RISKSPECTRUM MAGAZINE

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JUNE 2010

PSAM 10 Seattle

Renewed interest in new builds

Nuclear phase-out: Developments in Belgium, Germany & Spain

Transmission & distribution in focus at POWERGRID Europe

SOFTWARE NEWS:

- New RiskWatcher with Chinese help
- RiskSpectrum HRA
- New basic event relations

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This year's issue of RiskSpectrum Magazine turns the spotlight on two conferences: PSAM 10 in Seattle and POWERGRID Europe in Amsterdam, both held in June 2010. You can also find articles of high technical and practical value, insight into software development, PSA news, and views from Europe, China and the USA.

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"I get the feeling that the risk analysis community sometimes does not see the forest for the trees, or to twist the expression a bit: We run the risk of not seeing safety for the fault trees."

…to not see the forest for the trees

When asked by friends or relatives what RiskSpectrum is about, I usually give them a very simple answer:
RiskSpectrum is a software tool for analysing risk in complex systems. This risk can be expressed in different terms, for example as the frequency of derailment of a train or of severe core damage in a nuclear power plant.

This almost always gives rise to very relevant follow-up questions regarding levels of safety and consequences of accidents.

As risk analysis professionals, we agree that RiskSpectrum is about analysing risk or safety. However, we also know, unlike most of the public, that the analysis of safety in facilities with the potential for major accidents is a very complex task and subject to major uncertainties.

Consequently, if we discuss RiskSpectrum and PSA with risk analysis professionals, the questions we bring up will deal with, e.g., methods for modelling CCF and HRA, fault tree and event tree structures, calculation algorithms, truncation errors, house events, or boundary condition sets.

These are all relevant issues, but I get the feeling that the risk analysis community sometimes does not see the forest for the trees, or to twist the expression a bit: We run the risk of not seeing safety for the fault trees.

Having been a member of the Swedish PSA community almost since its birth in the early eighties, I have had the good luck to be involved in a substantial part of the PSA projects performed in Sweden to date, either on the analysis side or as an independent reviewer. My work has included method development in many of the problem areas mentioned, and lately it has increasingly dealt with issues related to the quality and relevance of PSA and PSA results and with making efficient use of PSA in risk-informed applications.

Looking at some current trends I see reason for hope. In software development, many ongoing activities aim at making PSA models more traceable and easier to use – without compromising the required complexity of the models. In safety analysis, the steadily increasing focus on risk-informed decision-making and the associated need to integrate deterministic and probabilistic analysis will help to direct attention towards analysis results rather than towards the inevitably complex underlying data and model infrastructure. This will help bring the focus back to where it ultimately belongs – on safety. ■

Michael Knochenhauer
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Michael Knochenhauer was appointed President of Scandpower Sweden on 1 February 2010.

He has close to 30 years of experience in nuclear safety, and started his career at ABB Atom, followed by a long period as an independent consultant.

Michael came to what was then RELCON in 2005; his most recent position was Vice President for Nuclear Consultancy in Sweden.

Michael succeeds Jerzy Grynblat, who has been the company president since 1995.

As a result of Scandpower's acquisition by Lloyd's Register, Jerzy has been appointed Nuclear Business Director within the Lloyd's Register Group, with overall responsibility for development of nuclear services within the group.

RISKSPECTRUM MAGAZINE

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SCANDPOWER IN BRIEF

- Offices in Norway, Sweden, the USA and China
- Developers of the world-renowned RiskSpectum PSA Software
- Provides Risk Management consultancy services in:
  - **Nuclear power licensing and PSA**
  - **Risk Analysis**
  - **Health and Safety**
  - **Reliability and Maintenance**
  - **Quality and Management**
  - **Human Factors**
- Product line:
  - **RiskSpectrum PSA**
  - **RiskSpectrum FTA**
  - **RiskSpectrum Analysis Tools (RSAT)**
  - **RiskSpectrum RiskWatcher**
  - **RiskSpectrum FMEA**
  - **RiskSpectrum Doc**

SCANDPOWER Risk Management

A member of the Lloyd's Register Group

RiskWatcher – soon web-based

I have often talked about our plan to develop a web-based RiskSpectrum RiskWatcher. This will now be realised as part of a cooperation agreement between Scandpower and China Nuclear Power Engineering Company (CNPE). The agreement was signed by Mr Ji Xing, Vice President of CNPE, and Mr Jerzy Grynblat, Director of the Lloyd's Register Nuclear Power Sector, at a ceremony at CNPE's headquarters in Beijing.

Cooperating with CNPE will open up tremendous opportunities for RiskSpectrum software and RiskSpectrum RiskWatcher in particular. In the next few weeks the first order for RiskSpectrum RiskWatcher in China is expected. Discussions regarding a second order for another nuclear power plant are already underway.

"CNPE has very ambitious plans for developing nuclear power in China, and safety has always been the focus of all our activities. Scandpower is an internationally recognised leader in the area of nuclear safety, and as such is an ideal partner for our company", says Mr Ji Xing and he continues:

"I consider this an important step in accelerating our efforts and ensuring that we will successfully fulfil our ambitious goals."

"CNPE is an ideal partner since its striving for excellence and safety in the nuclear field fits very well with Scandpower's ambitions", says Mr Grynblat

The cooperation agreement primarily focuses on software development, particularly the new web-based version of RiskSpectrum RiskWatcher risk monitoring software, and related consulting services. ■

By **Johan Sörman**

Facts about the agreement:
China Nuclear Power Engineering Company (CNPE) will be responsible for equipment purchasing, and design and construction of some 40 reactor units in the next 20 years. CNPE is part of China National Nuclear Corporation (CNNC).

Facts about RiskWatcher:
RiskSpectrum RiskWatcher is a risk monitor developed by Scandpower. It is designed to work seamlessly with PSA models realised in RiskSpectrum PSA. A number of organisations and nuclear power plants in seven countries are licensed to use RiskSpectrum RiskWatcher. It is currently available in English, Russian, Chinese and Japanese.

New Employee at Scandpower Inc. in Houston, Texas

Dr Zhiping Li has joined the PSA team in Houston, Texas.
In his new role as a Senior Consultant, Dr Li will provide PSA application services to Scandpower's clients in North America. He will also actively support our activities relating to RiskSpectrum, including sales and training.
Education and former positions:
Dr Li has a PhD in Nuclear Engineering from the University of Missouri at Columbia (2006). For the past three years he has worked as a PSA engineer at Callaway Nuclear Power Plant, which is located in Fulton, Missouri. While at Callaway he supported various PSA application tasks.

News and views from the USA
By Bengt Lydell

Nothing seems to stop the advance of PRA in the US industry

"Today's PRA models are maintained and upgraded by a relatively large group of highly motivated, well trained PRA engineers."

Risk-informed PRA applications are actively pursued by all utility organizations in the USA and there are many examples of risk-informed applications that have been successfully developed, approved and implemented. Extensive experience now exists in the development and management of increasingly complex PRA models that can support a broad range of risk-informed applications.

In this article I will summarize the current state-of-application of probabilistic risk assessment (PRA) methods in the US nuclear industry. I will also mention the industry initiatives and trends since the US Nuclear Regulatory Commission (NRC) Final Policy Statement regarding the use of PRA at the NRC was issued on August 16, 1995. The Policy Statement formalized the NRC's commitment to risk-informed regulation through the expanded use of PRA. In response, the nuclear utilities have actively supported the development of methodologies and guidance that respond to regulatory requirements.

Brief background

The early history of PRA is well documented. In short, many individuals and organizations played key roles in the early development of PRA methods and techniques in the mid-1960s to mid-1980s. While greatly influenced by early developments, the current state-of-application has evolved mainly from the Individual Plant Examination (IPE) program, which stems from the Generic Letter 88-20 issued in November 1988 by the NRC. This letter acknowledged that each nuclear power plant is unique and may have plant-specific safety vulnerabilities. The NRC therefore required each plant owner to gain experience with PRA by using its own staff as much as possible to perform PRA. The ensuing (post-1988) years of the IPE program proved instrumental in shaping the current regulatory approach. The program also influenced the analytical tools and techniques, databases, and PRA software platforms that remain in use today, albeit in much enhanced forms. By the conclusion of the IPE program, the use of PRA had become well established in the nuclear industry, and the NRC had issued the PRA Policy Statement.

Risk-informed framework

The US nuclear regulatory framework is "risk-informed", meaning that results and insights obtained from plant-specific PRA studies are used to complement deterministic analyses of nuclear power plant safety. Traditional deterministic concepts such as "defense-in-depth" and "safety margin" also remain important. From a regulatory perspective, all decisions concerning the license basis for individual plants include consideration of risk. Not only is PRA a key element of nuclear safety and related regulations, it also is an important element in how plants are operated, maintained, refurbished, and inspected.

The 1995 PRA Policy Statement includes four main statements:

1. Increase the use of PRA to the extent supported by the state-of-the-art and in a way that complements traditional engineering approaches.
2. Use PRA both to reduce unnecessary conservatism in current requirements and to support proposals for additional regulatory requirements.
3. Be as realistic as practicable.
4. Consider uncertainties appropriately when using safety goals and subsidiary numerical requirements.

These statements capture the essence of the motivations behind industry and regulatory initiatives to improve the quality of PRA applications and the R&D programs to make methodological improvements. During 1998 a series of Regulatory Guides (1.174, 1.175, 1.177 and 1.187) was published. These Regulatory Guides include guidance on the use of PRA findings and risk insights in support of requests for changes to a plant's licensing basis. Examples include changes to technical specifications and in-service inspection programs.

Technical adequacy

The importance of PRA quality and the technical adequacy of applications have been recognized by PRA practitioners, industry organizations and regulators alike. Indeed, PRA quality is central to risk-informed regulations and all practical PRA applications in support of proposed changes to the licensing basis. Independent peer review of PRA is recognized as a key element of PRA quality. On behalf of the industry, the Nuclear Energy Institute (NEI), with support from PRA practitioners, developed the "Industry Peer Review Process Guidelines" NEI 00-02, which were adapted on the basis of the review process originally developed and used by the Boiling Water Reactor Owners Group (BWROG). The BWROG "PRA Peer Review Certification Implementation Guidelines" were published in January 1997. A PRA supporting risk-informed applications must meet certain quality standards. A well-structured independent peer review is one accepted approach to determining the technical adequacy of PRA.

On what technical basis should PRA quality be determined?

The approach taken by the US nuclear industry has been to develop a "what-to-do" standard for PRA rather than a "how-to-do" standard. In 2004 the American Society of Mechanical Engineers (ASME) Board on Nuclear Codes and Standards (BNSC) and the American Nuclear Society (ANS) Standards Board mutually agreed to form a Nuclear Risk Management Coordinating Committee (NRMCC). This committee was chartered to coordinate and harmonize PRA-related standards activities between the two organizations. The current "Standard for Level 1/Large Early Release Frequency Probabilistic Risk Assessment for Nuclear Power Plant Applications" (RA-Sb-2009) was approved by the American National Standards Institute (ANSI) in February 2009. The Committee on Nuclear Risk Management (CNRM) is responsible for ensuring that the PRA Standard is maintained and revised as necessary. The CNRM operates under procedures accredited by ANSI as meeting the criteria of consensus procedures for American National Standards.

Quality attributes

What are the quality attributes needed for a plant-specific PRA to be fit for risk-informed applications? The ASME/ANS PRA Standards is a "what-to-do" standard in the sense that it defines required capabilities that must be met. Three Capability Categories are defined in the Standard, with supporting requirements for each category. Before pursuing a risk-informed application, a PRA must be subjected to a peer review. The ASME/ANS Standard includes basic peer review requirements.

The Boiling Water Reactor and Pressurized Water Reactor Owners Groups (BWROG and PWROG, respectively) have been facilitating peer reviews of plant-specific PRAs for more than 10 years. The format for conducting these peer reviews follow the abovementioned NEI 00-02 guidelines. Peer review comments are documented and the hosting utility is responsible for resolving any identified deficiencies.

The regulatory perspective on PRA quality is documented in Regulatory Guide 1.200 "An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities", which was issued for trial use in February 2004. The final version of this document (Revision 2, March 2009) largely endorses the ASME/ANS PRA Standard. When used in support of an application, Regulatory Guide 1.200 obviates the need for an in-depth review of the base-PRA by NRC reviewers, allowing them to focus their review on key assumptions and areas identified by peer reviewers as being of concern and relevance to the application.

State of PRA applications

Risk-informed PRA applications are actively pursued by all utility organizations in the USA. As an example, the risk-informed in-service inspection (RI-ISI) program has been under development for over 10 years, and today almost all US nuclear power plants have implemented such a program. There are many other examples of risk-informed applications that have been successfully developed, approved and implemented. These include risk-informed technical specifications, including allowed outage time extensions, configuration risk management, and risk significance categorization. Extensive experience now exists in the development and management of increasingly complex PRA models that can support a broad range of risk-informed applications.

Whereas PRA once was performed by a select, relatively small group of highly-motivated engineers with in-depth knowledge of applied risk and reliability analysis, today's PRA models are maintained and upgraded by a relatively large group of highly-motivated, well-trained PRA engineers. ■

Bengt Lydell is responsible for developing Scandpower's nuclear risk and reliability services in the USA.

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1. USNRC, "Use of Probabilistic Risk Assessment Methods in Nuclear Activities: Final Policy Statement," Federal Register, Vol. 60, p. 42622 (60 FR 42622), August 16, 1995.

Safety and risk – hot topics in Seattle

The improvement of performance and safety of complex technological systems, economics, and the environment, accentuating a broader PSA application and the human element.

These are the goals set out for the tenth PSAM conference held in Seattle, Washington, on June 7, 2010.

Karcher workers hang off the side of the Space Needle to give the Seattle monument a deep cleaning.

"I expect that we will see some new technical areas of significant interest emerge from the meeting, and at least one new formalized working group established under IAPSAM."

Bruce P. Hallbert, General Chair of the PSAM 10 conference.

A conference of high interest

Mr. Hallbert, is this the first time Seattle will be hosting a PSAM conference, and why was Seattle chosen for the 10th PSAM conference?

Yes, it is. Although it is a hub for other major industries, this is the first time a conference of this kind and size has come to Seattle.

Seattle is home to a number of industries that address risk in their own ways. You are probably most familiar with companies like Microsoft and Boeing that have significant presences in this city. Both of them economically important to the US and other countries, and both approach the issues of risk and high reliability in their own unique ways; part of the reason for hosting meetings in certain locations is to generate interest among new organizations, countries, and industries.

We are hoping to develop new technical engagements in Seattle as well – perhaps with some of these industries that I've mentioned.

What are your expectations for PSAM 10?

Following on the heels of a very successful meeting in China, the location in Seattle provides for continued easy access for Asian participants and for many direct connections from Europe. Interest in the conference is very high and we have over 400 papers accepted for this meeting.

I expect we will see some new technical areas of significant interest emerge from the meeting, and at least one new formalized working group established under IAPSAM.

The quality of technical exchange is expected to be as high as other PSAM conferences, which are noted for their high technical quality already.

I also believe that with all the recent attention that the nuclear renaissance has received in the US there will be renewed interest in and emphasis on new builds.

How many visitors do you anticipate will attend the conference?

Somewhere between 400 and 500 nominally, including guests.

I suppose there is a lot of preparation involved in organizing this kind of event. When did you start planning PSAM 10?

We began planning PSAM 10 in 2008 – before PSAM 9 had been carried out. This allowed the planning and organizing committee to incorporate some of the good practices from previous PSAM into the current program. As we speak, we are far along into the logistics and contractual matters related to PSAM 11, which will be held in Helsinki, Finland, two years from now. – I am not organizing that one! – And we have begun discussions for PSAM 12.

What do the conference and the PR for events of this kind bring of importance to the Seattle area?

In the scheme of things in Seattle and the region, this technology sector is smaller than the others I've mentioned – software and airframe manufacturing. In fact, the week following our meeting there will be a city-wide conference and they are expecting somewhere in the neighborhood of 18,000 participants – all related to Microsoft. Having our meeting in advance of other meetings lets us benefit from some of their PR. Seattle and the Pacific Northwest regions are also known as very green communities in the US. As such, safety and risk are hot topics in the Seattle area, where people are very conscious and aware of their environmental impact. A conference like PSAM probably speaks to those sensibilities in a way that a commercial meeting doesn't.

What sites of interest do you recommend visiting in Seattle?

Some historical sites are: the Space Needle, part of Seattle's famous skyline; Pike Place Market, also called "the soul of Seattle"; the waterfront and islands in and around the Olympic peninsula; the Boeing museum; and clubs that are part of the Seattle music underground, says Bruce P. Hallbert, the General Chair of the conference. ■

By **Gunilla von Feilitzen**

Key facts: Seattle and the State of Washington

The State of Washington is a state in the Pacific Northwest region of the United States. It was admitted to the union as the forty-second state in 1889. The state's population was estimated at 6,664,195 (2009).

(California is number one with a population of 36,961,664). ■

The State of Washington has a land area of 66,544 square miles. The Capital is called Olympia and the largest city is Seattle. The 2007 total gross state product for Washington was $311.5 billion, placing it 14th in the nation. ■

The State of Washington is the only state to be named after a United States president, George Washington. The state has also a nickname: the Evergreen State. ■

In Seattle William E. Boeing founded the major aerospace and defense corporation The Boeing Company. Boeing is the largest global aircraft manufacturer by revenue, orders, and deliveries, and the third largest aerospace and defense contractor in the world based on defense-related revenue. In September 2001, Boeing moved its corporate headquarters from Seattle to Chicago. ■

Washington's water resources provide both irrigation and hydroelectric power. Hydroelectricity has been a key energy source in Washington for many years.

During the Great Depression, a series of hydroelectric dams were constructed along the Columbia River as a part of project to increase the production of electricity. This culminated in 1941 with the completion of the Grand Coulee Dam, the largest dam in the United States. ■

Apples are the largest agricultural product grown in Washington State. 10 - 12 billion apples are handpicked in Washington State each year.

Because of the favorable climate of dry, warm summers and cold winters of central Washington, the state has led the U.S. in apple production since the 1920s.

About 2,500 known varieties of apples are grown in the United States. More than 7,500 are grown worldwide. ■

The State of Washington is home to:

▶ Four of the five longest floating bridges in the world. The longest floating bridge of the world is the Governor Albert D Rossellini Bridge at Evergreen Point. The bridge connects Seattle and Medina across Lake Washington.

▶ Many innovative Internet companies, including Microsoft, Amazon.com, Classmates.com, Whitepages.com, and Marchex.

▶ 140 public airfields, including 16 state airports.

▶ The biggest coffee chain in the world, Starbucks (in Seattle).

▶ Popular games Pictonary, Pickle ball, and Cranium.

▶ The first revolving restaurant 1961 (Seattle).

▶ An extensive ferry system which is the largest in the nation as well as the third largest in the world.

▶ Everett is the site of the world's largest building – the Boeing factory. It has a size big as 75 football fields or 911 basketball courts.

▶ The world's first soft-serve ice cream machine – located in Olympia Dairy Queen.

▶ The Grunge or "Seattle sound" – Nirvana, Pearl Jam etc etc ...

▶ Seattle is also the birthtown of Jimmy Hendrix.

Sources: www.psam10.org, www.beautifulseattle.com www.50states.com, www.access.wa.gov

One of the highlights of the social programme at PSAM 10 is the Wednesday evening trip to Tillicum Village.

All-time high at PSAM!

Already during the successful PSAM 9 conference in Hong Kong 2008, people in the RiskSpectrum Users Group began to discuss participation in the tenth PSAM in Seattle 2010.
It became quite clear to us at Scandpower that we should try to break the 11-paper record.

Today, we are proud to present 20 papers for PSAM 10 authored or co-authored by Scandpower employees together with colleagues in other organisations.

The papers range from software development projects to the use of probabilistic risk criteria to dynamic risk analysis modelling for offshore platforms.

Seven of the papers cover the latest research and development regarding algorithms for solving PSA models as well as presentations of solutions for specific software issues. Meanwhile, papers such as **"A comparison of two different methods of solving a fault tree using binary decision diagrams"** and **"Treatment of not logic in fault tree and event tree analysis"** will probably satisfy conference participants inclined towards theoretical mathematics. Another interesting paper describes how the add-on to RiskSpectrum PSA – "the consequence matrix" – is used for risk analysis of offshore platforms.

There are another seven papers dealing with comparison, status and experience, development, guidance, interpretation and evaluation of risk criteria, CCF methods, probabilistic safety criteria for nuclear PSA and their applications, technical specification criteria, and Defence-in-Depth – all related to nuclear PSA.

Three papers discuss calculation of pipe failure probabilities. One of them is Part 3 on the Reliability Data Handbook for Piping Components in Nordic Nuclear Power Plants. Parts 1 and 2 on the same subject were presented at PSAM 8 and PSAM 9 respectively. The PSAM 8 paper (No. 0063) addressed a pilot project whose purpose was to define the prerequisites for producing a Reliability Data Handbook for Piping Components ("R-Book") using the database developed by the OECD Pipe Failure Data Exchange Project (OPDE). The PSAM 9 paper (No. 0097) dealt with the methodology and issues relating to different damage and degradation mechanisms. The PSAM 10 paper presents the methodology for deriving application-specific failure event populations and corresponding exposure terms.

In the interesting paper **"Using PSA to Develop a Tool for Rapid Source Term Prediction Based on Baysian Belief Networks"**, Bayesian belief networks are used to model severe accident progression in a nuclear power plant. The output is a set of possible source terms with associated probabilities.

We are particularly pleased to present two technical papers originating in the oil gas industry: **"Use of Computational Fluid Dynamics, CFD, for defining accidental loads and optimizing risk mitigating measures"** and **"Dynamic risk analysis model for an offshore platform"**. The latter describes a project where the RiskSpectrum Consequence Matrix has been used. The model has the required flexibility to analyse ongoing and future modifications and provides results reflecting the dynamics of platform operations. ■

By **Johan Sörman**

The fourth POWERGRID Europe in Amsterdam –

a place for technology trends from the smart grid arena

"It takes a full year to put together all the pieces."

Kathleen Davis, POWERGRID Europe's conference director.

It is not a coincidence that Amsterdam in the Netherlands is this year's host when the POWERGRID Europe conference opens its doors for the fourth time in June 2010.

"Amsterdam is doing very progressive work in using smart grid technology. Amsterdam's Smart City, for example, is a project which is updating a spot known as 'Climate Street', a holistic concept for sustainable inner-city streets that works with the public and businesses to offer sustainable energy solutions says," Kathleen Davis, POWERGRID Europe's conference director.

There are four conferences that cover the four key facets of the power industry: electricity transmission and distribution, conventional, nuclear and renewable power generation. The conferences are:

- POWERGRID Europe
- POWER-GEN Europe
- Nuclear Power Europe
- Renewable Energy World Europe

With growing global focus on the transmission and distribution (T&D) of electricity, the three-day POWERGRID Europe conference, in Amsterdam, offers an inside look at industry adjustments, growing pains, experiments and successes.

There is an unequalled programme of strategic, technical, keynote and plenary sessions, along with over 450 exhibitors and a diverse range of companies and services on show. Scandpower will have a combined presence with Lloyd's Register at the Nuclear Power Europe 2010 booth in the main throughway at the event. The presentation will cover all types of services, from Assurance and Compliance services through to consulting services, including Risk Management Consulting, and different software products, including the RiskSpectrum suite of products.

Former CEO at Relcon Scandpower, now Nuclear Business Director Lloyd's Register.

We asked Jerzy Grynblat, Nuclear Business Director Lloyd´s Register:

Why is this an important event for Lloyd's Register to participate in?

We will be showcasing our capabilities, skills, and knowledge. This is the first time we will have exhibited at a nuclear event together (Lloyd's Register and Scandpower).

How many conferences and exhibitions does Lloyd's Register normally participate in every year?

Too many to list! Considering the four market sectors approach just for the energy business, we need a balance of priority events we attend.

Is there anything particularly interesting that Lloyd's Register wants to display or demonstrate this year?

The key aspect at any event is to showcase our skills and capabilities. This means employees talking to prospective enquirers, using the new nuclear brochure to highlight our strengths, and discussing how we can help. Technical papers have also been submitted by Ton Holthuis and Terry Mundy. For this year, the main focus will be our 250-year celebration. However, for next year we would like to develop our approach to include physical models at the booth.

Do you evaluate your participation in conferences and exhibitions?

Yes, we continuously evaluate our participation at such events. The evaluation process will be improved once our software tool Sales force is fully integrated. At previous events we have always measured enquiries and possible leads generated to follow up. In the future such evaluation will be performed by the regional business development team together with our sales organization, says Jerzy Grynblat, spokesman for Lloyd's Register and leader of the Lloyd's Register Nuclear Power Sector. ■

By **Gunilla von Feilitzen**

A look at smart city planning

POWERGRID Europe's conference director, Kathleen Davis, is this the first time Amsterdam is hosting the POWERGRID Europe conference?

Yes. While POWERGRID Europe has visited many lovely European cities before, including Madrid, Milan, and Cologne, our June 8-10, 2010 conference will be the first time we have taken the show to Amsterdam.

What are your expectations for POWERGRID Europe?

As with every show, we hope that POWERGRID Europe brings attendees, visitors and exhibitors the most up-to-date information and technology trends from the smart grid arena. This year, we are especially proud to be offering a look at how to incorporate smart grid technology inside "smart city" planning.

How many visitors do you anticipate will attend the conference?

Because we have four shows at the same venue (POWERGRID Europe, POWER-GEN Europe, Nuclear Power Europe and Renewable Energy World Europe), we get quite a crowd. The overall total for all four shows is anticipated to top ten thousand people.

I suppose there is a lot of preparation involved in organizing this kind of event. When did you start planning the conference?

We start planning for the next annual event about two weeks after each show. For this year, we started late last summer putting together information for paper submissions and new committee members. It takes a full year to put together all the pieces.

Why was Amsterdam chosen for the POWERGRID Europe conference? Does it have any particular connection to the transmission and distribution industry or were there other considerations taken into account?

Amsterdam was chosen because of its lovely charm and the venue available (the RAI). While we did not specifically look at Amsterdam's transmission and distribution connections when choosing the site location, I must say that Amsterdam is very progressive in this area. We are very proud to be able to show off some of the great work of TenneT and Alliander at the show.

What do the conference and the PR for events of this kind bring of importance to Amsterdam?

I think showcasing Amsterdam's progressive smart grid work, along with its charm and hospitality, at a large European conference event like POWERGRID Europe is a great way to advertise the city to engineers and tech insiders who may have never thought to travel to the city before. I do know that, once they visit, they'll want to return. So, the show is a very good "travel advertisement" for the city of Amsterdam.

What sites of interest do you recommend visiting in Amsterdam?

Well, I would recommend one industry-specific site in Amsterdam. In fact, we will be taking a tour of it during the show itself. Amsterdam is doing very progressive work in using smart grid technology to update older shopping areas. Amsterdam's Smart City project is updating a spot known as "Climate Street", a holistic concept for sustainable inner-city streets that works with the public and businesses to offer sustainable energy solutions. I recommend everyone visit, eat, have coffee and shop while examining how the city is incorporating the smart grid into the lives of Amsterdam's citizenry, says Kathleen Davis, POWERGRID Europe's conference director. ■

By **Gunilla von Feilitzen**

Key facts: Amsterdam and the Netherlands

Amsterdam Smart City is a collaboration between the inhabitants of Amsterdam, businesses and government in order to illustrate how energy can be saved, now and in the future. With help from IBM, Cisco, Philips, and other companies, the city's infrastructure is becoming ultra energy-efficient, attracting global attention. In Amsterdam, the Dutch grid operator Alliander, which is 30% owned by the province that includes Amsterdam, will spend €100 million ($127 million) annually until 2016 to upgrade its entire network to a smart grid. While the city's energy infrastructure gets a facelift, local policymakers also are devising ways to maximize the new smart grid technology. The ultimate goal of these projects is the reduction of CO_2 emissions on an Amsterdam, national and European scale.
Sources: www.businessweek.com, www.amsterdamsmartcity.com ■

The Netherlands borders the North Sea to the north and west, Belgium to the south, and Germany to the east. It has a land area of 33,939 sq km, which is twice the size of New Jersey, and an estimated population of 16,5 million.
The capital is Amsterdam and the seat of government is The Hague. ■

▶ The Netherlands is the 25th most densely-populated country in the world, with 395 inhabitants per square kilometre. ■

▶ The Netherlands is often incorrectly called Holland. Only the central part of the Netherlands is geographically named Holland. ■

▶ The Netherlands has traditionally been divided into 12 provinces, which each have their own capital, self-rule and administration. ■

▶ The Netherlands has the largest port in Europe (Rotterdam). In 2006, Rotterdam was the world's seventh largest container port in terms of twenty-foot equivalent units. ■

▶ When you land at Schiphol Airport, you are actually four metres below sea level. ■

▶ The Netherlands is home to the headquarters of some of the world's biggest companies, such as Shell and Unilever, as well as the banking giant ING Group, among others. ■

Amsterdam

▶ has over 1 million bikes, but only 700,000 "Amsterdammers".

▶ is built entirely on piles: huge stakes driven into the ground. Central Station is held up by 6,000 of them.

▶ boasts more museums than any city in the world, measured per square metre .There are over 40 major, well-known museums in the Netherlands. The Van Gogh collections in the Van Gogh Museum and the Kröller-Müller Museum are the largest in the world.

▶ is the base for as many as five of the world's top 500 companies (including Philips and the ING Group).

The Netherlands

▶ has one of the largest natural gas fields in the world.

▶ has the 16th largest economy in the world and ranks seventh in GDP (nominal) per capita.

▶ is the third largest exporter of agricultural products in the world (fresh-cut plants, flowers, and bulbs, among others).

▶ has the oldest standing army in Europe (established back in 1567).

▶ has more than 4,800 kilometers of navigable rivers, lakes and canals.

▶ has the tallest people in all of Europe and the second tallest in the world.

▶ has over 15,000 kilometers of bicycle lanes.

▶ has over 70% of the world's bacon production (poor pigs!).

By **Gunilla von Feilitzen**

Sources: The Netherlands Ministry of Foreign Affairs, Wikipedia, CIA World Factbook 2009, Encyclopaedia Britannica, International Monetary Fund 2009, discoverthenetherlands.org, FORTUNE on CNNMoney.com

Picture from Grafenrheinfeld Nuclear Power Plant. Germany has 17 nuclear reactors generating one quarter of its electricity.Its first commercial nuclear power reactor began operating in 1982.

HELLO ...

... The Ministry for the Environment, Nature Conservation and Nuclear Safety

Years of commitment to phasing out nuclear power in Germany will be rescinded as an outcome of the general election in 2009, when Germany's newly elected conservative coalition headed by Chancellor Angela Merkel declared their support for nuclear power. Energy policy was one of the few issues about which Chancellor Merkel and her Christian Democratic Union (CDU) spoke candidly during the campaign.

Germany shouldn't risk falling behind the economies of France and Britain, both of which have renewed commitments to nuclear energy, according to a statement by Chancellor Angela Merkel. She has also argued that nuclear energy produces fewer climate-damaging emissions than coal, Germany's main fuel alternative.

The Greens, in a late 1990s coalition with the Social Democratic Party (SPD), enacted a law to phase out the country's remaining 17 nuclear power plants by 2020.

Germany obtains one-quarter of its electricity from nuclear energy generated by 17 reactors.

We asked the Ministry for the Environment, Nature Conservation and Nuclear Safety:

For more information about the Ministry: www.bmu.bund.de

Does the law to phase out nuclear power in Germany still apply or has the law been cancelled? Is the attitude towards nuclear power different in Germany today compared to when the law was passed?

In the Coalition Agreement the governing parties agreed that nuclear power shall be used as a bridging technology until it can be reliably replaced by renewable energies. This means that a longer operating life of nuclear power plants is possible under certain conditions, such as compliance with strict German and international safety standards.

The Coalition Agreement furthermore makes it clear that the ban on the new construction of nuclear power plants in Germany as stipulated in the Atomic Energy Act shall remain in force. This autumn the German government plans to adopt an overall energy concept. In this context a decision is also to be taken on extending the operating life of nuclear power plants. It cannot yet be said what specific legislative proposals will result from the energy concept. ■

By **Gunilla von Feilitzen**

Skills and services without boundaries

In 2010 the Scandpower Group became a part of Lloyd's Register, which has 250 years of experience of making the world a safer place.

With business in 240 offices in 80 countries and focus on improving safety, quality, and the environment in the nuclear, transportation, marine, and oil gas industries, this acquisition is by all means a true globalisation of skills and services within the Risk Management business.

By **Gunilla von Feilitzen**

Director of the Lloyd´s Register Nuclear Power Sector, Mr Jerzy Grynblat

"At the beginning of this year Lloyd's Register acquired Scandpower and together we are now going to develop our nuclear services in selected markets around the world. I have accepted to lead this process as a leader of the Lloyd's Register and Scandpower nuclear power sector.

In my new role I am committed to developing a world class nuclear business for Lloyd's Register and I cannot achieve this alone. We have developed a great camaraderie in Scandpower and with my new colleagues in Lloyd's Register I am determined that we will take this to a new level. Nothing but the best will do and I am fully supportive of the business goal to be world class and the first choice for any company operating in the energy sector.

I have been working in the nuclear risk management business since the mid-1970s. In 1984 I was one of the co-founders of RELCON and its President between 1995 and 2010.

RELCON was a risk management consulting company, with activity mainly in the nuclear business, that merged with Scandpower, with activities mainly in the oil & gas business, in the beginning of 2007.

We developed and marketed RiskSpectrum®, the software that dominates the Probabilistic Risk Analysis (PRA) market in the nuclear business, with users at more than 50% of all nuclear power plants worldwide!"

Group Energy Director at the Lloyd´s Register Group Mr Iain M Light

"The Scandpower RiskSpectrum suite of products provides a world leading platform that enables us to provide the highest quality and reliable quantified risk based solutions to our increasing client base around the world.

Whilst Scandpower brings world leading risk services, Lloyd´s Register brings a truly international brand with global reach. This will open up great opportunities for all our staff as well as bringing a more integrated service and set of software solutions that already have benefited our clients.

In addition to supporting the supply chain objective through compliance services the Lloyd Register Group has a strategy to provide risk management services to capital intensive high risk industries. As the world and industry become more complex, the needs to adopt risk-based approaches and to understand complexity become increasingly important. That is a primary reason for the acquisition with Scandpower."

President of Scandpower in Sweden. Mr Michael Knochenhauer

"For me personally, becoming President of Scandpower in Sweden right after having joined Lloyd's Register feels like the perfect timing. We have been through quite a remarkable growth period during the past four years, going from around 30 to over 80 people in Sweden, at the same time broadening our activities considerably. This has been very stimulating, and joining Lloyd's Register will open up new international possibilities – still largely unknown to us. I'm sure there will come some sobering setbacks from time to time, but basically the feeling right now is that the sky's the limit. In parallel I believe our existing software and consultancy customers will experience 'business as usual +', i.e., our existing activities and customers will remain in focus, but the new situation will enable us to improve our services."

FACTS

▶ The Lloyd´s Register Group has been making the world a safer place for industry and people since 1760, providing independent assurance to companies operating high-risk capital intensive assets in energy, marine and transportation to enhance the safety of life, property and the environment. The Group comprises charities and non-charitable companies, with the latter supporting the charities in their main goal.

▶ The Scandpower Group has a staff of over 250 highly skilled professionals from 20 countries. Lloyd´s Register Group has 240 offices in 80 countries and approximately 8,000 employees.

▶ Thanks to the acquisition, Scandpower´s clients now have access to a much more complete service portfolio and broader network of people and competence. Together Scandpower and Human Engineering, a subsidiary of Lloyd's Register, have more than 75 human factor specialists with experience from practically every industry and public sector. Their expertise and activities cover shipping, railways, oil and gas, nuclear energy and other asset-based industries.

▶ The Lloyd's Register Group provides risk assessment and engineering analysis consultancy services, and risk-based inspection services. The organisation carries out independent design appraisal and inspection of plant and equipment, to international codes and standards, and is authorised as an independent inspection agency by industry bodies.

For further reading about the acquisition:
Risk Management News. Scandpower Group - www.scandpower.com
Horizons. Lloyd's Register Group - www.lr.org

Picture from Columbia Generating Station. The USA has 104 nuclear reactors in 31 states generating a fifth of its electricity. The USA was a pioneer in nuclear power development and the first fully commercial pressurised water reactor started up in 1960.

HELLO ...

... Spokesman for the nuclear industry in the USA and Senior Media Relations Manager at the Nuclear Energy Institute

Mr Tom Kauffman

US utilities have plans or proposals for 30 more reactors, but many plans for new nuclear power in the USA have been postponed. The recent economic downturn has reduced both the current demand and the projected future demand for electricity.

The Nuclear Energy Institute is the policy organisation for the nuclear technologies industry and participates in both the national and global policy-making process. NEI's objective is to ensure the formation of policies that promote the beneficial uses of nuclear energy and technologies in the United States and around the world.

What would you say are the reasons for the delay in building new nuclear facilities in the USA and how does that delay affect the US nuclear industry?

From the 1980s to the present, much of the new demand for electricity in the USA was satisfied by building additional fossil-fuelled power plants. The accident at Three Mile Island in 1979, and economic factors, brought the growth of the nuclear industry to a standstill.

While the construction of a number of nuclear plants was completed during that period, no new nuclear plants were ordered. Conditions for nuclear energy began to change after the turn of the century with growing concerns about the negative impacts of burning fossils fuels, including air pollution, greenhouse gas emissions, global warming, and climate change. As the nation looked for solutions, nuclear energy began to gain acceptance.

This acceptance was enhanced by the nuclear industry's excellent performance in cost, safety, and reliability. There also was growing recognition of nuclear energy's low-carbon benefits.

The delay in building new nuclear facilities allowed the industry to incorporate lessons learned from the first generation of US plants, develop simpler, safer and more efficient, high-tech standardised plant designs and implement a more predictable licensing process.

What problems does the industry face today?

A major challenge facing the US nuclear industry is the disposition of used nuclear fuel. At this time, the used fuel is very safely stored at the plant sites, but this is not a long-term solution. President Obama doesn't favour the use of the Yucca Mountain repository, but he recognises the need for a comprehensive, long-term plan. He and Energy Secretary Steven Chu established a blue ribbon commission to directly address the issue, says spokesman for the nuclear industry Tom Kauffman. ■

By **Gunilla von Feilitzen**

For more information: www.nei.org

Tomas Eliasson is Principal Consultant at Scandpower, Malmö, and specialises in power upgrade and modernisation projects for nuclear power plants.

4 Questions for SNAC Headmaster Tomas Eliasson

In 2009, Scandpower started a school for exchange of qualified knowledge – the Scandpower Nuclear Academy (SNAC) – a kind of mentorship programme designed to transfer know-how from Scandpower employees to new recruits, who often come directly from university.

1) Why is there a need for this kind of school? Aren't the students prepared for the labour market after completing their university degrees?

The education at the universities is very good, that's not the problem. Some of our new recruits actually get to teach some classes – we want to make sure that students with specific competence transfer their knowledge to others with a broader spectrum of competence. One example is human factors, which is of great value for our new employees. An important part of SNAC is to teach new employees about Scandpower's way of working.

It is a kind of exchange of knowledge, and it is worth mentioning that not all of our new employees have completed a programme specializing in nuclear power. Their backgrounds vary from risk analysis and human factors to statistics, says Tomas Eliasson, headmaster of SNAC.

Following the SNAC curriculum, new employees have the chance to gain important competence, and Scandpower guarantees that all employed consultants fulfil customer's expectations and that projects are carried out with professionalism.

The purpose of SNAC can be summed up in a few points:

- To develop our new employees' knowledge of nuclear technology.
- To transmit information from older, more experienced consultants working in the nuclear industry.
- To disseminate knowledge and experience to our colleagues in the Lloyd's Register Group.
- To be able to guarantee that our services within nuclear technology are of high quality.
- To offer our new employees an attractive in-house education.

2) Can't you get this education or knowledge elsewhere? I mean by taking a special class at a university?

It is not only about skills in special topics, it is also a way to network and have a chance to meet other colleagues at Scandpower and the Lloyd's Register Group. With SNAC we have created a platform for knowledge exchange, and there are few things that can top long work experience and the benefits of mixing experienced employees with inexperienced ones.

Meeting the new generation

Consultants from Scandpower with many years of experience are recruited for teaching, and the educational programme is divided into four parts. Some topics are: nuclear technology, nuclear history, safety technology, reactor physics, radiology, safety analysis, PSA, and human factors. The SNAC programme includes homework as well as written examinations.

3) Is this something unique to Scandpower?

I don´t think so. The nuclear industry is facing a generation shift and a common problem of passing on knowledge to the younger generation in order to guarantee the exchange of competence.

4) Can engineers who are not employed at Scandpower also participate in SNAC?

Yes, we have launched a special programme divided into two parts for non-employees of Scandpower. The first part, which includes five days of lectures and exercises, is an introduction to PSA. The second part covers nine advanced PSA topics that we teach in two-day programmes and that you can take individually. The first course was scheduled for 19-21 April 2010, but due to the ash cloud from the volcano on Iceland, no one could fly to Stockholm to attend the course.

The course has been rescheduled for 6-10 September 2010, says Tomas Eliasson, Headmaster of SNAC at Scandpower. ■

By **Gunilla von Feilitzen**

SNAC
SCANDPOWER Nuclear Academy

Facts

The Scandpower Nuclear Academy is a six-month programme. Total education time is about 28 days, which includes the students' own time spent on homework and preparing for examinations.

Scheduled SNAC training courses 2010 are 6-10 September (Introduction to PSA) and advanced topics in October-November (Advanced PSA topics).

To register your interest in SNAC, please send an email to sales@riskspectrum.com.

News and views from Europe
By Michael Knochenhauer

Not only the souvenirs differ in Europe.

How to generalise the multi-faceted?

In Europe, there has historically been a strong tradition of handling most aspects of nuclear regulation on a national basis. This has resulted in different approaches to and legislation for nuclear safety, which makes it a difficult task to describe PSA in Europe in general. In recent years, initial steps towards harmonisation have been taken, especially within the EU, and there is also a growing awareness of the need for harmonisation in the risk assessment of new nuclear power plants.

Footnote: I gratefully acknowledge contributions from Krassimir Avdjiev (Bulgarian Nuclear Regulatory Agency), Jan Erik Holmberg (VTT Technical Research Centre of Finland), Marie Gallois (EDF, France), Martin Andernacht (TÜV NORD, Germany), Jens-Uwe Klügel (Gösgen NPP, Switzerland), Anders Olsson (Scandpower, Sweden), Geoff Grint (HSE, UK), Andrey Prokhodtsev (Energoatom, Ukraine), and Irina Kuzmina and Artur Lyubarski (IAEA).

This article compiles information from Bulgaria, Finland, France, Germany, Russia, Sweden, Switzerland, the UK and Ukraine, which is a colourful sample, but also means that some nuclear countries are not covered.

The current focus of the authorities and nuclear industry in the various countries differs a lot, from maintaining an ageing fleet of nuclear power plants (Germany and Ukraine), through lifetime extensions and extensive modernisation (Finland, Sweden, and Switzerland), to a mixture of maintenance and new builds (Bulgaria, France, and Russia). This difference of focus is also reflected in ongoing PSA activities.

Looking at PSA scope, most countries with ongoing new builds require full-scope Level 1 and 2 PSAs to be performed for new plants (all operating modes, including cold shutdown, and all initiating event categories). Most countries have the same requirements for existing plants, and have either reached this state (Finland, Sweden, Switzerland, and the UK) or are close to doing so (Russia, Ukraine, and Bulgaria). In France and Germany, where PSAs are updated in connection with the 10-year Periodic Safety Review (PSR), the PSA scope is typically extended step-wise in connection with a new PSR. Currently, in France Level 1 and 2 PSAs are full scope. In Germany, Level 1 PSAs are full scope, and Level 2 PSAs will soon be as well. Only the UK requires a level 3 PSA to be performed (for new plants and some existing).

The frequency of PSA updates differs a lot. In some countries updates are done in connection with the PSR, as in Germany (PSA update part of PSR) and France (PSA update twice per PSR period). Other countries require PSAs to be fully updated at least once a year (Bulgaria, Finland, Sweden, and Switzerland), while the remaining ones typically update PSAs after significant modifications have been made in a plant. Obviously, there is a relationship between the update frequency and the scope and ambitions of PSA-based risk-informed activities.

The details of the regulatory framework differ a lot among the countries, but all the countries require the performance of PSAs.

There are formal requirements for PSA to be used actively in risk-informed applications in Bulgaria, Finland, Sweden, and Switzerland. In some countries, the authorities also issue guidelines for performing PSA, e.g., the "Leitfaden PSA" in Germany, the YVL 2.8 PSA guide in Finland, the PSA guide T/AST/030 in the UK, and PSA Regulatory Guides in Bulgaria and Switzerland. In other countries, consensus documents are issued by groups of stakeholders, or utilities issue internal methodology descriptions. As an example, utilities in the Nordic countries (Finland and Sweden) have co-operated on the development of a number of state-of-the-art analysis guidances covering, e.g., CCF methods and data, external events, component data, and specific risk-informed applications. Meanwhile, the German guideline "Leitfaden PSA" includes Methodology and Data Appendices prepared by a group of stakeholders including utilities, the authorities and TSOs. These appendices are updated at regular intervals (typically every five years) to take account of changes in the state-of-the-art and planned extensions of PSA scope.

Uses of PSA range from static (PSA update mainly for PSR) to very active use in various risk-informed applications. Important among these are risk follow-up and risk-based analysis of technical specifications. Other areas mentioned are configuration control advice, maintenance optimisation, and evaluation of plant changes and operator actions. The use of risk monitors is mentioned by some countries as an important up-and-coming area. In countries building new plants, current uses include the consideration of how best to make use of PSA in design and licensing, and probabilistic safety goals are used in assessing the acceptability of new builds (Finland, Russia, and the UK). In countries that do not require full-scope PSAs, increasing PSA completeness is a current issue.

"Generally, IAEA guidelines have an important status as consensus approaches in Europe."

Looking at other issues and trends, many of the challenges seen are common, e.g., how to model software-based I&C systems, and issues related to risk- informed applications.

Some countries also mention CCF data and analysis methods, adaptation of seismic PSA methods to conditions in various parts of Europe, and Level 3 PSA. Current issues also include evaluation of PSA tools and quantification methods. Looking forward towards G3+ reactors, methods for analysing the reliability of passive systems will be important.

Generally, IAEA guidelines have an important status as consensus approaches in Europe, and are also seen as a baseline in countries with more detailed and specific national requirements. Current IAEA activities consider the level of maturity in Level 1 and Level 2 PSAs to be sufficient for standardisation, making it necessary to ensure technical consistency and quality. Safety Standards on the Development and Application of Level 1/2 PSAs will be issued shortly. The documents aim to provide technical consistency of PSA studies to reliably support PSA applications and risk-informed decisions, and to promote a standard framework that can facilitate regulatory and external peer review of a PSA and its various applications. In addition, the IAEA is currently preparing a TECDOC on Integrated Risk Informed Decision Making (IRIDM).

Can we draw any conclusions from this?

The review shows that PSA has grown greatly in importance in all the countries. This is manifested in increased scope requirements, increased update frequency, and a growing degree of formalisation through authority requirements as well as PSA guidance documents. This reflects both the growing maturity of PSA techniques internationally, and the wish to make increased use of PSA in risk-informed decision-making. IAEA activities are explicitly aimed at supporting this development by issuing safety standards for the performance and use of PSA. ■

Michael Knochenhauer
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Finland gets the green light!

The Finnish government has endorsed the construction of two new nuclear reactors, and has proposed granting licenses to the energy firms Fennovoima and Teollisuuden Voima (TVO). According to Minister of Economic Affairs Mauri Pekkarinen, the new reactors will make Finland completely self-sufficient in electricity production.

The Fennovoima nuclear reactor will be built in either Pyhäjoki or Simo, both of which are located on the northwestern coast of Finland; the decision will be taken by the end of the year. TVO plans to build its nuclear reactor at Olkiluoto, where a third nuclear reactor is currently being built.

Parliament is to make the final decision on constructions, most likely next autumn.

Today Finland has four nuclear reactors, which provide 27% of its electricity; a fifth reactor is under construction. ■

Sources: YLE, World Nuclear org.

DID YOU KNOW THAT?

- Uranium is one of the 50 most common elements in the Earth's crust.
- The majority of the nuclear power plants in the world use a Swedish software program – RiskSpectrum – for their safety analysis.
- A large amount of the world's nuclear fuel is manufactured in a Swedish town called Västerås.
- If your total lifetime consumption of electricity was produced from nuclear energy, the amount of fuel and waste produced could be held in a teacup.
- Sweden produces the greatest quantity of nuclear energy in the world in terms of electricity per capita.
- About 2 million years ago there was a natural nuclear fission reactor at Oklo in Gabon in west central Africa. And there is a spot on Earth where the waste has been stored for 2 million years. Scientists are amazed because they also discovered that at the same time that life on Earth consisted only of single-celled organisms, a natural nuclear fission reaction in the newly-formed uranium ore had taken place.

Sources: DI/environmental technology, www.alamut.com

60%

The IEA estimates that the demand for energy will increase in the years up to 2030, and believes that the reduction in consumption resulting from the financial crisis is only temporary. The demand for oil alone is expected to increase by nearly 60 % in the next 20 years. Source: IEA

Nuclear – our youngest source of energy

"Nuclear energy is unconditionally our youngest source of energy, and was discovered about 100 years ago, and the technology is even younger – with only 50 years of application," states Jan Blomgren, senior expert on nuclear education at Vattenfall and Director of SKC – Swedish Centre for Nuclear Technology.

Source: DI/ environmental technology

1.6% The world's electricity power production decreased by 1.6 % during 2009, and energy consumption decreased by 2 %, according to the IEA's latest figures. This is the first time since World War II that the use of electricity has decreased. This is primarily due – it is said – to the world's financial situation. Households have reduced their use of energy-consuming products and transport. Reduced demand has also led to drop in production and energy use in industry.

Source: IEA

News and views from China
By Dr Xuhong He

"PSA is playing and will continue to play a more important role in the development of the nuclear industry in China."

Tang Bo, Deputy Director of Nuclear Radioactivity and Safety Center of NNSA

The Daya Bay nuclear station is situated on the beautiful coast of the South China Sea north of Shenzhen.

PSA making inroads in China

As the nuclear industry in China develops, the regulatory body and the utilities are paying more attention to the development and use of PSA in plant operation and management. Now all the operating nuclear power plants have completed their Level 1, internal, full-power PSA projects and are extending their PSA scopes.

The National Nuclear Safety Administration of China (NNSA) technical policy on PSA application, scheduled for publication in 2010, is expected to give a major boost to PSA development and applications. According to Tang Bo, Deputy Director of the NNSA's Nuclear and Radiation Safety Center: "PSA is playing and will continue to play a more important role in the development of the nuclear industry in China."

Probabilistic Safety Assessment (PSA) development in China can be traced back to the 1980s, when scientists at a number of research institutes began learning the basic PSA methodologies described in the WASH-1400 report – which was a lot like doing homework and a bit far from a real nuclear power plant situation. At that time, the first nuclear power plants (Qinshan 1 and Daya Bay) were still under planning in China.

In April 2002 the NNSA issued its policy statement on PSA requirements for new nuclear power plants, recommending the use of both deterministic approaches and probabilistic approaches in safety analysis during the design phase and setting out two quantitative probabilistic safety goals: CDF (Core Damage Frequency) < 10-5/RY and LERF (Large Early Release Frequency) < 10-6/RY. Although the statement did not stipulate any coercive PSA requirements for operating nuclear power plants, it was obvious that the safety authority was positive to the development and use of PSA.

In October 2008 the NNSA issued technical guidelines on PSA – "Standardized PSA format and contents for Level 1, internal events" – which provided clear requirements for "what-to-do" and partial requirements for "how-to-do" for PSA.

In November 2008 the NNSA issued a draft version of its "Technical Policy: Application of PSA in the nuclear safety areas" and circulated it for public comment. Meanwhile, some pilot PSA application activities were underway at several active plants, e.g. risk-informed PSA management at Daya Bay.

With PSA requirements in place, all new plants must submit PSA reports to obtain a licence. Given the large-scale development of nuclear power in China – at present Mainland China has 11 nuclear power reactors in commercial operation, 28 reactors under construction and construction of additional plants is about to start soon – I believe the demand for PSA activities will be huge, especially once many plants are in operation. Design phase PSAs are generally provided by the reactor designers as part of the design documents that are submitted for review and approval by the NNSA. ■

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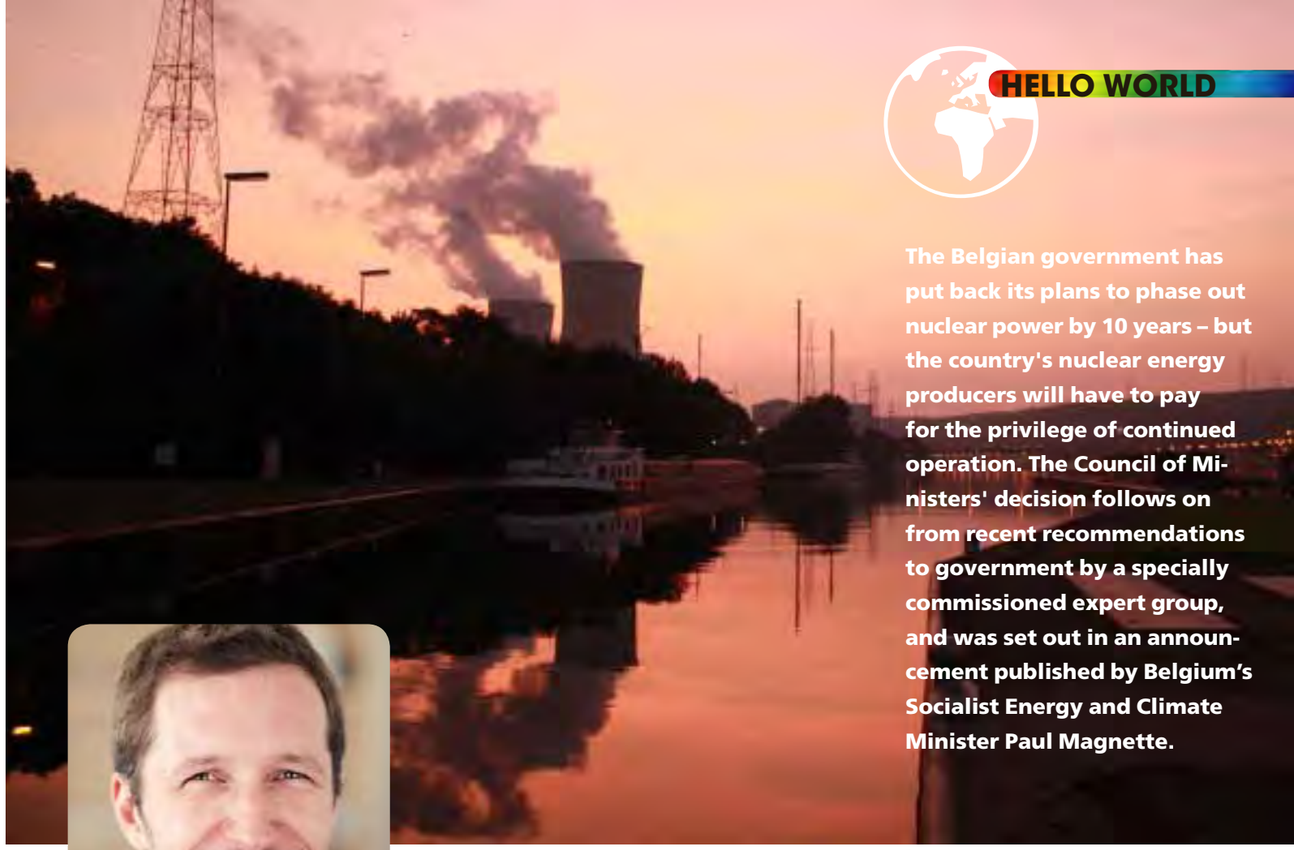
See www.lr.org for a complete list of Lloyd's Register offices in Asia.



HELLO WORLD

The Belgian government has put back its plans to phase out nuclear power by 10 years – but the country's nuclear energy producers will have to pay for the privilege of continued operation. The Council of Ministers' decision follows on from recent recommendations to government by a specially commissioned expert group, and was set out in an announcement published by Belgium's Socialist Energy and Climate Minister Paul Magnette.

Picture from Tihange Nuclear Power Station. Belgium has seven nuclear reactors generating more than half of its electricity. Its first commercial nuclear power reactor began operating in 1974.

HELLO ...

... Belgian Energy and Climate Minister
Mr Paul Magnette

What plans does the Belgian government have for nuclear power?

First of all it is important to say that safety and security factors prevail in the nuclear power debate. They are the absolute priorities, together with nuclear waste management, energy efficiency, and renewable energy, says Mr Paul Magnette.

A group of international experts were asked by the Belgian government to convey a study on the optimal "energy mix" (the ideal combination of different power suppliers) that is required to ensure both a sufficient and sustainable energy supply for Belgium in 2020-2030. The GEMIX report is the result of their work and was presented to me at the end of the year 2009.

The report recommends several ways to achieve the goals set by, amongst others, the European Union: energy consumption must decrease by 15% by 2020 and 13% of the total energy consumption must be supplied by renewable energy, also by 2020.

The GEMIX report also makes clear recommendations about nuclear power. The three oldest Belgian nuclear reactors were supposed to be shut down by 2015. But by doing so, GEMIX says it will be impossible to achieve the goals mentioned above. Nuclear power can guarantee the national energy supply, can help us reduce our CO_2 emissions and will allow energy prices to be kept at an acceptable rate.

Nuclear with responsibility

Mr Paul Magnette adds that the nuclear energy producers had to make several commitments. For example:

Reasonable energy prices, massive investments in renewable energy and energy efficiency, ambitious research and development programmes for the nuclear institutions – for approximately 5 million euro each year – the creation of employment and professional education in the energy sector – 10,000 more by 2015.

A structural mechanism that regulates flow between nuclear margin profits and the national financial budget – estimated between 215 and 245 million euro each year in 2010 – 2014.

A committee will evaluate the nuclear power production costs and the market prices each year. Also the price that households need to pay will be held under strict surveillance and compared to the prices in our neighbouring countries.

Of course security factors play a crucial role in that decision, thanks to the constant supervision by the federal agency for nuclear control, says the Minister of Climate and Energy Mr Paul Magnette. ■

By **Gunilla von Feilitzen**

For more information:
www.magnette.fgov.be , info@magnette.fgov.be

Do you sample your data correctly?

Vidar Hedtjärn Swaling is Senior Consultant at Scandpower's Stockholm office. Among other PSA activities, he is engaged in method development and consultancy on data analysis and parameter assessment.

QUESTION: How should you sample from a parameter distribution?

ANSWER: It depends on how the parameter is derived. Similarly, the understanding of a distribution is a prerequisite for using it consistently.

At the beginning of 2010 Scandpower completed the first part of an R&D project aimed at solving a classical dilemma within nuclear data analysis – that of whether nominally identical components should be considered equal with respect to failure rates. If they are, failure data should be pooled. If they are not, components should be treated individually. The project has been carried out in co-operation with Systecon AB and is funded by the Nordic PSA Group (NPSAG).

The issue originates from a benchmark of the Swedish "T-Book approach" and the German "ZEDB approach". The benchmark stated that the two approaches rely on similar algorithms for parameter estimation, i.e. the Two-stage Bayesian framework. However, the underlying assumptions on similarity between components appear to be diametrically opposed. The governing principle within the ZEDB community is homogeneity, whereas the T-Book community has adopted the principle of non-homogeneity (to be explained in more detail below).

The NPSAG project concludes that the difference has considerable impact on PSA results, i.e. different assumptions on component level yield significant differences on system level. One striking result is that this effect is considerably boosted if so-called parameter sampling is applied in the PSA. (Parameter sampling is one of two available sampling strategies in RiskSpectrum®. The alternative is event sampling. These two strategies are schematically explained in **FIGURE 1.**)

Boosting conservatism

To see how parameter sampling affects the propagation of a T-Book parameter we have to understand how such a parameter is actually composed. As mentioned, in the T-book framework component failure rates are considered non-homogeneous and should be treated individually. Nevertheless, plant-specific distributions are derived for components of the same type, i.e. for nominally identical components. This is achieved in two steps: Firstly, a parameter is assessed for each component individually. For most of the components this will give quite broad, and conservative, distributions due to the lack of individual data. Secondly, these individual distributions are merged yielding a plant-specific uncertainty distribution. The merging procedure is illustrated in **FIGURE 2**. The resulting distribution thus covers all members of the population, even the most extreme ones, which implies that the distribution is maximally conservative.

In the ZEDB framework, on the other hand, the plant specific distributions are derived from pooled data, i.e. no individual parameters are calculated. This yields a relatively narrow distribution since it is based on a lot more evidence.

One might say that in the T-Book framework parameters are pooled while in the ZEDB framework the pooling concerns raw data. This difference is schematically illustrated in **FIGURE 3.**

Now, what happens if in your PSA you use parameter sampling to sample values from these distributions respectively? As far as ZEDB distributions are concerned, parameter sampling is the natural strategy because it simply reflects what is intended by the pooling of data – that the components have the same failure rates. Parameter sampling guarantees that this condition is fulfilled in each and every sample.

If, on the other hand, parameter sampling is applied to a T-Book distribution, a value that stems from the "worst component" may be distributed to every component simultaneously, yielding an unreasonably high failure probability on system level. In other words – not only will the plant-specific distribution cover individuals with exceptionally high failure rates, it will also allow all components in the group to have this failure rate simultaneously. This might be conceived as a duplication, or over-interpretation, of the conservatism that is already imbedded in the plant-specific distribution.

If event sampling is applied instead, the values are allowed to level each other out, i.e. if a very high value is sampled for one component, other components in the system will most likely get lower values. This equalizing effect is analogous to the effect of redundancy. Event sampling could thereby be held to produce more realistic results on system level in the form of more narrow and less conservative uncertainty distributions.

To sum up, parameter sampling from T-Book distributions seems to manifest a misinterpretation of what they actually express. They are not expressing that components have the same failure rates, but rather that a plant-specific distribution covers all its members.

Undoubtedly, if the assumption of non-homogeneity was followed categorically, the parameters would not even be merged. Instead the T-Book would present one distribution per component. However, with today's merged distributions the only way to reasonably reflect the underlying assumption of non-homogeneity is to use event sampling.

Event sampling – some drawbacks

Unfortunately, choosing event sampling means we have to face two new dilemmas:

Firstly, even though event sampling appears to be the superior strategy with respect to T-Book parameters, it is not 100 % accurate. The reason is that, even if the components are assigned different values in each different sample, asymptotically they will get the same distribution. This means that the accuracy of the strategy is dependent on the system configuration – the more asymmetric, the less accurate the top distribution – and there is no guarantee it will be conservative.

Secondly, in a PSA you traditionally choose one sample strategy – parameter sampling or event sampling – for the whole analysis. But T-Book parameters are not the only parameters in a PSA model. What if other parameters are derived from pooled data, just like the ZEDB parameters? In that case event sampling would most likely produce non-conservative results and this is exactly why parameter sampling is the default setting in RiskSpectrum PSA.

Possible solutions

The main point made here is that, as far as T-Book parameters are concerned, parameter sampling will produce unreasonable results, not only numerically, but also conceptually since the strategy conflicts with the notion of non-homogeneity. In principle there are three alternative ways of dealing with this dilemma:

Firstly, the assumption of non-homogeneity might be interpreted categorically, implying that parameters are derived component-wise and not merged. Since this would result in a vast number of parameters it requires data to be automatically transferred to the PSA model. Moreover, with this approach we reject the possibility of similar components in a plant to form a population.

Secondly, as suggested above, event sampling might be used as a way of reflecting non-homogeneity. This implies that the PSA tool allows both sample strategies to be applied in the same analysis. However, it has been argued that the accuracy of event sampling is dependent on the system configuration and thus not completely accurate.

Finally, and most radically, the components might be assumed homogeneous, thus allowing data to be pooled and parameter sampling to be applied. This solution is of course not valid unless components are actually proved to be homogeneous. The point here is that IF they are, the process of deriving and implementing parameter distributions will become perfectly consistent. Moreover, it will yield more precise and less conservative results.

Thus, if the T-Book components could be arranged in a way that makes an assumption of homogeneity valid much would be gained. What also speaks in favour of this solution is that today's T-Book distributions are large and based on quite vague criteria of resemblance.

Therefore, an attempt in the direction of forming homogeneous populations, be it with new grouping criteria, is highly attractive. ■

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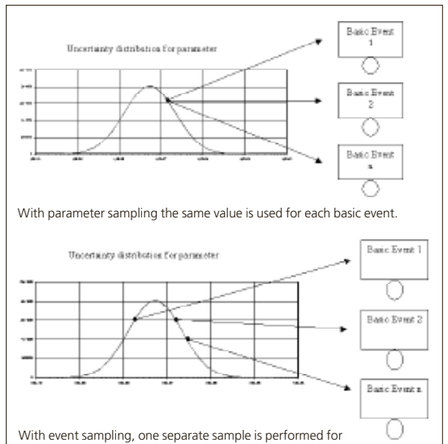
"Therefore, an attempt in the direction of forming homogeneous populations, be it with new grouping criteria, is highly attractive."



With parameter sampling the same value is used for each basic event.

With event sampling, one separate sample is performed for each basic event, however from the same distribution.

Figure 1

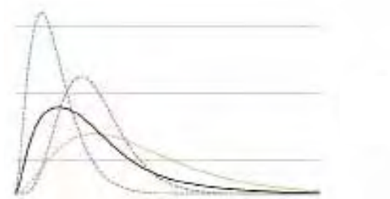


Figure 2
The procedure of merging component-specific distributions (dotted curves) into one average distribution.

$$\hat{\lambda} = \frac{\lambda_1 + \lambda_2 + \ldots + \lambda_n}{N}$$

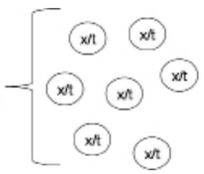


Figure 3(1)
In the T-Book framework group-specific failure rates are based on pooled parameters, i.e. the average of individual failure rates.

$$\hat{\lambda} = \frac{x_1 + x_2 + \ldots + x_n}{t_1 + t_2 + \ldots + t_n}$$

Figure 3(2)
In the ZEDB framework group-specific failure rates are based on pooled raw data, i.e. individual events (x) and exposure times (t) are summarized.

References

This article is based on the report "Principles for Data Analysis and Parameter Assessment. Part 1: Homogeneity assumptions", available on www.npsag.org.

The following articles are recommended for further reading on this topic:

1. Apostolakis, G. & Kaplan, S., (1981). "Pitfalls in Risk Calculations", Journal of Reliability Engineering, vol. 2 issue 2,135-145.
2. Pörn, K., (1993). "Methods for reliability data analysis – A new perspective", Safety and Reliability Assessment – An Integral Approach, Kafka, P. & Wolf, J. Eds. Elsevier Science Publishers B.V.

1 ZEDB designates both the database and the tool for parameter estimation used in Germany.

HOW-TO

Improved QA in PSA – RiskSpectrum helps you

Today, state-of-the art is to have and maintain full-scope Level 1 and Level 2 PSA models. This was not the case some 10 years ago. This article summarises a number of features available in RiskSpectrum software for quality assurance of input and review of PSA models.

The actual use of PSA has also expanded, as more and more countries move to employ risk-informed strategies. This, in turn, has increased demands regarding PSA quality and how quality assurance (QA) is performed.

QA support is needed in several different areas, including PSA model input, review and documentation. A worldwide trend is for software tools to provide better direct support for QA, and several of the new features added to the RiskSpectrum software suite during the past few years have been developed for the purpose of supporting QA of PSA models.

PSA MODEL INPUT

In many cases, a large amount of the PSA model input has already been documented in another format, for example as failure data in the failure mode and effect analysis (FMEA) or the cable routing in a database.

Therefore an automated import to the PSA model, that also is quality assured, is desirable in order to avoid time consuming manual work.

When the FMEA is documented in RiskSpectrum FMEA, the parameters and basic events can be generated automatically from the FMEA tool and imported into the RiskSpectrum PSA model. In this way, the failure data does not have to be updated twice, which would be the case if the FMEA was documented in a spreadsheet.

Another newly developed feature in RiskSpectrum PSA – soon to be released – is MS Excel® Export/Import, which allows the user to export the model record tables to an Excel file. The records and relations may be added and edited in this file, and the changes can then be imported into the model. This can be used for adding room dependencies to basic events, for example, or for creating a large amount of analysis cases and corresponding boundary condition sets. Figure 1 illustrates the MS Excel Export/Import Interface.

The ASCII import format also provides the possibility for adding or updating fault tree logic, basic events etc. This format is used extensively by some organisations for import of fault trees automatically generated by separate tools.

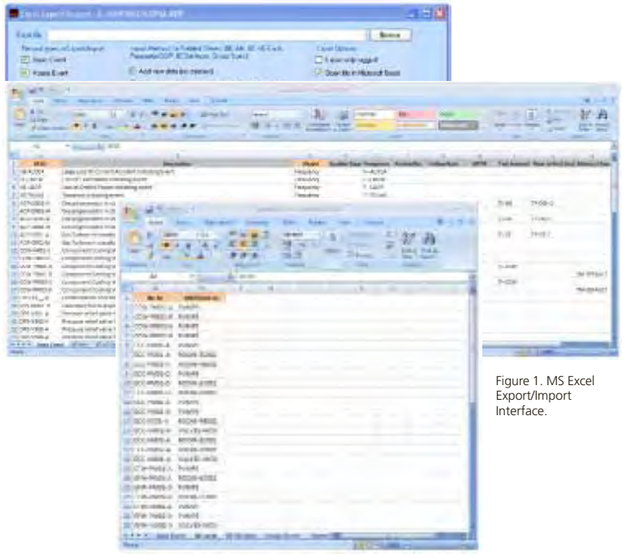


Figure 1. MS Excel Export/Import Interface.

PSA MODEL REVIEW

One important task is to keep track of which changes have been made to the model. Another is to keep track of which records have been reviewed and approved and to ensure that they have not been changed after that. To perform a complete review, the reviewer must also be able to evaluate the overall impact of the changes on the model.

Tag by Date

All records in RiskSpectrum PSA hold information about when and by whom they have been edited, and the Tag by Date function makes it possible to tag all records that have been changed after a specific given date. This makes it easy to sort out all changes made in an update.

Propagate Tag

Unlike the Tag Dependent on Tagged function, the Propagate Tag propagates the tagged records upwards through the PSA model structure. Figure 2 illustrates how this works. The basic event ACP-GT01-A has been tagged in this example. By using the Propagate Tag function, the way this event propagates through the fault tree structure is tagged. The top gate, @MFW-1, is used as input to function event, Q, which is then tagged as well.

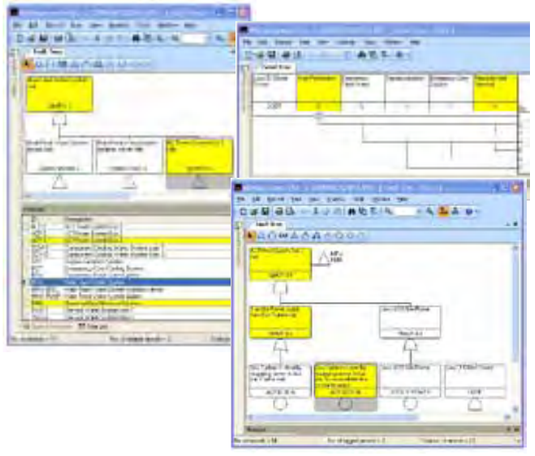


Figure 2. Failure of the gas turbine can be propagated up through the fault trees and on to the event trees using the Propagate Tag function.

Together with the Tag by Date function, the Propagate Tag is a very powerful feature allowing a reviewer to see all parts of the fault tree model that have been affected by an update.

Save Tag Info to File

All the records that are tagged in a model can be saved to a text file by using the Save Tag Info to File function. The text file will include the IDs and descriptions, together with the date the record was edited and the initials of the user who did it. This makes it possible to actually see which record has been edited after a certain date and which records are affected by other changes.

Review/Approve

To keep track of reviewed and approved records, RiskSpectrum PSA offers the possibility to mark the records with a symbol for “approved” or “reviewed”. To make the reviewing process transparent, the information about the reviewing/approving user is saved together with the date and time the action was performed; see the example in Figure 3.

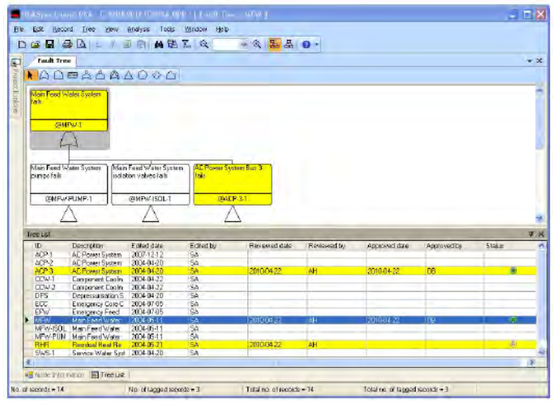


Figure 3. Each record in the PSA model database includes information about when and by whom it was edited, reviewed and approved.

As soon as a record is changed, the “reviewed” or “approved” symbol will disappear. The right to review and approve records is determined by the user’s rights.

Lock Project

The Lock Project function makes it possible to lock a model in order to prevent unintended changes. No records can be edited in a locked project, but it is still possible to run analyses from existing analysis cases. When the model needs to be updated, the project can easily be unlocked again. The user has to have Approve or Administrator rights to be able to lock or unlock a model.

PSA MODEL DOCUMENTATION

The Memo function is a tool for documenting assumptions, limitations, references etc. in the PSA model. Although this function has been available since the DOS version of RiskSpectrum and offers an excellent way of storing information for different record types, it is often overlooked. A memo could, for example, hold the reference for a certain parameter value or describe the system criteria; see the example in Figure 4. Memos are available for all types of records in the PSA model.

The use of memos is a very efficient way of facilitating the review of a PSA model.

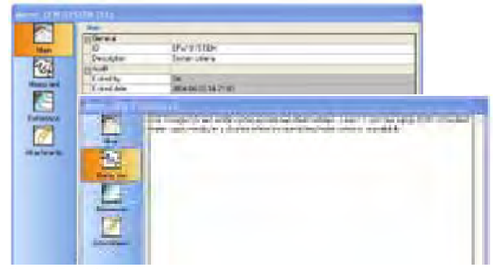


Figure 4. Example of a memo.

RiskSpectrum Doc was developed to further facilitate the documentation of the PSA model. With this tool the PSA model is linked directly to the documentation generated by the tool. This is an ideal way of, for example, keeping a system note-book updated since the memos created when modelling can be printed in a report generated by RiskSpectrum Doc. It is also very useful for generating data and result reports. ■

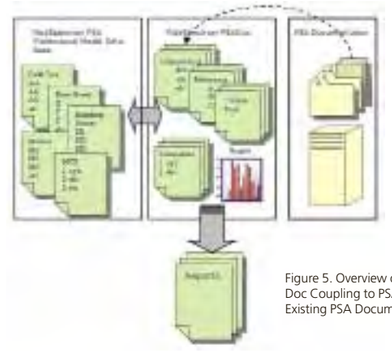


Figure 5. Overview of RiskSpectrum Doc Coupling to PSA Model and Existing PSA Documentation.

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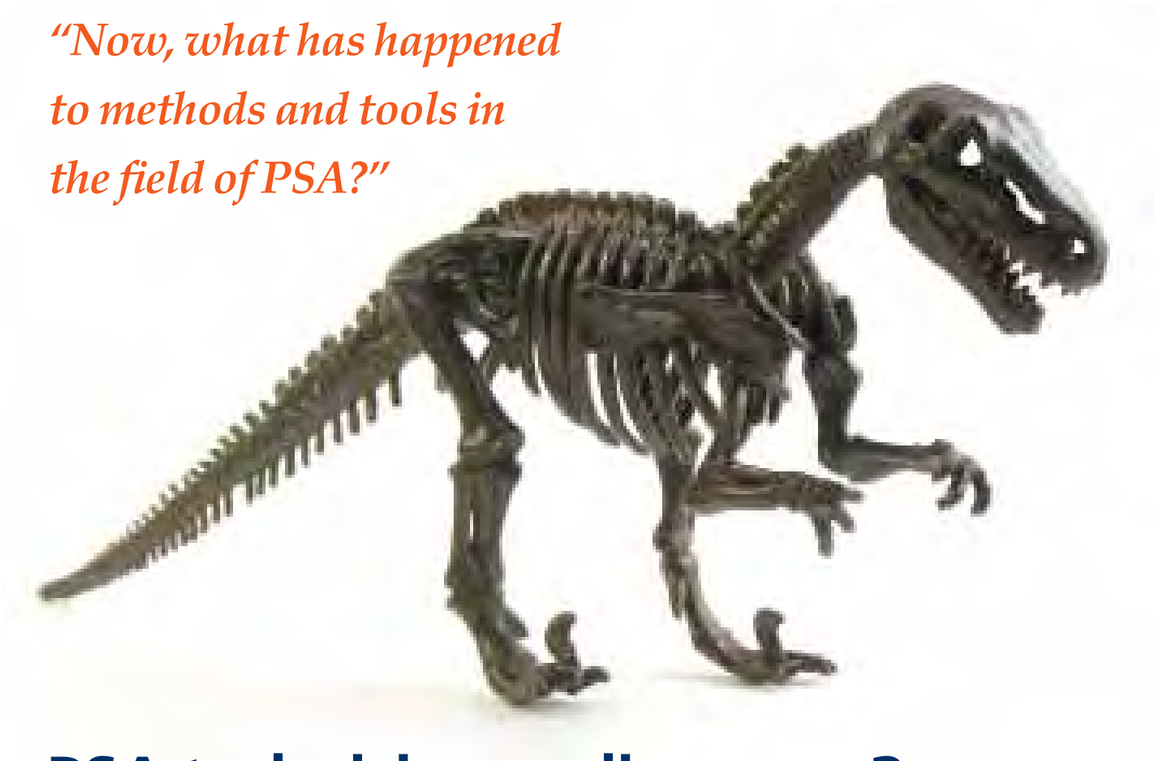
Insights software
By Ola Bäckström

"Now, what has happened to methods and tools in the field of PSA?"



PSA technicians – dinosaurs?

Fifteen to twenty years ago most communication was by telephone, fax or surface mail. Around this time e-mail was introduced to the public. It has had a magnificent effect on ways of working and efficiency. Actually, the fax machine is more or less doomed.

I got my first mobile phone around the same time. It has had an extremely positive effect on my way of working over the years. Combine e-mail and the mobile phone and you can be reachable and working almost anywhere.

The Internet is another area that has really changed our way of behaving and working. When I want to find the latest news or weather report, or see what is on TV, I first look on the Internet. If I am looking for information, the Internet is the place to search. There are many areas of the Internet that I do not understand or participate in, such as the widespread use of social networking communities. But I guess that is because I am not young enough.

Now, what has happened to methods and tools in the field of PSA?

It must be admitted that the methods have been refined, and we are looking at faster and more accurate predictions. However, these are just scratches on the surface compared to the evolvements in surrounding areas. Control rooms in nuclear power plants are now equipped with computers and screens, and all new reactor protection systems installed will be based on software. Compare this to the situation 10 years ago – these are evolvements!

We, the PSA technicians, are dinosaurs. We do not want to try or use new tools. We do not want to change our way of working in any way. I wonder what is going to be the first real dramatic change in how we conduct PSAs. Will it involve virtual reality, some way of getting a real feeling for the equipment? Or will PSAs even exist – maybe they will be part of artificial intelligence systems?

Why don't we start a community? I don't know what it is, but let us evolve. ■

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HRA – a new member of the RiskSpectrum Family

"We believe that by using RiskSpectrum Human Reliability Analysis (HRA), analysts are able to consistently conduct HRA and produce results of high quality, good traceability and documentation," says Dr Xuhong He, Scandpower AB.

Historically, the focus of Probabilistic Safety Assessment (PSA) has been on modelling of hardware and its impact on the plant safety level. Although the human component was modelled from the beginning, it was initially treated quite superficially, partially due to the level of knowledge and limited availability of relevant data.

Today, Human Reliability Analysis (HRA) is an important element of PSA for quantifying the risk contribution from human errors. HRA has gained a great deal of attention in recent years, for example in terms of HRA methods development, HRA benchmark studies and HRA good practice requirements. This is not surprising due to the relative importance of human errors in PSA results and the significant differences in quantitative results from different HRA studies, i.e. the major uncertainties in HRA results.

RiskSpectrum HRA is a software tool being developed by Scandpower to help PSA/HRA analysts to do good HRA by going through necessary HRA steps to generate Human Error Probabilities (HEPs) for the defined Human Failure Events (HFEs), and to document important assumptions, conditions, inputs and results in the HRA process at the same time.

Although RiskSpectrum HRA is mainly being developed/tailored for HRA as an element of PSA for the nuclear industry, it also includes essential HRA features that may be used for other high-risk industries, such as the oil and gas industry.

RiskSpectrum HRA includes a number of commonly-used HRA methods, such as THERP, ASEP, HCR/ORE, SPAR-H and HEART. Other selected HRA methods will be included in later releases. As there are so many varied methods available for HRA, a feature to support user-defined methods is therefore planned to be included. Through user-defined methods, the user will be able to define specific quantification formulas and performance shaping factors and use specific plant historical data in the HRA project.

For each HFE, multiple methods may be used in quantification, allowing for different results from different methods to be compared. One result from any of the methods may be used as the final HEP for a HFE.

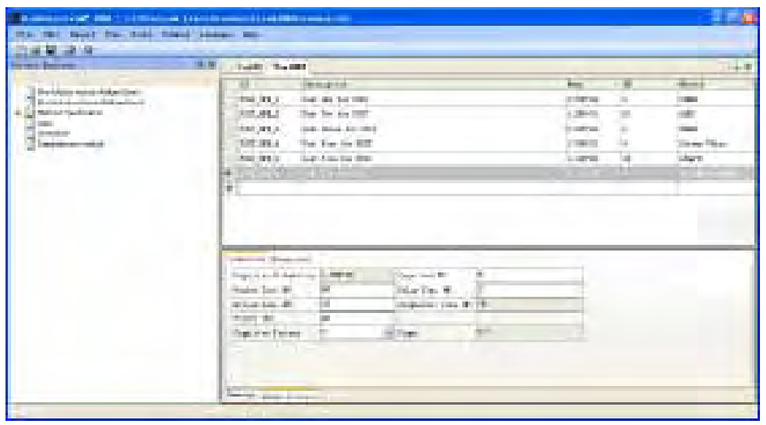

Figure 1. Example interface of RiskSpectrum HRA.

Figure 2. Results from different methods for one HFE.

Two screening values (one for pre-initiator and one for post-initiator) can be defined by the user and then assigned for any or all of the HFEs.

RiskSpectrum HRA is a standalone program. However, as a member of the RiskSpectrum family, it is compatible with RiskSpectrum PSA. For example, it may be used to automatically import/export HFEs and HEPs from/to RiskSpectrum PSA. Special features will be included to facilitate dependence analysis.

RiskSpectrum HRA is designed to help to meet the requirements of the ASME PSA Standard and the NRC's "Good Practices for Implementing Human Reliability Analysis (HRA)" in the HRA analysis process: HFEs identification, quantification, dependency analysis, documentation, etc. ■

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Improving basic event relations

In this article Dr Pavel Krcál and Dr Daniel Ying at Scandpower AB describe three new features they are developing, which will be available in upcoming versions of RSAT.

Dr Daniel Ying holds a PhD in applied mathematics and is a senior software developer at Scandpower AB.

Dr Pavel Krcál holds a PhD in computer science and was hired by Scandpower AB in 2009. Dr. Krcál is the latest addition to the software team and has already proven to be a valuable team member.

In the last couple of years the development of RiskSpectrum Analysis Tools (RSAT) has mainly been concerned with resolving issues due to changes in the analysis models for the release of the 32-bit version of RS PSA. This work has started to ease off and we have recently been able to concentrate on new features for RSAT that have been discussed with our users.

A new calculation model for basic events

In RiskSpectrum PSA, a basic event takes the value that is represented in the parameter connected to the basic event. However, there are situations where you may want to define a basic event whose value is dependent on other events in the model. For example, when using several event tree branches you may want to define the value of the success event as 1 – (the failed sequences).

Normally there is no reason to evaluate the success branch to this extent because the simplifications in the standard calculation treat success branches as having probability one. This is the effect you get when running an analysis using the negation method logical ET success.

However, recent features in RSAT have allowed the use of the negation setting logical and simple quantification in both sequence analysis cases and consequence analysis cases. In such cases, the success branch will be evaluated with respect to the fail cut-set combinations, and will be quantified using the Min Cut Upper Bound approximation (MCUB).

Since the MCUB approximation is a conservative approximation that assumes that the probabilities are low, this works fine in normal PSA models dealing with rare events. However, lately RSAT has been used in models where events sometimes represent high probability failures or successes. In rare cases this may lead to overestimating the sequence probabilities.

IE	F1	No	Freq	Conseq	Code
		1	2,40E-01		
	1	2	2,00E-01		F1
	2	3	7,00E-01		F1(C)

Figure 1. **Event tree sequence.** To see how this situation may arise, consider the following event tree: Function event F1 has two input alternatives. Input alternative 1 is a basic event A with probability 0.2, and input alternative 2 is a basic event with probability 0.7 (see Figure 1). The success treatment of function event F1 is set to logical and simple quantification.

When using logical and simple quantification success treatment, the success branch is calculated using the Min Cut Upper Bound approximation (MCUB) on the minimal cut-sets generated in the fail branches. In this example this will be calculated as $1 - Q_{MCUB}(A, B)$ which becomes

$$Q_{success} = 1 - \big(1 - (1 - P(A))(1 - P(B))\big) = \\ = 1 - \big(1 - (1 - 0.2)(1 - 0.7)\big) = 0.24$$

That is, the success branch has a probability which is higher than expected

$$1 - P(Failed\ branches) = 1 - P(A) - P(B) = \\ = 1 - 0.2 - 0.7 = 0.1$$

This can be avoided if we can define the success branch event as a basic event whose value is precisely this.

In a coming version of RSAT it will be possible to define a basic event whose value is calculated using a formula including other existing events in the model and simple arithmetical operators such as multiplication, division, subtraction and addition. It will also be possible to use parenthesis in the expressions.

Figure 2. You will be able to define the probability of a Basic Event based on other Basic Event probabilities.

IE	F1	No	Freq	Conseq	Code
		1	1,00E-01		
	1	2	2,00E-01		F1
	2	3	7,00E-01		F1(C)

Figure 3. **Event tree with success alternative defined.** In the above example, you can add another input alternative (branch point alternative 3 in Figure 3) and define this as a basic event C with the formula below.

$$C = 1 - A - B$$

This means that when quantifying the event probabilities event C will be evaluated as $P(C) = 1 - P(A) - P(B)$ and by setting this event as a branch point alternative for the success branch the desired result will be obtained.

Treatment of mutually exclusive events in the cut-set list

When, for example, modeling plant operations, there are sometimes events that will appear in the cut-set list that are mutually exclusive to each other. This means that they can never occur at the same time or in probabilistic language, if A and B are two mutually exclusive events then $P(A \cap B) = 0$. For inclusive events A and B the probability of either events occurring is given by $P(A \cup B) = P(A) + P(B) - P(A \cap B)$. From this it follows that the probability of two mutually exclusive events occurring is given by $P(A \cup B) = P(A) + P(B)$.

When quantifying cut-sets, the normal assumption is that cut-sets are not mutually exclusive since they contain several combinations of inclusive events. The exact quantification of the cut-set list is then done by using the inclusion-exclusion principle. For several events $A_1, A_2, A_3, \ldots, A_n$ this becomes

$$P(A_1 \cup A_2 \cup A_3 \cup \ldots \cup A_n) = P(A_1) + P(A_2) + \cdots + P(A_n) - \\ -P(A_1 \cap A_2) - P(A_1 \cap A_3) - \cdots - P(A_{n-1} \cap A_n) + \\ +P(A_1 \cap A_2 \cap A_3) + P(A_1 \cap A_2 \cap A_4) + \cdots + P(A_{n-2} \cap A_{n-1} \cap A_n) + \\ +\ldots + (-1)^{n-1} P(A_1 \cap A_2 \cap \ldots \cap A_n)$$

This method is very time-consuming, especially when dealing with long cut-set lists, so in order to not end up with very long series of calculations, different types of approximations are made (first, second, and third order approximation or the Min Cut Upper Bound approximation).

These approximations do not take into account whether the cut-sets are mutually exclusive, but for low probability events in normal PSA models this is not noticeable and the approximation is good enough for the purpose.

Taking events into account

There may, however, be situations where the mutually exclusive events do affect the top results, for example when using events that have high probabilities or have a high impact in other ways on the top result. In such cases, it may be necessary to take these events into account when quantifying the cut-set list.

The new, mutually exclusive event feature in RSAT will allow you to define which events are mutually exclusive with respect to other events. Using this information, RSAT will be able to quantify the cut-set list by using the principles for mutually exclusive events.

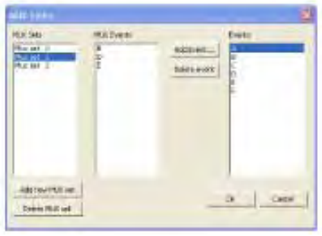

Figure 4. You can define mutual exclusivity relations between Basic Events.

One example of how the mutually exclusive event may come into play is when performing consequence analysis in event trees using the negation treatment logical and simple quantification.

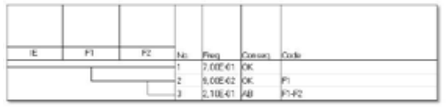

Figure 5. **Event tree used for studying consequence OK.**

Consider the event tree setup pictured in Figure 5. The event tree has two function events F1 and F2 together with initiating event IE.

The initiating event is set to frequency 1 for simplicity. Now each of the function events has a basic event as input, A and B, respectively, with probabilities $P(A) = 0.3$ and $P(B) = 0.7$.

If you set the success treatment of the function events to use logical and simple quantification treatment and also set the analysis case specification to use this treatment, the event tree branches will become mutually exclusive to each other because the success modules of the fail branches will be taken into account.

When you run a consequence analysis for the consequence OK, you will obtain the two cut-sets corresponding to the sequences 1 and 2 in the fault tree. These sequences will have the cut-sets:

Sequence 1: IE, -FE:F1
Sequence 2: IE, A, -FE:F2

where –FE:F1 and –FE:F2 are the corresponding success modules of the event tree branches under each function event.

The probabilities of the cut-sets are given in the following equations

$$Q(IE, -FE{:}F1) = 0.7$$
$$Q(IE, A, -FE{:}F2) = 0.09$$

Since the cut-sets are mutually exclusive, the probability for the complete consequence of OK is expected to be

$$Q_{Expected} = Q(IE, -FE{:}F1) + Q(IE, A, -FE{:}F2) = 0.79$$

However, since RSAT does not take the mutual exclusivity into account it uses Min Cut Upper Bound approximation (MCUB) on the cut-sets, which gives the result

$$Q_{MCUB} = 1 - \big(1 - Q(IE, -FE{:}F1)\big)\big(1 - Q(IE, A, -FE{:}F2)\big) = 0.727$$

You may notice that the result is smaller than the expected result, and may wonder why this is so. The reason for this is that in this unusual model the cut-sets contain both a success event and a fail event, where both events substantially affect the top result. In rare cases like these, the result from the MCUB approximation will be slightly incorrect.

To resolve this, we have added an option in RSAT to consider such mutually exclusive events when quantifying the cut-set list and thus applying the MCUB only to groups of minimal cut-sets for which it is known that each group contains independent or positively correlated cut-sets.

User-defined simulation values

When performing uncertainty simulations in RiskSpectrum PSA, there are two sampling types available today: parameter sampling and basic event sampling. Parameter sampling means that at each step (simulation) a parameter value is simulated and then each event connected to this parameter uses this value when calculating the top event. In the case of basic event sampling, each basic event is treated as a separate parameter and the respective parameter value is simulated for each event.

Parameter sampling is done using predefined statistical models, where the possible distribution types are listed below:

- Lognormal distribution
- Beta distribution
- Gamma distribution
- Normal distribution
- Uniform distribution
- Log-uniform distribution
- Discrete distribution

However, there may be cases when these distribution types are not enough and you would like to use external simulation values. Such situations arise, for example, when performing seismic simulations where the distribution values can be more complex and dependent on several outer parameters. Therefore, these values can be created outside RiskSpectrum PSA and then imported for use in uncertainty simulations in RiskSpectrum PSA.

Finally, another functionality of this feature is that you can keep certain parameters fixed during a simulation while using normal simulations or external simulation values on other parameters. ■

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2015

One of the world's most sustainable urban developments – Masdar City – which will house 40,000 residents and 1,500 companies – is rising from the sanddunes in Abu Dhabi in the United Arab Emirates. The vision is for the city to be carbon-neutral. One of the UAE Government's main aims is to make Masdar City a hub for global clean technology, and it was designed according to a set of 10 guiding principles of sustainability.
These include: zero waste, sustainable transport (with substantial transport by electric vehicles), and sustainable materials (construction materials, for example, must have a high content of recycled waste).
The headquarters of the International Renewable Energy Agency (IRENA) will be located in Masdar City.
Switzerland will occupy its own quarter of the city, which will be home to 33 environmental technology companies.

Sources: wspgroup.com, MIT Energy Initiative (MITEI), www.masdarcity.ae

11 pm

New Year's Eve 2009 saw the closing of the second of two nuclear reactors at the 26-year-old Ignalina Nuclear Power Plant in Lithuania – which had satisfied 70 % of the country's energy demand. Lithuania was ranked second after France in terms of the proportion of energy produced by nuclear power.
Built in the Soviet era, the plant shared similarities with the Chernobyl Nuclear Power Plant in Ukraine, which exploded in 1986 in the world's worst nuclear accident to date.
Lithuania's 3.3 million inhabitants are facing galloping energy prices.
On New Year's Day they woke up to a 30 % increase in price for households and a 20 % increase for industry. Meanwhile, the country is experiencing one of the world's worst financial crises.

Sources: Ignalina Nuclear Power Plant www.iae.lt, wikipedia.com

India buys Russian-made nuclear reactors.

Russian organisations have been contracted to build 16 nuclear power reactors in India, two of which currently are being constructed in the state of Tamil Nadu. There are a total of 17 nuclear power reactors in operation in India today.

Sources: TT, AFP

The cost of electricity in the coming years will depend on a number of key parameters, foremost among them the costs of raising financial capital and the price of carbon. This is one of the main conclusions of Projected Costs of Generating Electricity: 2010 Edition, a new joint study by the International Energy Agency (IEA) and the OECD Nuclear Energy Agency (NEA).

Sources: IEA, OECD

The latest figures from the World Nuclear Association (WNA) reveal that the number of nuclear reactors in the world may double in the next 15 years. There are 438 reactors in operation today, and 54 more under construction. Another 148 are on order or planned. These reactors are expected to go into operation in the next 8-10 years. There are 342 proposed reactors that are expected to go online in the next 15 years.

Source: WNA

Companies support research. The research institute Stockholm Environment Institute has entered into cooperation with the 3C (Combat Climate Change) network. This business network was established by Vattenfall's CEO Lars G Josefsson, and counts 67 large international enterprises among its members.

Sources: DI, www.sei-international.org

Picture from Ascó Nuclear Power Plant. Spain has eight nuclear reactors generating a fifth of its electricity. Its first commercial nuclear power reactor began operating in 1968.

HELLO ...
...Mr Miguel Sebastián,
Spanish Minister of Industry, Tourism and Trade

Santa María de Garoña, Spain's oldest nuclear power plant (started up in 1971), will be in operation for four more years. A non-binding Nuclear Safety Council report unanimously recommended the extension of its licence, as it deemed the plant safe.

The four-year extension to Garoña's lifespan means that it will operate until 2013, two years after it was originally supposed to shut down and beyond its 40-year design lifetime.

The Ministry of Industry, Tourism and Trade, called the four-year extension "adequate" because the government needs time to implement an economic development plan for the area, to replace the jobs that will be lost when Garoña no longer exists, and to build a central temporary warehouse for the storage of spent fuel before dismantling the plant.

Has the life extension for the Santa María de Garoña nuclear power plant finally been approved?

The nuclear power plant Santa María de Garoña, in Burgos, will continue to operate until 5 July 2013, when it will cease its activity. Thus, Garoña will become the first nuclear power plant which operates for more than 40 years in Spain.

The time limit gives a reasonable margin to carry out a reindustrialisation of the area to allow workers to relocate.

What is the reason for this life extension and what are the future plans for nuclear power in Spain?

The closure is manageable in terms of power generation because the supply is guaranteed.

This closure is a decision that is politically consistent with the PSOE electoral programme presented in the general election 2008, which advocates the promotion of renewable energy.

The PSOE electoral programme states: "We will maintain a commitment to gradual replacement of nuclear power with energy that is safe, clean and less expensive, closing nuclear power plants in an orderly manner at the end of their useful life, giving priority to ensuring safety and maximum social consensus."

The government plans for 2020 are that all nuclear power plants currently in operation will continue their activity, as none except Garoña will have reached their 40-year design lifetime before that date.

The Spanish Government is committed to an energy mix following the principles of security of supply, competitiveness, and respect for the environment. ■

By **Gunilla von Feilitzen**

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