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Towards Convergence of
Technical Nuclear Safety Practices in Europe

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CONVERGENCE OF SAFETY PRACTICES

Review of the main themes discussed at the fourth Eurosafe Forum held in Berlin in November 2002.

TO OUR READERS

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All the papers referred to in the seminar review are available on www.eurosafe-forum.org

Daniel Quéniart and Lothar Hahn

Over the years, the Eurosafe Forum has increasingly been establishing itself on the international scene as an unmissable rendez vous for the stakeholders – scientists, researchers, engineers, operators, managers, regulatory bodies, NGOs, opinion leaders and policy-makers – engaged in the nuclear safety debate. In Berlin, on 4 and 5 November 2002, we were delighted to welcome the so far largest number of participants who mostly came from all parts of the European continent to express their views on a pivotal issue for nuclear safety: the convergence of technical safety practices in Europe. The speeches, lectures and discussions were testimony to how much importance is attributed to the numerous facets of this highly complex issue. The forum thus dealt with such issues as defining and sharing a standardised vocabulary, consolidating data bases, harmonising regulatory requirements and making more rational use of R&D budgets, facilities and experience feedback on a continental scale. This was done in a way that took into account the technical, economical, social and political aspects of convergence. Reports on recent initiatives highlighted the crucial contribution of the EU and international organisations – commencing with the IAEA and the OECD's NEA –, bilateral and multilateral co-operation programmes. With a view to providing the reader with a balanced sample of the Berlin lectures and debates, the Eurosafe Tribune tapped this valuable source of knowledge to extract suitable approaches to policy-making in the context of EU enlargement and terrorist threats. Again, nuclear safety concerns us all. As a reader, you too can make a difference by commenting on the contents of the Eurosafe Tribune and suggesting topics you would like to see addressed. Last but not least: keep in touch with us in preparation for the next Eurosafe Forum, to be held in Paris on the 25th and 26th November 2003. ●

PANEL DISCUSSION → CONVERGENCE OF SAFETY PRACTICES

VOCABULARY: A PREREQUISITE TO CONVERGENCE

When people from different regions, cultures, professions, standpoints etc. interact closely, it is important to be precise about what terms mean. And when safety is at stake, sharing clear definitions becomes quite critical. This is why the speakers at the Eurosafe Forum 2002 started cautiously, by explaining what they meant by terms like convergence, harmonisation, safety, security, etc. Some definitions are proposed below.

CONVERGENCE

"To me, convergence means first and foremost developing an approach in which various aspects of regulation are looked at in an integrated way, on a common basis. This includes regulation •••

How Much Convergence is Necessary?

Promoting convergence in nuclear safety issues sounds self evident. Trying to share and harmonise concepts, techniques, knowledge, skills, criteria and legal standpoints seems to be a matter of common sense. Nevertheless, such a long and time consuming process can only be justified by high stakes. These revolve around undeniable facts: first, current technologies will be operated for the next 20 or 30 years. Second, there is a continuing need to improve safety and to identify and plug safety gaps. Third, there will be a number of areas where the present knowledge base is consolidated and extended. Fourth, from an industry perspective there will be a trend to reduce the safety margins.

In his introductory speech to the plenary session held on the first day of the Eurosafe Forum, Ashok Thadani, the Research Director of the US Nuclear Regulatory Commission (US NRC), depicted the current context and future prospects of nuclear facilities, providing a range of reasons for global convergence of safety practices. First, he said, about 80% of nuclear power plants are based on light water reactor technology. Second, the world has shrunk and an accident anywhere will impact all countries in a significant way. Third, security issues must not be separated from safety issues, they must be looked at in an integrated way. Fourth, besides safety there are many issues of common interest such as high burn-up fuel and moves towards reducing safety margins and maximising power of NPPs, particularly since the deregulation of power generation and supply. Optimising operations now means getting as much as possible out of these plants and maximising profits, but safely. Thus, countries equipped with nuclear facilities are pushed into thinking about how to balance these changes and yet maintain appropriate safety levels. Other reasons for global convergence pertain to the potential for new plants being built in countries like the US.

Peter Storey of the UK Health & Safety Executive (UK HSE) introduced complementary elements into the picture by pointing out that research budgets have been in decline for several years, causing research facilities and capabilities to be lost. *"Unfortunately, at the moment, industry tends to be focused on fairly short-term safety issues at the same time as corporate knowledge is also being lost. There is a lack of technology. Perhaps most critically of all, young scientists and engineers are not attracted to the nuclear industry"* he said. Maintaining competence, enhancing the cost-efficient use of research facilities and strengthening European competitiveness are thus key motivations in intensifying co-operation between European countries, including the EU candidate countries. In this context, several countries have already mapped their present and future nuclear skill needs to identify the required strategic approaches. The work is finished in the UK and Germany and still underway in countries like Sweden and the USA. For its part, the EC has been undertaking work in this area to try to map the current availability of nuclear competence and research facilities in the EU. In this respect, some of the efforts being developed through the EC's Sixth Framework Programme will help countries to deliver their nuclear competencies. Peter Storey added: *"The centres of competencies should have certain characteristics considered very important to the Community. These are chiefly a high level of technical expertise, a high reputation for delivery, adaptability to future changes and responsiveness to stakeholders' needs. This calls for good networking with other centres as well as access to all countries."* He stated more specifically that, from a regulator's point of view, co-ordination and co-operation help develop a level of peer review. It also helps benchmark approaches against other regulators and promotes the sharing of good practice. Perhaps most importantly, it helps develop an international consensus on technical issues.

For Pierre Govaerts, former Director General of the Belgian safety organisation and Chairman of the Nuclear Regulatory Working Group of the European Community, further convergence must enable more in-depth discussion of safety requirements, some of which are of a historical nature, and take into account the regulator's capability vis-à-vis the public. In this respect, *"plants that are 20 kilometres apart but with a border between them should be subject to the "same" regulatory requirements"*, he stated categorically.

For Riitta Kyrki Rajamäki, professor at the Finnish Lappeenranta Technical University, convergence and harmonisation are pre-requisites if the nuclear field is to be politically credible in a world which is becoming increasingly standardised internationally. *"As a practical example, I could mention that out of the 6,000 pages of the call for tender for the fifth Finnish reactor, 5,000 pages were from the European utility requirements"* she remarked, adding that *"harmonisation should be done through co-operative systems so that it does not result in an additional inflexible system that could endanger the effective local work."* Supporting this view, the former Director General of the Swedish Nuclear Power Inspectorate (SKI) and special adviser to the →

••• programmes and performance assessment programmes like inspections. They all need to have a standardised safety basis. They need to be integrated so that they can complement one another fully at the same time as being internally self-consistent."
Ashok Thadani, NRC (USA)

"For the Slovak Republic, i.e. one of the EU applicant countries, convergence represents the point where we become more credible, and let us say, transparent, because then it will be very easy to compare the safety of all utilities worldwide. Although the regulatory framework was established before, now all the best practices we get from Western countries can thus be reflected in our regulations."
Marta Ziakova, UJD (Slovakia)

DESIGN REQUIREMENTS AND NUCLEAR SAFETY REQUIREMENTS

"Design is an industry concern and goes hand with hand with design requirements. Design requirements have always been initially proposed by the industry and the designers. The EUR work is a very good example. In terms of •••

••• core meltdowns or nuclear safety requirements, the objective is to increase safety. The public expects a higher level of safety and increased transparency in the regulations. This entails including best practice procedures within nuclear safety standards."
Jukka Laaksonen, Stuk (Finland)

EUROPEAN STANDARD
"We are faced with the problem of what the European standard is. Nevertheless, we managed to identify a number of upgrades for each reactor needed to achieve a level of safety that corresponds to the requirements and practices widely applied within the present European Union. That means we aimed at a good average; i.e., neither the lowest common denominator, nor the state-of-the-art represented by the most recent reactors licensed in the Community."
Lars Högberg, Retired SKI Director General, Special adviser to the Ministry of the Environment (Sweden)

HARMONISATION
"This means there is no substantial difference between countries from the safety point of view in either generic national safety requirements or the resulting implementation in nuclear power plants. It means the harmonised safety level must have a legal basis and that harmonising safety based on voluntary or other less formal agreements with the industry is not seen as enough."
Pierre Govaerts, AVN (Belgium) •••

➜ Swedish Ministry of the Environment, Lars Högberg saw increased convergence as a way of providing public credibility, both nationally and across borders, and also as a way of improving existing standards and guidelines: *"The IAEA guidelines, for example, do not provide enough specific guidance to designers."* Lars Högberg concluded by pointing out the problem of converging standards in operational safety and safety management. *"Safety management and operational safety are as important to overall safety as design requirements. Consequently, it is just as important to attain a common level of quality in safety management as it is in design characteristics"* he stressed. ■

Willingness and Routes to Converge

■ Convergence between regulatory bodies is not new and was implicitly supported by some provisions of the 1957 Euratom treaty, and cross-border collaboration programmes have been set up. Collaboration in international working groups, a common knowledge base, a better management of nuclear competencies, common industrial projects, comparisons of safety objectives and safety requirements, an internationally established space for decision-making, key research priorities, etc. Many methods are potentially conducive to a convergent approach to nuclear safety. Now the question is how they should be selected and prioritised? Some insights are proposed below.

› Sharing knowledge

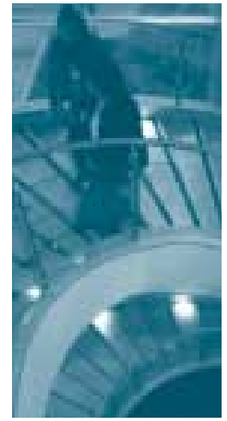
"Before speaking of convergence at the regulatory level, we should of course say that a prerequisite is a common understanding of the underlying physical phenomena. This means that research and development programmes like the Euratom framework programme, the OECD Nuclear Energy Agency programmes or the Eurosafe conferences are needed" Pierre Govaerts pointed out. Adding to this, Vladimir G. Asmolov, the R&D Director at the Moscow Kurchatov Institute, stressed that convergence of nuclear safety requirements and practices must be supported by three key elements: a common knowledge base, safety objective and internationally established space for decision-making. Moreover, if the consolidated effort of American, European, Russian and other countries' nuclear experts has brought new knowledge, this should be capitalised upon by sharing capability, brainpower and costs to adapt to tighter budgets and higher public expectations.
For Peter Storey too, convergence is first and foremost a matter of knowledge since, whatever the outlook for European countries, all share the need to ensure nuclear safety competence. The decline in research capacity felt in many countries and the threats to nuclear education in a number of universities puts at risk the ability of countries to realise their nuclear energy plans, whatever they may be. Peter Storey sees increased co-operation in these matters between European countries – including the EU candidate countries – as a way to cope with declining research and increasing European competitiveness. *"In this context, I believe we can bring about better convergence of safety approaches through three main activities: improved co-operation, better management of our nuclear competencies and focusing on key research priorities"* he remarked, expressing the opinion that there is no need to race towards setting standards and that co-operation is the key point. *"We are bringing the candidate countries into the EU and we must co-operate with them as they come in. I do not think we should be setting pre-qualifying standards that must be met before they can join. I think we should bring them in and help if they have difficulties. Certainly, there is no doubt that regulation must be done at the national level."*
All agreed on one point: the prerequisite to convergence is common understanding. But how is that understanding to be reached among such diverse European cultures? *"That is a very hard path, which we are used to in Switzerland. It is actually about working together. Working together means that people should move around. The big challenge is working in a foreign language and trying to share experience and understand how other people work and live. There is always a strong cultural component in every action. It is a topic that goes well beyond writing down principles. It is a long-term goal, where people have to learn from each other by working together"* Patrick Miazza, Plant Manager at the Mühleberg NPP (Switzerland), pointed out. In Switzerland – where five different reactors of four different designs are operated by four different companies- the Swiss Federal Nuclear Safety Inspectorate (HSK) has made considerable efforts to converge in trying to assess the safety of the country's NPPs.

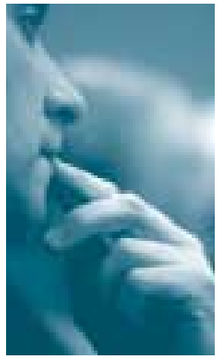
› Implementing common industrial projects

Significant initiatives started nearly a decade ago, in 1993, when the French and German safety authorities issued a common declaration on the main safety objectives of future pressurised water reactors and, in particular, the practical elimination of certain severe accident sequences. This bilateral project considered system details in depth. In the meanwhile, the European Technical Safety Organisations also performed work on the key safety issues surrounding future large evolutionary pressurised water reactors. A list of 30 key safety issues was thus established and 12 were prioritised for in-depth analysis and the development of a common approach. On the utility side, the European utility requirements (EUR) document – which contains a set of requirements to be met by the vendors and suppliers of nuclear systems – was issued. This document recommended the addition of a fourth safety level in the defence in depth concept, which encompasses a number of situations formally beyond the design basis, including severe accidents. Now, how can reactor designers contribute to technical convergence? One view is provided by Reinhold Horstmann from Framatome ANP GmbH: *"As a designer, I think we should concentrate on making links between existing top-level regulatory documents like the EUR guidelines, and the detailed regulations in several countries. By this I mean, for example, siting conditions, regulatory protection limits, requirements for redundancy and diversity of safety systems and features, definition and interpretation of criteria, conditions and time delay for operator actions and plant shift actions."*
Conditions for tests, maintenance and ➜

•••
MEASURE
"A mechanism for feedback when requirements are based on monitoring performance, looking for any precursors that might identify potential problems and feeding that information back into design and operation. That is what meant by thinking in a performance-based way."
Ashok Thadani, NRC (USA)

SAFETY AND SECURITY
"In most countries, when nuclear safety and the safety of nuclear installations are discussed, it is to ensure that the probability of accidents is kept very low. If accidents occur, there will be the means to mitigate any environmental consequences. This concept includes all aspects of safety in design and operation. Security usually refers to physical security and the protection of plants against certain external events. Some of them are wilful such as sabotage and terrorist incidents, and some •••





••• are more probabilistic such as plane crashes and seismic events. However, usually security is taken to mean the protection of installations from certain wilful acts intended to cause damage to the plant."
Lars Högberg, Retired SKI Director General, Special adviser to the Ministry of the Environment (Sweden)

"How safe is safe enough, keeping in mind that individuals should not bear significant additional risk to life and health? Safety goals were developed in the mid eighties for a large number of generic applications based on the principle that, basically, one-thousandth part of the risk from other sources is an acceptable level. This basically implies that the public is exposed to similar threats. The same concept was applied in terms of population risks that one tenth of one percent of the sum of cancer fatality risks resulting from all other causes is what we judge to be an appropriate level of safety in a societal way."
Ashok Thadani, NRC (USA)

→ repair as well as the scope of severe accidental conditions to be taken into account during design should also be fields for greater harmonisation. *"This would be a good target to reach, although I know it is complicated to do"* Reinhold Horstmann admitted.

› Intensifying the collaboration of international working groups

Back in July 1975, a European Council resolution required member states to collaborate effectively at Community level. It mentioned gradual modernisation of safety requirements and criteria and no lowering of safety standards already attained. To compare those requirements and criteria, it also provided a procedure which consisted in making a list and then drawing up a balance sheet of similarities and dissimilarities. The resolution evoked the possibility of a recommendation under article 124 of the Euratom treaty, although that was not ultimately used. It also sought common positions and harmonisation of the work and research conducted by international organisations. The European Community Nuclear Regulation Working Group (NRWG) was thus set up. It is composed of representatives from the licensing and regulatory authorities of member states and associated safety and control organisations on the one hand, utilities and vendors on the other. The NRWG worked on accidents with internal origins like, steam line breaks, anticipated transients, etc. and also on accidents with external origins like floods, aircraft crashes and earthquakes. *"On that topic, a European catalogue of earthquakes was drawn up from national catalogues to make the data consistent, which is also a way of establishing convergence at very basic level"* Pierre Govaerts underlined. Moreover, the NRWG issued the basic safety principles for water reactor nuclear power plants. In its introduction, the document states that, although its aim is to achieve a satisfactory degree of protection for the population and the environment, the way to achieve this protection may differ from country to country. The basic principles, however, can and must be common insofar as they reflect objectives, if not methods of attaining them.

In 30 years, the NRWG achieved valuable results and contributed to increased convergence of approaches and methods, demonstrating the effectiveness of the work performed by international working groups. It enabled common regulatory positions in such fields as periodic safety reassessment, non-destructive testing qualification, the licensing of safety-critical software, looking not only at licensing issues but also at life-cycle phase licensing issues, the qualification of electrical and J&C equipment, risk-informed in-service inspection, the effects of deregulation… In the latter cases, the goal was to sum up the experience gained in the countries already engaged in these processes.

› Assessing results and use

Last but not least, common indicators must be identified to measure how much a programme has contributed to improving safety. According to Peter Storey, a lot remains to be done in this field: *"We – and I do not just mean our organisation – are very happy to spend millions of dollars or pounds or euros on research, and when that research is over, very quickly to move on to something new without looking back to justify the expenditure. We have to take the next -and probably the most crucial step of taking and internalising information to make sure that full use is made of the knowledge that has been created."* ■

"Year after year, international conferences like this Eurosafe Forum in Berlin increasingly emphasise deep co-operation among the countries concerned with nuclear issues as the only way to achieve progress. In this respect, let me add that participating in the Eurosafe Forum affords an opportunity to meet people directly involved in nuclear matters on a daily basis.
In different ways, major nuclear accidents – like Chernobyl and TMI – showed the limitations of isolated, national action plans when safety improvement is at stake. To me, the only way to proceed is first to launch cost-shared, brain-shared and capability-shared projects. Cost-shared means accumulating the funds needed to conduct expensive nuclear safety projects in participating countries. At present it is beyond a single country's power to complete such a project on its own. Brain-shared means accumulating "real" knowledge in terms of computer codes, data bases, etc. through co-operation in international programmes. Capability-shared means that each participating country contributes what it can to the project – e.g. centres of excellence (teams, facilities) or the results of previous research work. In this respect, lots of important tests and experiments have been and can be carried out in Russia for the benefit of partner countries. The RASPLAV and MASCA projects are very good examples of that sort of research.
I think the most important element paving the way towards international decision-making is knowledge: if the base is aligned the different standards will not matter, since the results will be similar."

Vladimir G. Asmolov
Professor, R&D Director, Kurchatov Institute, Moscow

The Specific Role of Supranational Stakeholders

■ Making safety practices converge in an effective manner does not only require safety goals and convergence processes to be set clearly. It is also mandatory that supranational stakeholders such as nuclear agencies (IAEA, NEA…), international organisations (G7, Western Nuclear Regulators Association…) or working groups (Nuclear Regulatory Working Group) provide the legal, financial, technical and political framework for successful achievements. The panel of speakers invited to the Berlin Eurosafe Forum offered the audience considerations of the supranational stakeholders' role.

"The regulatory work should remain national in view of the differences between countries," Pierre Govaerts suggested. *"You would need to know the exact details of the plants in order to regulate them well. Consequently, it is difficult to imagine some kind of supranational inspection regulatory regime."* A standpoint shared by Peter Storey, who placed the role of cross-border institutions elsewhere. *"I actually think the current structure works fairly effectively,"* he said. *"We have the IAEA setting the safety standards. We have WENRA who look at harmonisation. We have the Nuclear Energy Agency's CNRA and CSNI, all looking to try to achieve consensus among regulators on technical and safety issues."* To him, the EC plays a crucial role at the research level, in developing research thinking and underpinning technical input to identify objectives and associated means.
Beyond these issues, Rainer Baake, Secretary of state at the German Federal Ministry for the Environment, Nature, Con- →

servation and Nuclear Safety, highlights other types of contributions made to safety by supranational stakeholders. Firstly, ensuring funding for nuclear safety. Mr. Baake pointed out that the G7 began to deal with nuclear safety in central and eastern Europe countries in 1992, and that as a result special funds were created at the European Bank for Reconstruction and Development in London. Secondly, creating international conventions on the strengthening of nuclear safety and safe handling of spent fuel assemblies and radioactive waste. These conventions have now become important instruments in achieving an acceptable level of nuclear safety worldwide. Thirdly, preventing the proliferation of weapons of mass destruction and dangerous materials: the G8 have decided to deal with the question of weapons-grade nuclear material and the physical protection of nuclear facilities, as well as the safe elimination of the stock piles of radioactive material from past activities. As another category of cross-border organisations, plant designers contribute to convergence in safety practices in the nuclear engineering field by performing four types of projects. Firstly, the multinational development of new power plant models such as EPR and SWR 1000. *"The EPR is a good example of inter-European harmonisation. Due to close co-operation with the leading European power utilities and due to the involvement of French and German safety authorities and expert organisations, an optimum balance of economic factors and a high safety status could be reached"* Reinhold Horstmann stressed. Secondly, international projects to modernise and improve the safety of older power plants in western Europe. For a plant designer, safety enhancement and equipment modification projects for equipment of their own design were, and are still, the major source of a broad backfitting knowledge. Thirdly, international projects in eastern Europe on the safety enhancement and reconstruction of power plants. Lastly, European technical support programmes – Tacis and Phare – and IAEA activities for eastern European reactors. *"Many of those projects were carried out in multinational design company partnerships,"* Reinhold Horstmann emphasised, *"with the involvement of institutes and companies from beneficiary countries. The resulting benefits for plant operators are therefore multiple: new or modernised equipment that is technologically state of the art; safety analysis and proof of qualification based on actual and internationally accepted rules and standards and an assurance that technical safety status and safety practices are in harmony with internationally agreed principles for those plants."*

From the European perspective, there are a number of important areas where research co-ordination is essential with a view to maintaining the safety of existing installations and to giving support to EU candidate countries regarding their safety level improvement. In this context, the European Commission's role is to support technical exchanges on safety issues and joint activities as well as a greater interrelationship between countries through cross-sharing and opening up of national research programmes, leading to major integrated programmes being adopted between countries. ■

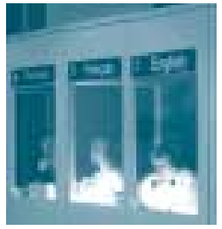
"With its focus on the convergence of technical safety practices, the 2002 Eurosafe Forum is the right place to promote initiatives supported jointly by different European governments. This is the case of the Centre for Nuclear Safety (CENS), a civil association founded in Slovakia on 27 April 2002 and currently financially supported by the Swiss and Slovak governments. Headquartered in Bratislava, the CENS aims to provide four main kinds of service that contribute to aligning safety practices. Since most training centres are oriented towards operators not regulators, this centre could attract people looking for regulatory training. Therefore our first area of provision is training and education pertaining to technical and management issues, workshops, project management, communications, regulatory staff training programmes, etc. In this area, CENS relies upon its own staff and also invites international specialists to teach.
In May 2002, in the Bratislava region, the Centre co-organised its first international workshop, mainly dedicated to PSA tools for safety assessment, upgrading and decision-making, alongside IAEA and USDOE.
The second area of provision relates to networking and encompasses technical cooperation in regional programmes, coordination of safety studies, peer review of studies, consulting services, etc. Third is decision-making support involving technical expertise in specific areas like independent safety evaluation, probabilistic safety assessment, Web publishing, electronic library services and newsletters.
Our fourth service line, linked to safety information management, consists in sharing information, compiling and updating safety databases, report warehousing, etc.
A fairly new organisation, the Centre for Nuclear Safety is in the process of setting up links both with technical safety organisations and companies like Riskaudit. We are glad to note that several organisations are already members of CENS, starting with the Swiss Nuclear Safety Inspectorate, Slovak Regulatory Authority, IAEA, GRS, IRSN and USDOE. Still, our participation in the Eurosafe Forum has helped us reach many people at a stroke. It has provided us with easy information exchange between experts from western and central Europe and given us indications for planning our priorities and strategy over the coming years. At a time when the risk of losing nuclear competence is becoming a major challenge because of the age of nuclear specialists, strong support should be given to any joint initiatives that help optimise the transmission of experience through teaching programmes geared to engineers involved in regulatory activities. Moreover, since nuclear safety is one the EU's enlargement priorities, the knowledge gained by RBMK and VVER specialists should be valued as creating a centre of excellence offering training, a platform for knowledge and information exchange and a place for discussing issues and managing projects. This could provide a major contribution to ongoing decommissioning projects, particularly in central and eastern Europe. **"**

Lubos Tomík,
Director,
Sahyasachi Chakraborty,
President,
Centre for Nuclear Safety (CENS)

A new Dimension for Convergence

■ Reactors are operated across the territory of the present European Union and further in the candidate countries. Therefore, almost 180 reactors are concerned by harmonisation within the enlarged EU. The central European countries that are about to join the Union operate almost exclusively Russian VVER and RBMK design reactors. Some applicant countries have closed down some reactor units and all EU candidates have given assurances that they will comply with the EU's demands… Now the question is: based on which standards? A few comments below on this key issue.

Fairly well acquainted with several central European countries, Reinhold Horstmann posed the problem in straightforward terms: *"For the last ten years, the applicant countries have heard our western complaint that they should increase their safety level so that it complies with the European standard. They are still asking what the European standard is!"* His suggestion is that western European countries use EUR ➜



➜ documents and, as the first step, try to fix those areas where they think consensus can be achieved, staying away from others where there is probably no consensus.
For his part, Rainer Baake explained that the coalition parties in Germany proposed, in the framework of their agreement dated 16 October 2002, that the federal government lay down agreed minimum standards for the safe operation of nuclear power stations in an extended European Union. *"If we leave aside the question of legal basis, then one has to clarify which safety standards might be used. And the federal government will support this,"* he underlined.

So, should the stakeholders of an enlarged EU be content with concentrating their efforts on achieving European standards? Not quite, according to the Chairperson of the Slovakian Nuclear Regulatory Authority: *"Just to focus on the European level would be a bit short-sighted, because in the future we will also need input from other countries. There should be the same safety regimes worldwide, rather than separate regimes in Europe, America and the Far East. I also think we should co-operate closely and have the same requirements worldwide"*, Marta Ziakova suggested in conclusion. ■

Evolution of Nuclear Safety Concepts and Standards: US and German Perspectives

■ In their address to the Eurosafe Forum 2002, Ashok Thadani, Director of the Office of Nuclear Regulatory Research at the US Nuclear Regulatory Commission, and Rainer Baake, Secretary of State at the German Federal Ministry for the Environment, Nature, Conservation and Nuclear Safety, summarised the evolution of nuclear safety concepts and standards in their respective countries.

› The evolution of safety concepts in the US: from Design-Based to Probabilistic Risk Assessment

• Most regulations were developed 30 to 40 years ago. While there was some implicit consideration of probabilistic thinking, by and large these regulations were based on the best engineering judgement then available. At the time, the worst possible accident envisaged was a double-ended pipe break. Safety was thus largely based on one category of scenarios: design-based accidents.

• The first major impact in US understanding of the change from design-based accidents really occurred in 1975 when a very comprehensive analysis of two nuclear plants was carried out. This was the so-called Reactor Safety Study, headed by Professor Rasmussen of MIT, which for the first time, and in a very comprehensive way, used the concepts of risk analysis using event trees and fault trees. Probabilistic risk assessment really changed the way we think.

• Over the years, through operational experience, research and individual staff concerns were called generic safety concerns or generic concerns about the safety of nuclear power. It was important to understand which of these generic concerns required prompt attention, deliberate attention or, perhaps, no attention at all. The ideas in the Reactor Safety Study were utilised for the first time in assessing a number of these generic concerns or issues.

• 1979: Three Mile Island. This accident caused the US truly to try to understand what severe accidents can in fact do. The early emphasis was on design-based accidents, as there was a presumption that severe accidents could not happen. Three Mile Island caused us to step back and try to make sure that we understood what might happen should a severe accident occur, and all the phenomena that might be involved and then to identify appropriate actions that might need to be taken. In the US, there are 103 operating reactors, all of which are different. It was thus clear to the Nuclear Regulatory Commission that generic evaluations were not truly applicable in some areas and there- ➜

Dr Alain Mailliat,
Project leader, Phebus 2000 and Phebus-APRP-irradié projects, Safety Research Department, Cadarache, France

"The closer to reality, the higher the costs of research: on the basis of this generally accepted statement the EURSAFE project, aimed at rationalising severe accident research by prioritising reactor processes potentially impacting severe NPP accidents, was launched in January 2002. The objective is to provide the nuclear safety community with a rational, consensual basis for making decisions about future reactor safety research programmes in a context of tighter budget allocation. EURSAFE involves nineteen organisations from ten countries, several utilities from Europe (EDF, TVO, VEIKI), a vendor (Framatome ANP), regulatory bodies and their supports (IRSN, HSE, GRS, US-NRC, CSN) and research centres (CEA, FZK, RIT, JRC, PSI, IKE, CIEMAT, UPM, AEAT). The project was approved and funded by the Fifth Framework Programme as a two-year long concerted action. The EURSAFE work is carried out by reactor physics and reactor safety specialists. The first phase is devoted to Phenomena Identification and Ranking Tables, hereafter called PIRTs, which includes three consecutive steps. Step one consists of listing the phenomena for each phase of a severe accident, from core degradation up to the release of fission products into the containment and the environment, taking into account possible countermeasures. Step two is focused on safety. The reactor safety experts scrutinise the lists of phenomena and rank each of them in terms of their importance for primary circuit safety, containment safety and source term. Step three allows the reactor physics experts to assess levels of knowledge about the phenomena that have been ranked highly important for safety. After completion of this procedure, the result is a consensual list of phenomena that are both highly important for safety and about which there is a substantial lack of knowledge. The preliminary PIRTs results are now available. Nearly 900 processes were identified and defined in the list of the phenomena which potentially impact severe NPP accidents. The experts highlight 230 phenomena as very important for reactor safety with, for almost 60 of them, significant lack of knowledge. These 60 phenomena will obviously be candidates for further R&D work, which will be defined in the second phase of the EURSAFE project, the so-called PIRTs implications.
It includes i) defining R&D needs in terms of objectives and priorities; ii) identifying the required R&D tasks in terms of experimental programmes and codes; iii) reviewing the European facilities and codes that could be used for these tasks, taking account of existing and planned programmes. The recommendations arising from EURSAFE's second phase will dictate the primary thrust of severe accident research programmes in the near future.
To optimise the use of resources available in Europe and enhance the cost-effectiveness of research work, such programmes should be conducted and co-ordinated within a single structure: the SARNET Network of Excellence presently being prepared under the Sixth European Framework Programme."

➜ fore we had to require the industry to do evaluations of each plant.

• The Commission issued a policy statement, of which this is a key excerpt: 'The use of Probabilistic Risk Assessment (PRA) technologies should be increased in all regulatory matters,' followed by the qualification, 'to the extent of the state of the art in PRA methods and data and in a manner that complements the NRC's traditional in depth defence and philosophy.' So the point is to supplement decision-making, not to supplant decision-making.

• There are still gaps in our understanding and there are still limitations in terms of the analytical tools that we apply today. So, defence in depth considerations should be maintained.

For more details on this topic: see Ashok Thadani's address to the Eurosafe Forum, 4 Nov. 2002.

› Improving Germany's safety standards in the fields of safety management and work on waste management concepts

• Principle: the responsibility for the burden of nuclear safety and waste management has to be carried by the corresponding countries which have used nuclear energy for the production of electricity and which will continue to do so.

• With a view to guaranteeing the safe operation of German facilities during their remaining operational period, it was decided to draft a catalogue of questions on the practical aspects of safety management in Germany's nuclear power plants on the basis of the corresponding international regulations.

• The Federal and State Governments hold the view that no facility in Germany possesses a comprehensive safety management system and that is why the decision of the Minister of the Environment was right. The unanimous decision – taken in June 2002 – was that the operators of the facilities should develop the concept of a comprehensive safety management system on the basis of understandable safety indicators and implement it in their respective facilities.

Such a safety management system has to fulfil the following requirements.

• Operators have to formulate a safety policy derived from the safety goals.

• They then have to implement it.

• The safety goals have to be measurable so that existing standards for safety and the success of measures for improving safety can be shown objectively.

• Processes and tasks to be stipulated must relate to the assurance of safety.

• The safety goals have to be checked on the basis of indicators and this applies to process results, reliability, the technical reliability of the facility, the reliability of the reporting of mistakes and improvement in performance where mistakes are found, as well as an assessment of the effectiveness of the procedure, for continuous improvement in safety management processes.

Concerning waste management:

• The goal of the Federal Republic of Germany is to provide a repository in deep geological formations for all radioactive waste by the year 2031.

• This requires speedy progress on this matter and the first milestone on that path is the establishment of a transparent, socially acceptable method for choosing the site.

• Our national experience and progress towards solving the problem of disposing of radioactive waste will be submitted to international organisations and bodies, such as the OECD NEA, who we hope will give us positive feedback. ■

For more details on this topic: see Rainer Baake's address to the Eurosafe Forum, 4 Nov. 2002.

Lars Högberg,

Director General (retired), Swedish Nuclear Power Inspectorate (SKI), Special adviser to the Ministry of the Environment, Sweden

"I came to Berlin to participate in the Eurosafe Forum's plenary discussion and enjoyed listening to the presentations and moderating debates between people who managed to give a comprehensive picture of the issues involved in moving towards harmonised safety standards. It is difficult to draw specific conclusions from the discussions, but if I try to summarise, I can at least make three statements.

Firstly, I would say there is now a widespread view that we need to move towards more convergence in Europe, but not only in Europe. It is a matter of political and public credibility but it is also being driven by the move towards a common electricity market in the EU. Moreover, the utilities see big savings to be made from standardised designs. They therefore specify common requirements and it is up to the vendors to compete with the best designs to meet them. When our Finnish colleagues asked for bids on their fifth reactor, they used specifications largely based on the EUR document (European Utility Requirements).

Secondly, I would emphasise that a common understanding of the scientific and technical issues is fundamental to developing more harmonised safety standards. To me, continued co-operation in research, to develop a consensus in various domains, is therefore essential. In this respect, the work done through the IAEA and the NEA, as well as the exchange of views and co-operation within the EU – also among industrial operators – is crucial. Even if many countries know that they are not going to develop new reactors in the near future, participation in such technical co-operation is essential to maintain and develop their nuclear safety competence, also with regard to existing reactors. Going from common technical understanding to common legal requirements will however be a very complex and time-consuming task, not least for the regulators. This is partly due to the variety of regulatory systems within the EU: a legacy of history. Before embarking on such a task, it must be ensured that there are net benefits to safety commensurate with the resources spent.

Thirdly, I would say that increasing harmonisation of safety standards requires some political guidance on "how safe is safe enough", based on a dialogue between political decision-makers and the competent technical bodies. Our Finnish colleagues have got such guidance from both parliament and the government.

Last but not least, I would like to add that I see the Eurosafe Forum as a powerful tool for creating common technical understanding and also, to some extent, contributing at the policy level by helping regulators and operators advise their governments. This contribution should by no means be restricted to Europe, but shifted towards a global position."

Nuclear Installation Safety Assessment: the Trend Towards Increased Benchmarking and East-West Co-operation

Besides design-based nuclear safety, operating experience is increasingly viewed as a highly valuable resource for improving the safe running of facilities faced with equipment ageing, partly upgraded information and control systems, regulatory evolutions, etc. Taking examples from a wide array of concerns ranging from neutron behaviour in the reactor pressure vessel to the renewing of I&C systems through piping failure and fire-induced damage to electrical cables, the lecturers at the seminar on assessment and analysis of nuclear installation safety compared practices and highlighted the role of bilateral and international co-operation within the framework of EU enlargement.

› Benchmark: how the French and Germans cope with neutron fluence

"Neutron leakage" represents a loss of fuel efficiency and causes neutron embrittlement of the reactor pressure vessel wall. The latter raises safety concerns and therefore needs to be monitored closely, which may necessitate mitigating measures. Two different approaches have been followed in France and Germany:

- French units have largely been constructed with a relatively high fluence level and an extensive surveillance programme. This has been accompanied by the development of sophisticated methods for fluence calculations. The large number of identical units helped to limit the efforts per unit and to improve the statistical basis of the results.
- In all but the three oldest German plants the vessel fluence level has been reduced by design to such a level that the surveillance programmes could be limited to just ascertaining that design level embrittlement is not exceeded. For the oldest plants, special measures have been taken to decrease uncertainties about vessel fluence and material properties, reduce neutron flux into the vessel and – where appropriate – to mitigate accident loading of the vessel.

On this subject, read: Neutron fluence in the reactor pressure vessel wall – a comparison of French and German procedures and strategies in PWRs by U. Jendrich (GRS) and N. Tricot (IRSN)

› Benchmark: how the French and Germans renew I&C systems in their NPPs

In France, the NPP operator launched feasibility studies on the refurbishment of the nuclear instrumentation system installed in its 900 MWe units in 1996. The upgrade from analogue to digital technology had organisational impact (changes in periodic test and parameter setting procedures, etc.) as well as human implications (operator training and mastery of the digital system), both of which must be considered in safety analysis. The assessment method applied by IRSN was based on documentation supplied by the operator and dealt primarily with system design, hardware, software, operation, requalification, health physics, fire protection and human factors. This experience revealed that a few areas – such as engineering processes and interface dynamics – required special attention in future update assessments.

In German nuclear power plants, the experience with digital I&C shows that reportable events are attributed to deficiencies in the specification, development and qualification of software, system structure, commissioning tests and the planning and performance of maintenance. Therefore, it is necessary to define equipment rules and requirements properly so as to ensure the quality of safety-relevant components in NPPs. Moreover, GRS considers that it is necessary to collect operational experience on a wider basis, compared to current notification criteria, in view of the increasing importance of software-based digital I&C for safety-relevant systems in nuclear power plants.

On this subject, read: French Experiences on Renewing of I&C Systems in NPPs by F. Fradet, J. C. Péron, B. Soubies, O. Elsensohn (IRSN) and German Experiences on Renewing of I&C Systems in NPPs by E. Piljugin, H. Heinsohn (GRS)

› Co-operation: how the EU supports Lithuania's efforts at Ignalina NPP

As Lithuania's national regulatory authority, Vatesi is responsible for the establishment and implementation of state nuclear power safety regulatory policy and for the supervision of safety-relevant activities at the Ignalina NPP, wich operates RMBK-1500 units, two of the largest civil nuclear power reactors in the world. With the objective of entry into the European Union, Lithuania is actively seeking harmonisation with European standards in a wide range of areas. In the nuclear power field, one of the points that Vatesi is actively considering relates to the implementation at Ignalina of an adequate Equipment Qualification programme, including the implementation of European Network for Inspection Qualification (ENIQ) methodology.

Executed between November 2000 and October 2001, a Phare project entitled "Support to Lithuanian Power Safety Inspectorate and its Technical Support Organisations" provided Vatesi with assistance in such domains as the qualification of equipment important for safety at Ignalina NPP and the development of national guidance for NDE performance techniques.

On this subject, read: Regulations and Equipment Qualification Programme for Increased Operating Safety at Ignalina NPP by A. Alejev (State Nuclear Power Safety Inspectorate, Vatesi), M. Chouha (IRSN), R. Shipp (Firecrest Consulting Ltd) and G. A. Georgiou (Jacobi Consulting Ltd)

› Co-operation: how the "2+2" approach contributes to the convergence of safety practices

Implemented in upgrading the Ukrainian VVER plants, the "2 + 2" approach consists of building a team composed of two EU entities and two Ukrainian entities, for instance the Ukrainian National Regulatory Authorities (SNRCU) in tandem with EU Utilities + the Ukrainian Operating Organisation (NAEK) in tandem with Riskaudit, a GRS-IRSN joint venture.

This approach applies to upgrading measures financed by the EU through Tacis, such as the replacement of steam generator safety valves and pressuriser safety valves, adding new safety functions; the modernisation of the steam generator level control and of the containment's sump filters, the improvement of the liquid radioactive waste treatment systems.

Among other benefits, the "2 + 2" approach allows a smooth adaptation of Western technologies to VVERs and a comprehensive verification of Ukrainian and Western regulatory requirements, as well as the transfer of know-how to Ukrainian organisations. ■

On this subject, read: Upgrading Ukrainian NPPs and the "2 + 2" approach applied to the licensing of major modifications by V. Redko (Ukrainian National Regulatory Authorities), A. Gorbatchev , D. Goetsch (IRSN/ France) and A. Madonna (ANPA).

More papers dealing with the assessment and analysis of nuclear installation safety are available on the Eurosafe Web site: www.eurosafe-forum.org

Nuclear Installation Safety Research: Establishing Priorities in the Context of Reduced Budgets

At a time when the EU welcomes ten new member states – most of which operate nuclear facilities – although declining budgets are being devoted to nuclear safety research, progress is expected to result from cost-effective research planning. Gaining knowledge on specific points, integrating knowledge into existing bases and sharing it with other countries, and assessing the safety knowledge and understanding still to be acquired is a trilogy that henceforth guides the prioritisation of future experiments and cost-efficient use of resources and facilities.

› Gaining knowledge on specific points: experiments on core degradation

The Codex (COre Degradation Experiment) out-of-pile integral test facility was built and put into operation in 1995 at the KFKI Atomic Energy Research Institute in Hungary, in order to investigate some specific aspects of core degradation and extend the experimental database for code validation and development. Some of the experiments were VVER-specific, while others were of general interest for any light water reactor.

Between 1995 and 2002, an experimental series of tests was carried out with electrically heated UO2 fuel rod bundles. The test matrix included the first VVER-440-type integral severe accident experiment. The experimental results contributed to the general understanding of severe accident progression in the rod-like geometry loss phase. The tests are available for model development and code validation purposes. The last test of the current series helped to resolve the methane production issue during the oxidation of a boron-carbide control rod in a severe accident.

On this subject, read: Summary of the Core Degradation Experiments CODEX by Z. Hózer (KFKI Atomic Energy Research Institute, AEKI)

› Gaining knowledge on specific points: the MCDET method

In technical systems like nuclear power plants, an accident sequence starts with an initiating event and evolves over time through the interaction of dynamics and stochastics. This interaction is capable of producing an infinite number of different sequences. Along the time-line they define a continuous dynamic event tree with an infinite number of branch points. At each point in time, the stochastic variability of the accident consequences is summarised by a multivariate probability distribution. It is felt that the conventional event tree analyses of Level 1 and of Level 2 probabilistic safety analyses (PSA) often does not permit a satisfactory probabilistic representation, for PSA purposes, of such phenomena as the distribution of the total hydrogen mass generated during the transient up to a given point in time. For this reason various methods of probabilistic dynamics have been suggested over the past decade. One of them is MCDET, a combination of Monte Carlo simulation and dynamic event tree analyses. MCDET which allows an approximate treatment of continuous random transitions and also of discrete random transitions with many transition alternatives. It is thus possible to account fully for the interactions between stochastics and dynamics. The application of the dynamics code is controlled so that sequence sections shared by paths of the tree are computed only once.

On this subject, read: Dynamic Event Trees for Probabilistic Safety Analysis by E. Hofer, M. Kloos, B. Krzykacz-Hausmann, J. Peschke, M. Sonnenkalb (GRS)

› Integrating knowledge: Astec application to VVER reactors

The integral Astec (Accident Source Term Evaluation Code) code has been jointly developed by IRSN and GRS with the aim to get a fast-running code for the simulation of total severe accidents sequences in LWRs from the initiating event up to the possible release of fission products to the environment. The code can be applied to accident sequence studies, probabilistic safety assessments, efficiency assessment of current accident management procedures, establishment of future procedures as well as preparation of experiments and interpretation of experiment results. Since the code requirements include code applicability to VVER severe accidents, a programme of collaboration with eastern European organisations was set up around VVER applications: validation of VVER-specific experiments and plant applications. Astec V0 applications showed that most VVER features can be simulated correctly with the code. As for simulation of accident management measures, the code allows most existing safety systems to be represented correctly. Developments are still necessary for new generation VVER reactors, for instance for simulation of passive hydrogen removal systems or core catchers.

On this subject, read: Astec applications to VVER reactors by J.-P. Van Dorsselaere (IRSN), W. Plumecocq (IRSN), H.-J.Allelein (GRS), Y. Zvonarev (NSI/RRC-Kurchatov Institute), A.Bujan (VUJE), J.Dienstbier (NRI), P.Kostka (VEIKI), L.Kubisova (UJD), P.Matejovic (IVS)

› Assessing the knowledge to be acquired: ISP experiments on containment thermal-hydraulics

During the course of a severe accident in a PWR, large amounts of hydrogen could be generated and released into the containment. A detailed knowledge of containment thermal-hydraulics is thus necessary to predict the local distribution of hydrogen, steam and air inside the containment under conditions representative of severe accidents conducive to LOCA (loss of coolant accident) conditions. Several ISP experiments were carried out, showing that every ISP has been subjected to a rather complicated integral test and that there has been a lack of separate phenomena testing within the framework. Therefore, a new series of experiments called ISP-47 will be performed to demonstrate the actual capability of CFD and "lumped parameter" codes in the field of containment thermal-hydraulics, e.g. to predict the hydrogen distribution under LOCA conditions. Those experiments are subdivided into three programmes: Tosqan for model validation through separate effect test experiments, Mistra for large-scale code validations and THAI for code validations in more complex and more realistic conditions. They are due to provide local measurements for the prime variables needed for field code assessments. ■

On this subject, read:
ISP 47 "Containment thermal-hydraulics" Computer codes exercise based on TOSQAN, MISTRA and THAI experiments by J. Vendel (IRSN), P. Cornet (IRSN), J. Malet (IRSN), E. Porcheron (IRSN), H. Paillère (IRSN), M.L. Caron-Charles (IRSN), E. Studer (IRSN), K. Fischer (Becker Technologies GmbH) and H.J. Allelein (GRS).

More papers dealing with the research on nuclear installation safety are available on the Eurosafe Web site: www.eurosafe-forum.org

Waste Management:
Increasing Knowledge on Disposal, from R&D to Societal Issues

The lectures at the seminar dedicated to waste management were mostly focused on different approaches to deep disposal issues: a factual introduction to the site selection and characterisation processes in various EU member states; a presentation of methodological issues such as indicators, safety criteria, the limits of models, etc.; a reflection on technical issues: characterisation tools, problems relating to model validation and transfer, etc. The *Eurosafe Tribune* digested a few selected papers which highlight – among other things – the various strategic choices of Sweden, Germany and Belgium.

› Spin: converging on waste disposal safety and performance indicators

Spin is the name of a research project funded by the European Commission and carried out by eight organisations from seven European countries for testing safety and performance indicators, which have been under discussion for many years in several countries and international organisations.

The assessment of safety indicators resulted in the following conclusions:

- Effective dose rate: useful for all time frames, with a greater preference for early time frames (the first several thousands of years).
- Radiotoxicity concentration in biosphere water: useful for all time frames, with a greater preference for early and medium time frames (several thousands to several tens of thousands of years).
- Radiotoxicity flux from geosphere: useful for all time frames, with a greater preference for late time frames (more than several tens of thousands of years).
- Radiotoxicity outside geosphere / Time-integrated radiotoxicity flux from geosphere: not useful, because safety-related reference values cannot be established.
- Relative activity concentration in bio sphere water: not applicable unless reference values are found.
- Relative activity flux from geosphere: not generally applicable unless reference-values are found.

The assessment of performance indicators showed that each of them is useful for a specific purpose and provides specific added value in terms of measurement, comparison, understanding, etc.

On this subject, read: The SPIN Project: Testing of Safety and Performance Indicators by R. Storck (GRS), D-A. Becker (GRS), Jesús Alonso (Enresa), Markus Hugi (Nagra), Matthias Niemeyer (Colenco), Ales Laciok (NRI), Jan Marivoet (SCK·CEN), Patrick O'Sullivan (NRG), Henrik Nordman (VTT)

› Public participation: a cornerstone in the German approach for disposal site selection

Entrusted with developing a new approach to siting a geological repository for radioactive waste in Germany, the AkEnd assessment team defined a new site selection procedure aimed at providing the Federal Ministry of the Environment (BMU) with recommendations for potential decision-making. The AkEnd assessment team is of the opinion that not only the host rock, but also a generally favourable overall geological location, is decisive for the suitability of a site which ensures the longest possible isolation of the waste and prevents inadmissible releases. Any site qualified for detailed site investigation thus has to meet some basic geological requirements which add up to a favourable geological setting. Beyond these technical criteria, a number of socio-ecological criteria have to be applied at the various stages of the selection procedure. They refer to the sociological development of the regions concerned, as well as to regional planning and nature conservation. For AkEnd, the issue of public participation is a cornerstone in the new approach to disposal site selection in Germany.

On this subject, read: Siting of a Geological Repository for Radioactive Waste in Germany - Latest Results of the AkEnd Regarding a New Site Selection Procedure by W. Brewitz & B. Baltes (GRS).

› Shifting from technical to societal assessment: the Belgian experience

Ondraf/Niras – the Belgian radioactive waste management agency – is currently trying to establish if it is feasible, both technically and financially, to design and build a safe, deep disposal facility for high-level and/or long-lived radioactive waste on Belgian territory, without prejudging the issue of the site location for the implementation of such a solution. The agency is therefore performing a methodological R&D programme in a silty-clay formation located in the Mol-Dessel nuclear zone, home of the Nuclear Energy Research Centre. In July 2002, the agency released the Safety Assessment and Feasibility Interim Report 2 (Safir 2), aimed at providing supervising authorities with a state-of-the-art document that will enable them to assess the progress made during the period 1990-2000 with regard to the feasibility and safety of a Belgian disposal solution. This report confirms the favourable results of assessments, especially regarding the key contribution to long-term safety made by the host formation.

With a view to addressing societal and economic aspects of the waste management issue, Ondraf/Niras now proposes to establish a Strategic Environmental Impact Assessment-type document.

On this subject, read: Assessing Long-term Safety of Deep Disposal in Belgium: The Safir 2 Report by P. De Preter and Ph. Lalieux (Ondraf/Niras)

› A programme at maturity: Sweden's plan for deep-disposal site selection

Following national and international review of the KBS-3-study, in 1984 the Swedish Government decided that it provided sufficient evidence for safe long-term disposal of spent nuclear fuel into the crystalline bedrock and gave permission for start-up of the last reactors in the Swedish nuclear programme. Since then, the KBS concept has been developed further and many details have been modified.

The next major safety assessment for the deep repository will be conducted when the data from the site investigations are available. The assessment will be appended to the application for a permit for the siting and construction of the deep repository, planned for 2007. The account also comprises a basis for the safety assessment that will accompany the application for a permit for the siting and construction of the encapsulation plant, planned for 2005. At later stages, assessments are planned that will comprise supporting material for applications for a permit to commission the repository and a permit for closure. ■

On this subject, read: SKB studies on deep disposal and safety by Claes Thegerström (SKB)

More papers dealing with waste management are available on the Eurosafe Web site: www.eurosafe-forum.org

"There is a general belief that after a disaster people have to wait for help. As a member of the Belarusian Research Institute for Soil Science & Agrochemistry, I am involved in an experiment which shows that solutions can be implemented by the disaster victims themselves. The philosophy of the "Potatoes" project – a pilot experiment carried out in Belarus among 69 farmers in four villages hit by Chernobyl fallout – is that people living on contaminated territories can use their own abilities to help themselves rather than simply wait for help from the government.
At this stage, it should be remembered that 1.2 million hectares were contaminated in Belarus. The "Potatoes" project, carried out over two years in the framework of the ETHOS II project, provides farmers with important theoretical and practical training in agriculture production on radioactive contaminated land. After discussing what could be done in the agricultural sector to improve farmers' lives, the decision was taken to focus on the production of potatoes for personal consumption, animal feed and commercial sale. In the affected areas, 70% of the collective irradiation dose is acquired through the consumption of radionuclide-contaminated food.
The main problem is •••

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... therefore to grow high quality food with a low concentration of radionuclide, and it could be solved by the improvement of potato cultivation technology using a three-pronged method. First, a new variety of potatoes that accumulates less radionuclide and gives a higher yield was selected. Second, a special set of fertilisers was developed to suit the soil's agrochemical properties and caesium deposition was analysed for each plot. Third, it was considered that protecting the plants against diseases and insects would help reduce nuclide concentration and enhance yield. For example, the use of potassium-based fertilisers enables the concentration of caesium in potatoes to be decreased since potassium and caesium are placed "in competition". Moreover, the reduction of diseases and insects results in higher yields and lower concentration, since the latter decreases per dilution. Farmers were invited to divide their individual plots into two parts, to go on growing potatoes using traditional methods on one part, implement the new technology on the other, and compare. As a result of our experiment, the caesium concentration in potatoes was diminished by 30% and the yield increased 1.7 fold. The average net ...

Environment and Radiation Protection: Focusing on Practicality

If contributions to the Berlin Eurosafe Forum 2002 reflect the wide scope of issues related to environmental and radiation protection, a common denominator is to be found in the practical orientation of the reports. Refining assessments so as to get closer to reality, adding practical competencies to the theoretical knowledge of radiation protection professionals, developing agricultural countermeasures to cope with a nuclear accident... Whatever subject is addressed, lecturers stressed the efforts towards applicable solutions, not only from a technical, but also from a social and economical perspective. Three examples are given below.

› Epidemiological surveys: working on sensitivity and uncertainty

The controversy raised by the uncertainty associated with the findings of the Nord-Cotentin Radioecology Group[1] concerning radiation-induced leukaemia in the Beaumont-Hague canton of the Nord-Cotentin region led to the launch of a second study to estimate the uncertainty of the number of excess cases of leukaemia. Broadly speaking, the sources of uncertainty in the risk assessment are linked to:

- Specific parameters of the nuclear facility and of the Beaumont-Hague area, i.e. radioactive discharges from the Cogema reprocessing plant at La Hague, atmospheric transfer coefficients and canton residents' lifestyles.
- Parameters that are an integral part of the models, such as marine and terrestrial transfer coefficients.
- Models themselves, which represent complex transfer phenomena with varying degrees of precision.

This uncertainty study, conducted for radiological impact evaluation purposes, is exemplary in more ways than one: the diversity of the models used, numerous parameters processed, the choice of different methods to quantify uncertainty. Efforts devoted to refining variation ranges and parameter distributions have enhanced existing know-how by providing a database for future sensitivity and uncertainty studies. Finally, in subsequent research, application of possibility theory to this type of evaluation merits further reflection.

(1) The Nord-Cotentin Radioecology Group (GRNC) is a multidisciplinary group of experts from diverse organisations (governmental institutions, universities, nuclear operators, NGOs, foreign scientists). It was set up by French ministries in 1997 when a scientific controversy erupted about the high incidence of leukaemia in the Nord-Cotentin region and its hypothesised link with radioactive discharges from the reprocessing plant in La Hague.

On this subject, read: Nord-Cotentin radioecological study - sensitivity and uncertainty analysis by A. Merle-Széréméta, J. Brenot, E. Chojnacki, C. Rommens, P. Germain and A. Sugier (IRSN)

› Animal radioecology: developing post-accidental countermeasures

Understanding the factors which affect the transfer of radionuclides to, and their behaviour in, animals is essential if we are to be able to interpret monitoring results, accurately predict activity concentration in animal-derived food products and develop effective and appropriate countermeasures. There has been significant progress with respect to countermeasure techniques. The focus has been not only on effectiveness, but also on other issues such as cost, acceptability (to stakeholders and society) and practical considerations (e.g. availability, feasibility and side-effects).

- Contamination of milk by radioiodine is thus to be dealt with by the provision of uncontaminated feed to the cattle and by the storage of contaminated milk or its conversion to other storable products.
- Contamination of milk by radiostrontium can be handled by doubling the dietary calcium intake by animals.
- Condemnation of meat contaminated by radiocaesium can be handled by the provision of clean feed, the administration of feed additives which reduce radiocaesium absorption from the gut, changing slaughter times, pasture improvement/management and use of live monitoring, which are therefore considered better alternatives.

However, the usefulness of countermeasures and an assessment of whether they are realistically likely to be useful and effective in contamination of animals will vary with many different factors[1], both inside and between countries, including:

- severity of contamination;
- importance of affected areas to national economies;
- type of ecosystem affected and existing management systems;
- priority given to maintaining existing ways of life;
- animal species and products contaminated;
- availability of suitable waste disposal options;
- way of life;
- national economy;
- legal and administrative framework.

It is clear that suitable countermeasures are likely to vary considerably from one area or community to the next, and national authorities need to evaluate their own relevant criteria.

(1) More information available on www.ec-farming.net On this subject, read: Recent advances in animal radioecology and mitigation of animal product contamination after accidents by B.J. Howard (Centre for Ecology and Hydrology-Merlewood, UK), N.A. Beresford (Centre for Ecology and Hydrology-Merlewood, UK) and G. Voigt (Agency's Laboratories Seibersdorf, Austria).

› Radiation Protection: a UK perspective on adapting profiles to new challenges

In Britain, the requirement for a Radiation Protection Adviser was introduced in the Ionising Radiation Regulations 1999. The HSE criteria require applicants to demonstrate, beyond basic knowledge and training, practical competencies such as supporting risk control, updating radiation safety policies, assessing risk, establishing radiation controls, cultivating safety awareness, complying with legislation, training staff and contributing to advances in safety. This broadening scope of required competencies is in line with higher expectations of radiation protection professionals, e.g.:

- improve knowledge pertaining to non-ionising radiation;
- pay increased attention to credibility and communication (both listening and providing information);
- provide appropriate advice about possible health effects linked to electromagnetic fields;
- enhance public awareness regarding radon and medical exposures;
- develop expertise on optical radiations, low dose controversies, epidemiology, environmental issues; →

... return for every 1 euro invested in experimental technology (cost of seeds, fertilisers and plant protection methods) was 2.0 euro. ETHOS I started in a Belarusian village called Olmany in 1996. ETHOS-II – including the "Potatoes" project – was the continuation of ETHOS I and it was extended to cover four villages. All these projects were financed by the European Union and French companies such as FERT. The funds were used to communicate with scientists, teachers, physicians, agriculturalists, radiometric services and all the people in the villages.
The ETHOS approach uses good multidisciplinary project methodology to give inhabitants the capacity to improve education, medical services, etc. by themselves. Further, modified extensions of the ETHOS experiment are planned in other radioactive contaminated parts of the country within the framework of the CORE programme. Now the challenge is to deploy the experiment with the aim of making the new self-rehabilitation and self-development methods and technologies a habit for the rural inhabitants. I should add that the ETHOS project is keenly embraced by local authorities. I think the Franco-Belarusian team succeeded in ...

... building trust with farmers to get some of them to act as volunteers. Now we hope this core constituency will help the initiative spread by itself. Extending the project to other products such as dairy products, cereals and vegetables with the co-operation of France, Germany, etc. is currently being considered. The contribution of various organisations from different countries is appreciated in developing the CORE programme and in this respect, EUROSAFE is an appropriate meeting place to hear new points of view concerning land rehabilitation and investigations in Ukraine, Russia, etc. Since other teams are doing the same investigations, let us find solutions together! ”

Siarhei Tarasiuk
Ph.D., Leading Radioecology, scientist in the Laboratory, Belarusian Research Institute for Soil Science & Agrochemistry (BRISSA)

→

• control occupational exposure without complacency,
• address orphan source issues, etc.

Whatever the issues, the key threads of the radiation protection profession's response must include ensuring the quality of the scientific base for standards and policies, being able to communicate information to different audiences and being inclusive in the consultation process. ■

On this subject, read: The Changing Role of the Radiation Protection Professional by J.R. Croft (National Radiological Protection Board, UK)

More papers dealing with environmental and radiation protection are available on the Eurosafe web site: www.eurosafe-forum.org

Nuclear Material Security: Challenging Times

■ **Despite the fact that the physical protection of nuclear installations and nuclear material against malevolence has been a matter of concern for many years, a variety of activities were triggered in this area in several countries, following the 11 September 2001 terrorist attacks. Beyond the technical and methodological aspects of security – fissile material accounting and monitoring, access control, etc. – the 2002 Eurosafe Forum emphasised such specific aspects as the regulatory framework of security, the contribution of nuclear safety to physical protection and the work performed by the IAEA in assisting countries to evaluate their maturity in this domain.**

› Protection of nuclear material: considering regulatory evolutions

Taking preventive measures against the illegal use of small amounts of radioactive or nuclear materials requires some fundamentals to be discussed with a view to setting up future regulations. Entrusted by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety with producing a study on this subject, GRS is presently reviewing a wide range of issues such as the scope of protection, the concept of protective measures, responsible persons, safety studies, access control, storage of radioactive material, inspection of personnel and material, administrative measures (e.g. regulations for bringing material in and out, accessing the controlled/restricted areas, etc.), supervision, etc.

Based on the GRS draft outline, decision-making bodies at Federal and state level are currently discussing modifications of the German nuclear regulatory regime to impede unauthorised removal of small amounts of radioactive or fissile material in future.

› Safety and physical protection: complementary approaches

Many of the provisions taken to cope with accidental sequences resulting from failures and hazards - whether internal (missiles from inside the containment area, →

Georges Van Goethem,
Co-ordinator of Reactor Safety Research European Commission.

In line with the “European Research Area” (ERA) strategy, the European Commission (EC) is proposing an in-depth reorganisation of European research under the umbrella of the new Sixth Framework Programme (FP-6 / 2003-2006). Its ambition is twofold:
• To integrate critical masses of (human, material and financial) resources, with the aim of producing new knowledge and/or industrial processes able to compete with the best high-technology world-wide (integrated projects);
• To structure a number of sustainable research programmes that are currently fragmented across too many laboratories, both governmental and industrial, with the aim of optimising all available resources (networks of excellence).

This is expected to enable EU research to contribute to the implementation of a number of EU integration policies, in particular the completion of the internal market (e.g. by producing high quality competing products that are accepted in all Member States), EU enlargement (e.g. by actively involving the candidate countries in EU research networks), and the protection of European citizens (e.g. by improving health and safety conditions for staff working in nuclear installations).

In this context, it seems only natural that the EUROSAFE Forum gets support from the Euratom research budget (for one year, October 02 - September 03), especially as its main scope is to achieve “Convergence of technical safety practices in Europe”. This ambitious objective fits in well with the aforementioned EU policies (the internal market, EU enlargement and civil protection) and it is particularly achievable through EU research, if the relevant governmental and industrial RTD programmes and operational feedback from operating plants are better co-ordinated throughout Europe.

The remarkable scientific/technical (S/T) collaboration between the French and German technical safety organisations (IRSN and GRS, respectively) that lies at the heart of the EUROSAFE initiative should now be expanded to other similar organisations in the rest of Europe, naturally including the candidate countries. This S/T collaboration could be improved further if more effort were devoted to nuclear knowledge management, i.e. the acquisition, qualification, formalisation and dissemination of operational know-how and material data with a common research (as opposed to commercial) interest.

In the knowledge market represented by the suppliers and consumers of relevant S/T safety data, a discussion should take place with the aim of establishing rules for sharing and exploiting the knowledge needed to support the aforementioned ambition (i.e. convergence of technical safety practices in Europe).

Education and training in nuclear fission technologies and radiation protection is another important aspect of knowledge management that receives particular attention from the Euratom FP-6 research programme.

Not only a new series of challenging FP-6 research project proposals but also the robust S/T base needed to build a common safety justification framework in Europe might be expected to result from this extended collaboration between regulatory-minded research organisations. This common framework could enable the regulatory organisations to optimise their safety research activities in areas of common interest throughout Europe (while reducing the burden on industry, which often has to deal with quite different regulatory procedures in the Member States). Last but not least, this process of convergence towards common technical safety practices may also contribute to the transparency of the current political debate about energy supply in Europe and ultimately help reconcile decision-makers and the public at large to the electro-nuclear option.

In conclusion, it is believed that the ERA concept launched by the EC, and especially the accompanying Euratom FP-6 research programme, can contribute to bringing about these long-term objectives.

To contribute to the objective of EUROSAFE (i.e. convergence of technical safety practices in Europe), the actors in FP-6, in particular, need more than ever to think globally (e.g. think about why common technical safety practices are really of benefit to the EU and develop a global research strategy) and act locally (e.g. share relevant safety knowledge and push for mobility wherever possible to disseminate the safety culture).

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➜ results of piping breaks, fire, etc.) or external (earthquakes, aircraft crashes, floods etc) – could be useful to cope with accidental sequences resulting from sabotage. Several fundamental principles, such as the defence-in-depth concept, deal with the general organisation of safety and are therefore applicable to both nuclear safety and physical protection. The characteristics of components and layout also provide synergies: the single failure criterion for instance requires that systems involved in nuclear safety be able to fulfil their duty in an adequate manner even in the case of failure of any one of their components. Redundancies reduce the relative sensitivity of each component and the possible impact of sabotage. Equipment diversification, along with physical and geographical separation, also contributes to both nuclear safety and physical protection.

Nevertheless, some specific aspects of physical protection are not covered by safety. The sabotage of a nuclear facility could thus lead to cooling water becoming unusable because of tank leakage or circuits being connected to other components than those envisaged in the operating rules. Two solutions are possible to reduce the specific risks identified. The first consists of reducing the sensitivity of the relevant equipment, thus minimising the consequences of failure. The second consists of reducing the vulnerability of the relevant equipment and thus the possibilities of attacks on the equipment.

In certain situations, nuclear safety provisions such as the provision of numerous exits for the fast evacuation of personnel, in the event of a critical accident, may be contrary to the physical protection provisions. Potentially conflicting requirements resulting from safety and physical protection considerations should therefore be analysed to ensure that they do not jeopardise nuclear safety.

On this subject, read: Complementarity between Safety and Physical Protection in the Protection against Acts of Sabotage of Nuclear Facilities by R. Venot (IRSN)

› International co-operation: providing assistance in physical protection assessment

Started in 1996, the International Physical Protection Advisory Service (IPPAS) missions of the IAEA are aimed at assisting states – at their request – to evaluate their physical protection systems. Missions normally cover legislation, the role and responsibility of the competent authority, regulatory and licensing processes, participation of other organisations, physical protection implemented at facilities and during transport, inspection and regulatory enforcement and recovery and response arrangements, for example in case of theft of nuclear material. The IPPAS missions resulted in a number of recommendations for defining better supporting regulations and upgrading the regulatory structure. In some cases where urgent upgrades were identified, the IAEA supplied the necessary advice, legislative assistance and equipment. In other cases, the Agency has provided training and expert assistance or organised several Design Basis Threat methodology workshops to assist requesting countries in their development.

Beyond assistance, the IPPAS missions provide key staff from the relevant national authority and facility operators with opportunities to broaden their experience and knowledge of their own field by discussing their practices with qualified and experienced experts from other countries.

On this subject, read: IAEA-activities for physical protection: role and importance of IPPAS missions by Mark S. Soo Hoo (IAEA)

The next Eurosafe Forum
will be held in Paris
on 25 and 26, November 2003.

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