiation require the development of appropriate, stable ceramics for the fuel pellets and cladding material for the assemblies. Just as important, we plan to develop a cooling system capable of safely withstanding transients and accidents.

What is the current status of the project and what are the forthcoming steps?

We started R&D projects related to ALLEGRO in Slovakia, the Czech Republic and Hungary. In Slovakia, we are completing the loop by testing the natural circulation of helium, including passive decay heat removal. In the Czech Republic, a similar loop is under construction, also for testing purposes. We hope that these two loops and the simulation codes we have developed will help us qualify the targeted heat removal technology. Regarding the very high temperatures, we expect to use two different fuels: mixed oxide (MOX) fuel – just as for ASTRID, a French demonstration assessing sodium-cooled, fast-spectrum technology – and a completely new ceramic fuel. The next R&D calls will seek to validate new types of fuel ceramics, new types of cladding material, etc. The testing facilities are either commissioned or under construction, with a goal of producing experimental results for decision-making by 2018. ✖

An overview of NUGENIA's safety research priorities

Steve T. Napier is Head of International Technical Relations at the Science and Technology Directorate of National Nuclear Laboratory, a U.K. member of NUGENIA, a European association dedicated to the research & development of nuclear fission technologies, with a focus on Generation II and III NPPs. He summarises below the association's research priorities to strengthen the safety of NPPs, notably severe accidents and lifetime extension.

NUGENIA – from birth to a mature research and development platform

As one of the Sustainable Nuclear Energy Technology Platform (SNETP) pillars, NUGENIA gathers more than 100 stakeholders – from industry, research, safety technical support organisations (TSOs) and academia – committed to develop joint R&D projects in the field. TSO participation in NUGENIA is motivated by their dedication to the highest possible safety standards in Generation II and III NPPs. In 2013, the association published its "roadmap," a document describing its R&D priorities. Then it launched NUGENIA+, a EURATOM FP7 project aimed at more efficiently coordinating and integrating the European safety research on Generation II and III facilities to ensure safe and effective long-term operations. Thus, in autumn 2014, it launched the "open public NUGENIA+ research project proposal call" with eight topics that reflect the association's R&D priorities. In April 2015, it published its global vision, including the objectives of the 2014 European safety directive.

Eight priority research items to enhance the safety of Generation II and III NPPs

Identified as 'cross-cutting' through the various technical areas of NUGENIA, these eight items aim, respectively, to:

- **Improve safety in operation and by design**
  To identify preventive and protective measures against all sources of external or internal events and identify how to efficiently and effectively implement them in current and future reactors. One objective is to comply with the conclusions of the recently conducted Nuclear Power Plants (NPPs) stress tests.
- **Achieve high reliability of components**
  To ensure the safe operation of components in Generation II and III NPPs through high reliability. This implies technological developments in the fabrication process for structural and fuel components to enhance maintainability and inspectability.
- **Optimise reliability and functionality of nuclear power plant systems**
  To ensure safe operation of systems in Generation II and III NPPs through high reliability and optimised functionality by producing unified European-wide guidance for nuclear energy stakeholders.
- **Improve modelling of phenomena in NPPs**
  To demonstrate the aptitude of advanced simulation codes to reliably predict the different phenomena that occur in NPPs, for design

and safety assessment purposes, relying upon existing databases from mock-up experiments and operational feedback.

- **Increase public awareness**
  To increase dissemination and transparency to the public about nuclear safety and research. This objective expands on the process typically used in producing guidelines – to now include safety and research. It respects the viewpoint of the public in political decision-making, especially in energy choices involving nuclear power.

- **Integrate NPPs efficiently in the energy mix**
  To use all energy sources in the most efficient way. Because NPPs are designed to operate under constant load without large load cycles, coping with the unstable grid resulting from the energy mix requires innovative operation of the light-water reactors focussed on the power manoevrability of NPPs – without disturbing their operability.

- **Prepare the future to prevent technology obsolescence**
  To accurately identify key components or systems where obsolescence affects NPP safety and availability. To develop obsolescence-mitigation procedures and recommendations. This requires identifying the key components and systems in NPPs that cannot be replaced readily (e.g. due to codes and standards), based on feedback from current operations.

- **Enhance performance and anticipate ageing of NPPs for long-term operation**
  To enhance understanding of ageing/degradation mechanisms and find new approaches and tools to effectively monitor and mitigate these effects, especially as operators consider extending the lifetimes of their NPPs.

> “In NUGENIA’s view, some predominant phenomena require a better understanding, in particular to improve Severe Accident Management Guidelines (SAMGs) and to design new prevention devices or systems to mitigate severe accident consequences.”

Eija Karita Puska
Senior Principal Scientist & Programme Manager, VTT.

Severe accidents and ETSON, a major dimension of NUGENIA’s safety research

Among the many networks that have been integrated within the NUGENIA association, the Severe Accident Research Network of Excellence (SARNET), under the aegis of the FP6 (2004-08) and FP7 (2009-13) programmes of the European Commission, was established to improve knowledge about severe accidents. This reduces uncertainties about pending issues – thereby enhancing plant safety – by coordinating research resources and expertise available in Europe, preserving research data and disseminating knowledge.

SARNET joined NUGENIA to contribute its knowledge in severe accident management (prevention and mitigation) at a time when the association is seeking improvements to its Severe Accident Management Guidelines (SAMGs) and launching R&D projects focussed on the efficiency of mitigation systems (such as filters, vents or recombiners in the containment area) and engineering features that improve, optimise and innovate. Similarly, the majority of the European Technical Support Organisation (ETSON) are members of NUGENIA, using the NUGENIA platform to create consensus based on dialogue with all nuclear stakeholders and R&D concerning safety directives and improvements.

Two European Pressurised Reactor (EPR)-type units with a 1,750 MWe planned output each are under construction in Taishan, in the Chinese Guangdong province. The project is owned by a joint venture (70% CGNPC – 30% EDF) named Guangdong Taishan Nuclear Power Joint Venture Company Ltd (TNPC).

Methods & Organisation

What are the implications of the 2014/87/Euratom directive for the parties in charge of reactor safety – responsibilities, organisation, etc.? Insights are proposed hereafter from two different perspectives: the TSOs and the industry.

What challenges lie ahead for the TSOs?

What are the implications of the 2014/87/Euratom directive for TSOs? Representatives from three ETSON member TSOs – **Leon Cizelj** from the Jozef Stefan Institute (Slovenia), **Eija-Karita Puska** from VTT (Finland) and **Steve Power** from Amec Foster Wheeler RSD (U.K.) – give their respective views on this important issue.

What is the status of the nuclear power programme in your country?

Steve Power
Nuclear reactor safety specialist at Amec Foster Wheeler's Regulatory Support Directorate (U.K.)

In the U.K., the most advanced new-build projects are the Hinkley Point C-1 EPR in Somerset and the Wylfa ABWR in Wales. With two additional projects, there could be four different designs operated by four different utilities. In the U.K., nuclear power represents one-fifth of electrical output, and we have witnessed huge developments in wind during the last few years.

Eija-Karita Puska
Senior principal scientist at VTT (Finland), coordinator of NUGENIA+ and executive committee member of NUGENIA

In Finland, we operate two VVER-type reactors in Loviisa, two BWR in Olkiluoto and one EPR unit (OL-3) is under construction, also in Olkiluoto. In addition, STUK, the Finnish regulatory body, is reviewing the construction license application of the Fennovoima AES-2006 VVER plant. As regards renewables, Finland uses a lot of biomass.

Leon Cizelj
Head of the Reactor Engineering Division at the Jozef Stefan Institute (Slovenia)

I like to say Slovenia is the smallest nuclear country in the world, as we share with Croatia only one-half of an NPP located in Krško! Slovenia targets a balanced energy mix, with one third hydroelectricity, one third conventional thermal generation and one third nuclear.

Major changes and the 2014 directive

Steve Power

The preamble of the directive implies a shift in thinking in the wake of Fukushima, as it invites us, for instance, to prepare for things that we don't

actually believe will ever happen. In the U.K., what may change is not so much the legislation itself as the guidance in nuclear safety.

Eija-Karita Puska In Finland, most of the requirements of the directive, such as those that address safety culture, are already part of our legislation and of STUK guidelines, so the change shouldn't be that significant. In the hazard area, we are emphasising the risks associated with the increasing sea traffic in the Gulf of Finland, in particular as regards oil tankers, since a major oil spill could hinder the pumping of seawater to cool the reactors at Loviisa.

Steve Power In the U.K., we have a similar concern with warships carrying weapons; accidental blasts could affect neighbouring NPPs or facilities.

What does the new directive imply in terms of practices?

Leon Cizelj It gives institutional legitimacy to practices such as the stress tests, the peer reviews, the IRRS missions, etc., which may bring added value to small nuclear countries, who also rely on the expertise available outside. In addition, the directive emphasises the scientific basis for decision-making, giving indirect support to the TSO function.

Steve Power In the U.K., regulatory research programmes declined during the past few years, but now we see some efforts to reinvigorate them. The directive pushes in that direction and it's a good thing! Research directly funded by the regulator is very small, although it coordinates a larger regulatory research programme funded by operators. But pure safety research remains limited.

Eija-Karita Puska In Finland, the national safety research programme is based on the Nuclear Energy Act. It is financed through a contribution from the utilities to the ministry in charge of energy. There is a call for tender every year as part of a four-year framework programme of research: VTT, the universities, etc., bid on a totally transparent basis. The total volume is around € 8M annually, and the programme encompasses human factors, safety culture, reactor cores and fuels, thermal hydraulics, severe accidents, SSC materials, aircraft crashes, extreme weather conditions, etc. We also have a smaller programme with a € 2M budget devoted to waste management.

What are the main challenges associated with the directive?

Eija-Karita Puska A real challenge is to preserve our staff, our competence. When I started in the late '70s, safety research was entirely funded by the Finnish state. Now state funding represents only a small share, so we have to compete on research programmes, for example, with universities or other institutes. In addition, we have to perform a certain amount of 'commercial' work to maintain our incomes and competencies.

Hinkley Point (UK), where an Advanced Gas-cooled Reactor (Hinkley Point B) is in operation, was selected for the eventual construction of an EPR power plant (Hinkley Point C).

Leon Cizelj In Slovenia, the budget for safety research is decreasing very fast! This augments the importance of the research money coming from the EU research calls for tenders. It is difficult to attract the young generations into a sector where real projects are lacking.

Steve Power In the U.K., the state-funded Atomic Energy Authority used to have thousands of people doing research. But this went away with the privatisation and contractorisation of the industry, and the responsibility now lies with the operators. In terms of technical challenges, the TSOs must convince not only the licensees, but also sometimes the regulators, that improvements need to be made, particularly as regards the 'unexpectable' events, as was said previously. Regulators used to control compliance with rules, but rules reflect the past, not the future, and now regulators must think more broadly about safety.

Leon Cizelj The problem here is to find the right balance in our commitments: Fukushima taught us we should not disregard the 'unexpectable'. At the same time, we should keep appropriate focus on what is expectable! This is a potential risk that can only be managed through competent staff.

Eija-Karita Puska In a similar way, I would say that new threats such as cybercriminality must be considered today, but this shouldn't be at the expense of, for example, thermal-hydraulics!

3 questions on...

the Foro Ibero-americano

An interview with Alfredo de los Reyes, CSN

Head of International Relations at the Spanish Nuclear Safety Council (CSN), Alfredo de los Reyes is also a member of the Board of the Ibero-American Forum of Radiological and Nuclear Regulators (FORO). He gives an overview of the FORO's position, notably regarding ETSON.

Could you briefly introduce the FORO: its aim, its vision, its members?

The FORO was established in 1997 with the purpose of promoting and maintaining high levels of safety in all uses of radioactive materials in the member countries and, subsequently, in the countries of the Ibero-American area. At present, FORO is composed of the regulatory authorities of Argentina, Brazil, Chile, Colombia, Cuba, Mexico, Peru, Spain and Uruguay. Its vision is to foster an environment conducive to strengthening nuclear and radiological regulatory organisations in its member countries through the exchange of information, regional and international cooperation, as well as the conduction of a robust technical programme in key safety areas it identified as priorities.

FORO enables the sharing of knowledge, experiences and good practices among the heads of the regulatory bodies and the specialists within their organisations with a common official language: Spanish. It is keen to cooperate with other organisations with similar goals, like the IAEA, WHO, PAHO, ICRP and peer associations as ETSON. Let me point out further information on these subjects is accessible at www.foroiberam.org.

Latin American countries are not concerned by the 2014 EC Safety Directive. However, can such a document be a source of inspiration for them?

Any relevant document related to nuclear safety and security and radiation protection is of interest for FORO, in particular a legal document issued by a supranational structure involving 28 countries. Spain, as one of the 28 EU member states, is concerned by this Directive. And CSN, as a FORO member, has informed its fellow regulatory authorities about the new Directive, how it will be implemented in the national legislation and how it will affect the nuclear safety-related activities in Spain.

Furthermore, the exchange of relevant information, experience and lessons learnt is one of the key values of FORO. For instance, when participating in FORO's nuclear safety-related projects, such as on stress tests in Ibero-America or long-term operating practices, CSN's experts can share the 'acquis communautaire' fellow regulatory authorities just as the experts from the latter bodies share their own.

What is your perception of the future FORO-ETSON relations?

As associations with similar objectives, FORO and ETSON can share information on their mutual activities to exchange views on areas of common interest and to be abreast of the works and projects that each association is engaged in. This was the main objective of FORO's Side Event during the last IAEA's General Conference in September 2015. FORO and ETSON should take the opportunity of their attending international conferences to meet and exchange information on their respective results, short-and medium-term objectives and on their international events planning.

In the future, as one way to expand this relationship, FORO experts could be invited to participate in ETSON projects development and vice versa.

No nuclear safety without security

Head of Health & Safety - Nuclear Safety & Corporate Security at ENGIE Benelux, **Pierre Doumont** has the delicate job of defining and implementing measures, including cyber-security, to prevent the risk of malevolent acts against tangible and intangible assets. He gives some hints on the contribution of nuclear security to safety.

Nuclear safety and nuclear security share several common features, starting with their goal (protecting people and the environment inside and around a nuclear facility), their basic *concepts* (design basis condition for nuclear safety and design basis threat for security) and their corresponding tools (risk analysis, benchmarks, peer review and safety culture).

The fundamentals of nuclear security

Nuclear security is, first, a matter of *culture*, drawing upon the development of fundamentals that will be clearly specified as management expectations, such as the correction of behavioural routines and security briefings that require individuals to sign a commitment. Nuclear security also is a matter of *organisation*, since it is an element of an integrated management system, along with the health, industrial and nuclear safety & environment (HSE) and other operational processes. Therefore, in the same manner as HSE, nuclear security requires the development of governance documents, procedures, instructions and other tools.

Note, also, that safety attributes, such as making everyone personally responsible for security, the commitment of leaders to security, and an attitude of trust throughout the organisation also can inspire improved nuclear security.

Some obstacles to security deployment

One of the obstacles is *scepticism*: It is difficult to secure people's commitment to preventing a risk if they do not believe it is a true risk because, in some cases, it has not occurred yet. Another obstacle is *transparency*: In essence, trust means transparency, but transparency is not really consistent with security. Furthermore, questioning negative attitudes and deploying organisational learning contribute to imbedding security concerns in people's minds.

Considerations for security improvement

Nuclear security is often understood as protection against malevolent acts from the outside. But insider threats are not a myth: They can be active or passive, violent or nonviolent, and with diverse motivations, from ideological to

Safety analysis reviews in Russia
In the Russian Federation, independent safety analyses of nuclear facilities and/or the licensed activities in the nuclear power sector are one way to strengthen the role and independence of the national regulatory authority (Rostechnadzor). This approach correlates with the provisions of EU directive 2014/87/Euratom.
For these purposes, SEC NRS, as Rostechnadzor's TSO, focusses on verifying calculation models created during independent assessments. The results of experimental studies verify our calculation models. The best practice in this area is a series of experimental studies of safety parameters, notably during VVER-1000 SNF transportation in cask TUK-153, performed with SEC NRS experts.

Andrey Kirkin,
Head of Laboratory,
Nuclear and Radiation Safety Division
SEC NRS

financial. This fact increases the importance of a security culture, such as the predictive profiles and suspicion indicators that ENGIE Benelux developed beginning in 2012. This was part of an effort to improve the overall nuclear security culture based on a variety of international standards (IAEA, World Institute for Nuclear Security, etc.). Among other features, it focusses on observations of suspicious behavioural patterns, consideration of external influences from employee circumstances, and similar factors.

Challenges in the implementation of a safety culture

Managing nuclear sites is a huge challenge from a security perspective, in particular during outages and large-scale works that affect multiple contractors. In addition to physical threats, cybersecurity has become a major issue. Another challenge is to find the right balance between sometimes contradictory imperatives: For instance, requiring individuals to be accompanied for security reasons (applying the 'four eyes' principle) is not consistent with the ALARA principle of decreasing radiation exposure among personnel.

Last but not least, nuclear security is not just a matter of physical protection. Intangible assets also can be affected, for example, via viruses such as Stuxnet. When we design facilities to resist external aggression, we also must design them to resist attacks on intangible assets.

Special Focus

MOVING FORWARD THROUGH DIALOGUE

Rehabilitation of living conditions in territories contaminated by severe nuclear accidents

The merits of stakeholder-centric approaches

Radiation protection is here to support people living in a contaminated area, to help individuals recover some control over their lives – not to put up hurdles between them and their aspirations. This quote from a Fukushima Medical University radiologist perfectly summarises the aim of the initiatives carried out by local participants and radiation protection experts in Belarus and Fukushima, two territories contaminated by fallout from the two worst accidents in nuclear power history.

From 'for' to 'with': the fundamental shift in expert-resident dialogue

Thirty years have elapsed since the Chernobyl accident in Ukraine and five years since the Fukushima Daiichi accident in Japan. Though barely comparable in terms of sequencing, the two catastrophes released considerable radioelements – such as iodine or caesium – into the biosphere, notably contaminating farmland in areas where agriculture once played an important part in the local economy. In a similar manner, they also altered the daily life of the people concerned.

The Vice-Chairman of the International Commission on Radiological Protection (ICRP), Jacques Lochard, is one of the international experts who spent months in Belarus and Japan, respectively, to set up dialogue with their local counterparts and with residents living in contaminated areas, thereby creating a paradigm shift that can be summarised as: no longer making plans *for* the population, but *with* the population. This is the very aim of the Ethos project and of the Fukushima Dialogues.

Ethos in Belarus: a bottom-up approach to empower people

A senior scientist at the Belarusian Research Institute for Soil Science and Agrochemistry (BRISSA) and a

Learn more:

The Ethos project

A series of abstracts from articles published by peer-reviewed journals on the rehabilitation of living conditions in territories contaminated by the Chernobyl accident and on the Ethos project are downloadable at: http://ethos.cepn.asso.fr/categorie3/abstracts

Measuring food helps Fukushima residents decide what can and what cannot be eaten safely. Here, a radiation protection expert comments on the results obtained.

This type of measurement is performed alongside atmospheric air measurements aimed at quantifying external exposure and anthropogammametry aimed at quantifying internal contamination.

member of the National Academy of Science, Professor Iossif Bogdevitch, spent several years in different villages impacted by the fallout from the Chernobyl accident, with the support of international radiation protection experts such as Jacques Lochard (ICRP). Bogdevitch's aim was to help the farmers who had decided to stay in zones that were contaminated below the level of forced evacuation – to reduce their radioactivity uptake. "*Depending on the level of deposition in e.g. caesium or strontium, decision was made by the government to relocate people living in zones with a high density of contamination, to leave the choice up to the people living in medium-density zones, and not to relocate those living in low-density zones,*" he explains. In this part of Belarus, the majority of people were farmers who used to work in large cooperative farms, but who also used to own personal plots, mostly for their own consumption. "*The government implemented protective measures for agriculture such as fertilisation and liming of soils, radical improvement of pastures, additives to cattle fodder, the changing of crops and crop sequences, etc.*", Bogdevitch said. "*But those measures were mostly implemented in cooperatives, as the main goal of the government was to protect all Belarusians from contaminated food, 90 percent of which came from cooperatives. However, rural people ate vegetables, cereals, potatoes, milk, etc., produced on their own plots.*"

The Belarusian Government approved a pilot regional rehabilitation programme to be conducted in cooperation with foreign scientists: Ethos. Its original approach was to discuss problems with everybody – as opposed to the previous approach, in which governmental institutions talked only to the cooperative managers, not to the farmers – and not only about agriculture, but also about rearing children safely, protecting oneself against radioactivity, etc. "*The merit of this new approach,*" Bogdevitch stresses, "*is to change people from feeling victimised by a disaster to feeling empowered to manage the situation, thereby creating a positive spirit based on self-confidence.*" In learning how to use contamination abatement techniques in farming and husbandry, several villages succeeded, within one year, in sharply decreasing the contamination of milk and dairy products, thereby reducing the radioactivity uptake of the residents.

Professor Iossif Bogdevitch and some of his colleagues shared the lessons learnt from the Ethos experience with Fukushima people by participating in two of the dialogue seminars organised by the ICRP in the prefecture from 2011 to 2015, with a view to helping residents recover some control over their lives. "*We discussed what was and what wasn't 'transferable' to Japan. Although most of the protective measures dealing with improving soil quality or growing plants could be transferred, husbandry measures were irrelevant,*


РАДИАЦИОННАЯ ОПАСНОСТЬ
ВХОД И ВЪЕЗД ЗАПРЕЩЕН

Forest fires in contaminated zones

At the 2015 EUROSAFE Forum, SSTC NRS presented its assessments of radiological consequences from forest fires in the Chernobyl zone in summer 2015, which caused a stir among the public both in Ukraine and abroad. To assess the situation, we calculated and measured radiological parameters in Kyiv. The results showed that the fires did not affect the radiological situation. However, we identified some needs for further research. The first is to develop a special model for distributed source, which could be incorporated into a computer code such as RODOS, to assess radiological consequences and support decision-making. Second, the impact of burnt areas on humans and the environment should be analysed in terms of the physical and chemical compounds of radionuclides formed in fires, the elevation and transfer of hot spots with airflows, etc. And third, to enhance the fire-prevention monitoring system in the Chernobyl zone, we should analyse the risk in the most-contaminated areas. All of this could be accomplished through cooperation between Ukraine and the EU, taking into account the available capabilities and experience from previous activities.

Tetyana Lytvynska,
Deputy Head,
Radiation Protection Department
SSTC NRS

because in Japan, husbandry is performed with imported feedstuffs, not with pasture, so the milk was clean even right after the accident!" he concluded.

Ethos in Fukushima: self-help in the social network era

Ryoko Ando used to split her time between working with her husband, a nurseryman, and writing. She was – and still is – living in a rural district of Iwaki City, located outside the forced-evacuation zone established by the Japanese government after the Fukushima Daiichi NPP accident in March 2011.

'Outside the forced-evacuation zone' did not mean 'free of contamination', by far! Therefore, Ando and her neighbours were deeply worried by the radiological situation in Iwaki. They felt paralysed in their daily life, as they had no clue of the actual radiological risk and what to do to mitigate it.

The media coverage addressed the devastation from the quake and the tsunami, the situation at the NPP, and the management of the residents' evacuation, but offered almost no practical help for living in a contaminated environment without any preparations. "*When I realised this,*" Ando says, "*I understood I had to do something by myself!*"

In the Belarusian and Fukushima areas contaminated with radioactive fallouts, self-help actions such as measuring the levels of radioactivity and discussing the readings within the community and with radiation protection experts are key to restoring the residents' capability to regain control over their own lives.

Learn more:

The Fukushima Dialogues

The programmes and conclusions of the 12 Dialogues that took place throughout Fukushima Prefecture from autumn 2011 to autumn 2015 are accessible at: www.icrp.org > ICRP Activities > ICRP and Fukushima > ICRP Dialogue initiative
In addition, a web documentary devoted to this topic is available online at: www.fukushima-dialogues.com

Air dose-rate measurement stations are now part of the landscape throughout Fukushima Prefecture (here next to the main entrance of Date City Hall).

She used the Internet to study the Chernobyl post-accident period. Screening websites, blogs and Twitter, she reached Japanese experts. With their support, she organised a study group to acquire basic knowledge in radiation protection: "*We had no idea of what radioactivity meant concretely. We had to get acquainted with the different types of radiation, the different units, the different measurement techniques and equipment, the interpretation of measurement results, etc.*", she adds.

After a few study meetings, she understood two things: firstly, that measurement was instrumental in 'materialising' radioactivity, in making it perceptible; secondly, that discussing the measurement results within the group, with the support of radiation protection experts, helped restore dialogue among the community members, thereby gradually rebuilding the social fabric torn apart by the radioactive contamination.

Ryoko Ando participated fully in the programming and presentation of the 12 Dialogue seminars organised by the ICRP in Fukushima Prefecture from 2011 to 2015. In addition, she created a blog called Ethos in Fukushima, keeping track – among other things – of these 12 seminars.

The healing virtues of dialogue

The Coordinator of post-accident related actions attached to the Deputy Director General in charge of radiation protection at IRSN, François Rollinger, has devoted years to working with nuclear facility stakeholders for better radiation protection and safety. "*This starts with sharing information about environmental impact and, later, about safety issues. But it goes far beyond transparency,*" he says, "*as it extends to sharing technical knowledge and expertise with local people, with a view to jointly assessing their concerns. This is what we used to call co-expertise.*"

Rollinger's goals in participating in the Fukushima Dialogues were, firstly, to listen to the residents – farmers, mothers, local elected officials, doctors, etc. – to grasp the issues they were coping with and to share with them his experience from stakeholder involvement in Belarus. "*After four years of exchange within their community – with the support of radiation protection experts – these people, who were completely bewildered at the beginning, developed what I would call a 'practical radiation protection culture,' which helps them overcome so many hurdles in their daily attempt to regain some control over their lives,*" he says. Another of his goals was to learn from this experience and to share the main lessons with experts back in France.

Learn more:

Ethos in Fukushima

The blog, which includes some English content and provides a complete video recording of the Fukushima Dialogues, is accessible at:
http://ethos-fukushima.blogspot.fr

Credits

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COMING NEXT...

Severe Accident Management

The EUROSAFE Tribune #29 is the last issue of a series started in 2001. Times, reading habits, means of dissemination are changing and the magazine is changing with them. The formula under preparation will be Internet-based for easier access, published more frequently for more currentness, covering a broader scope of topics for more attractiveness, and it will be more condensed for faster reading. Its articles will draw upon the inputs from the EUROSAFE partners and from ETSON, the European TSO Network. Stay tuned, we will get back to you soon with this new formula.

The next EUROSAFE Forum will take place in Munich, Germany, on 7th & 8th November 2016. Keep the date open and plan to attend!

More on: www.eurosafe-forum.org

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