July 2013

EUROSAFE TRIBUNE

Towards Convergence of Technical Nuclear Safety Practices in Europe

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European stress tests: **How long** is the way to go?

Long term operation
A matter of awareness and information sharing

SPECIAL FOCUS: CONTINUING AIRWORTHINESS

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Nuclear safety: Towards enhanced robustness

EUROSAFE Tribune express their appreciation to Bel V for the valuable support provided throughout the design and production of the present issue.

To our readers

The stress tests performed on nuclear facilities in Europe at national level and at EU level have neared completion, confirming the key lessons learned from the Fukushima Daiichi accident. One is that the vulnerability against external events was partly underestimated. Another one concerns the questionable feasibility and effectiveness of practices aimed to limit the consequences of an accident, notably by mitigating the radioactive releases. The diagnosis has been established commonly at European level, the TSOs are here to support the implementation of the conclusions drawn in a harmonized way.

In this respect, it is important to remember that nuclear reactors are going to be built in several EU member states. To achieve an equal level of safety, their safety assessment should draw upon common requirements and expertise capability, making country-by-country assessments based on different requirements an outdated approach.

It is one of the TSOs´ roles to permanently develop the knowledge base to mobilise improvements in safety assessment. That requires consistent thinking and well-planned procedures among the European TSOs resulting in common research efforts for example on severe accident management, response to natural hazards, or ageing phenomena.

Besides the scientific and technical knowledge base and the resulting safety practices, other issues relate to societal aspects and countries' policies. Today, each country is sovereign in the definition of nuclear safety requirements and in practicing safety culture, but major crises such as the Fukushima Daiichi accident highlight even more clearly the important and urgent need for harmonisation of safety requirements and convergence of safety assessment practices at EU level, though the principal decision about the use of nuclear energy remains a national decision. In a bottom up approach, TSOs will go on providing the European regulators with commonly recognised knowledge as well as harmonised methods and practices to help not only their respective countries but also the international community. Ways for the TSOs to get increased influence at the international level are not only their close collaboration in the European TSO network ETSON but also their coordinated support to the European Commission, for instance in implementing the Instrument for Nuclear Safety Cooperation (INSC), or their participation in the EURATOM Framework programmes.

We submit these thoughts for consideration and wish you pleasant reading.

Frank-Peter Weiß and Jacques Repussard

● *Once a change has been implemented in an NPP, the organisation must be reviewed accordingly to update training, knowledge management, periodical testing, etc.* ●

Reinhard Stück, GRS page 25

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Front cover:
Withstanding the fury of the elements, the forces of the ground and the wrath of man over the centuries, this elegant viaduct erected in the south of France is an epitome of timeless robustness.

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Kaleidoscope

LESSONS LEARNED

Feedback from the 11-12 June 2013 ENSREG Conference

The aim of this conference held in Brussels, Belgium, was to provide an update on nuclear safety in Europe two years after Fukushima. It focused on the follow-up of the stress tests on nuclear power plants, particularly the national action plans and their implementation. More on: www.ensreg.eu/ensreg-conferences

MEETINGS

21-24 October 2013

International Conference on Topical Issues in Nuclear Installation Safety

This IAEA conference in Vienna, Austria, is devoted to Defence in Depth – Advances and Challenges for Nuclear Installation Safety. More on: www.iaea.org

PROJECTS

SARNET 2

As part of the work performed by the Severe Accident Research NETwork of Excellence 2 (SARNET2), two new projects have been recently launched: PASSAM (led by IRSN) on new systems for mitigation of the source term, and CESAM (led by GRS) on ASTEC improvements on SAM in the light of the Fukushima accidents. More on: www.sar-net.eu

ETSON News

ETSON welcomes two new members

During its general assembly in Saint Petersburg (Russia) on July 2nd to 4th, the ETSON network welcomed two new member TSOs: the Slovenian Jožef Stefan Institute (JSI) and the Bulgarian Institute for Nuclear Research and Nuclear Energy (INRNE). Furthermore, the network members elected their representatives at the Board.

FORGE

The EU project FORGE (Fate of Repository Gases) devoted to the build-up and migration of gases in geological repositories of radioactive waste reached its conclusion. More on the major findings from this project: https://www.bgs.ac.uk/forge/

ENSTTI News

2013 Training programme

ENSTTI published the comprehensive programme of its induction and specialised courses in nuclear safety, nuclear security and radiation protection for the second half of 2013. Downloadable at: www.enstti.eu

PUBLICATIONS

Four ETSON guides on nuclear safety assessment methods

The European TSO Network released one Safety Assessment Guide (SAG) as well as three **Technical Safety Assessment Guides** (TSAGs) dedicated respectively to: **Event review and precursor analysis**, Deterministic severe accidents analysis, and Human and organisational factors in nuclear facilities design and modification processes. More on: www.etson.eu

COOPERATION

G8GP

The Global Partnership Against the Spread of Weapons and Materials of Mass Destruction (G8GP) set up by the G8 member states in 2002 was successfully completed. A total of 23 countries took part in this disarmament initiative aimed to secure and dispose of the relics of the Cold War, spending a total of US$20bn (€15bn).

Stakes & Goals

When addressing the topic of enhanced robustness of nuclear safety, two major issues are at stake. The first one is obviously the prevention of a nuclear accident and, should it nonetheless happen, the mitigation of its consequences. The second one is the service life extension requested by nuclear utilities for some of their reactors.

These quite distinct objectives converge as regards the need for reassessment of these facilities' ability to face extreme and/or combined external hazards as well as unavoidable phenomena such as ageing.

Shifting expectations

One of the major lessons learned from the Fukushima Daiichi tragedy is that the external load assumptions taken as a design basis for the existing nuclear facilities must be re-estimated to increase their ability to resist in particular extreme and/or combined external events. But will this be sufficient to make nuclear safety more robust? The answer provided by Bel V's General Manager Benoît De Boeck at the 2012 EUROSAFE Forum, organised by the Belgian TSO in Brussels with the support of their French and German partners, is that 'robustness' goes far beyond the mere toughness of structures and equipment...

Benoît De Boeck delivered the welcome address to the 2012 EUROSAFE Forum in his capacity of General Manager of Bel V, the TSO which hosted the event in Brussels with the support of its French and German colleagues.

After dealing in 2011 with the new challenges, the experience gained and the public expectations in the context of the severe accident which occurred at the Fukushima Daiichi nuclear power plant, the 2012 EUROSAFE Forum held in Brussels was devoted to the enhancement of robustness in nuclear safety. *"Why this theme?"* questioned Bel V's General Manager Benoît De Boeck who chaired the Forum. *"The first obvious answer is that after Fukushima Daiichi and the stress tests, the need was felt to increase the robustness of our nuclear power plants, and other nuclear facilities, against some external events. As a matter of fact, the risk associated with extreme loads has clearly been underestimated in the past. We knew that, at some plants at least, the probability of beyond-design external hazards, such as flooding, earthquakes, tsunamis, and so on, were sometimes hundreds – or thousands of times – higher than of specific design-basis internal events."* Acknowledging the work performed by the engineers to improve the prevention and mitigation of severe accidents initiated by internal failures, he went on declaring: *"My impression today is that this focus on internal events resulted in a disequilibrium in the risk pie chart of all nuclear installations. We can do better."*

Enhancing the robustness of nuclear facilities involves on-going maintenance and upgrading based on experience feedback from operation.

Robustness and long-term operation

Addressing an audience of several hundred nuclear safety experts – TSOs, regulators, research institutions, etc. – Benoît De Boeck mentioned another reason for making the enhancement of robustness in nuclear safety the topic of the 2012 EUROSAFE Forum: *"The operating nuclear power plants were designed with an approximate lifetime length of 40 years. We know that this duration is conventional, and that in most cases, there is no reason not to expect a longer safe operating period. However, safety expectations are increasing with time, explaining why increased robustness is also an issue when considering the justification for long-term operation."*

In this regard, what do nuclear safety experts mean when talking about '*robustness*'? Obviously, this word's extent goes far beyond strong firm structures or tough reliable systems to cover the entire scope by which a nuclear facility displays built-in capabilities to convincingly face a wide spectrum of initiating events and conditions. *"It therefore covers diversity and redundancy, and it rests on the provision of adequate design margins,"* Bel V's General Manager stresses, adding: *"We know that it is not possible to test structures, systems, and components in all of the conditions that could be encountered during an accident. Margins to cover uncertainties are therefore taken into account, but robustness goes one step further. It is a process by which we try to answer questions such as: What if the model does not fully represent reality? What if the real parameters deviate from the expected values? What if the initiating event goes beyond what was assumed? A robust installation, where the answers to such questions would be available, is therefore not too sensitive to changes in requirements. It is able to resist a wide spectrum of events. When new knowledge is generated by research, when new insights come from experience feedback, or when past practice is found to be unacceptable, a robust design does not need to undergo performance changes, or need to be scrapped."*

How robust is robust enough?

Observing that future plants will have to incorporate even more robustness in their design because they will be intended for a lifetime that exceeds today's operating standards, Benoît De Boeck concluded: *"There is no way of knowing what safety requirements will be needed in 50 years from now, but if there is a robust design, the ability to face new issues becomes easier. Robustness is a soft concept, just like safety, and the same question therefore arises: how robust is robust enough?"*

20 Happy birthday Riskaudit!

2012 marks the 20th anniversary of RISKAUDIT IRSN/GRS International, a non-profit European Economic Interest Grouping (EEIG) established with a view to supporting the European Commission in its efforts to better manage the support activities to, firstly, ex-USSR countries, and later, accessing countries to the EU. Its fields of activity cover:

- Technical support in the licensing of modernisation measures to increase the safety of nuclear power plants and other nuclear facilities;
- Know-how transfer, methodology exchange and knowledge management as basis for a high level of safety culture;
- Performance of safety assessments according to internationally recognised practices in multinational expert teams;
- Harmonisation of rules and guidelines in the area of nuclear safety and security.

Knowledge, a cornerstone of nuclear safety

To which extent would beyond-design-basis events challenge a European nuclear power plant? What are the particular vulnerabilities of the Old Continent regarding the occurrence of a severe accident? Answering these ultimate questions requires the European TSOs to share available knowledge and experience, and to join forces in common research programmes. ETSON is seriously tackling these issues, reaching its first tangible results.

"I believe that nuclear safety has never faced as many technical challenges as it does today, due to an ageing fleet of European installations," declared Jacques Repussard, addressing the challenges associated with enhancing the robustness of nuclear safety. *"We know now that we cannot master all of the vulnerabilities that affected the Fukushima Daiichi plant at the time of the accident. Large uncertainties exist in some cases regarding the capability of plants to resist beyond-design-basis events, and I would say that even internal vulnerabilities are not completely understood. Plants are ageing, but the people who serve them are ageing even faster, and over the next ten years, there will be a massive replacement of generations in the nuclear industry, and probably in the TSOs and nuclear safety authorities as well. This is potentially an additional source of vulnerability."*

As pointed out by IRSN's Director-General, the accident that occurred in Japan provides Europeans with food for thought regarding the Old Continent's ability to cope with a severe accident situation: *"When we look at the difficulties Japan had to deal with, it is quite clear that similar difficulties would probably be faced in Europe, with the additional complication resulting from geography: the European Union consists of 27 neighbouring countries, and borders create extra difficulties in dealing with nuclear safety problems,"* he asserted.

Placing increased emphasis on severe accident mitigation

Accident mitigation established itself as an integral part of nuclear safety, as the Fukushima Daiichi catastrophe showed that knowledge of the accident phenomenology failed to prevent it. Therefore, at IRSN, we continue to work on gaining knowledge of severe accidents – phenomenology, fission product release and transport, etc. – while placing increased emphasis on mitigation. Several areas are concerned such as, for instance, studies on efficient cooling of severely degraded reactor cores with a view to limiting the core melt or studies on reducing the risk of hydrogen explosion by means of catalytic recombiners. A 4-year European research programme starting in January 2013 under the co-ordination of IRSN is devoted to developing efficient passive and/or active systems for the mitigation of fission product releases. This programme called PASSAM will include experiments on innovative systems such as zeolites filters to trap aerosols and iodine. The objective is to improve the knowledge on the trapping phenomena both for existing and innovative systems. Then, the corresponding models will allow improving computer codes dedicated to severe accidents, such as ASTEC, and helping utilities and vendors choose the right mitigation technology.

Thierry Albiol
Deputy head of the SEREX department in charge of experimental research on severe accidents, IRSN

Europe: the continent where different kinds of challenges compound

In a period of significant economic difficulties getting the industry to reduce investments and governments to restrict public spending, the nuclear safety challenges Europe is faced with are not only technically oriented. Moreover, the fragmentation of Europe as regards nuclear safety, with national authorities having each their own policies, makes regulatory convergence a particularly delicate issue, and a total harmonisation in this field seems impossible, at least in the short term. Given such limitations, the TSOs are focussing on the key questions raised by nuclear safety assessment, and first and foremost the knowledge issue.

IRSN's Director-General Jacques Repussard pointing out the importance of knowledge and experience sharing to enhance nuclear plant safety.

"Nuclear safety is mainly science-based," IRSN's Director-General reminded the audience, *"therefore, the challenge we face is the availability of knowledge, in the right place, at the right moment, and to ensure that the best decisions are made by those in charge. However, how do we make it available when an assessment has to be performed, in a way that allows e.g. a safety demonstration being actually assessed, providing conclusions usable in the decision-making process? It needs proper organisation, and the TSOs' aim and contribution is to work together in order to share this knowledge, to develop it together, and to ensure that the methods used are compatible across countries. This is a very important step for us to take towards the harmonisation of good practices in Europe."*

The challenge we face is the availability of knowledge.

The European TSOs' collective contribution to taking up nuclear safety challenges

Recalling the EUROSAFE initiative's contribution to sharing knowledge and experience, Mr. Repussard emphasised the effort performed by the TSOs over the last decade to set up the ETSON network and the European Nuclear Safety Training & Tutoring Institute (ENSTTI) as permanent initiatives to foster common safety assessment methods and training. *"ETSON is in the process of issuing a first series of four guides for assessing nuclear safety,"* he announced. *"They consist of a general assessment methodology and three technical guides dealing respectively with event review and precursor analysis, deterministic severe accidents analysis, and human and organisational factors in nuclear facilities design and modification process. This is the type of literature that cannot be found in regulations for instance, it is practical knowledge of safety assessors at its best, invaluable knowledge, which will be made public in the interest of the entire community."*

The current period is a time of challenge, but the momentum exists with new members or associate members such as Russia, Ukraine and Japan joining ETSON, and an increasing number of research projects being merged in the strategic research and innovation agendas of European platforms set up with a view to contributing to the enhancement of the robustness of nuclear safety.

Awareness and sharing: the best arms against the impact of time

What should we understand by 'long-term operation'? What are the safety implications of extending an NPP's lifetime? How does it fit with the lessons learned from the stress tests performed in Europe? What role can TSOs play in this context? Four experts working for ETSON member TSOs exchange views on these questions together with a regulator.

Lars Skånberg
Head of Section, Structural Integrity and Event Analysis (SSM)

In a context where most of the NPPs , including in **Sweden**, were originally designed and built for approximately 40 years of operation, long-term operation could be understood as going beyond that period of time, and the main challenge would be to handle physical ageing and technological obsolescence.

Pieter De Gelder
Department Head Nuclear Safety and Radiation Protection Assessment Training (Bel V)

You are right, Lars. Unlike in the US, most European regulators deliver licences to operate without specifying any duration. However, most people have an implicit 40-year period of time in mind, since this duration has been usually taken as a reference by the vendors for the design of some key components, to make sure that these components can withstand a certain number of transients. The concept of long-term operation thus was originally associated with the question: are there still margins in terms of transients if the plant is to be operated for a longer period of time? In the meantime, many other aspects have been added in safety evaluations for long-time operation.

Matthieu Schuler
Department Head Strategy and Partnerships (IRSN)

This is certainly the question! To me, long-term operation means basically preparing for a longer road than originally planned, and this starts with getting a clear vision of the actual state of the plants, which must be seen as 'as operated', and no longer 'as built'. Too often, the first thing that comes to mind is to justify the acceptability of deviations, on the ground that implicit margins had been taken at the design stage regarding e.g. material fatigue. In this respect, an important role for TSOs is to discuss with the utilities whether or not the 'implicit' safety margins taken at the design phase are still sufficient, and to push for restoring significant margins through repairs, replacements or implementation of design enhancement. Safety reviews are a privileged period of time to push for progress.

Peter Hardegger
Department Head Technology Transfer & Controlling Nuclear Energy and Safety Department Paul Scherrer Institute (PSI)

Assessing whether safety margins are sufficient or not is a difficult task, and by using state-of-the-art technology and performing in-depth investigations, we sometimes find out margins are actually larger than we thought. But to go back to the requirements associated with long-term operation, let me stress that **Switzerland** operates today the oldest plants in the world and, by means of an ongoing monitoring and research effort, continuously adapts these plants to the latest scientific and technological safety standards. To mention one example: the regular upgrades of the safety systems conducted at Beznau sum up to CHF 1.5 billions, which is almost three times the initial investment! Another programme of several hundred millions is planned in view of its long-term operation.

Pieter De Gelder (BEL V) — The option we have taken in **Belgium**, now that some plants are nearing a 40-year lifetime, is to integrate the long-term operation process into the 4th periodic safety review. Issues such as ageing are thus paid particular attention to in order to upgrade the plants' safety. Beyond ageing and upgrading considerations, I think it is essential to keep a complete picture of the plant's safety, including e.g. human factor, knowledge management, etc. Therefore, the full process of periodic safety review remains important.

> The actual state of the plants must be considered from an 'as operated', not from an 'as built' perspective (Matthieu Schuler, IRSN).

Lars Skånberg (SSM) — When you build new reactors, you can benefit from increased diversity, redundancy and so forth, including the possibility for the containment to withstand extreme conditions. Such things cannot be easily envisaged with older plants! So, I understand long-term operation as a continuous process that requires safety upgrades to be based on state-of-the-art knowledge. If utilities decide to go for long-term operation, they have to establish that there is no risk linked e.g. to fatigue, based on the use of the latest data, computer codes and experimental results.

Matthieu Schuler (IRSN) — Lars, you just brought up an important point: using state-of-the-art knowledge. Knowledge management is obviously a key issue for long-term operation. Let me take an example: Several reactors in **France** were faced with stress corrosion cracking issues attributable to Inconel alloy 600. Steam generator tubes had to be replaced; reactor pressure vessel heads are still currently being replaced. Should the lifetime of these plants be extended, then we would have to keep in mind that alloy 600 was a significant problem – a problem that could be solved for instance, but that still could generate new issues in operation.

Peter Hardegger (PSI) — In this respect, the stress tests showed that some research topics initiated well before the Fukushima Daiichi event, such as research on aerosols and filtering, or on hydrogen stratification and containment, allowed gaining knowledge

translatable into technological innovation. A good example of that is the technique developed by the Paul Scherrer Institute with a view to retaining 100% of any type of iodine produced during an accident. I think the Fukushima Daiichi accident and the stress tests have changed the authorities' and the operators' approach to new technologies, giving technological developments and its implementation new momentum.

I understand long-term operation as a continuous process that requires safety upgrades to be based on state-of-the-art knowledge (Lars Skånberg, SSM).

Lars Skånberg (SSM) — Just one remark which doesn't particularly relate to long-term operation: A universal lesson learned from the stress tests is that we have to reconsider the basic design assumptions of our facilities on a regular basis. Would the Japanese have performed such ongoing reassessments based on the latest available knowledge, the Fukushima Daiichi accident would probably not have reached that extent. This is a general rule we should follow, not only during the periodic safety reviews.

Matthieu Schuler (IRSN) — A point of attention for me when we discuss about the experience feedback from Fukushima Daiichi is the necessity to make our plants open to technical assistance from the outside in case of a severe accident. Up to now, TSOs have been working closely with safety authorities and utilities to strengthen as much as possible the defence-in-depth concept with a view to making the plant self-sustaining in an emergency situation. But as far as France is concerned, we recommended the set-up by the utilities of a rapid action force to support their plants and teams in emergency situations.

Identifying differences and areas of commonality in approaches to 'long-term operation'. From left to right: Matthieu Schuler (IRSN), Lars Skånberg (SSM), Pieter De Gelder (Bel V) and Peter Hardegger (PSI).

Pieter De Gelder (Bel V) — I think we should not forget that the lessons learned from the Fukushima Daiichi accident are part of the picture, but they are not the entire picture. We should continue to look at all aspects of nuclear safety following a comprehensive assessment approach. This is certainly no easy task, but we must stick to it.

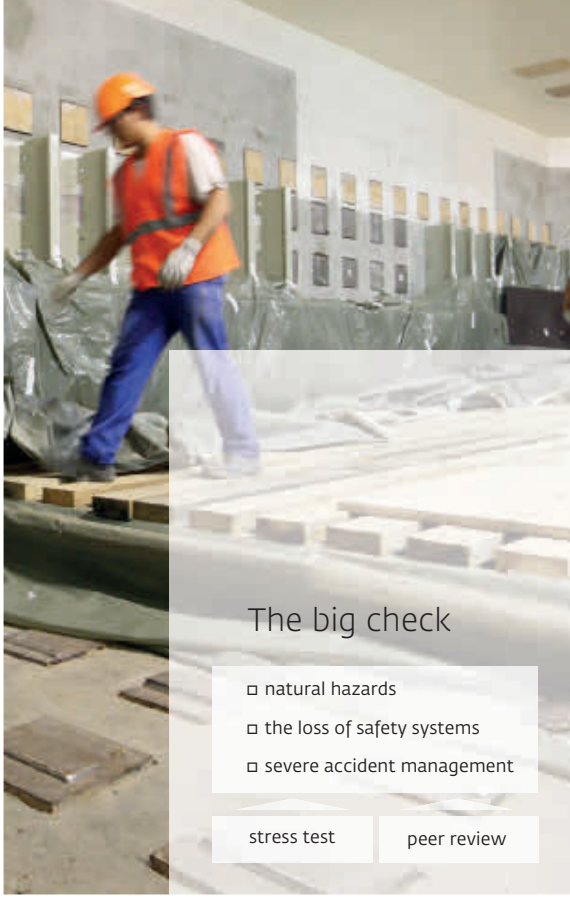
Peter Hardegger (PSI) — It is also important that we Europeans remember that a failure anywhere in the world is a failure of the whole safety system. Thus, we should draw upon our experience to persuade the rest of the world to follow the same path, regardless of local regulations and customs. Sharing a culture of progress in the management of nuclear safety is key to enhancing robustness and, ultimately, allowing long-term operation.

Lars Skånberg (SSM) — As a conclusion, I would say I support fully the idea of increasing further cooperation for harmonising not only the safety practices, but also the regulations worldwide. ✖

From needs to results

Based on the initial lessons learned from the Fukushima Daiichi accident, extensive stress tests were performed on the European NPPs from three perspectives: natural hazards, the loss of safety systems, and severe accident management. These issues concern all nuclear facilities, be they in operation, under construction or under development. They are also the cornerstone of any long-term operation strategy.

Nuclear facility safety in Europe: the big check



Appointed head of the European stress tests on behalf of the European Nuclear Safety Regulators Group (ENSREG) in 2011, French Nuclear Safety Authority commissioner Philippe Jamet gave the EUROSAFE Tribune an interview on the stress tests, the peer review and its outcome.

Learn more about...
THE EUROPEAN STRESS TESTS

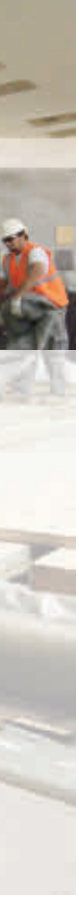
Comprehensive information on the background and specification of the tests, on the country specific reports, the EU level reports, and the public engagement and the follow-up of the tests is provided by the European Nuclear Safety Regulators Group (ENSREG) at: www.ensreg.eu/eu-stress-tests

How would you summarise the rationale of the stress tests and peer reviews?

Just two weeks after the Fukushima Daiichi disaster occurred, the European Council requested that ENSREG, the European Commission and the Western European Nuclear Regulators Association (WENRA) should perform stress tests, reviewing all of the EU plants, in light of the initial lessons learned from the accident in Japan. National authorities were to perform the assessment, and the peer review was requested to allow any conclusion being shared. The terms of reference were drafted by WENRA, and approved by ENSREG. Three technical topics were selected: natural hazards, the loss of safety systems, and severe accident management.

How was the work scheduled?

Basically, the stress test and peer review followed three different periods: firstly, the assessment of the plants, performed by the operators following the terms of reference by the regulatory authority; secondly, the review of the operators' reports by national regulators who produced a report to the EC, and thirdly, a peer review performed on the national reports by experts from the EU plus two external countries: Ukraine and Switzerland. The results of the peer review were formally approved by ENSREG in a document issued in April 2012.



What are the main results of the stress tests and peer review?

A considerable amount of work was carried out with the production of a main report aimed to present the final conclusions and recommendations at European level as well as 17 country reports, and a compilation with the main recommendations and suggestions that emerged from the peer review. Now, concerning the main conclusions, the first one was a judgement on the adequacy of the assessment in regard to their design basis. It was found that all of the national reports provided clear evidence of plant compliance. Inspections were performed on plants and, of course, some issues were found, but there were no severe issues regarding the licensing basis of any plant.

And what about the second main conclusion?

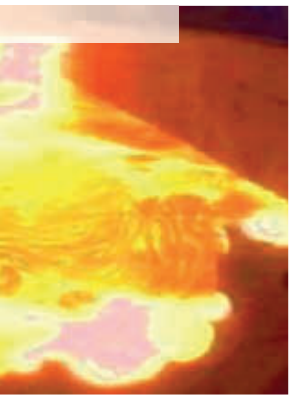
It pertains to the adequacy of the assessment in regard to the robustness of the plant. Here the situation was slightly different. Concerning extreme natural hazards, we clearly saw that the assessment performed by the different countries was generally not consistent with the requirements of the stress tests. It was requested to increase the level of the external hazard considered and then attempt to detect when cliff-edge effects began to appear. Globally, the different countries did not do this correctly. Conversely, the terms of reference of the stress tests were closely followed for the topics two and three, which are loss of safety systems and accident management.

What recommendations did the peer review issue based on these conclusions?

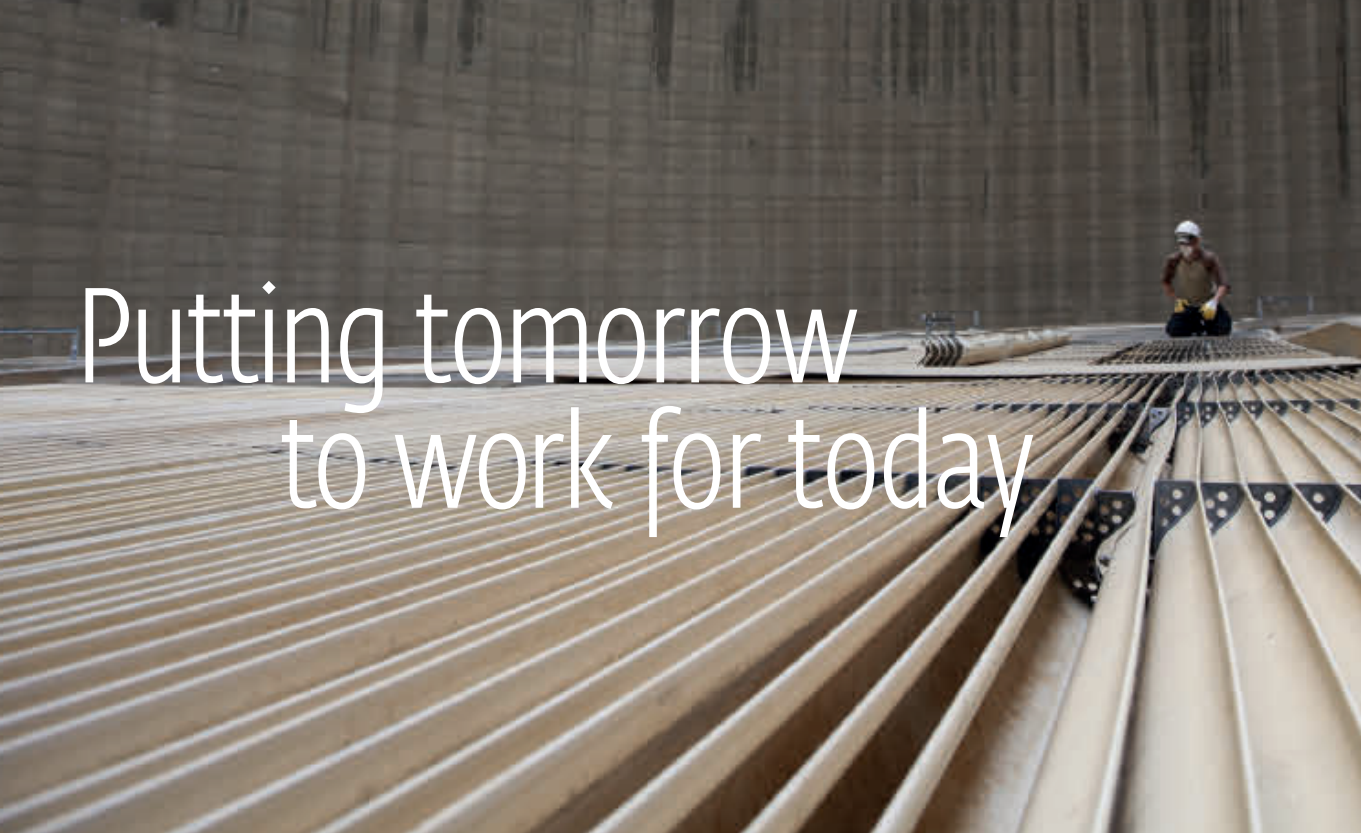
Four recommendations were made at European level. The first one is to ask WENRA to produce a reference guide in order to have more harmonisation in the assessment of natural hazards and of margins beyond the design basis and cliff-edge effects. The second one, directed at ENSREG, deals with periodic safety reviews. In particular, ENSREG was to highlight the necessity to re-evaluate natural hazards, and relevant plant provisions as often as is deemed appropriate, but at least every 10 years. The third European-level recommendation, requests an urgent implementation of the measures issued after the Three Mile Island (TMI) accident with a view to protecting containment integrity. And the last one says that the necessary implementation of measures allowing the prevention of accidents, and limitation of their consequences, in case of extreme natural hazards, is a finding of the peer review that national regulators should consider.

What is the status of the follow-up action plan?

Its implementation has begun, involving key players such as ENSREG and the national regulators. Each regulator has to publish a plan explaining publicly how the suggestions and recommendations from the peer review are taken into account. Fact-finding and site visits, focussing on the implementation of the measures to improve safety, are organised and form part of the action plan.



A matter of safety experts, the stress tests were relayed to the public at large through public meetings and the ENSREG website, in addition to the information publicised by national NRAs and TSOs.



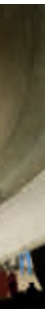
Putting tomorrow to work for today

Geert Backaert is currently the project manager for long-term operations (LTO) for the nuclear power plants operated by the Belgian utility Electrabel. He explains why the safety assessment to be performed with a view to demonstrating that 10 additional years of operation are feasible with a decreasing risk – or a positively increasing safety level – represents an opportunity for a utility to screen the actual status of its plants from a physical and a non-physical ageing perspective, thereby enhancing the robustness of facilities in operation.

Electrabel operates two nuclear sites in Belgium: Doel (four units) in the north and Tihange (three units) in the south. *"Some units will reach 40 years of operation in a relatively short time. 2020 and 2022 are not that far away for Doel 3 and Tihange 2,"* stressed Geert Backaert, adding: *"When we talk about LTO, the main issue for us was to demonstrate that 10 additional years of operation are feasible with a decreasing risk or a positively increasing safety level."* To get forward, Electrabel looked for information and benchmarks from colleagues who were operating older plants – such as Beznau in Switzerland or Borssele in the Netherlands – and who had already obtained authorisation for continued operation.

The regulatory context in Belgium

"There is no technically defined lifetime for nuclear power plants in Belgium," recalled Mr. Backaert, *"In 2009, a protocol agreement was signed by GDF-Suez and the Belgian government, in which both parties agreed notably upon a lifetime extension of 10 years for Doel 1 and 2 and Tihange 1."* Electrabel decided to prepare for LTO of these units and submitted the corresponding file to the Federal Agency for Nuclear Control (FANC), who approved it in June 2012, including the proposed design of agreed actions. As explained by Geert Backaert,



Monitoring and alleviating the effects of ageing are key conditions for long-term operation of nuclear facilities.

"In 2009, the Safety Authority published the reference document, where Electrabel as an operator had to demonstrate that safety for the next 10 years is increasing and that risk is conversely decreasing. Four different points of view have been used for this evaluation: preconditions, ageing, design and then competence, knowledge and behaviour." In order to address these four points, different entities of GDF-Suez involved besides Electrabel, such as Tractebel, the group's engineering company, were integrated with the motto 'One project, one plan, one team.'

Electrabel

A Belgium-based energy corporation, Electrabel is a 100% subsidiary of GDF Suez. It operates generating facilities of 16,000 MW in the Benelux countries, including renewable energy sources, natural gas and coal, pumped storage power plants and nuclear power plants. It owns the Doel (four units) and Tihange (three units) NPPs with a capacity of roughly 3,000 MW per site.

Assessing the preconditions for LTO

The four categories of preconditions that needed to undergo a systematic self-assessment, with the IAEA guidelines as a reference, were: plant programmes, management system and configuration management, safety analysis, and licensing basis documents. *"This self-assessment resulted in proposed actions. If we fulfil them, together with all actions coming out of the ageing management evaluation, we hope to be ready for LTO by the beginning of 2015,"* Geert Backaert claimed.

Secondly, for ageing, the project team defined and listed all components that are subject to long-term operation and that can directly or indirectly impact safety. *"Once this list was determined, we performed a review to analyse our actual ageing management programmes. Where necessary, specific programmes have been set up,"* highlighted the project manager for LTO, *"We demonstrated that the existing plant was well maintained from a physical ageing viewpoint and that we could operate for at least 10 more years."*

The third viewpoint, which is related to non-physical ageing, is design. The question at stake is whether it is acceptable to operate a plant in 2025 that was originally designed in the 1960s, even when the design has been upgraded during the lifetime by periodic safety reviews? *"To answer this question, we firstly evaluated the design-basis documentation,"* Geert Backaert explains, *"then we considered the operational experience feedback and the periodic safety reviews, we looked at benchmarks with other countries and at all the regulations that influenced design. Based on those results, we defined and clustered safety concerns, giving them a relative rating factor. We started listing potential improvements and performed a brief feasibility study to evaluate all the pros and cons for each of them."* This process resulted in an integrated programme including actions from the stress tests, as far as they affected the units physically.

Work carried out on the stator of Tricastin-1 NPP during the ten-year inspection performed in June 2009.

Strengthening nuclear security cooperation

We welcome the decision made by the EU Council to set up an Ad Hoc Group on Nuclear Security (AHGNS) tasked on the one hand with addressing security issues relating to NPPs in terms of methods, best practices and further improvement in the assessment of security levels, enhanced prevention of malicious acts – such as theft and diversion of nuclear material and sabotage –, and on the other hand with better protecting nuclear power plants. We also welcome the initiatives of the IAEA, developing its nuclear security series – in particular the INFCIRC 225 rev. 5 – which is truly the backbone of nuclear security, as well as the development of the International Physical Protection Advisory Service (IPPAS) in a logic of peer reviews for the benefit of each IAEA Member State. In this respect, on behalf of the IAEA, a seminar will be held in Paris in late 2013 about IPPAS missions conducted over the past twenty years. We more than acknowledge the benefit of increased bilateral and multilateral exchanges within the EU to deal with security issues, drawing in particular upon the European Nuclear Security Regulators Association (ENSRA), which facilitates exchanges on sensitive topics. The co-operation between Member States was carried out in an excellent spirit of efficiency. As an IAEA Member State, France works closely with the Agency in the preparation of recommendations and guidance relating to nuclear security through the Nuclear Security Guidance Committee (NSGC).

General Laurent Demolins
Senior Defence and Security Official, Head of the Defence, Security and Economic Intelligence Board
*Ministry of Ecology, Sustainable Development and Energy**

Competence, knowledge and behaviour

This typical non-physical ageing issue is difficult to measure or quantify, but it is important for safety that the people who operate a plant have sufficient knowledge and that they demonstrate the right behaviour. *"We defined three sections – i.e. nuclear safety, the development of competencies, and the knowledge of the design basis – and specified for each of them the scope of our self-assessment based on IAEA references as well as applicable procedures. Then we perform the assessment itself. This resulted in an action plan for competence, knowledge and behaviour,"* observed Mr. Backaert, who acknowledged that this LTO project had been an opportunity for Electrabel to perform a systematic screening of the actual status of its plants, not only from a physical perspective, but also considering non-physical ageing, an issue which is difficult to quantify, but proves to be an essential part of safe operation. ✖

*Deputy Director of International Cooperation at the French Ministry of the Interior as of January 2013

The impact of safety research on LTO

Taking care of ageing issues of nuclear plants that have not even been built… A paradox? By no means, if we consider safety from a long-term operation perspective, as claimed by Rauno Rintamaa, the Vice-President of VTT Technical Research Centre of Finland, the Finnish TSO.

How does research contribute to enhancing the robustness of nuclear facilities?

When we consider safety in long-term operation for instance, we have in mind failure conditions or acceptance levels including safety factors for any system structure and components in a nuclear power plant. There are thousands of categories of components, and some of them become obsolescent, resulting in lesser operating performances. From an R&D point of view, it is very important to identify the limits of safe service life for all safety-related systems, structures and components. That is the basic idea in performing research.

What does this mean from a TSO perspective?

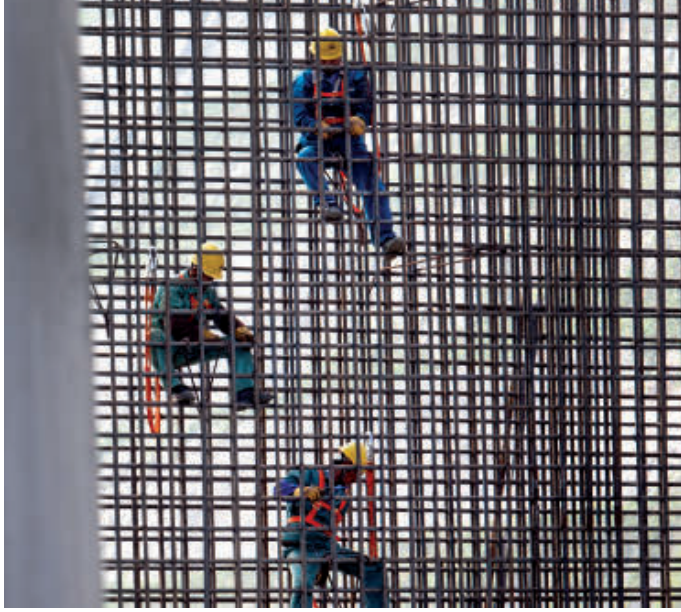
For a TSO, the aim of research is largely to update procedures to assess the safe service life of key components. In Finland for instance, even for new plants, there must be some kind of programme for ageing management as part of the construction and operational licencing process. For instance, it is mandatory to perform probabilistic safety assessments on both new and existing plants. Such analyses provide valuable data for safety-critical components, which indicate that we need to consider ageing, for example.

What is at stake with extending the design life of NPPs?

Just to give our readers a sense of the potential for the existing fleet in Europe, if we increase from 40 years to 60 years the service life of the NPPs in operation in the EU, then we can generate an extra 700 terawatts a year of decarbonated electricity. There is a lot of potential actually!

How is safety research organised in a country like Finland?

VTT Technical Research Centre of Finland – which is celebrating the 70th anniversary of its foundation – belongs to the Ministry of Employment and the Economy. So we get some funding from two sources: the Nuclear Safety Foundation and also the Innovation Department,



which provides money for R&D in general. The research organisation employs about 3,300 people and has a policy to maintain effective separation between R&D activities and technical support activities for the authority.

How do you manage to maintain such segregation?

The regulatory safety authorities may want support during the licensing process, and at the same time, the plant owner and vendor may also need an independent safety assessment to make sure that the plant will meet its design and performance criteria based on the Finnish legislation and nuclear rules. Our principle is that we do not use the same analysis, the same people, the same equipment, the same software, but if it is the same application and if there is a conflict for us, then we agree in advance whom we will provide services to, utility or vendor. This has worked very well. For the EPR plant under construction in Finland, for instance, we have performed a lot of general R&D services, safety analyses and given advice about safety requirements to licence holders such as TVO, vendors such as AREVA and some sub-suppliers. In parallel, we have performed safety research and analyses for regulators. In other words, for the industry, we are involved as an independent organisation, and for the regulator, we carry out the role of a TSO. That pattern was agreed by ETSON so that there are also some joint activities between industry and TSOs, such as basic research in accident phenomena representation and safety methodologies.

What are the priorities of the Finnish research?

A major programme called SAFIR2014, co-ordinated by VTT, aims at meeting the requirements of Finnish legislation by developing and maintaining the experimental research capability related to safety assessment methods and the nuclear safety expertise of Finnish NPPs. So, should new matters related to nuclear safety arise, their significance can be assessed without delay.

What are the priority topics dealt with?

Many of them are more or less related to the structural safety of reactor circuits: e.g. environmental influence on cracking susceptibility and ageing of nuclear materials, fracture assessments, monitoring of the structural integrity of materials and components, risk informed in-service inspection analyses of piping systems, advanced surveillance techniques and embrittlement modelling, water chemistry and plant operating liability, fatigue affected by residual stresses, environment and thermal fluctuations. These topics are very much identical to those addressed in priority by ETSON and the NUGENIA Association. ✖

Built in robustness of future facilities

In the previous article, the Vice-President of VTT explained how consideration of long-term operation issues such as ageing in safety research was contributing to an enhanced robustness of NPPs in operation and under construction. Bernard Neerdael, head of the MYRRHA Management Team at SCK-CEN, transposes this rationale to facilities under development.

The Multi-purpose hybrid research reactor for high-tech applications (MYRRHA) is planned to replace, from 2023 onwards, a material testing reactor called BR2, operated by SCK-CEN in Mol, Belgium since 1963 (see article on page 36). It aims to provide protons and neutrons for various R&D applications and to serve as a basis for the European experimental demonstration of transmutation in an accelerator-driven system (XT-ADS). MYRRHA is conceived as a flexible irradiation facility, able to work in both subcritical and critical modes. In subcritical mode, the reactor core is driven by an external source of neutrons produced by means of a high-intensity, 600 MeV proton beam bombarding a heavy liquid metal (lead-bismuth) target.

The project is currently in a pre-licensing phase in which the safety methodology and the main safety challenges are discussed with the regulatory body. The way safety is currently addressed in this quite innovative design should ensure that, before entering the licensing phase, sufficient confidence exists that the reactor can be built and operated in a safe way.

Addressing new safety challenges

"The MYRRHA facility is developed based on the following safety principles and goals," Bernard Neerdael explains, *"all major safety functions should be as passive as possible and at least independent of any external support system; human intervention for the mitigation of design-basis accidents should be minimised with an operator grace time of 72 hours; and thirdly, severe accidents should be practically eliminated thanks to highly reliable, redundant and diversified safety functions."* Among other features of this facility, lead-bismuth eutectic (LBE) coolant is used to lower the core temperature to 270 degrees, with a view to decreasing the risk of corrosion. The choice of that Pb-Bi coolant poses nevertheless safety challenges such as structural material degradation by corrosion, solidification, the build-up of important radionuclide quantities in the >spallation< target, etc.

To address these safety challenges, SCK-CEN pursues research in close European collaboration at all steps of project development through the European Framework Programmes, bearing witness to the technical and scientific interest for the MYRRHA project at EU level. After consolidating the proposed design in 2013, the SSC's performance will be further assessed and analysed with a view to enhancing safety robustness for the MYRRHA project, and to supporting substantially most of the demonstration and validation exercises still required today for licensing purposes.

>spallation<
In nuclear physics, spallation is the process in which a heavy nucleus emits a large number of nucleons as a result of being hit by high-energy particles, thus greatly reducing its atomic weight.

Methods & Technology

Enhancing the robustness of nuclear safety reaches far beyond the physical strengthening of plants and other facilities to encompass skills and organisation, with a particular focus on training and knowledge management.
This comprehensive approach entails systematic dissemination of operating experience feedback as well as an on-going research effort to be shared among the different nuclear countries by setting up platforms and elaborating strategic research and innovation agendas at EU level.

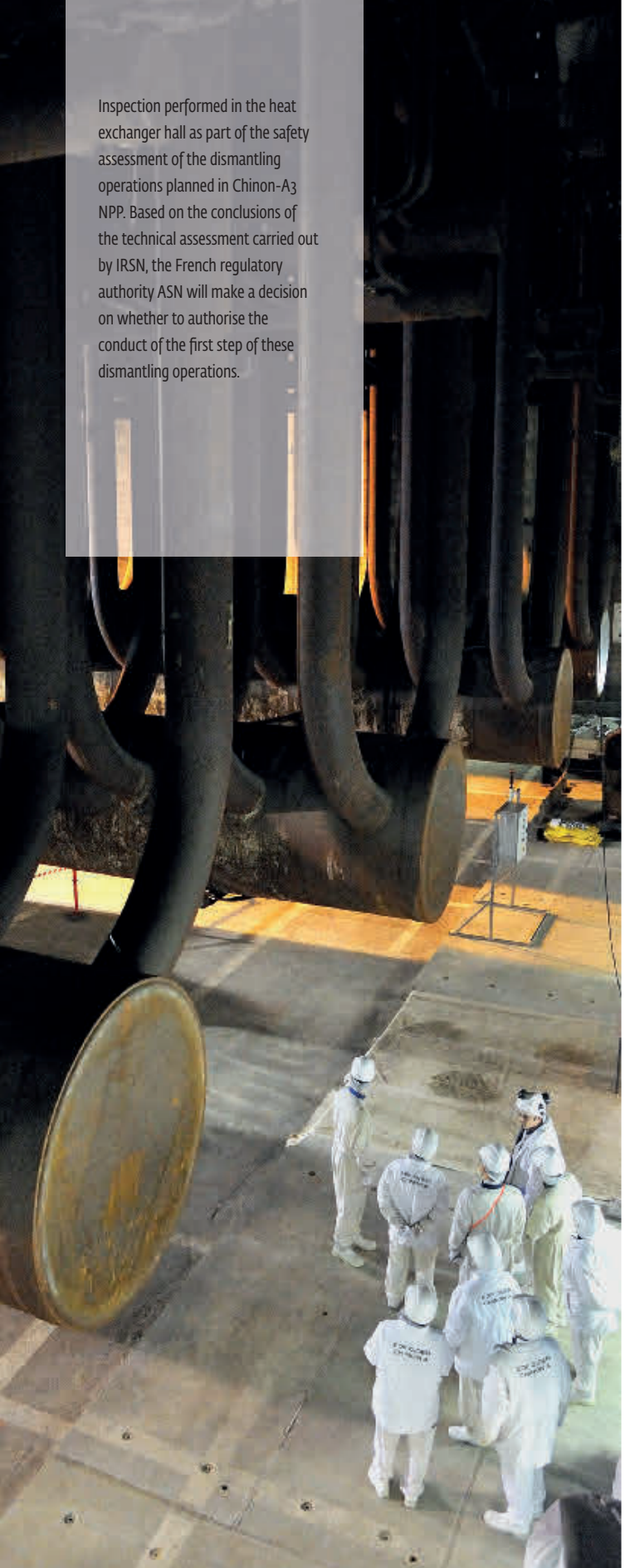
Towards more robust tools and organisations in nuclear safety and security

As witnessed by the numerous contributions to the 2012 EUROSAFE Forum's seminars, the enhancement of robustness in nuclear safety prompted rich discussions on the need for closer co-operation to get the best from operating experience feedback of facilities in operation, for increased training and knowledge management, for further integration of research projects into international research agendas and for progress in the field of severe accident mitigation as well as emergency situations management. The participants also highlighted the importance of refining the current computer models used to simulate the transport of radionuclides through host rock layers in deep repositories for radioactive waste with a view to reducing uncertainties. Last but not least, they took stock of the policies implemented throughout Europe in the field of nuclear security, promoting a strong security culture based on the ex-change of best practices and on the use of the IAEA recommendations. The co-chairmen of the seminars exchange views on these issues hereafter.

Easing information exchange rules

Improving the exchange of information between the TSOs themselves and with other stakeholders is key in the management of an emergency situation, especially in the EU where a large number of nuclear facilities are operated, raising transboundary issues. A major obstacle in this area – besides the alignment of methods and procedures for collecting, processing and circulating data – is the national sovereignty in the decision-making processes during emergency response. Today, information exchange between TSOs is restricted to raw, technical data on plants and their potential releases, since national decision-makers would consider any exchange of proposals for recommendations of protective actions to the authorities as a loss of sovereignty. So, our challenge as TSOs is to improve common understanding by increasing information exchange among ourselves and with stakeholders, and by developing appropriate response mechanisms. By doing so, we expect to contribute to fostering transboundary trust. Perhaps EU member states will one day consider the merits of making the rules more flexible in this domain to improve nuclear safety.

Didier Degueldre
Area Manager/Inspections
Nuclear Facility Sites
Bel V



Inspection performed in the heat exchanger hall as part of the safety assessment of the dismantling operations planned in Chinon-A3 NPP. Based on the conclusions of the technical assessment carried out by IRSN, the French regulatory authority ASN will make a decision on whether to authorise the conduct of the first step of these dismantling operations.

What does the enhancement of robustness in nuclear safety entail primarily?

Marc Vincke (Bel V). Some important implications are updates of existing regulations, a systematic recording and dissemination of operating experience feedback (OEF) as well as an effort to raise safety levels in facilities other than nuclear power plants. Concerning regulatory updates for instance, a new regulation on the assessment of the flooding hazard was issued based on the Blayais event of 1999 and the Fukushima Daiichi event of 2011. In this respect, I would like to point out that the reassessments performed e.g. in the Tihange NPP in Belgium call for significant design evolutions. As regards OEF, it is important for safety to be able to retrieve quickly the data related to an issue that occurred in some plant, and I think the European Clearinghouse has a role to play by making the data collected available to all its members.

Does the focus on the post-Fukushima actions jeopardise the daily safety assessment work?

Pascal Quentin (IRSN). While focusing on the stress tests and their implications, the TSOs must beware of leaving aside daily safety topics such as instrumentation and control ageing or long-term operation. For example, the enhancements or studies to be performed in some plants to better withstand external events such as earthquakes or flooding do not rule out the consideration of other aspects such as maintenance or ageing, which requires components to be monitored and inspected more frequently with time. All safety aspects must be dealt with, based on systematic diagnoses, PSA studies, and so forth.

What are the organisational consequences of the changes performed on reactors?

Reinhard Stück (GRS). Once a change has been implemented in an NPP, the organisation must be reviewed accordingly to update training, knowledge management, periodical testing, etc.

Safety enhancement requires a holistic approach.

If we take the example of site effects in multiple-unit plants, the Fukushima Daiichi accident shows that such effects must be taken into consideration for loads like flooding or earthquakes. This implies current knowledge and human skills to be adapted to allow operators to work in different areas of a site and not only in one unit. ETSON can contribute to meeting such needs for skills through initiatives such as the European Nuclear Safety Training and Tutoring Institute, ENSTTI, where senior experts transfer their knowledge and experience to junior experts.

What role does research play in the enhancement of robustness in nuclear safety?

Jean-Claude Micaelli (IRSN). Safety is built on science-based regulation and research is a key element to develop the necessary scientific knowledge and competence. In addition, enhancing robustness in nuclear safety will be very challenging for research and will require very close links between research and assessment activities, since the aim is now to assess the capability of a plant to withstand extreme events that were not considered up to now.

What do you regard as major trends in nuclear safety research?

Martin Sonnenkalb (GRS). One is the growing importance of international collaboration. Everywhere, budgets are under pressure and given the wide spectrum of scientific and technical aspects to be considered, we must collaborate on the basis of well-established priorities and we must, as far as possible, integrate national research projects into international research agendas through networks of excellence and associations such as NUGENIA for generation II and III reactors. Today, too many international research programmes are still a mere aggregation of national research programmes. It is now necessary to extend the international research agenda's pattern to all areas of nuclear safety research. This implies of course sharing the knowledge gained as well as the human and material resources available with regard to the huge amount of work to be performed.

What is the other major trend in nuclear safety research?

Jean-Claude Micaelli (IRSN). The second one pertains to mitigation. If the prevention of accidents remains a primary objective of research, there is a pressing need for progress in the field of severe accident mitigation. In the current post-Fukushima era, TSOs have to push the nuclear community – and in particular vendors and operators – towards this direction. Let me point out that a stronger focus on human factor research will be required to achieve improvements in accident prevention as well as mitigation.

What are the specific features of this year's Forum in the fields of radiation protection, environment and emergency preparedness?

Didier Degueldre (Bel V). New topics pertain to the extension of the radiation protection requirements to facilities other than reactors, e.g. irradiation facilities or geothermal power production facilities. The development and application of tools and methods including to other industrial sectors using for example naturally occurring radioactive materials such as rare earths is another trend. Such moves contribute improving the common understanding in the field of emergency preparedness & response and, subsequently, to managing emergency situations in a more efficient manner.

3 questions to...

Kazuo Shimomura

on enhancing the robustness of nuclear safety

Kazuo Shimomura is Executive Advisor to the President of the Japan Nuclear Energy Safety Organization (JNES), the Japanese TSO. As an associate member of ETSON, JNES participates actively in the network's projects to enhance the robustness of nuclear facilities and the preparedness of organisations.

What do you consider as the key advances to be performed in order to better prevent and mitigate nuclear accidents in the future?

I think that the implementation of the Defence-in-Depth (DiD) concept remains the basis for the prevention and mitigation of nuclear accidents. This concept needs to be reassessed and updated drawing upon the lessons learned from operating experience and accidents worldwide, and upon the results from safety research. One main lesson learned from the Fukushima Daiichi NPP accident pertains to the interactions between multiple and simultaneous extreme external hazards hitting multiple-unit sites. This means on the one hand that site-specific aspects should be considered to review the DiD concept in the future, and on the other hand that closer harmonisation should be encouraged on a global scale, as its implementation varies from country to country so far. With respect to mitigation of the accident consequences, I think the importance of having robust onsite/offsite emergency preparedness and response plans should obviously be re-emphasised, as it complements DiD in case of significant offsite releases of radioactivity. Last but not least, effective drills should be regularly carried out by using crisis management and communication devices.

In which ways can ETSON contribute to enhancing nuclear safety?

ETSON provides a unique forum for exchange of analyses and R&D results in the field of nuclear safety among its members and also associate members from outside Europe, such as JNES. Some differences exist between ETSON members from various countries, but all of them are dedicated to protecting people and the environment from the harmful effects of ionising radiation. It should be noted that the power of a TSO network such as ETSON allows conducting independent safety assessments and developing common nuclear safety research programmes, whose results are shared among its members. The ETSON Expert Groups governed by the Technical Board on Reactor Safety (TBRS) and the Research Group provide a valuable forum for sharing information and discussing emerging issues on nuclear safety voiced by the members.

What can JNES bring ETSON in terms of knowledge and experience, and conversely, what does JNES expect from its ETSON fellow TSOs in this area?

JNES was set up as an expert organisation tasked with ensuring safety and supporting nuclear regulatory activity in co-operation with the Nuclear Regulation Authority of Japan. JNES conducts a wide range of safety assessments, develops standards, performs safety research, and establishes co-operation with a number of countries on a bilateral basis as well as with international organisations such as the IAEA or the OECD/NEA. Acknowledging the importance of sharing knowledge and experience with other TSOs, JNES joined ETSON as an associate member in 2011. JNES experts contribute their knowledge and experience to ETSON through activities of specific Expert Groups such as the Groups of Severe Accidents, Human and Organisational Factors, PSA, and Post Fukushima NPS Follow-up Task Force (emergency preparedness). Conversely, they also expect knowledge and experience from other ETSON fellow TSOs in these areas. JNES therefore has interests in the new activity of the ETSON Knowledge Management Group. ✖

Besides nuclear facilities, conventional plants such as geothermal power stations are increasingly subject to radiation protection requirements.

How would you characterise the progress achieved since the previous EUROSAFE Forum?

Gunter Pretzsch (GRS). At the 2011 Forum, we had first of all the fact-finding of what had happened at Fukushima Daiichi and the estimated consequences of the accident. This year, we consider the broader picture and we are also questioning the regulatory system: is it robust enough regarding extreme events? Another point pertains to the suitability of the arrangements made, for example, to shelter people in case of radioactive releases lasting a month or more. Last but not least, Fukushima Daiichi showed the importance of having mobile measuring equipment available to get a precise idea of the radioactivity released in the environment in case of a severe accident, with a view to implementing different countermeasures in case of limited releases and massive releases.

What are the key points of this year's Forum as regards geological disposal?

Olivier Smidts (Bel V). Among the papers presented this year on geological disposal, one emphasises the role of underground research laboratories in the R&D aimed to demonstrate long-term safety. Other interesting papers deal with the role of research on clay media, bentonite and fractured systems in the safety assessment of geological waste disposal facilities.

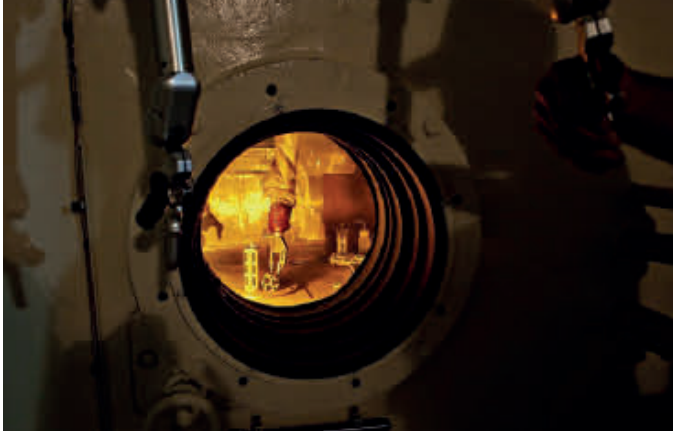
Does geological disposal represent a major challenge in terms of robustness?

Tilmann Rothfuchs (GRS). The geological disposal of high- and intermediate-level waste undeniably poses major problems, as it is supposed to be safe over one million years or so. And to assess the safety of such repositories, we need very robust computer models to simulate, over such a period of time, the transport of radionuclides and of fluids through e.g. argillaceous media and granite. The challenge is to refine the current models so as to reduce uncertainties.

What is this year's focus in nuclear facility decommissioning?

François Besnus (IRSN). A quite noteworthy paper provides interesting insights into the experience feedback from the decommissioning and dismantling of the Belgian MOX facility operated by Belgonucléaire. Another paper addresses the need for an international approach to assess the safety issues associated with decommissioning. From a technical perspective, the different dismantling options – immediate vs. differed – are compared, and waste management strategies such as entombment are assessed. The papers show that the main issue to be considered in the safety assessment of dismantling is actually the radiation protection of workers rather than the source term.





What advances have been achieved in the field of security of nuclear installations and materials?

Jean Jalouneix (IRSN). In this regard, I think an important feature of this year's seminar is probably the paper titled *Results of the European Stress Test Security Track*, which deals with the conclusions of the Ad Hoc Group on Nuclear Security (AHGNS) brought together by request of the EC with a view to addressing security issues in parallel with the safety issues handled through the stress tests conducted after the Fukushima Daiichi event. According to its mandate, the goal of the work of the AHGNS was to concentrate on methods for evaluation, taking preventive measures and protecting NPPs and to consider ways to improve general security principles based on the security documentation of the IAEA. The main conclusions of the AHGNS were focussed on the need to exchange best practices between EU Member States, on asking stakeholders to ratify the 2005 amendment to the Convention on the Physical Protection of Nuclear Material (CPPNM), to use the IAEA's IPPAS missions on a regular basis and also to encourage co-operation more closely than in the past.

Was it the AHGNS' aim to assess the security of the NPPs in the EU member states?

Wenzel Brücher (GRS). First of all, let me make clear that the AHGNS' aim was not to perform such kind of assessment, but to provide insights into the policies implemented throughout Europe in the field of nuclear security and to promote a strong security culture based on the exchange of best practices and on the use of the IAEA Nuclear Security Series, which is a list of recommendations and guidance for the implementation of security measures. Now, adding to what my colleague Jean Jalouneix just said, let me point out that the AHGNS conclusions highlight two other points. The first one is the potential role of the European Nuclear Security Regulators Association (ENSRA) – which brings together most of the security authorities in the EU – as a forum for further discussions and exchanges on nuclear security in Europe. The second point pertains to the role of the missions conducted by the International Physical Protection Advisory Service (IPPAS) in the assessment of the nuclear security regime of each Member State and of the physical protection at facility level. In this regard, I would like to remind you that 55 IPPAS missions were conducted during the past ten years, not only in EU member states but also in Eastern and South-American countries.

Learn more about...
THE TOPICS DEALT WITH AT THE FOUR SEMINARS OF THE EUROSAFE FORUM 2012

The full text of the contributions presented by the lecturers is available online at:
www.eurosafe-forum.org
→ Previous Forums
→ EUROSAFE Forum 2012

Special thanks are due to François Besnus (IRSN), Wenzel Brücher (GRS), Didier Degueldre (Bel V), Jean Jalouneix (IRSN), Jean-Claude Micaelli (IRSN), Gunter Pretzsch (GRS), Pascal Quentin (IRSN), Tilmann Rothfuchs (GRS), Olivier Smidts (Bel V), Martin Sonnenkalb (GRS), Reinhard Stück (GRS) and Marc Vincke (Bel V), co-chairmen of the technical seminars at the EUROSAFE Forum 2012, for their contribution to this article.

Special Focus

ENHANCING ROBUSTNESS IN AIR TRANSPORT SAFETY

With a fatality rate which decreased to 1 person per 7.1 million passengers in 2011, air transport consolidates its leadership from a safety perspective. And yet this average number conceals significant differences depending on the level of development of countries. At EU level, air transport safety is the responsibility of the European Aviation Safety Agency (EASA). The Agency's director of certification, Dr. Norbert Lohl, explains the contribution of continuing airworthiness to this achievement.

Making flights even safer

How does EASA define 'continuing airworthiness'?

As aircrafts enter into service, they are subject to operational wear and tear, which may cause performance degradations. The monitoring of the day-to-day operations and the approved maintenance programme are aimed at maintaining the aircrafts' continuing airworthiness. EASA's major task is to ensure it through the certification of new aircrafts or modifications.

What are the requirements to ensure continuing airworthiness?

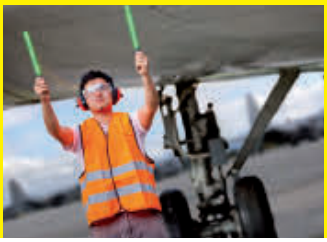
We draw upon regulations issued by the EC and revised in 2012. They provide the basic requirements for dealing with certification and continuing airworthiness. As holders of what we call >type certificates<, the aircraft and engines manufacturers are responsible for, e.g., setting up a system aimed to collect, investigate and analyse reports of – and information related to – failures, malfunctions, defects or other occurrences. Another regulatory provision concerning the investigation report of occurrences requires holders of type certificates to investigate the reasons for any deficiency and to report the results to EASA as well as any corrective action they propose to take. If necessary, we can impose corrective actions – may it be an inspection or a technical modification –, which we call *airworthiness directives*. This is the most powerful tool in our hands to ensure safety, as our directives, just as the FAA's directives, are disseminated and followed worldwide.

Is the regulatory framework of air transport safety harmonised at EU level?

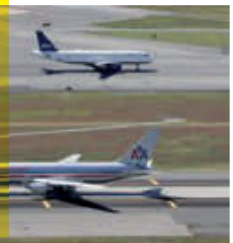
In the past, each country had its own regulatory framework as part of its national aviation system, but since 2003, all these regulations have been issued by the EC and are directly applicable in each of the 31 EASA member states (1). This move towards a unified regulatory system is in the DNA of air transport, since this activity is *per se* an international one. The European aerospace industry was the driving force in this process, as they claimed a European aviation safety agency to be set up as a counterpart to the US Federal Aviation Administration (FAA). Obviously, the competition between Airbus and Boeing prompted this change! Let me highlight the same trend in European rail transport under the influence of the successive railway packages and the

>type certificate<
Aviation's regulatory bodies award a type certificate to aerospace manufacturers after it has been established that the particular design of a civil aircraft, engine, or other equipment has fulfilled the current prevailing airworthiness requirements for the safe conduct of flights under all normally conceivable conditions. Aircraft produced under a type-certified design are issued a standard airworthiness certificate.

(1) This comprises the 27 EU member states plus Iceland, Lichtenstein, Norway and Switzerland.



From de-icing to airplane separation rules, ground and air procedures make flights continuously safer.



increase in cross-border traffic. In addition, EU-wide certification is a must for industrial players to market their products worldwide, then third-country airlines, rail operators or power companies are no longer thinking in terms of national systems, but in terms of interoperability. Today, they want a European system!

What does continuing airworthiness imply in terms of research and knowledge?

Our safety system is dependent on the risk assessment of available data and on investigations performed after each incident or accident, leading to

Dr. Norbert Lohl: a career dedicated to air transport safety

After his university education in physics, Dr. Norbert Lohl started his professional career at the German Aeronautics Research Center DLR on flight guidance and navigation where he made his doctor-engineer degree in aeronautics. In 1982 he joined the German Aviation Authority Luftfahrt-Bundesamt (LBA) starting as project certification manager in the transport category airplanes division. From 1990 he acted as head of the LBA regional office Berlin and in 1993 became head of the LBA engine/equipment type certification division. From 1998 he was deputy to the LBA director and head of the LBA administration department. In 2001, he became head of the LBA commercial operators department. Dr. Norbert Lohl has been director of certification at the European Aviation Safety Agency (EASA) since the beginning of 2004.

Estimating the value of prevention

A nuclear accident would give rise to one of the most complex crises which make cost estimates a complex and time-consuming task. However, underestimating the cost of an accident would lead, sooner or later, to underestimating the value of prevention. Therefore all cost items should – ideally – be included. IRSN is now proposing comprehensive accident cost estimates: a core melt with controlled releases could cost €120 bn, while a major accident, comparable to Fukushima Daiichi, would cost France around €430 bn. The range of variation due to climate scenarios and other factors goes roughly from half to twice these representative figures. The estimated huge costs must be tempered by the low probability of occurrence of an accident – low but not nil, justifying continued efforts to ensure the highest possible safety standards. The low probability of a major accident does not necessarily balance its catastrophic potential. In case of a major accident, 40% of the costs would be attributable to radiological consequences, with exclusion zones extending typically over some 1500 km² and 100 000 radiological refugees leaving. The impact in terms of image could be as costly with large business loss due to reduced tourism and agricultural demand. The effect on electricity prices could represent 20% of costs. It would be an unmanageable European disaster. Conversely, controlled releases would lead to a manageable national crisis within France.

Patrick Momal
Economic analysis expert, IRSN

the issuance of safety recommendations. EASA does not conduct research on its own, nor has any capability available to do so. But a lot of aviation research is performed in the EU, notably as part of a Framework Programme for new technologies and, in addition, national accident investigation boards such as BFU in Germany or BEA in France produce reports based on in-depth investigations and research performed to identify the root cause(s) of an incident or accident. These are valuable sources of scientific and technical knowledge to EASA. In addition, being part of the European Safety Initiative, EASA is involved in many expert groups tasked with drawing lessons from past events and assessing the value of e.g. new computerised decision-support systems, or fully automated systems meant for maintaining the aircraft within the approved flight envelope.

Common procedures rule information exchange between regulators.

How does EASA adapt to changes in the air transport sector?

Adaptation is in our blood, since the air transport sector is permanently developing new aircraft technologies as a response to drivers such as competition, environmental protection, noise reduction, fuel consumption, etc. To us, this is business as usual! Just to mention a couple of examples: the fly-by-wire system that replaces the conventional manual flight controls with an electronic interface has become standard equipment in any Airbus aircraft. We also had to address the new communication system between the aircraft and the control tower, which is based on automatic data transfer with a view to reducing the risk of misunderstanding between pilots and traffic controllers that results from insufficient language capabilities or strong accents.

What do you consider as the major challenges to be taken up and how?

Well, it is surely to handle all available data to get the right information at the right time at the right level. My plea is that we have a functional European or even worldwide occurrence reporting system, as we need to collect all possible information in due time, with a certain kind of rating that allows us identifying whether a certain category of malfunction is occurring repeatedly. Availability of information will remain a major challenge also in the near future.

Is access to proprietary data a particular issue?

As a regulator, we are used to deal with proprietary data but we keep them confidential; we are not allowed

3 questions to...

Alexander Khamaza

on common procedures to exchange information

As the Director of SEC NRS, the Russian TSO, Alexander Khamaza provides the perspective of an ETSON associate member on the new challenges of nuclear safety and the mutual benefit a membership in ETSON can provide in taking them up.

What do you consider as the key advances to be performed in order to better prevent a nuclear accident in the future and to better mitigate its consequences in case it nevertheless happens?

I think it necessary to consider prevention and mitigation in a holistic manner and to work subsequently in five simultaneous directions: firstly, the harmonisation of national legislations, based on norms and recommendations developed by international organisations; secondly, the enhancement of legal and regulatory practice by analysing effective rules and regulations as well as legislative and regulatory compliance practices; thirdly, the analysis of events that occur in operation at nuclear facilities; fourthly, the availability of emergency preparedness and response planning integrated at national level for utilities, regulatory authorities and emergency agencies. And, last but not least, international co-operation.

Although the analysis of the Fukushima Daiichi NPP accident has not changed our fundamental assumptions on safety, that extraordinary event has made us reconsider the approaches used from a new perspective. This is the case for defence-in-depth, where the levels aimed at mitigating accident consequences are now paid equal attention as the ones aimed at preventing accidents. This impacts several aspects of nuclear safety, starting with the site selection for new NPPs, the robustness analysis of plants – notably multi-unit sites –, the protection of accident management means or the provision of on-site and off-site arrangements and preparedness to manage an accident.

In which ways can ETSON contribute to enhancing nuclear safety in the respective countries of its member TSOs and beyond?

As an organisation aimed at fostering scientific and technical co-operation among TSOs, ETSON is competent to support the enhancement of nuclear safety through a wide array of activities, in accordance with the association's statutes. ETSON was created as an EU association, but organisations such as SEC NRS, JNES and SSTC NRS are now associate members. Thus, its reach goes beyond the EU and it is generally assumed that its scope of activity will also extend to e.g. research projects carried out in non-EU countries. In bringing together experts in nuclear safety and radiation protection analysis from different countries and continents, ETSON creates an extra-mechanism to support and enhance safety in the association's member countries and beyond.

What can SEC NRS bring ETSON in terms of knowledge and experience, and conversely, what does SEC NRS expect from its ETSON fellow TSOs in this area?

As the TSO of Rostechnadzor, SEC NRS provides comprehensive scientific and technical support to the Russian regulatory authority. Over 25 years, we have accumulated wide-ranging experience and knowledge in the field of nuclear and radiation safety regulation. Such kind of 'intellectual databank' can benefit ETSON working group activities as well as the new projects on safety review for foreign nuclear power plants. Conversely, our involvement in ETSON at different levels – Research Group, Technical Board on Reactor Safety, Project Initiative Group... – will help us capitalise on, and take advantage of, the experience gained in NPP safety reviews, including assessments of new power unit designs, NPP life cycle extensions and other aspects.

to disclose any of them. This is the cornerstone of trust. We are no police, no judges trying to sue people. We are here to have open cooperation and a reliable relationship with all stakeholders in our industry in order to put safety first.

How does EASA cooperate with its counterparts?

According to the EU's Safety Management System, EASA's role is rulemaking, standardisation and as well as type-certification activities, whereas national authorities perform other activities such as the issuance of pilot licence or air operator certificates and their oversight. This pattern implies close co-operation through numerous standardisation and rulemaking meetings, etc. Let me point out that many EASA people come from national authorities and that I myself worked for LBA, the German Federal Aviation Office [editor's note: see biography]. We also have bilateral safety agreements with the US FAA or Transports Canada – and hopefully soon with the Brazilian authority ANAC –; we frequently meet in bilateral oversight boards, exchanging information, making joint proposals to move regulations forward, etc. We are also discussing with many other authorities from Russia, China, Japan, etc. in order to work with them on common procedures to exchange information.

Does 'continuing airworthiness' rely primarily on accident prevention or mitigation?

Whenever an event happens, regulatory requirements are issued, based on the identification of the root-cause through a forensic approach, in order to prevent the same event from happening again. In addition, risk analyses are systematically performed as part of certification activities to identify all possible kinds of malfunctions that could theoretically occur in an aircraft with a view to achieving a failure-tolerant design. Thus, should malfunctions occur, mitigative means such as redundancies keep an accident from ending up in a crash and provide the possibility to have a safe emergency landing. Moreover, intelligent health monitoring systems allow calculating how many flight cycles can safely be performed before an aircraft needs to be grounded for corrective maintenance such as the replacement of a piece of structure. This is how continuing airworthiness raises safety levels, step by step. Perhaps some approaches developed for air transport safety purposes may prove attractive to enhance nuclear safety? ✖

Finding the right balance

Safety assessment is an iterative process aimed at improving the planning of work to be performed. It is also an integrative process that, ultimately, results in a final safety assessment confirming that the overall planning is safe. In this sense, the aim of safety assessment for nuclear plant operation is also valid for decommissioning, as the starting point is to determine how the work – the dismantling work for instance – must be performed. There are different possible safety assessment approaches: the fully analytical one is applicable to operation until removal of the spent fuel, whereas a more simplified one is applicable to dismantling once the spent fuel has been removed. The aim is to find the right balance between different parameters such as minimising the dose intake, the quantity of waste generated, the timescale of dismantling work, the associated cost, etc., knowing that all parameters cannot be optimised simultaneously.

Jörg Kaulard
Chief Expert, Decommissioning GRS

MYRRHA, a Swiss army knife for Belgian nuclear research

The Belgian Nuclear Research Centre SCK-CEN is a centre of excellence which operates several facilities such as the BR2 research reactor. To replace this ageing reactor, SCK-CEN is developing a versatile facility with a view to a commissioning by 2023.

>eutectic<
A eutectic system is a mixture of chemical compounds or elements that behave as a single chemical composition which solidifies at a lower temperature than any other composition made up of the same ingredients.

The Multi-purpose hybrid research reactor for high-tech applications (MYRRHA) facility under development in Mol, Belgium, really deserves its name, given the wide scope of needs it is intended to meet. Let us mention, among others, the technological demonstration of the accelerator-driven system (ADS) concept (see below), the waste transmutation studies of minor actinides and long-lived fission products, structural material studies for PWR, fusion and ADS-type reactors, nuclear fuel behaviour studies for PWR, BWR and ADS-type reactors, the production of radioisotopes for medical and industrial applications, fundamental nuclear physics research, etc.

Demonstrate the ADS concept

Currently in a pre-licensing phase in which the safety methodology and the main safety challenges are discussed with the regulatory body, MYRRHA will demonstrate the accelerator-driven system (ADS) concept by coupling the three components (accelerator, spallation target and subcritical reactor) at a reasonable power level to allow for operational feedback (scalable to an industrial demonstrator) and for studying efficient transmutation of high-level nuclear waste. Since MYRRHA is based on the heavy liquid metal technology, namely the lead-bismuth >eutectic< (LBE), it will be able to significantly contribute to the development of Lead Fast Reactor (LFR) technology. In critical mode, MYRRHA will play the role of European Technology Pilot Plant in the roadmap for LFR.

Learn more:

A detailed presentation by Bernard Neerdael, head of the MYRRHA Management Team at SCK-CEN, is available online at:
www.eurosafe-forum.org/2012-plenum

A sign of the great importance attached to enhancing the robustness of nuclear facilities and organisations, the attendance to the EUROSAFE Forum 2012 in Brussels reached 342 experts coming together from 27 countries from all continents.

Credits

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COMING NEXT...

The contribution of stress tests to enhanced nuclear safety

What do the stress tests performed on nuclear facilities in Europe teach us regarding the practices aimed to limit the consequences of an accident? How do the TSOs envisage their role in mobilising the best available knowledge to enhance nuclear safety? This and much more will be addressed in issue 24 of the EUROSAFE Tribune.

Issue 25 will report from the EUROSAFE Forum 2013 to be held in Cologne (Germany) on 4 and 5 November 2013 on the *Safe disposal of nuclear waste.*

More on: www.eurosafe-forum.org

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Towards Convergence of Technical Nuclear Safety Practices in Europe