

Putting safety first!



Safety is of paramount importance where nuclear reactors are concerned, and whilst severe accidents are rare, the probability of their occurrence needs to be calculated. **Emmanuel Raimond** is coordinating ASAMPSA2, which brings together international best practice in advanced safety assessment methodologies

Can you outline the motives that prompted the implementation of the Advanced Safety Assessment Methodologies: Level 2 Probabilistic Safety Assessment (ASAMPSA2) project?

ASAMPSA2 concerns methodologies for the assessment of risks that may be induced by a severe accident on a nuclear power plant (NPP). A severe accident is here defined by the possibility of significant release of radioactive materials. Whilst such accidents have an extremely low probability of occurrence they remain, nevertheless, possible. The Level 2 Probabilistic Safety Assessment (L2 PSA) methodology was first developed in the U.S. in the late 1980s and has since become a universally-used risk assessment system for nuclear power plants. International standards now exist (eg. from the International Atomic Energy Agency), but when comparing the existing studies or the real applications for plant safety improvement, some discrepancies in the details of the studies are discernable, as is a lack of confidence in the results (due, for example, to the high uncertainties that may exist in the quantification of severe accident progression).

What are the project's goals, and what key issues does it seek to address?

Our goal, under the European Commission's 7th Framework Programme, is to develop specific guidance and best practice for European organisations, by bringing together a variety of partners. ASAMPSA2 is made up of 21 partner organisations from 13 European countries, and includes safety authorities, technical safety organisations (TSOs), utilities, vendors, service providers and research bodies. The project's main goals are to: highlight common best practices; develop the appropriate scope and criteria for different L2 PSA applications; and promote optimal use of the available resources by European end users. Such a common assessment framework will support a harmonised view on nuclear safety, and

help formalise the role of probabilistic safety assessment. Alongside this, the project aims to identify some of the remaining issues where research activities are still needed in order to enable a more comprehensive and meaningful quantification of risks.

In layman's terms, what does a Level 2 Probabilistic Safety Assessment constitute?

Assessments of NPPs are initially conducted against a limited number of postulated design basis accidents (DBA), and it must obviously be established that the plant can withstand such DBAs without any loss of systems, structures, or components necessary to ensure public health and safety. The PSA approach is considered complementary to this deterministic approach; it offers an overview of the plant behaviour for a broader scope of plausible accidents (which may be caused by human error or by material or equipment failure, rather than by design fault), even if their frequencies of occurrence seem extremely low.

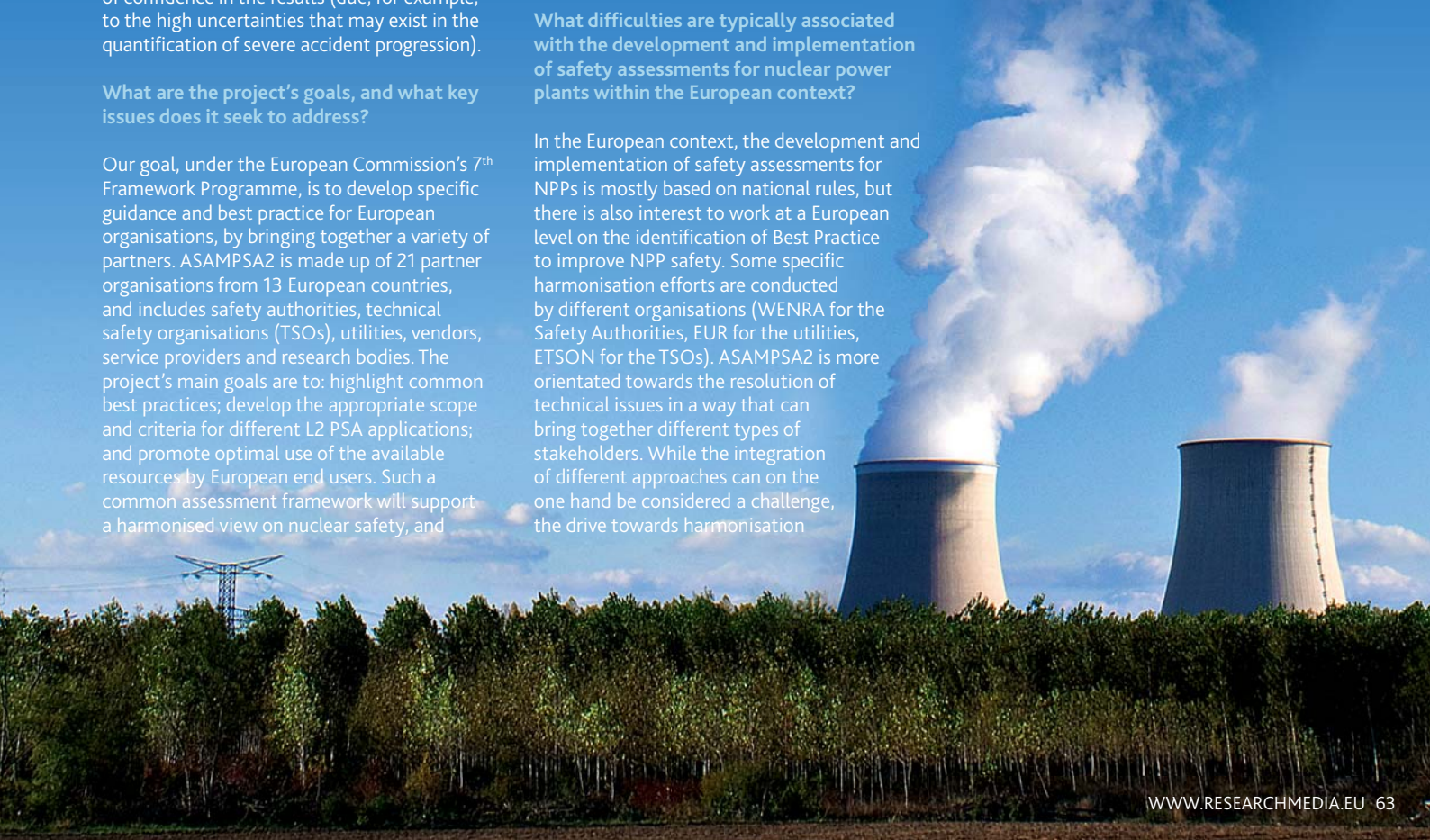
What difficulties are typically associated with the development and implementation of safety assessments for nuclear power plants within the European context?

In the European context, the development and implementation of safety assessments for NPPs is mostly based on national rules, but there is also interest to work at a European level on the identification of Best Practice to improve NPP safety. Some specific harmonisation efforts are conducted by different organisations (WENRA for the Safety Authorities, EUR for the utilities, ETSON for the TSOs). ASAMPSA2 is more orientated towards the resolution of technical issues in a way that can bring together different types of stakeholders. While the integration of different approaches can on the one hand be considered a challenge, the drive towards harmonisation

can, on the other hand, be viewed as a source of progress.

To what extent does ASAMPSA2 endeavour to promote dialogue with end users? How central is collaboration to the fulfilment of the project's objectives?

The feedback from the Severe Accident Research Network (SARNET) highlighted the need to harness liaisons between industry, safety authorities and research organisations. For that reason, we have tried to include all types of stakeholders as partners in ASAMPSA2, and in addition have also organised a formal interaction between the project and some L2 PSA end users outside the project. The relationship with end users has been considered a key part of the project and has really helped to orientate the project's activity towards practical applications. It has also focused the work of research programmes and helped researchers evaluate the knowledge and tools that they use to perform meaningful risk assessments.



Best practice makes perfect

Be it in an office or a laboratory, we are all familiar with issues of health and safety in the workplace. But in the context of nuclear power plants, the stakes are somewhat higher. The **ASAMPSA2** project aims to harmonise existing protocols in the development of an integrated code of best practice

CONTRARY TO SOME common anxieties, nuclear power plants are incredibly safe places: health and safety assessment is probably more advanced and comprehensive in this domain than in any other industry. While the likelihood of a severe accident occurring is low, the threat is far from negligible, for example, in the case of a default in the core cooling (eg. the Three Mile Island nuclear power plant [NPP] accident), or a reactivity accident (eg. the Chernobyl NPP accident). The ASAMPSA2 project brings together a range of international partners to share research and resources with the aim of developing best practice guidelines for application in NPPs across Europe.

A METHODOLOGICAL APPROACH

The basis of ASAMPSA2 is Probabilistic Safety Assessment, which is defined by the International Atomic Energy Agency as “a methodological approach to identifying accident sequences that can follow from a broad range of initiating events. It includes a systematic and realistic determination of accident frequencies and consequences”. International practice recognises three levels of PSA: the first concerns the design and operation of a plant and the possible sequences of events that can lead

to core damage; level two (L2) evaluates the chronological progression of such core damage sequences and the ways in which releases from reactor fuel can carry environmental consequences; and the third level estimates public health and societal consequences arising from accident sequences that lead to a release of radioactive material into the environment.

ADDRESSING A LACK OF UNIFORMITY

Whilst PSA is a widely used approach, it is by no means definitive or universal. A clear lack of uniformity is discernible if we compare L2 PSA applications internationally. In some countries, like Finland and France for instance, L2 PSAs now have a role in regulating of plant safety. In some other countries, however, there is still a lack of confidence in the final results of L2 PSAs, which are not yet used in practical application. This situation is one to which ASAMPSA2 responds, as its project coordinator, Emmanuel Raimond, points out: “The definition of probabilistic safety goals (risk acceptance), or the methodology for L2 PSA results applications, remains a field where harmonisation could be fruitful,” he explains. For some very specific issues, the conclusions of risk assessment may differ depending on the L2 PSA (eg. ex-vessel steam explosion, impact of a degraded core reflooding, core coolability), and this may underline some areas where specific research efforts are still needed.

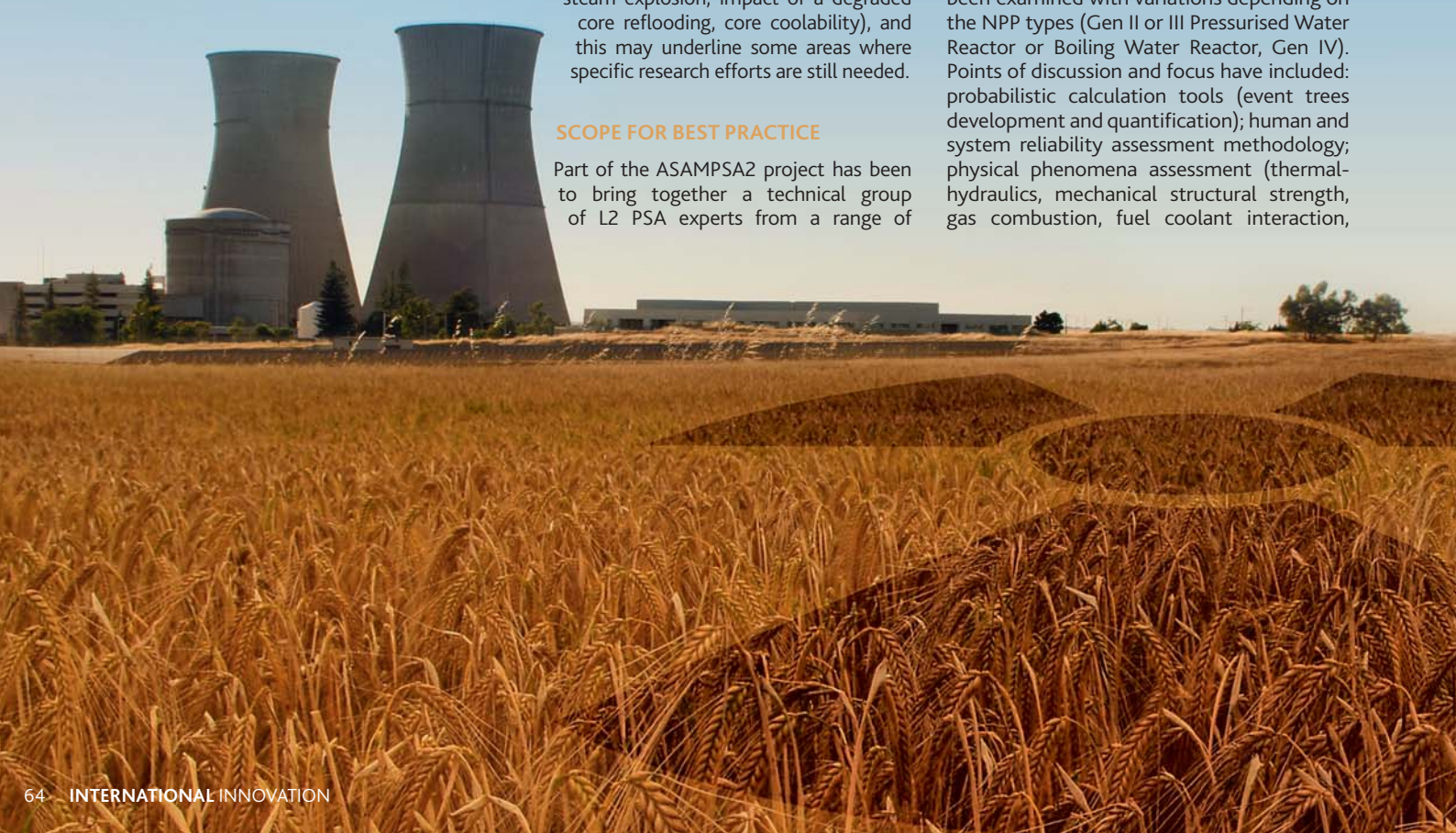
SCOPE FOR BEST PRACTICE

Part of the ASAMPSA2 project has been to bring together a technical group of L2 PSA experts from a range of

ASAMPSA2's project partners to propose some best practice guidelines for L2 PSA. Earlier on in the project, the group sought to define the notions of 'limited-scope' and 'full-scope' L2 PSA to make their task more manageable. Yet if the project was to encompass all factors and variables relating to NPP safety (all initiators of accident, all details in the accident progression including systems behaviour or repairing, uncertainties assessment), a comprehensive L2 PSA would be so huge an effort that it could not be achieved from a practical point of view. As such, when developing the guidelines, it was found that the distinction between 'limited-scope' and 'full-scope' could be difficult to define. The team decided to develop a unique set of guidelines which cover all issues relevant for L2 PSA development and application. The result is an 800 page document in three volumes: L2 PSA general consideration; L2 PSA specific recommendations for existing and future Light Water Reactors (Generation II and III); and L2 PSA for Generation IV reactors.

CHANNELLING THEIR STUDIES

Before providing specific recommendations, the project needed to discuss a very broad range of topics. To date, over 80 topics have been examined with variations depending on the NPP types (Gen II or III Pressurised Water Reactor or Boiling Water Reactor, Gen IV). Points of discussion and focus have included: probabilistic calculation tools (event trees development and quantification); human and system reliability assessment methodology; physical phenomena assessment (thermal-hydraulics, mechanical structural strength, gas combustion, fuel coolant interaction,



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fission product behaviour, etc.); and the application of simulation codes. With consideration for the efficient use of the project's resources, the different topics have been distributed between partners according to their specific knowledge.

FEEDBACK AND DISSEMINATION

Two open workshops have been organised as part of the project, and an important element of each is a comprehensive survey (in the form of a questionnaire) of participants. This aims to elucidate a clear view of end users' opinions. The first workshop in Hamburg in 2008 was hosted by Vattenfall, and aimed at identifying specific guidance needs among end users. The second workshop, set to take place in March 2011, will be hosted in Helsinki by FORTUM (Finnish utility), and will provide the opportunity to discuss the draft version of the guidelines, as well as to aid the dissemination of results. It will also be open to the wider research community: an invitation for Severe Accident Research Network (SARNET) participants has been organised, along with requests for others involved in Organisation for Economic Co-operation and Development (OECD) activities.

A GLOBAL VIEW

By the end of the ASAMPSA2 project, Raimond hopes that a global view of the capacity of NPPs to perform relevant severe accident risk assessments will be established. Raimond anticipates that the developed recommendations should be first used by the L2 PSA developers (or reviewers), and undoubtedly

some further improvement of the robustness of the L2 PSA can be expected in the next few years. Some of the project's recommendations will be proposed on the definition of severe accident research programmes, and on the development of simulation codes, which are the basis of such assessments. They already complement SARNET's Accident Source Term Evaluation Code (ASTEC), which is now considered a reference for severe accident analysis in Europe.

THE NEXT DIRECTION

The guidelines of ASAMPSA2 can serve as a basis to develop particular legislation, but specific work would be needed before going in that direction. Raimond reiterates the reach of the current project and its objectives: "The recommendations provided in the guidelines are not formulated as 'requirements' but 'good practices,'" he explains. Raimond has also revealed that some further discussions are planned with the United States Nuclear Regulatory Commission (US-NRC) and the American Nuclear Society (ANS) – the latter of whom are preparing a new L2PSA standard that will be formulated as a requirement for U.S. utilities. Whilst issues of legislation might not be in the immediate remit of ASAMPSA2, it is certain that the work of Raimond and the ASAMPSA2 partners will harmonise and improve safety assessment methodologies of NPPs across the world. Moreover, beyond the field of nuclear power, the organisation and outcomes of the ASAMPSA2 project might serve as a model for other efforts concerned with health and safety assessment within the European framework.

INTELLIGENCE

ASAMPSA2

ADVANCED SAFETY ASSESSMENT METHODOLOGIES: LEVEL 2 PSA

OBJECTIVES

ASAMPSA2 brings together nuclear industry stakeholders to develop common views on the development and application of Level 2 PSAs. The consortium partners, who were all chosen on the basis of their long experience in the development, application or review of PSAs, comprise plant operators, plant designers, technical safety organisations and research bodies.

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PARTNERS/KEY COLLABORATORS

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**ASAMPSA2
SEVENTH FRAMEWORK
PROGRAMME**