Société de Calcul Mathématique SA
(Mathematical Modelling Company, Corp.)
Tools for decision help
since 1995

Nuclear Safety

This is a whole set of methods, of disciplines, the objective of which is to make sure that no accident may occur, at any time, in any of the existing nuclear plants, or in the plants under construction. This concerns the whole life cycle of all equipments.

We worked on several aspects:

I. Natural risks

The evaluation of natural risks (for instance earthquakes) concerns nuclear safety, but more generally all activities, including transportation. One needs data which are reliable enough, so that the probability of occurrence of each risk may be estimated, as well as the possible consequences.

II. Probabilistic methods for nuclear safety

A safety concern is usually addressed by means of scenarii, which describe the occurrence of an accident and its consequences. Many parameters may appear; the methods built by SCM allow a "hierarchy" of these parameters, that is a ranking in order of importance. Those which appear first in this ranking are those which deserve closest attention.

Our method also allow to find the "dangerous zones" in the space of configurations: this is the set of all values, for the control parameters, which may lead to dangerous situations, such as an important increase in temperature.

III. Methodological help to concerned institutions

We worked with almost all actors of the French Nuclear Sector, and in particular:

A. Institut de Radioprotection et de Sûreté Nucléaire

We had a cooperation agreement (2010-2015) with the IRSN, under the theme "Probabilistic Methods for Nuclear Safety". Our main concerns are:

- improving measurements;
- help for inspections;
- improving the methodology in the probabilistic safety studies;
- taking uncertainties into account in computational codes;
- computing economical indicators;
- evaluating the performance of a network of sensors, such as the TELERAY network;
- evaluating the capacities of the surveillance system of the future EPR reactor;
- evaluating the consequences of malfunctions in sensors' networks.

Most of these works were published.

B. Nuclear Energy Agency, OCDE

The NEA is an intergovernmental organization, for nuclear studies, which gathers countries from North America, Europe, and Asia. Its purpose is to share the best practices in the domain of nuclear energy.

The NEA has databases of type "archive", such as the EXFOR database; they contain information relative to nuclear reactions under the form of numerical data and text. NEA also has "evaluated" databases, such as ENDF, which were treated by experts. The result of this treatment is usually the definition of a continuous curve, from isolated experimental points.

The questions we had to face concern the existence of aberrant data in the archive databases and poor evaluations in the evaluated databases. We had 5 contracts (from 2010 to 2016) and we developed robust probabilistic tools, allowing NEA to detect aberrant data, both isolated or in groups.

Most of these works were published.

IV. Publications

1. Books

Bernard Beauzamy: Nouvelles Méthodes Probabilistes pour l'évaluation des risques. SCM SA. ISBN 978-2-9521458-4-8. ISSN 1767-1175, april 2010 (in French).

Olga Zeydina - Bernard Beauzamy: Probabilistic Information Transfer, SCM SA, ISBN 978-2-9521458-6-2, ISSN 1767-1175, april 2013 (in English).

Bernard Beauzamy: Méthodes probabilistes pour la gestion des risques extrêmes. SCM SA, ISBN: 978-2-9521458-9-3, ISSN: 1767-1175, june 2015 (in French).

2. Ph.D. Thesis

Olga Zeydina: Probabilistic Methods for Nuclear Safety, december 2011.

3. Articles

[1] Bernard Beauzamy, Hélène Bickert, Olga Zeydina (SCM), Giovanni Bruna (IRSN): Probabilistic Safety Assessment and Reliability Engineering: Reactor Safety and Incomplete Information. Proceedings of ICAPP 2011 Nice, France, May 2-5, 2011 Paper 11399 http://scmsa.eu/RMM/ART_2011_ICAPP_11399.pdf

[2] Emmeric Dupont (NEA), Bernard Beauzamy (SCM), Hélène Bickert (SCM), M. Bossant (NEA), Carmen Rodriguez (SCM), N. Soppera (NEA): Statistical Methods for the verification of databases. Publication de la Nuclear Energy Agency de l'OCDE, 2011. http://www.oecd-nea.org/nea-news/2011/29-1/29-1-int-e.pdf#page=31

[3] O. Zeydina (SCM), A.J. Koning (NEA), N. Soppera (NEA), D. Raffanel (SCM), M. Bossant (NEA), E. Dupont (NEA), and B. Beauzamy (SCM): Cross-checking of large evaluated and experimental databases, Science Direct, Nuclear Data Sheets 120 (2014) 277–280. http://www.scmsa.eu/archives/NEA_SCM_2014.pdf

[4] F. Godan (SCM), O. Zeydina (SCM), Y. Richet (IRSN), B. Beauzamy (SCM): Reactor Safety and Incomplete Information: Comparison of Extrapolation Methods for the Extension of Computational Codes. Proceedings of ICAPP 2015 Nice, France, May 3-6, 2015, Paper 15377. http://scmsa.eu/archives/ART_IRSN_SCM_15377.pdf

[5] Emmeric Dupont (CEA): Exfor: Improving the quality of International Databases. NEA News, 2014, 32.1, p. 28. http://www.scmsa.eu/archives/EXFOR_NEA_News_2014_32.pdf

[6] Achim Albrecht (ANDRA) and Stephan Miquel (SCM): Modelling soil and soil to plant transfer processes of radionuclides and toxic chemicals at long time scales for performance assessment of Radwaste disposal. Geophysical Research Abstracts, Vol. 17, EGU2015-10476-1, 2015 http://www.scmsa.eu/archives/ART_Albrecht_Miquel_Modelling_Soil_2015.pdf

[7] Bernard Beauzamy : La Méthode de Wilks, utilisation incorrecte pour les études de sûreté, publications de la SCM, janvier 2016. http://www.scmsa.eu/archives/BB_Wilks_2016_01_11.pdf

[8] Gottfried Berton (SCM) : Verification of the databases EXFOR and ENDF. Nuclear Energy Agency, JEFF Meetings - Session JEFF Experiments, November 28 - December 1, 2016. http://www.scmsa.eu/archives/SCM_NEA_JEFF_Meeting_2016_11.pdf

V. Recent contracts

– IRSN, 2003-2007: Improving the methodology in order to handle enrichment in Uranium and Plutonium

- Framatome-ANP, 2003-2004. Probabilistic methods for the study of accidents (thermo-hydraulic analyses)
- CEA, Saclay, 2005-2006: Analysis of the risks connected with the transportation of dangerous materials and connected with the flight of planes over the site
- ANDRA, 2007: Probabilistic analysis of radionuclides transfer
- Institut de Radioprotection et de Sûreté Nucléaire, 2007-2011: Applying the Probabilistic Hypersurface Method to the problems of safety for nuclear reactors
- EdF, CIDEN, 2007: Probabilistic methods for nuclear plants decommissioning
- CEA, Saclay, 2007: Probabilistic methods for earthquakes analysis
- CEA, Saclay, 2007-2008: Probabilistic methods for epidemiology
- Delegation for Nuclear Safety, Defense concerns, 2007-2008: Probabilistic studies
- IRSN, 2009, 2012: Tools for inspections help
- IRSN, 2009: Methodology for probabilistic studies for safety
- ANDRA, 2009-2012: Mathematical models for the propagation of radionuclides in the soil
- Areva, 2010: Probabilistic methods for the study of a site devoted to nuclear waste
- IRSN, 2010-2011: Mathematical analysis of the surveillance sensors in a nuclear reactor
- Nuclear Energy Agency (OCDE), 2010-2015: detection of aberrant data
- IRSN, 2012: Computing economical indicators in the case of serious nuclear accidents
- Areva, 2012-2013: Probabilistic methods for the assessment of mechanical properties of steel parts
- IRSN, 2013: Statistical analysis on tritium data
- IRSN, 2013-2015: Methodological help about the national accounting for nuclear components
- IRSN, 2013-2015: Analysis of the TELERAY Network: surveillance of radioactivity in the environment
- IRSN, 2014: Analysis of the "residual risk", for nuclear safety
- EDF/SEPTEN, 2015: Taking into account uncertainties in the Probabilistic Studies for Safety
- IRSN, 2015: Comparison of two extrapolation methods (EPH and Krigeing) for the reconstruction of missing data
- IRSN, 2015-2016: Malfunctions in sensors' networks
- ANDRA, 2016 : Optimization of the position of sensors in a site for nuclear waste.