IRSN

INSTITUT
DE RADIOPROTECTION
ET DE SÛRETÉ NUCLÉAIRE

Enhancing nuclear safety

2010
ANNUAL REPORT

ENHANCING NUCLEAR SAFETY IN FRANCE AND AROUND THE WORLD

IRSN, a public authority with industrial and commercial activities, was set up under Article 5 of French Act No. 2001-398 of May 9, 2001, enacted through Order No. 2002-254 of February 22, 2002. This Order was amended on April 7, 2007. The Institute is placed under the joint authority of the Ministries of Defense, the Environment, Industry, Research, and Health.

It is the nation's public service expert in nuclear and radiation risks, and its activities cover all the related scientific and technical issues. Its areas of specialization include the environment and radiological emergency response, human radiation protection in both a medical and professional capacity, and in both normal and post-accident situations, the prevention of major accidents, nuclear reactor safety, as well as safety in plants and laboratories, transport and waste treatment, and nuclear defense expertise.

IRSN interacts with all parties concerned by these risks (public authorities, in particular nuclear safety and security authorities, local authorities, companies, research organizations, stakeholders' associations, etc.) to contribute to public policy issues relating to nuclear safety, human and environmental protection against ionizing radiation, and the protection of nuclear materials, facilities, and transport against the risk of malicious acts.

HUMAN RESOURCES

1,768 (1)

employees, including many specialists, such as engineers, doctors, agronomists, veterinarians, technicians, experts and researchers, including 36 doctors or persons qualified to direct research. IRSN is also the place of work of

- **85.5**(2) **doctorate students,**
- **28**(2) **post-doctorate students.**

BUDGET(3)

296.4€M

spent by IRSN in 2010

- **43.3% of budget devoted to research,**
- **47.9% of budget allocated to technical support and public service missions.**

(1) This workforce consists of 1,638 persons on permanent contracts and 130 on fixed-term contracts (including 62 persons assigned to other organizations, but excluding 24 temporary assignments).
(2) Expressed in full-time equivalent terms.
(3) Budget excluding property restructuring project and special fund. See Financial Report for further details.

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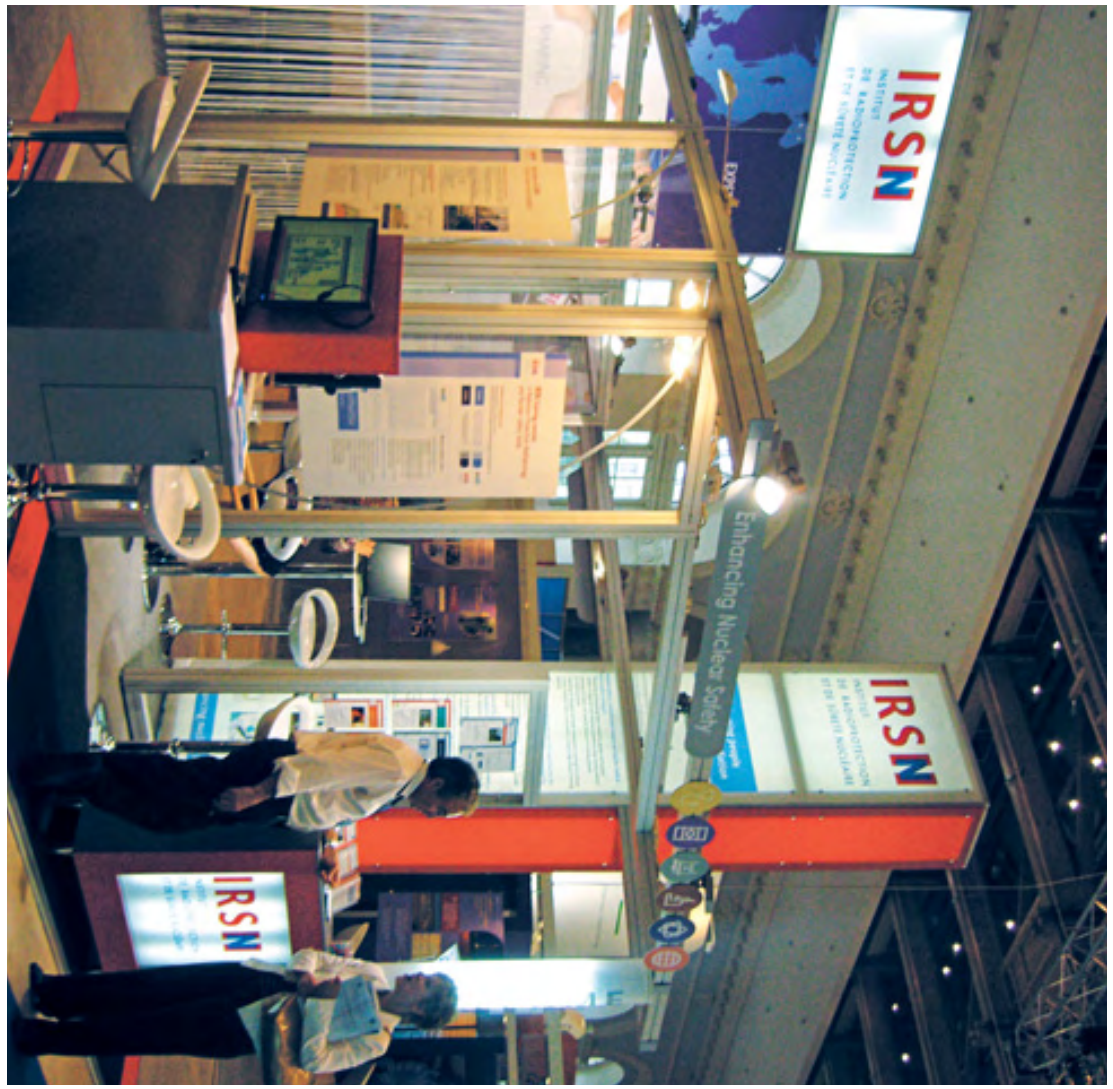
03 ACTIVITIES

04 EFFICIENCY

+ 01

IRSN took part for the first time in ATOMEXPO, a forum organized by Russia's nuclear industry. IRSN offered assessment, study, research, and training services to a public composed of Russian, Indian, Chinese, and Italian organizations.

MOSCOW, RUSSIA | JUNE 7-11



ORGANIZATION

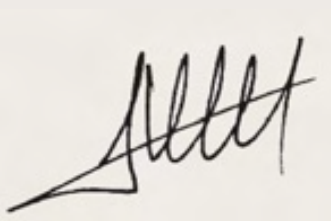
> In 2010 IRSN completed all the necessary steps to consolidate its governance.

AGNÈS BUZYN, CHAIRPERSON

In 2010, IRSN fulfilled all its assessment, research and training obligations, and moved forward with its initiative to open up to society, inform the public, and promote transparency in its activities, thus confirming its credibility in the eyes of French society as a whole, during a period overshadowed by the recent Japanese nuclear crisis. This activity report provides an overview of all the Institute's 2010 activities, together with a certain number of cross-disciplinary reports concerning radiation protection, nuclear safety, and environmental monitoring that have been submitted to the authorities and released to the public at large.

In addition to conducting its daily business in 2010, IRSN completed all the necessary steps to consolidate its governance. Thanks to the commitment of all its employees, the Institute saw its ISO9001 certification renewed, a clear reflection of efficient management and high quality. The Contract of Objectives between the State and IRSN for the period 2010-2013, a major strategic instrument governing exchange between IRSN and the French authorities, was completed and signed by the Institute's supervisory ministries at the beginning of 2011. The latest version of the contract includes some new indicators which, although simplified, are better suited to realities in the field. They will be used to monitor the Institute's performance in accomplishing its tasks year by year. Lastly, IRSN's research activities were evaluated by AERES, an evaluation that the Institute came through successfully. The recommendations made during the evaluation process, combined with an ongoing restructuring initiative in certain areas of internal organization, should put the Institute in a position to rise to the major challenges that lie ahead in the field of safety and radiation protection.

As part of a drive to cut government spending, state-run institutions and organizations have been asked to make a greater effort towards cost-effective management. This constraint has encouraged the Institute to pursue its efforts to plan effectively and define its priorities. It has also raised questions as to the funding of certain activities. In this respect, the Government decided to compensate for the cut in the public grant to IRSN in 2011 by setting up a special annual contribution to be paid by nuclear operators to partially finance work conducted by IRSN to support the French nuclear safety authority, the ASN. Talks are still underway to address the issue of funding for the Institute's major research programs, such as those involving the Cabri reactor. It is essential for these talks to succeed, as IRSN's research is one of the mainstays of nuclear safety in the long term. Nothing is ever achieved for good where nuclear safety is concerned, which is why the Institute must constantly open up new avenues of research to ensure that it can go on adding to the body of knowledge needed to drive progress in nuclear safety and radiation protection. With this in mind, IRSN can and must build on the results of the recent AERES evaluation and the opinions of the Nuclear Safety and Radiation Protection Research Policy Committee (COR). One example of this is the opinion issued on extending the service life of nuclear reactors, a prospect that has already begun to raise new and sometimes unexpected questions concerning safety. Similarly, recent events in Japan have pushed back the limits and margins for which we were prepared, obliging us to consider increasingly complex emergency response situations, and review safety at nuclear facilities in France. Our expertise will be needed in situations beyond the scope of our routine assessment activities, while our research teams will be called on to tackle new issues. If it is to rise to all these challenges, the Institute must open up and draw on the support of existing and future cooperation structures and partnerships, both at home and abroad. It is a matter of preserving the scientific and technical excellence for which the Institute's research activities are renowned, and working to ensure that its recognized performance as a public expert continues to build on innovative, forward-looking research in an increasingly competitive, globalized world. In this way, it will be sure to preserve the skills and expertise it needs to fulfill its public service obligations and safeguard its values of excellence and independence. ■



> Enhancing nuclear safety in France and around the world, in industry, science, regulations, and society.

JACQUES REPUSSARD, DIRECTOR GENERAL

IRSN came into legal existence under the terms of an Act passed by the French parliament on May 9, 2001, in recognition of the need to consolidate the nation's nuclear safety and radiation protection institutions.
With this in mind, it was decided to create a new public institution that would be independent from the French Atomic Energy Commission (CEA) and from nuclear operators. The new institution would be tasked with providing the public authorities with high-level, independent assessments to help implement national policy in the field of nuclear safety, and radiological environmental protection, occupational health and safety, and public health.

Less than ten years on, observers who keep themselves regularly informed of IRSN's activities and results all agree that the Institute has now achieved a high degree of scientific, technical and organizational maturity. It is regarded by other institutions and the media as "the French public expert in nuclear and radiological risks".
Its opinions are respected because they are founded on expert knowledge of state-of-the-art science, and on the considerable technical experience the Institute has acquired in the past thirty years or more spent in close observation of nuclear facilities operating in France and abroad, in research work, and onsite activities in the field of radiation protection.

Following a clear strategy backed by its supervisory ministries, and drawing on the commitment and scientific and technical strengths of its 1800 or so employees, IRSN continues to progress.
To a great extent, the Institute owes these promising results to the strong commitment of its personnel, and to support from the public authorities and parliament.
The 2010 Budget Act set up an additional public funding system for the Institute, based on a "contribution" to be paid by nuclear operators. This decision is a clear sign that policy makers recognizes the need for sufficient, long-term funding to support research and scientific assessments in the field of nuclear safety and security.

IRSN does not work alone, however. New and outstanding examples of scientific cooperation are emerging. For example, the Institute's excellent scientific relations with Météo-France deserve a special mention, as they made it possible to forecast occurately the dispersal of release from the Fukushima nuclear power plant across the northern hemisphere.
Similarly, 2010 saw the creation of several joint laboratories with universities and the CNRS, alongside IRSN's long-standing relationship with CEA's research teams.
The new laboratories should generate a wealth of programs combining fundamental research with the Institute's main applied research priorities.
If IRSN is to make optimum use of the significant public funds allocated to it, then it must also implement a strict management policy, based on:

- quality assurance in production processes, validated by ISO 9001 certification,
- constantly optimized human resource management, with a demanding hiring policy and proactive careers advancement measures, in line with best practices. This is essential in an institute with a relatively young workforce (average age under forty-two years) and whose leading experts are justifiably prime targets for nuclear industry recruitment agencies,
- improved risk control, which calls in particular for heightened awareness of internal risks, and the development of a special structure for organizing emergency response and speeding up the related decision-making process. IRSN is not immune to risks liable to interfere with its own activities and objectives. This was demonstrated by the radiological incident at the Feursmétal plant in May 2010, and by costs and delays in the renovation program concerning the Cabri reactor operated by CEA for IRSN.

Further progress in nuclear safety must now be achieved to reach a still higher level of assurance that extensive areas around nuclear sites cannot be seriously polluted in the event of an accident. Such progress calls for a concerted effort in the four aspects – industrial, scientific, regulatory, and societal – that are central to effective performance in nuclear safety. In the wake of the Fukushima disaster, progress in this field will no doubt receive more urgent attention worldwide. IRSN must

FOREWORD

therefore pursue its action in this direction, nationally and within Europe. A European framework is often well suited to research and development efforts and initiatives to share knowledge and pool certain emergency response resources. In 2010, IRSN endeavored to promote scientific and technical cooperation among technical safety organizations (TSOs), by consolidating ETSON, the European association that brings them together, and through research networks such as SARNET, which sets the standard for research into the management of nuclear reactor core meltdown accidents.
The Institute also contributed to efforts to disseminate knowledge. As part of these efforts, it joined other TSOs in founding ENSTTI, the European Nuclear Safety Training and Tutoring Institute, further to the French President's announcement at the Paris international nuclear conference in April 2010.

The importance of the economic and societal factors of radiation protection have been brought to our attention not only by the Fukushima accident, but also by incidents which, although negligible in comparison with the disaster in Japan, are closer to home, one example being the incident in St-Maur-des-Fossés near Paris, which caused small quantities of tritium to be released in an urban environment.
Effective management of nuclear or radiological accidents and incidents relies on a number of vital parameters, including the ability to develop models to predict the migration of radionuclides in natural environments, rapidly obtain the results of field measurements performed to quantify any additional radionuclides present in the environment or in foodstuffs, and carry out fast and thorough assessments of doses received by exposed populations.

IRSN is among the few expert organizations in the world with the necessary skills and resources to perform such operations. As evidence of this, the Institute had the honor of being designated as a World Health Organization reference center in the field of radiation protection.
Nonetheless, many challenges still lie ahead for radiation protection scientists, and much remains to be done to develop measurement methods that will deliver high-quality results with the speed that the situation demands.
Progress must also be made to understand more about how radioactivity affects living organisms exposed over long periods to doses which, though low, are higher than those associated with natural radioactivity. Here, too, international cooperation is the best answer. In 2010, IRSN was involved in setting up MELODI, an international association for research into the effects of low-dose radiation. It also headed a group of European organizations in creating a network of excellence specialized in radioecology research.

"Enhancing nuclear safety in France and around the world" – this is the motto that IRSN has chosen to illustrate its contribution to the combined efforts of all those determined to rise to this challenge. Just a few words to encapsulate a large number and wide variety of activities in the field, to support the many partners and customers whose satisfaction is our greatest achievement. ■

An organizational structure adapted to defense and security assessment activities.

MICHEL BRIÈRE, DEPUTY DIRECTOR GENERAL IN CHARGE OF DEFENSE-RELATED MISSIONS

Eight years after IRSN's Nuclear Defense Expertise Division was set up, the time seems ripe for a reminder of its goals, resources and activities.
The Order enacted to create IRSN stipulates that the purpose of the Division is to carry out activities aimed at ensuring the application of the defense code in the nuclear sector, whether for civil or defense purposes. In most cases, these activities consist of assessments performed directly as part of the Government's action, or in a support capacity and, whenever necessary, in compliance with official secrets legislation. They are carried out by one of the following four departments depending on their type:

■ **The Nuclear Defense Safety Assessment Department** employs twenty engineers who are perfectly familiar with defense-related nuclear facilities and activities. Drawing on the Institute's various fields of expertise (civil engineering, criticality, mechanical engineering, seismic design, radiation protection, etc.), they analyze files submitted by operators in the defense sector or other branches of industry and give their opinion regarding compliance with safety and radiation protection requirements to the safety authority for defense-related activities. Without losing sight of the purpose served by military applications, the methods and reference systems used by the Department's engineers are, wherever possible, based on those used in safety analysis for civil applications. Every year, IRSN responds to a hundred or so assessment requests from the Representative in charge of Nuclear Safety and Radiation Protection for Defense-related Activities and Facilities.

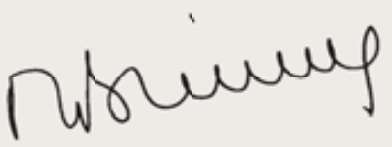
■ **The Nuclear Facility Security Department** consists of thirty experts specialized in protection against malicious acts relating to nuclear materials, facilities, and transportation. They carry out two types of activity:
– examining files submitted by operators concerning physical protection, accountancy and control of nuclear materials at their facilities. Nearly 400 files are examined each year for the competent authority,
– supporting the above authority by performing facility inspections (about a hundred every year).

■ **The International Inspections Application Department** employs twenty specialists who provide the relevant authorities with the technical support required to implement international agreements and bilateral undertakings signed by the French Government on nuclear materials control, and in connection with the ban on chemical and biological weapons. Every year, these specialists prepare and assist about fifty inspections conducted by Euratom or the IAEA, as well as ten or so OPCW inspections in France.

■ **The Technical Support and Study Department** employs a little over thirty specialists who carry out the following activities:
– centralized accountancy of nuclear materials (excluding the nuclear deterrent) as part of the national control of these materials, and in connection with French obligations to submit declarations for accountancy purposes under international nuclear non proliferation agreements,
– examination of nuclear transportation security files, operational control of these shipments, and inspections for the competent authority. IRSN controls some 1600 nuclear materials shipments per year,
– research and studies to support activities relating to protection against malicious acts targeting nuclear materials, facilities and transportation.

The activities of the Nuclear Defense Expertise Division are inspected several times a year by a steering committee that brings together representatives of the chief civil and military authorities responsible for ensuring compliance with the defense code in the nuclear field. This committee reports to the Board of Directors.

IRSN devotes almost eight per cent of its resources to the activities concerning application of the defense code in France, in the area of nuclear safety, security and proliferation. The provisions made in accordance with the Order enacted to create IRSN, take account of the specific nature of these activities, while drawing on the Institute's knowledge, methods and policies as a whole. ■



KEY EVENTS

FEBRUARY 2

The website of the French national network of environmental radioactivity measurements (RNM) was set up. This site (www.mesure-radioactivite.fr) provides the public with access to all the environmental radioactivity monitoring data made available by the various organizations concerned: government departments, nuclear operators, associations, and so on.

JANUARY 21-22

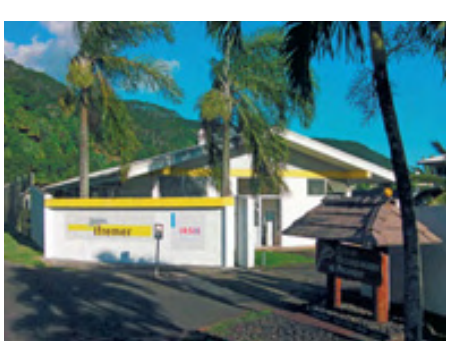
A technical seminar was held in China to discuss problems relating to the construction of nuclear power plants inland. The seminar was jointly organized by IRSN and Huaneng, the future constructor of the AP 1000 plant, under the aegis of the China Nuclear Energy Association (or CNEA, the Chinese equivalent of SFEN, the French nuclear energy society), and the Nuclear Safety Center (NSC), IRSN's counterpart in China.

JANUARY 22

The Finnish Minister of the Economy and Employment appointed an IRSN expert, Giovanni Bruna, as Chair of the Evaluation Committee of Finland's four-yearly research and development program on nuclear power plant safety.

FEBRUARY 4

Marie-Luce Penchard, Minister of Overseas France, Adolphe Colrat, High Commissioner of the Republic for French Polynesia, and Gaston Tong Sang, President of French Polynesia, visited LESE, the IRSN laboratory for environmental studies and monitoring set up at the local site of IFREMER, the French research institute for exploration of the sea, in Vairao, Tahiti. The visit was organized in connection with plans to develop an observatory for monitoring pollutants in Polynesian lagoons, including metals, radioactive substances, hydrocarbons and organochlorine compounds).



MARCH 8

French President, Nicolas Sarkozy, announced the creation of ENSTTI, the European Nuclear Safety Training and Tutoring Institute. The President made the announcement during his opening speech at the International Conference on Access to Civil Nuclear Energy at the OECD in Paris.

MARCH 16

Two IRSN/CNRS joint laboratories were officially opened, namely C3R for the study of chemical kinetics, combustion, and reactivity with the University of Lille I, and ETIC, for the study of fires in enclosed spaces, with the Universities of Aix-Marseille I and II.

MARCH 25

Pierre Moscovici, President of PMA, the Metropolitan Community of Montbéliard, and Jacques Repussard,

Director General of IRSN, signed a cooperation agreement on radiation protection. Under the three-year agreement, a center of expertise in radiation protection will be set up and a radiation protection culture developed within PMA.

APRIL 7

IRSN's Ethics Commission held its first meeting.

APRIL 9

A framework agreement on cooperation was signed by ENEA, the Italian national agency for new technologies, energy and sustainable economic development, and IRSN. Under the agreement, the two organizations will collaborate extensively on various aspects of nuclear safety. The first two areas in which the agreement will come into effect concern public information on nuclear reactor safety, and personnel exchange and training.

APRIL 16

Jean-Denis Combrexelle, Director of Labor Relations, visited IRSN. During his visit, the Institute's Director General presented him with the latest developments concerning SISERI, the information system for occupational dosimetry registration, as well as innovative techniques (calixarenes) aimed at improving dose assessment following internal contamination or radiological accidents.

JUNE

AERES, the French agency for the evaluation of research and higher education, began its audit of IRSN's research units.

JUNE 9

Denis Flory, IRSN's former Director of International Affairs, was appointed Deputy Director General of the IAEA (becoming the first Frenchman ever to occupy this position) and Head of the Department of Nuclear Safety and Security.

JUNE 28

Claire Cousins, Chair of ICRP, the International Commission on Radiological Protection, paid her first visit to IRSN. During her talks with the Institute's Director General, the issue of changes in the relations between ICRP and leading radiation protection organizations was raised.

JULY 5

IRSN launched Aktis, its new multimedia newsletter devoted to all fields of science. Supplements to update the topics covered in this quarterly publication are published regularly on the Institute's website.

JULY 20

ASN and ATMEA, a joint subsidiary of Areva and Mitsubishi Heavy Industries, signed a contract under which ASN and IRSN are to initiate a process to assess safety options on ATMEA1, the new 1,100 MWe reactor.

SEPTEMBER 15

The joint expert group (GEP) on uranium mines in Limousin submitted its final report to Jean-Louis Borloo, the French Minister of State and Minister for Sustainable Development, and André-Claude Lacoste, Chairman of ASN, the French nuclear safety authority. IRSN was behind the creation of the joint expert group. The report is the result of three years' work, involving fifteen members of IRSN, aimed at ensuring the long-term protection of human health and the environment.

SEPTEMBER 22

IRSN organized a public meeting in Pierrelatte, in southern France, attended by about 140 people, including local residents, elected representatives and representatives of Areva and a number of associations. The meeting was held to present the results of an IRSN study aimed at determining the causes for the traces of uranium found in the ground water around Tricastin. The study was backed by a multidisciplinary monitoring group.

SEPTEMBER 23

IRSN received a visit from Tatsuo Sato, the new Vice-President of JNES, the Japanese TSO. The aim of the visit was to renew the general cooperation agreement between the two organizations and discuss methods for developing joint service initiatives in favor of French-Japanese offers on international markets.

OCTOBER 25-29

The IAEA international conference on challenges faced by nuclear technical safety organizations (TSOs) in enhancing nuclear safety and security was held. The Tokyo conference was chaired by IRSN's Director General and organized jointly by the IAEA and the Japan Nuclear Energy Safety Organization, the Japanese TSO. Attended by 220 participants from 57 countries, the conference stressed the need for adequate scientific and technical resources in support of nuclear safety and security, and for stronger regional and international cooperation among TSOs to meet the requirements of countries with ambitious nuclear power programs.

SEPTEMBER 21-24

The "IRSN Dissertation Days" were held in Arles in the south of France, giving IRSN's doctorate and post-doctorate students an opportunity to present their research in radiation protection and nuclear safety. The event opened with a science day, during which key figures from outside the organization spoke on the theme of "Research in risk assessment".

NOV. 7-8

The EUROSAFE Forum 2010, organized by GRS, the German TSO, in collaboration with its Belgian (Bel V) and French (IRSN) counterparts, was held in the German city of Cologne. The event focused on innovation in nuclear safety and security. It was attended by more than 400 participants from thirty countries.

NOVEMBER 15

A delegation from the United States Nuclear Regulatory Commission (US NRC), visited IRSN. The delegation was led by George Apostolakis and William Ostendorff, the two new Commissioners appointed by President Obama. The members of the delegation, who had asked to meet with IRSN's Director General, were shown the Institute's work on nuclear safety. Talks centered especially on taking advantage of reviews to enhance the safety of operating reactors.

DECEMBER 16

IRSN organized the first session of the CAMARI aptitude certificate for operating industrial radiology equipment in Morocco, in partnership with CNESTEN, Morocco's national center for nuclear energy, science and technology, and AMS-AP, the Moroccan welding and pressure vessel association. ■

MAJOR REPORTS PUBLISHED

All IRSN reports and scientific and technical publications can be consulted on the Institute's website on www.irsn.fr

RADIATION PROTECTION AND HUMAN HEALTH

- Assessing the health risk relating to X-ray backscatter body scanners
  Publication date: February 2010
- Exposure to ionizing radiation relating to medical diagnostic procedures in France in 2007.
  Publication date: March 2010
- Practical guide for conducting dosimetric studies at work stations with a risk of exposure to ionizing radiation (Version 2).
  Publication date: April 2010
- Analysis of diagnostic reference levels in radiology and nuclear medicine - 2007-2008 report.
  Publication date: October 2010
- 2009 report on occupational exposure to ionizing radiation.
  Publication date: October 2010

NUCLEAR SAFETY

- Translation of the report "Enseignements tirés des incidents déclarés entre 2005 et 2008 dans les laboratoires et usines nucléaires et dans les installations nucléaires en démantèlement" (Lessons learned from incidents reported between 2005 and 2008 at nuclear laboratories and plants, and at nuclear facilities in the process of being dismantled).English translation of the December 2009 report.
  Publication date: May 2010
- Production sources and management of tritium produced by nuclear facilities.
  Publication date: July 2010
- Analytical guide to criticality risks and their prevention at plants and laboratories.
  Publication date: December 17, 2010
- IRSN's viewpoint on safety and radiation protection issues relative to French nuclear power plants in 2009.
  Publication date: January 2011

ENVIRONMENTAL MONITORING

- Dosimetric assessments of environmental management options for the area contaminated by carbon-14 around the site of the former Isotopchim laboratory in Ganagobie.
  Publication date: March 2010
- Study of the radiological impact of dredging sediment at Les Minimes port in La Rochelle.
  Publication date: April 2010
- Tritium in the environment – IRSN summary report.
  Publication date: July 2010
- Tritium in the environment – IRSN's viewpoint on key issues and avenues for research and development.
  Publication date: July 2010
- Study of the causes for the presence of uranium in alluvial ground water around Tricastin.
  Publication date: September 2010
- 2009 management report of the national network of environmental radioactivity measurements (RNM) IRSN/ASN.
  Publication date: November 2010
- Radioactive flux conveyed by the River Rhône to the Mediterranean Sea in 2008.
  Publication date: September 2010
- 2009 report on radioactivity monitoring in French Polynesia.
  Publication date: October 2010

Special report published further to the work of the joint expert group (GEP) on uranium mines in Limousin

- Critical appraisal of information on the ecological impact of mining sites on the Ritord catchment basin and Saint-Pardoux lake.
  Publication date: September 2010 - signed on June 2, 2006
- Method for assessing the environmental risk associated with the release of radioactive substances. Adaptation to the case of mining sites in Haute-Vienne.
  Publication date: September 2010 - signed on December 20, 2007
- Contribution to the assessment of the environmental risk associated with uranium release in the Ritford catchment basin.
  Publication date: September 2010 – signed on August 6, 2008
- Consideration of the impact of chemical speciation in the analysis of the ecotoxic effects of uranium in fresh water.
  Publication date: September 2010 – signed on November 12, 2009
- Preparing a proposal for an environmental quality standard for uranium in fresh water.
  Publication date: September 2010 – signed on November 20, 2009

OTHER

- IRSN barometer 2010: Risk perception.
  Publication date: July 2010
- CAMARI aptitude certificate for operating industrial radiology equipment. 2009
- Annual Report: organization, results and outlook.
  Publication date: November 2010
- 2009 Report on Research Training.
  Publication date: January 2011

Summaries of the assessment reports submitted to the advisory committees in 2010 can be downloaded from: www.irsn.fr/rubrique Notices and reports

ACTIVITY KEY FIGURES

RESEARCH

43.3% of IRSN's budget devoted to research. (45% in 2009)
(1) excluding property project and special fund.

158 publications in Journal Citation Reports. (157 in 2009)

25 dissertations defended. (28 in 2009)

329 scientific lectures at conferences. (318 in 2009)

INTERNATIONAL

Number of bilateral agreements signed with research and assessment organizations.

34 countries involved in these agreements. (36 in 2009)

84 international projects in progress. (93 including 22 projects European projects in 2009)

TECHNICAL SUPPORT FOR PUBLIC AUTHORITIES

47.9% of IRSN's budget (1) devoted to technical support and activities in the general interest. (47% in 2009)
(1) excluding property project and special fund.

84 technical notices to the ASND. (93 in 2009)

386 technical notices to the security authority. (402 in 2009)

658 technical notices to the ASN. (646 in 2009)

INTELLECTUAL PROPERTY

63 patents in force abroad. (58 in 2009)

2 software applications and databases placed with the software protection agency APP. (11 in 2009)

SERVICE CONTRACTS

39.2€M revenue. (37.7 in 2009)

24,304 customers. (23,063 in 2009)

TRAINING

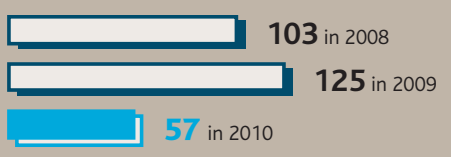
2,153 participants in IRSN training courses over the year. (3,271 in 2009)

2,406 hours of teaching given outside the Institute (universities, engineering schools, INSTN, etc.). (2,417 in 2009)

1,372 hours of education given in 140 training sessions on radiation protection. (2,387 in 2009 – 192 training sessions)

735 hours of education given in 29 training sessions on nuclear safety. (786 in 2009 – 21 training sessions)

HUMAN RESOURCES



Number of employees recruited on permanent contracts

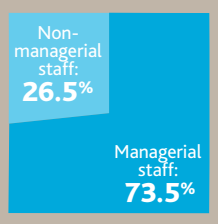
60,471 hours of training given to maintain the skill levels of engineers and experts. (61 293 en 2009)

Average age

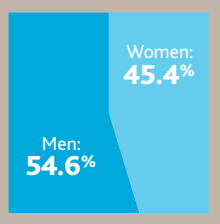
41.1 for women

42.6 for men

Proportion of managerial/ non-managerial staff



Proportion of men/women



Distribution of employees on permanent contracts
Paris Region: 1,314 employees
Southeast Region: 324 employees

DISSEMINATION OF KNOWLEDGE

1,631,014 visits to the IRSN website.
(1,700,000 in 2009)

41 notices and reports published on the IRSN website.
(41 in 2009)

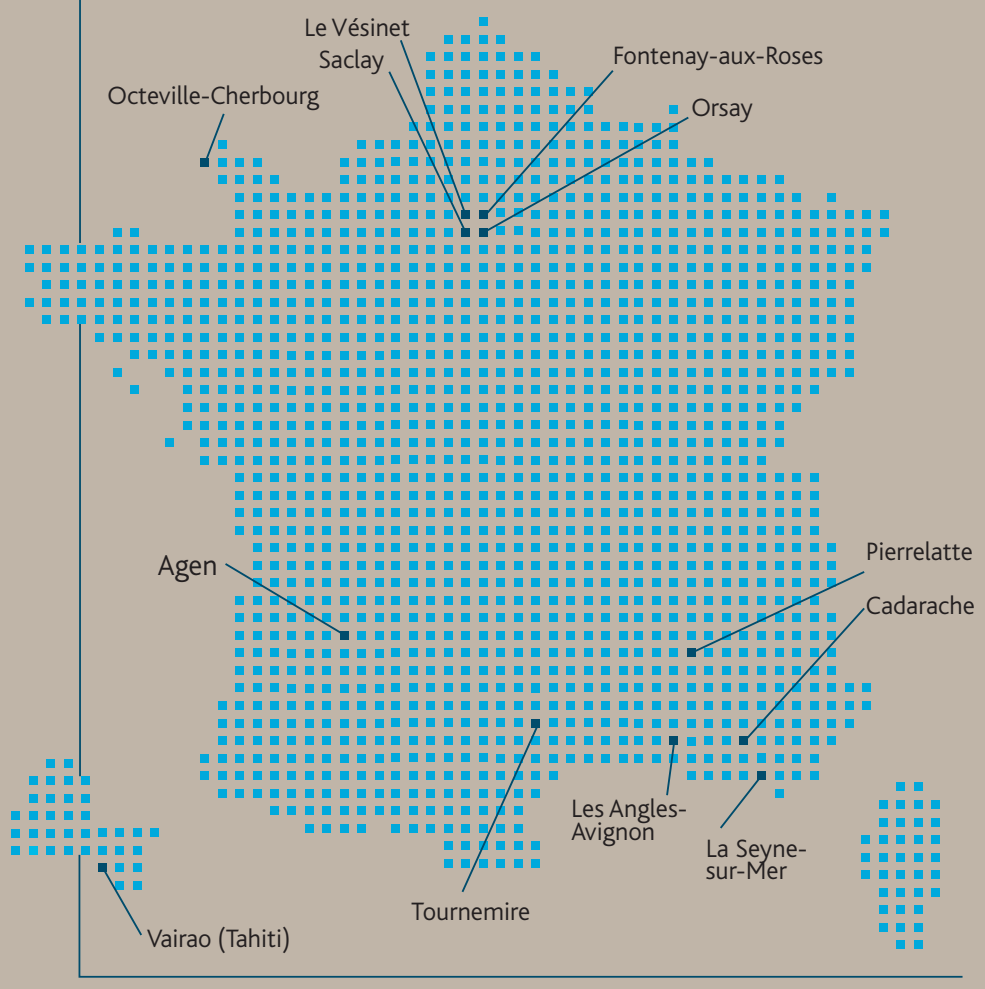
12 IRSN operations at local information committees.
(16 in 2009)

204,000 consulted in the "Research" section (formerly the "scientific site") of the IRSN website.
(234,000 in 2009)

25 requests for IRSN action received from local information committees.
(30 in 2009)

1 IRSN publication.
(2 in 2009)

LOCATIONS as of december 31, 2010

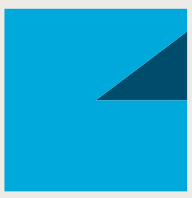


BUDGET BREAKDOWN

316 €M revenue. (283 €M in 2009)

313 €M expenditure including 25 €M for equipment investment.
(301 €M including 23 €M in 2009)

Operating and investment expenditure



10.23% Investment

89.77% Operating expenses

Total funding

73.14% Budget Act 189 grant

1.02% Budget Act 212 grant

25.84% Other French funds (aside from Budget Act)

French funds (aside from Budget Act)

Other 77.89% including 20.99% loan

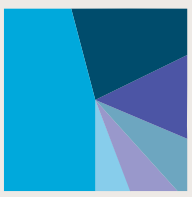
EDF 9.94%

State 6.59%

Areva 2.82%

CEA 2.76%

Foreign funds



Riskaudit 45.86%

Other 21.67%

EU 14.13%

Stockholm University 6.77%

Batelle Energy Alliance 5.88%

Stuk Radiation and Nuclear 5.69%

ORGANIZATION CHART

EXECUTIVE COMMITTEE (as of April 30, 2011)

The IRSN Executive Committee is chaired by the Director General and made up of 20 members representing the Institute's operational and functional divisions. It meets twice monthly to examine matters of strategy, development, operation, and the positions adopted by the Institute on various topics.

> Executive committee - From left to right and from top to bottom: Didier Demeillers and Marc-Gérard Albert / Alain Cernès / Bruno Dufer and Jacques Repussard / Jean-Bernard Chérié and Marie-Pierre Bigot / Patrick Gourmelon / Daniel Quéniart and Jean-Luc Pasquier / Jérôme Joly / Michel Schwarz / Michel Brière / Patricia de la Morlais / Martial Jorel and Thierry Charles / Jean-Claude Micaelli / Didier Champion and Matthieu Schuler.

BOARD OF DIRECTORS

Agnès BUZYN, Chairperson

GENERAL MANAGEMENT

Jacques REPUSSARD, Director General

Michel BRIÈRE, Deputy Director General in charge of defense-related missions

Jean-Bernard CHÉRIÉ, Deputy Director General in charge of administrative affairs

Jean-Luc PASQUIER, Deputy Director

Michel SCHWARZ, Scientific Director

Alain CERNÈS, Inspector General

Daniel QUÉNIART, Advisor

OPERATIONAL DIVISIONS

NUCLEAR DEFENSE EXPERTISE

Jérôme JOLY, Director

> Safety of defense-related nuclear facilities
> Security of nuclear materials, transport and facilities
> Enforcement of international inspections
> Technical support and studies

ENVIRONMENT AND RESPONSE

Didier CHAMPION, Director

> Study of radionuclide behavior in ecosystems
> Study and monitoring of radioactivity in the environment
> Environmental sample processing and metrology
> Analysis of risks related to the geosphere
> Radiation protection response and support
> Emergency situations and response organization

PREVENTION OF MAJOR ACCIDENTS

Jean-Claude MICAELLI, Director

> Experimental study and modeling of the behavior of fuel and its component materials in accident situations
> Experimental study and modeling of fires
> Experimental study and modeling of core meltdown accidents

RADIATION PROTECTION AND HUMAN HEALTH

Patrick GOURMELON, Director

> Radiation protection studies and assessments
> Radiobiology and epidemiology
> External dosimetry
> Internal dosimetry

REACTOR SAFETY

Martial JOREL, Director

> Pressurized water reactors
> Gas-cooled, fast-neutron and experimental reactors
> Equipment and structures
> Systems and risks
> Thermal-hydraulics, reactor core and operation of nuclear facilities
> Severe accidents and radiological consequences
> Human factors

SAFETY OF PLANTS, LABORATORIES, TRANSPORT AND WASTE

Thierry CHARLES, Director

> Fuel cycle transport and facilities
> Laboratories, irradiators, accelerators and decommissioned reactors
> Radioactive waste
> Industrial risks, fire and containment
> Criticality
> Air dispersion of pollutants

FUNCTIONAL DIVISIONS

STRATEGY, DEVELOPMENT AND PARTNERSHIPS

Matthieu SCHULER, Director

> General strategy with a strong focus on scientific and technical content
> Partnership and contracting policy
> Relations with supervisory authorities, partners and customers
> Openness to society
> Promotion and development of the Institute
> Strategic technology watch and exploiting knowledge
> Teaching and training in radiation protection and nuclear safety

INTERNATIONAL AFFAIRS

Marc-Gérard ALBERT, Director

> International relations
> International business development

COMMUNICATIONS

Marie-Pierre BIGOT, Director

> Public relations
> Websites
> Information and media relations
> In-house communications

SUPPORT DIVISIONS

HUMAN RESOURCES

Patricia de la MORLAIS, Director

> Social policy
> Human resource management
> Staff administration and pay

FINANCIAL, BUSINESS AND LEGAL AFFAIRS

Didier DEMEILLERS, Director

> Budget monitoring
> Administration of expenditure and revenue
> Application of tax and customs regulations
> Cost accounting and management control
> Commercial and legal support

SECURITY, ASSETS AND INFORMATION SYSTEMS

Bruno DUFER, Director and IRSN Security Officer

> Security of assets and sites
> Buildings and logistics
> Health, safety, and environmental protection
> Sustainable development
> Information systems

ACCOUNTING OFFICE

Stéphane ROCHARD, Accounting Officer

BOARD OF DIRECTORS

Composition (as of December 31, 2010)

MISSIONS

Deliberations by the Board of Directors rule on IRSN activities. More specifically, the Board deliberates on general conditions governing the Institute's organization and operation, its strategy and program, and its annual activity report. It also approves the budget, decisions involving changes, year-end financial statements and income appropriation.

24 members

4 meetings in 2010

5-year mandate

■ TEN GOVERNMENT REPRESENTATIVES

Patrick RENVOISÉ, Nuclear Safety Inspector for DGA, the French Armament Procurement Agency, representing the Minister of Defense. **Régine BRÉHIER,** Director of Research and Innovation, representing the Minister for the Environment. **Jocelyne BOUDOT,** Deputy Director of Environmental and Food Risk Prevention at the French Directorate General for Health, representing the Minister for Health. **Thomas BRANCHE,** Deputy Director for the Nuclear Industry, Directorate General for Energy and Climate, representing the Minister for Industry. **Laurence PIKETTY,** Scientific Director of the Energy, Sustainable Development, Chemistry and Process Department of the Directorate General for Research and Innovation, representing the Minister for Research. **Guillaume DEDEREN,** Head of the Major Risks Office at the Directorate for Defense and Civil Security, representing the Minister for Civil Security. **Jean-Denis COMBREXELLE,** Director of Labor Relations, representing the Minister for Employment. **Mathieu DUFOIX,** Head of the Energy, Profit-sharing, Industry and Innovation Office at the Budget Directorate, representing the Minister for the Budget. **Marcel JURIEN DE LA GRAVIÈRE,** Representative in charge of Nuclear Safety and Radiation Protection for Defense-related Activities and Facilities. **Nicolas CHANTRENNE,** Head of the Nuclear Safety and Radiation Protection Mission.

■ SIX ADVISORY MEMBERS

Serge AUBERT, Air Force Major General, nominated by the Minister of Defense. **Jean-Claude DELALONDE,** Chairman of the National Association of Local Information Commissions and Committees, nominated by the Minister for the Environment. **Patrick LEDERMANN,** Vice-President of the Nuclear Division at Alstom Power, nominated by the Minister for Industry. **Jean-Marc CAVEDON,** Director of the Division for Research into Nuclear Energy and Safety at the Paul Scherrer Institute in Switzerland, nominated by the Minister of Research. **Agnès BUZYN,** Chairperson, Board of Directors, physician and professor of hematology, nominated by the Minister for Health. **Claude BIRRAUX,** President of the Parliamentary Office for the Evaluation of Scientific and Technological Choice.

■ EIGHT STAFF REPRESENTATIVES

Yves BRISSET, CFE-CGC. **Nicolas BRISSON,** CGT. **François DUCAMP,** CGT. **Thierry FLEURY,** CFDT. **François JEFFROY,** CFDT. **Yves LE RESTE,** CFE-CGC. **Christophe SERRES,** CFDT. **Carine STRUP-PERROT,** CGT.

■ EX OFFICIO OR ASSOCIATE MEMBERS

Laurent MICHEL, Director General of Risk Prevention and Government Commissioner. **Bernard ABATE,** Auditor General. **Jacques REPUSSARD,** Director General. **Michel BRIÈRE,** Deputy Director General in charge of defense-related missions. **Stéphane ROCHARD,** Accounting Officer. **Philippe BOURACHOT,** Works Committee Secretary. **André-Claude LACOSTE,** Chairman of the French Nuclear Safety Authority.

MAIN ACCOMPLISHMENTS 2010

- **Definition of the basis for discussions on the future of the Cabri water loop project,**
- **Review of IRSN's organizational structure and general operating rules,**
- **Launch of phase 1 of the property restructuring project for the Fontenay-aux-Roses site.**

STEERING COMMITTEE FOR THE NUCLEAR DEFENSE EXPERTISE DIVISION – CODEND

Composition (as of December 31, 2010)

MISSIONS

The committee examines the activity program prepared by the Nuclear Defense Expertise Division before it is submitted to the Institute's Board of Directors. It is consulted when the Board of Directors is called upon to make decisions relating specifically to the organization or running of this Division and advises the Board of Directors on matters related to division activities.

Marcel JURIEN de la GRAVIÈRE, Chairman of CODEND, Representative in charge of Nuclear Safety and Radiation Protection for Defense-related Activities and Facilities. **Laurent MANDARD,** Commander, representative of the Armed Forces Chief of Staff. **Patrick RENVOISÉ,** Engineer General for Armaments, representing the DGA, the French defense procurement agency. **Rony LOBJOIT,** Colonel, representing the administrative Secretary General of the Ministry of Defense. **Éric CHAPLET,** Rear-Admiral, Nuclear Weapons Inspector. **Mathieu DUFOIX,** representing the Budget Director. **Sabine SCIORTINO,** representing the Director of Strategic Affairs, Security and Disarmament at the Ministry of Foreign and European Affairs. **Alain ROCCA,** Head of the Economic and Nuclear Infrastructure Security Department for the Senior Defense and Security Official of the Ministry of Industry. **Laurent DEMOLINS,** Brigadier-General, Head of the Department of Defense, Security and Economic Intelligence, representing the Senior Defense and Security Official at the French Ministry of Ecology, Sustainable Development, Transport and Housing. **Jean-Baptiste FLEUTOT,** Chief Medical Officer of the French Armed Forces, advisory member appointed by the Minister of Defense. **Serge POULARD,** advisory member appointed by the Minister for Industry.

MAIN ACCOMPLISHMENTS 2010

• Review of defense and safety aspects of the following:

– DEND 2009 Activity Report and IRSN 2009 Annual Report,
– Medium- and Long-term Plan,
– DEND activity program for 2011.

11 members

2 meetings in 2010

5-year mandates for the two advisory members

SCIENTIFIC COUNCIL

Composition (as of December 31, 2010)

MISSIONS

The Scientific Council examines and gives its opinion on IRSN activity programs and ensures that its research programs are scientifically relevant and of the highest quality. It examines program results in order to prepare recommendations on Institute strategy. It may be consulted by the Board's Chairperson or by the supervisory ministers on any subject that comes under the Institute's authority.

12 members

2 meetings in 2010

5-year mandate

Michel QUINTARD, Scientific Council Chairman, CNRS Research Director at the Toulouse Institute of Fluid Mechanics, nominated by the Minister for Research. **Philippe ACKERER,** Deputy Director of the Institute of Fluid and Solid Mechanics in Strasbourg, nominated by the Minister for the Environment. **Jean-Claude ANDRÉ,** Emeritus Research Director, Scientific Advisor at the CNRS Institute for Engineering and Systems Science, nominated by the Minister for Labor. **Dietrich AVERBECK,** CNRS Emeritus Research Director at the Curie Institute, nominated by the Minister for Health. **Bernard BONIN,** Deputy Scientific Director of the CEA Nuclear Energy Division nominated by the Minister for Research. **Yves-Sébastien CORDOLIANI,** medical practitioner, human radiation protection expert, nominated by the Minister for Health. **Denis GAMBINI,** medical practitioner, researcher at the Occupational Health Department at the Hôtel-Dieu hospital in Paris, nominated by the Minister for Labor. **Pierre LAROCHE,** Chief Medical Officer of the French Armed Forces, Head of the Medical Division of the Armed Forces' Radiation Protection Department, nominated by the Minister of Defense. **André PINEAU,** Professor at the Paris School of Mine Engineering, nominated by the Minister for Industry. **Bernard SEVESTRE,** Head of the Radioactive Sources Team at the CEA Nuclear Energy Division nominated by the Minister for Research. **Patsy-Ann THOMPSON,** Director of Environmental Assessments and Protection at the Canadian Nuclear Safety Commission, nominated by the Minister for the Environment. **George YADIGAROGLU,** Emeritus Professor of Nuclear Engineering at the Swiss Federal Institute of Technology, nominated by the Minister for Industry.

MAIN ACCOMPLISHMENTS 2010

- **The Council's assessment on "Assessment of risks to ecosystems" (November 2010) was completed and presented,**
- **Assessment of the environmental monitoring strategy in progress,**
- **Two new assessments were launched in November 2010:**
  – critical software,
  – epidemiological studies.

ETHICS COMMISSION

Composition (as of December 31, 2010)

MISSIONS

Included as part of the order organizing the IRSN, the Ethics Commission reports to the Board of Directors and is responsible for advising it on preparing ethical charters that are applicable to the Institute's activities and for monitoring their application, including conditions at the Institute for distinguishing between assessment missions performed on behalf of government departments and those performed for public or private operators. It also serves as a mediator when problems of an ethical nature arise.

Jean-Pierre DUPUY, Corps des Mines Engineer General, philosopher, professor at the École Polytechnique and Stanford University, California, and member of the French Academy of Technology.
Jean-Claude AMEISEN, biologist, immunologist, professor of medicine at University of Paris Diderot and Bichat Hospital, – member of the French National Ethics Advisory Committee, Chairman of INSERM's Ethics Committee.
Anne BERRIAT, magistrate on the Council of State *(Conseil d'Etat)*, took part in steering national sustainable development strategy (2003) and preparing the report on strengthening and structuring environmental policy.
Éric VINDIMIAN, Engineer General specializing in agricultural engineering, water and forests, Regional Director of CEMAGREF (French research institute for agricultural and environmental engineering), specialist in the impact of toxic substances on the environment and health and in assessing government environmental policies.

MAIN ACCOMPLISHMENTS 2010

- **April 7, 2010:** the Commission held its first meeting. The Commission acquainted itself with IRSN's various missions and activities, as well as the rules it follows and the responsibilities it takes on to ensure that they are carried out effectively.
- **July 7, 2010:** visit to the Fontenay-aux-Roses site. The Commission followed the various stages involved in examining a nuclear operator file and discovered how a research program is constructed for assessment purposes. IRSN's teams explained these topics in concrete terms. The Commission also visited the Institute's Biological Dosimetry Laboratory and the External Dosimetry Department.

4 members

1 meeting in 2010

4-year mandate

NUCLEAR SAFETY AND RADIATION PROTECTION RESEARCH POLICY COMMITTEE – COR

Composition (as of December 31, 2010)

MISSIONS

The Nuclear Safety and Radiation Protection Research Policy Committee, or COR, is an advisory body to the IRSN Board of Directors, giving opinions on research objectives and priorities in the fields of nuclear safety and radiation protection. It adopts a global approach that takes into consideration the requirements of society and the public authorities. It thus complements the activity of IRSN's Scientific Council, which focuses on the quality and relevance of the Institute's research programs and outcomes from a scientific perspective.

■ PUBLIC AUTHORITIES

Supervisory ministry representatives: **Laurence PIKETTY,** Scientific Director of the Energy, Sustainable Development, Chemistry and Process Department of the Directorate General for Research and Innovation, representing the Minister for Research. **Didier HOUSSIN,** Director General of Health, representing the Ministry of Health. **Claire HUBERT,** Head of Research – Directorate for Health and Innovation, representing the Ministry of Ecology. **Pascal QUENTEL,** Head of Nuclear Security and Assessment Division – French Armament Procurement Agency, representing the Ministry of Defense. **Thomas BRANCHE,** Deputy Director for the Nuclear Industry, Directorate General for Energy and Climate, representing the Ministry of Industry.

Representative of the Directorate General for Labor: **Thierry LAHAYE,** in charge of matters relating to the protection of workers against physical hazards – Directorate General for Labor, representing the Ministry of Labor.

ASN representative: **Jean-Christophe NIEL,** Director-General.

■ COMPANIES AND PROFESSIONAL ASSOCIATIONS

Philippe GARDERET, Scientific Vice-President – Areva. **Noël CAMARCAT,** Nuclear Research and Development Officer – Generation and Engineering Branch – EDF. **Bruno CAHEN,** Director of Risk Control – Andra. **Dietrich AVERBECK,** Curie Institute, SFRP representative. **Jean-Marc COSSET,** Head of Radiotherapy at the Curie Institute, SFRO representative.

■ EMPLOYEES IN THE NUCLEAR SECTOR

Representatives of national labor unions: **Jean-Paul CRESSY,** FCE-CFDT. **Jean-François DOZOL,** FO. **Claire ÉTINEAU,** CFTC. CFE-CGC (being appointed). **Alain VASSAUX,** CGT.

■ ELECTED REPRESENTATIVES

OPECST representatives: **Claude LETEURTRE,** Member of Parliament for Calvados. **Jean-Claude ÉTIENNE,** Senator for Marne.

Representative of the Local Information Committees (CLI): **Monique SENÉ,** Vice-President of ANCCLI.

Representatives of towns with a nuclear facility, proposed by the Association of French Mayors: **Yves LE BELLEC,** Mayor of Pierrelatte. **Bertrand RINGOT,** Mayor of Gravelines.

■ ASSOCIATIONS

David BOILLEY, President of ACRO. **Jacky BONNEMAINS,** President of Robin des bois. **Élise CHAMPEAU,** President of MANES, an association that supports victims of industrial diseases and accidents in the nuclear and chemical sectors and their friends and families. **Maryse ARDITI,** President of France nature environnement. **Simon SCHRAUB,** Administrator of the Ligue nationale contre le cancer.

■ ADVISORY MEMBERS

Jean-Claude DELALONDE, President of ANCCLI. **Henri REVOL,** President of the High Committee for Transparency and Information on Nuclear Safety. **Agnès BUZYN,** Chairperson, IRSN Board of Directors, ex officio Chairperson of the Nuclear Safety and Radiation Protection Research Policy Committee.

■ RESEARCH ORGANIZATIONS

Christophe BEHAR, Director of Nuclear Energy – CEA. **Thierry DAMERVAL,** Deputy Director General for Strategy – Inserm / Director of Paristech School of Chemistry (being appointed). **Farid OUABDESSELAM,** President of Grenoble 1 – Joseph Fourier University, representative of the French Conference of University Presidents (CPU). **Cyrille THIEFFRY,** Task Officer for Radiation Protection and Nuclear Affairs – IN2P3, CNRS representative.

■ FOREIGN MEMBERS

Jean-Jacques VAN BINNEBEEK, Director General – AVN – Belgium. **Ted LAZO,** NEA (Nuclear Energy Agency) – OECD. **Christophe BADIE,** Head of Environmental Assessments Department – Health protection agency (HPA) – United Kingdom. **George YADIGAROGLU,** Emeritus Professor of Nuclear Engineering at the Swiss Federal Institute of Technology.

■ EX OFFICIO MEMBERS

Catherine CEZARSKY, Atomic Energy High Commissioner. **Laurent MICHEL,** Government Commissioner and Director General of Risk Prevention at the Ministry of Ecology, Energy, Sustainable Development and the Sea. **Michel QUINTARD,** IRSN Scientific Council Chairman, CNRS Research Director at the Toulouse Institute of Fluid Mechanics. **Jacques REPUSSARD,** Director General.

MAIN ACCOMPLISHMENTS 2010

- **April 15, 2010:** third plenary meeting of the COR, focusing on IRSN's positioning within the French, European, and world research structure. The COR issued a notice outlining the main criteria to be considered in assessing the relevance of the Institute's research work.
- **September 30, 2010:** fourth plenary meeting of the COR. A working group was set up, led by Claude Leteurtre, Member of Parliament for Calvados.
- Furthermore, the working group on the effects of low-dose ionizing radiation on human health and the one set up to study the issue of extending the service life of existing nuclear reactors continued their work with a view to submitting their findings to COR members in 2011.

43
members

2
plenary meetings in 2010

+02

During President Sarkozy's visit to India, IRSN's Director General, Jacques Repussard, signed a cooperation framework agreement on nuclear safety with Shri Satinder Singh Bajaj, Chairman of AERB, India's Atomic Energy Regulatory Board.

NEW DELHI - INDIA | DECEMBER 6, 2010

SUMMARY AND STRATEGY

PROGRESS AND MAIN ACTIVITIES IN 2010

IRSN can rely on governance principles capable of taking up major challenges between 2010 and 2020

The Institute made significant progress in implementing its strategy in 2010. In particular, it completed preparatory work on the Government/IRSN Contract of Objectives (known as COB 2010-2013). From the strategic viewpoint, the new contract carries on from its predecessor, focusing on the same four main areas and highlighting a number of scientific, technical, and social topics relating to safety, security and radiation protection. In this area, the Institute is increasingly concerned with issues relating to aging existing facilities, building Generation III reactors, conducting research into the safety of Generation IV reactors, protecting nuclear facilities against malicious acts, and developing radiation protection in the medical field.

IRSN's ISO 9001 quality certification was also renewed in 2010, following a restructuring phase concerning its operating procedures. As part of this work, tools and bodies relating to governance were set up to consolidate and drive progress in the management of the Institute's human and financial resources. At a time when the Government continues to express the need for public policies that are both efficient and economical, it is such operating maturity that enables IRSN to remain in line with national priorities.

IRSN's strategy is intended to address three types of issues. The first area concerns changes in the French nuclear sector relating to aging nuclear power plants and fuel cycle facilities, some of which have been in operation for more than thirty years, and to the use of new technology for equipment and facilities, such as new I&C systems in plants. The second area is to do with how society perceives the risks associated with the use of nuclear energy, such as major accidents, environmental and health hazards, radioactive release from facilities, and long-lived nuclear waste. These issues reflect the public's growing desire to play an active part in enhancing awareness and risk control. The last concern changes in the nuclear industry around the world. Whether considered in terms of the technological offer in facility design and construction or the use of nuclear power capabilities, these issues represent a growing challenge that calls for a consolidation throughout Europe of the processes of standardization, if not gradual integration, of concepts and practices concerning nuclear safety, security and high-level radiation protection. IRSN has every intention of driving this consolidation process.

90
man.years devoted to international activities.
(90 in 2009)

Fostering a nuclear safety culture in Europe and the rest of the world

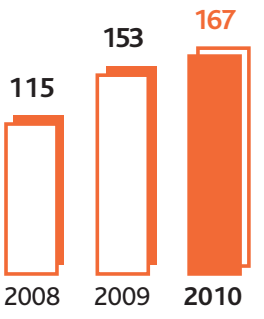
In 2010, IRSN developed its action in several inter-related areas. Chief among them was its involvement in assisting in setting up an appropriate doctrine and regulatory framework in countries wishing to acquire nuclear power capability. With its expertise in this field, the Institute has stepped up its cooperation with a number of countries, such as Italy, and Jordan, which are seeking

On October 18-20, 2010, more than 200 scientists and low-dose specialists gathered in Paris to attend the second international conference on MELODI, the Multidisciplinary European Low Dose Initiative.

partners to help them acquire the human skills required for setting up safety authorities and technical support organizations that are capable of fulfilling all their duties. Within this context, the Director General of IRSN chaired the second IAEA international conference on the nuclear safety and security challenges faced by technical safety organizations (TSOs), held in Tokyo at the end of October. The conference led to broad consensus on the need for a solid network of technical safety organizations and for closer cooperation among them.

The Institute, which is recognized as a major player in the field of nuclear safety and security, continued to support international organizations in several ways. This included helping the IAEA to draft fundamental nuclear security principles and recommendations, and organizing, on its behalf, an international training session in nuclear security culture in November in Paris.

At the same time, it increased initiatives involving expert networks aimed at learning more about nuclear reactor safety, or the health effects of chronic exposure to low-dose ionizing radiation (MELODI). Representing TSOs on Europe's Sustainable Nuclear Energy Technology Platform (SNETP), IRSN took part in selecting research priorities for 2010 relating to generation II and III reactors. Under a contract with the European Union, IRSN undertook to analyze operating experience feedback from the major nuclear power plants in Europe. Alongside its nuclear risk prevention activities, the Institute took part in preparing response and remediation scenarios in the event of nuclear and radiological emergency situations. This activity was carried out within the European network NERIS.



Opportunities for IRSN to participate in international expert groups.

In 2010, in a move backed by the European Commission, ETSON, the European Technical Safety Organisations Network, underwent a change of legal status to become an independent body. The Institute's European strategy largely contributed to this new structure, which incorporates the different fields of TSO activity, such as research, assessments and training.

This shows how the Institute and its counterparts have succeeded in producing a joint response regarding the three main TSO activities by: i) developing and standardizing nuclear safety practices within EUROSAFE; ii) performing interna- ■■■

tional technical assessments, particularly through Riskaudit, a jointly-owned subsidiary of IRSN and its German counterpart GRS; iii) providing practical training at ENSTTI, the European Nuclear Safety Training and Tutoring Institute, for engineers whose activities will impact on the safety of nuclear facilities.
The relevance of this approach is reflected in the interest it has aroused outside the European Union. For example, safety organizations in Japan and Ukraine have expressed their desire to become associate members of ETSON.

Stronger governance and more partnerships for research

The research carried out by IRSN targets nuclear and radiological risk prevention. In this respect, the Institute must acquire and maintain a sufficient level of scientific and technical expertise to ensure balanced input into technical discussions with nuclear operators when examining their safety analysis documentation. Research at IRSN is also aimed at building scientific knowledge in the area of safety and radiation protection and encouraging operators to put available technology to the best possible use in the interest of safety.

The year 2010 saw a major change in the Institute's organizational structure when its science and strategy divisions were merged into a single functional division, called the Strategy, Development and Partnership Division and set up on January 1, 2011. The merger between the two former divisions - one devoted to scientific excellence, the other to guiding strategy – reflects both the high degree of interaction between these two activities and IRSN's ability to streamline its organizational structure to increase efficiency and make optimum use of the resources allocated by the Government. One highlight in the year for the Institute's research activities was the audit by AERES, the French agency for the evaluation of research and higher education (see box on p. 30).
As well as undergoing this audit and reinforcing its organizational structure, IRSN took various initiatives in favor of its research activities, starting with increased partnership activity both in France and abroad. This reflects its ability to work hand in hand with other research organizations and its ambition to play a part in the country's national research and innovation strategy (SNRI) and the national research policy. Within this context, IRSN became a member of two "national alliances", namely ANCRE, devoted to energy research coordination, and AVIESAN, for life and health sciences, and set up two joint laboratories with CNRS.
The Institute's research policy committee finalized initiatives to involve stakeholders in its activities through working groups on the health effects of chronic exposure to low-dose ionizing radiation, and the Institute's research programs devoted to issues relating to the extension of the service life of nuclear power plants, in response to requests from electric utilities.
Outside France, IRSN took part in setting up STAR, a European network of excellence in the field of radioecology, and continued its work in networks such as DoReMi (research into low-dose ionizing radiation) and SARNET (major accidents).
Modeling and experimentation activities were also stepped up, thanks to the Institute's continued investment in facilities like the Tournemire experimental station or AMANDE, an accelerator designed to produce single-energy neutrons.
As part of its effort to maintain an outstanding degree of scientific excellence and thus guarantee a high profile for its research activities, IRSN continued to open its doors to a significant number of doctor-

IN THE WORDS OF...

Dominique Ristori, Director General of the European Commission's Joint Research Centre

"The European Commission has followed with great interest the development of ETSON ever since the Institute was founded in 2006. The TSO network is known throughout the world for its valuable contribution to nuclear safety and security, based on its assessment activities, research programs, and work on standardizing nuclear safety practices. IRSN's role as a driving force behind this process was demonstrated when its Director General was appointed Chairman of the TSO network.
In 2010, ETSON registered its new articles of association, which are more in line with the variety and growth of its European activities.
I particularly welcome the fact that the network has reached this important milestone in its development. I'm now counting on it to devote its energy to working with the regulators on continuing efforts to standardize nuclear safety practices. This entails defining Generation III and IV reactors, helping to guarantee the uniform application of European directives on nuclear safety and waste management, and promoting knowledge sharing in these fields among European countries."

ate and post-doctorate students in 2010, following a project selection process. As at November 1, 108 of them were carrying out research at the Institute. Of all the doctorate students present at IRSN in 2010, 67% benefited from joint funding, a clear sign of increased partnership activities with other research organizations (CNRS, universities, industry, regional authorities, etc.). The Institute drew up a charter to improve integration of doctorate students and supervise their activities more effectively.

Lastly, two French patents resulting from IRSN research were published in 2010. The first protects a pharmaceutical formulation for emergency treatment of accidental contamination of the skin by actinides. The second describes a process for making leaktight cable penetrations in vacuum or pressurized reactor pressure vessels. In addition, the year 2010 saw the arrival of *Aktis*, a multimedia newsletter devoted to science. *Aktis* is available in electronic format to reach the widest possible readership.

12%

share of research program funding from external revenue.

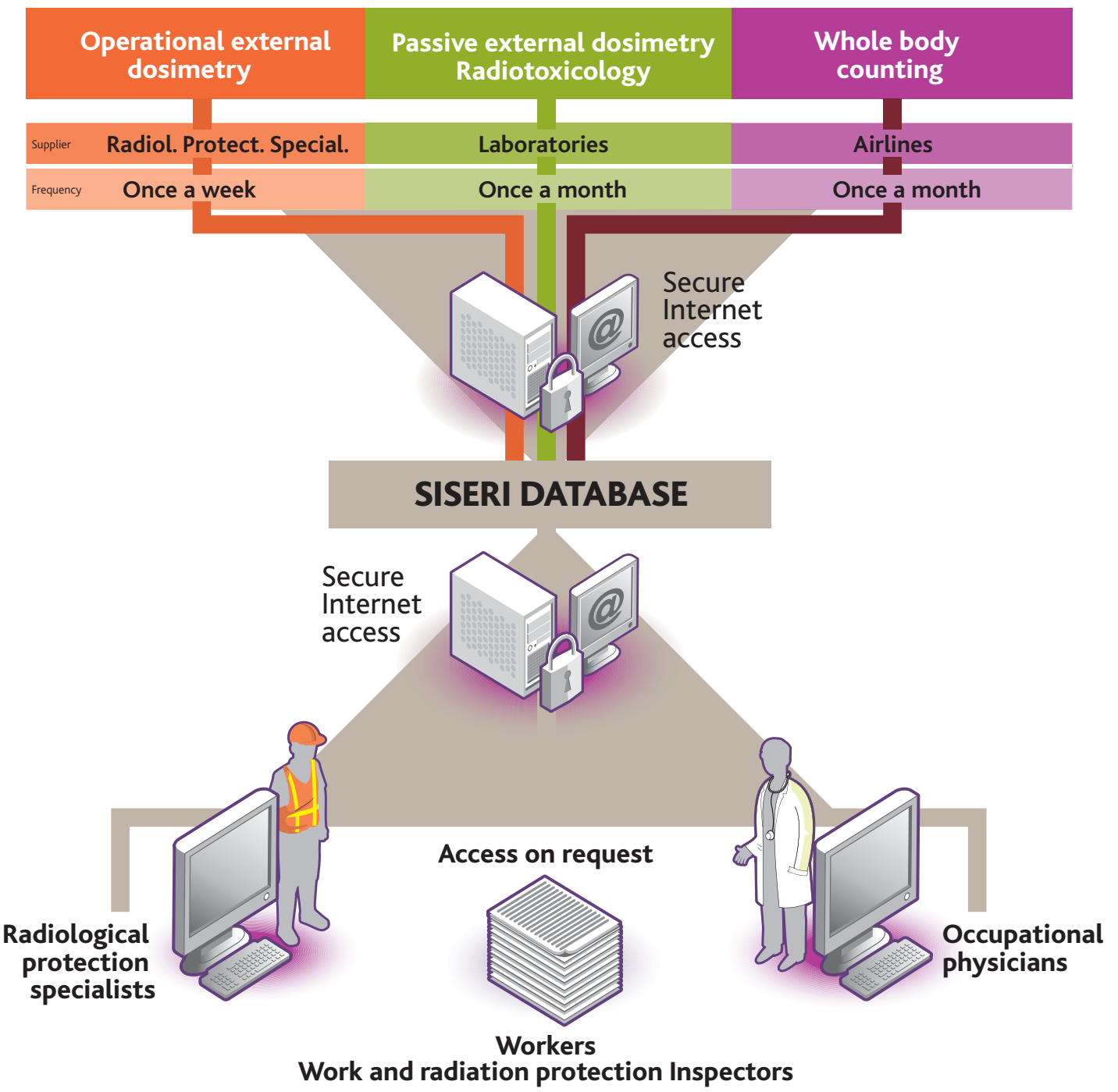
(11% in 2009)

Enhancing the technical and economic control of assessment activities

IRSN's assessment strategy is designed to ensure that it fully considers the wide range of requirements encountered from one organization to another, and that it complies strictly with the ethical principles that guarantee its independence as a support organization for the safety authorities and other public bodies.

Recent years have seen a rise in the public authorities' need for technical support from IRSN, largely induced by the need to continue activity at existing nuclear power plants while new projects are in progress. This situation has led the Institute ■■■

■ **IRSN steps up its participation in various networks of excellence, in particular those concerning low-dose ionizing radiation.**



■ **Organization and operation of SISERI, the information system for occupational dosimetry registration.**

and its supervisory ministries to study funding mechanisms that will enable IRSN to match its resources to these growing needs. Within the context of these studies, the Government has decided to allocate an annual contribution to IRSN to fund some of its activities in support of ASN, the French nuclear safety authority.

The contribution, approved in an amendment to the Finance Act for 2010 (passed on December 29) is part of the current nuclear and radiological risk prevention and management mechanism. It will replace part of the grant allocated to IRSN and should provide the Institute with funding that keeps pace with assessment requests received from operators.

A process is underway to contractualize relations between IRSN and government bodies and the authorities in order to obtain a definition of priority topics for examination and the related operating procedures. In 2010, IRSN concentrated particularly on optimizing the human, material, and budget resources devoted to its assessment activities.

As part of the above process, it signed a framework document with ASN aimed at defining the working principles for IRSN assessments carried out within the context

of its support for ASN. The document shows how both parties share the same vision of their relations and is built on a common baseline of work carried out and the related procedures in an effort to streamline the assessment request and examination process. At the same time, IRSN continued to sign or renew conventions and partnership agreements with most of the public organizations coming within the scope of its support activities.

It is also involved in efforts to ensure that public agencies implementing general government policies adopt mutually consistent strategies.

With this in mind, the Institute increased its participation in national plans and health networks set up by the public authorities. Examples of national plans include the French national health and environment plan 2009-2013 (PNSE2), the occupational health plan (PST) 2010-2014, and the cancer plan 2009-2013.

Examples of health networks include CASA, the health agency networking committee, and the R3I network managed by ANSES, the French agency for food, environmental and occupational health and safety.

Under the occupational health plan, IRSN was tasked with optimizing SISERI, the information system for occupational dosimetry registration for the purpose of conducting epidemiological surveys of targeted groups of workers. This is in line with government objectives concerning occupational health management.

IRSN is also working on a study devoted to the risk of radiation-induced cancer in individuals who were exposed to a scanner during their childhood. This epidemiological work comes under the cancer plan. The Institute is also involved in several scientific and technical projects identified in the PNSE2 plan, through its work to protect human health and the environment against ionizing radiation. This work targets in particular environmental radioactivity, occupational radiation protection, the quality of air indoors, and radon exposure.

In 2010, IRSN was closely involved in helping ASN to prepare documentation relating to safety and human health and environmental protection requirements applicable to basic nuclear installations.

These activities included work on the draft order on basic nuclear installations, and ASN draft decisions on the operating conditions of these installations, safety reviews, and the content of the general operating rules.

IRSN must respond to accidents and incidents such as the tritium contamination of an industrial facility in Saint-Maur-des-Fossés, near Paris, at the end of the year. The Institute helped the authorities to deal with the event by providing them with expertise and emergency response and measurement resources, clearly demonstrating the effectiveness of its capability in this area.

47.9% (1)

Share of IRSN budget allocated to technical support and public service missions.

(47% in 2009)
(1) Excluding property restructuring project and special fund.

Involving the population in radiological and nuclear risk assessment and control

Two areas in which the Institute makes a vital contribution to progress in nuclear safety and radiation protection are promoting transparency with regard to its research and assessment activities ■■■

IN THE WORDS OF...

Jean-François Monteils, Secretary General and Senior Defense and Security Official, Ministry of Ecology, Sustainable Development, Transport and Housing

"With its nuclear material experts and longstanding experience, IRSN plays a vital role in the French nuclear security system. It provides the Senior Defense and Security Official with technical support to help him carry out his duties in this area. The quality of work performed by DEND, particularly its managers and personnel in charge of material inspection, enable the Senior Defense and Security Official to obtain an excellent understanding of various situations and the decisions which have to be taken. Moreover the commitment of their management to the exercises also improves the security of facilities and shipments.

Following the Washington Summit in April 2010, France asked the IAEA to audit its security system and some of its facilities at the end of 2011. I know that I can count on IRSN's international experience, technical expertise and unfailing commitment."

197
students taking part in *Rencontres lycéennes de radioprotection* (radiation protection workshops in schools).
(130 in 2009)

and keeping the public informed. Efforts in these areas respond to the growing concern of the public and their elected representatives to become actively involved in keeping a watchful eye on and controlling risks relating to technology. With the new responsibilities of local information committees, defined under the Nuclear Security and Transparency Act (TSN), this is now a right. Working with social stakeholders to develop a shared understanding of complex issues relating to radiological and nuclear risk control is central to the commitments made by the Institute in its Contract of Objectives for 2010-2013 and in its Charter on Openness to Society, which was presented to the public in April 2009. IRSN's commitments in this area are: a) ensuring the transparency of its research and results; b) sharing its knowledge with professionals and the public and helping to keep them informed; and c) supporting efforts to build stakeholders' skills and promote participative action.

In 2010, IRSN made an initial assessment of progress regarding both these external commitments and internal commitments aimed at promoting dialog between the Institute and its staff and social stakeholders (see box).

Several initiatives to open up the Institute's activities were completed in 2010. In some cases, this was achieved with the help of recommendations from Georges Mercadal (former Vice-Chairman of the French National Commission on Public Debate) and from the monitoring committee that was set up to help implement test cases recommended at the end of a previous mission to promote initiatives to open up the Institute's research and assessment work. One of the main purposes of the tests was to prepare the ground for technical discussions on nuclear safety documentation with local information committees (CLIs) and ANCCLI, two key partners in the Institute's initiatives to open up to society. Within this context, a joint working group was set up in 2009 and 2010 to keep track of progress in the third ten-year inspection (VD3) program concerning EDF's 900 MWe nuclear reactors.

This led to an IRSN-ANCCLI seminar on November 9, focusing on CLI involvement in these activities. The seminar gave IRSN an opportunity to set out the key safety issues highlighted in its VD3 report, and allowed the local information committees to express their concerns in a number of areas, including incident monitoring and their experience regarding independent assessments.

Another highlight of the year was the public meeting that IRSN organized in Pierrelatte in southern France on September 22, 2010 in cooperation with the local authorities of the area. During the meeting, which was attended by 140 people, IRSN presented the results of a study to account for the presence of uranium in the ground water around Tricastin, carried out with the support of a multidisciplinary monitoring group.

As recommended by Georges Mercadal, IRSN also set up a "citizens' workshop" on radon risk prevention in homes. In their recommendations, the citizens put forward a strategy of action combining information and support activities. They also considered that although Government supervision was required, there was no need for immediate regulation as a number of simple actions could be implemented to reduce the health impact of radon. Furthermore, they stressed the importance of setting up local and regional relay organizations and insisted on the key role played by doctors and housing professionals.

On September 15, 2010 another important milestone was reached when the multidisciplinary expert group on mines in Limousin submitted its final report to the Minister for Ecology and the Chairman of ASN.

From the international perspective, IRSN's

RESEARCH

First AERES audit

As a fully-fledged research institute, IRSN was evaluated by AERES in 2010. Prior to the evaluation, the Institute embarked on a structured self-evaluation initiative, focusing on the outcomes of the Government/IRSN Contract of Objectives for 2006-2009 and the contract objectives being discussed for the period 2010-2013.

The AERES evaluation was carried out in two stages.

The first, in the middle of the year, concentrated on IRSN's research units, while the second, in the second half of the year, covered the Institute as a whole.

The AERES audit focuses on the quality of IRSN's scientific results and other criteria, such as active involvement in national and international networks and programs, partnerships with other research organizations and institutes of higher education, openness to social concerns, applied research and assessment activities. The findings of the audit will be published in 2011.

■ The ANCCLI-IRSN seminar on the third ten-yearly inspections was held in Paris on November 9, 2010.

initiative to open up to society was largely devoted to European and French efforts concerning concrete applications of the Aarhus Convention to the nuclear field. The Convention, signed by 39 nations on June 25, 1998 lays down rights concerning access to information, public participation in decision-making, and access to justice in environmental matters. In 2010, the Institute was involved in discussions coordinated by the French high committee for transparency and information on nuclear safety and ANCCLI, with the support of the Minister for Ecology.
In October 2010, the Institute took part in a seminar, called Corex, to discuss and consolidate operating feedback from an international program called CORE, which is devoted to the rehabilitation of the regions in Belarus contaminated by fallout from the Chernobyl accident. ■

OPENNESS TO SOCIETY

First report on the application of the IRSN Charter on Openness to Society

In keeping with its undertaking, IRSN took stock of progress made and the difficulties encountered, a year after the charter came into effect.

Regarding the transparency of its activities, the Institute put online summaries of reports submitted to advisory committees working with ASN, together with occasional and regular reports (on occupational exposure to ionizing radiation, exposure relating to medical diagnoses in France, etc.) and a series of explanatory sheets on different topics such as radon and uranium. One point to be highlighted regarding knowledge-sharing initiatives was the third school "workshop" session devoted to radiation protection culture. The Charter on Openness to Society provided for new initiatives in the medical field as part of the effort to build skills among social stakeholders and develop participative actions. For example, a working group was set up to focus on the issue of patient information on radiation protection relating to radiodiagnosis.

The commitments set out in the Charter also inspired an initiative concerning post-accident situations, which is aimed at working with ANCCLI to design a mapping tool, known as OPAL, to heighten local stakeholders' awareness of the consequences of a nuclear accident.

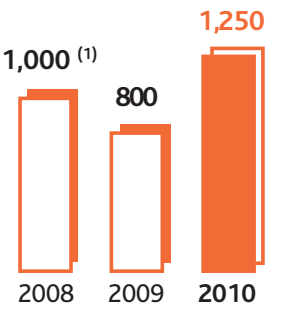
As part of the implementation of the Charter inhouse, a seminar was organized to make the personnel more aware of efforts underway to open the Institute up to society. IRSN will continue to report periodically on progress made regarding the commitments set out in the Charter.

TRANSPARENCY AND COMMUNICATIONS POLICY

Enhancing nuclear safety is also a matter of information and communication

IRSN, which has now acquired an institutional signature, continued to build up its website in 2010 and launched a new multimedia newsletter for scientific information.

■ *Aktis,* **presents the Institute's research results.**



Number of mentions in the press.

(1) Includes numerous references to the Socatri incident during the summer of 2008.

In 2010, to symbolize its determination to fully assume its role as the public service expert in nuclear and radiological risk assessment for all concerned, IRSN adopted a corporate signature, *Enhancing Nuclear Safety* (and in French, *Faire avancer la sûreté nucléaire*) that will appear on its information and communication media. It embodies the commitment of all the Institute's staff – researchers, experts, engineers, and technicians – to put all the available knowledge and skills to the best possible use.

Aktis, a new multimedia publication for scientific information

In keeping with this knowledge-sharing initiative, IRSN decided to do more to put the spotlight on its research and the results obtained. To this end, it launched *Aktis*, a new quarterly multimedia newsletter, at the end of July, in replacement of its annual scientific and technical report. Intended for scientists in every field, *Aktis* is chiefly distributed in digital format by email or via an RSS feed to make sure that informa-

tion reaches new readers. Future readers can subscribe directly via the Institute's website, free of charge, and consult back issues as well.

IRSN's website at www.irsn.fr goes from strength to strength

In 2010, the Institute continued to develop its transparency policy, with ever more nuclear safety and radiation protection information being made available via its website.

Professionals and general public alike were thus able to consult some 65 news items and press releases, 25 special reports and feature articles, 22 expertize reports and 19 notices to the authorities and summaries of reports submitted to the ASN advisory committees.

As part of its ambition to publicize the results of its research to an increasingly large audience, the Institute made a particular effort to propose educational content on subjects relating to its technical assessment activities.

Examples of such subjects included the third round of ten-year inspections of 900 MWe PWR plants, the EPR, PWR steam generators, and the loss of cooling water incident on a reactor at the Cruas nuclear power plant in southern France in 2009.

IRSN also responded to requests for information from civil society and the press, often concerning topical news items, by providing informative reports on nuclear non proliferation and security, the Haiti earthquake, X-ray backscatter body scanners, effects in France of forest fires in Russia, and the tritium contamination incident in Saint-Maur-des-Fossés near Paris.

Press relations: growing media coverage

In response to the steadily growing demand from the media, IRSN issues news releases and press kits and organizes meetings with its experts and press trips.

The 2010 trip organized around the theme of nuclear waste disposal management in northern Europe took journalists to Sweden, Belgium and Finland, where they were also able to visit the EPR construction site in Olkiluoto.

Two events drew particular media interest in 2010, namely the forest fires in Russia, for which IRSN was mentioned in the press nearly 300 times, and tritium contamination of a residential area in Saint-Maur-des-Fossés near Paris at the end of the year, which resulted in some 150 press mentions.

Repères: recognition in the world of professional journals

In 2010, IRSN conducted a readership survey of Repères, its quarterly magazine, in preparation for a change of format in 2011. Readers considered the publication to be informative, educational and helpful for understanding complex or sensitive issues. They appreciated the balance of information covering subjects such as nuclear safety and radiation protection and human health, and the environment.

Exhibitions: information and dialog close to home

In 2010, the Institute continued three traveling exhibitions organized on different models and targeting different audiences. Organized in collaboration with IFFO-RME the French institute for training in major risks and environmental protection, *Gafforisk* seeks to step up the work carried out by the French Ministry of Education with young people, and to support local authorities in their public information initiatives, in particular in areas around nuclear facilities. Another traveling exhibition, to which the Institute contributes, entitled *Did you say radiation protection?* visited the Swiss city of Lausanne and Helsinki in Finland.

Lastly, the exhibition *Nuclear Power and Society*, jointly organized by IRSN and ASN, went to the cities of Cherbourg, Epinal and Saint Etienne. However, in view of a significant drop in the number of visitors in 2010, the two organizations decided to work on a new concept. ■

■ In 2010, the *Gafforisk* exhibition was held in several towns in the Paris region, as part of the *Fête de la Science* in Palaiseau and in Leuville to the south of Paris, during the emergency response drill in Saclay, and training courses, in particular for teachers working for the Versailles regional education authority.

MORE ABOUT

IRSN Barometer 2010: trust in the nuclear sector takes a downturn, but IRSN's credibility goes on climbing

Every year since 1988, the *IRSN Barometer* has analyzed the findings of a survey on how risks and safety are perceived by the French public, with particular regard to exposure to nuclear and radiological risks.

Although the results of the 2009 survey, put online in 2010, indicate that the nuclear risk is not among the chief concerns of the French public, the relatively positive image enjoyed by nuclear facilities for many years, as far as reliability and safety are concerned, was undermined by the series of incidents that occurred during the summer of 2008 on the Tricastin site.

Another point to be noted is that nuclear waste topped the list of most frequently mentioned arguments used against nuclear energy, ahead of the Chernobyl accident.

The findings of the *IRSN Barometer 2010* also reflected the Institute's increasing efforts in favor of transparency, education and sharing its expertise. While the survey showed that associations are still considered as the most reliable sources of information, the technical expertise of nuclear organizations – and IRSN for 86 % of respondents – is gaining in recognition.

PROMOTING A SAFETY AND RADIATION PROTECTION CULTURE

Education and Training: a changing landscape

With respect to safety and radiation protection culture, 2010 was marked both by a cyclic downturn in IRSN's regulatory activities, and the arrival of new offers.

■ IRSN regularly organizes training sessions for radiation protection specialists.

2,153
persons benefited from IRSN training programs (including 1,774 in the radiation protection field).
(3,271 in 2009)

On-site training for future nuclear safety officers

The year 2010 was marked by the first session in English organized by the European Nuclear Safety Training and Tutoring Institute (ENSTTI), set up in December 2009 when a memorandum of understanding was signed between IRSN and three of its partners in the European Technical Safety Organizations Network (ETSON): GRS (Germany), LEI (Lithuania) and UJV (Czech Republic). ENSTTI aims to meet training needs for staff working in nuclear safety and security research and assessment by supplementing training for new safety engineers with presentations and practical group work and technical inspections supervised by experts in the areas concerned.

The first ENSTTI session – which took place in July and September, first in Germany and then in France – involved 37 participants from 14 countries, who considered that they had acquired knowledge in all

the technical fields required by a future nuclear safety expert. In addition, thanks to instructor involvement in safety at existing facilities, participants from "newcomer" countries to civil nuclear power were able to acquire concrete, realistic notions of nuclear safety.

With regard to IRSN nuclear safety training, the induction course for safety engineers (SAIS) catered for new categories of external participants in 2010, in particular from CNES, the French government space agency, following the implementation of a statutory safety framework for the aerospace sector.

Adapting regulatory training in radiation protection

Some IRSN training courses in this area meet the requirements of statutory obligations; others are delivered in response to requests made by other bodies or companies.

In 2010, the Institute observed a significant reduction in its statutory training activities, although a large number were still performed. This drop is explained by the fact that most of the people concerned were trained in previous years, especially in the field of radiation protection for patients during medical imaging or radiotherapy. It also reflects budgetary constraints, which have affected many bodies and companies, leading to a reduction in the demand for training.

Other types of training have begun to develop, such as training for radiation protection specialists, which must be renewed every five years and for which the start of a new cycle in 2010 should be followed by a rise in demand in 2011. The same is true of training in radon metrology in the workplace, following decisions taken by ASN in 2009 with regard to accreditation in this field.

Meeting the requirements of new categories of professionals

Also in 2010, IRSN completely revised the materials used in its radiation protection for patients course and started to develop new radiation protection training modules, in particular for occupational health and operating theater staff, as well as medical equipment manufacturers and fitters.

In the field of nuclear security, the Institute has produced a new offer for companies involved in monitoring and controlling nuclear materials – such as plant operators and engineering design consultants. It has used mailouts, advertisements in professional journals, and increased participation in trade shows and exhibitions to promote its training offers more widely. Discussions are currently underway regarding web-based training (e-learning).

Progress in CAMARI-related activities

The aptitude certificate for operating industrial radiology equipment (CAMARI), which IRSN has issued on behalf of the French authorities since 2008, is compulsory in France for anyone wishing to practice industrial radiology, which is used in particular for nondestructive testing. It demonstrates that its holder is competent in radiation protection, to ensure his or her own safety and that of others during the radiology operations performed. In 2010, IRSN saw a rise in the number of candidates for CAMARI certification, due to the development of the *"industrial particle accelerator"* option, (see box). ■

664
candidates for Camari training.
(584 in 2009)

341
Camari cards issued[1].
(140 in 2009)

(1) Including 90 cards issued to national defense candidates who have passed the armed forces radiation protection service (SPRA) exam.

MORE ABOUT

IRSN provides Morocco with training support

Following the signing, in spring 2010, of a contract with the Moroccan association for welding and pressure equipment (AMS-AP) for CAMARI certificate testing in Morocco, IRSN organized the first sessions in Rabat in mid-December, assisted by CNESTEN, the Moroccan institute for research and training in nuclear applications. AMS-AP's request was followed a decision by the Moroccan radiation protection authority to require industrial radiology companies in Morocco to have at least one holder of French CAMARI certification.

03

IRSN received a visit from a delegation from IBRAE, the Russian institute of nuclear energy safety, to celebrate twenty years of cooperation between the two institutes. The delegation was led by IBRAE's Director General, Leonid Bolshov.

TOURNEMIRE, SOUTH-CENTRAL FRANCE | SEPTEMBER 15-17

ACTIVITIES

SAFETY

An institute rising to all the challenges of nuclear safety

IRSN's contribution to the safety of existing and future nuclear facilities as well as to the safety of nuclear material transportation and storage covers a wide range of activities: examining the files submitted by operators, supporting inspection teams, contributing to the process of updating national and international regulations, and research. In these fields, 2010 was notably marked by the preparation for the safety review of EDF's twenty 1300 MWe reactors, the completion of large-scale modeling and experiment programs regarding the prevention of criticality accidents and fires, and the management of the consequences of major accidents liable to lead to reactor vessel failure and radioactive iodine releases. These programs were generally performed in the context of international cooperation. IRSN also performed an in-depth examination of planned nuclear fuel cycle operation in France over the period 2007-2017.

SAFETY OF EXISTING FACILITIES

Monitoring reactors

As part of its support work for the French nuclear safety authority, IRSN assesses the safety of nuclear reactors, whether in operation or under construction.

Preventing the risk of steam generator tube rupture

In 2010, IRSN approved the solutions adopted by EDF to prevent the steam generator tube rupture following the discovery, in 2009, of circumferential cracks on several tubes during a periodic inspection carried out on the Bugey 3 reactor.

Such defects are carefully monitored because they could lead to a sudden tube rupture and radioactive release to the atmosphere.

Following this discovery, EDF implemented an exhaustive inspection program and for the first time carried out inspections using a more efficient probe. The tubes showing the greatest deterioration were condemned by plugging and removed from service.

The Institute drew the operator's attention to the fact that tube corrosion affected the leaktightness of the tubes, while EDF considered that the reactor was fit for restart and that the operating rules in force were suitable for the in-service monitoring of tube leaktightness.

On the basis of IRSN's assessment and following consultation with the advisory committee for nuclear pressure equipment, ASN requested that a hydrotest be performed prior to any restart. EDF eventually opted to replace the steam generators at Bugey 3 earlier than initially planned.

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Nuclear reactor operation under abnormal conditions

On the night of December 1 to 2, 2009, the intake of the cooling water pumping station of reactors 3 and 4 at the Cruas nuclear power plant on the River Rhône in southern France was obstructed by vegetal debris.

A "loss of cooling water" event was then declared. In addition to providing emergency response, which was hindered by inadequate operating procedures, EDF quickly drew up an action plan and corrected the procedures in question. In 2010, IRSN analyzed the corrective action file submitted by EDF. The Institute concluded that the modifications proposed by EDF

were acceptable, but raised a number of issues to be addressed as part of the normal examination of changes to incident and accident operating procedures at nuclear power plants.

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Preparing for the third ten-yearly inspections for 1300 MWe pressurized water reactors

In 2010, IRSN assessed the approach, scope and objectives of the generic studies proposed by EDF for the 1300 MWe PWR safety review associated with the third ten-yearly inspections.

In compliance with the French transparency and nuclear security act (TSN), reactor safety is reviewed in France every ten years. The objective is to analyze the state of the reactors and also to reassess their safety taking into account the improvements in knowledge and the most recent achievements.

Prior to the safety review for each reactor, EDF must propose the generic studies that it plans to carry out to prepare the new safety reference system and determine the modifications that it intends to implement on all reactors of the same type. In preparation for the safety review of its twenty 1300 MWe reactors, EDF defined about twenty themes, in particular regarding probabilistic safety analyses, climate-related hazards and severe accidents. In this respect, the Institute suggested a broader program, including a design review of the computerized integrated protection system, a risk analysis regarding the handling of fuel transport packaging, and a study of the possible consequences of a tornado on reactor safety. Plant effluent treatment facilities will also undergo a safety review during the third ten-yearly outages.

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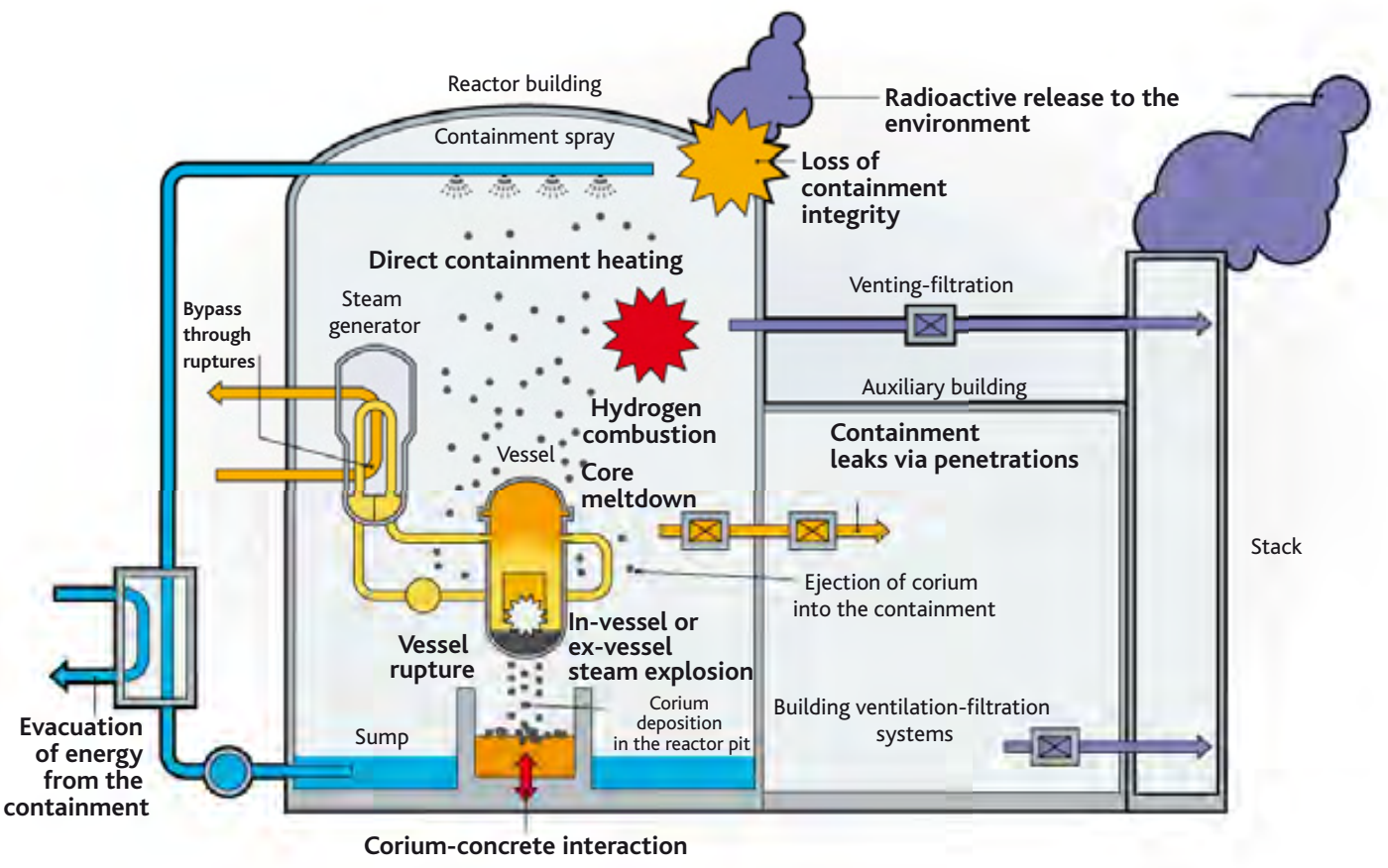
■ IRSN analyzed the loss of cooling water incident that occurred at the Cruas NPP.

12
reports prepared for meetings of advisory groups or expert committees.
(15 in 2009)

First version of the level 2 PSA for 1300 MWe reactors

In 2010, IRSN completed the first version of its level 2 probabilistic safety analysis for 1300 MWe reactors (PSA2 1300).

The study was started in 2007 in ■■■



■ Physical phenomena that may be observed during a severe accident.

■ IRSN's engineers use SOFIA to simulate the operation of reactors in service in France.

preparation for the third ten-yearly inspections of these reactors. Level 2 PSAs identify, as exhaustively as possible, core meltdown accidents that would lead to radioactive release and, for each, quantify its probability of occurrence and the predicted amount of radioactivity liable to be released.
Furthermore, the level 2 PSAs developed by IRSN provide an estimate of the radiological consequences associated with the different scenarios. They use modeling software and methods developed by IRSN and draw on input from R&D in the field of core meltdown accidents. They allow contributors to risks of radioactive release and possible routes for improving facilities to be identified and prioritized. They thus contribute, alongside deterministic studies, to the assessment of reactor safety. The IRSN's PSA2 1300 study will make it possible to effectively judge similar studies performed by the operator in the safety review associated with the ten-yearly inspections concerning these reactors.

SOFIA: a new simulator to support safety studies

Since November 2010, IRSN has been able to use SOFIA, a simulator of incidental and emergency operation to provide a representative model of 900, 1300 and 1450 MWe reactors. This modeling platform integrates the CATHARE thermal-hydraulic software, which is the reference application in France. The SOFIA simulator, developed in collaboration with Areva and Canadian simulator designer L3-Mapps, can simulate an extensive range of operating conditions, from shutdown to at-power states. Its modern, modular IT architecture can integrate modifications to the reactors in the French nuclear fleet, thus ensuring that configurations representing the current state of the facilities are available at all times.

SOFIA was first used in 2010 to meet the training requirements of IRSN engineers in supporting assessment of safety files, to prepare emergency response drills and to analyze incidents at nuclear facilities. In this respect, it was used by the Institute to simulate the loss of cooling water incident that occurred at the Cruas plant in December 2009.
The simulation helped to get a more comprehensive understanding of the transient and to assess the robustness of the countermeasures adopted by EDF.

■ The Flamanville 3 EPR construction site.

EPR

In 2010, IRSN continued to assess the detailed design of the EPR. The main issues addressed during the year included:

- **The Instrumentation & Control (I&C) system:** IRSN considered that EDF had yet to fully demonstrate compliance with the initial specifications of the automated safety system used for reactor control following the initial phases of an accident, although the information supplied so far was considered satisfactory. The Institute then recommended that additional provisions be implemented to strengthen the robustness of the EPR I&C system;
- **The safety systems:** detailed examination of these systems serves to assess design in light of the safety objectives to be met. The year 2010 was spent analyzing systems involved in the containment function and carrying out an initial examination of the main safety systems (such as safeguard systems, electrical systems and cooling water);
- **The accident study methodology:** some EPR accident studies are performed by EDF using new methods. In 2010, considerable effort was made to assess these methods and ASN gave an initial opinion on four of the five new methods. At the same time, IRSN provided ASN inspectors with technical support on the EPR construction site at Flamanville in Normandy and on equipment suppliers' sites. In particular, IRSN civil engineering and mechanical assembly experts helped to prepare and conduct inspections and analyze the anomalies detected, such as the high percentage of welding defects in the inner containment wall liner in the reactor building or deformation in prestressing tendon sheaths. Finally, on the international scene, IRSN has been using its knowledge of EPR reactor safety to help the safety authorities of countries that are contemplating the use of this type of reactor. IRSN took part in a seminar in India and in international working groups devoted to the EPR.

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Examining safety and radiation protection management at CEA

At ASN's request, IRSN examined safety and radiation protection management at CEA, the French alternative energies and atomic energy commission, and its operational application to the day-to-day practices in use at the organization's basic nuclear installations. The Institute's assessment was based on CEA documentation and about a hundred interviews of CEA safety and radiation protection staff working in the facilities or carrying out cross-disciplinary or oversight functions at civil research centers.

The assessment was presented to the relevant advisory committees in November 2010. Based on IRSN's report, the advisory groups concluded that improvements had been made in management action regarding safety and radiation protection since 1999, when these points were last examined, leading to a generally satisfactory situation today. They, however, did make some recommendations, regarding changes occurring to CEA's organizational structure, capitalization of results from human factor and organizational studies, and closer control of subcontracting and safety and radiation protection in day-to-day activities. Implementation of these recommendations by CEA should improve the performance of its management system in terms of safety and radiation protection and increase its commitment to con-

MORE ABOUT

HEMERA: improved analysis of accident phenomena

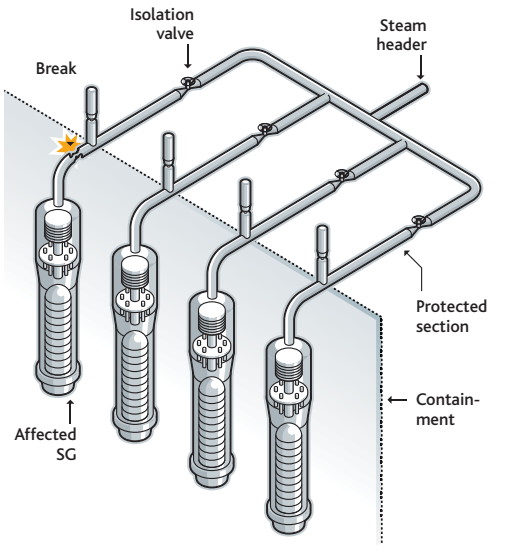

Diagram of a steam line break.

IRSN has acquired the 3D HEMERA coupled high-performance computer code package, which is now operational. The package is designed to study nuclear reactor control rod ejection or steam line break accidents, during which neutronics, thermal-hydraulic and system effects interact. 3D HEMERA was put to good use in 2010 to assess the fully coupled 3D model (MTC 3D) that EDF the intends to adopt to study the EPR steam line break accidents. The method proposed by EDF is based on MTC 3D package, a coupled kinetics computer code package using three modules: 3D neutronics, 3D core thermal-hydraulics, and thermal-hydraulics of the reactor coolant and secondary systems The performance of the models in the 3D HEMERA package and the quality of the interfaces implemented between the modules have revealed safety-related phenomena that the MTC 3D package was unable to identify. In particular, IRSN revealed a risk of natural circulation being interrupted in reactor coolant loops not affected by the steam line break, in the event of reactor coolant pump shutdown. From this observation, the Institute concluded that the method recommended by EDF could not be used for the EPR safety demonstration without substantial improvements to modeling.

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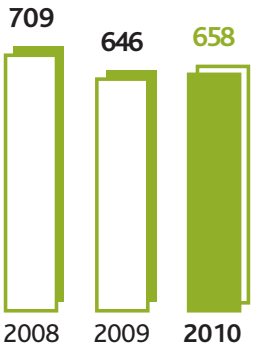
tinuous improvement. IRSN assessments such as these, distinct from the regulatory process, contribute to continuous improvements in safety of facilities.

Analysis of the EDF's on-site emergency plan reference file

In August 2010, IRSN sent ASN its opinion on the draft reference file that EDF has drawn up for producing the on-site emergency plans for its plants. The procedures set out in this document, which specifies the organization that nuclear power plant operators must put in place in the event of an emergency, will be implemented on each site. IRSN has examined the feasibility and consistency of the project, giving special attention to the handling of accident conditions that could lead to risks for the general population.
Following its examination, IRSN considers that the draft document proposed by EDF should improve the consistency, robustness and accuracy of the emergency response systems implemented at its power plants. IRSN has also drawn up recommendations with a view to improving the operational aspects of the emergency response systems described in the document. ■



Number of technical notices to ASN (excluding defense-related activities).

■ Monitoring plants, fuel cycle facilities, and radioactive material shipments

IRSN puts all its skills and expertise to work to provide consistent safety assessments of facilities and a wide range of activities.

Safety review for the CIS bio international plant

On July 7, 2010, IRSN presented the relevant ASNadvisory committee with the conclusions of its safety review for the artificial radio-isotope production plant located at Saclay near Paris, and operated by CIS bio international.
The Institute noted that significant renovation work had been undertaken at the facility since 2005, mainly with a view to improving provisions taken to control risk of fire and spread of radioactive materials. Nevertheless, further studies should be provided to assess the behavior of structures in the event of an incident (such as fire, load drop or external explosion) and to rule on the adequacy of the provisions adopted by the operator concerning of those risks.
Furthermore, IRSN identified areas for improvement at the facility, in particular concerning the management of risks relating to fire and the spread of radioactive materials, and the organizational provisions put in place to mitigate risks associated with the sensitive activities performed at the facility.
Pending additional studies on these issues, which will undergo a new examination in 2011, the Institut recommended that the operator make provisions to reduce the quantity of radioactive iodine liable to be released in the event of an accident.

International regulations on the transportation of radioactive materials

As part of its support activities for ASN, IRSN participated in meetings organized by the IAEA in 2010 to reach a consensus among member states and international organizations on the publication of a new edition of the international regulations on the transportation of radioactive materials. The decision to publish a new edition (the first dates back to 1961) was taken during a revision cycle initiated in 2008 to which IRSN actively contributed by suggesting changes aimed at increasing the level of safety in the transportation of radioactive materials. During 2010, IRSN presented the French position on exemp-

IN THE WORDS OF...

Didier Wattrelos,

Head of the Clearinghouse project for IRSN

"By participating in the European Clearinghouse project, which aims to share experience in pressurized water reactor operation throughout Europe,
IRSN makes good use of its knowledge and databases to perform analyses.
The studies in progress focus on external hazards and spare parts supply, as well as a more general analysis of the types of incident included in the Institute's incident database. In performing these studies, the Institute is helping to enhance safety on a European level, to the extent that Clearinghouse is a data-sharing mechanism that allows countries with only a few nuclear facilities to benefit from greater analytical capabilities and more extensive operating experience feedback."

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tion thresholds, conditions for the transportation of naturally occurring radioactive materials and requirements associated with fissile materials that are exempt from a criticality-safety demonstration.
The current revision cycle will be completed in 2012. Before coming into force in France, the new regulations will have to be integrated into road, rail, waterway and air transport regulations.

MIRTE experimental criticality program

The MIRTE 1 program, performed under IRSN leadership at the CEA's criticality facility in Valduc, in eastern France, and jointly funded by the U.S. Department of Energy (DOE), Areva and ANDRA, was completed as planned in June 2010.
The program comprised 43 experiments involving the use of one or more fuel assemblies surrounded or separated by various screens. Its main aim was to contribute to the validation of criticality calculation packages for various structural materials likely to be used in shipping casks and at fuel cycle facilities.
IRSN's initial analyses of the experimental results have already produced basic data concerning the neutronic characteristics of the materials tested (copper, nickel, titanium, iron, aluminum, Zircaloy, lead and glass). The effect of the water content of concrete, which is a significant parameter in criticality risk analyses, was also studied.
The successful completion of the MIRTE 1 program demonstrated the professionalism of the IRSN and CEA teams and how they complement each other in world-class experimental programs such as this.
Areva, ANDRA and the DOE are convinced of the benefits of such experiments and have committed themselves to performing a second phase of the program, called MIRTE 2. This second phase will set out to supplement the MIRTE 1 program and test additional materials. The partners are currently collaborating closely on the detailed design of the MIRTE 2 program.

■ Road transportation of irradiated fuel is governed by international regulations.

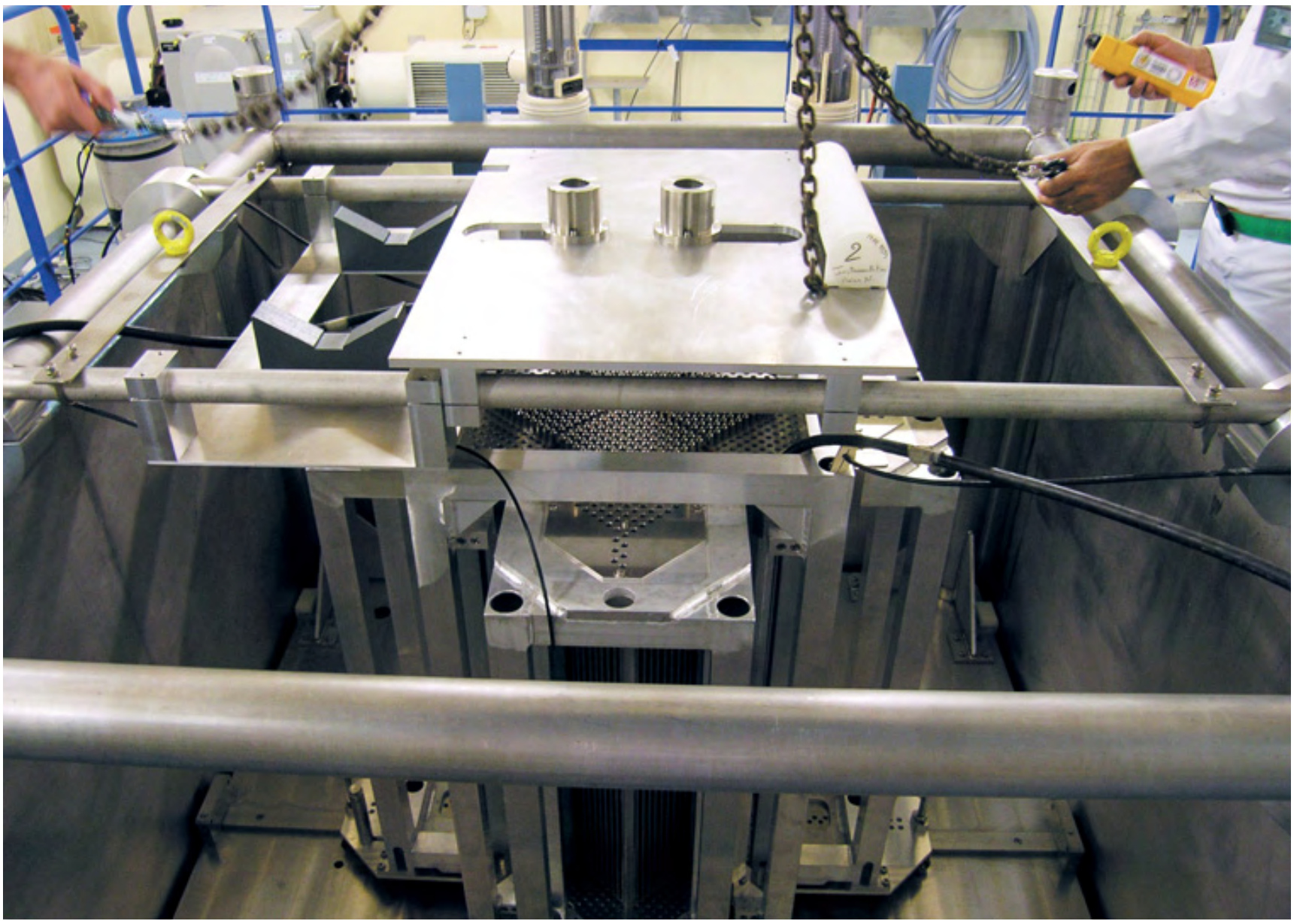
Nuclear fuel cycle operation

In June 2010, IRSN presented to the relevant advisory committees with the conclusions of its assessment, from a safety and radiation protection standpoint, of how the French "fuel cycle" is planned to operate for the period 2007-2017. This analysis, ■■■

INTERNATIONAL ACTIVITY

French-Chinese seminar on nuclear fuel cycle facility safety

At the request of its Chinese counterpart NSC, the Nuclear Safety Center, IRSN helped to organize a French-Chinese seminar on fuel cycle facility safety in Beijing, in October 2010, with the participation of representatives of NNSA, China's safety authority. The seminar was held in partnership with Areva and China National Nuclear Corporation (CNNC) in the context of Chinese plans to build fuel cycle facilities (a spent fuel reprocessing plant, MOX fuel manufacturing facility). The presentations focused on French and Chinese approaches to assessing safety files for fuel cycle facilities and on the technical basis of these assessments. IRSN made a significant contribution in sharing its know-how in these various areas. The seminar highlighted the safety concerns shared by all parties and on which future exchanges could be based.



■ Installing the "fine" test device with its 5 mm copper shield in equipment test tank B of the criticality facility at the CEA Valduc site.

based on files produced by the operators concerned (EDF, Areva and Andra) with EDF taking overall responsibility, focused in particular on the operations and logistical resources required to run EDF's nuclear reactors and manage spent fuel.
In order to confirm the data concerning inventories and flows of nuclear materials for its assessment, IRSN simulated fuel cycle operation, taking past and future operation of nuclear reactors into account. This type of simulation was also used to study changes that would be brought about by the deployment of next-generation nuclear reactors.
In particular, IRSN concluded that available storage capacities, both for reprocessed uranium and for irradiated fuel, could prove insufficient in the short to medium term. Based on these conclusions, the advisory committees have recommended that EDF present a detailed analysis of its available capacity in the coming years, taking into account any difficulties that might affect its plans to increase storage capacity for spent fuel. ■

INTERNATIONAL ACTIVITY

Long-term collaboration on criticality

Since 1995, IRSN has contributed to the production of an international handbook of criticality experiments, serving to validate criticality calculation packages, as part of the OECD's ICSBEP project.
Several close collaborations, set up with the criticality teams of the Japan Atomic Energy Agency (JAEA), the DOE and the Russian Institute for Physics and Power Engineering (IPPE), have led on to joint experimental programs, such as the ISTC MOX project, led by IPPE in collaboration with IRSN and the DOE, and IRSN's MIRTE 1&2 programs involving the DOE, Areva and ANDRA.
These collaborations also identify experimental needs and assess experimental programs designed to fill them. Within this context, IRSN has been invited by the DOE to help define the forthcoming TEX program, which will be carried out in the USA as of 2014.

Fuel safety

IRSN research in fuel safety seeks to provide a better assessment of the safety limits to be considered for the new nuclear fuel management methods contemplated by operators.

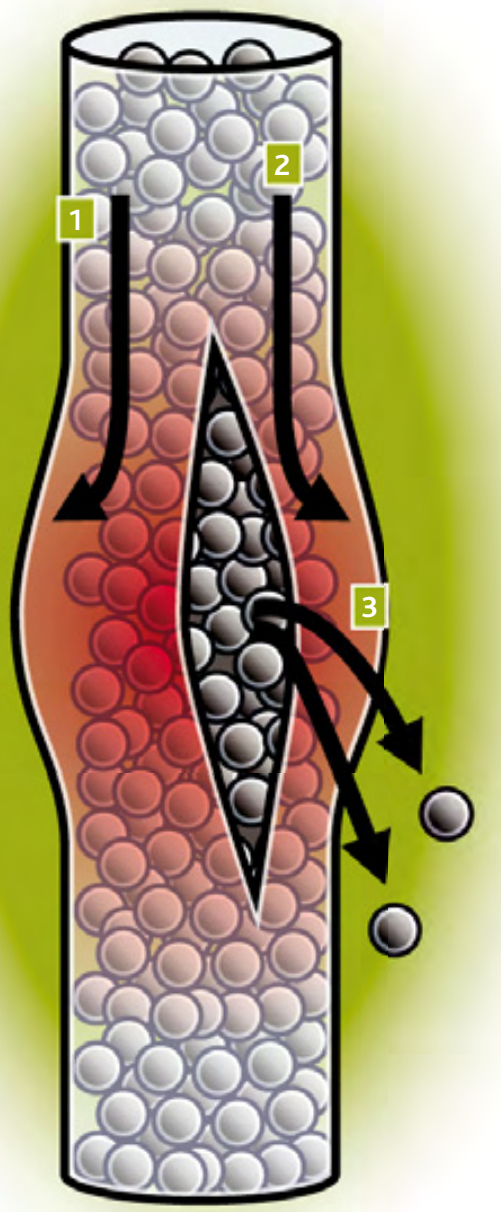
Reference system for the study of a loss-of-coolant accident

In 2010, IRSN presented the advisory committee for nuclear reactors with its assessment of EDF's planned modifications to the reference system for the study of a loss-of-coolant accident (LOCA). The assessment focused on the guarantee of reactor core cooling. The proposed orientations approved by the advisory committee will have to be further developed over the coming years. They concern the size of breaks to be considered and fuel strength requirements during quenching, together with the mechanical loads to be calculated and physical phenomena to be taken into account, such as the movement of fuel pellet fragments inside fuel rod cladding. The advisory committee should meet again to discuss these topics by 2013.

Significant, tangible progress in LOCA simulation

In 2010, the structural integrity and micromechanics (MIST) laboratory, a joint laboratory setted up by IRSN, CNRS and Montpellier University 2, made significant advances in LOCA simulation. It provided a major contribution to the validation of mechanical models of the IRSN DRACCAR software, which models the thermo-mechanical behavior of a fuel assembly during a LOCA. The laboratory also offered a simplified model for assessing the movement of fuel fragments inside the cladding during this type of accident. Modeling this phenomenon, called fuel relocation, is one of the keys for determining fuel behavior during a LOCA. It is the subject of numerous studies and experiments, in particular for the revising safety criteria associated with a LOCA.

More generally, since 2007, the MIST laboratory has been developing theoretical and simulation tools for nuclear safety, supporting IRSN's safety analysis work. Those tools, have helped to understand key ■■■



■ Schematic illustration of the fuel relocation phenomenon and fuel ejection in the event of cladding failure.
1. Fuel cladding.
2. Fuel fragments (shown as spheres).
3. Clad ballooning and cracking induced by fission gas pressure in the fuel.

MORE ABOUT

Loss of coolant accidents (LOCAs)

These accidents are taken into account at the design stage of pressurized water reactors. They are relevant to the design of safety-related reactor systems and components, notably the safety injection system, the mechanical components of the reactor coolant system, and the containment building.
An accidental break in the reactor coolant system causes a decompression wave that travels through the system and subjects its components, and reactor internals and fuel assemblies, to huge hydraulic loads.
For safety purposes, mechanical stresses on reactor internals and fuel assemblies must be limited so that fuel assembly and core geometries can ensure continued cooling.
Furthermore, a LOCA leads to reactor core uncovery. This causes the fuel rod cladding to heat up, which can lead to cladding failure. The water injected by the safety injection system restores the flow of water, thus putting an end to the overheating. The arrival of this cold water may, however, cause the overheated, oxidized cladding to fail and lead to additional dispersal of radioactive substances into the reactor coolant system.

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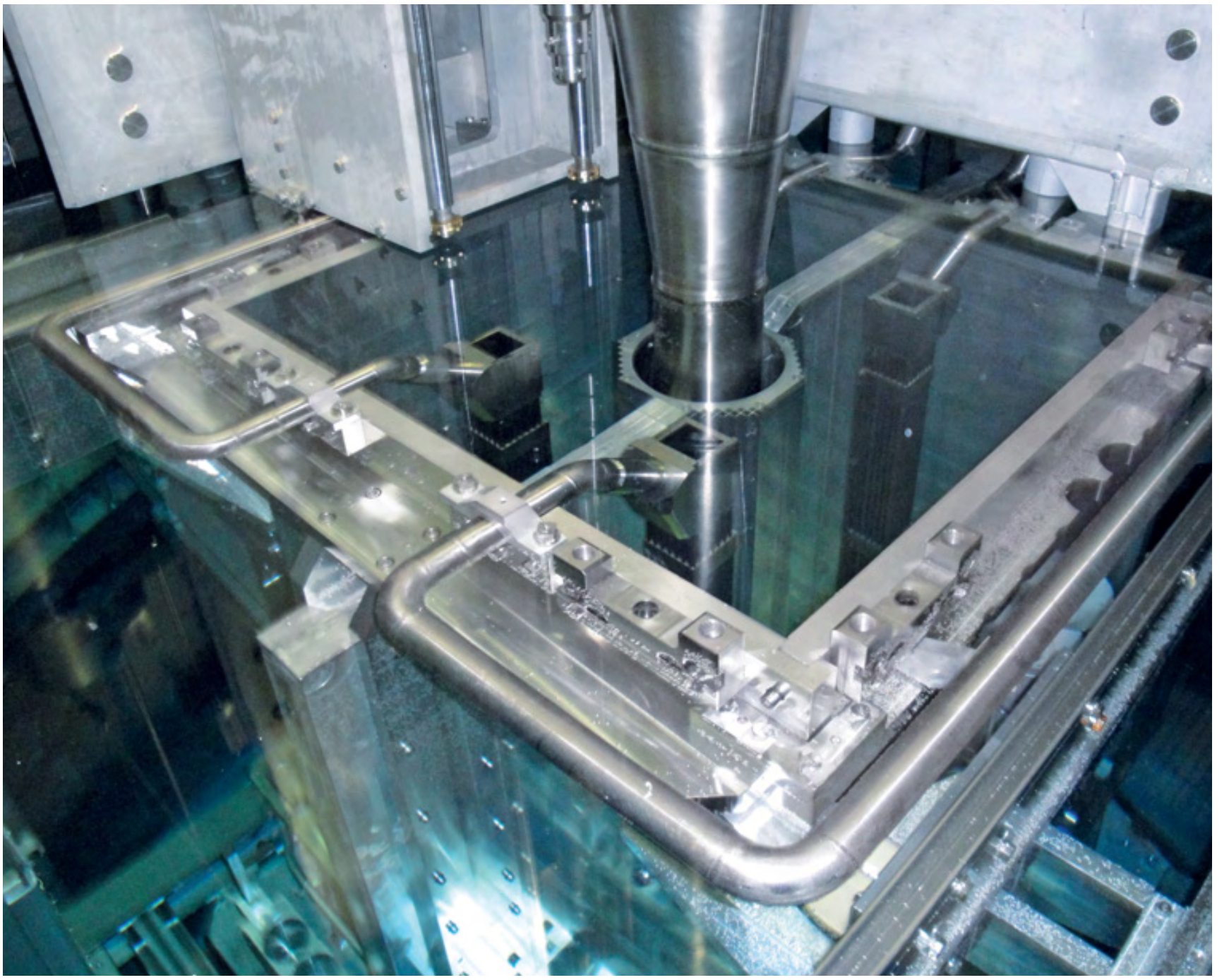

■ The CABRI reactor vessel was filled with water on November 30, 2010.

mechanisms involved in pressurized water reactors accidents such as fuel behavior (fragmentation, changes in properties with reactor residence time), cladding behavior (changes in properties, failure modes, transient swelling) and interactions between cladding and fractured fuel.

Progress in CABRI reactor upgrade work

In 2010, a number of key phases were completed in the upgrading work on CABRI. This IRSN-funded work includes the construction of a pressurized water loop that reproduces the conditions encountered in a pressurized water reactor and the enhancement of facility safety and security. The CABRI test reactor operated by CEA on the Cadarache site in southern France is used by IRSN for its research into the behavior of nuclear fuel under accident conditions.
The operations performed in 2010 involved completing seismic strengthening work on the reactor building and adjoining buildings, commissioning the new nuclear ventilation system for the reactor building, renovating the two external tanks and reactor core water pipework, performing functional tests on the radioactive effluent systems and reinstalling reactor internals prior to water filling at the end of the year.
In addition, a characterization campaign for hodoscope sensors, designed to detect fuel movements in the fuel rod being tested under accident conditions in CABRI, was successfully carried out through tests in CEA's SILENE reactor.

Internal and external deployment of SCANAIR software

The SCANAIR software, which is now fully mature, is used by IRSN to identify the various phenomena that must be taken into account in the study of pressurized water reactors Reactivity Initiated Accidents (RIA) safety criteria. In the context of IRSN's research into this type of accident, the SCANAIR application was used to prepare the tests of the CABRI International Program. Within France, the software is also widely used by EDF to produce safety documentation and by the CEA for studies relating to the safety of the CABRI core.
The year 2010 also saw SCANAIR distributed internationally, in particular to the Finnish technical support body (VTT), the Spanish safety authority (CSN), and the Japan Atomic Energy Agency (JAEA), thus allowing a larger validation of the software and, more generally, consolidating IRSN's international profile. ■

Aging nuclear facilities and service life extension

IRSN is a fully independent organization that provides the public authorities with the technical assessments they need to make decisions as to the continued operation of reactors in the short to medium term.

Reactor vessel strength analysis

In 2010, IRSN examined whether the reactor vessels of 900 MWe reactors were capable of operating for 40 years. Reactor vessel integrity is vital for safety and is therefore reviewed every 10 years to consider the effects of aging and actual operating conditions. At ASN's request, IRSN examined the file submitted by EDF that is intended to demonstrate that there is no risk of failure in the event of cold shock due to water from the safety injection system. IRSN and ASN's Nuclear Pressure Equipment Department presented their conclusions to the relevant advisory committee on June 16 and 30, 2010. The group ruled in favor of continuing operation for the reactor vessels of all 900 MWe reactors until their fourth ten-year inspection, provided that the temperature of the water used for safety injection on reactor B1 at the Saint-Laurent plant (on the River Loire, southwest of Paris) is increased.

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Safety review for the first 900 MWe reactor as part of its third ten-yearly inspection

In 2010, following the generic safety review carried out within the context of the third ten-yearly inspection of 900 MWe reactors, and drawing on a critical analysis of findings of the safety review performed by EDF, IRSN assessed the suitability of the modifications made and the results of the checks performed for the compliance review of reactor 1 at the Tricastin plant in southern France as part of its third ten-yearly inspection. The Institute also examined the file concerning the suitability for the continued operation of this reactor. The file in question is aimed at demonstrating that aging is managed in a way that guarantees safe operation of this reactor for at least another ten years. IRSN considered that, despite certain reservations regarding the generic studies, it could see no obstacle to continued operation of Tricastin 1.

This reactor was the first of the 58 reactors in France to undergo a safety review under the new enhanced framework introduced by the French Nuclear Security and Transparency Act (TSN). In 2010, IRSN's work made it possible for ASN to publish the technical grounds for its decision regarding continued operation of this reactor, with an unprecedented level of information brought to public attention.

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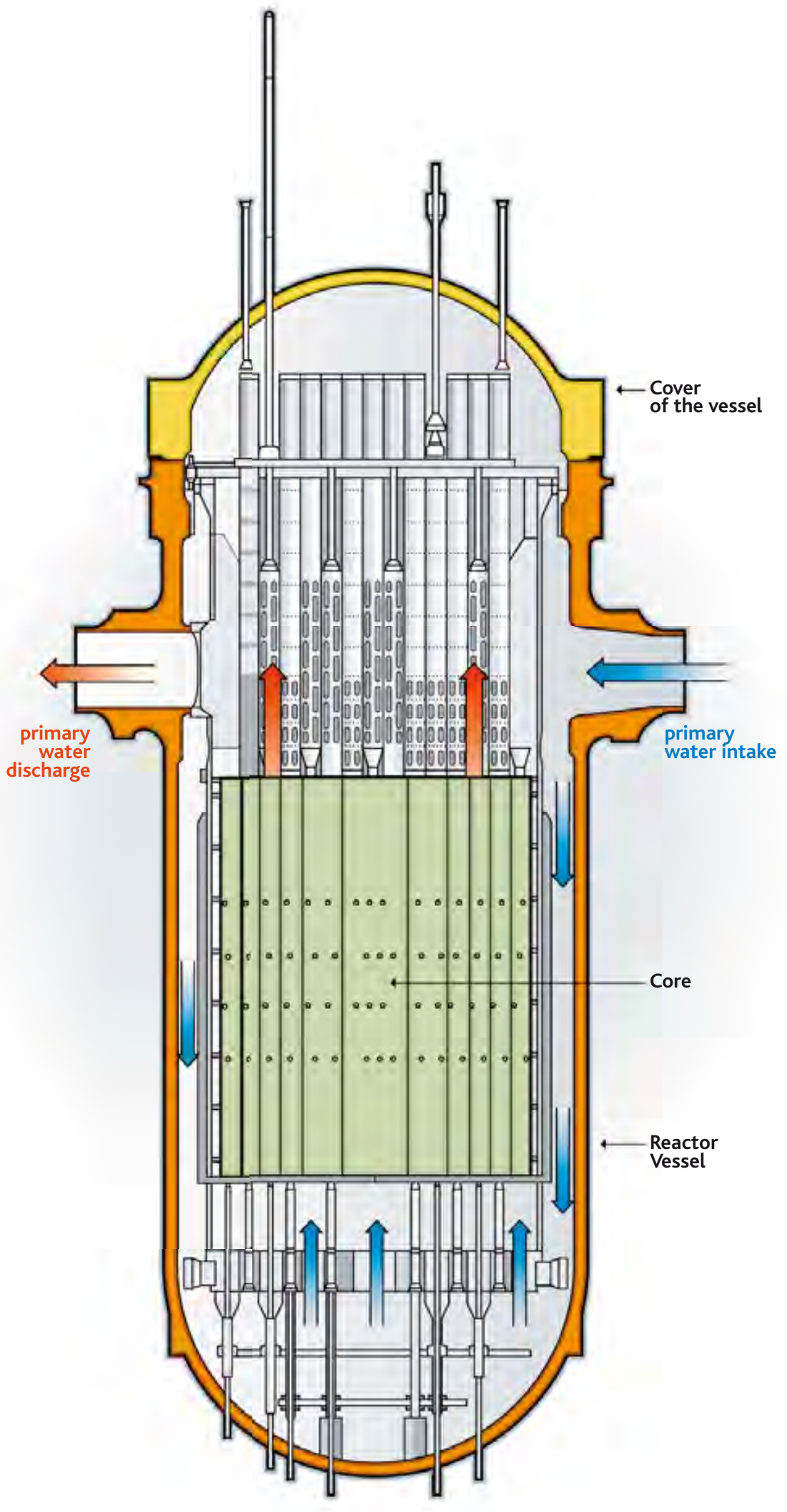


Cross-section of the vessel of a 900 MWe pressurized water reactor.

Reactor service life extension

In the context of discussions regarding the possible extension of the service life of reactors in the EDF fleet beyond 40 years, IRSN has identified two major subjects for investigation:

- EDF's management of the aging and obsolescence of safety-related structures, systems and equipment after 40 years and, in correlation to this, its ability to anticipate the best time to replace any safety-related components as necessary;
- modifications that may be specified and implemented to significantly reduce the probability or consequences of accidents.

Initial discussions on these matters were held with EDF in 2010, to prepare a meeting of the relevant advisory committee to examine EDF's orientations. The meeting is planned for 2011. ■

■ The SATURNE calorimeter hood is used to study the behavior of fires in an open environment.

IN THE WORDS OF...

Lounes Tadrist, Director of the Institute for thermal industrial systems (IUSTI, University Aix-Marseille I and II – UMR CNRS 6595)

"The creation in January 2010 of ETIC, a joint research laboratory for the study of fire in a confined space, stems from the shared desire of IRSN and IUSTI to strengthen their long-standing collaboration. For IUSTI, this collaboration is an opportunity to enlarge the scope of our activities to include research into fire in ventilated-confined spaces, a significant issue for nuclear safety. It will draw on our skills in the field of fire research in urban, industrial and natural environments that have been developed over the last 15 years or more. Through ETIC, the goal-oriented research performed by IRSN will be able to rely on prior research that will consolidate its advances in understanding and simulating fires in nuclear facilities. ETIC is an "open" laboratory that plans to share skills and tools around four research themes that we have specified together: smoke propagation, combustion under fire conditions, developing instrumentation dedicated to fire-wall interactions and developing field models. For each of these themes, a roadmap has been drawn up, identifying the scientific barriers to be overcome and setting objectives for results over the next four years."

■ Fires and containment

The research work performed by IRSN regarding fire protection aims to improve understanding of how a fire develops in a confined space and the related risk of radioactive release to the environment.

Studying fires liable to occur at nuclear facilities

In 2010, IRSN analyzed the results of three PICSEL-S program tests, which were performed in 2009 as part of a joint program with Areva NC, in partnership with JNES, the Japanese technical support organization.

These full-scale tests, carried out at the DIVA facility, focused on the effects of compartmentation (using fire dampers for example) on combustion and smoke propagation at a nuclear facility such as a laboratory or plant. The source of the fire was an electrical cabinet - with its door open - similar to those found at nuclear facilities.

The analysis distinguished three phases of combustion: first, a slow fire-propagation phase, then a rapid-combustion phase during which the flame propagates over the whole cabinet surface, and lastly, a relatively long burning-out phase until the fire dies out. It appears that only the last combustion phase is affected by compartmentation of the room involved, with the opening and closing of fire dampers affect-

ing fire duration and the transfer of smoke to adjacent rooms.

Understanding the role and mechanisms of smoke transfer

IRSN performed the last test campaign of the international PRISME project in 2010. The six tests involved fire sources such as solvents or electrical cabinet and power cable fires.

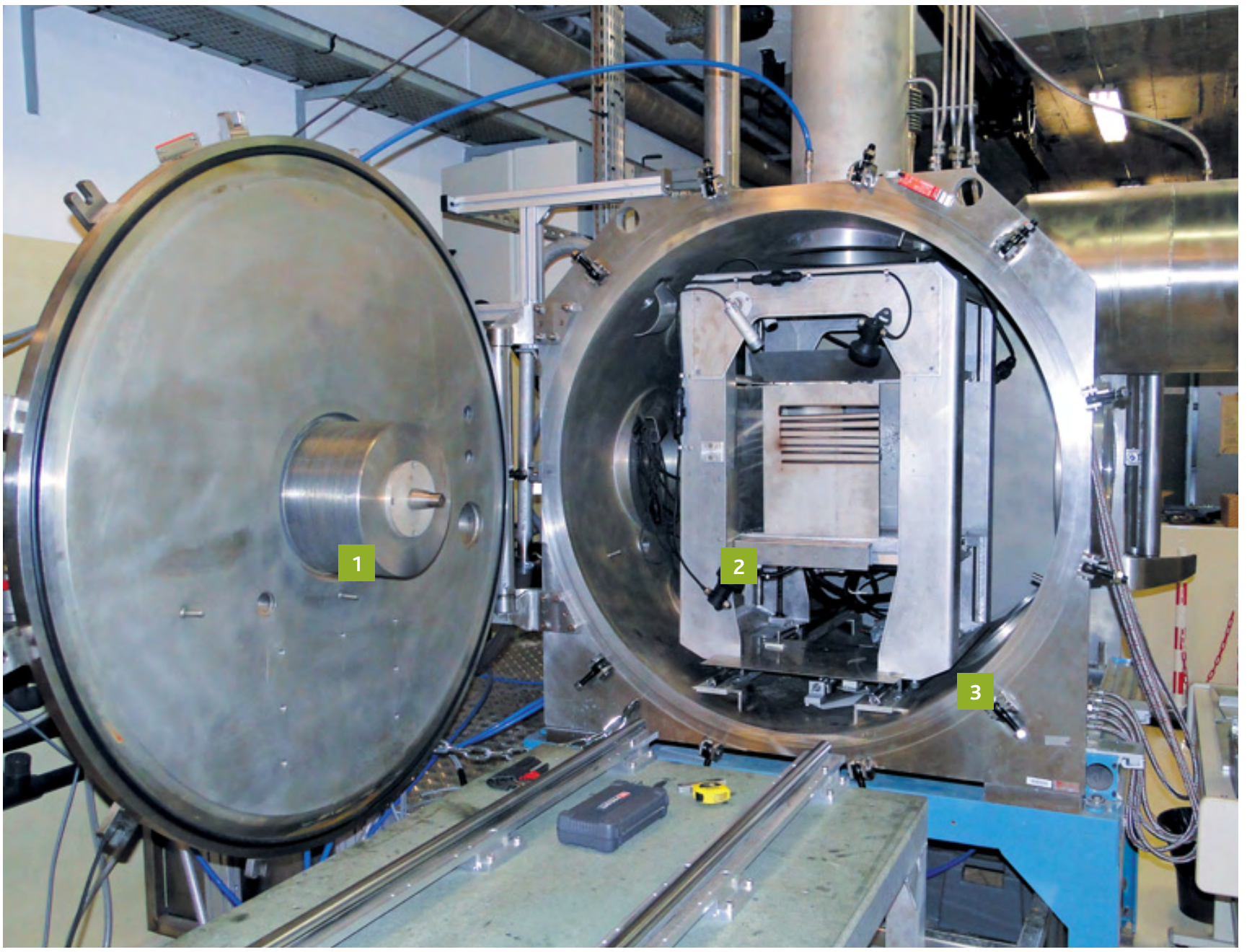
One of the major aim of the PRISME project was to study various smoke transfer mechanisms during a fire in a nuclear reactor and to assess the consequences for facility components (in particular for electrical cables). It involved 22 partners from 12 different countries (European countries, plus South Korea, Japan, Canada and the USA) between 2006 and 2010.

At the same time, a working group carried out cross-comparisons to assess the performance of various simulation software packages in simulating the tests included in the program. Drawing on unique experimental data obtained from the PRISME program, this work led to improved consideration of smoke transfer phenomena when modeling fires in a ventilated-confined space and enhanced validation methods for fire simulation software.

Patents for minimizing aerosol emissions induced by laser cutting

In 2010, as a result of research carried out in partnership with the CEA's Assembly Technologies Laboratory in Saclay, near Paris, two patent applications were filed with a view to minimizing aerosol emissions induced by laser cutting operations. The cutting process in question could be used in dismantling nuclear facilities.

At the DELIA facility for underwater and air laser cutting, steel plates up to 80 mm thick were cut in air using a continuous wave 8 kW YAG laser. The concentration and particle size distribution of the aerosol emitted during cutting operations were determined as a function of parameters (nozzle diameter, plate-to-beam waist distance, laser power and speed) and plate thickness. The process was validated and measurements were used to obtain the optimum conditions for minimizing aerosol emissions. ■



■ The work carried out in cooperation with the CEA's joining technology laboratory (LTA) in Saclay, near Paris, involved the use of the continuous wave 8 kW YAG laser at the DELIA facility, for underwater and air laser cutting facility.
1. Laser cutting head 2. Steel plate 3. Underwater cell.

Accidents

In addition to the considerable work it carries out on the prevention of PWR core meltdown accidents, IRSN is conducting research into the physics of such accidents and their potential impact on human health and the environment.

Experimental studies on iodine chemistry

IRSN performed the 29th and last test of the ISTP/EPICUR program in September 2010. The radioactive iodine produced in nuclear reactors is a radiotoxic element that exists in volatile forms (molecular iodine and organic iodides). It is the main contributor to radiological effects in case of radioactive release to the environment following a reactor core meltdown accident. In particular, organic iodine gas is difficult to capture in filter systems.

The ISTP/EPICUR program, which began in 2005, aimed to study iodine behavior within the reactor containment building. More specifically, it studied the quantity and nature of iodine (aerosols, molecular iodine or organic iodine) released from the sump located at the bottom of the containment building. It also considered the production of organic iodine through irradiation of the iodine deposited on the painted surfaces of the containment walls. The effects of the pH of the water in the sump, temperature, gas-phase oxygen concentration, water vapor pressure and initial quantity of iodine deposited on the paint were examined.

The experimental data gathered serves to improve software used for estimating the release of radioactive iodine and so, to reduce the uncertainty of the corresponding calculations.

Completion of the BECARRE experimental program

IRSN performed the final experiment in the BECARRE program in March 2010. This program was set up to study degradation phenomena affecting the boron carbide (B_4C) neutron absorber rods in nuclear reactors in the presence of water vapor. It centered on four areas: the oxidation of B_4C pellets, the oxidation of liquid mixtures of steel and B_4C formed at high temperature, the deformation of a B_4C control rod segment, and the modeling of the carbonaceous gases emitted, under conditions representative of accident scenarios.

The results were used to establish the appropriate oxidation laws and identify phenomena that were not previously taken into account by modeling codes, for example the dissolution of previously-formed oxide layers on the surfaces of Zircaloy guide tubes by the B_4C-steel mixture. They confirmed that, in the event of a core meltdown accident, the materials making up the control rods would have an impact on the degradation of the surrounding fuel rods and, in the case of B_4C rods, this effect could be increased as a result of the mixtures formed splashing and flowing down along the rods (candling). The results of the BECARRE program also demonstrated that only very small quantities of methane are produced by boron carbide oxidation, which limits the potential production of volatile organic iodine under these conditions.

Launch of the ECOBA project

In 2010, IRSN received funding from the French national research agency for the ECOBA project it is running in partnership with the GeM laboratory (Ecole Centrale in Nantes, University of Nantes and University of Saint-Nazaire), the University of Pau and Pays de l'Adour and the Ecole Normale Supérieure in Cachan. The project, scheduled to last three years, will study the containment properties of reinforced concrete structures and includes a program of experiments aimed at testing the behavior of a full-scale mock-up representing a reinforced concrete containment wall under the influence of pressure and temperature. In 2010, the project chiefly focused on designing the mock-up and the various measuring devices to be set up during the tests. IRSN will measure containment leakage.

The results of research work carried out by doctoral students at the IRSN on the behavior of early age concrete and the mesoscopic approach (modeling on the scale of individual granules) to explain the cracking phenomena will be used to define these measurements. The ECOBA project will provide additional data for evaluating double-wall containment systems for reactors, which will be the subject of an ■■■

IN THE WORDS OF...

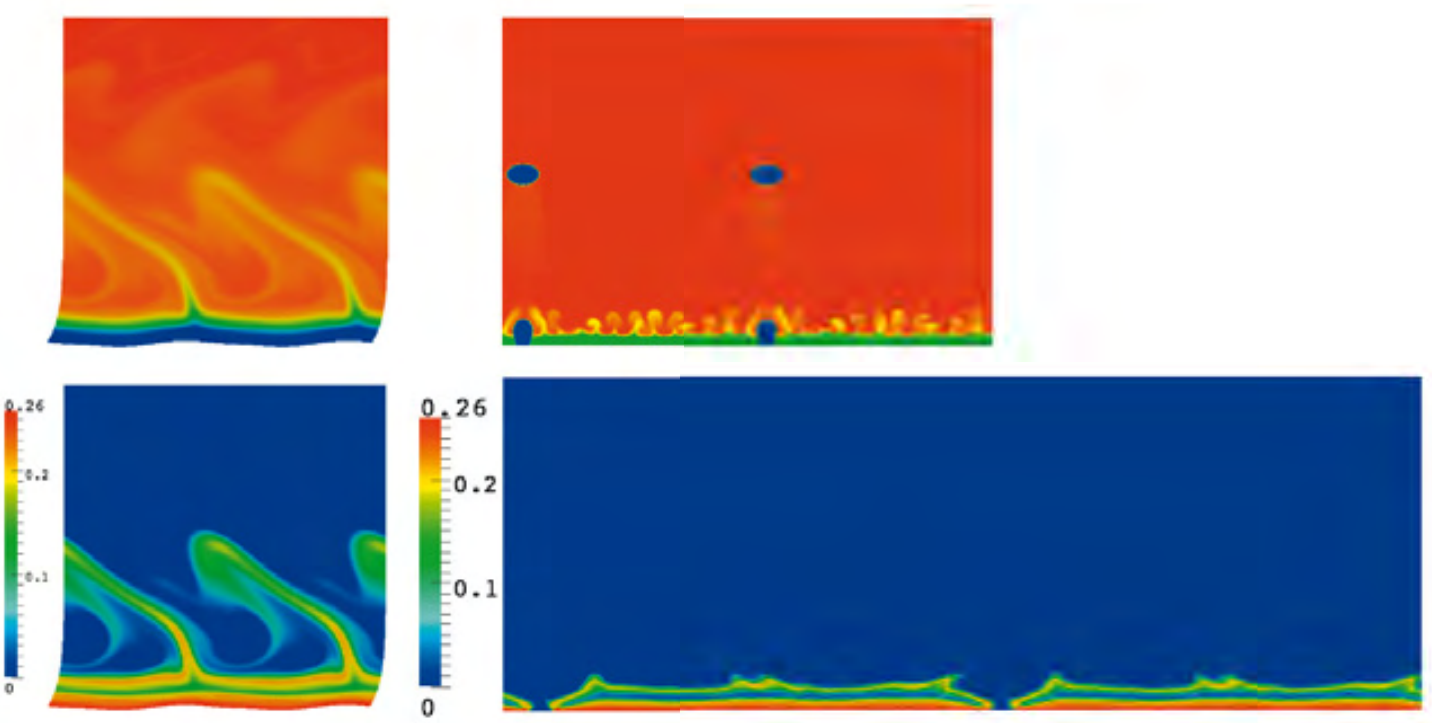
Dr Richard Y. Lee, Office of Nuclear Regulatory Research, U.S. Nuclear Regulatory Commission

"I took part in the Phebus FP program, which was completed at the end of last year, from the time the US NRC became involved in 1989. We worked with IRSN on five tests that proved extremely useful for the NRC, as they provided the data required for updating and validating our computer codes, in particular those relating to major accidents. This is the case with MELCOR, the American equivalent of the ASTEC code developed by the European Union. They also provided us with information relating to the relevance of the assumptions used to develop the "Revised Source Term" that we published in 1995 in report NUREG-1465. Phebus FP and the International Source Term Program showed that although many of our assumptions were correct, some of them relating to iodine behavior in the containment needed to be reviewed. This emerged from the EPICUR tests in particular. These test results are very important not only for designing safer reactors, but also for maintaining and enhancing the safety of reactors already in service."

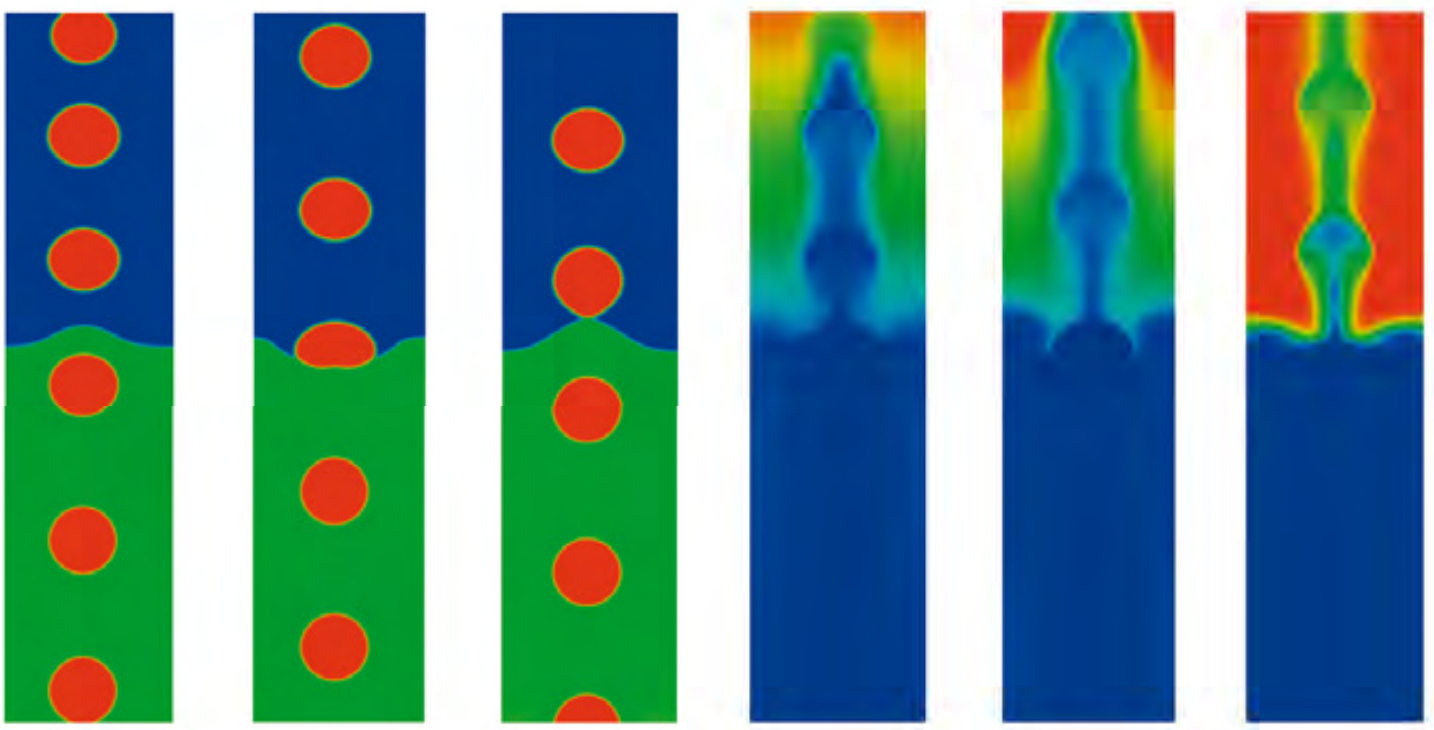
MORE ABOUT

Simulation of corium-concrete interactions

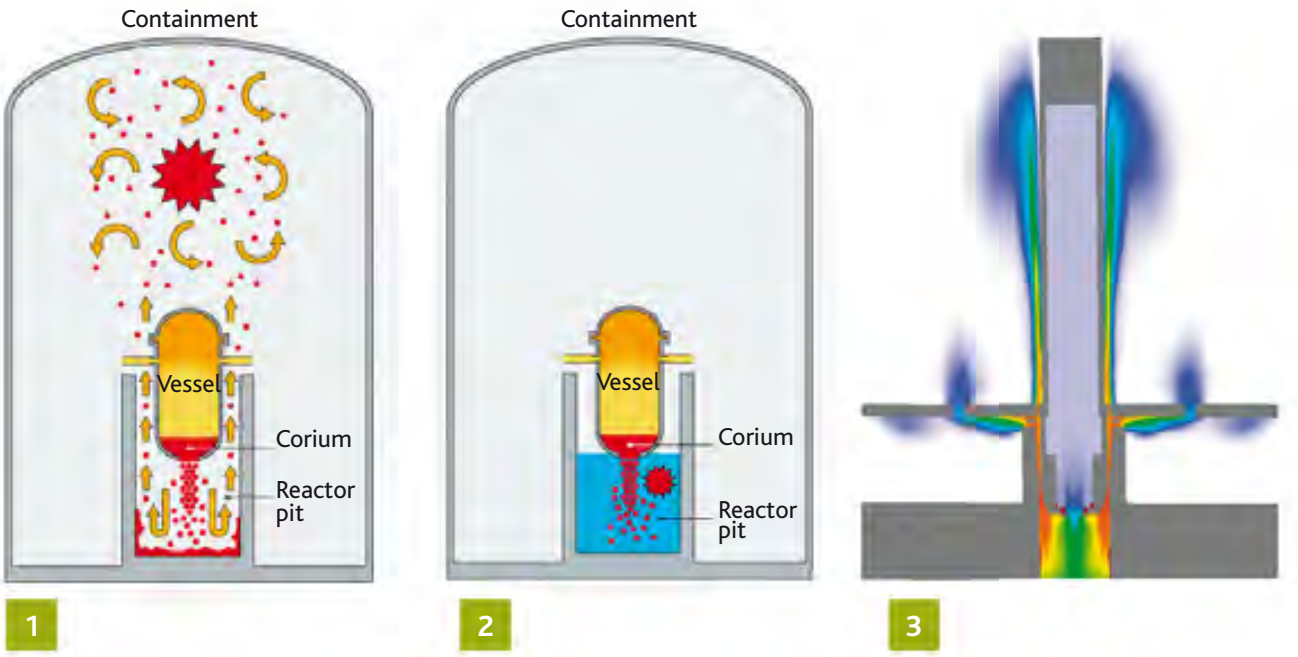
The year 2010 saw some of the outcomes of work started in 2002 on the detailed simulation of the interaction between corium (mixture of materials resulting from reactor core meltdown) and the concrete used in the foundation slab supporting the reactor vessel. Simulations involved determining heat transfers taking place between the different phases present. Dissertations in this area made a significant contribution. The structure of the interfaces in question cannot be examined experimentally as the materials in question are corrosive and opaque at very high temperatures. It does, however, play a crucial role in the rate at which the concrete is eroded by the corium. As far as safety is concerned, the aim is to obtain a more precise estimate of the distribution of heat released by the corium on the surface in contact with the foundation slab concrete, a value that determines the foundation slab erosion rate. The problem is made all the more complex by the fact that gas bubbles (CO_2, H_20) released by the concrete as it heats up and melts enter and disturbs the corium-concrete interface. The detailed model used will be validated by analytical tests carried out in collaboration with the Toulouse Institute of Fluid Mechanics, (dynamics of liquid interfaces/ liquid crossed by a gas) and by tests performed at the CNRS PROMES laboratory (thermal degradation of concrete in a solar oven).



■ Display of the interface between corium and siliceous concrete with (right) and without (left) gas release. Density deviation (top) and solid fraction deviation (bottom).



■ Change in an interface in the corium between an oxide layer and a metal layer with gas bubbles released by the concrete passing through it. Density deviation on the left and temperature fields on the right used to quantity heat transfer.



**1. Pressurized corium ejection can cause containment overheating and pressurization.
2. Corium falling into the reactor pit can cause a steam explosion.
3. Display of an MC3D calculation of corium flowing into the reactor pit water.**

advisory committee meeting on reactors planned for the end of 2012.

Modeling phenomena resulting from reactor vessel failure in the event of a major accident

Developed by IRSN in partnership with EDF and CEA, MC3D is a thermal-hydraulic software program primarily used for assessing phenomena liable to occur immediately following a postulated reactor vessel failure in the event of a core meltdown accident. If there is water in the reactor pit, the molten core which is spreading breaks up and mixes with water, which could lead to a steam explosion.

In 2010, IRSN carried out realistic 3D assessments on a reactor-scale steam explosion. This work was made possible by recent improvements to the MC3D software application. If there is no water in the reactor pit, and if the reactor vessel is pressurized at the time of failure, the molten fuel may spread through the containment building and pressurize it as a result of direct containment heating (DCH). MC3D software has also been successively used for several years to study the spread of molten core material in this type of scenario for 1300 MWe reactors, the EPR, and 900 MWe reactors.

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Increased recognition for SARNET

The 4th ERMSAR (European Review Meeting on Severe Accident Research) conference, hosted by ENEA in May 2010 in the Italian city of Bologna, was attended by 98 delegates from various countries.

The conference presented details of work carried out in partnership by members of SARNET, the European network of excellence. Coordinated by IRSN, SARNET is devoted to research into possible severe accidents involving nuclear reactors. Presentations and discussions highlighted the capitalization of knowledge acquired in SARNET in the ASTEC software package, developed by IRSN and its German counterpart GRS, to simulate the full scenario of a severe accident.

New requests to use the software (by KINS, the Korea Institute of Nuclear Safety, and VTT, the Finnish technical research centre) confirm ASTEC's position as an international reference code.

In addition, new partners have joined the network: KINS and soon India's Bhabha Atomic Research Centre (BARC).

Progress in the ASAMPSA2 project

The ASAMPSA2 project, coordinated by IRSN, sets out to create a best practice guide for level 2 Probabilistic Safety Assessments (PSA2). In 2010, a first version of the guide was completed and sent for review to over a hundred European agencies and OECD partners. Practices vary widely across Europe, and the guide should harmonize the implementation of PSA2s and the use of the conclusions of these studies in the overall safety assessment of nuclear power plants.

Although it deals primarily with plants currently operating in Europe, the guide also considers Generation IV reactors.

The ASAMPSA2 project includes 21 agencies from 12 European countries involved in nuclear reactor safety, including nuclear operators, service providers, safety authorities, constructors, and research agencies. It began on January 1, 2008 for three and a half years as part of FP7, the European Commission seventh framework program for research and technological development. ■

www.asampsa2.eu

MORE ABOUT

Getting back to the basics in chemistry to further understanding

Theoretical chemistry, the use of which has shot up in the past 20 years, serves to calculate macroscopic properties, such as reactivity, that are difficult to obtain experimentally, by determining the electronic properties of atoms, molecules and their interactions. It is also a good tool for helping to interpret complex experiments that optimize test matrices in advance. In 2010, these techniques were used successfully at the C3R joint laboratory (IRSN-CNRS University of Lille 1), to calculate the kinetic constants of reaction systems involving iodine in the reactor coolant system to determine the stability and solubility of iodine oxides. They are also used in interpreting interactions between iodine and paint in the containment building.

IRSN is working with IPG, the French institute of earth physics, and the Ecole normale supérieure in Paris, to study the processes of deformation of the rift in the Corinth region in Greece.

Natural hazards

The research carried out by IRSN in the area of natural hazards is aimed at improving understanding of the risks and consequences for a nuclear facility of events, such as earthquakes, heat waves, storms, or flooding.

Post-earthquake mission in Chile

IRSN is regularly called on to participate in post-earthquake missions following significant quakes. This allows it to build up its expertise in both seismology and seismic design for buildings.
In 2010, the Institute was called in on a post-earthquake mission organized by the international laboratory Montessus de Ballore, following the earthquake of magnitude 8.8 that struck Chile on February 27. The two-week mission provided seismological and geodesic data for use in studying the mainshock and its aftershocks. The initial geological observations made concern the changes to the landscape caused by the earthquake on the coast (uplift or subsidence of soil) and the extent of the zone flooded by the tsunami.

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Seismic hazard assessment

In 2010, ANR decided to fund the SISCOR research project that brings together IRSN, IPG, the French institute of earth physics, and the Ecole Nationale Supérieure in Paris. The studies planned as part of the project set out to observe and model the deformation processes affecting the rift in the western part of the Corinth region in Greece – Europe's most seismically active region. Tectonic studies and permanent seismological and geodesic networks set up in 2000 will help to improve understanding of how active faults work and will also serve to develop seismicity models. In particular, the results of geodesic measurements (taken over a period of 10 years) will be compared with paleoseismological studies along the faults (covering a period of 10,000 years) to quantify the share of deformations absorbed by each fault. The age of faults and the presence of fluids will then be studied to determine whether these factors explain in any way the considerable diversity of seismic behavior observed. Based on the results of this work, a method will be produced for integrating the contribution of active faults into probabilistic seismic hazard calculations, by taking their mechanical behavior and seismic history into account.

INTERNATIONAL ACTIVITY

Site survey services

Several countries wishing to acquire nuclear power capability have initiated a site selection and validation processes and have called on IRSN for its expertise to characterize the sites under consideration.
IRSN is supporting the United Arab Emirates nuclear safety authority (FANR) by providing a technical assessment of the preliminary safety analysis report chapter devoted to the characterization of the selected site. In Tunisia, it is helping STEG, the Tunisian gas and electric utility, to assess certain natural hazards as part of an agreement with AFNI, the French nuclear international agency.

The Institute also performed a study in associate with AFNI for the Kuwait nuclear safety authority (KNNEC), as part of a preliminary siting process for a nuclear power plant.
Lastly, it is also working in Jordan and Egypt for EC-funded projects on behalf of the local safety authorities.
Here too, its experts are helping the authorities to acquire the methods and set up requirements that any nuclear facilities built in these countries will have to meet.

About defense

ASSESSING THE SAFETY OF MILITARY NUCLEAR SYSTEMS, NUCLEAR FACILITIES AND DEFENSE-RELATED TRANSPORT

IRSN's activities in this area, particularly those of its Nuclear Defense Expertise Division (DEND) come under a technical support agreement with the French Representative in charge of Nuclear Safety and Radiation Protection for Defense-related Activities and Facilities (DSND), operating under the aegis of the Ministry of Defense and the Ministry for Industry.

SAFETY OF SUBMARINES, AIRCRAFT CARRIERS AND DEFENSE-RELATED MILITARY OR CIVIL FACILITIES

IRSN's safety assessments of facilities and equipment operated by the Ministry of Defense, CEA and Areva cover their entire life cycle, from design and construction, to operation and dismantling. They also concern any major transformations on the facilities and equipment brought about by changes in their activity.

DESIGN AND CONSTRUCTION

In 2010, IRSN examined the supporting documentation submitted by DGA, the French defense procurement agency, for the definitive operating authorization request for the next nuclear ballistic missile submarine, "Le Terrible", the last of this class, following its sea trials.

The Institute also assessed the documentation submitted for the commissioning of the new fuel storage pool at the Ile Longue base in Brittany, as well as preliminary studies in preparation for the arrival of future nuclear attack submarines of the "Barracuda" program at the port of Cherbourg on the Channel.

■ IRSN conducted the safety review of the "Rubis" class nuclear attack submarines.

It also continued its examination of the application for a provisional operating license for the experimental reactor (RES) at the Cadarache secret nuclear facilities in southern France.

For the laboratories and plants used for Defense activities at the CEA center in Cadarache, IRSN assessed the safety of the future nuclear materials storage facility of the nuclear propulsion fuel manufacturing plant, together with plans for a spent fuel dry storage facility.

The Institute also began the safety examination for construction permits for the planned plutonium recycling facility and tritiated waste storage facility at the CEA/DAM center in Valduc in eastern France.

It examined the safety analysis report concerning the construction of four new buildings intended for the storage of uranium-bearing materials (P35) at the Areva NC plant in Pierrelatte in southern France.

Regarding the CEA center in Marcoule in the south of France, IRSN examined the safety baseline of the alpha waste packaging facility (UCDA) prior to commissioning.

OPERATION

IRSN's work included a safety review of the "Rubis" class nuclear attack submarines, for which most of the documentation was examined in 2010 to comment on the modifications required for their final operating period, pending the arrival of the "Barracuda" class vessels.

The Institute examined, as it does every year, the lessons learned from events affecting the operation of on-board nuclear steam-supply systems and their land-based support facilities.

It also began to examine new water intake and discharge permit applications (DARPE) submitted by the bases in Cherbourg, Brest and Toulon, which are involved in building and providing support for nuclear-powered vessels.

The Institute began assessments relating to the safety review of the liquid effluent treatment station and a legacy-waste storage facility (MAR 400) at the CEA Marcoule center, so as to determine whether or not they could continue to operate. It also examined the documentation submitted by the operator following the safety review of the Marcoule Vitrification Facility, performed in 2009. As part of its facility monitoring activities, it examined the causes of and lessons learned from a number of incidents that had occurred at the facility.

Lastly, it began the process of examining the new DARPE.

The Institute has analyzed the safety review documentation for the nuclear propulsion fuel manufacturing facility at the CEA center in Cadarache, together with several applications for authorization to carry out modifications including structural reinforcements and fuel element production equipment.

As part of the safety review of the facilities at the CEA/DAM center in Valduc, it examined the safety baselines of facilities

designed for the storage of recyclable depleted plutonium-contaminated products and waste such as tritium, and VLLW, alpha waste. It also examined several safety files related to the improvement of the production tool at the Valduc center (new tritiated water treatment process, changes to storage conditions in a nuclear materials warehouse, etc.)
IRSN examined reports on several incidents that occurred at the CEA/DAM center in Valduc and the Areva NC center in Pierrelatte and assessed how they were handled. Overall safety at the Tricastin site was examined.
In addition, the Institute began to examine how nuclear operators at Valduc, Pierrelatte and Marcoule had responded to the DSND's request for them to take into account operating experience feedback from the criticality-related events that occurred at the CEA Cadarache ATPu facility.

7
IRSN reports for meetings of "defense-related" technical safety commissions.
(6 in 2009)

DISMANTLING

IRSN examined the safety documentation concerning the transfer of effluent due to final shutdown and dismantling activities at the UP1 plant to the Marcoule Vitrification Facility (APM), and the dismantling of some high-level process cells at the Marcoule prototype facility.

RADIOACTIVE MATERIAL TRANSPORT

Documentation examined by IRSN relating to the transport of defense-related radioactive materials included:

- requests for extension of approvals for transport on public domain,
- applications for the authorization of on-site transport,
- proposals for updates to IAEA recommendations concerning the transport of radioactive materials, in preparation for the publication of a new version of the recommendations in 2012,
- emergency plans relating to the transport of radioactive materials.

IRSN proposed a model for producing emergency plans, together with dimensioning guidelines.
It also examined additional evidence relating to the 81,000 weapon parts transport package. The additional information was sent by CEA in response to recommendations issued by the Transport Safety Commission following a meeting in 2009.

ONSITE EMERGENCY PLANS AND DRILLS

In 2010 IRSN was involved in developing scenarios for emergency drills at the Istres airbase, the CEA Marcoule site, and the Areva Pierrelatte site – all located in southern France – as well as the naval bases in Toulon and Cherbourg, and for a transport

IRSN regularly examines shipping containers for weapons parts.

MORE ABOUT

The nuclear propulsion fuel manufacturing facility at the CEA center in Cadarache

The nuclear propulsion fuel manufacturing facility at the CEA center in Cadarache was discussed in a joint meeting of the French commission for safety of laboratories, plants and waste management, and the French commission for criticality safety in 2010, when the safety review documentation for this facility was examined.
The operator's review process defined actions that would significantly improve facility safety.
As part of the reassessment of seismic risks, the operator launched the process for building a new earthquake-resistant storage facility for fissile materials.
Following this assessment, DSND authorized both the continuing operation of the existing facility, and the construction of the new storage facility.

84
technical notices to ASN for defense-related activities.
(93 in 2009)

■ An emergency drill was organized at the Toulon naval base.

MORE ABOUT
Safety review at the Marcoule facilities

In 2010, IRSN assessed the safety review documentation of two facilities at the Marcoule Center in southern France.
In view of the improvements already made and those planned by the operator of the irradiated fuel assembly surveillance facility (ISAI), the DSND authorized continued operation of the facility for another ten years. IRSN assessed operating conditions at the CEA Marcoule center's tritium facility (ATM) up to its planned shutdown date in 2012.

operation. The Institute also took an active part in three drills, as well as an internal French Navy drill.
It issued technical notices to the DSND concerning a number of onsite emergency plans. These included:
- the operational aspects of the onsite emergency plans at CEA's Cadarache center in southern France and Saint Dizier airbase in eastern France,
- accident conditions covered by the onsite emergency plan at Areva's Pierrelatte site,
- the operational aspects of CEA's emergency transport plan.

RADIOACTIVE SOURCES
In 2010, IRSN issued a notice at the DSND's request on the use of some fifty electrical devices emitting ionizing radiation at the CEA's Gramat center in the southwest of France. ■

CONDUCTING ASSESSMENTS ON FUTURE FACILITIES

Reactors of the future

Looking ahead to the development of Generation IV reactors, IRSN is enhancing its knowledge so that it can assess the safety of these reactors and their associated fuel cycle facilities when the time comes. It is focusing in particular on issues related to sodium-cooled fast reactors.

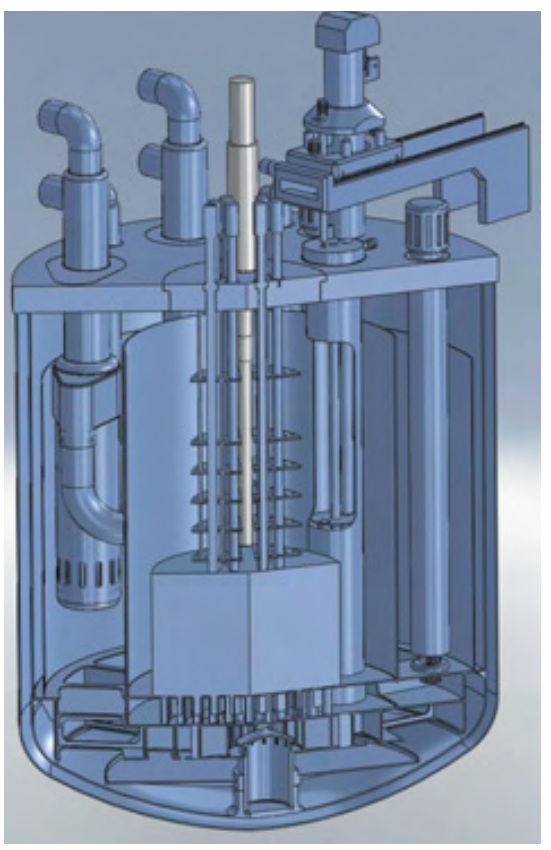
ASTRID project examination process

In 2010, IRSN continued discussions with ASN and the various participants in the ASTRID project for the industrial demonstration of sodium-cooled fast reactor (SFR) technology.

Drawing on its technical assessment experience in this field, the Institute conducted an analysis of the technical examination process that should be adopted for the ASTRID project. This work focused on several areas including:

- new regulatory framework (French Nuclear Security and Transparency Act),
- lessons learned from experience feedback from the authorization and technical examination processes for other projects (EPR, Jules Horowitz reactor),
- specific issues associated with the very nature of ASTRID which is a prototype and not a first-off plant unit for industrial deployment,
- the need for sufficiently early validation of the key safety issues connected with SFR technology, and an assessment of R&D areas identified by the industry players involved in the project to achieve significant progress in safety aspects such as core neutronic characteristics, residual heat removal in passive mode and in-service inspection.

The conclusions of this analysis and the related proposals were submitted to ASN.



Schematic illustration of the Astrid reactor.

IRSN research strategy concerning sodium-cooled fast reactors

In 2010, IRSN continued work to restore its expertise in the area of SFRs in preparation for the safety assessments that will be required for the ASTRID project. Summary documents were produced by building on the experience gained from projects developed in France and abroad between the 1970s and 1990s.

This work led to an initial identification of theoretical and experimental R&D requirements, in connection with international projects like OECD's working group on experimental facilities for advanced reactors (TAREF and ADRIANA) under FP7.

INTERNATIONAL ACTIVITY

Participation in European projects

IRSN was involved in several other projects in 2010 relating to Generation IV reactors and set up as part of FP7.

These included:

- EUROPAIRS, which is aimed at studying the coupling of a very high-temperature reactor to a hydrogen production factory;
- GoFastR, relating to design and safety studies for a gas-cooled fast reactor (GFR);
- CP-ESFR, for the development of a sodium-cooled fast reactor (SFR);
- ADRIANA, which reviews existing or potential test methods for developing sodium-, gas- or lead-cooled fast reactors;
- THINS, for the development and validation of thermal-hydraulic simulation tools applicable to various Generation IV reactor concepts.

Inventory of simulation software

Alongside efforts to rebuild its SFR expertise, IRSN has begun to resume research on digital simulation applications used in the past: GERMINAL for the initial state of the irradiated fuel, SIMMER for generalized core meltdown and FEUMIX and PULSAR for sodium fires.

Validation of the models is in progress, on the basis of the results of recent experimental programs. IRSN is in the process of defining a strategy for developing next-generation software.

This work draws on all the knowledge acquired on SFRs through operation, studies and R&D. It also makes use of software applications developed for modeling PWR accidents, particularly for determining the type and quantity of radioactive substances liable to be released to the environment in the event of an accident. ■

Deep geological repositories for nuclear waste

The work carried out by IRSN in this field seeks to improve understanding and acquire the skills and tools required in time to assess the deep geological repositories for nuclear waste planned for the future.

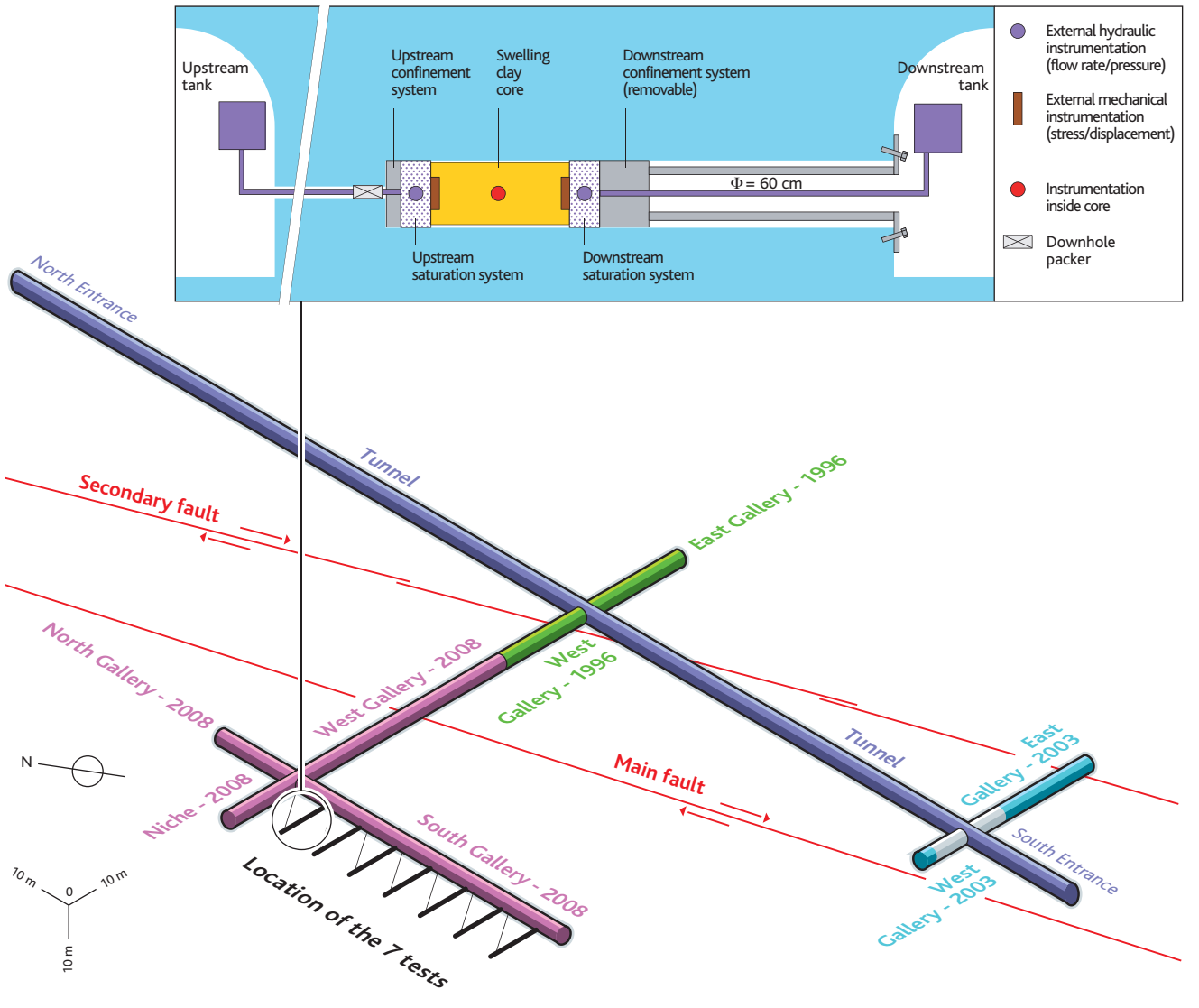
Assessment of a zone of interest for detailed reconnaissance

In 2010, IRSN examined the criteria adopted by Andra for choosing a 30 km2 zone of interest for detailed reconnaissance close to its underground laboratory in Bure the east of France. ANDRA considers the selected zone particularly appropriate for siting the underground installations of a geological repository for high- and intermediate-level long-lived waste, required by the French Act of June 28, 2006, relative to the sustainable management of radioactive materials and waste. Detailed geological reconnaissance techniques will be used in this zone.
Overall, IRSN considered that the criteria adopted by ANDRA were appropriate from the safety perspective. It did draw attention, however, to the fact that damage to the host rock during excavation could increase with depth, bearing in mind that some areas of the detailed reconnaissance zone are deeper than the underground laboratory. It might be necessary to adapt the design of repository structures to take into account the effects of siting the repository at a greater depth than that studied until now.

Geological disposal facilities for high- and intermediate-level long-lived waste

On November 29, 2010 IRSN presented its assessment of ANDRA's "Dossier 2009" to the relevant ASN standing advisory group. "Dossier 2009" is an intermediate report on the high-level and intermediate-level long-lived waste repository project, submitted before the next milestones defined by law.
Based on IRSN's report, the advisory group concluded that Andra's safety approach is satisfactory, but that some safety-related aspects of repository operation should be developed further for license application. This mainly concerns risks associated with simultaneous activities related to construction and nuclear operation in the underground facility, containment, measures for radioactive materials, and fire hazard. The need for supporting evidence regarding the performance of the sealing concepts designed to guarantee the leaktightness of the large repository structures was also highlighted. Based on the assumption that the repository will be built in several stages, the Institute also recommended that Andra

IRSN examined the criteria adopted by Andra for choosing a zone of interest for detailed reconnaissance (ZIRA) close to its underground laboratory at Bure in the east of France.



■ **SEALEX project: schematic diagram and location of in situ tests in the tunnel at the Tournemire site.**

specify the construction phases, prior to which an updated version of the facility safety demonstration will be submitted.

First SEALEX experiments

The first test setup was completed in 2010 for the SEALEX project on the performance of clay seals in a repository for high- and intermediate-level long-lived waste and the related studies and research began.

Launched early in 2009 to meet IRSN's assessment requirements, SEALEX will involve in situ experiments at the Tournemire experimental station in southern France aimed at quantifying the chief factors that control the long-term hydraulic performance of clay seals.

Within this context, a dissertation study was launched in association with the Ecole des Ponts Paris Tech to characterize the long-term behavior of swelling materials used for sealing purposes.

The goal is to improve the reliability and relevance of future simulations required for assessing the long-term performance of these materials. The first of seven in situ test setups was successfully installed in December 2010. The remaining test setups are planned over a period of several years. ■

MORE ABOUT

A delegation of the French national assessment board at Tournemire

In June 2010, the national assessment board visited IRSN's experimental station in Tournemire in southern France.

In the assessment report published after its visit, it stated "... the Board is highly impressed with the scientific and technical activity of the Tournemire experimental station. It contributes to IRSN's assessment capabilities. [...]" The Board underlined the quality of the activities carried out to enhance geological repository safety. Furthermore, IRSN researchers also welcomed the local information and oversight committee of the Andra underground laboratory in Bure in eastern France, reflecting IRSN's desire to open up to society.

■ **IRSN studies the long-term strength and performance of seals in the tunnel at its experimental station in Tournemire in south-central France.**

SECURITY – NON-PROLIFERATION

Advancing the cause of nuclear safety in France and around the world

IRSN, and in particular its Nuclear Defense Expertise Division (DEND), contributes to national and international efforts to control nuclear and sensitive materials and protect facilities against malicious acts. The Institute took part in reviewing regulatory texts in both these areas in 2010.
Regarding the control of nuclear and sensitive materials, it continued to carry out its tasks of examining files and escorting inspection teams. Concerning the prevention of malicious acts, the Institute worked on organizing emergency exercises to gain a better understanding of how nuclear safety and nuclear security come together. It also worked on procedures for organizing nuclear security training on a European – or even a broader international – level.

■ IRSN tests the performance of radioactive material detection barriers.

■ Protection and control of nuclear and sensitive materials

Protection of nuclear materials at facilities

In 2010, IRSN examined 242 files at the request of Senior Defense and Security Official (HFDS) from the Ministry of Energy, the authority in charge of nuclear material protection and control.
Furthermore, experts from the Institute, officially appointed as "nuclear materials inspectors", are mandated by the Senior Defense and Security Official to conduct inspections at facilities holding nuclear materials. In 2010, these experts performed 96 facility inspections, two in reaction to specific circumstances: one at the Tricastin plant in the lower Rhone valley and the other at the Gravelines plant in the north.
During 2010, the inspection effort focused more particularly on systems for receiving and shipping nuclear materials. Inspections also concerned:

- controlling access to nuclear materials and sites;
- remote monitoring and periodic testing of physical protection systems;
- implementation of measures applicable to annual physical inventories.

Several local exercises were carried out, some at night, with nuclear materials inspectors standing by to observe how local security forces implement the procedures and emergency instructions prepared by plant operators.
In 2010, IRSN procured physical protection equipment for test purposes. Testing covered biometric access control systems, detection barriers and infrared detectors.
Tests were also conducted on a laser scanning digitizer. This device is used to construct a 3D image of a facility and to identify any

IRSN Transport Operations: monitoring a shipment at the Command Post at the Prefecture in Metz.

changes that have occurred by comparing two pictures taken at different times. Tests were carried out at Areva's Pierrelatte site in southern France in October.
The purpose of the study was to assess the advantages of using this type of system to control nearly static nuclear material stocks.

Protecting nuclear materials during transport

The year 2010 was marked by the publication and implementation of the Order of August 18, 2010 on the protection and control of nuclear materials in transport (excluding nuclear deterrent materials).
This text delegates the powers of the Minister in charge of national transport of nuclear materials, a key position, to the IRSN deputy director general.
Assisted by IRSN Transport Operations Center, he is responsible for managing nuclear materials transport, processing applications to authorize transport, monitoring shipments and sending prior notice of shipments to the relevant authorities.

152
inspections involving nuclear material control.
(171 in 2009)

The Order is part of the work underway on nuclear security regulations, in which IRSN plays an important part.
In 2010, IRSN processed 65 requests for technical notices on the physical protection of nuclear material transport. This involved analyzing transport plans, applications for transport permits, or applications for approval of transport methods.
IRSN helped prepare about 1,000 accomplished domestic shipments in 2010 with nothing notable to mention. The Institute also monitored international shipments which were sometimes sensitive from a public relations perspective, such as the export of MOX fuel or returning vitrified waste to Germany packaged at La Hague in Normandy. For the first time, part of IRSN Transport Operations Center went out to the regional Command Posts set up by the authorities to help them geographically locate the shipments in real time and provide better communication between the authorities' command posts and IRSN Transport Operations Center at Fontenay-aux-Roses near Paris. ■■■

8
inspections conducted in facilities under the "declaration" regime.
(12 in 2009)

In 2010, 46 inspections were performed on nuclear material during transport and 18 were performed on approved transportation equipment. These inspections covered all means of transport – road, rail, sea and air – but with a special focus on road vehicles.
In 2010 IRSN defined a new list of road transport routes for nuclear material with a cartographical description and detailed road maps. The list was sent out to all authorities and users affected by the routes. Finally, a procedures manual is being prepared on the protection of nuclear material and radioactive sources transport including protection against theft and sabotage. The manual provides background information on regulations, defines the roles of those involved and explains how to apply for protection. A presentation was given at the international PATRAM 2010 symposium.

Nuclear material monitoring and accounting

In terms of centralized accounting, in 2010 IRSN carried out IT development work needed to upgrade the remote link used to transmit accounting operations declaring nuclear material stock changes by the main nuclear operators. This major IT activity was also highlighted by real-world scale testing of the new Ar Men control software which is in its final acceptance phase.
In 2010, the public authorities decided to separate accounting for nuclear materials used for the deterrent policy from accounting for other nuclear materials.
The Institute studied the advantages and drawbacks of doing this in a document sent to the relevant authorities and contributed to preparing protocols and agreements for carrying this out.

Nuclear material inventory control in an emergency

At the request of the authorities, IRSN regularly organizes emergency situation inventory control exercises for nuclear material at a facility. The purpose of the exercises is to test decision making chains as well as the coordination of those involved (operators, public authorities and so on).
The exercises entail carrying out a nuclear material inventory at one or more facilities within a few hours to confirm or rule out the existence of any malicious acts, such as theft or misuse of nuclear materials, or acts of sabotage. During 2010 the Institute managed an exercise involving the CEA ATALANTE facility at Marcoule and the CEA LECA STAR facility at Cadarache, both in the south of France, as well as a readying exercise for the nuclear material emergency room in the IRSN Emergency Response Center. Fifteen exercises of this type, usually scheduled on an almost annual basis, have already been performed. They enable the emergency procedures used the main French nuclear operators to be tested.

International non-proliferation inspections

International inspections in the chemical field

In 2010, IRSN supported seven inspections conducted by the Organization for the Prohibition of Chemical Weapons (OPCW) on the French chemical industry. The inspections concluded that France

IN THE WORDS OF...

Jacques Raharinaivo, Deputy Director of Arms Control and the OSCE at the Ministry of Foreign and European Affairs who is responsible for implementing the Chemical Weapons Convention (CWC)

"IRSN provided us with their expertise to implement the Chemical Weapons Convention in France. We need its capabilities to analyze technical issues to do with the implementation of the Convention. This covers general negotiations but also all the specific issues, particularly chemical site inspections which are how the CWC is physically implemented.

From May 2010 to April 2011, France holds the Presidency of the OPCW Executive Council and will have to prepare the destruction of all chemical weapons by April 2012.
The deadline is not without its problems for some countries. In this situation it will be all the more important to be able to rely on an organization like IRSN whose expertise, reliability and availability have been widely demonstrated."

is complying with terms of the Chemical Weapons Convention (CWC). The Institute also produced the two annual declarations for activities carried out in 2009 and those scheduled for 2011 for more than 120 French chemical sites. These declarations were sent to the OPCW within the time limits laid down by the Convention.

IRSN carried out a major update to the declaration manuals used by industry to incorporate changes in some of the declaration procedures and to some declaration thresholds. The update also included a description of how to use the IODA Internet portal used by a very large number of companies.

The Institute provided technical support to the Ministry of Industry to modify regulations to incorporate OPCW decisions and to clarify various measures to do with challenge inspections. Regarding the latter point, IRSN also provided the French authorities with a set of detailed emergency instructions which were reviewed and validated by the relevant ministries and by an industrial operator in December 2010.

Bilateral negotiations initiated with OPCW in 2009 on the use by its inspectors of encrypted USB keys continued in 2010 with IRSN involvement to define procedures for checking data collected by inspectors.

■ **The declaration manual for industry was updated.**

■ **Nuclear material samples for the Euratom inspection.**

International inspections in the nuclear field

In 2010 IRSN supported 52 international inspections performed by Euratom and the IAEA, roughly the same number as in 2009. The Institute carried out significant targeted work supporting inspections at certain facilities affected by changes in accounting breakdowns and inspection procedures.

IRSN produced a new version of the nuclear material import and export notification manual and made it available to operators and the Ministries concerned. This incorporates all the latest regulatory developments and information on how the PIMENT Internet portal operates for declaring international nuclear material transfers. The manual was presented to operators in June 2010.

In November 2010, IRSN signed a protocol with Areva governing the roles and responsibilities of the different people involved when IRSN sends Euratom accounting reports drawn up by Areva Group facility managers.

The Institute provided technical support to the French authorities ■■■

■ IRSN is involved in IAEA inspections in France. The IAEA's headquarters in Vienna, Austria are pictured here.

52
missions to escort inspections involving international nuclear material control.
(54 in 2009)

7
missions to escort inspections involving the chemical weapons ban.
(8 in 2009)

11200
recorded movements of radioactive sources.
(13500 in 2009)

as part of a working group on sending data to Luxembourg and also took part in a European Safeguards Research and Development Association (ESARDA) working group on Euratom audits performed on nuclear material accounting and control systems.

To prepare for 24-hour prior notice, "expanded-access" inspections, which the IAEA can perform in France under the Additional Protocol to the Safeguards Agreements, IRSN was involved in an alert phase coordination and response exercise carried out by the French authorities. It also ensured that procedures put in place remained operational by carrying out an internal IRSN exercise on notification for "expanded access" and advised operators potentially concerned by this type of inspection.

IRSN also actively took part in training Areva and CEA operators on international nuclear non-proliferation saveguards. ■

■ Protection against malicious acts

Regulatory text reviews

In 2010 IRSN continued to participate in the review of French regulations on the protection and control of nuclear materials, both at facilities and during transportation. This involved the use of significant Institute resources both for preparatory work on regulations and preparing presentations given to operators by the Authority. The main regulations concerned are as follows:

- an order relating to license application procedures for holders of nuclear materials,
- an order specifying the procedures for studying the protection of nuclear materials and facilities,
- an order defining the physical protection measures to be implemented by the licensee,
- an order on the conditions for approving nuclear material shipment methods.

Facility protection assessment

On February 12, 2010 during a meeting with the Senior Defense and Security Official (HFDS), the French Nuclear Safety

Authority and the operator, IRSN presented its analysis on incorporating foreseeable malicious acts into protection of the MAGENTA facility at the CEA's Cadarache plant.

IRSN organization in the event of a radiological emergency of malicious origin

At the request of the Senior Defense and Security Official, IRSN organized the fourth "Security Protection and Evaluation Exercise". The purpose of this type of exercise is to test coordination between nuclear facility operators, who are responsible for the protection of their sites, and public authorities, including the Senior Defense and Security Official, the Prefect, the State Prosecutor, and local and national police forces. The preparatory work for the exercise with the different entities involved continued throughout the year in several working groups led by the Institute. The exercise itself was performed during the night of November 3 and 4, 2010 at the CEA Saclay center near Paris. Around 300 people were involved for around seven hours. More than a hundred observers and evaluators took part and were able to see the close connection that exists between nuclear safety and nuclear security.

International activities

In 2010 at the request of the IAEA, IRSN was involved in courses organized in Morocco on the security of radioactive sources and in Kazakhstan on dealing with internal threats. The Institute also contributed to a course on physical protection of nuclear facilities in Japan and to organizing an international IAEA course in France on security culture. IRSN security experts were involved in a training course for future IAEA physical protection trainers, which took place in Slovenia.

IRSN also took part in working groups organized by the IAEA involving:

- the document defining fundamental security principles,
- Revision 5 of circular INFCIRC 225, containing recommendations on protection of nuclear materials and facilities,
- the recommendations document on security of radioactive source,
- the structure of IAEA recommendation documents,
- the document on recovering out of regulatory control radioactive material,
- the document on nuclear and radioactive material inspection and accounting,
- the development of a method for identifying and assessing risks that must be covered by implementing regulatory and organizational measures under a "nuclear security regime".

Within the context of relations between IRSN and its Japanese counterpart JNES, a meeting was held from November 20 to 22 in Tokyo on the security of nuclear materials and facilities.

IRSN was also involved in two European Commission contracts: SERAMA, which covers security of radioactive sources and STAR, which addresses management of a nuclear emergency caused by a serious malicious attack.

In addition a communication was presented at the Eurosafe 2010 forum in the Germany city of Cologne on a safety emergency exercise caused by a malicious event. The exercise was the first of its type performed in France and provided many useful lessons. ■

MORE ABOUT

Security culture seminar

From November 16 to 18, 2010, IRSN organized in Paris an IAEA "regional course" on security culture. Intended for a European audience, 26 people took part from 17 countries.

It covered the part played respectively by the State, organizations involved (nuclear operators), management systems and individuals in establishing a security culture as well as similarities and differences between safety and security cultures.

The course brought together government authority representatives, nuclear facility operators and representatives from the police services.

Discussions highlighted an improved understanding of the concept compared with the first courses held by the IAEA in this area a few years ago.

■ The lecturers of the regional training course on nuclear security culture.

RADIATION PROTECTION – ENVIRONMENT AND HUMAN HEALTH

Improving protection through progress in measurements and knowledge

In 2010, IRSN began upgrading its radiological alert networks, conducted environmental studies to explain the nature and origin of the radioactivity detected in certain regions, and launched a regional radiological report system. It undertook these actions as part of its work to carry out radiological monitoring of the environment and protect both workers and the public from ionizing radiation. The Institute also conducted surveys to assess occupational, public and environmental exposure following radiological incidents, and made significant progress in radioecology in securing EC funding for STAR, a network of excellence in which it is a prominent player. Also in 2010, to increase awareness of the health effects of chronic exposure to low-level radiation, the Institute assumed chairmanship of MELODI, an initiative which brings together the chief European radiation protection institutions. Finally, in the medical sector, IRSN continued researching new radiotherapy and data collection techniques for the optimization of patient exposure.

ENVIRONMENTAL AND POPULATION EXPOSURE

Environmental monitoring

IRSN's is responsible for performing radiological monitoring throughout France. For this purpose, the Institute has monitoring networks that make use of advanced technology and implement equipment that is currently being upgraded.

Upgrading the Teleray radiological alert network

In 2010, IRSN launched an initiative to renovate its radiological alert networks, particularly its Teleray network, in order to update the aging technologies that have been used on these networks for the past 20 years.

The Institute chose a secure, proprietary ADSL data transmission system, along with the operator to handle data routing. The first new-generation probes were received and tested, and the new SPARTE remote alarm supervision system entered the production phase.

In addition to the existing functions, this system enables real-time collection of data from EDF gamma ray measurement probes. Designed using a standard software

Testing a "Teleray" new-generation beacon.

171
radiation monitors in the national remote monitoring network (including 164 Teleray).
(191 in 2009)

package, SPARTE automatically manages alert thresholds, checks data integrity, triggers alert messages and transmits its data to emergency response players in France and Europe. With a probe in each of the French administrative departments, the new Teleray network will provide uniform coverage of the entire country. Additional probes will be installed for enhanced coverage of measurement points within a perimeter of up to 30 kilometers around nuclear facilities, outside the 10 km radius covered by each plant operator's own systems. By 2015, IRSN expects to be equipped with approximately 420 Teleray probes, up from 163 in 2010.

Training - a part of IRSN's role as a leading national laboratory

As a "national reference laboratory" (LNR) for the laboratories of the French general directorate for food safety (DGAL) and directorate for competition, consumer rights, and protection against fraud (DGCCRF), IRSN provides them with technical training to develop their skills and know-how. In 2010, it set up a training course on the use of gamma spectrometry for measuring radioactivity in foodstuffs. The course comprises two modules including the theoretical bases of gamma spectrometry and practical exercises involving simulation scenarios. It gives trainees the chance to come into contact with the Institute's radiation measurement experts and to acquire practical tools that can be directly applied in their laboratories and possibly used in testing environmental or food samples in accident situations.
In connection with its national reference laboratory status, IRSN also organizes laboratory proficiency testing on the measurement of test specimens representative of environmental or agri-food samples.

Environmental studies

IRSN conducts in-depth studies to learn more about and account for the origin of the radioactivity observed in certain regions.

Setting up a regional radiological reporting system

In 2010, IRSN completed its pilot study for the regional radiological reporting system in the Loire Valley region. Regional radiological reports cover an extensive geographical area in which several nuclear facilities are located, and set out to provide up-to-date reference data on radioactivity levels in a wide variety of samples, particularly foodstuffs. In the event of emergency, this type of information can provide valuable indicators of activity levels existing prior to an accident. The study, carried out in the Loire Valley, tested the feasibility of the approach, which has since been

MORE ABOUT

The OPERA network is called on to monitor radioactivity in the air

In 2010, due to two unusual events outside France, large amounts of particles containing traces of radioactivity were released to the atmosphere: ash from the Icelandic volcano Eyjafjöll (natural radioactivity) and ash from the forest fires in areas contaminated by radioactive fallout from the Chernobyl accident (artificial radioactivity). The public authorities asked IRSN to assess the environmental impact of these two events in France.

Using the most advanced stations in its atmospheric radioactivity monitoring network (OPERA-Air network) and its highly sensitive radioactivity measurement facilities, IRSN was able to demonstrate that the events had induced no significant change in the concentration of particles in the air – measured at ground level – thereby ruling out any radiological hazard to the environment and, more importantly, public health.
The Institute was also actively involved in answering the many questions from the press and providing information for the public.

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IRSN's OPERA-Air network: a very high-flow aerosol collector in Dijon.

900
ambient dose rate measurement points.
(900 in 2009)

extended to the Rhone Valley, Northeast, Southwest and Mediterranean regions.
These reports, which come under IRSN's revised environmental monitoring strategy, begin by analyzing earlier results, and then complete and update this information using samples pre-selected according to a statistical ranking of produce, on the regional, then local level. Working mainly through local information committees (CLI), local contacts help adjust the choice of foodstuffs. In addition to samples of local produce, standard samples such as tree leaves, milk, salad vegetables, fish, and seaweed are collected for comparison with national data.

Information on radioactivity around the Bure site

On October 5, 2010, IRSN and the French national radioactive waste management agency (Andra) signed a partnership agreement to study surface environment radiation levels in the area around the underground research laboratory in Bure, in eastern France, operated by Andra.
This initiative seeks to determine the origins and concentrations of the radionuclides under study, by reviewing existing reports and analyzing samples from all compartments of the environment (air, rainwater, soil, suspended solids and sediments in streams and rivers, and plants and animals).
The study will provide a baseline for environmental monitoring in the area, which will begin while the site is in operation, and continue for at least a century after closure. The Institute uses the area around Bure for its radioecology research. The area will provide data for the radiological report on the Northeast region that IRSN began in 2010 as part of its environmental monitoring activities.

Study on the origin of uranium in the ground water at Tricastin

From January 2009 to May 2010, in partnership with the Vaucluse and Drôme regional health agencies and Areva, IRSN conducted a study to determine the reasons for the high uranium content found locally in the ground water at the Tricastin nuclear site in the Rhône valley. Several Institute departments worked on the study, which required expertise in a variety of fields (geology, hydrogeology, geochemistry, metrology of stable and radioactive elements, etc.). The study's content and progress was discussed with members of the site's local information committee (CLIGEET). Reports on the findings were submitted to this committee, and a public meeting to present the results of the study was held in Pierrelatte on September 22, 2010.
The study provided clearer understanding of the behavior of the ground water in the area, as well as a detailed map of uranium content. Fewer than 1.5 % of the measurement points contained levels above the WHO guide values for drinking water (15 µg/l). The points where content levels exceed 5 µg/l are distributed between two areas: south of Tricastin, in Bollène, and

INTERNATIONAL ACTIVITY

Monitoring the South Pacific: IRSN joins the GOPS

On March 19, 2010, IRSN became one of 14 French institutions making up GOPS, a major observatory set up to monitor the environment and marine and terrestrial biodiversity in the South Pacific. The various members of the observatory collaborate in the areas of research, training, experimentation and innovation, basing their work on long-term observation and monitoring of the environment, ecosystems and biodiversity affected both by environmental changes and pressures from human activity.

The findings of the environmental radioactivity monitoring network obtained by the IRSN laboratory based in Tahiti will be fed into a database. Also selected by GOPS as a priority project is the monitoring network for multi-pollutants (chemical and radiological) in lagoons in the archipelagos of French Polynesia, co-developed by IRSN with the French research institute for exploration of the sea (IFREMER) and national center for scientific research (CNRS).

Involved in environmental monitoring in French Polynesia for 50 years, IRSN will bring precious radiological knowledge of the region to the GOPS.

■ IRSN is studying the reasons for the high uranium content found locally in the ground water to the south of the Tricastin site.

southwest in the village of Lapalud. Three hypotheses were considered to explain the cause of the higher concentrations: 1) the presence of a geological formation that is particularly rich in uranium; 2) the result of non-nuclear anthropogenic activities (use of ash, clinker and fertilizers); and 3) past or current activities on the Tricastin nuclear site. For the area to the southwest, the consensus was that the higher content can be explained by geological reasons. For the area to the south, IRSN's view, based on hydrogeological modeling, is that chronic pollution and past pollution associated with nuclear activities is the most likely cause. ■

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RADON

Map of radon potential in soils

After two years of work based on the analysis of available geological data, IRSN submitted its radon potential maps to the French nuclear safety authority (ASN). These local and regional maps (scale 1:1,000,000) cover metropolitan France and distinguish three levels (low, medium and high) of radon potential in geological formations. They provide information on the areas most likely to present a risk of high radon concentrations in buildings, and specify areas where investigations and in situ measurements would be most useful.

Regulations on radon risks require radon gas testing in certain buildings open to the public and workplaces in designated "priority" areas. The boundaries of these areas currently coincide with the borders of the administrative départements. In practice, 31 such départements are considered as priority areas. As ASN is not entirely satisfied with this breakdown, however, it asked IRSN to create more precise maps of radon potential in soils. The method chosen for this task consisted in determining the capacity of geological formations to produce radon and facilitate its transfer to the surface. The maps obtained can be used to observe overall radon potential trends in the areas concerned and as a guide for radon risk management policies. They do not, however, serve any forecasting purpose and on no account can they be considered as a substitute for radon concentration estimations based on measurements. ■

■ Analyzing radiological incidents

IRSN uses its know-how to assess occupational, public and environmental exposure in the event of radiological incidents involving the dispersion of radioactive particles.

Tritium contamination due to incidents

Following the use of a molecular sieve provided by the CEA and which, after the event, was found to contain tritium, a building belonging to 2M Process in Saint-Maur-des-Fossés, near Paris, was contaminated, as were members of the company's staff. As a result of this contamination, tritium was found in the immediate vicinity of the building in question.

Since November 4, 2010, at the request of ASN, IRSN has conducted various analyses of the contamination of 2M Process premises, adjacent buildings and the surrounding area. It has also assessed the doses received by the personnel working on the premises and by local residents. Its investigations have also identified traces of tritium on another site, in Bondoufle (south of Paris), where the contaminated molecular ■■■

sieve was used for similar tests before being transferred to Saint-Maur. In November and December, IRSN took weekly air, water and plant samples from the area around the 2M Process site in order to map the range of tritium contamination and track its evolution over time.
Over this period, eight information notices were published, and the Institute took part in three public meetings organized by the local authorities in Saint-Maur-des-Fossés to present the measurement results and explain the risks for the population.
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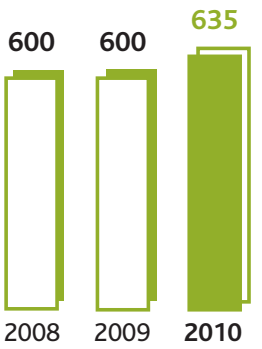

Number of sampling points for radioactivity monitoring throughout France.

Incident at the Feursmétal plant

At the request of Cegelec and Feursmetal, a company located in Feurs in central France, IRSN carried out an operation using robotic equipment to retrieve a high-level cobalt-60 source that was trapped in a gamma ray source in one of the plant's workshops.
The radioactive source in question was damaged during the operation, leading to the accidental dispersion of cobalt-60 particles.
As a result, the workshop in question was contaminated, as were the six people present during the operation. The doses received, however, were low.
At Feursmétal's request, IRSN analyzed the dispersion of radioactivity in the workshop where the incident occurred as well as its immediate surroundings. It also helped Feursmétal define and implement an action plan aimed at securing the contaminated facilities and decontaminating the equipment required for its industrial activities.
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Industrial radiography incident on the Flamanville site

In 2010, IRSN analyzed an incident that occurred in 2009 during an industrial radiography operation at the Flamanville site in Normandy. A radiology worker was accidentally exposed to ionizing radiation when he misinterpreted a co-worker's gesture and entered the room where the work was being carried out, before the radioactive source was set to the safe position. In a matter of seconds, he received a quarter of the annual regulatory dose
IRSN's analysis of the incident showed that multiple lines of defense had failed. In this particular case, a radiographic operation was being resumed after a period of intense work, following five nights of work and on the last day of the job.
The resulting loss of diligence and alertness contributed to the radiologists' failure to apply all the safety rules associated with this activity. Another contributing factor was the lack of instructions for using the detection equipment. For IRSN, some important lessons can be learned from its analysis of the incident to help improve radiation protection during industrial radiography operations, including those not connected with nuclear power plants. ■
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■ Proper warning signs must be used for all industrial radiography operations.

■ Main building of the former Orflam-Plast plant in Pargny-sur-Saulx in eastern France.

■ Radiological pollution map of site.

■ Polluted sites and soils

At the request of the public authorities and plant operators, IRSN conducts studies to assess the industrial pollution of certain sites.

Managing polluted sites

In 2010, IRSN conducted analyses areas of La Gravière pond and the poplar plantation in Pargny-sur-Saulx in eastern France, at the request of the French national advisory committee for public funding in the field of radioactivity (CNAR). These analyses followed cleanup operations coordinated by Andra after areas of soil contaminated with radioactive elements from the thorium-232 family were discovered in 2009 around the former Orflam-Plast plant.

Also in 2009, radiological investigations conducted on Ile-Saint-Denis near Paris revealed the presence of significant radon concentration levels in a building adjacent to the site of the Satchi company's former radium extraction plant. A study of the site, conducted by IRSN in 2010 at the site manager's request, provided valuable insight into the entry and transfer of this radioactive gas in the building. Finally, trees near the former laboratory of the isotope manufacturer Isotopchim in Ganagobie, in southeast France, were contaminated by carbon-14 released by the company from1989 to 1997. At the request of ASN, IRSN assessed the doses that could be released as a result of this contamination in the event of forest fire, use of the wood for fuel, or composting, etc. The results of the analysis, based on very conservative scenarios, were presented at a public meeting in Ganagobie in 2010. They show that the radiological risk to local residents of leaving the trees in place is extremely low.

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IRSN participation in radium diagnostics

At the request of ASN and the Minister for the Environment, IRSN helped prepare and carry out the national radium diagnostics operation in the Île-de-France region around Paris as soon as it was launched in October 2010. The operation is aimed at detecting and treating cases of radium pollution in residential and business areas where this radioelement was used for medical or traditional small-scale industrial activities (such as watch making) during the first half of the 20th century. When IRSN's surveys shows that radium is present, a series of additional measures are carried out to determine the exact levels of radioactive pollution and assess the residents' exposure to ionizing radiation. Andra then steps in to define a cleanup program, where necessary. IRSN is tasked with conducting the final diagnostic tests after cleanup to ensure that the pollution has been thoroughly eliminated. During the last quarter of 2010, the Institute carried out diagnostic tests on six different sites (buildings, detached houses, shops, etc.), revealing the presence of radium, at least in certain facilities. Scheduled over period of three years, the operation will cover more than 130 sites across France, including 84 in Île-de-France.

Former mining sites: GEP Mines recommendations

In September 2010, after more than three years of work in which IRSN played a significant role, the joint expert ■■■

20,414
samples taken from the environment for radiological measurements.
(28,000 in 2009)

group (GEP) on uranium mining sites in the Limousin region, in central France, submitted its final report to the Minister of Sustainable Development and the Chairman of ASN. This initiative is based on a transparent, cross-disciplinary approach that will ultimately provide an overview of the impact of uranium mining in France. The work involved some thirty experts from a variety of fields and backgrounds. The Institute worked on aspects relating to radon, the environmental transfer of uranium and its decay products, and risk assessment for humans and ecosystems. As a result, the GEP issued 15 recommendations aimed at continuing the action already underway and defining a long-term management strategy. For example, it recommended defining terms for the transfer of responsibility for the sites to the Government, optimizing environmental monitoring, and increasing awareness and involvement among local stakeholders. It also recommended conducting research to gain better insight into how waste from former mines and mine tailings disposal facilities will change over time, measuring the toxicity of released substances for ecosystems more accurately, and obtaining a better grasp of what causes uranium to build up in sediments.

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Securing abandoned uranium mines

In 2010, at the request of the Minister for the Environment, the regional directorates for the environment, town and country planning and housing (DREAL) surveyed some fifteen abandoned or "orphan" uranium mines in France. In some cases, there is either no organization managing the mine, or else the manager has defaulted, in which case, the Government assumes responsibility.

In this framework, IRSN, Andra, the French geological survey (BRGM) and Geoderis have been jointly assigned the task of examining the mining and radiological risks associated with the sites in question. The first step was to compile the data in the possession of sites and create a consolidated list of the sites. The second step was to perform diagnostic tests on 14 identified sites (nine in Auvergne, five in Limousin). Based on field investigations conducted by Geoderis and IRSN with the help of the DREALs, these diagnostic tests identified the sites that needed to be secured. Based on this data, action proposals complete with forecast budget and timeline information have been presented to the Minister for the Environment. ■

IN THE WORDS OF...

Pierre Barbey, scientific advisor for ACRO, the association for radioactivity control in western France, member of the joint expert group (GEP) on uranium mines in Limousin

"As with any team effort, participation in a joint expert group implies many confrontations due to differences of opinion and motivation!
It requires lengthy discussions, sometimes using terms that may seem simple but which can mean very different things for an operator or association. Another problem is to do with the actual subject matter as we must consider the combination of natural radioactivity around the mines and the radioactivity resulting from mining activities. The debate on this complex issue is long and arduous. But this work was constructive, and comparing [these different views] allowed us to move forward and meet some of the population's expectations. By bringing together a range of multidisciplinary skills and through our many discussions, we were able to reach a certain consensus, even though each individual may of course have his or her own views on the Group's recommendations. The final report provides some important data that is sure to be useful to the supervisory authorities for the sustainable management of mining sites in Limousin and throughout France."

Radioecology

IRSN is conducting research in order to expand its knowledge in the field of dispersion and transfer of radioactive materials in atmospheric, terrestrial and marine environments.

Experimental validation of atmospheric dispersion models

Until now, most of the experimental campaigns of this type have concentrated on low-level release on terrain with a simple topography and observations were in the near field.

To be able to work in environments closer to reality, the Institute has developed original experimental techniques for tracing, sampling and measuring within air masses. In 2010, it embarked on experimental studies of atmospheric dispersion of pollutants for Areva NC and TOTAL.

The lessons drawn from these studies highlight the fact that while some processes or parameters can be generalized to apply to all types of sites, others are specific to a particular site. This confirms that models used for operational or research purposes to predict atmospheric dispersion of pollutants require experimental validation on the sites where they will be used, especially if the site is "complex" (presence of buildings, relief, release at heights).

Behavior of selenium in "unsaturated" soil layers

After several years of research in collaboration with Andra on the behavior of selenium in the soil-plant-atmosphere system, IRSN was able in 2010 to quantify the main dispersion pathways of this element into the different surface soil components.

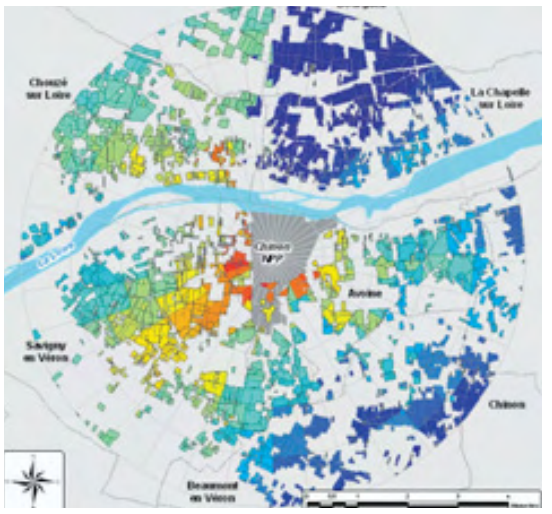
In the event of loss of confinement integrity at a geological repository for radioactive waste, some of the radionuclides found there could be released to the biosphere, thus contributing to the dosimetric impact of the facility. Of the different radionuclides released, and according to the various scenarios studied, selenium-79 would be one of the key factors in this impact.

The studies carried out by IRSN and Andra were used to build a new model to illustrate the behavior of selenium, taking into account the exchanges between selenium and the soil components, while considering the varying kinetic rates involved. This model helps explain the changes in the behavior of selenium, in the soil, in the short and medium term. Much of 2010 was spent determining the main parameters of the model, based on the oxidation states of selenium, its chemical form, the mineralogical and organic soil quality, and the intensity of the microbiological activity of the soil. Integration of this new model into the SYMBIOSE platform, used to model transfers of radionuclides in the biosphere, seeks to improve predictions of selenium distribution in soil in the short and medium term.

Preparing IRSN's captive balloon for high-altitude tracer gas measurements.

Testing modeling tools for a real-life case study

In 2010, IRSN's modeling tools were tested by assessing the dosimetric impact of radioactive liquid and gaseous effluent release from the Chinon power plant in the Loire valley between 2004 and 2008, under normal operating conditions. The aim of this exercise, carried out by IRSN on its SYMBIOSE platform in collaboration with EDF, was to test the feasibility of a full-scale study, assess the platform's operational limits and learn lessons relating to methodology and calculation. Calculations took into account the specific features of the area within a radius of 5 km around the plant. They also made use of data including specific features of the site, such



■ Simulation of contamination due to atmospheric deposition and irrigation: the 60Co activity levels simulated in cereals in the dark blue areas are 30 times lower than those in the read areas.

as actual radioactive gaseous and liquid release, meteorological and hydro-sedimentary measurement series, agricultural practices, food intake and lifestyle of the population. Simulation of the variation in radioactivity in the environment over space and time made it possible to estimate the doses and dose rates received by an adult rural population as a result of external (irradiation, deposition) and internal (inhalation, ingestion) exposure.

Study of the transfer of radionuclides to plants grown in open fields

In 2010, the FORTRESS project advanced knowledge of the transfer of radionuclides from the leaves to the parts of plants used for food.
Led by IRSN in collaboration with Andra, the project is designed to experimentally determine factors governing the transfer – or translocation – of chlorine-36, iodine-129 and selenium-79 to edible parts of the main crop categories (cereals, fruiting vegetables, root vegetables and tubers), following contamination of the leaves caused by spray irrigation. The experiments were conducted in open fields in the Chernobyl exclusion zone by the Ukrainian Institute of Agricultural Radiology.
The focus of attention in 2010 was on completing the third growing season and processing the results obtained in 2009, which showed low translocation of iodine (up to 2.1%), medium to high translocation of selenium (up to 17%) and very high translocation of chlorine (up to 27%), the values depending on the plant species and the development stage of the plant at the time of contamination. These results will be incorporated into the models used in the SYMBIOSE platform for modeling radionuclide transfers to the biosphere.

IN THE WORDS OF...

Thomas Hinton, Department for the Study of Radionuclide Behavior in Ecosystems at IRSN

"The STAR network of excellence is part of the European Radioecology Alliance, an entity created by eight European organizations conscious of the need to coordinate research in the field of radioecology within the scope of a joint strategic research agenda. Integrating research conducted by different organizations represents both extraordinary progress and a major challenge! It's early days yet but you can feel that there's an incredible determination, at the highest level, to establish a strategic research agenda and a road map, which makes the project all the more motivating.
STAR will take a highly innovative approach to radioecology, based on a multidisciplinary concept. For instance, radioactive, chemical and biological contaminants will no longer be studied separately, but rather in terms of their interactions.
This approach gives a more realistic picture of the actual exposure of organisms in the environment.
STAR will also contribute to disseminating knowledge, enhancing the training of young scientists and fostering collaborative research.
This initiative will help us to determine the main issues to be tackled in radioecology over the next 15 to 20 years and to promote effective integrated research, in order to achieve the objectives set."

Environmental and health impact of tritium release

IRSN published six reports in 2010 on the latest research findings on tritium as part of the preparatory work for a White Paper, published by ASN in June 2010.
The reports, which are available online, list tritium production sources and describe how it tritium is managed by nuclear facilities.
They also deal with key questions concerning the behavior of tritium in the environment, the health risk it poses and, lastly, its release limits and impact, particularly on the marine environment.
In addition to presenting the current information available on tritium, the IRSN reports identify three main areas where further research is required to enable a better assessment of the health and environmental impact of tritium.
Three main areas are concerned:

- improving measurement techniques to reduce the detection limits of tritium in the environment;
- reaching a better understanding of the behavior of tritium in its different forms, particularly tritium bound to organic molecules in ecosystems;
- assessing, under realistic exposure conditions, the biological and health effects of tritium on living organisms.

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Calculating the health impact of radioactive release under normal operating conditions

In 2010, IRSN developed a new tool for assessing the health impact of radioactive release from nuclear facilities under normal operating conditions. Known as CONDOR, the tool is used in the Institute's assessment activities, superseding three tools used until now to assess the impact of chronic release to the atmosphere, rivers and the sea. CONDOR provides integrated and consistent assessments of the three types of environment, making use of the latest available models, particularly for the impact of tritium release, and a radionuclide library that allows it to incorporate release from the great majority of nuclear facilities. Its main advantage is its optimized ergonomics, designed to facilitate daily use by experts.

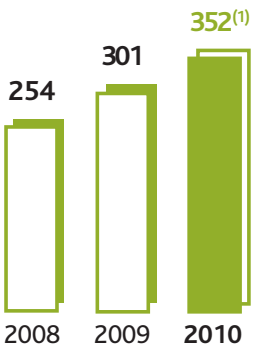
Radiation protection in the workplace

IRSN carries out research and analysis to gain a better understanding of the exposure of workers to ionizing radiation.

Assessment concerning the Port of La Rochelle

The municipal authorities of the city of La Rochelle on the west coast of France asked IRSN to assess the radiological impact on workers and the population at large of sediment dredging operations planned as part of the extension of the marina development Port des Minimes. The sediment, which represents about a million cubic meters, is to be dumped offshore. It is, however, contaminated by industrial discharges containing radioactive material such as thorium.
A sediment coring campaign was carried out and the results analyzed

IRSN assessed the radiological impact on workers and the population at large of dredging works in the port of La Rochelle.



Whole-body radiation counts for worker monitoring.
(1) 324 fixed and 28 mobile.

Measurements taken by IRSN at an EDF power plant to characterize neutron exposure at certain work stations.

by IRSN. On the basis of its findings, the Institute estimated the potential doses for workers involved in dredging operations: the calculated maximum effective dose is 0.012 mSv. The radiological impact was also estimated for the population at large. The calculated effective dose for the population group of adult professional fishermen who consume large amounts of fish or seafood is 0.035 mSv per year. These doses are low and well below the 1 mSv legal maximum yearly exposure limit defined for populations.

Work station study at Blayais nuclear power plant

At EDF's request, IRSN conducted a dosimetric and spectrometric study at the Blayais nuclear power plant site in southwest France in 2010. The aim of the study was to characterize neutron exposure of personnel at workplaces involved in the removal of a MOX fuel assembly.

A week-long measurement campaign was carried out in June 2010 to define the neutron energy distribution and compare measurements obtained using different dosimeters in the vicinity of transport casks.

The results of the study will help EDF to improve personal dosimetry for workers at the work stations in question, particularly for the new operational dosimeters it has chosen for neutron dosimetry. The study will also help EDF radiation protection staff to interpret the measurements obtained from different dosimetric systems.

Optimization of nuclear worker monitoring

IRSN has conducted research, co-funded by Areva, with a view to optimizing programs to monitor internal contamination of workers by examining the uncertainties of dose assessment.

This work culminated in 2010 in the development of software to help occupational health physicians set up and assess their monitoring program for exposed workers. In particular, it will allow them not only to calculate the effective dose but also to determine, for a given monitoring program, the minimum detectable dose with a given confidence level. This can be used to choose the most appropriate program for the type of exposure considered, striking a balance between the sensitivity of the program and its cost. Areva is planning to implement this solution in the field after conducting tests jointly with the Institute.

Intercomparison of passive dosimetry laboratories

In October 2010, IRSN organized the fourth regulatory intercomparison of passive personal dosemeters. The exercise proceeded in accordance with regulatory provisions, specifying the conditions for granting approval of laboratories in charge of personal dosimetry to monitor the dose of workers to ionizing radiation. Within this context, IRSN is tasked with organizing an intercomparison of results from each laboratory involved, at least once every three years, to check the quality of dose measurements.

In all, ten passive dosimetry laboratories took part in the exercise and more than 300 dosimeters were irradiated at IRSN reference facilities, in Fontenay-aux-Roses near Paris for photons, and at the Cadarache center in southern France for neutrons. The report on this intercomparison was issued at the beginning of 2011.

Epidemiology and radiotoxicology to characterize the effects of uranium more accurately

In 2010, the conclusions of an epidemiological study by the Institute revealed an increased risk of lung cancer after exposure to insoluble reprocessed uranium. The toxicity of uranium results from the combination of its chemical properties, as a heavy metal, and its radiological properties, as an emitter of ionizing radiation.

This study therefore assessed the incidence of lung cancer in workers as a function of

1,372,107
personal dosimeters marketed and analyzed. (1,461,614 in 2009)

exposure to uranium, based on a cohort of 2,709 workers at the Areva NC Pierrelatte plant in southern France, who were present on the site between 1960 and 2005.
For this purpose, work began on reconstructing the individual exposure of these workers to six forms of uranium, with different solubility and isotopic composition, using a job-exposure matrix. This retrospective estimate of workers' individual exposure was then validated through comparison with radiotoxicological measurements on a sample of 30 workers.
Furthermore, a data base completed in 2010, and conducted in collaboration with the University of the Mediterranean, revealed biological markers that can be used to determine, for a given isotopic mixture of uranium, which effects on DNA are associated with the chemotoxic properties of uranium, and which with its radiotoxic properties. These potential markers will have to be validated using blood samples taken from workers exposed to uranium.

Dosimetry and metrology of neutrons

As part of Ph. D. Thesis completed in 2010, IRSN has developed a spectrometer designed to measure the energy of neutrons encountered in high-energy radiation fields around particle accelerators (for example in proton therapy in medical applications) or natural cosmic radiation in the atmosphere.
After characterizing this system in reference neutron radiation fields, on-site tests were performed in 2010, which enabled the entire measuring channel to be characterized. As part of a collaborative venture, measurement campaigns were thus carried out underground and at elevation in the underground low-noise laboratory (CNRS).
Under a collaboration agreement with IRSN, the French national aerospace research center (ONERA) acquired the same system to equip an experimental platform dedicated to measuring cosmic radiation, set up at the Midi-Pyrénées Observatory in Toulouse at an altitude of 2,800 meters on the Pic du Midi. ■

IN THE WORDS...

Juliette Feuardent, engineer in the Occupational Exposure Monitoring and Analysis Unit at IRSN

"Every year, IRSN reports on worker exposure to ionizing radiation. In 2009, the number of workers monitored using external passive dosimetry reached 319,091 – 4.1% more than in 2008; the average individual dose was found to remain steady.
At the same time, as part of the Institute's initiative to open up more to society, we formed a joint expert group to improve the structure and presentation of the annual report on worker radiation protection. This group brought together employees' and employers' representatives and members of a local information committee, as well as occupational health physicians and radiation protection specialists. It represented the various fields of activity involved.
One of the proposals to emerge from the group's discussions is that the results should be presented per field of activity in future; this would require that the data collected should associate information on the workers' activity with the workforce monitored, according to the nomenclature of activity sectors defined by IRSN."

■ **Bonner spheres with metal shells used in the spectrometer for measuring high-energy neutrons.**

EFFECTS OF CHRONIC EXPOSURE

The ENVIRHOM program

Since 2001, IRSN's ENVIRHOM program has helped to deepen its understanding of the effects of chronic exposure to ionizing radiation on the environment and human health.

Impact of radionuclides and metals on fish DNA

In 2010, IRSN carried out research to discover the effect of exposure to gamma radiation and to toxic substances such as cadmium, aluminum, copper and uranium on the DNA of the zebrafish (Danio rerio). The zebrafish was chosen as the biological model because of its short lifecycle and because its genome has been fully sequenced. The research focused on the characterization of DNA double-strand breaks – number of breaks and repair time – which are known to be particularly harmful to cells.

In the case of uranium, DNA double-strand breaks and a malfunction in DNA repair mechanisms were observed in vitro in zebrafish embryonic cells, as from an internal uranium concentration of 6.8 µg/g, and in vivo, as from comparable internal concentrations in the gonads of this species exposed to 100 µg/l.

These effects are associated with disruption of embryonic development in this species.

In addition, a study on exposure to gamma radiation compared the effects of acute exposure and chronic exposure. The kinetics of DNA repair at the cellular level and embryonic development were examined in each of these cases of exposure.

DNA double-strand breaks were also observed following exposure to common trace metals in the environment (cadmium, aluminum).

This research was conducted with support from the French national research agency ANR (HEMI-Breaks project) and in collaboration with EDF. The ultimate aim is to find biomarkers that can be used to monitor ecosystems.

■ **Laboratory experiment to determine the impact of chronic exposure to uranium on the DNA of zebrafish (Danio rerio).**

Interactions between exposure to uranium and treatment with drugs

Ph. D. Thesis completed in 2010 at IRSN aimed to characterize the effects of depleted uranium on two organs, both primary targets of uranium: the kidney and the liver. One of the physiological functions of these organs is to detoxify the body. The effect of depleted uranium was studied in rodents subjected to drug treatment, since medicines can become toxic if the kidney or liver are not performing their detoxification function properly.

Research carried out in vivo showed that chronic contamination with doses of depleted uranium on a par with the highest levels of uranium found in the environment does not result in renal toxicity, and does not exacerbate renal toxicity induced

INTERNATIONAL ACTIVITY

Collaboration with the International Radioecology Laboratory

What are the effects of chronic exposure to radionuclides on biodiversity and the functioning of natural ecosystems?

To find some answers to this question, IRSN started three new R&D projects in 2010, in collaboration with the International Radioecology Laboratory in Ukraine, with the aim of studying the influence of contamination levels.

The focus is on the decomposition of leaf litter in streams and forests, the abundance and diversity of communities of nematode-type worms, which are involved in the decomposition process, and root uptake of radionuclides by plants.

This research began with work on selecting the research sites. A total of 20 experimental plots of land with different levels of contamination have been selected on the Chernobyl site in Ukraine and equipment to monitor the decomposition of leaf litter has been set up.

experimentally by the antibiotic gentamicin. With regard to the liver, depleted uranium can alter the expression of genes coding for certain enzymes involved in the metabolism of xenobiotics (EMXs). This alteration disrupts the metabolism and elimination of a drug like paracetamol, but only when it is administered in doses that are toxic to the liver. Results obtained in vitro revealed that the location of depleted uranium in renal or hepatic cells depended on its concentration. Thus, the lowest concentrations of depleted uranium are found in soluble form in the nucleus and the highest concentrations in insoluble form in the cytoplasm.
These results provide fresh insight into the mechanisms by which uranium enters a cell, as well as those involved in the organism's detoxification systems.

MORE ABOUT

Dosimetric impact and health risks related to the use of body scanners at airports

The Ministry for the Environment tasked IRSN with assessing the dosimetric impact and health risk of X-ray scanners following the introduction of tighter airport security measures and the planned use of imaging equipment that is more advanced than the metal detectors currently in operation.

It was found that the effective dose received as a result of a security check using X-ray scanners is equivalent to one or two minutes' exposure to cosmic radiation during a high-altitude flight, or to about 20 minutes' natural exposure to radioactivity in France.
Although the calculated dose is very low, IRSN recommends that the authorities should give priority to other techniques using non-ionizing radiation, which is less aggressive in terms of its physical properties and biological effects.

■ **The effects of chronic depleted uranium contamination are studied in organs rat such as the liver and kidney.**

European coordination of low dose research

In 2010, IRSN stepped up its involvement in an initiative to ensure better European coordination of research activities on the health effects of exposure to low doses of ionizing radiation. The same year saw the creation of the MELODI association (Multidisciplinary European Low Dose Initiative), a consortium of fifteen European research organizations in the field of radiation protection, presided over by IRSN's Director General.
In addition, the second international MELODI workshop, held in Paris in October 2010, brought together more than 200 scientists from all over the world to discuss future low dose radiation research.
Jointly organized by IRSN and CEA, the workshop paved the way for the development of the first version of a strategic research agenda, defining priority avenues of research over the next 20 to 30 years.
Finally, within the framework of the European network of excellence on low dose research, DoReMi, which is MELODI's operational tool, IRSN organized a scientific seminar in December 2010, following which 31 international experts issued recommendations on future research requirements for gaining a better understanding of the vascular effects that may be observed after exposure to low doses of ionizing radiation. ■

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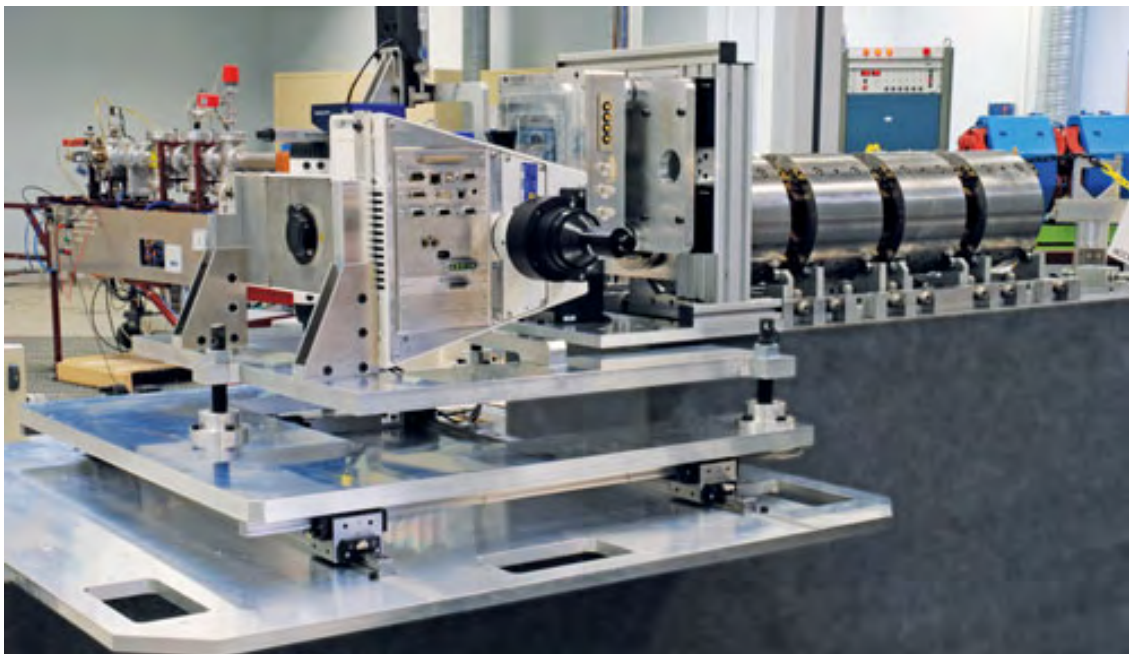


■ MIRCOM microbeam line prototype developed by the Bordeaux Gradignan Nuclear Research Center in the southwest of France.

PROTECTION IN HEALTHCARE

Ion microbeam: characteristic example of new radiotherapy techniques

Under a partnership agreement with the Bordeaux Gradignan Nuclear Research Center, IRSN has decided to develop MIRCOM, an ion microbeam that should be coupled to the AMANDE facility. Its originality lies mainly in the variety of ions available (from protons to oxygen) and their energy levels (up to 10 MeV). MIRCOM will be used to irradiate, with micrometer precision, cellular or subcellular components with a defined number of charged particles, characteristic of the radiation induced by new radiotherapy techniques (proton therapy or hadron therapy, for example).
In the field of radiation protection and low doses, MIRCOM will make it possible to study "local" intercellular phenomena in the presence of complex radiation.

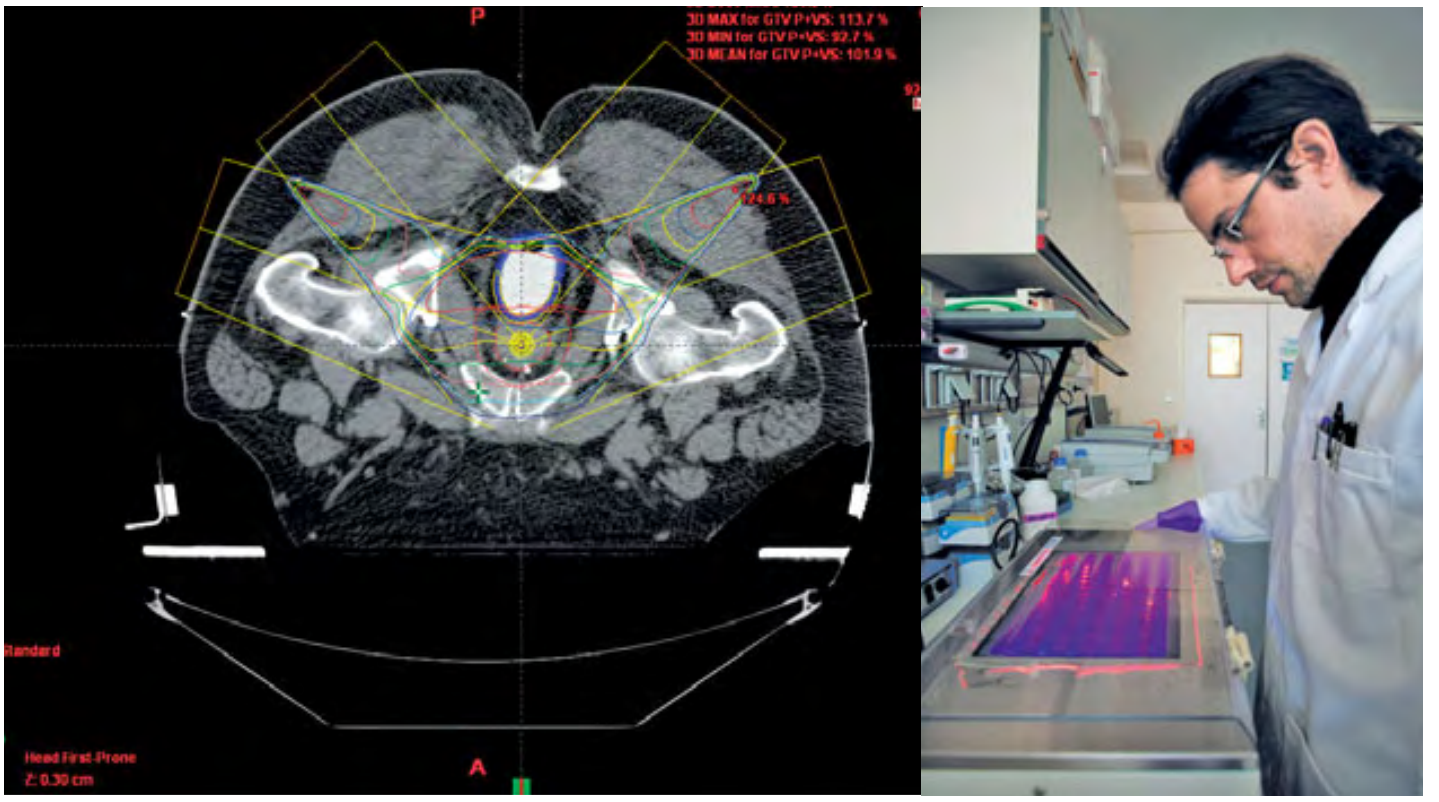
How radiation-induced intestinal damage is caused

IRSN is developing a research program with the aim of identifying the mechanisms behind complications associated with radiotherapy in order to find therapeutic methods for the prevention and treatment of this type of lesion. Two Ph. D. Thesis, both completed in 2010, helped identify the role of certain biological "agents" in these early and late effects.
The first Ph. D. Thesis revealed the key role of a protein, called PAI-1, in triggering radiation-induced intestinal complications. Results obtained in vivo showed that PAI-1 is involved in the radiation-induced death of endothelial cells, which make up blood vessels. In vitro studies confirm the involvement of PAI-1 in the radiosensitivity of endothelial cells.
In the second Ph. D. Thesis, tissue samples taken from patients treated by radiotherapy for cancer of the rectum revealed that the severity of radiation-induced lesions was correlated to an increase in the number of certain immune cells, known as mast cells. Furthermore, the harmful role of mast cells and their involvement in radiation-induced intestinal inflammation were confirmed on an experimental model of intestinal inflammation. All of this research suggests that the early damage associated with tissue vascularization, as well as the inflammatory response of the vascular system, play a key role in early and later radiation-induced toxicity in the intestine. These results helped focus the research program on a single biological model: the endothelial cell.

Exposure to scans in childhood

In 2010, IRSN analyzed the initial data collected as part of a study to compare the impact of exposure to scans on the development of cancer and leukemia in a cohort of children with that observed in the general population. The children concerned were exposed before the age of five for a non-cancerous disorder requiring examination by scanner. The study was conducted in association with the French Society of Pediatric and Prenatal Imaging with the support of the National Anti-Cancer League. The incidence of cancer in these children is monitored using the national pediatric registers. By the end of 2010, 19 French university hospitals had provided IRSN with information about scans performed on 30,000 children during the period 2000-2006. The initial data collected shows that 42% of the children were less than a year old at the time of their first scan, and that they had received an average of 1.5 scans A scan of the skull is the most common, accounting for 63% of all scans, followed by the thorax (21%), the abdomen and pelvis (8%) and other parts of the body (8%). The dosimetric reconstruction carried out by IRSN revealed that the most exposed organs were the brain and the crystalline lens.

■ IRSN's research activities are aimed at learning more about the side effects of radiotherapy.



The EPOPA project monitors patients who suffered from overexposure during the radiotherapy accident in Epinal.

Monitoring overexposed patients

At the request of the Ministry of Health, IRSN and AP-HP, the Paris public hospital system, are collaborating on the EPOPA project, which involves clinical and scientific monitoring of 425 patients who were overexposed during radiotherapy at Epinal Hospital in northeastern France.

In 2010, a centralized clinical database built after a standardized assessment of the severity of the complications of the patients involved, together with a "bank" of blood samples, were set up for the purposes of EPOPA study. Initial results indicate that, to date, 82.5% of patients have developed complications above grade I (on a scale of I to IV). In other words, several years after being overexposed, more than 60 patients are still suffering from severe grade III/IV radiation-induced inflammation of the rectum (radiation proctitis).

In the case of 133 patients, the Institute is currently supplementing this database with details of the assessment of the doses actually delivered to organs at risk.

Two studies have also been launched focusing on the blood samples collected. The first is a broad-spectrum (proteomic) analysis, aimed at identifying new biological markers for radiation proctitis, which might be able to predict severity. The second sets out to measure variations in the expression of more than 20,000 genes, with the aim of identifying one or more genes that characterize the most radiosensitive patients. All data collected on these patients undergoes statistical analysis to detect any correlation between certain clinical symptoms, the actual doses delivered to patients and one of the biological markers identified.

Doing more to optimize patient exposure

In October 2010, IRSN published a summary of dosimetric data relating to diagnostic imaging procedures (radiology, CT scanning, and nuclear medicine) submitted by health professionals for the period 2007-2008. The summary is the second since the Order of February 12, 2004, which set up a system establishing national diagnostic reference levels (DRLs) for commonly performed diagnostic procedures. Following analysis of the data collected since 2004, IRSN has identified the need and the potential for progress in the optimization of patient exposure by adjusting the DRLs. The results submitted must allow the nuclear safety authority to define any regulatory changes required. In particular, proposals were made to update reference values for certain types of examination, based on IRSN's analysis of doses delivered during radiology procedures and of activity levels administered in nuclear medicine.

Although it is increasing, there is still plenty of room for improvement in the reporting rate of X-ray and CT scan centers. This is detrimental, since centers that are out of the mainstream do not compare their practices against the national references To improve reporting rates, IRSN has developed an application for health professionals to facilitate online registration of their dosimetric data and real-time comparison with the national DRLs.

Furthermore, as part of efforts to monitor medical exposure of the French population connected with imaging examinations for diagnostic purposes (ExPRI project), IRSN and the French national institute for health surveillance (InVS) conducted a survey of 50 radiology departments in the public hospital sector in 2009. The following year, the Institute analyzed the dosimetric data collected over a week in each department, for all types of X-rays and CT scans performed. Considerable variation was observed in the doses delivered for the same type of examination and for patients showing similar morphologies. The results were also used to compare clinical practices against national reference protocols, from a dosimetric point of view. Furthermore, based on the data collected, a dose indicator was linked with each type of examination performed on adults, and the average doses delivered to organs during the examination were also determined. The average effective doses associated with these examinations were calculated in order to supplement and update the medical exposure data used in the ExPRI project which, until now, was estimated from the reference protocols. ■

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EMERGENCY AND POST-ACCIDENT SITUATIONS

IRSN boosts its emergency and long-term response capability

IRSN endeavors to prevent nuclear and radiological accidents and, if such an accident were to occur, to limit the potential impact on human health and the environment. It is in the second area that the Institute is working to improve its emergency response organization – specifically to be able to perform reliable measurements and analyses of contamination and exposure in an emergency – and evaluate strategies based on the administration of stable iodine to prevent the risk of thyroid cancer.
In 2010, at the request of the public authorities, it was involved in preparing methods for predicting the radiological and dosimetric impact of any post-accident situations and quantifying the contamination of the areas concerned, as well as the doses received by the exposed population.
The Institute also pursued its work in developing tools to centralize and provide access to environmental measurements carried out during an emergency, and completed the renovation of its mobile response unit.

Preparing emergency exercises

To enhance its readiness for nuclear emergencies, IRSN continues to prepare its laboratories to perform emergency radioactivity measurements on samples that exhibit particularly complex forms of contamination. External laboratories have also been invited to take part in this preparation for the first time.
The Institute has also issued recommendations aimed at standardizing stable iodine prophylaxis in the event of a nuclear reactor accident.

Exercises opened up to external laboratories

In 2010, the Hubert Curien Multidisciplinary Institute (CNRS) became the first non-IRSN laboratory to take part in a measurement exercise organized within the metrology network that groups together IRSN's radioactivity measurement laboratories.
In this respect, with the development in 2010 of a specific gamma-spectra simulation tool capable of simulating realistic accident scenarios, IRSN continued its efforts to prepare all its metrology laboratories to respond in an emergency or post-accident situation. In this type of situation, samples must be analyzed rapidly, as measurement results are mainly intended for validating the assumptions in the models used to determine the dispersion of radionuclides in the environment. Wherever possible, gamma spectrometry is the preferred measurement technique.
Through such exercises, the Institute's laboratories are able to improve their performance in complex gamma spectrum analysis.

3
actual equipment of the Emergency Response Center.
(4 in 2009)

Report on stable iodine prophylaxis

In response to a European Commission call for tenders, IRSN wrote a report in 2010 presenting the latest research findings on the preventive administration of stable iodine, as well as a description of current practices in the European Union, the United States and Japan.
In the event of a nuclear reactor accident, radioactive iodine isotopes can be released to the atmosphere, exposing the population

■ Schematic illustration of post-accident zoning proposed by CODIRPA.

to a risk of thyroid cancer if received doses are large. To minimize this risk, stable iodine tablets can be administered to saturate the thyroid gland with non-radioactive iodine, thus preventing the absorption of radioactive iodine by this organ.

The first part of the IRSN report is based on a bibliographic review, and the second on a questionnaire completed by the national authorities responsible for radiation protection. The report makes recommendations for harmonizing the various aspects of stable iodine prophylaxis (levels of response, administration pathway, dosage, informing the public, communications between neighboring countries). ■

■ Work of CODIR-PA

IRSN is a member of the post-accident steering committee (CODIR-PA) set up by the public authorities to prepare the management of the post-accident phase of a nuclear accident.

Radiological and dosimetric impact of a post-accident situation

Two working groups, led by IRSN as part of the steering committee in charge of managing the post-accident phase of a nuclear accident or radiological event (CODIR-PA), submitted their final reports in 2010.

The first report proposes a method for making predictive assessments of radiological and dosimetric impact in a nuclear post-accident situation. These assessments would be particularly intended for the public authorities responsible for deciding on and implementing measures to protect populations and manage contaminated areas.

The second report deals with the assessment methods and radioactivity measuring instruments that could be used in a nuclear post-accident situation, in order to quantify the area contaminated and the ■■■

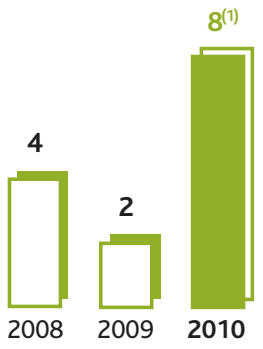
5
national nuclear emergency exercises excluding defense-related activities.
(5 in 2009)

IN THE WORDS OF...

Addil Sellam, radiation protection engineer, RaMsEs Group, Hubert Curien Multidisciplinary Institute, UMR 7178 CNRS-University of Strasbourg

"In June 2010, our laboratory took part in a gamma-spectrum analysis intercomparison exercise, organized by IRSN, for the first time. This involved three gamma spectrometry specialists from the group interpreting a gamma-ray spectrum within a limited timeframe. An exercise like this is important for two reasons. It makes us aware that carrying out relatively simple tasks is more complicated under pressure and in an emergency! It also got us thinking about ways to speed up spectrum processing, by developing a code or computer program that would do some of the preparatory work. This was a really positive experience for us, because it confirmed our expertise in this area and opened up new avenues for improving our processing and analysis techniques."

6
national nuclear emergency exercises involving defense-related facilities.
(3 in 2009)



Dose assessments by biological dosimetry.
(1) 8, including 6 for the Feursmétal incident.

doses received by individuals exposed. The two reports supplement the contributions made by other working groups in which IRSN has actively participated.
Now CODIR-PA is continuing to develop a national policy for managing a nuclear post-accident situation, specifically by drawing up guidelines for the public authorities and stakeholders. In addition to these reports, IRSN has compiled:

- a draft national emergency response guide, which has been sent to ASN. It has been distributed by ASN and the Directorate for Civil Security to the prefectures of three pilot areas: Haut-Rhin for the Fessenheim site, Vienne for the Civaux site and Drôme for the Tricastin site. The prefectures in question must test its operational implementation in their offsite emergency plans and make suggestions as to how the guide can be improved.
- a good practices guide for laboratories measuring radioactivity in a post-accident situation. This document is intended for all radioactivity measurement laboratories likely to be called upon in a post-accident situation. It aims to encourage these laboratories to produce reliable analysis results within a timeframe appropriate for an emergency conditions. ■

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■ **CRITER in use at the operational command post during an emergency response exercise.**

■ Developing tools

In order to be able to assess the impact of a radiological accident on the population and the environment as accurately as possible, IRSN is developing modeling tools for its Emergency Response Center and is renovating its mobile response unit.

Centralizing and providing access to environmental measurements in an emergency

A CRITER system prototype was tested for the first time during an exercise at Cattenom in northeastern France in April 2010. Developed by IRSN, this system will be used to centralize and provide access to environmental measurements carried out in the event of an emergency. To ensure consistency and resource-sharing, it incorporates tools developed for the national network of environmental radioactivity measurements.
Based on feedback from five exercises organized in 2010, CRITER has been improved and is now reliable enough for use on a routine basis at the Institute's Emergency Response Center. It effectively meets the requirements of the Interministerial Order of November 29, 2005 on the performance and processing of environmental radioactivity measurements in the event of an incident leading to a radiological emergency. Under this order, IRSN is responsible for centralizing and processing all analyses, as well as defining the format of results and how they are communicated to the various stakeholders (public authorities, ASN, etc.).
The CRITER system was also used in 2010 to map out the results of samples taken from the ground water under the Tricastin site in southern France.

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Completion of renovation work on the IRSN mobile response unit

In 2010, IRSN acquired its first two trucks, shelter-type response vehicles as part of its plan to renovate its mobile response units. The vehicles in question are containers equipped with ten whole body counters and a secure satellite communication system. They complete the Institute's renovated fleet of mobile response units dedicated to evaluating internal contamination in an emergency, adding to the four small mobile facilities and two large mobile facilities that can be mobilized in the event of radiological accidents or malicious acts involving radioactive materials for in vivo measurement.

■ In 2010, IRSN acquired heavy-duty response vehicles to make up its mobile response facilities.

The shelters can be transported by road, rail, sea or air to respond to any emergency. Various qualification tests to improve or validate the operation of this new measuring facility for measurements have been successfully completed.

EDF acquires IRSN's C3X platform

In 2010, IRSN signed a contract to install C3X, an operational platform it has developed to compute radiological impact, at EDF's national emergency centers.
C3X comprises several modules for rapidly assessing atmospheric dispersion of contaminants, soil deposition and potential impact on human health and the environment in the event of an accident leading to the release of radioactivity. A mapping module enables the results to be displayed on a map.
Under the terms of the above contract, IRSN will provide EDF with C3X platform software, as well as ScenarX software for preparing and conducting emergency exercises. It will also provide maintenance services and the necessary training to help EDF employees familiarize themselves with the platform. ■

MORE ABOUT

OPAL: a mapping tool for raising awareness of post-accident issues

In 2010, IRSN and the post-accident advisory committee of ANCCLI (the French national association of local information commissions and committees) worked on defining a tool for raising local stakeholders' awareness of post-accident management following accidental release of radioactive material.
Known as OPAL, the tool will allow local information committees to select a site, a type of accident and certain environmental parameters (e.g. weather) and will then display maps showing the post-accident impact of a radioactive release.
OPAL will cover the main types of accidents likely to occur in French nuclear facilities.
The data provided by the tool can be used by a geographical information system, and can therefore be cross-referenced with information on contaminated areas held by local bodies.
The local information committees will then be able to prepare maps to make the various stakeholders more aware of the issues involved in post-accident management in their region.

04

IRSN and CEA organized the second Multidisciplinary European Low Dose Initiative (MELODI) workshop in Paris. The event brought together more than 200 scientists and specialists in exposure to low-dose ionizing radiation, from all over the world, to achieve a multidisciplinary scientific consensus on the choices underpinning Europe's future strategic research agenda in this area.

PARIS, FRANCE | OCTOBER 18-20, 2010

EFFICIENCY

CONTROL AND OPERATION

Enhancing efficiency

After several years spent developing control and operating tools, IRSN took action in 2010 to enhance its efficiency, in line with its commitments to the French Government during the preparation of its Contract of Objectives for 2010-2013.

Optimization of support functions

To enhance its efficiency through excellent human resource and administrative management practices, IRSN has set up a program called AMELIS to optimize its support functions. The specific aims are to make these support processes simpler, smoother and clearer, to match human and financial resources to the objectives set, and to change the organizational structure accordingly.

Six defining projects were thus defined with a view to drawing up sector-based action plans in the following areas: human resources, information systems, purchasing, terms of payment for suppliers, sales, and management control.

This led, for example, to a review of how training is organized, and the formation of an investment committee responsible for validating significant investment projects.

Lastly, the creation of a "dosimetry" business unit in January 2010 met the objective of adapting this service contracts sales activity to the competitive market in which it operates. This unit is now an independent profit centre, strategically managed by a board that includes representatives of IRSN's General Management, the operational division, and the support divisions involved in dosimetry. In 2010, it focused on improving the effectiveness of its customer relations and the quality of customer service.

Preparation of the Contract of Objectives for 2010-2013

The year 2010 was devoted to drawing up the Government/IRSN Contract of Objectives (COB) for 2010-2013, under which IRSN's commitments to the Government are defined for a period of four years. The second contract confirms the Institute's credibility and provides the framework for its national and international activities aimed at driving progress in safety, security and radiation protection.

IRSN's commitments center on four strategic areas of improvement::

- research and scientific excellence,
- support for the public authorities and customers,
- promoting transparency and openness to society,
- contributing to the promotion of a safety, security and radiation protection culture in Europe and around the world.

Action in these areas can be broken down in operational terms in IRSN's different fields of expertise and its success relies on efficient management of the Institute:

- steering programs and tailoring financial resources required to maintain a proper balance between research and consulting activities;
- an attractive HR policy to ensure IRSN has the skills in-house to accomplish its tasks;
- optimized economic, financial and asset management in a restricted institutional context;
- controlled, visible governance in the interests of continuous improvement. ■

PROPERTY ASSETS

Rational, economical and reassuring property management

In order to plan the management of its property assets, IRSN has drawn up a multiyear Property Master Plan that programs action to be taken in the short and medium terms.

View of the Institute's new building in Fontenay-aux-Roses.

The multiyear Property Master Plan, prepared by the Institute and submitted to its supervisory ministries and its own Board of Directors, has three objectives: to enhance the safety of its activities and personnel, optimize IRSN facilities, and reduce operating costs.

Written in 2009, the plan made provision for renovating a number of buildings and bringing them in line with safety regulations. It also provided for the acquisition and construction of buildings with a view to grouping together various units and freeing up buildings, in keeping with the Government's property policy.

In 2010, IRSN had to review the multiyear Property Master Plan to bring it in line with decisions made by its supervisory authorities during the year:

- a project was selected for the demolition and reconstruction of two buildings at Fontenay-aux-Roses, near Paris, this work being funded by a loan;
- the transfer of CEA and IRSN teams to their respective sites was postponed;
- IRSN's activities on its Le Vésinet site in the Paris region were moved back to occupy the former OPRI site; the space made available will allow the development project (construction of a sustainable district) planned by the local authority to go ahead.

The revised Property Master Plan led to the start of a new "program" in documents in 2010, in line with the above decisions. This will be submitted to the Institute's Board of Directors in mid 2011. ■

HUMAN RESOURCES

Skills and careers management at a time of full employment for the Institute

IRSN's human resource management policy is designed to anticipate and meet the Institute's future skills needs to enable it to fulfill its tasks. It also seeks to encourage the development of individual skills and provide career guidance in an effort to improve employees' working conditions.

For the first time since it was founded, the Institute had all vacancies filled and a full complement of staff, having recruited 180 employees on permanent contracts over a period of two years (2009-2010). This situation was mainly the result of IRSN's highly proactive recruitment policy in the past few years, reflected in its participation in various job forums and the development of exchanges with institutions of higher education to promote its work and achievements. It also stems from a raft of measures to improve working conditions at the Institute and increase staff loyalty. For instance, all employees enjoy the same employment status within the organization and are eligible for company-wide remuneration schemes (company savings plan, profit-sharing, collective retirement savings plan, etc.).

€1.67 million spent on training.
(1.99 in 2009)

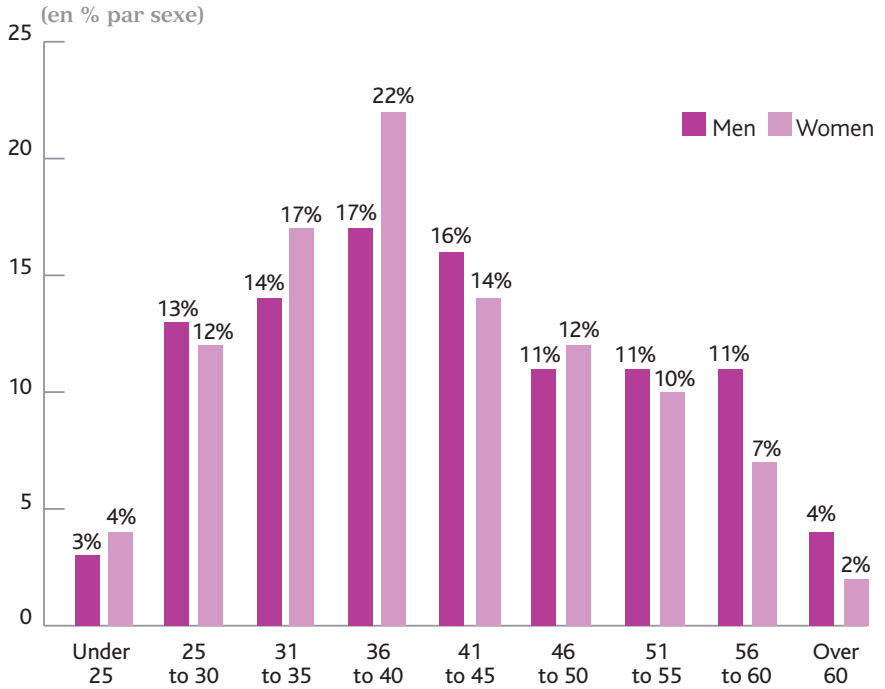
5,547 participants in training courses.
(4,181 in 2009)

Ongoing initiative to forecast staff and skills requirements

The GPEC initiative launched by IRSN to forecast staff and skills requirements has two aims: to create tools capable of anticipating the skills needed in the medium to long term, and to offer employees clearly identified career paths to give them a better idea of the various options open to them. In this context, 2010 was devoted to completing the task of mapping careers and skills: more than 150 careers were defined, a directory of associated skills was created and employees were divided up into the various careers.

The Institute now has a complete map of employment that it can use to determine its future strategy and priorities, as defined in its Contract of Objectives for 2010-2013. The map will also help bring medium- and long-term planning in line with this second Contract of Objectives.

Age pyramid
(en % par sexe)



Second internal opinion barometer

In September 2010, IRSN conducted its second staff opinion barometer. The survey, sent by e-mail to the Institute's staff, contained more questions relating to working conditions and working environment than the first barometer in 2007.
With a response rate of 57% (as against 52% for the previous survey), the main results show some progress since 2007. Strong points are still direct management, working conditions and training opportunities. Significant improvement can be seen in employee perception of remuneration (47% of respondents satisfied as against 32% in 2007) and the Institute's strategy and external image both nationally and internationally. Confidence in IRSN has also considerably increased. One area where respondents were less satisfied, however, concerned careers, and questions persist as to the general organization of the Institute, particularly regarding the distribution of roles between the "line organization" sector, the "expert" sector, project managers and "quality process" managers.

Agreement on the collectively agreed wage structure for non-managerial staff

An agreement on the collectively agreed wage structure for non-managerial staff was signed with all of the trade unions on December 2, 2010. This agreement, which provides coherent wage structures for managerial and non-managerial staff, is based on the principle of individual measures for all employees, calculated on a yearly basis. Employees now enjoy a higher monthly salary, due to the fact that the income bonus equal to an extra month's salary is paid in monthly installments and the productivity bonus has been incorporated; transitional measures have also been set up, backdated to January 1, 2010.
Lastly, special measures have been taken to improve the situation of employees recruited before June 2003 whose career development, under the CEA arrangements in force at that time, was less favorable than that provided for in the IRSN company-level agreement signed the same year.

Agreement on stress prevention and quality of life at work

On December 3, 2010, a second agreement, relating to stress prevention and quality of life at work, was unanimously approved. The agreement demonstrates the commitment of IRSN trade union representatives and management to work together to improve working conditions and organization. Some of the actions already under way include a charter for good relations at work; the creation of an observatory responsible for monitoring changes in quality of life and stress based on various indicators and proposing individual or collective preventive measures; management training; efforts to promote greater staff awareness; and a survey prepared by the Institute's occupational health physician. The agreement, which has been signed for a three-year period, will be an opportunity to assess the situation so that the systems in place can be adapted, if necessary. ■

IN THE WORDS OF...

Patricia de la Morlais,

IRSN's Director of Human Resources

"Regarding human resources, we began 2010 with a full complement of staff: a full-employment situation is unprecedented for such a young institute and entails a few changes in human resource management. While our main aim up to now has been to fill vacancies either by hiring externally or from within, we must now give priority to internal recruitment and ensure that staff movements within the Institute are consistent with the future development of programs.
In this respect, our human resources policy is a key part of IRSN's strategy and it was with this in mind that we planned the implementation of the GPEC policy to forecast staff and skills requirements. In 2010, we also pursued a project to create an internal university; the first module on safety analysis should be tried out in 2011.
At the same time, we developed new tools, which will be available early in 2011.
The aim is to offer employees tailored appraisals at each stage of their career so that they receive support appropriate to their particular project.
Last but not least, 2010 ended with the signing of two important unanimous agreements, one aimed at harmonizing the Institute's pay policy for managerial and non-managerial staff, and the other paving the way for a joint approach to stress and quality of life at work.
All these initiatives enable us to build on and sustain IRSN's human resource development policy and to imagine the Institute of the future."

HEALTH, SAFETY AND SECURITY AND ENVIRONMENTAL PROTECTION

Consolidating security and sustainable development

In the area of health, safety and security and environmental protection, policies on information protection, information system security and sustainable development were formalized in 2010.

Information protection and information system security

Much of the information handled by IRSN, whether scientific, technical or personal, is sensitive, which means that divulging it could seriously harm not only the Institute but also its partners and other parties.
To guarantee confidentiality and the integrity of its computer systems, IRSN formalized existing practices in this area in a new information protection policy in February 2010.
This specifies the principles to be observed as well as the procedures to be used when briefing personnel required to have access to sensitive information.
IRSN's information protection policy has two prongs: information protection and information system security.
Each deals specifically with the protection of sensitive information and systems, national defense-classified or otherwise.
Under the revised information system security policy, new procedures have been drafted.
These provide, in particular, for a security risk analysis to be performed on any new IT projects at IRSN, and for the development of an approval mechanism for systems dealing with national defense-classified information.
Each year, new recruits receive training in how to protect sensitive information, national defense-classified or otherwise, and existing employees undergo refresher training to remind them about potential threats and the protection rules.
Similarly, as part of a campaign to bring the security culture in line with the measures provided for under the policy on information system security, IRSN organized 60 training sessions for all members of staff in 2010.

■ IRSN tightened its information system security policy.

Setting up the sustainable development policy

Having spent 2009 completing an analysis of the sustainable development situation at IRSN, the Institute developed and formalized its policy in this area in 2010. The sustainable development discussion group prepared a draft version based on the directions determined: skills, employment and training; how each person relates to his/her job and employee participation, involvement and motivation; the environment and pollution; and purchasing policy. The draft was submitted to staff for approval and approved by 65% of respondents. Some suggestions were also made and taken up, such as an inter-site relocation plan, energy saving, preservation of biodiversity, and integration of environmental and social aspects into purchasing policy. Following this work, a sustainable development policy document was drawn up and approved in December.
The document describes IRSN's responsibilities and reflects the commitment of the Institute and its employees to sustainable development in areas such as the environment, risk control, social advocacy, and responsible purchasing and sales. ■

QUALITY POLICY

Driving the work of IRSN

The purpose of IRSN's quality policy is to help the Institute perform the tasks entrusted to it and achieve its objectives through a continuous improvement process.

ISO 9001 certification renewed

Having been certified in compliance with the ISO 9001 standard in 2007, IRSN was evaluated in 2010 with a view to renewing its certification. In June, auditors from the certification authority LRQA met with IRSN teams from Cadarache, in the south of France, and from Le Vésinet, Saclay and Fontenay-aux-Roses, near Paris, to assess compliance of the Institute's total quality management system processes with the 2008 version of ISO 9001.

The auditors detected no cases of non-compliance, concluding that: "The system is functional. It is used as a true control tool. We observed a marked improvement since 2007 in the use of the system by the people we interviewed."

As a result, IRSN's ISO 9001 certification has been renewed until July 2013.

This result comes after a great deal of preparatory work involving all IRSN departments, aimed in particular at taking into account the changes between the 2000 version and the 2008 version of the standard.

Improved management system

On October 18, 2010, during a meeting of the total quality management committee, IRSN validated the different aspects of its new "quality project". The current system will be simplified and its efficiency improved over the period 2010-2014. The aim is to make the total quality management system an effective tool for managing internal and external changes, now and in the future. To achieve this, the 2010-2014 project is divided into two parts. The first, called processes for the benefit of the Institute's customers and to enhance performance, prompted efforts, in 2010, to develop a general procedure for listening to the Institute's external customers. This must make it possible to gauge customer satisfaction with the Institute as a whole rather than with individual units, and obtain an overview of any necessary general improvements to be made. The second part focuses on making the transition from the current system to a "quality, safety and environment" management system in the medium term, incorporating sustainable development in particular.

As part of its commitment to listen to its customers and meet their expectations, IRSN conducted its first satisfaction survey among its internal customers in May and June 2010. The survey covered IRSN's support processes and was sent by e-mail to 99 managers: the response rate was 50%, with an average satisfaction score of 83%. The results highlighted some possible areas of improvement that should be addressed starting in 2011. ■

10
ISO 17025-accredited laboratories.
(10 in 2009)

■ The Institute's ISO 90041 certification was renewed until July 2013.

GLOSSARY

A

AERES: French agency for the evaluation of research and higher education.
Alpha radiation (symbolized as "α"): A highly ionizing form of particle radiation with low penetration consisting of helium-4 nuclei. A simple sheet of paper can prevent its propagation.
AMANDE: Accelerator for dosimetry metrology and neutron applications (Cadarache).
ANCCLI: French national association of local information commissions and committees.
ANDRA: French national radioactive waste management agency.
ANR: French national research agency.
ASAMPSA2: Advanced Safety Assessment Methodologies: Level 2 Probabilistic Safety Assessment.
ASN: French nuclear safety authority.
ASTEC: Accident Source Term Evaluation Code.
ASTRID: Advanced Sodium Technological Reactor for Industrial Demonstration. A planned prototype sodium-cooled fast neutron reactor (SFR).

B

BECARRE: Tests on control rod degradation phenomena induced by boron carbide and on the related release.
Becquerel (Bq): Official international unit of measure used for radioactivity. The becquerel is equal to one transformation per second.
Bel V: Technical safety organization of the Belgian Nuclear Safety Authority.
Beta radiation (symbolized as "ß"): Radiation consisting of electrons with a positive or negative charge. Propagation can be stopped by leaving a space of a few meters around the source or providing a barrier using a simple sheet of aluminum foil.
BRGM: French geological survey.

C

CABRI: CEA test reactor used by IRSN to study nuclear fuel safety.
CATHARE: Thermal-hydraulic computer code used to study the behavior of pressurized water reactors during accident situations.
Cesium (Cs, atomic number 55): Toxic rare metal with characteristics comparable to those of potassium.
CLIGEET: Local information committee on the major energy facilities at Tricastin.
CLI: Local information committee.
Corium: Agglomeration of fuel and structural elements from a nuclear reactor core, melted and mixed together following a major accident.
Criticality (risks): Risks associated with uncontrolled fission phenomena in fissile materials.

D

DSND: Representative in charge of Nuclear Safety and Radiation Protection for Defense-related Activities and Facilities.
DOE: Department of Energy (USA).
Double-strand break: Complete break in a DNA molecule.
Dosimetry: Determination of the dose of radiation (radioactivity) absorbed by a substance or an individual through assessment or measuring.
DRL: Diagnostic reference level.

E

Effective dose: A physical variable used in the field of radiation protection, where it serves to assess the impact of exposure to ionizing radiation on biological tissue. It takes into account the sensitivity of the affected tissues and the type of radiation. The sievert (Sv) is the unit of effective dose.
ENEA: Italian national agency for new technologies, energy and sustainable economic development.
ENVIRHOM: Research program that studies the processes involved in radionuclide accumulation and the biological effects induced by this accumulation in flora, fauna and humans in a chronic exposure situation.
ENSTTI: European Nuclear Safety Training and Tutoring Institute.
EPICUR: Experimental program on iodine chemistry under radiation.
EPR: European Pressurised-water Reactor.
ERMSAR: European Review Meeting on Severe Accident Research.
ETSON: European Technical Safety Organisations Network.
EURATOM: European Atomic Energy Community.
ExPRI: Long-term information system on the medical exposure of patients to ionizing radiation.

F

Fuel assembly: Bundle of fuel rods assembled in a metal structure, used in nuclear reactors.
Foundation raft: Thick, reinforced concrete foundation providing stable support.
FP: European Union Framework Programme for research and technological development.

G

Gamma radiation (symbolized as "γ"): Electromagnetic radiation with high penetration but low ionization, emitted during the transformation of radionuclides. Protection is provided by concrete or lead screens.
GRS: Gesellschaft für Anlagen- und Reaktorsicherheit (German technical safety organization).
GWd/t: Fuel burnup unit. Gigawatt-hours per metric ton of fuel. Commonly used unit of measure giving the level of irradiation of fuel assemblies, expressed as energy output by the assembly in the reactor per ton of the initial uranium.

H

HILW-LL: high level and intermediate level long-lived waste.
HFDS: Ministry of Energy Senior Defense and Security Official, the authority in charge of nuclear material protection and control in France.

I

IAEA: International Atomic Energy Agency.
ICRP: International Commission on Radiological Protection.
ICSBEP: International Criticality Safety Benchmark Evaluation Project.
IFREMER: French research institute for exploration of the sea.
InVS: French national institute for health surveillance.
IPPE : Russian Institute for Physics and Power Engineering.
IRPhE: International Reactor Physics Experiments Evaluation.
Isotopes: Elements whose atoms have the same number of electrons and protons, but a different number of neutrons. Designated by the same name, they display the same chemical properties. There are currently 325 known natural isotopes and 1,200 artificial isotopes.
ISTC: Russian International Science and Technology Center.
ISTP: International Souce Term Program.

J

JAEA: Japan Atomic Energy Agency.
JNES: Japan Nuclear Energy Safety Organization.

K

kV: kiloVolt.

M

MELODI: Multidisciplinary European Low Dose Initiative, a European governance instrument set up to organize research into risks relating to low-dose radiation exposure.
MOX: Fuel made from (natural or depleted) uranium and plutonium oxide.
mGy (milligray): Unit of radiation absorbed dose used in the international system.
mSv (millisievert): Unit of effective dose used in the international system.
MWe: Megawatt electric, unit of electric power produced. In a pressurized water reactor, the thermal power released is about three times greater.

N

NRC: United States Nuclear Regulatory Commission.
NSC: Chinese Nuclear Safety Center.

O

OECD: Organisation for Economic Co-operation and Development.
ONERA: French national aerospace research center.

P

PICSEL: Research program on the propagation of solid fuel fires in laboratory and plant environments.
PRISME: Research program on fire propagation in elementary multiple-enclosure scenarios.
PSA: Probabilistic Safety Assessment.
PUI: On-site emergency plan.

R

Radioelement: Natural or artificial radioactive element.
Radionuclide: Radioactive isotope of an element.

S

SARNET: Severe Accident Research NETwork of excellence, a European research project to study core meltdown accidents on water reactors.
SCANAIR: Computer system developed by IRSN for analyzing injection reactivity accidents.
SFR: Sodium-cooled fast reactor.
SNETP: Sustainable Nuclear Energy Technology Platform.
STUK: Finnish nuclear safety authority.
SYMBIOSE: "System approach for modelling the fate of chemicals in biosphere and ecosystems", a software platform used to simulate the impact of environmental radioactive contamination on human health.

T

TAREF: Task Group on Advanced Reactor Experimental Facilities.
TELERAY: French national automatic gamma air monitoring network. It also emits a warning in the event of unusually high ambient dose rates.
TSO: Technical Safety Organisation.
TSN: French act relative to Transparency and Security in the Nuclear Field.

U

Unsaturated zone: Portion of the subsurface above the groundwater table.

V

VVER or WWER: Vodo-Vodianoy Energetichesky Reactor ou Water-Water Energetic Reactor, Russian-designed reactors that operate in a similar way to western pressurized-water reactors.

W

WHO: World Health Organization.

X

Xenobiotic: a toxic chemical compound that is foreign to a living organism.

Z

ZIRA: Zone of interest for detailed geological reconnaissance.

For further information, consult the glossary on the IRSN website at:
www.irsn.fr

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IRSN

INSTITUT
DE RADIOPROTECTION
ET DE SÛRETÉ NUCLÉAIRE

Enhancing nuclear safety

2010
FINANCIAL REPORT

CONTENTS

Management Report

GENERAL OUTLOOK

Significant events in 2010:

- the public service grant paid by the Ministry of Ecology, Sustainable Development, Transport and Housing (MEDDTL) under budget program 190 was increased by €7 million. Of this amount, €5.2 million is intended to cover the rising cost of dismantling operations, and €1.8 million to the cost of renovation work on the CABRI experimental reactor, which has exceeded budget forecasts;

- the current economic climate led to an increase in the Institute's self-generated revenue, largely stemming from industrial and commercial operations at home and abroad;

- after several years of tough job-market competition with operators in the nuclear sector, IRSN reached a situation of full employment;

- the cost of work on the CABRI facility overshot the budget estimate by €7.3 million in the June 2010 budget revision (budget amendment no. 2), and a €2 million loss was recorded in EDF revenue owing to delays in the project;

- the Institute might have to pay some of the costs – currently estimated at €15 million - resulting from an incident that occurred at the Feursmétal industrial site. A €5 million provision was booked for this purpose in the accounts for 2010;

- the Institute was ordered to pay the cost of decontaminating its Le Vésinet site, following an environmental accident, for an estimated cost of €2.5 million. A provision has been set aside for several years to cover these costs, the contribution for 2010 being approximately €1.5 million;

- €9.1 million was paid out from the special dismantling fund to cover the cost of works carried out in 2007, 2008, and 2009.

Budget execution in 2010 involved a vast investment program totaling €46.7 million, after incorporation of operations carried over from the previous year, including, in particular, the first phase of the Institute's property project, which was funded through a €16.7 million loan.

Not all of these investments were completed during the fiscal year, and a proposal to carry over €19.2 million for operations in progress will be put forward in the projected revenue and expenditure statement for 2011.

BUDGET BALANCE

Exécution (in €M)	2008 (1)	2009	2010	Difference 2010/2009
Total resources	255.2	283.0	**316.4**	+ 11.8%
Total expenditure	281.2	301.8	**312.9**	+ 3.7%
BALANCE	**– 26.0**	**– 18.8**	**3.5**	**– 118.7%**

(1) Fiscal year 2008 shows an exceptional reduction of €15 million, corresponding to reconciliation of the €20 million VAT adjustment on one hand, and a special contribution of €5 million added to the dismantling fund on the other.

Budget execution in 2010, as in previous years, shows a budget balance that appears to be amplified by the €19.2 million in investments carried over. Furthermore, incorporating investments carried over from the previous year reduces the budget execution specific to the year. Appropriate recalculations give the following results:

Recalculated execution (in €M)	2009	2010
Actual balance	– 18.8	**3.5**
2008 carryover	10.2	**–**
2009 carryover	– 14.5	**14.5**
2010 carryover	–	**– 19.2**
RECALCULATED BALANCE	**– 23.1**	**– 1.2**

The year 2010 can be characterized as follows:

- results match the balance figures given in the projected revenue and expenditure statement approved by the Board of Directors;
- a budget execution rate of 93.5% (compared with 93.6% in 2009), i.e. a difference of €21.6 million, of which €19.2 million corresponds to an offset in the execution of certain investments. If these offsets were excluded, the budget execution rate would be 99.3% compared with 98.1% in 2009.

INCOME STATEMENT ANALYSIS

Revenue

Execution (in €M)	2008	2009	2010	Difference 2010/2009
Sale	31.8	37.7	**39.2**	+ 4.0%
Grant	195.5	216.5	**230.6**	+ 6.5%
Other operating income	4.0	7.6	**8.1**	+ 6.8%
Operating income subtotal	231.2	261.8	**277.9**	+ 6.1%
Investment income	3.7	1.4	**0.3**	– 76.1%
Extraordinary revenue	6.4	9.1	**11.2**	+ 22.1%
TOTAL	**241.3**	**272.3**	**289.4**	**+ 6.3%**

Overall, the income recorded by the Institute during the year rose by 6.3%:

- Operating income rose by €16.1 million (+6.1%) compared with the previous fiscal year, with:

– €225.8 million from the public service grant paid by the Ministry of Ecology, Sustainable Development, Transport and Housing (MEDDTL). The total in government grants received for Budget Program 190 amounted to €243.8 million, of which €18 million was recorded as a capital grant;

– €3.4 million from the agreement signed with the Ministry of Defense as part of Budget Program 212, €0.3 million up on the previous year;

– €1.4 million from other grants, including from local government authorities, €0.5 million up on the previous year;

– €39.2 million of self-generated revenue from consultancy services, co-funding of research programs, or other services, representing a 4.0% increase over the previous year;

The main differences observed between 2009 and 2010 are as follows:

Execution (in €M)	2008	2009	2010	Difference 2010/2009
Catalog services	9.5	10.9	**11.7**	+ 7.5%
R&D and co-funded research	10.0	13.6	**11.7**	– 13.5%
Services and non co-funded research	6.2	7.1	**10.0**	+ 40.4%
Other services	6.1	6.2	**5.8**	– 5.8%
TOTAL	**31.8**	**37.7**	**39.2**	**4.0%**

– for catalog services: dosimetry activity (up by €1 million to €9.3 million in 2010),

– for co-funded research: EDF contribution to the CABRI project (down by €2 million to €3 million in 2010),

– for services and non co-funded research: international services (up by €2.4 million to €3.7 million in 2010),

– other services: invoicing for seconded personnel (down €0.6 million to €5.2 million).

– €8.1 million in other operating income, compared with €7.6 million in 2009. This amount mainly includes fees paid for industrial property (€0.1 million, steady), other operating income (€0.6 million, steady) representing adjustments made from previous years, as well as write-backs on depreciation and provisions (€7.3 million, up by €0.5 million compared with 2009).

■ Investment income, which amounted to €0.3 million, was much lower than in 2009 (down by €1.1 million), reflecting a drop in interest rates on financial markets.

■ Extraordinary revenue rose to €11.2 million, compared with €9.1 million in 2009. Capital grants of €9.7 million, recorded in the income statement, accounted for most of this amount.

Expenditure

Execution (in €M)	2008	2009	2010	Difference 2010/2009
Purchases	116.2	132.8	**136.6**	+ 2.9%
Personnel	113.6	120.0	**124.2**	+ 3.5%
Taxes	9.2	12.8	**13.3**	+ 3.7%
Depreciation	17.5	22.8	**23.1**	+ 1.1%
Provisions	1.4	2.3	**6.3**	+ 173.9%
Other operating expenses	1.2	1.6	**2.2**	+ 38.6%
Operating expenses subtotal	259.1	292.2	**305.6**	+ 4.6%
Financial charges	0.7	0.5	**1.2**	+ 141.2%
Extraordinary charges	0.3	0.4	**0.5**	+ 37.3%
TOTAL	260.1	293.1	307.3	+ 4.8%

With a 4.8% increase, expenditure rose less than income in 2010:

■ Operating expenses for the year amounted to €305.6 million, an increase of €13.4 million or 4.6%. This variation was concentrated mainly in purchases and provisions, and breaks down as follows:

– Personnel expenses rose by 3.5% to €124.2 million. The average number of employees over the year 2010 was 1691 (full-time equivalent worked) for a budget of 1,679.5. The Institute was momentarily overstaffed at the beginning of the year but the excess was gradually absorbed to reach 1,676.3 (full-time equivalent) at the end of the year, which is below the job ceiling.

– Taxes amounted to €13.3 million, up by €0.5 million.

– Depreciation expenses were up slightly - by €0.3 million - to reach €23.1 million. Provisions, allocated mainly to the employee profit-sharing plan and contingency provisions, rose by €4 million compared with 2009, to reach a figure of €6.3 million. This was mainly due to a €5 million provision set aside in connection with the incident at the Feursmétal site.

– Purchasing of goods and services rose by €3.8 million (or 2.9%) to €136.6 million. This was essentially due to the higher than planned cost of work on the CABRI experimental reactor.

– Other expenses represented €2.2 million, compared with €1.6 million in 2009. Fees (€1.4 million) accounted for much of this amount .

124.2 million. The average number of employees over the year 2010 was 1,691 (full-time equivalent worked) for a budget of 1,679.5. The Institute was momentarily overstaffed at the beginning of the year but the excess was gradually absorbed to reach 1,676.3 (full-time equivalent) at the end of the year, which is below the job ceiling.

This table breaks down the year's outside expenses, which amount to €136.6 million. Purchases, Outside services, and Other outside services were up by 3.9%, 1.8%, and 1.2% respectively.

Breakdown of outside expenses (in €M)	2008	2009	2010	Difference 2010/2009
Purchases	63.0	72.0	**74.8**	+3.9%
Outside services	35.4	40.8	**41.6**	+1.8%
Other outside services	17.8	20.0	**20.2**	+1.2%
TOTAL	116.2	132.8	136.6	+2.9%

This variation was concentrated mainly in purchases and provisions, and breaks down as follows:

■ Financial charges rose sharply by 141% (or €0.7 million), from €0.5 million to €1.2 million. Interest payments on loans accounted for much of this amount. The increase in these charges was mainly due to the new loan taken out to fund the Triangle building, for which interest payments began in 2010 (€0.5 million). Other loans running concern funding for the head office and new dosimetry technology.

■ Extraordinary charges rose by €0.1 million.

RESULTS AND FINANCING

Results and financing (in €M)	2008	2009	2010	Difference 2010/2009
Profit "+" / loss "–" recorded	– 18.7	– 20.8	**– 17.9**	– 13.8%
Cash provided by operations "+" / "–"	– 9.3	– 10.2	**– 5.6**	– 45.6%
Variation in working capital	– 26.0	– 18.8	**+ 3.5**	– 118.7%

The balance figures at year-end can be characterized as follows:

■ The net balance for the year 2010 showed a deficit of €17.9 million, which is close to that recorded for the previous years (deficit of €20.8 million in 2009 and €18.7 million in 2008). The difference between the revised forecast in the second budget amendment, predicting a deficit of €16.9 million, and the accounts at closing on December 31, 2009 was €1 million, which can be explained by a favorable balance between:

– a growth in income estimated at €3.4 million,

– an increase in charges estimated at €4.6 million.

■ The deficit in cash provided by operations, budgeted at – €4.2 million in the second budget amendment, reached – €5.6 million, i.e. a negative difference of €1.7 million. This deficit was compensated by the portion of the public service grant paid by

the Ministry of Ecology, Sustainable Development, Transport and Housing allocated to capital grants (€18 million), an above-forecast reimbursement by the special dismantling fund, and a €16.7 million increase in financial charges for funding the first phase of the Institute's property project. This deficit was compensated by the portion of the public service grant paid by the Ministry of Ecology, Sustainable Development, Transport and Housing allocated to capital grants (€18 million), an above-forecast reimbursement by the special dismantling fund, and a €16.7 million increase in financial charges for funding the first phase of the Institute's property project. The resulting total resources paid for jobs and a €3.5 million contribution to the working capital against a planned withdrawal of €20.1 million in June 2010. This variation was mostly due to a sum of €19.2 million carried over as part of the investment program.

MANAGEMENT BALANCES

The following table shows the variation in working capital, cash, and working capital requirements:

In €M	2010 actual	DM2 2010	2009 actual
Contribution to or withdrawal from working capital	**3.5**	– 20.1	– 18.8
Variation in working capital requirements	**3.9**	– 7.9	– 19.0
Cash variation	**– 0.4**	– 12.1	0.2
Level of working capital	**25.3**	1.7	21.8
Level of working capital requirements	**– 59.7**	– 71.5	– 63.6
Cash level	**85.0**	73.2	85.3
– Prefinancing of special fund	**3.4**	–	8.6
– Recalculated cash level	**88.3**	73.2	93.9

Variation in working capital

The projected variation in working capital in June 2010 was due to a withdrawal of €20.1 million, broken down as follows:

– withdrawal from CABRI working capital ..... 4.5 €M
– PHEBUS ..... 1.0 €M
– investments carried over from 2009 ..... 12.2 €M
– write-back on profit-sharing provision 2009 ..... 1.3 €M
– write-back on sources ..... 1.1 €M

The contribution to working capital at the end of 2010 amounted to €3.7 million, an increase of €23.8 million compared with June 2010 forecasts.
The difference can be broken down as follows:

– investments not completed in 2010, proposed to be carried over to 2011 ..... + 19.2 €M
– provision for profit-sharing plan 2010 ..... + 1.1 €M
– difference in funding via special fund ..... + 2.9 €M
– other operating savings ..... + 0.4 €M

Expenditure relating to investments and specific projects not completed in 2010 is the subject of a carryover proposal for the 2011 budget. The payment of dismantling expenses via the special fund is delayed because of the way the fund works (expenditure is reimbursed after the event on presentation of documentary evidence).
In view of the above, the level of working capital at December 31, 2010, estimated at €1.7 million according to the second budget amendment, is actually €25.3 million.

Cash variation

LThe cash level stood at €85.0 million at the end of 2010, compared with the €73.2 million projected in June 2010.
It was almost stable compared with the year-end level for 2009 (€85.2 million), due to the combined effects of the increase in working capital and the variation in working capital requirements.

Like the working capital, cash was affected by the delay in reimbursing the cost of remediation and dismantling operations via the special fund. Thus €6.2 million in expenditure projected in the second budget amendment for 2010 concerned PHEBUS dismantling costs. Of this amount, €3.4 million was executed but will only be reimbursed by the special fund on presentation of documentary evidence when the 2011 budget is executed.
Because of the way in which the special remediation and dismantling fund works, IRSN must bear the cost of pre-financing dismantling operations out of its cash and working capital.

Variation in working capital requirements

Working capital requirements stood at -€59.5 million at the end of 2010, compared with a projection of -€71.5 million. The €3.9 million increase in working capital requirements compared with 2009 can be explained by the fact that operating assets (especially accounts receivable, see point 6.2 below) rose more rapidly than operating debts (+€7.4 million compared with +€3.4 million).

BALANCE SHEET ANALYSIS

Liabilities

With a recorded loss of €17.9 million, the net position dropped to €37.5 million, compared with €55.4 million in 2009. The capital grant saw an €8.2 million increase, rising from €67.3 million to €75.5 million. Furthermore, contingency and loss provisions fell by €1 million, reaching the figure of €71 million on December 31, 2010. This drop was the result of two opposing trends, namely an increase in contingency provisions (up by €5 million) to account for a provision set aside to cover the incident at the Feursmétal site, and a decrease in loss provisions (down by €6 million). The Institute's long-term capital dropped, falling from €194.7 million in 2009 to €184.1 million in 2010.

Debt saw a significant rise, climbing from €119 million in 2009 to €135.4 million. This was due to the combined effect of increases in debts not only in the short term, but also – and especially – in the medium and long term. These changes break down as follows: trade payables (up by €3.2 million), tax and social liabilities (up by €1.3 million, other liabilities (down by €1.1 million) and long-term debts (up by + €12.9 million), which consolidate capital reimbursements on current loans to the amount of €3.7 million, and a new loan with Crédit Agricole. This loan, for €16.7 million over a period of 25 years, has been taken out to fund works on property at the Fontenay-aux-Roses site and the acquisition of the Triangle building.

Assets

Fixed assets fell to €182.9 million (down by €1.2 million), due to depreciation expenses (up by €22.9 million) progressing faster in 2010 than fixed assets acquisitions (up by €21.7 million).

Current assets rose to €136.6 million (up from €129.6 million in 2009), due mainly to a €4.8 million increase in accounts receivable. Furthermore, liquidities fell very slightly from €85.2 million on December 31, 2009 to €85 million at year-end, 2010.

CONCLUSION

The 2010 budget was executed within the forecast budget balance presented to the Board of Directors.
A €3.5 million contribution was paid into the working capital, which stood at €25.3 million at year-end 2010.
The withdrawal from working capital for 2011 provided for in the projected revenue and expenditure statement stood at €0.6 million (write-back on sources). Deferred expenditure of €20.3 million must be added to this amount, representing €1.1 million for the employee profit-sharing plan and €19.2 million for carryover of investment projects in progress.

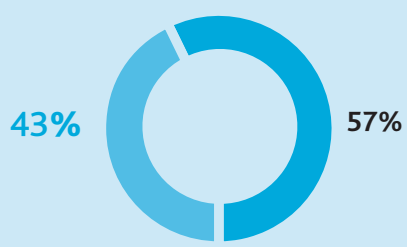
The available balance of €4.5 million covers the first provision set up to meet the consequences of the incident at the Feursmétal site. To this end, €2.1 million will be paid at the beginning of 2011, further to a ruling of the Paris court of first instance on January 25, 2011.

Balance sheet

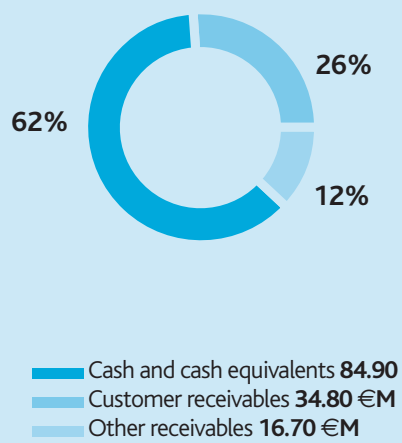
ASSETS

In euros	Gross	Depreciation and provisions (to be deducted)	2010 Net	2009 Net	2008 Net
Intangible assets	20,741,718.26	15,339,630.63	5,402,087.63	5,152,254.53	3,254,384.31
Tangible assets	299,015,905.44	130,784,936.07	168,230,969.37	166,660,722.33	127,259,750.21
Financial assets	9,273,132.97	–	9,273,132.97	12,264,531.14	5,115,702.80
Fixed assets	**329,030,756.67**	**146,124,566.70**	**182,906,189.97**	**184,077,508.00**	**135,629,837.32**
Inventory and work in progress	–	–	–	–	–
Prepayments and advances on orders	128,584.85	–	128,584.85	626,921.85	431,094.07
Accounts receivable	51,504,408.85	27,331.59	51,477,077.26	43,650,599.73	46,709,534.13
customer receivables	*34,830,393.58*	*27,331.59*	*34,803,061.99*	*28,411,055.33*	*30,497,436.91*
related receivables	*16,674,015.27*	–	*16,674,015.27*	*15,239,544.40*	*16,212,097.22*
Other receivables	–	–	–	3,689.80	3,689.80
Investment securities	76,706,174.36	–	76,706,174.36	77,925,874.35	75,854,958.53
Cash	8,244,314.03	–	8,244,314.03	7,403,786.48	9,297,888.40
Prepaid expenses	–	–	–	–	–
Current assets	**136,583,482.09**	**27,331.59**	**136,556,150.50**	**129,610,872.21**	**132,297,164.93**
GRAND TOTAL	**465,614,238.76**	**146,151,898.29**	**319,462,340.47**	**313,688,380.21**	**267,927,002.25**

Assets



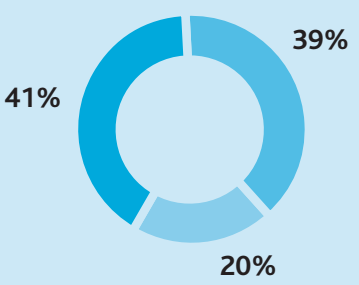
Current assets



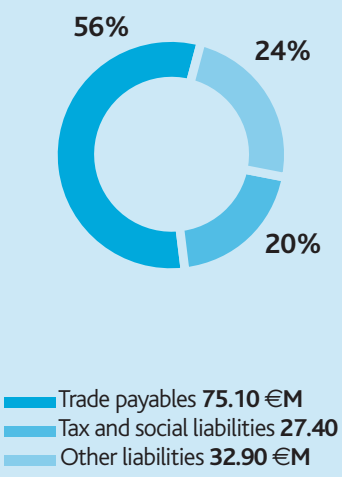
LIABILITIES

In euros	2010	2009	2008
Allowances	4,183,945.65	4,183,945.65	4,183,945.65
Reserves	90,783,098.42	90,783,098.42	90,783,098.42
Retained earnings	– 39,524,209.85	– 18,724,287.79	–
Fiscal year profit or loss	– 17,930,305.13	– 20,799,922.06	– 18,724,287.79
Net position	37,512,529.09	55,442,834.22	76,242,756.28
Capital grants	75,534,368.49	67,282,860.81	50,013,274.68
Equity	113,046,897.58	122,725,695.03	126,256,030.96
Contingency provision	6,052,933.75	2,666,100.00	1,978,000.00
Provision for taxes due	–	–	177,000.00
Loss provision	64,951,818.22	69,321,702.00	33,294,000.00
Contingency and loss provision	71,004,751.97	71,987,802.00	35,449,000.00
Bank borrowings	24,101,127.54	11,056,525.76	14,429,135.32
Various debts and liabilities	–	190.50	190.50
Trade notes and accounts payable	75,129,356.62	71,948,636.59	58,826,534.14
Tax and social liabilities	27,383,713.64	26,111,320.17	24,015,522.27
Other operating liabilities	–	–	–
Trade notes and accounts payable	4,650,730.31	6,045,394.01	7,197,842.14
Other liabilities	4,145,762.81	3,812,816.15	1,752,746.92
Liabilities	135,410,690.92	118,974,883.18	106,221,971.29
GRAND TOTAL	319,462,340.47	313,688,380.21	267,927,002.25

Long-term capital



Debt analysis



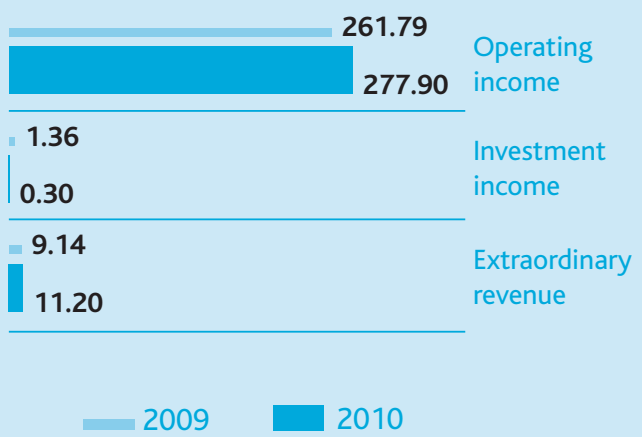
Income statement

In euros before tax	2010	2009	2008
Research work	11,743,488.82	13,569,471.06	11,165,866.34
Service contracts	21,667,148.27	18,145,983.08	14,937,300.43
Other services provided	5,797,319.53	5,996,863.90	5,720,848.65
Net revenue	**39,207,956.62**	**37,712,318.04**	**31,824,015.42**
Operating grants	230,576,638.37	216,500,738.38	195,447,206.52
Write-backs on depreciation and provisions	7,326,896.29	6,835,490.36	3,270,980.62
Capital grants recorded in fiscal year's income statement	9,748,492.32	7,928,749.89	6,286,126.30
Expense transfer	98,755.67	147,682.24	128,863.34
Other income	665,373.17	596,141.76	553,067.57
Operating income	**287,624,112.44**	**261,792,370.78**	**231,224,133.47**
Outside expenses for the fiscal year	136,551,172.79	132,765,002.38	116,148,653.80
Taxes, duties, and similar payments	13,264,085.43	12,795,271.46	12,373,634.74
Personnel expenses	124,213,013.06	119,962,166.29	110,426,772.00
Depreciation and provisions	29,385,527.00	25,143,505.80	18,924,712.32
Other expenses	2,205,994.59	1,582,253.46	1,179,411.04
Operating expenses	**305,619,792.87**	**292,248,199.39**	**259,053,183.90**
OPERATING INCOME	**– 17,995,680.43**	**– 30,455,828.61**	**– 27,829,050.43**
From controlled entities	–	–	–
Other interest income	21,153.87	26,886.07	24,566.87
Foreign exchange gains	95,672.34	92,325.73	38,754.50
Gains on sales of short-term investments	208,778.61	1,243,941.94	3,627,624.62
Investment income	**325,604.82**	**1,363,153.74**	**3,690,945.99**
Interest expense	882,065.05	471,602.42	564,466.81
Foreign exchange losses	298,456.82	17,844.88	153,739.95
Losses on sales of short-term investments	–	–	–
Financial charges	**1,180,521.87**	**489,447.30**	**718,206.76**
FINANCIAL INCOME	**– 854,917.05**	**873,706.44**	**2,972,739.23**
INCOME BEFORE EXCEPTIONAL ITEMS	**– 18,850,597.48**	**– 29,582,122.17**	**– 24,856,311.20**
Gains on sales of assets	73,040.85	–	–
Capital grants strictly for the period	–	–	46,879.34
In operations	1,339,207.75	1,211,820.71	88,447.78
Extraordinary revenue	**1,412,248.60**	**9,140,570.60**	**6,421,453.42**
In operations	372,640.25	316,223.72	222,636.97
Book value of assets sold and other capital losses	119,316.00	42,146.77	66,793.04
Depreciation and provisions	–	–	–
Extraordinary charges	**491,956.25**	**358,370.49**	**289,430.01**
EXTRAORDINARY INCOME	**920,292.35**	**8,782,200.11**	**6,132,023.41**
Income tax	**–**	**–**	**–**
FISCAL YEAR INCOME	**– 17,930,305.13**	**– 20,799,922.06**	**– 18,724,287.79**

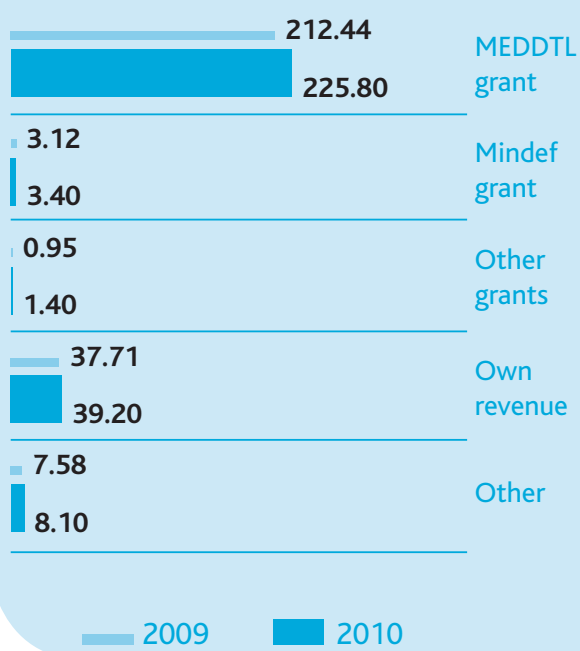
Income statement subtotals

CAPTIONS	31/12/2010	%	31/12/2009	31/12/2008
Sales	39,207,956.62	14.53	37,712,318.04	31,824,015.42
+ Operating grants	230,576,638.37	85.47	216,500,738.38	195,447,206.52
FISCAL YEAR PRODUCTION	**269,784,594.99**	**100.00**	**254,213,056.42**	**227,271,221.94**
– Outside expenses	136,551,172.79	50.61	132,765,002.38	116,148,653.80
ADDED VALUE	**133,233,422.20**	**49.39**	**121,448,054.04**	**111,122,568.14**
– Taxes	13,264,085.43	4.92	12,795,271.46	12,373,634.74
– Personnel expenses	124,213,013.06	46.04	119,962,166.29	110,426,772.00
OPERATING INCOME BEFORE INTEREST	**– 4,243,676.29**	**– 1.57**	**– 11,309,383.71**	**– 11,677,838.60**
+ Write-backs, expense transfer	7,425,651.96	2.75	6,983,172.60	3,399,843.96
+ Other income	665,373.17	0.25	596,141.76	553,067.57
– Depreciation and provisions	29,385,527.00	10.89	25,143,505.80	18,924,712.32
+ Write-back on capital grants	9,748,492.32	3.61	7,845,142.87	6,286,126.30
– Other expenses	2,205,994.59	0.82	1,582,253.46	1,179,411.04
OPERATING INCOME	**– 17,995,680.43**	**– 6.67**	**– 22,610,685.74**	**– 21,542,924.13**
+ Investment income	325,604.82	0.12	1,363,153.74	3,690,945.99
– Financial charges	1,180,521.87	0.44	489,447.30	718,206.76
INCOME FROM CONTINUING OPERATIONS BEFORE INCOME TAXES	**– 18,850,597.48**	**– 6.99**	**– 21,736,979.30**	**– 18,570,184.90**
+ Extraordinary revenue	1,412,248.60	0.52	1,295,427.73	135,327.12
– Extraordinary charges	491,956.25	0.18	358,370.49	289,430.01
– Income tax	–	–	–	–
FISCAL YEAR RESULT	**– 17,930,305.13**	**– 6.65**	**– 20,799,922.06**	**– 18,724,287.79**

Income (in €M)



Operating income (in €M)



Budget Versus Actual Report

INCOME STATEMENT in euros	2010 Budget	2010 Actual
REVENUE		
Service contract sales	43,663,010.00	39,207,956.62
Government grants	228,322,660.00	230,576,638.37
Other operating revenue	1,500,000.00	2,562,941.41
Internal operations	12,207,000.00	17,014,429.46
TOTAL REVENUE	285,692,670.00	289,361,965.86
EXPENDITURE		
Personnel expenses	137,953,127.00	124,213,013.06
Other operating expenses	139,684,628.00	153,574,414.93
Internal operations	25,000,000.00	29,504,843.00
TOTAL EXPENDITURE	**302,637,755.00**	**307,292,270.99**
RESULT (PROFIT)	–	–
RESULT (LOSS)	*16,945,085.00*	*17,930,305.13*
TOTAL INCOME STATEMENT BALANCE	**302,637,755.00**	**307,292,270.99**

TRANSFER OF RESULT TO CASH PROVIDED BY OPERATIONS in euros	2010 Budget	2010 Actual
RESULT	**– 16,945,085.00**	**– 17,930,305.13**
+ Loss on sale of assets	–	46,275.15
+ Depreciation and provisions	25,000,000.00	29,385,527.00
– Gains from offsetting depreciation	–	–
– Portion of grants recorded in result	3,500,000.00	9,748,492.32
– Write-backs on depreciation and provisions	8,707,000.00	7,326,896.29
CASH PROVIDED BY OPERATIONS	– 4,152,085.00	– 5,573,891.59

SUMMARY STATEMENT OF CHANGES IN FINANCIAL POSITION in euros	2010 Budget	2010 Actual
CASH PROVIDED BY OPERATIONS	**– 4,152,085.00**	**– 5,573,891.59**
Acquisition of tangible and intangible assets	46,721,442.00	25,013,439.26
Financial assets	6,300,000.00	6,239,901.46
Long-term debt paid	3,815,000.00	3,768,709.08
TOTAL USES OF CASH	**60,988,527.00**	**40,595,941.39**
Government capital grants	17,812,440.00	18,000,000.00
Other sources (excl. internal operations)	6,400,000.00	9,302,758.69
Increase in long-term debt	16,705,000.00	16,813,120.36
TOTAL SOURCES OF CASH	**40,917,440.00**	**44,115,879.05**
CONTRIBUTION TO WORKING CAPITAL	**– 20,071,087.00**	**3,519,937.66**

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meanings