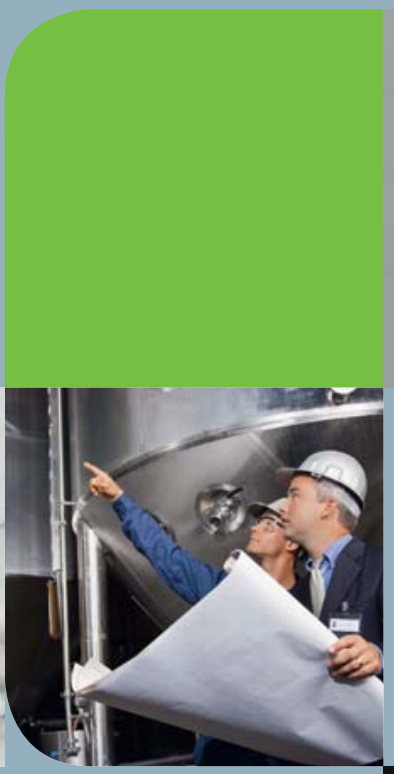
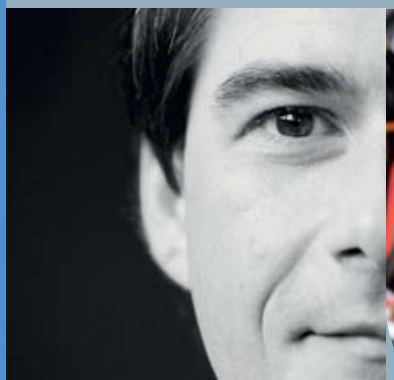
IRSN

INSTITUT
DE RADIOPROTECTION
ET DE SÛRETÉ NUCLÉAIRE

Annual Report 2009






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

1,786 [1] employees in various professions, including specialists, engineers, agronomists, veterinarians, technicians, experts, and researchers.

These figures include:
85.5 [2] doctorate students.
28 [2] post-doctorate students.
36 doctors or persons qualified to direct research.

Budget

IRSN spent **€301** million in 2009 [3]:

45% of which went to research and regulatory activities in the general interest;

47% to support services to the public authorities.

(1) This workforce consists of 1,644 persons on permanent contracts and 142 on fixed-term contracts (these figures include 77 persons contracted out to other organizations, but do not include 24 secondments).
(2) Expressed in full-time equivalent terms.
(3) See Financial Report for further details.

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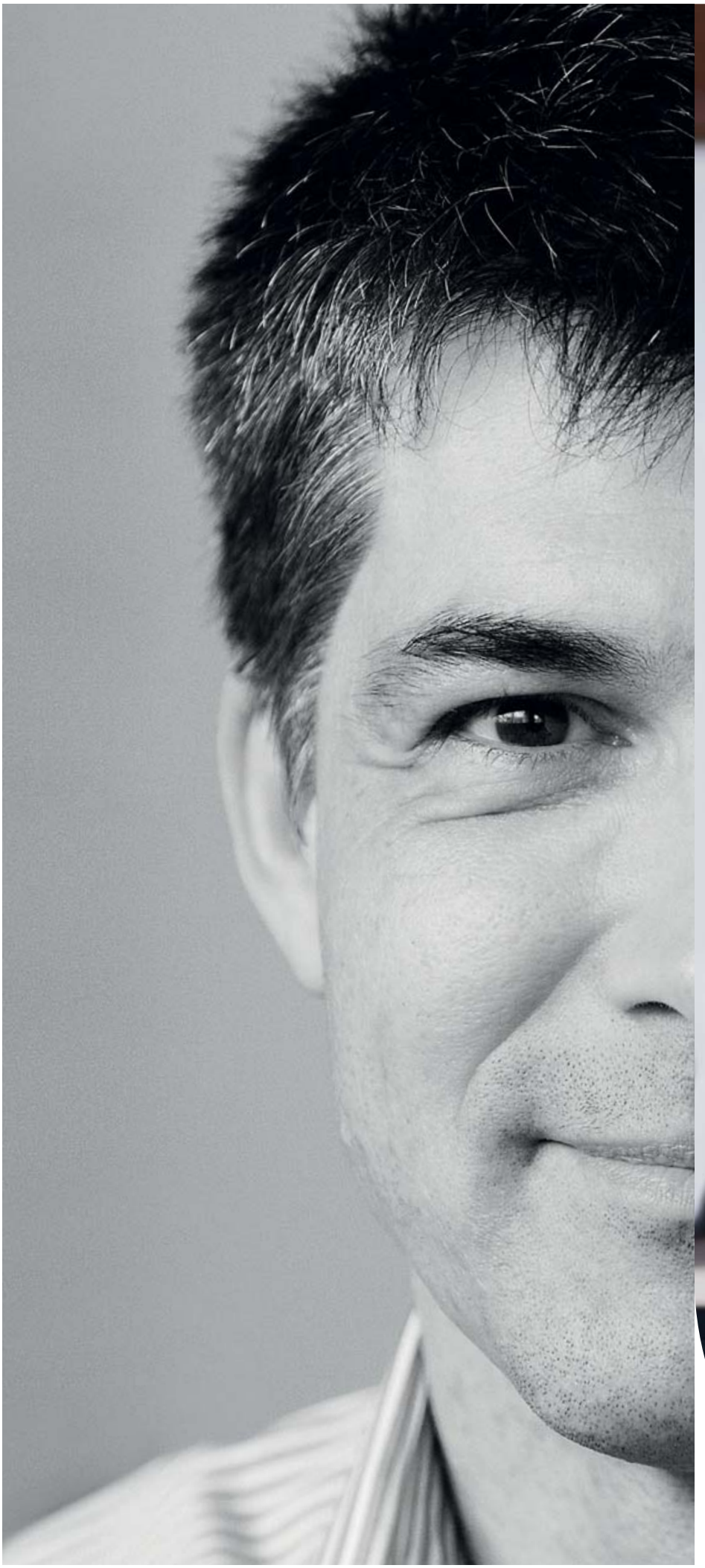


« Nuclear safety and radiation protection are complex technical issues. To grasp them fully, we need a partner we can count on, an organization that is competent, transparent and tuned in to our needs. »

JEAN-CLAUDE DELALONDE, CHAIRMAN OF ANCCLI

ORGANIZATION

EDITORIAL BY AGNÈS BUZYN AND JACQUES REPUSSARD

Advancing the cause of nuclear safety – a long-term global challenge, shaped by science and social expectations.

The challenges posed by nuclear safety and security, and by radiation protection, will need to be addressed throughout the century if nuclear energy is to be part of the energy mix, on a lasting basis, in a growing number of countries.

With some 1,800 employees, researchers, engineers, and technicians, IRSN plays a crucial role in improving safety, both in France and in the rest of the world. It is now part of the European and worldwide network of technical safety organizations or TSOs. Consequently, safety challenges are of direct concern to IRSN, which looks to science to build the knowledge and skills of its experts and drive progress in this area.

The development of new generations of reactors, which is increasingly organized within international structures, is built on progress in science and technology. Although third-generation reactors may be in the news today, top researchers specialized in various areas such as mechanical engineering, physics, and thermal-hydraulics, are already at work developing the fourth generation.
In this way, ITER can be considered on the dividing line between fundamental research and energy project. This type of technological development is carried out by major research and industrial organizations that pool their resources and work together on large-scale projects, often involving several countries.

But what about safety? The Three Mile Island accident in 1979, followed by the Chernobyl disaster in 1986, signaled the start of a period of intense effort to improve safety and protection against ionizing radiation. Research teams focused on the behavior of nuclear fuel and vital components of reactor systems and containments, and governments and industry invested significant financial resources in the area. New emergency response tools and decision-making aids were developed to help manage post-accident situations, together with novel dosimetry methods and therapeutic techniques to deal with cases of severe irradiation.

New types of reactors, known as "Generation III", of which the EPR is one example, were developed, taking advantage of all these development efforts. The new reactors were designed to offer improved performance in terms of behavior in accident situations, waste generation, and worker exposure to ionizing radiation.
Looking at these efforts and the concrete results obtained, can we consider that safety issues are now behind us? Nothing would be riskier!

Social acceptance of civil nuclear energy is based on the assumption that there will never be another severe accident at a nuclear plant anywhere in the world. But when it comes to safety, to stand still is to fall behind. New avenues of research are emerging. Examples include

learning how to control aging phenomena in structural materials, of course, but also in other materials, such as electric cables and concrete, where long life is essential for plant safety. If the service life of existing reactors is to be significantly extended, then this scientific hurdle must be overcome. Similarly, optimizing nuclear waste management policies implies learning more about the effects of chronic very low-dose exposure to ionizing radiation.

Cutting-edge capabilities in science, research, and assessment must be acquired and brought together in multidisciplinary science and technology centers if these challenges are to be met. In France, IRSN has been assigned the role of science and technology center in the field of safety, security, and radiation protection.

Drawing on the knowledge and scientific skills it has acquired through research and analysis of operating feedback on nuclear facilities, the Institute examines the safety, security, health, and radiation protection measures planned by operators to assess their suitability and determine their limits. This task must be built on open dialogue with operators, who are immediately responsible for the safety of their facilities. We are pleased to see that IRSN and nuclear operators continue to enjoy this spirit of dialogue, which has always been the hallmark of nuclear safety in France.

The public authorities, which are responsible for defining nuclear safety policy, can thus count on the results of IRSN assessments to carry out their tasks in full.

In 2006, these three stakeholders - operators, public authorities, and national expert in risks – were joined by a fourth player, civil society, which now has increased access to stakeholder information, and plays an active role in risk alertness. Today, the local information committees, and the High Committee for Transparency and Information on Nuclear Safety, are full-fledged members of the French safety system.

A center of expertise in nuclear and radiological risk control that is completely in tune with social expectations

In order to act effectively, a scientific and technical safety organization like IRSN requires considerable human and financial resources, and a technical infrastructure, built on a social base.

Today, recruiting and training experts is of concern to all technical safety organizations. Providing research opportunities is surely one of the best ways to attract talented young people.
But new generations of engineers and researchers must also be trained and perfected in assessment methods. With this in mind, IRSN decided to join forces with its German counterpart, GRS, and with two other TSOs to create the European Nuclear Safety Training and Tutoring Institute or ENSTTI.

As of 2010, our partners in Europe and elsewhere will be able to benefit from the training provided at ENSTTI to acquire a culture shared by all future experts. Backed by the European Commission and the IAEA, the new institute is destined to become one of the world centers of excellence for training specialists in nuclear safety assessments, downstream of university training programs, and an instrument for promoting the standardization of safety practices around the world.

Although nuclear safety research is expensive, cost-sharing initiatives have been developed: several research platforms have been set up within the European context, examples being the new MELODI platform, which focuses on low-dose radiation, and SNE-TP, which is concerned with nuclear technology and safety.
Similarly, the analysis of operating feedback from nuclear reactors currently in service is being optimized at the European level through the "Clearing House" project. The technical investigation resources for this project will be set up in 2010 through a cooperation contract between the European Commission and Riskaudit, a jointly-owned subsidiary of GRS and IRSN.

The experimental facilities for nuclear safety research, and the development of sophisticated computer codes call for extremely heavy investments. Here, too, the answer can be found in pooling resources, especially within the context of programs coordinated by the OECD Nuclear Energy Agency.

According to Rabelais, "Science without conscience is but the ruin of the soul." It is IRSN's strong ties with and responsibility towards civil society that guarantee the utility of its research activities.
These ties are reflected in the Nuclear Safety and Radiation Protection Research Policy Committee, which was set up in 2009 as an advisory body to the Institute's Board of Directors.
The Committee members come from a wide range of backgrounds, reflecting the spirit of the French Environment Round Table.

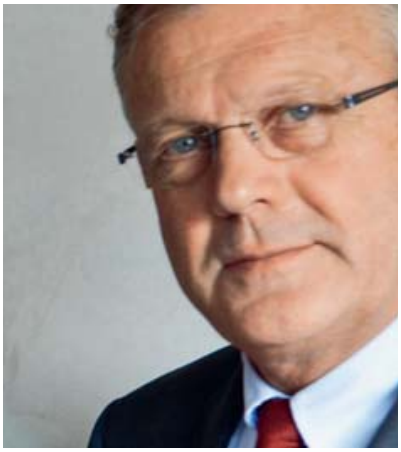
When a country chooses to develop nuclear energy, it makes a lasting commitment. It must therefore ensure that the long-term safety of its facilities is built on sound scientific and technological expertise, and a strategy of open dialogue with researchers, experts, facility operators, and authorities. This is the goal of the second Government/IRSN Contract of Objectives currently under negotiation.

No country, however, has to face this challenge alone. Knowledge and research costs can be shared through international cooperation and the development of technical safety organization networks, in a joint effort to promote a standardized approach to technical safety.

The next IAEA conference on Technical Safety Organizations, to be held in Tokyo in 2010, will provide an opportunity to explore these paths to progress further, promote increasingly standardized approaches, and share efforts to advance the cause of safety for the common good.

Agnès Buzyn,
Chairperson,
Board of Directors.

Jacques Repussard,
Director General.



EDITORIAL BY MICHEL BRIÈRE

The development of nuclear energy involves two inter-related requirements: safety and security.

The predicted revival in nuclear energy around the world, which now seems increasingly likely, has brought with it growing international concern for nuclear "safety" and "security", both of which entail guarding against the risks liable to affect nuclear activities.

Risks relating to safety can arise in connection with natural or industrial external events, or internal events induced by equipment failure or human error. Knowledge of these risks can be acquired through systematic analysis of operating feedback and, more generally, through scientific progress, and must be universally shared to develop risk prevention around the world.

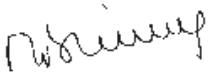
Security risks are the result of deliberate action taken with malicious intent. These are intelligent acts, perpetrated with theft or sabotage in mind, and capable of adapting to any preventive measures taken against them. Such acts therefore leave no room for "speculation" by Government departments and, if they cannot be stopped by the preventive measures set up jointly by the Government and Facility Operators, they must be addressed by national Law Enforcement Agencies.

While these two areas may be similar in terms of technical aspects and objectives, the gap between them is wide enough to justify differences in their regulatory organization and transparency requirements. That is why IRSN assigns security-related risk assessment activities to its Nuclear Defense Expertise Division, which liaises with the Institute's other safety and radiation protection experts whenever necessary.

Recent years have seen the emergence of what can only be described as a "security regime" on the international nuclear scene, a phenomenon that has been observed in nuclear safety for over thirty years. In 2009, in particular, IRSN's Nuclear Defense Expertise Division was instrumental in putting French expertise at the service of the International Atomic Energy Agency, a UN organization responsible for preparing recommendations and codes of practice that will soon be applicable around the world.

Turning to France, further progress was made in the nuclear security regime, with the implementation of a new decree on the "protection of nuclear materials, facilities, and transport", which reinforces preventive action, in line with the measures adopted in France in 2006 for the protection of vital infrastructures. IRSN's Nuclear Defense Expertise Division was actively involved in preparing this decree and, in 2009, in preparing its implementing orders. The Division will also provide technical assistance to the Senior Defense and Security Official of the Ministry of Energy, which is the authority in charge of implementing these regulations, and to the Minister of Defense.

Michel Brière,
Deputy Director General
in Charge of Defense-related
Missions.



Key events

» February 25

A general cooperation agreement on nuclear safety and radiation protection with Ukraine was signed by Jacques Repussard, Director General of IRSN, and Olena Mykolaichuk, Chairperson of SNRCU, the State Nuclear Regulatory Commission of Ukraine.

January 7

IRSN and Météo-France signed a framework cooperation agreement to transmit and exchange climatological data used, in particular, for emergency management and operational monitoring of nuclear material transport.

January 19

IRSN launched an institutional recruitment campaign in *Monde économique*.

March 26

Creation of the Nuclear Safety and Radiation Protection Research Policy Committee (COR), an advisory body to the IRSN Board of Directors. The committee's task is to ensure that research objectives are consistent with requirements expressed by the authorities, and take into consideration other countries' experience.

March 26

The Hauts-de-Seine local authority for labor, employment and vocational training (DDTEFP) approved the disabled persons agreement signed by IRSN and the trade unions represented at the Institute.

April 2

US NRC Commissioner, Peter B. Lyons, visited IRSN.

April 3

Launch of SARNET2, the European network of excellence on severe reactor accidents. Supported by the EU under its FP7 R&D program, SARNET2 also involves partners from outside the EU, such as AECL (Canada), KAERI (Korea), NRC (USA) and PSI (Switzerland).

» April 9

IRSN visit by Ambassador Florence Mangin, the Permanent Representative of France to the United Nations and international organizations in Vienna.

April 10

IRSN presented to the public its Charter on Openness to Society, which sets out to share information relating to radiological and nuclear risk assessments with civil society stakeholders.

July 5-10

The European Technical Safety Organisations Network (ETSON) held its summer school in Cadarache. The event provides an opportunity for young TSO engineers to further their training.

June 22

IRSN signed a cooperation agreement with the French National Gendarmerie Intervention Group (GIGN). The aim is to address more effectively potential threats of serious attacks liable to have an impact on nuclear facilities and the transport of nuclear materials. Under the terms of the agreement, each organization will be able to draw on its partner's skills and expertise in providing protection against malicious acts.

April 16

IRSN and AP-HP, the Paris public hospital system, signed a cooperation agreement under the EPOPA protocol for the surveillance of patients overexposed during radiotherapy.

June 10-11

The OECD Nuclear Energy Agency's Committee for the Safety of Nuclear Installations (CSNI) held its 45th meeting. In December 2008, Jacques Repussard, Director General, was appointed as Chair of the Committee for the period 2009-2011.

April 23

A technical cooperation agreement was signed in Beijing by Jacques Repussard, IRSN's Director General, and Mr. Xing Ji, Deputy General Manager of China Nuclear Power Engineering Corporation (CNPE).

September 1

IRSN, CNRS and the University of Lille 1 for Science and Technology set up C3R, a new joint laboratory for the study of chemical kinetics, combustion and reactivity. Its activities will focus on chemical kinetics in both gaseous and heterogeneous phases, and on radiochemistry and combustion.

November 26-27

A joint seminar between IRSN and China's Nuclear and Radiation Safety Center (NSC) was held in Beijing to celebrate NSC's 20th anniversary.

September 23 and 29

IRSN signed two partnership agreements, one with the French National Cancer Institute (INCA), the other with the Directorate General for Health (DGS). The two agreements reflect the intensification of IRSN's activities in areas relating to radiation protection, particularly in the medical field.

September 23

IRSN's new website was put on-line. The site has been thoroughly reworked to highlight the pedagogical aspects of the content presented by the Institute.

September 23

IRSN took part in an IAEA-WHO joint exercise simulating a radiological emergency. The aim of the exercise was to test conditions for transporting blood samples for biological dosimetry across international borders.

October 7

IRSN and Areva NP signed an agreement for the joint development of a simulator configuration representing the Flamanville 3 EPR. Scheduled for delivery by the end of 2010, the configuration is part of the simulator renovation project that the two partners launched in 2005.

November 10

A cooperation agreement was signed with LNE, the French national laboratory for metrology and testing. The agreement concerns fires and explosions.

November 17

IRSN was heard by the French National Assembly Economic Affairs Committee and the Committee on Sustainable Development and Town and Country Planning. The hearing concerned the assessment of an incident connected with the underestimation of the quantity of fissile material contained in equipment to be dismantled at the Areva plutonium technology facility (ATPu) in Cadarache, in the south of France. The hearing was organized as part of French parliamentary control procedures.

November 18-20

During a joint seminar, IRSN and JNES, its Japanese counterpart, outlined a new cooperation framework relative to fire hazards in nuclear facilities.

November 30 to December 2

A seminar, *Science et valeurs en radioprotection* ("Radiation protection: science and values") was held at the Abbaye des Vaux-de-Cernay near Paris, on the initiative of the OECD Nuclear Energy Agency's Committee on Radiation Protection and Public Health (CRPPH), in partnership with IRSN, the French Ministry of Ecology, Energy, Sustainable Development, and the Sea, and CEPN, the French Nuclear Protection Assessment Study Center.

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

Enhancing safety in radiotherapy by fostering a safety culture.
Publication date : March

Measuring absorbed dose in very small photon beams used in stereotactic radiotherapy. *Publication date : July*

Dosimetric reconstruction in interventional neuroradiology at Haute Pierre university hospital in Strasbourg.
Publication date : September

Worker radiation protection: 2008 report on occupational exposure to ionizing radiation.
Publication date : November

Environmental monitoring

Global assessment of the Areva NC ten-yearly environmental report – Part 3: reuse of waste rock in the public domain. *Publication date : February*

Radioactivity monitoring around the Loire basin – Partnership between IRSN and two local information committees in the region. *Publication date : March*

Radioecological study of the Malvési site and its surroundings – Further study conducted in 2008.
Publication date : June

Report on the radiological quality of water distributed in France 2005-2007. Prepared by IRSN/ASN/DGS.
Publication date : June

2008 management report of the national network of environmental radioactivity measurements (RNM) – IRSN/ASN. *Publication date : October*

2008 report on radioactivity monitoring in French Polynesia: results from the IRSN monitoring networks.
Publication date : November

Radiological "zero point" in Taaone lagoon before Jacques Chirac hospital was opened in Tahiti.
Publication date : November

2008 report on the radiological state of the environment in France: summary of results from the IRSN monitoring networks.
Publication date : December

Nuclear safety

Rapport de sûreté des modèles de colis destinés au transport de matières radioactives (French translation of the European PDSR guide). *Publication date : June*

Lessons learned from incidents reported between 2005 and 2008 at nuclear laboratories and plants, and at nuclear facilities in the process of being dismantled.
Publication date : December

IRSN's viewpoint on safety and radiation protection issues relative to French nuclear power plants in 2008.
Publication date : December

Safety review of 900 MWe pressurized water reactors during their third ten-year inspection.
Publication date : December

Other

IRSN Barometer 2009 Perception of risks and safety.
Publication date : May

CAMARI aptitude certificate for operating industrial radiology equipment. 2008 Annual Report: organization, results and outlook. *Publication date : July*

2008 Technical and Scientific Report.
Publication date : July

2008 Report on Research Training.
Publication date : December

Summaries of the assessment reports submitted to the standing advisory groups in 2009 can also be downloaded from: **www.irsn.fr > rubrique Avis et rapports.** A complete list of these summaries can be found on page 28.

Activity: key figures

Research

45% of IRSN's budget is devoted to research (46% in 2008).

318 lectures at conferences (360 in 2008).

157 publications in JCR-listed journals (175 in 2008).

Technical support for public authorities

47% of IRSN's budget devoted to technical support (47% in 2008).

646 technical notices to the ASN (709 in 2008).

93 technical notices to the safety authority for defense-related activities (97 in 2008).

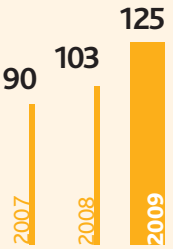
402 technical notices to the nuclear security authority (439 in 2008).

Training

2,417 hours of teaching given outside the Institute (universities, engineering schools, INSTN, etc.) (2,170 in 2008).

Human resources

Number of employees recruited on permanent contracts



» Average age

40.5 for women.
42 for men.

» Proportion of men/women

» Proportion of managerial/ non-managerial staff

61,293 hours of training given to maintain the skill levels of engineers and experts (48,357 in 2008).

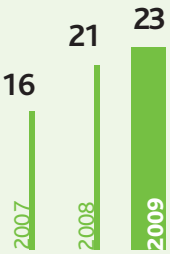
Service contracts

37.7 revenue (in millions of euros) (31,8 in 2008).

23,063 customers (21,449 in 2008).

Intellectual property

French patents in force (including 2 co-owned with CEA)

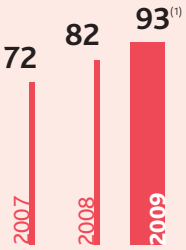


16 patents in force abroad (15 in 2008).

11 software applications and databases placed with the software protection agency APP (6 in 2008).

International activity

Number of international projects in progress



(1) Including 22 European projects.

187 bilateral agreements signed with research or assessment organizations from 36 countries (180 in 2008).

788 visits from foreign scientists (782 in 2008).

Dissemination of knowledge

1.7 million million visits to the IRSN website (1.1 in 2008).

234,000 visits to the scientific website (205 000 in 2008).

41 notices and reports published on the IRSN website (17 in 2008).

30 requests for IRSN action received from local information committees (40 in 2008).

16 IRSN operations at local information committees (20 in 2008).

2 IRSN publications (3 in 2008).

Locations (as of December 31, 2009)

North Region: 1,316 employees – Southeast Region: 328 employees

Budget breakdown

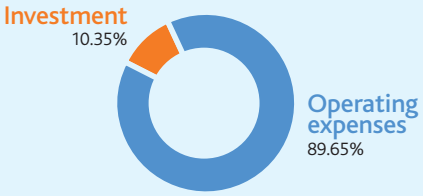
Revenue

€283 million (€255 million in 2008).

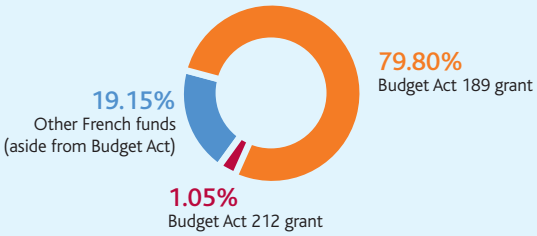
Expenditure

€301 million including €23 million for equipment investment (€281 million incl. €35 million in 2008).

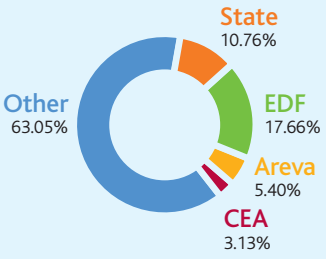
Operating and investment expenditure



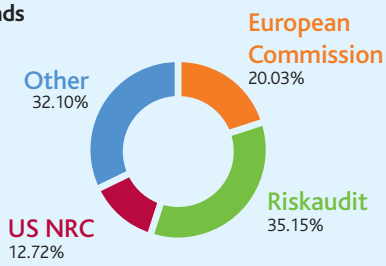
Total funding



French funds (aside from Budget Act)



Foreign funds



Organization chart

EXECUTIVE COMMITTEE (as of April 30, 2010)

The IRSN Executive Committee is chaired by the Director General and made up of 18 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.

> From left to right and from top to bottom:
Jean-Bernard CHÉRIÉ and Jean-Luc PASQUIER / Thierry CHARLES, Daniel QUÉNIART and Didier CHAMPION / Didier DEMEILLERS / Michel BRIÈRE and Jacques REPUSSARD / Jean-Bernard CHÉRIÉ and Jean-Claude MICAELLI / Alain CERNES and Michel SCHWARZ / Sylvie SUPERVIL / Denis FLORY and Bruno DUFER / Didier CHAMPION, Thierry CHARLES, Jérôme JOLY and Patricia DE LA MORLAIS / Marie-Pierre BIGOT, Patrick GOURMELON and Martial JOREL.

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

Alain CERNES,
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 EXTERNAL RELATIONS

Sylvie SUPERVIL, *Director*

> General strategy
> Contract of objectives
> Coordination and follow-up of liaison with supervisory authorities and main partners in assessment and research activities
> Medium- and Long-term Plan

INTERNATIONAL AFFAIRS

Denis FLORY, *Director*

> International strategy
> International business development

SCIENCE

Michel SCHWARZ, *Director*

> Assessment and scientific activities
> Scientific and technical knowledge engineering
> Scientific information resources
> Teaching and training in radiation protection, nuclear safety and security

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

Catherine ALBARET, *Accounting Officer*

Board of directors

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 report. It also approves the budget, decisions involving changes, year-end financial statements and income appropriation.

MAIN ACCOMPLISHMENTS 2009

- **Approval of strategy** regarding the future development of environmental radiological monitoring.
- **Adoption of general rules** on price policy applied by IRSN.
- **Review of IRSN's organizational** structure and general operating rules.
- **Launch of property restructuring project** for the Fontenay-aux-Roses site.

Members
(as of December 31, 2009)

> TEN GOVERNMENT REPRESENTATIVES

Jocelyne BOUDOT, Deputy Director of Environmental and Food Risk Prevention at the French Directorate General for Health, representing the Minister for Health

Régine BRÉHIER, Director of Research and Innovation, representing the Minister for the Environment

Mathieu DUFOIX, Head of the Energy, Profit-sharing, Industry and Innovation Office at the Budget Directorate, representing the Minister for the Budget

Jean-Denis COMBREXELLE, Director of Labor Relations, representing the Minister for Employment

Gabriele FIONI, Director of the DGRI A2 Department of the Directorate General for Research and Innovation, representing the Minister for Research

Patrick RENVOISÉ, Nuclear Safety Inspector for DGA, the French defense procurement agency, representing the Minister of Defense.

Marcel JURIEN DE LA GRAVIÈRE, Representative in charge of Nuclear Safety and Radiation Protection for Defense-related Activities and Facilities

Guillaume DEDEREN, Head of the Major Risks Office at the Directorate for Defense and Civil Security, representing the Minister for Civil Security

Stéphane NOËL, Head of the Nuclear Safety and Radiation Protection Mission

Thomas BRANCHE, Deputy Director for the Nuclear Industry, Directorate General for Energy and Climate, representing the Minister for Industry

> SIX ADVISORY MEMBERS

Agnès BUZYN, Chairperson, Board of Directors, physician and professor of hematology, nominated by the Minister for Health

Serge AUBERT, Air Force Major-General, nominated by the Minister of Defense

Claude BIRRAUX, President of the Parliamentary Office for the Evaluation of Scientific and Technological Choices

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 for Research

Jean-Claude DELALONDE, Chairman of the National Association of Local Information Committees, nominated by the Minister for the Environment

One advisory member yet to be nominated by the Minister for Industry

> EIGHT STAFF REPRESENTATIVES

Yves BRISSET,
CFE-CGC union representative

Nicolas BRISSON,
CGT union representative

François DUCAMP,
CGT union representative

Thierry FLEURY,
CFDT union representative

François JEFFROY,
CFDT union representative

Yves LE RESTE,
CFE-CGC union representative

Christophe SERRES, CFDT union representative

Carine STRUP-PERROT, CGT union representative

> EX OFFICIO OR ASSOCIATE MEMBERS

Bernard ABATE, Auditor General

Catherine ALBARET, Accounting Officer

Philippe BOURACHOT, Works Committee Secretary

Michel BRIÈRE, Deputy Director General in charge of Defense-related Missions

André-Claude LACOSTE, Chairman of the French Nuclear Safety Authority

Laurent MICHEL, Director General of Risk Prevention and Government Commissioner

Jacques REPUSSARD, Director General

4 MEETINGS
24 MEMBERS
5 YEAR MANDATE

Steering committee for the nuclear defense expertise division

Members
(as of December 31, 2009)

Emmanuel SARTORIUS, Chairman of CODEND, Senior Defense and Security Official at the Ministry for Industry

Georges-Henri MOUTON, Rear-Admiral, Nuclear Weapons Inspector

Rony LOBJOIT, Colonel, representing the administrative Secretary General of the Ministry of Defense

François REVARDEAUX, representing the Director of Strategic Affairs and Security at the Ministry of Foreign and European Affairs

Jean-Baptiste FLEUTOT, Chief Medical Officer of the French Armed Forces, advisory member appointed by the Minister of Defense

Marcel JURIEN DE LA GRAVIÈRE, 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

Serge POULARD, advisory member appointed by the Minister for Industry

Patrick RENVOISÉ, Engineer General for Armaments, representing the DGA, the French defense procurement agency

Mathieu DUFOIX, representing the Budget Director

Claude AZAM, Head of the Department of Defense, Security and Economic Intelligence, representing the Senior Defense and Security Official at the French Ministry of Energy

4 MEETINGS
11 MEMBERS
5 YEAR MANDATES FOR THE TWO ADVISORY MEMBERS

MISSIONS

The committee examines the activity program prepared by the Institute's Nuclear Defense Expertise Division before it is submitted to the 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.

MAIN ACCOMPLISHMENTS 2009

Review of defense and safety aspects of the following:
– DEND 2008 Activity Report and IRSN 2008 Annual Report;
– Medium- and Long-term Plan;
– DEND activity program for 2010.

Scientific council

MISSIONS

The Scientific Council gives an 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.

MAIN ACCOMPLISHMENTS 2009

- **The Scientific Council's assessment on "Material aging in reactors" (May 2009) was completed and presented.**
- **Two new assessments were launched:**
  – Risk assessment methods relating to ecosystems (June 2009),
  – Environmental monitoring strategy (October 2009). (octobre 2009).

Composition
(as of December 31, 2009)

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 Research Director, Radiation Protection Manager in the Curie Institute Research Division, 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, Nuclear Energy Division Task Officer at the CEA, nominated by the Minister of Defense

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

2 MEETINGS PER YEAR

12 MEMBERS APPOINTED FOR 5 YEARS

Nuclear Safety and Radiation Protection Research Policy Committee

Public authorities
> A representative of each supervisory ministry
> A representative of the ASN and of the Directorate General for Labor

Companies and professional associations
> Areva , EDF, Andra
> Professional associations: SFRO, SFRP

Employees in the nuclear sector
> One representative from each of the five representative national labor unions (CGT, CGE, FO, CFDT, CFTC)

Elected representatives
> Two representatives of the French Parliamentary Office for the Evaluation of Scientific and Technological Choices
> A local information committee chairperson
> Two municipal councilors from towns with a nuclear facility, proposed by the Association of French Mayors

Associations
> Five representatives of associations also represented on the High Committee for Transparency and Information on Nuclear Safety

Advisory members
> Chairman of the National Association of Local Information Commissions and Committees
> President of the High Committee for Transparency and Information on Nuclear Safety
> Chairperson of the IRSN Board of Directors (ex officio Chairperson of the Nuclear Safety and Radiation Protection Research Policy Committee)

Research organizations
> Five members appointed by the chief research organizations concerned: CEA, CNRS, INSERM, French Conference of University Presidents, Paristech

Foreign members
> Four members

Ex officio members
> Government Commissioner
> Atomic Energy High Commissioner
> Director General of IRSN
> IRSN Scientific Council Chairman

These persons participate in the committee's activities on an ex officio basis and in an advisory capacity

For full details of the membership of the Nuclear Safety and Radiation Protection Research Policy Committee, see the Appendix on page 96 or www.irsn.fr

2 MEETINGS

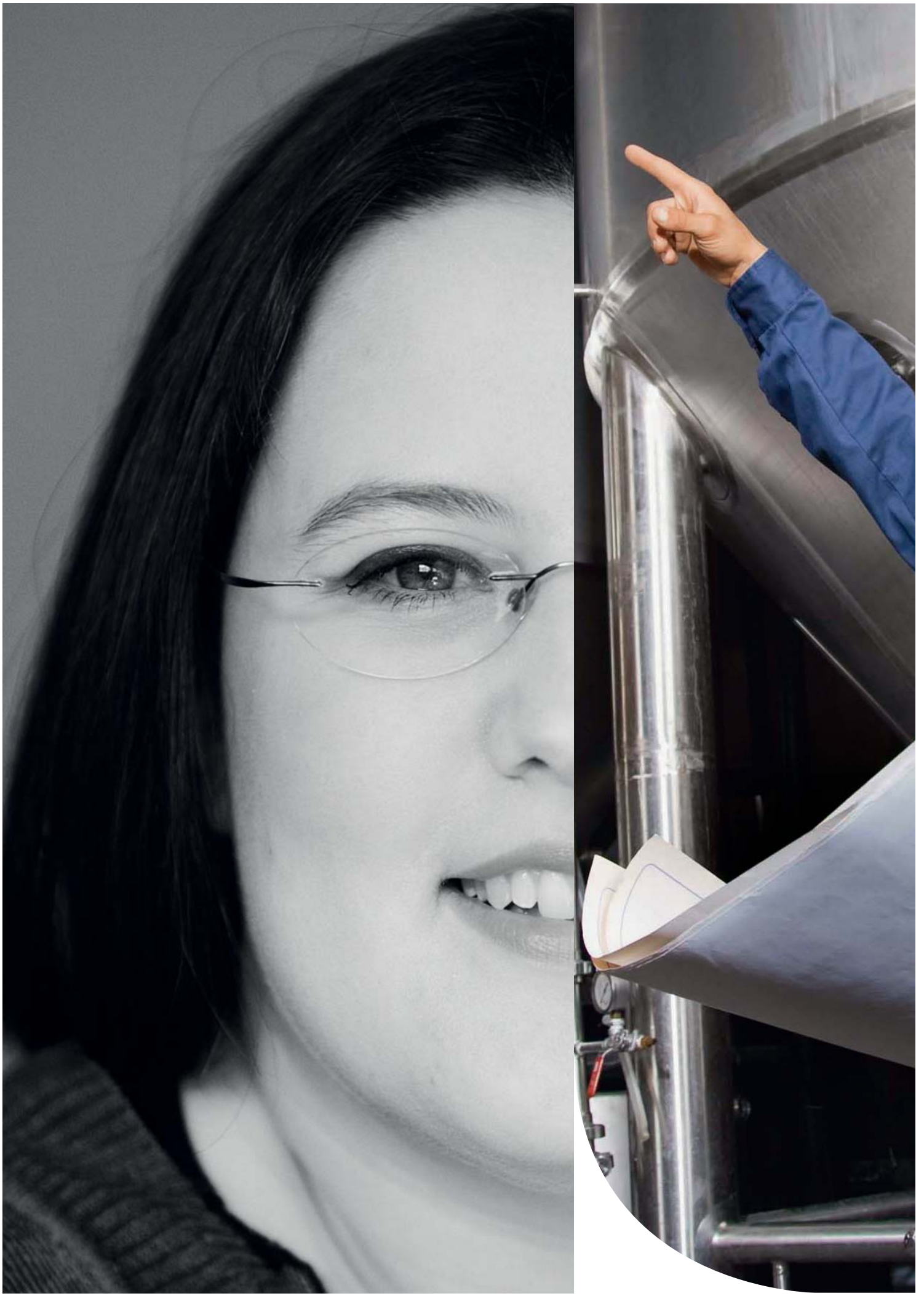
43 MEMBERS

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.

MAIN ACCOMPLISHMENTS 2009

- **March 26, 2009:** 1st COR meeting. A working group was set up to consider the impact of low-dose ionizing radiation on human health. The group is headed by Dietrich Averbeck, Research Director at CNRS and the SFRP representative, and Monique Sené, the representative of the Local Information Committees.
- **October 14, 2009:** 2nd COR meeting. A working group was set up to focus on the issue of extending the lifetime of existing nuclear reactors. The group is led by Claude Leteurtre, Member of Parliament for Calvados.



« Our constant effort to improve safety relies on our being able to compare points of view regularly with an independent expert, who has a watchful eye over the reliability of facilities and organizational structure. »

ANNE LAUVERGEON,
CHIEF EXECUTIVE OFFICER OF AREVA

STRATEGIC APPROACH

IRSN prepares to take up the challenges of a new era

For IRSN, 2009 was a pivotal year that saw the completion of the Contract of Objectives signed with the government for the period 2006-2009, and the preparation of the new contract for 2010-2013. The year was also marked by the creation of the Nuclear Safety and Radiation Protection Research Policy Committee (or COR), along with plans to create an International Affairs Division, reflecting a shift in the Institute's strategy. The COR has been set up to ensure that research responds to social concerns, while the International Affairs Division will set out to promote a French approach to nuclear safety and enhance IRSN's international profile.

Significant growth in international activities

IRSN's activity within the European Union centered on three priorities in 2009: work in favor of institutional frameworks, research, and training. Within this context, the Institute put forward a proposal for granting legal status to ETSON, the European Technical Safety Organization Network. In the research field, IRSN is now concerned chiefly with studying the effects of low-dose ionizing radiation on the body, through its participation in the DOREMI network of excellence, and with building the MELODI platform, which will support European research efforts in this area. In July, IRSN organized the second ETSON/JPS Summer School in Cadarache in the south of France. The event brought together 56 participants from five TSOs. The Institute was also a driving force behind plans to create ENSTTI, the European Nuclear Safety Training and Tutoring Institute, announced in Brussels at the EUROSAFE Forum on November 2-3, 2009.

In the area of multilateral activities, IRSN provided the French Government with assistance in checking the observance of international treaties. This entailed providing mission support and examining reports submitted to the IAEA by the parties to these treaties. IRSN's Director General was appointed Chair of the OECD Nuclear Energy Agency's Committee for the Safety of Nuclear Installations (CSNI).

In line with its clearly stated intention to contribute to efforts to improve safety around the world, the Institute responded to invitations to tender issued by governments interested in developing or stepping up nuclear power programs (including the United Arab Emirates, Jordan, Egypt, China, Belgium, and the United Kingdom). Contracts have already been signed with Egypt and the UAE. Lastly, the European Commission signed a framework agreement with IRSN, in association with GRS. Under the terms of the agreement,

IN THE WORDS OF

GUY CLAPISSON, CEO of NNR, South Africa's National Nuclear Regulator

In keeping with its nuclear energy development policy, South Africa is planning to build a number of new power plants and fuel cycle facilities over the next ten years to increase its nuclear power capacity. Within this context, NNR will be turning increasingly to technical support organizations, both at home and abroad. Support will be sought, for example, for building reactors or fuel cycle facilities on existing or new sites, and for acquiring additional regulatory control expertise through training. IRSN has been providing NNR with technical assistance in a number of areas for several years now. Last year, for example, it helped with work on modifying overpressure protection on the reactor coolant system at the Koeberg plant, examining NNR's severe accident management baseline, and investigating fuel cladding defects detected by Eskom, the South African electricity utility. In addition to fast response and strong involvement, IRSN's experts give us the benefit of their extensive and invaluable knowledge of French nuclear facilities, which are very similar in design to ours. That's why we believe we will be looking to IRSN for increasing support over the coming years."

Determining the distribution of uranium in individual cells helps to understand its impact on human health.

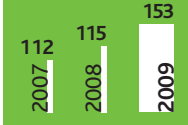
IRSN will allow European nuclear safety authorities access to its operating experience feedback concerning nuclear reactors. Looking at the longer term, the Institute continued its prospecting activities, particularly in China. It contacted many nuclear safety and radiation protection institutes and prepared a joint research program with its Chinese counterpart, NSC.
The new International Affairs Division to be created at the beginning of 2010 will make for greater consistency in the Institute's international activities and enhance its profile on the world stage.

IN THE WORDS OF

DENIS FLORY, IRSN's Director of International Affairs

At a time when nuclear energy is seeing renewed growth, an effort must be made to promote nuclear safety in all countries that seek to acquire or develop the means to produce nuclear electricity. As a key player in the field of nuclear safety and radiation protection, IRSN endeavors to ensure that all its activities – particularly at the European and global levels – make constant progress in terms of consistency, credibility, and visibility. This ambition is reflected in the recent creation of an International Affairs division, regrouping the International Relations and International Development departments. The new division is the main contact for Riskaudit, the European Economic Interest Grouping created with GRS, ETSON, the European Technical Safety Organizations Network, and, in the near future, for ENSTTI, the European Nuclear Safety Training and Tutoring Institute. The new division will also contribute to the Institute's activities to support action by the State. Two priorities have been defined: a) promoting safety, security and radiation protection culture around the world through cooperation and training, and b) providing services on a commercial basis to share the Institute's experience and know-how."

90 HUMAN RESOURCES DEVOTED TO INTERNATIONAL ACTIVITIES (in man-years) (85 in 2008).



OPPORTUNITIES FOR IRSN TO PARTICIPATE IN INTERNATIONAL EXPERT GROUPS.

IRSN rethinks research governance

The quality of tomorrow's assessment activities is built on the relevance of today's research. Making sure that activities relating to assessment and research are consistent has thus become central to IRSN's strategy, as reflected in the Contract of Objectives for 2010-2013. With this in mind, the Institute has created an advisory body to its Board of Directors, called the Nuclear Safety and Radiation Protection Research Policy Committee or COR. The committee's task is to ensure that research meets assessment requirements in all areas. The Institute has also renewed its Animal Experimentation Ethics Committee.

In preparation for an evaluation by AERES, the French agency for evaluation of research and higher education, scheduled for 2010, IRSN has created an inspection committee that will work with its Scientific Council to examine all the Institute's R&D programs over a period of four years. With an eye to the future, it is consolidating its ties with the academic research world to set up cooperation programs in specially targeted areas. In 2009, it made an inventory of graduate schools and university centers working in fields connected with its activities. It also opened its "Dissertation Days" to partner universities, and stepped up its training-through-research activities with 33 new dissertations. The various fields of research in which IRSN was involved in 2009 testify to the diversity of its assessment activities. To mention just a few examples, it took part in a working group set up by the Minister for Research to intensify toxicology-ecotoxicology studies, and chaired an international working group on research into Generation IV reac-

Research must meet future assessment requirements.

RESEARCH IN THE FIELD OF NUCLEAR SAFETY AND RADIATION PROTECTION: IRSN SETS UP A RESEARCH POLICY COMMITTEE

The IRSN Nuclear Safety and Radiation Protection Research Policy Committee – or COR – was set up to ensure that the Institute's research activities in these areas are relevant to requirements. Its members come from many backgrounds, and thus approach issues from various angles. This helps guarantee that the selected research topics meet the requirements of public authorities and live up to society's expectations. The committee advises IRSN's Board of Directors on research objectives and priorities. Its work thus complements the activities of the Scientific Council, which assesses the quality and relevance of the Institute's research programs and outcomes from a scientific perspective.

The committee held its first meeting, chaired by Agnès Buzyn, on March 26, 2009. IRSN took this opportunity to present its research strategy, with a focus on two particular topics: safety issues related to nuclear fuel developments, and the health effects of low-dose ionizing radiation.

A working group, led jointly by Dietrich Averbeck, Research Director at CNRS and the SFRP representative, and Monique Sené, the representative of the local information committees, was set up to address the second of these two issues.

In 2010, the group will organize an investigation, based on hearings of national and international experts, to obtain a multidisciplinary view of the Institute's medium-term research priorities, taking into consideration the international state of the art, its foreseeable assessment requirements, and concerns expressed by civil society and the public authorities.

During its second meeting, held on October 14, the committee examined two key safety issues: the possibility of extending the lifetime of reactors currently in service, and radioactive waste management.

The second of these issues calls for further research to increase knowledge and find answers to society's repeatedly expressed concerns. Once the various stakeholders had put forward their views concerning research priorities, a second working group was set up, under the leadership of Claude Leteurtre, Member of Parliament for Calvados. The group has been asked to examine the question of significantly extending the lifetime of nuclear facilities and the long-term effects of this on plant safety. It must submit a multidisciplinary opinion to IRSN's Board of Directors during the first half of 2011 to help optimize research priorities in this area.

tor safety for SNETP, Europe's Sustainable Nuclear Energy Technology Platform.
IRSN continued to explore several other areas as part of an initiative to optimize its international research strategy, which is built largely on shared access to large-scale research facilities. Examples of this included research into material and fuel behavior at the CEA facilities in Cadarache, and the study of criticality risks relating to future fuel management methods. This work is carried out at the CEA Valduc research center, which is soon to be renovated.

New framework agreements to promote closer cooperation in assessment activities

In 2009, IRSN stepped up initiatives to sign contracts with its various partners to formalize their relations. This is consistent with its efforts to carry out its radiological and nuclear risk assessment activities under optimum conditions. Two framework partnership agreements on safety and radiation protection in the medical field were signed within this context, one on September 23, the other on September 29. The first agreement, signed with INCA, the French National Cancer Institute, concerns training schemes organized as part of the Minister for Health's "radiotherapy roadmap", and will allow IRSN to enhance the safety of medical treatment involving the use of ionizing radiation. The agreement also covers experimental research into the health effects of low-dose ionizing radiation, and is concerned with preventing complications in radiotherapy. The two institutes will now be able to issue joint requests for research proposals in these areas. The agreement signed with DGS, the French General Directorate for Health, seals the long-standing cooperation between the two organizations. Under the agreement, IRSN will provide technical support for analyzing radiological events, incidents, or accidents, and will help draft regulatory documents. It also signed a quality charter on referrals with CASA, the health agency networking committee of the Ministry for Health (IRSN is a committee member) and is involved in a number of working groups under the committee's supervision. Other agreements came into effect in 2009, such as those signed in the environmental field with the Directorate General for Energy and Climate (DGEC), part of the Ministry of Ecology, Energy, Sustainable Development, and the Sea, under which IRSN provides the DGEC with support for monitoring the OSPAR Convention for the Protection of the Marine Environment of the North-East Atlantic. Further examples are the agreements signed with Météo-France concerning the transmission and exchange of climatological data used, in particular, for emergency management and operational monitoring of nuclear material transport.

Radiation protection is constantly changing in the healthcare sector.

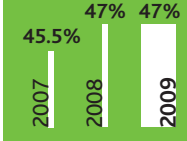
IN THE WORDS OF

FRANÇOISE QUINTIN-COLONNA,
Professor, and Chairperson of the Animal Experimentation Ethics Committee

Animal experiments involve some sensitive ethical issues that concern not only the justification for the protocols employed, but, more importantly, raise the question as to whether the experiments are needed at all. Justifying the need for experiments that inflict pain on animals, and often lead to their being euthanized, clearly requires serious thought, strong convictions, and the total lack of bias guaranteed by voluntary status. While the committee I chair at IRSN is, like any other ethics committee, an advisory body, it nonetheless plays a major role in governance. Any experimenters choosing to ignore the committee's opinion would run the risk of seeing their work rejected by their superiors and turned down for publication in scientific journals that check that the protocol used has been approved by the committee. The committee is not, however, a jury, let alone a court. It is there to think matters through and help experimenters answer three questions: what purpose does my experiment serve? Is there an alternative? And, if not, what protocols are most compatible with concerns for animal rights?"

Transparency – the key to progress in nuclear safety and radiation protection

In its Charter on Openness to Society published in April 2009, IRSN made a number of commitments. These include making its research and assessment activities more transparent, sharing knowledge, and helping stakeholders in society to understand and assess risks. Openness to society was presented as a strategic issue in the Contract of Objectives 2006-2009, and this will be reasserted in the new contract, for the Institute can only drive progress in nuclear safety and radiation protection if the public is fully aware of all the issues involved.
Following on from the proposals put forward by Georges Mercadal, former Vice-Chairman of the French National Commission on Public Debate, in response to a request from IRSN aimed at making the Institute more open to society, techni-



SHARE OF IRSN BUDGET ALLOCATED TO TECHNICAL SUPPORT AND PUBLIC SERVICE MISSIONS.

cal talks also began with the safety group of ANCCLI, the French national association of local information commissions and committees. A public meeting should be held in 2010 to present IRSN and ANCCLI findings. A similar process has been set up with the local information committee of Areva's La Hague plant for a dismantling project.
The Institute has also involved representatives of CLIGEET, the local information committee on the major energy facilities at Tricastin, in monitoring progress in a study to determine the reasons for the presence of uranium in the ground water at Tricastin in the south of France. The study was initiated jointly by Areva and the Drôme and Vaucluse local health and social services departments (DDASS), following an incident in the summer of 2008 in which uranium-bearing effluent was released from the Socatri plant. The initial findings of the study were presented to CLIGEET in November 2009.
IRSN organizes a number of targeted initiatives – aimed particularly at schools – to share as much knowledge acquired over the years as possible. Among these initiatives, the *Rencontres lycéennes de la radioprotection,* or radiation workshops in schools, involved several French and foreign high schools in 2009, and teaching tools were designed to introduce students to various notions of radiation protection.
The Institute is fully aware that transparency alone cannot answer all of society's concerns. It therefore helps stakeholders, such as local information committees, ANCCLI or the Metropolitan Community of the Montbéliard Region, to gain access to

REPORT SUMMARIES THAT CAN BE DOWNLOADED ON: www.irsn.fr > NOTICES AND REPORTS

IRSN prepares assessment reports as part of its technical support activities for ASN, the French nuclear safety authority, and submits the conclusions of these reports to the authority's standing advisory groups, whose task it is to submit opinions and recommendations to guide the authority in its decisions concerning nuclear safety and radiation protection. In keeping with its policy of increased openness, IRSN reached an agreement with ASN in 2009 to make summaries of these assessment reports available for consultation on its website. An example of this is the report on the safety review of 900 MWe reactors, in preparation for their third ten-year inspection (VD3 900).

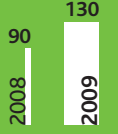
Reports submitted to the standing advisory group for reactors (GPR)	Publication date
Summary of the IRSN report on the safety review of the CABRI facility and the installation of the new pressurized water loop	May 2009
Summary of the IRSN report on the conclusions of the safety review conducted by EDF as part of the third ten-year inspection of 900 MWe reactors	July 2009
Summary of the IRSN report on certain aspects of severe accidents liable to occur in pressurized water reactors at plants currently in service	July 2009
Summary of the IRSN report on waste management at nuclear power plants currently in service, and on related radioactive and chemical release	October 2009
Summary of the IRSN report on instrumentation and control architecture and platforms for the EPR reactor under construction at Flamanville	November 2009
Summary of the IRSN report on countermeasures to be implemented to prevent contamination of ground water in the event of core meltdown on pressurized water reactors at plants currently in service	December 2009
Summary of the IRSN report on the radiological impact of accidents (except core meltdown accidents) liable to occur on pressurized water reactors at plants currently in service and on the EPR	December 2009
Reports submitted to the standing advisory group for transport (GPT)	
Summary of the IRSN report on the safety of the TN 117 waste package model	December 2009
Reports submitted to the standing advisory group for laboratories and plants (GPU)	
Summary of the IRSN report on the preliminary safety analysis report for ICEDA, the activated waste conditioning and storage facility planned for EDF's Bugey site in eastern central France	February 2009
Summary of the IRSN safety and radiation protection report for the CEA/Saclay solid radioactive waste management zone in the Greater Paris region	April 2009
Summary of the IRSN safety and radiation protection report for STAR, the treatment, cleanup and reconditioning facility on the CEA Cadarache site	August 2009
Reports submitted to the standing advisory group for radiation protection in medical and forensic applications of ionizing radiation (GPMED)	
IRSN/SFPM/SFRO working group report: *Mesure de la dose absorbée dans les faisceaux de photons de très petites dimensions utilisés en radiothérapie stéréotaxique ("Measuring absorbed dose in very small photon beams used in stereotactic radiotherapy").*	July 2009

© AREVA / Jean-Marie TAILLAT

General view of the Tricastin site in the south of France, where IRSN carried out a study to determine the reason for the presence of uranium in the groundwater under the site. The initial findings of the study were submitted to the CLIGEET in November 2009.

the information they need to grasp all the issues involved, and carries out a number of joint studies with them. For example, a pilot initiative for monitoring environmental radioactivity in the Loire basin, carried out with local information committees in the region, was completed in 2009. The joint report was widely circulated and the results shared and discussed with the representatives of local information committees throughout the country during a seminar in June 2009.

IRSN also contributes to various initiatives at the European level, such as the work it does for the *Cowam in practice* program, an EC-backed initiative to reinforce governance and transparency in decision-making processes concerning radioactive waste management. Lastly, the Institute is involved in the efforts of ANCCLI and HCTISN (the high committee for transparency and information on nuclear safety) to apply the provisions of the Aarhus Convention to the nuclear waste field. In this respect, IRSN works to enhance the technical skills of local stakeholders and fulfills an educational role in the field to ensure that the communities concerned can build their opinions on reliable technical knowledge.



NUMBER OF STUDENTS TAKING PART IN *RENCONTRES LYCÉENNES DE RADIOPROTECTION* (RADIATION PROTECTION WORKSHOPS IN SCHOOLS).

IN THE WORDS OF

PIERRE MOSCOVICI, President of the Metropolitan Community of the Montbéliard Region

A radiation protection project in a region that has no nuclear facilities might, at first glance, seem surprising, but a closer look shows that it is justified on several accounts. First, distance can be less important than wind direction in the event of a nuclear accident, and Fessenheim is only 70 km away. Second, as alternating president of Belfort-Montbéliard hospital (CHBM), I am particularly aware of radiodiagnosis and radiotherapy issues. This is largely because the oncology-radiotherapy department at CHBM has been working on ways to optimize doses delivered to patients for about ten years now. Last, the Doubs area is among the most highly exposed areas in France with regard to the radon hazard. In this context, there is no doubt as to the need for local expertise, working in conjunction with national and international expertise, available on demand. This is where our cooperation with IRSN truly comes into its own, whether we are looking at the educational exhibition "Did you say radiation protection?", the initiatives to prepare a regional response to radiological hazards by implementing contamination-simulating software applications in the geographical information system of the Metropolitan Community of the Montbéliard Region, or training and research activities carried out for doctoral thesis under joint IRSN/university supervision."

GOVERNMENT/IRSN CONTRACT OF OBJECTIVES

Outcomes for 2006-2009

The first Contract of Objectives (COB) between the Government and IRSN, signed on July 5, 2006 by the Institute's five supervisory ministers, defined the overall strategy adopted by the Institute to conduct its activities, and gave a detailed description of its main scientific and technical goals, in the absence of a medium- and long-term plan. The year 2009 marks the completion of the contract term and thus provides an ideal opportunity to take stock of results so far.

Governance and management policies and tools

In keeping with its commitments, IRSN set up a Medium– and Long-term Strategic Plan, upgraded its cost accounting system, and consolidated its major budget balances. It signed contracts to formalize relations with its institutional and research partners and respond more effectively to the significant growth in activity in this area. It also upgraded the range of services it offers. For example, it modernized its passive dosimetry services for workers, and developed training schemes, targeting radiation protection professionals in particular.

Regarding human resources, IRSN delivered on its commitments by setting up a management system that allows it to forecast requirements for jobs and skills, signing an agreement on managerial staff salaries, creating an "experts" sector, and signing a charter on inter-organization staff mobility.

The Institute's total quality management system, which resulted in ISO 9001:2000 certification on July 11, 2007, reflects its commitment to a continuous improvement approach.

Lastly, a Property Master Plan was drawn up. Under this plan, the Institute's teams have been grouped together around the new head office in Fontenay-aux-Roses, near Paris, and a number of the buildings owned by the Institute have been renovated and brought in line with regulations.

Exploratory research projects were stepped up in 2009.

Increasing knowledge and optimizing research and design tools

IRSN has set up partnerships with a number of organizations in France (CNRS, Ifremer, universities, and the army health service) and abroad to ensure constant access to state-of-the-art scientific and technical knowledge. It helped in a coordinator capacity to set up and operate international scientific networks like SARNET, the European network of excellence on severe reactor accidents, and the High-level Expert Group on European Low-dose Research, which focuses on the health effects of low-dose ionizing radiation. After consulting its supervisory ministries and partners (CEA, Areva, EDF), IRSN took some concrete decisions regarding the future of the large-scale facilities used for its research programs. Concerning scientific policy, it developed training through research, and

The Nuclear Safety and Radiation Protection Research Policy Committee held its first meeting on March 26, 2009.

set up a method for selecting and funding exploratory research projects. In addition, it formalized internal procedures for evaluating its research activities from the scientific perspective and, at the request of the Ministers for Ecology and for Research, set up a Nuclear Safety and Radiation Protection Research Policy Committee (COR). This committee is open to various stakeholders and serves to ensure that the Institute's research programs are relevant. It also makes recommendations to the Board of Directors on objectives and priorities.

Optimizing and diversifying technical support for the public authorities

Optimizing technical support for the public authorities is a key factor in IRSN's overall strategy, and a number of joint annual work programs were set up to meet requirements in this area. Practical procedures were also defined for the examination of certain specific topics, mostly with ASN and the Representative in charge of Nuclear Safety and Radiation Protection for Defense-related Activities and Facilities.

Over the period covered by the contract, the number of agreements signed with government departments (e.g. Directorate General for Risk Prevention, Directorate General for Labor, Senior Defense and Security Official) and institutional organizations (AFSSET, INRS, InVS) that receive technical support from IRSN has risen by more than 60%. The Institute also widened the scope of its technical support activities. The agreement signed with DGAL, the directorate general on food safety, is one of the most recent examples of this, and accompanies IRSN's designation as a national benchmark laboratory for measuring radioactivity in food products.

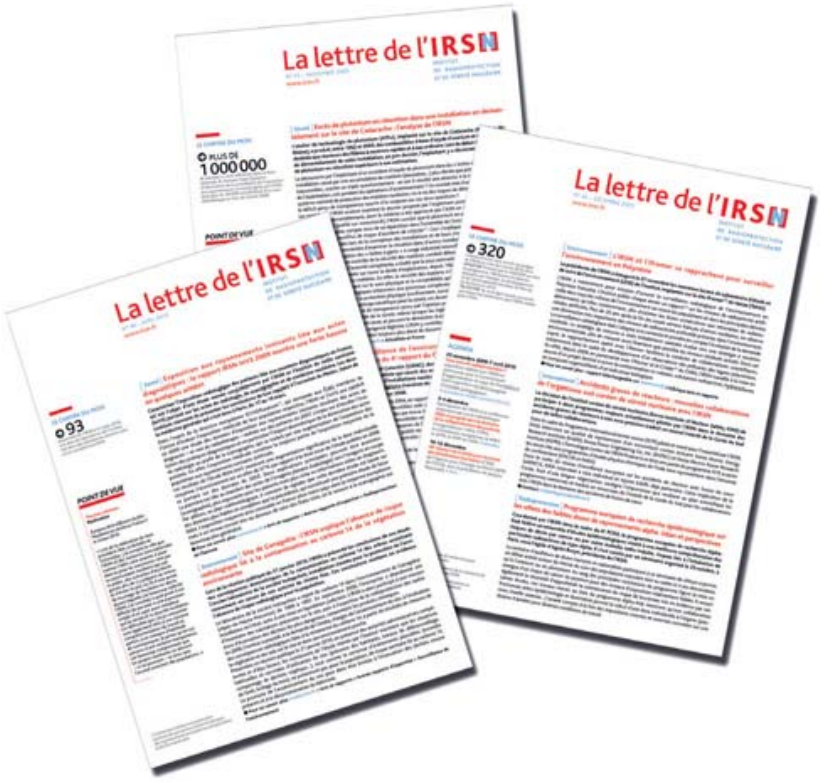
Significant growth in international activities

Developing IRSN's research and assessment activities on the global stage was one of the priorities defined in the first Contract of Objectives. This can be seen in the growth of technical cooperation activities, with 187 agreements signed with 97 organizations from 36 countries, including China, the USA, Japan, and Russia, and in the development of the European Technical Safety Organisations Network. Known as ETSON, this network was set up to standardize European nuclear safety practices and promote scientific and technical cooperation among its members. IRSN also helped develop ENSRA, the European Nuclear Security Regulators Association. Lastly, it took part in a number of studies, for the IAEA in particular, during the contract period.

Promoting transparency and openness to society

IRSN's efforts to promote transparency and make its work more accessible to social stakeholders were reflected in an inter-institute Charter on Openness to Society signed with AFSSET and INERIS. Within this context, the Institute consolidated its partnership with the local information committees and ANCCLI, their national association, chiefly through a number of concerted actions. At the request of the public authorities, it also took part in pluralistic expertise groups and, with the assistance of the French National Commission on Public Debate, conducted an in-depth study on ways of opening up to society even further.

As part of its policy on transparency, the Institute also created various news and information media over the contract period, including a bulletin intended for both an in-house and external audience, and a monthly newsletter for the supervisory ministries, members of parliament, and IRSN's institutional partners. Every year, hundreds of thousands of people connect to IRSN's website, www.irsn.fr, especially when events relating to nuclear safety and radiological hazards draw the public's attention, and the website is becoming increasingly important as a source of information. The public can now connect to the website to consult summaries of the reports IRSN submits to ASN's standing advisory groups.



IN CLOSE-UP: PREPARING THE GOVERNMENT/IRSN CONTRACT OF OBJECTIVES FOR 2010-2013

With the first Contract of Objectives scheduled to finish at the end of 2009, IRSN began to make preparations for its second contract as of late 2008. This involved setting up an internal project management structure and organizing regular talks with representatives of its five supervisory ministries.

The Institute based these preparations for the new contract on the specifications of the supervisory ministries, and on experience from the annual progress reports on objectives set for the previous contract, which the representatives of the supervisory authorities considered too detailed. One or more indicators will therefore be assigned to each objective. The indicators will be associated with targets and selected to simplify contract performance monitoring.

The new contract will be built around four strategic lines of improvement: research and scientific excellence, support for public authorities and the government and assessment services for other customers, openness to civil society, and international activities. It will incorporate a number of specific objectives regarding the management of the Institute as part of a continuous and sustainable improvement initiative.

Production as dynamic as ever

During the four years of the first Contract of Objectives, IRSN's research and assessment activities produced important results in many areas, including some significant research progress, as well as essential work in assessment and reinforced support in the public service arena. Examples of these activities are given in the Institute's annual reports.

COB 2006-2009: A FEW INDICATORS

		2006	2007	2008	2009
Assistance and technical support	Number of technical notices to the safety authorities in the civil and defense-related sectors	800	853	806	739
	Number of reports prepared for standing advisory group meetings or expert committees on reactors, plants and waste	22	21	15	15
	Nationwide emergency exercises	15	13	12	8
	Number of nuclear material inspections	172	171	196	171
	Number of technical notices to ASN	311	440	439	402
Public service regulatory activities	Number of workers monitored by external dosimetry systems	155,583	154,081	155,494	159,568
	Number of radiation protection training sessions	55	104	139	192
	Number of sampling points throughout the country	600	600	600	600
Research and scientific excellence	Number of international reference publications (in JCR listed journals)	122	123	175	157
	Number of ANR-funded projects	4	7	13	10
News and information	Media: Number of press releases	9	25	35	25
	Media: Number of press requests processed	230	200	270	173
	Public at large: Internet – Number of requests for information received through the contact@irsn mailbox	761	936	1,148	959
Education and vocational training	Continuous vocational training: hours of training	725	2,123	2,615	3,173
	Continuous vocational training: number of trainees	899	1,629	1,977	3,271
	Introductory training: hours of teaching	700	1,100	1,384	2,417
Activities relating to civil society	Number of actions at local information committee meetings	10	10	20	16
International activities	Number of agreements	112	143	180	187
	Number of organizations concerned	66	77	94	97
	Number of countries concerned	31	33	36	36
Human resources	Training effort (% of payroll)	4.4	4.4	4.6	5.76
	"Expert" sector created in 2006 – Number of experts	29	48	48	68
Scientific and technical excellence	Number of doctorate students(1)	79	85	86	85.5
	Number of post-doctorate students(1)	26	31	35	28
	Number of patents filed	2	3	2	1
Quality	Number of "quality reviews"	–	30	26	26
	Number of audits performed	19	35	32	19

(1) Expressed in full-time equivalent terms.

« Factoring safety and radiological protection from the very beginning of any R&D project is an absolute necessity. As a member of the European Technical Safety Organisations Network, IRSN provides in this respect a major contribution to European R&D projects. »

RAUNO RINTAMAA, VICE-PRESIDENT, ENERGY, VTT BUSINESS SOLUTIONS, AN ETSON MEMBER

Helping to ensure a high level of safety and radiation protection at existing facilities until the end of their life.

SAFETY AT EXISTING FACILITIES

Strengthening the connection between research and assessment activities to improve safety

Fully understanding the physical and chemical phenomena at work during the operation of civil nuclear reactors, laboratories, and plants such as waste disposal facilities, enables a more effective assessment of the safety of these facilities on behalf of the public authorities. The year 2009 was notable not only for the diversity of safety issues examined by the Institute, particularly regarding the construction of new reactors – the EPR in Flamanville, the Jules Horowitz Reactor (RJH) in Cadarache, and the new-generation VVER in Belene in Bulgaria – but also for the implementation of new industrial processes. Other activities included research on new transport packages, aging, and the decommissioning and dismantling of old reactors such as Phénix, Saint-Laurent-des-Eaux A1 and A2, and Chinon A3. As part of its technical support to the Representative in charge of Nuclear Safety and Radiation Protection for Defense-related Activities and Facilities (the DSND), IRSN also assessed the safety of military nuclear systems, basic nuclear installations, and defense-related transport.

Waste treatment control room in the nuclear auxiliary building.

1 – MONITORING FACILITIES AND TRANSPORT

To support the French Nuclear Safety Authority, IRSN examines documentation concerning safety and radiation protection for reactors, fuel cycle facilities, and the transport of radioactive materials.

Nuclear power reactors

Managing effluent and release from nuclear power plants

The year 2009 saw the completion of IRSN's assessment of the material, procedural, organizational, and documentary provisions implemented or being considered by EDF for managing effluent and release from nuclear power plants under normal operating conditions. The assessment was carried out with a view to reducing effluent and release.

On May 28, 2009 IRSN presented its conclusions to the competent standing advisory group to ASN.

The Institute found that the provisions presented by EDF were effective overall. IRSN's investigation showed, however, that improvement was required in certain aspects of effluent and release management. For example:

– providing for operating experience feedback that can be used to estimate the volumes and characteristics of effluent produced during periodic and recurring operations that contribute significantly to effluent production;

– performing "material balances" on sites to keep track of the quantities of chemicals entering and leaving the facility, and thus detect any abnormal release *(also see box on page 38)*.

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15 REPORTS
PREPARED FOR MEETINGS OF STANDING ADVISORY EXPERT GROUPS OR COMMISSIONS FOR REACTORS, PLANTS, AND WASTES (15 in 2008).

IRSN's experts are closely involved in work on the Flamanville construction site.

Reviewing EPR design and monitoring construction work

In 2009 IRSN carried out a detailed design review of the EPR under construction on the Flamanville site near the Channel in Normandy. Responding to a request from ASN, at a meeting of the competent standing advisory group to ASN, IRSN presented a report on instrumentation and control architecture and platforms on June 18, 2009.

The technical investigation of these matters, made especially complex by the designer's extensive use of computerized equipment, not only identified arrangements that help to make the I&C system more robust, but also led IRSN to point out several items calling for changes or more detailed supporting material. In particular, additional provisions for improving the system's robustness were recommended.

The conclusions of IRSN's assessment are broadly consistent with those of the Finnish and American authorities in this area: the differences noted arise mainly from differences in regulatory and industrial contexts. This led to the publication by the French, Finnish, and British authorities of a joint statement on the design of the instrumentation and control system in November 2009.

Monitoring reactor construction is essential, because the safety demonstration ultimately depends on the characteristics of the facility as built. IRSN is closely involved in monitoring the construction of the reactor on the Flamanville site. During 2009 its experts took part in every one of ASN's onsite inspections, which mainly concerned civil engineering aspects. The Institute detected a certain number of nonconforming items, such as problems with the welds in the metal liner of the reactor building and construction joints. IRSN is involved in examining deviations in construction quality and assessing the corrective measures taken by EDF.

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OPENNESS TO SOCIETY

TECHNICAL DISCUSSIONS WITH ANCCLI ON SAFETY REVIEWS FOR 900 MWE REACTORS

In April 2009 IRSN and ANCCLI's "standing advisory group on safety" engaged in a technical discussion on the general question of 900 MWe reactor safety reviews. This is one of the "test cases" initiated by IRSN to follow through with the recommendations of the advisory mission carried out by Mr. Mercadal, the Vice-Chairman of the French National Commission on Public Debate and appointed by the Commission, on "the procedures to be implemented to reinforce the transparency in IRSN's work".

In preparation for the public meeting, technical meetings were held in 2009, in which representatives of the local information committees involved took part. The proposed objective is to organize a public meeting with ANCCLI in 2010, during which EDF, IRSN, and ANCCLI will be set out and discuss their respective positions.

The broader objective is to allow any local information committees interested to take advantage of the lessons learned from this generic work for use in examining future safety review documentation.

The Belene plant in Bulgaria will be equipped with 3 VVER reactors.

IRSN carried out an assessment of operator training at the PHENIX reactor.

Safety analysis for the Belene power plant project

In November 2009, IRSN and its German partner, GRS, acting on behalf of their joint subsidiary Riskaudit, presented the Bulgarian Nuclear Regulatory Authority with its Intermediate Safety Analysis Report (ISAR) concerning the future nuclear power plant in Belene. In 2005 the Bulgarian Republic's Council of Ministers approved the construction of two new-generation VVER-type nuclear power plants on the Belene site.

Construction was conditional, however, on the performance of an independent assessment of the ISAR. In their assessment, IRSN and GRS checked that the ISAR complied with IAEA recommendations, the special conditions imposed by Bulgarian national regulations, and good international practice. The assessment was carried out in three stages over one year: the actual assessment leading to an interim report, a detailed study phase on topics such as large-break loss-of-coolant accidents, severe accidents, and radiation protection, and lastly, a summary phase leading to recommendations for action.

The working method can be duplicated for use in any similar international service contract.

Research reactors

Final test campaign for the Phenix reactor

As part of the research program on fourth-generation nuclear reactors, a large-scale test campaign was conducted on CEA's Phenix fast reactor in 2009.

Having endorsed the relevance and the safety principles of this test program in 2007, IRSN assessed the safety of each individual test in 2009. The assessments adopted the defense-in-depth concept, a fundamental and internationally recognized approach. They involved checking that safety conditions at the facility were maintained at a satisfactory level during the tests, that a special test organization had been set up, and that operators in charge of the tests were properly trained.

INTERNATIONAL

CONSIDERATION OF SANDSTORMS IN NUCLEAR POWER PLANT SAFETY ANALYSIS

In 2009, IRSN conducted a study on sandstorms and duststorms, and their effects on nuclear power plant safety, at the request of the United Arab Emirates. Sandstorms and duststorms can present hazards for industrial facilities located on the edges of deserts. They could have a lasting, sometimes serious, effect on nuclear power plant operation: clogging pipes and vents, blocking emergency exits, and interfering with the operation of electric generators and electrical and electronic equipment. They must therefore be taken into account during design studies and safety analyses.

IRSN's study comprised three phases: detailed investigation of the characteristics of these events, analysis of the possible impact on plant safety, and compilation of a list of sensitive points to be considered during safety analysis work.

They led the operator to make changes in the control of certain tests. They also revealed a need fuel behavior in accident situations.

Fuel cycle

Safety of laboratories and plants

For laboratories and plants, the year 2009 was marked by the examination of three safety review reports on behalf of the public authorities. Ten-year safety reviews are specifically intended to take into account operating experience feedback and aging of facilities, which undergo numerous inspections during these review periods.

On June 24, 2009, IRSN presented the conclusions of its assessment of the safety review documents on the treatment, cleanup and reconditioning facility (STAR), an extension of LECA, the active fuel study laboratory, to the competent standing advisory group to ASN.

This concerned CEA's Cadarache center in the south of France. The presentation also concerned the Institute's opinion on the forthcoming changes in operation, as a preliminary to reconditioning operations on new types of fuel. On this basis, the standing advisory group approved the continued operation of this facility.

IRSN also performed an assessment of the safety review documents for CASCAD, a dry storage facility for irradiated fuels.

In addition, the Institute issued report on the safety review of the solid radioactive waste management zone at the CEA Saclay site in the Greater Paris region, taking into account the fact that this facility is to be decommissioned in ten years.

The Institute found that in these circumstances the safety provisions adopted for operating the facilities were appropriate. On February 4, 2009 IRSN's conclusions were presented to the competent standing advisory group to ASN, which approved them.

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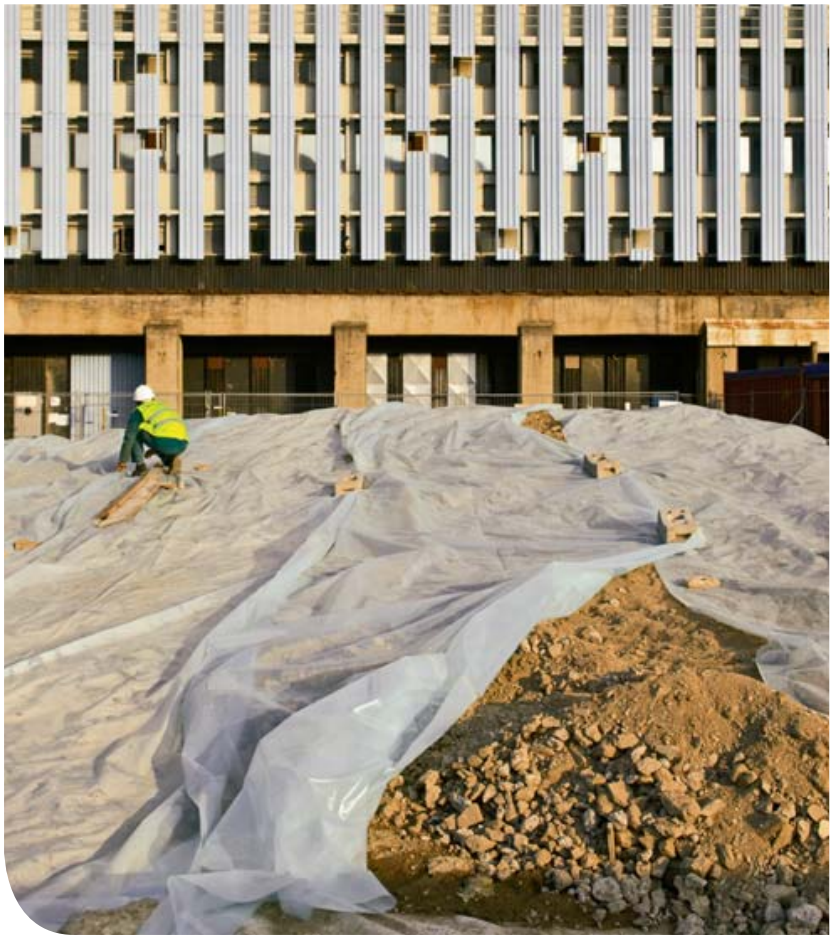

Demolition of the turbine hall of reactor A3 at the Chinon power plant.

Safety of fuel cycle facilities

Regarding the commissioning of facilities or processes, the Institute assessed, at ASN's request, the documentation for MAGENTA, a future storage facility for non-irradiated fissile materials to be built at Cadarache. The facility is designed to replace the MCMF facility, which is expected to close within the next few years.

Commissioning activities and operation of the new "cold crucible" vitrification process, set up at Areva NC's R7 facility at its La Hague plant in Normandy, was also examined by IRSN. The new process will be used to condition concentrates of fission and minor actinide products as well as waste from spent fuel shearing and dissolution. Compared with the process currently in use, it will enable the treatment of a wider range of fission-product solutions and increase the output of the vitrification facility.

IRSN also submitted several notices to ASN concerning the safety of the ATPu facility, following CEA's announcement that a significant quantity of plutonium was contained in glove boxes at this facility, which is currently undergoing cleanup. These notices were published on the IRSN website as they were sent to ASN.

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Reactor safety during dismantling

As part of its support activities for ASN, IRSN examined the scenarios planned by EDF for dismantling the St-Laurent-des-Eaux A1 and A2 reactors and the Chinon A3 reactor, all in the Loire valley region, and concluded that they were technically feasible.

Some operations were identified as requiring mandatory hold points. These dismantling operations are expected to take more than 20 years to complete as of the date of publication of the relevant authorization decrees, scheduled for 2010.

Transport

Safety analysis for new transport of packages

In 2009 IRSN assessed the safety of the new TN 117 package, developed by TN International. Its conclusions were submitted to the competent standing advisory group to ASN on October 13, 2009.

The TN 117 package is designed for the transport of fresh or spent fuel assemblies, including a number of rods that might leak. In this case the assemblies are placed in containers called "cylinders". IRSN's assessment focused particularly on the mechanical and thermal behavior of the package and on the demonstrations submitted by the applicant relative to the guarantee of containment, protection against ionizing radiation, and sub-criticality in all transport conditions.

Taking account of the commitments made by TN International during the assessment, and subject to the company's investigation of two additional accident scenarios, IRSN considered that the TN 117 package meets requirements applicable to type-B(U) packages designed to transport fissile materials, for the transport of leaktight fuel rods. Further substantiation, however, is required for the package design when loaded with non-leaklight fuel rods.

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Research and development programs

IRSN began a number of studies and research activities during 2009 to further enhance its assessment capabilities regarding the safe transport of radioactive materials.

A test program was carried out in 2009 to determine the fraction of resuspended particles from radioactive powder loaded in a package when subjected to accidental conditions as defined in the transport regulations.

Further tests are scheduled for 2010 to refine the preliminary results.

Moreover, IRSN began to study how expansion phenomena in the elastomer seals in the containment system could affect package integrity, under normal and accident conditions. Preliminary numerical calculations were carried out in 2009 and will be supplemented by more accurate calculations in 2010 to define a test program. The results of these activities will eventually serve as a basis for assessing the validity of assumptions currently made in safety documents to estimate variables phenomena such as radiation release following mechanical and thermal testing.

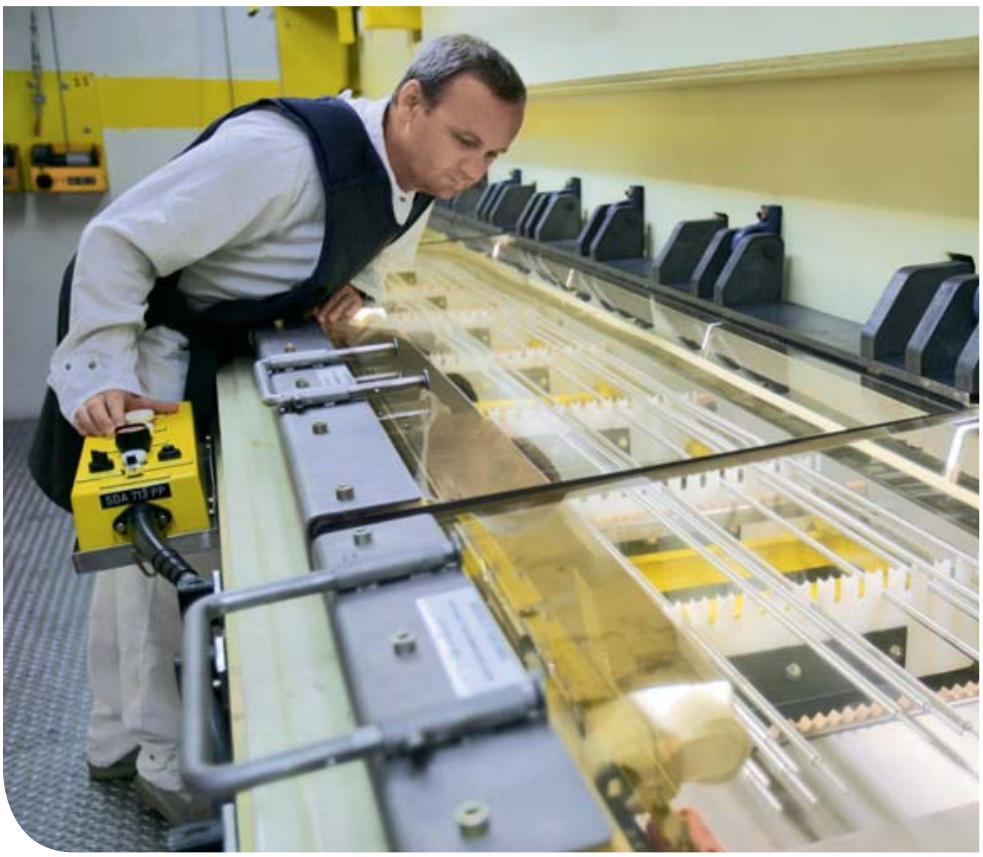
One experimental program sets out to study the thermal behavior of wooden shock absorbers used to protect packages, in particular the phenomenon of burning prolongation in the wood which is liable to occur after the flames have been extinguished. The study seeks to characterize this phenomenon and determine under which conditions it occurs. This phenomenon is not always taken into account in the fire-resistance studies included in the safety documents that IRSN examines on ASN's request. The program was defined in 2009 with the various partners involved, and the tests could be carried out in 2011.

As part of its initiatives to improve the tools used for emergency assessment activities, IRSN performs computer simulations to study the thermal behavior of the new TN 112 package, which is approved for spent fuel transport, during a fire that exceeds the duration and maximum temperature values defined in current regulations. The purpose of the study is to determine the fire duration and temperature maximum values that the seals may withstand without failure.

Lastly, research and development actions were extended in 2009 to include activities at fuel cycle facilities. In particular, the study of the mechanical properties of materials used for irradiated fuel rod cladding, which was initially limited to transport conditions, was expanded to include underwater fuel storage conditions.

TN 117 transport packaging.

646 TECHNICAL
NOTICES TO ASN (709 in 2008).



Visual inspection of fuel rods.

2 – FUEL SAFETY

In order to examine the changes in nuclear fuel management that reactor operators propose to the relevant authorities, IRSN conducts research designed to provide a better assessment of the safety limits to be included in these new procedures.

Reactivity accidents

In 2009, IRSN developed an approach to define a "non-failure" range for fuel rods in a pressurized water reactor in the event of reactivity-initiated accidents (RIAs). For the Institute, this is a major step in its preparations for forthcoming discussions on the revision of the safety baseline for this type of accident. The approach is based on:

– an in-depth study of the physical phenomena involved in a reactivity accident, based on interpretation of an international experimental database compiled from test results obtained in experimental facilities such as the CABRI reactor, and the results of analytical tests on cladding behavior;

– the development of IRSN's SCANAIR simulation tool, designed to provide quantitative interpretations of the results of these tests, and to extrapolate experimental results to the operating conditions of a power reactor;

– the development of a statistical method for defining a "non-failure" limit for claddings. Such a method implies a large number of calculations covering all possible failure modes, having first determined all the sensitive physical parameters relating to the thermomechanical behavior of cladding and fuel, as well as fuel stressing during operation.

The approach will be finally validated once the non-failure limit obtained has been compared with the test results from the CIP program carried out by IRSN on the CABRI reactor. The Institute will then be in a position to provide an appropriate and scientifically flawless opinion on the limits proposed by operators.

INTERNATIONAL

SEMINAR ON REACTIVITY ACCIDENTS

In early September 2009, IRSN and the OECD organized a seminar on fuel behavior in reactivity accidents.
This seminar brought together nearly 90 representatives from 19 countries and international organizations.
Technical discussions revealed that the phenomena involved in the first phase of the accident are well understood, thanks largely to work based on the results of tests conducted in the CABRI reactor (by IRSN and CEA) and the NSRR reactor (by the Japan Atomic Energy Agency).
The discussions also showed that more needs to be known about the second phase of the accident in order to improve safety standards and make them more relevant.
This is important because reactor coolant boiling and fuel rod failure may occur during the second phase of the accident.

CEA's CABRI reactor.

Loss of coolant accidents (LOCA)

In 2009, IRSN developed the experimental CYCLADES program, building on currently available knowledge and existing or planned international research programs. The program sets out to provide the knowledge required to improve the assessment of nuclear fuel behavior during an accident affecting the reactor's core cooling system.

This type of accident is known as a "loss-of-coolant-accident" or LOCA. The phenomena investigated include fuel rod deformation due to the formation of "balloons" liable to reduce rod cooling, the movement of fuel fragments in these "balloons", and cladding strength during - and after - the accident.

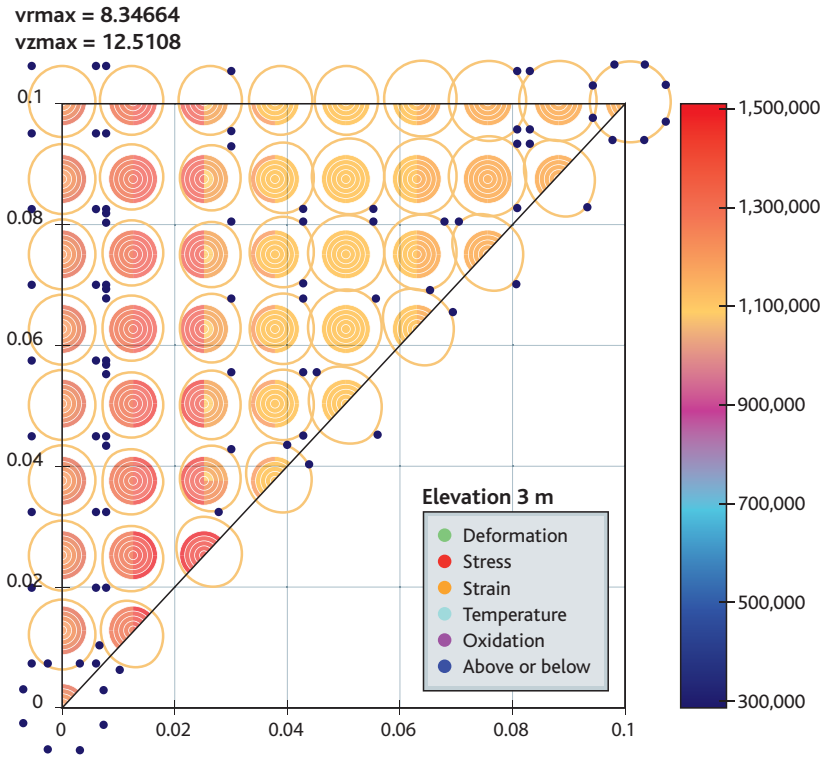
Changes in fuels and in how they are used in power reactors are causing the authorities to consider revising the current safety baseline, particularly the related safety criteria. This international program is associated with the development of simulation tools:

How equipment and components behave over time is crucial to the safety of nuclear facilities.

– DRACCAR software, used to estimate irradiated fuel assembly plugging;
– the DIFFOX simulation tool, which assesses the oxidation state of cladding.

Steam line break accident

In collaboration with CEA, IRSN developed the HEMERA 3-D computer code package for the study of accident situations in which neutronic, thermal-hydraulic, and "system" effects interact. The package combines four codes: APOLLO and CRONOS for neutronic aspects, FLICA for reactor core thermal-hydraulics, and CATHARE for system thermal-hydraulics. In 2009, the package was used for the first time to study new methods of investigating steam line break and control rod ejection accidents in a nuclear reactor. The methods in question were proposed by EDF for use in EPR safety documentation in particular.



Cross-section of a cluster of fuel rods deformed by a loss-of-coolant accident.

3 – AGING AND EXTENDING SERVICE LIFE

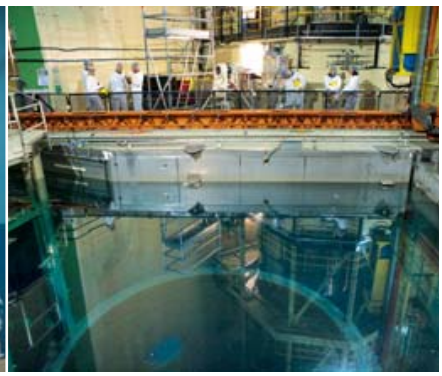
The aging of the nuclear reactor fleet and the possibility of extending are the service life of France's nuclear power plants are two crucial topics concerning the safety of nuclear facilities. For both these reasons, IRSN needs to be able to assess the behavior of plant equipment and components over time.

Extending the lifetime of nuclear power plants

In 2009 IRSN recommended to ASN that besides examining the management of aging, it should consider ways of extending the lifetime of reactors beyond the 40-year period for which they were originally designed.

Since 2003 the topic of reactor aging has been the target of IRSN investigations and presentations to the competent standing group to ASN, which means that it benefits from a proven methodology. EDF has recently indicated that it wishes *"to leave open the option of a sixty-year service life for all the reactors in its fleet."*

The proposed examination is intended to address the technical problems of a pro-



jected service life of 30 additional years, beginning at the third ten-year inspection. The issues involved for the operator are substantial, in both economic terms and from the safety perspective. Besides the aspects relating to equipment aging considerations, the exercise sets out to look ahead not only to changes in safety requirements, but also to climate-related hazards, and to identify exceptional maintenance operations to assess their industrial feasibility, etc. It will lead to a work program to define milestone dates to decide whether this objective is acceptable, or, on the contrary, to identify the technical difficulties to be overcome.

At the same time, IRSN intends to amplify and focus the research and development activities that it conducts to support its assessment activities, especially with regard to social expectations. Within this context, its research work on aging was assessed by its Scientific Council in 2009. Similarly, a working group chaired by Member of Parliament Claude Leteutre was set up within the Nuclear Safety and Radiation Protection Research Policy Committee, to develop a multidisciplinary opinion likely to help optimize research priorities regarding the extension of reactor lifetime.

Behavior of power cables

Along with the reactor pressure vessel and the containment building, power cables are among the components of nuclear reactors that are considered irreplaceable. Just the cables known as "K1" cables, i.e., cables qualified for LOCA conditions, represent a length of 50 km for a single reactor. IRSN therefore pays particular attention to aging in safety-related cables. As part of the intensification of its research on aging, the Institute began a work program in 2009 that must allow it to take informed positions concerning the aging of such cables. The program is based on three lines of research:

– an inventory and analysis of available experimental data and previous studies,

– an analysis of EDF's approach, based on the use of models that are, for the most part, qualified by measuring the properties of control specimen cables collected from power plants, with or without additional aging,

– the performance of additional tests if necessary, and improvement of the models.

These actions will be carried out as part of national and international industrial partnerships.

This work, currently being carried out under an OECD contract, is aimed at building a database covering qualification profiles and diagnostic methods for various types of cables.

IN THE WORDS OF

CLAUDE LETEURTRE,
Member of Parliament for Calvados

Energy independence, competitive electricity prices, and climate change are such major issues that we must ensure that the benefits of nuclear energy can never be weighed against the level of nuclear safety and security that every citizen has the right to demand. It is in this spirit that I accepted the leadership of the working group of the IRSN's Nuclear Safety and Radiation Protection Research Policy Committee (COR), devoted to the aging of nuclear power plants and the extension of their service life. Although absolute transparency was not always customary in the past, it seems to me that it is now essential to take stock of all our processes, whether we are talking about listing reported incidents or attempting to identify those that have not been reported. We should then identify the toughest issues and address them first. Within the context, I believe that IRSN should publicize its work and make it known that its findings are not influenced in any way by the organizations it works for. It would have all the more influence if it were recognized as a public expert organization with its own budget, with no need to depend on budgetary allocations from the ministries."

4 – FIRES AND CONTAINMENT

IRSN's fire and containment research is aimed at improving its understanding of the processes involved and obtaining a better assessment of the radioactive release liable to result from a fire or containment failure.

Working towards a common approach to fire hazard analysis

IRSN developed a draft document in 2009 describing its methods for examining fire hazards in nuclear facilities of all types. To meet the general objectives of nuclear safety and radiation protection, the document will define the Institute's position on the overall approach to be followed in analyzing fire hazards and their effects.

In particular, it will describe the safety principles to be adopted and the various stages the operator should follow to demonstrate that the fire protection measures it has selected are adequate.

This approach is in line with the new "fire safety engineering" methods developed as part of a nationwide technical consultation.

Instrumentation and control room at the DIVA facility.

The CATFISH test bench is used to obtain analytical data on HEPA filter clogging.

Advances in the field of aerosol filtration

As part of a common-interest program concerning high-efficiency particulate air (HEPA) filtering of aerosols, IRSN and Areva carried out research to provide a better understanding of (i) the uncertainties involved in measuring HEPA filter efficiency, and (ii) the performance of this type of filter in air with high relative humidity. In addition, dissertation studies have shown that when predicting the consequences of HEPA filter clogging in moist air, it is necessary to consider filter geometry, the aerosol deliquescence point and particle size distribution, as well as the duration of the interaction of moist air with the particles deposited on the filter.

Fire hazards in laboratories and plants

Two test campaigns devoted to the study of fire hazards in the nuclear laboratory and plant category were carried out in 2009 on IRSN's experimental platform called Galaxie, located in Cadarache in the south of France.

The PARFFIN campaign studied fires in drums of high-density polyethylene

(HDPE), used for very low-level radioactive waste. In particular, it sought to describe the development of the fire's heat release rate and its propagation from one drum to another placed on top of or next to it. A minimum safety distance between drums was thus determined.
After defining the average fuel load in a drum and its ignition mode (internal or external), 12 tests were performed on one or two drums. Ten further tests examined the conditions for igniting the drum's HDPE jacket.
The PICSEL-EP campaign studied the effect of sectorization equipment (fire doors and cut-off valves) and of ventilation filter clogging on fire dynamics, and on the propagation of hot gases and smoke in a facility made up of several rooms. The source of the fire is an electrical cabinet with the door left open to maximize the fire heat release rates involved. The campaign comprised two tests, carried out in October and November 2009 on the DIVA test facility.
Results are currently being analyzed, but it is already clear that the fire doors used in the tests displayed excellence resistance to the thermal and mechanical stresses caused by the fire.

Propagation of smoke and fire

The OECD's international research program PRISME, conducted by IRSN on the Galaxie experimental platform, is devoted to the study of the propagation of smoke and heat from a fire in confined spaces with mechanical ventilation, representative of a nuclear facility.
In parallel with this experimental program, a working group bringing together a large number of partners, led by IRSN, is helping to interpret the PRISME program's test results. The group is also conducting comparative studies using various computer tools, in order to assess their ability to simulate a variety of increasingly complex fire scenarios.
In 2009, as part of a comparative study on the PRISME program's tests, emphasis was placed on an objective assessment of discrepancies between experimental figures and simulation results.
A second objective consisted in using the preliminary calculations to define specifications for the latest test campaign, known as PRISME INTEGRAL.
This campaign will involve complex solid fire sources (fires in cables and electrical cabinets) as well as the effects of containment and the activation of sprinklers during the fire.

Creation of a database on equipment behavior

In view of the substantial volume of data available on the behavior of containment and sectorization systems in response to hazards, IRSN began to develop a computerized database in 2009 to take advantage of this knowledge.
The database, called BADIANE, will pool knowledge concerning the behavior of purification systems and containment and sectorization equipment obtained during tests carried out under normal, degraded, or accident conditions.
For a given scenario, BADIANE will be able to provide users with information on the aeromechanical and mechanical behavior of equipment (doors and fire dampers, filter components, cable troughs, etc.).
The database, which is designed to allow data from other scenarios or pieces of equipment to be added at a later date, includes experimental data acquired by IRSN or obtained from bibliographic studies.

IN THE WORDS OF

PIERRE CORTÈS, Manager of the ITER Organization's Safety Analysis department

We chose IRSN's Sylvia software to carry out our safety analyses on fires and their propagation, and for studies of material transfer in the ventilation systems, because it met our expectations better than the other products available. Sylvia's main advantage is that it incorporates data concerning fire propagation via the ventilation systems. Being able to use the same tool to study fire and its propagation is a real advantage for us, and it's something we didn't find in the other software we examined.

Sylvia's second advantage is that you can make use of experiments, that is, the physical validation of parameters encountered in real-life fire situations. In our opinion, this confirms that Sylvia is representative of reality and that it is constantly being expanded with every new experiment.

Lastly, the fact that this code was developed within the IRSN will make exchange easier when the Institute carries out safety analysis for ITER. Speaking the same language will help reduce errors of interpretation."

Electrical cabinet after a PICSEL EP test at the DIVA facility.

5 – CORE MELTDOWN ACCIDENTS

Research conducted by IRSN in this area is aimed at learning more about the progression and consequences of core meltdown accidents, and especially the release of radioactive materials to the environment.

Reflooding of a highly degraded reactor core

The probabilistic safety study carried out by IRSN for 900 MWe reactors showed that they are a significant number of accident scenarios where water may be injected into the reactor vessel during core degradation.

The uncertainties as to the possibilities of reflooding a degraded core, however, mean that the effectiveness of adding water in this way remains to be demonstrated.

The PEARL program, started by IRSN in 2008, is aimed at expanding knowledge through testing, and improving, models of degraded core reflooding using ICARE-CATHARE software.

In 2009, preliminary tests were conducted to qualify both the specific processes and the instrumentation to be implemented in the European SARNET 2 project's experimental facility, PEARL. The new facility will investigate the reflooding of a debris bed made up of materials typical of those in a damaged core, at higher temperatures and pressures.

PRELUDE – a reduced-scale prototype facility for the PEARL program.

Hydrogen combustion modeling

The year 2009 saw the start of a comparative study of the code results and the measurements obtained at IRSN's ENACCEF facility and the Becker Technologies THAI facility in Germany.

This exercise, known as International Standard Problem 49, is being coordinated by GRS, under the auspices of OECD. It involves research organizations, industrial firms, and universities.

Its objective is to determine the extent to which codes are able to predict pressure and temperature loadings on the reactor containment building, resulting from hydrogen combustion from a heterogeneous mixture. The difference in size between the two facilities (a factor of 60) will also provide information on scale effects.

A new reference tool for core meltdown accidents

To obtain a better understanding of the progression and consequences of core meltdown accidents, IRSN and GRS delivered a new version of the French-German ASTEC codes, known as ASTEC V2, to their partners in the European SARNET system in July 2009.

The new version consolidates ASTEC's position as an international reference tool. More particularly, the Institute plans to use it for a variety of applications such as a Level-2 probabilistic safety study for the EPR reactor, and studies of experimental or naval propulsion reactors.

The V2.0 version incorporates two major changes. First, the ICARE module used to process in-vessel core degradation has been integrated. Second, the MEDICIS module, designed to process corium-concrete interactions, has been extended to include EPR design, with models of the corium spreading area. ASTEC V2 is also coupled to the SUNSET statistical tool to make it easier to perform sensitivity studies and analyze their results.

More than forty ASTEC user agreements have now been signed with European, Indian, Russian, and Chinese partners. Towards the end of June 2009, IRSN organized a training session in the use of ASTEC V2, in response to a demand expressed by many users. The session was attended by 22 organizations from 13 countries.

Lastly, IRSN created a website in October 2009, the main purpose of which is to offer users a fast and easy way to download any future ASTEC upgrades.

www.irsn.fr

Examining the effectiveness of "waterborne-release" countermeasures

On June 25, 2009, at a meeting of the competent standing advisory group to ASN, IRSN presented its report on the effectiveness of the provisions under consideration by EDF to prevent radionuclides from spreading to the ground water after a molten core breaks through a reactor building foundation raft.

As part of its project to extend reactor lifetime, EDF is seeking to implement "waterborne-release" countermeasures to prevent core meltdown accidents and foundation mat melt-through. Although IRSN believes that this preventive approach is essential for safety, it considers that provisions for mitigating the consequences of a real accident involving a breach of the foundation mat still need to be studied.

It therefore believes that EDF should continue working on "waterborne-release" countermeasures, while planning ahead for preparatory studies for the construction of a geotechnical enclosure compatible with the site. IRSN also believes that EDF should examine the capacities required for storing, controlling, treating and discharging the contaminated water that will be pumped out, and estimate any additional arrangements that would be required.

Moreover, it considered that EDF should study the process by which strontium and cesium isotopes are retained in a water-bearing alluvial formation made up of sands and gravels, representative of certain sites..

www.irsn.fr

Radiological consequences of accidents

On June 25, 2009, IRSN submitted to the competent standing advisory group to ASN its report on the updated baseline proposed by EDF for assessing the radiological consequences of accidents (excluding core meltdown accidents).

The new baseline will apply to nuclear reactors in existing power plants and to the EPR reactor under construction on the Flamanville site.

The Institute took this opportunity to point out that assessing the radiological consequences of accidents was part of an initiative for the continuous improvement of safety, and that every step should be taken to reduce release from accidents, and its impact on human health and the environment, as far as is reasonably achievable.

It thought it necessary for EDF to continue its studies in order to define ways of reducing the impact of an accident involving a steam generator tube rupture.

Regarding the methods and assumptions adopted in the studies, IRSN believed that the changes EDF had made to its assessment approach were positive, and that the company should be able to obtain a sufficiently solid baseline to identify priorities for improvements.

This is especially important looking ahead to the safety review of 1300 MWe reactors in preparation for their third ten-year inspection, beginning in 2015.

Whatever the case, IRSN believed that EDF should propose more ambitious radiological objectives in its baseline at this point in time.

www.irsn.fr

IN CLOSE-UP

WHAT IS MEANT BY "WATERBORNE-RELEASE" COUNTERMEASURES?

Two methods of transferring radioactive products into the environment may be involved during a core meltdown accident to a pressurized water reactor: atmospheric release, and liquid release following foundation raft melt-through. Liquid release liable to contaminate the ground water is known as "waterborne release".

The purpose of "waterborne-release" countermeasures is to limit – or even prevent - the spread of radionuclides to ground water after the molten core breaks through the reactor building foundation raft. One way to do achieve this is to build a geotechnical enclosure and pump out the water that pours into it. These countermeasures must be implemented within 10 to 200 days, depending on the site.

First Level 2 PSA for 1300 MWe reactors

In 2009, IRSN devoted considerable effort to developing the first Level 2 probabilistic safety analysis for 1300 MWe reactors (PSA2 1300), which is aimed at identifying changes that could be made to improve safety in these reactors, in preparation for their third ten-year inspection. It should be noted that by developing its own PSAs, the Institute acquires the means to effectively appraise similar studies carried out by the operator. The studies also represent a tool that will allow it to build on the latest knowledge acquired from reactor core meltdown accidents.

PSA2 1300 is organized around an event tree that includes detailed modeling of the main phenomena that are likely to occur during a core meltdown accident. This modeling is based on a large number of studies and supporting calculations, many of which were performed using ASTEC V1.3 software.

More than 100 accident scenarios, calculated up to reactor pressure vessel failure, are used to assess the thermal-hydraulic behavior of the core cooling systems and the containment, as well as the physical phenomena induced by in-vessel core degradation (fuel melt, release of fission products or hydrogen into the containment, etc.).

Phebus Fission Products program: publication of the summary report on the FPT2 test

In 2009 IRSN presented its summary report on the results of the FPT2 test to the international partners in the Phebus PF research program, which it manages. The test was carried out in 2000 to investigate a core meltdown accident under reducing conditions in the reactor pressure vessel, primary circuit and containment, whereas the conditions for the first tests were more oxidizing. The last significant step in consolidation work performed by the Institute consisted in analyzing the consistency of all the measurements made during the test, then evaluating the uncertainties associated with the results.

The PHEBUS FP experimental program, which was conducted between 1993 and 2004 in the Phebus research reactor operated by CEA for the needs of IRSN's safety research, is one of the main international research programs devoted to core meltdown accidents in pressurized water nuclear reactors. It comprised five comprehensive experiments, i.e., experiments reproducing as realistically as possible the physical phenomena that may occur during a core meltdown accident. The experiments have yielded essential data for the validation of simulation software used in water-cooled reactor safety analyses.

Progress made in CABRI modification work

Work on modifying the CABRI test reactor, operated by CEA for the needs of IRSN's safety research, began in 2003. The purpose of the work is to equip the facility with a pressurized water loop that can be used to

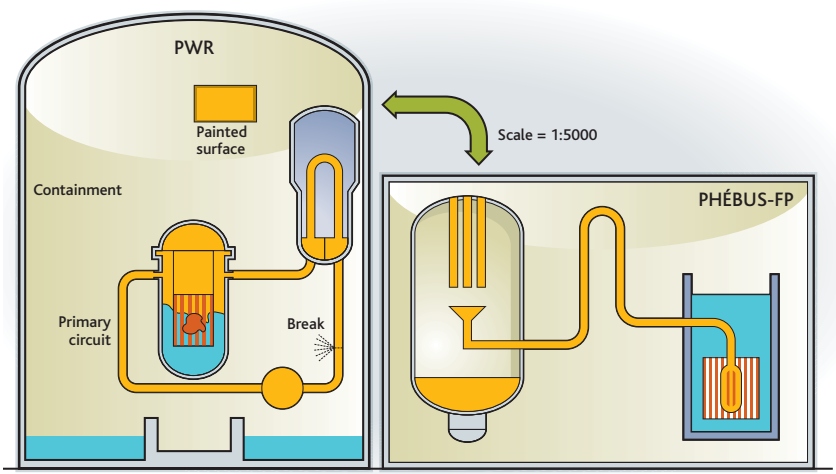
IN CLOSE-UP

SARNET 2 PROJECT LAUNCH

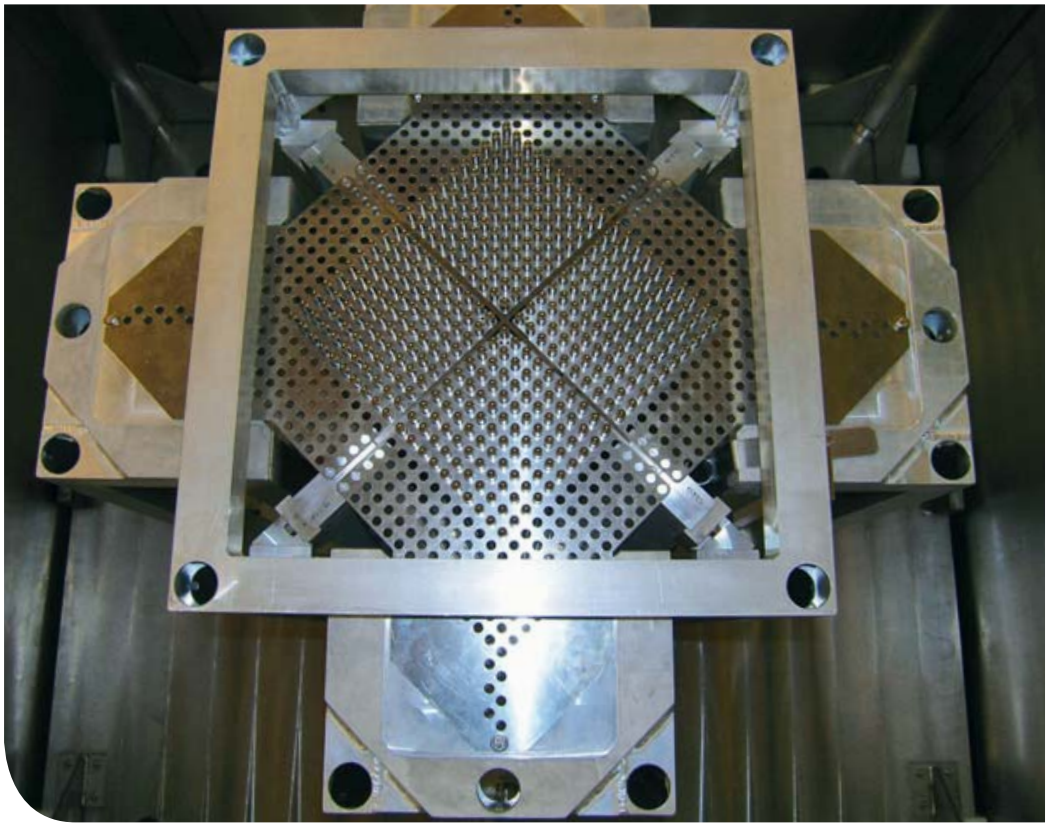
SARNET, the European network of excellence for research on nuclear reactor core meltdown accidents, coordinated by IRSN, has continued its activities since April 2009, with support from the European Commission under a new four-year contract (SARNET2 Project under FP7, Europe's seventh R&D framework program. It brings together 41 international partners including IRSN, four of them from outside the European Union: AECL (Canada), KAERI (S. Korea), NRC (USA), and PSI (Switzerland).

Research and development work has been prioritized, starting with degraded core reflooding, corium-concrete interaction, and the behavior of release under oxidizing conditions in the reactor coolant system. IRSN provides the network with results from the ISTP and PEARL programs, both of which are cofunded by the European Commission. ISTP is devoted to the study of release, while PEARL concerns degraded core reflooding. Another essential action concerns the development and improvement of models in the ASTEC software system, where knowledge is stored for future use.

Ties with the European SNETP platform should be developed, in particular by drawing on the network's unrivaled concentration of skills, which enable it to identify research priorities and define and launch appropriate research programs.



PHEBUS FP facility - a 1:5,000 scale replica of a PWR.



MIRTE experimental device at CEA Valduc: "fine" configuration with 5 mm of titanium.

study the behavior of PWR fuel in an accident situation, under representative conditions. The studies will focus on control rod ejection or loss of reactor coolant. The modifications, funded by IRSN, also include upgrading the facility to take into account changes in regulations and practices, and new knowledge. Two important milestones were reached in 2009. July saw the hydrotest performed on the water loop (290 bar, 50°C) that replaces the original sodium loop, while October saw main construction work begin to reinforce the buildings and equipment to reflect changes in the seismic loading adopted for the Cadarache site where the reactor is located. Commissioning tests also began on the various systems of the facility, in particular the ventilation and radioactive-effluent systems.

Partnership with the United States for experimental programs concerning nuclear criticality

Since 2007, IRSN has been working with the U.S. Department of Energy (DOE), Areva, and Andra in the MIRTE experimental criticality program. The aim is to contribute to the qualification of criticality computer codes used for transport packaging and fuel cycle facilities. In 2009, no fewer than 30 experiments were carried out for this purpose at the CEA's experimental criticality facilities in Valduc in east-central France under IRSN supervision. Analysis of the results of these experiments has yielded precise information on the neutronic characteristics of seven materials of interest (copper, nickel, titanium, iron, aluminum, Zircaloy, and glass).

In view of the high quality of results obtained by CEA and IRSN teams, Areva and the DOE have committed to a second test phase (called the MIRTE 2 program), to be carried out in 2011. Furthermore, the success of this cooperation has led IRSN, CEA, and the DOE to discuss renovating the Valduc facilities to create an international criticality experimental laboratory.

INTERNATIONAL

PARTICIPATION IN THE POST-SEISMIC SURVEY IN L'AQUILA

IRSN took part in the post-seismic survey organized by the French Association for Earthquake Engineering (AFPS) in the L'Aquila region of Italy, following the magnitude 6.3 earthquake that severely affected this region during the night of April 5-6, 2009, causing 300 deaths, leaving 70,000 people homeless, and calling for the reconstruction of a quarter of the buildings in the vicinity of the epicenter. Although the earthquake occurred in an area where strong seismic activity was known, it concerned a fault that had previously been considered inactive. The AFPS report provides a full description of the event, the behavior of the buildings, and crisis management. It underlines the close similarities between Italy and France, particularly in terms of geology and urbanization, and highlights the effectiveness of the operational solutions employed by the Italian authorities to deal with the crisis. The experience feedback acquired will enable specific improvements in the regulations concerning the prevention and management of seismic risks in France.

www.afps-seisme.org

6 – NATURAL HAZARDS

In order to meet safety requirements, nuclear facilities must be designed to withstand natural hazards such as earthquakes, floods, and heatwaves. IRSN's work is designed to obtain a more accurate assessment of the risks associated with these hazards.

Seismic hazard assessment

The working group set up by ASN and bringing together seismic hazard specialists from EDF and IRSN, completed its work in 2009 after more than three years of discussions.

The group's work was aimed in particular at investigating the characteristics of the "safe shutdown earthquakes" adopted by EDF for its various sites, and their conservative approach.

Drawing on the latest knowledge available, it examined the seismic levels to be considered for each of the 900 MWe PWR sites.

As part of this work, IRSN held in-depth talks with EDF on how to address uncertainties, particularly those associated with the characteristics of design-basis seismic events and seismotectonic zoning. The Institute was able to apply the results of the studies and research that it has conducted over the last few years, in particular concerning uncertainties in calculations for assessing the earthquake resistance of facilities.

Flood protection

Following the flooding of the power plant platform in Blayais in southwestern France, a working group was set up to revise the fundamental safety rule concerning the protection of basic nuclear installations against flooding.

This working group, managed jointly by ASN and IRSN, completed its work in 2009, enabling draft guidelines to be prepared for the assessment of phenomena likely to lead to flooding (heavy rains, storms, etc.) and for protecting installations with the necessary protection.

The document will be subjected to broader scrutiny before it is submitted to the standing advisory groups of experts for nuclear reactors and for laboratories and plants, for approval.

IRSN is also involved in modifying IAEA guidelines relating to flooding. In 2009, it took part in two editorial meetings on the draft IAEA guidelines concerning meteorological and hydrological hazards. The draft was sent to the Member States of the Vienna-based agency for comment in November.

The Blayais power plant was affected by flooding in 1999.

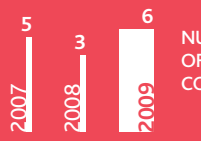
ABOUT DEFENSE

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

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



NUMBER OF IRSN REPORTS FOR MEETINGS OF "DEFENSE-RELATED" TECHNICAL SAFETY COMMISSIONS.

Design and construction

In 2009, in preparation for the commissioning of the new-generation nuclear ballistic missile submarine, "Le Terrible", IRSN examined the results of dockside testing of its steam-supply system prior to DSND's authorization to undertake sea trials of the vessel.

Concerning land-based support facilities for naval propulsion, IRSN completed its examination of the changes to the facility housing the irradiated-fuel storage pool at the Ile Longue base in Brittany. The Institute also undertook the examination of the provisional safety documents for the test reactor (RES) in the secret basic nuclear installation (INBS) at Cadarache as part of its commissioning process.

In 2009, in connection with the laboratories and plants for which the DSND is responsible at the CEA/DAM center in Valduc, IRSN examined the facility's future tritium storage building and began to examine the future plutonium recycling facility.

IN CLOSE-UP

COMMISSIONING OF THE RES TEST REACTOR AT THE CADARACHE INBS

The RES, located at CEA's Cadarache center, is scheduled for commissioning in 2011.
CEA having provided its safety report on the facility in mid-2008, IRSN started its examination prior to the DSND's authorization of the loading and subsequent divergence of this test reactor.
The RES is a pressurized water reactor, designed to reproduce various operating configurations of on-board nuclear steam-supply systems.
The assessment of a provisional safety report requires the application of a broad set of skills in order to perform detailed analyses in a variety of fields, such as mechanics, instrumentation and control, civil engineering, fuel behavior, severe accidents, and probabilistic safety studies.
In early July 2009, IRSN presented to the reactor safety commission its analysis of the characteristics of selected natural hazards and of civil engineering and containment design.

ABOUT DEFENSE (continued)

The Tricastin site underwent an examination in connection with the restructuring of the uranium enrichment systems.

This work will continue in 2010 within the framework of the construction license for the facility in question. The Institute also began the analysis of the safety documents for the future storage warehouse for nuclear materials of the nuclear propulsion fuel manufacturing facility, located at the CEA center in Cadarache.
Concerning CEA's Marcoule center in the south of France, the Institute examined the safety documents for a new evaporator at the Marcoule Vitrification Facility, as well as the safety documents for the construction of two new storage buildings at the "Multipurpose Storage Facility", and for the plans to update the liquid effluent treatment station.

Operation

In connection with the restructuring of the uranium enrichment systems at the Areva NC Pierrelatte facility on the Tricastin site in southern France, IRSN examined:
– the safety of the various prototype equipment (liquid-sample collection system and press for compacting solid wastes) for – subsequent installation at new, modernized facilities,
– the safety baselines for the facility's effluent treatment station and analytical laboratory.
IRSN also continued to study risks relating to external flooding, and monitored the progress of the preparation of the site operators' action plans for providing greater protection against these risks. It also examined the safety of the facility's storage areas (P50) for uranium-bearing materials, for which the DSND is responsible, to allow them to go on working. Regarding the CEA/DAM center at Valduc, IRSN examined the documents submitted by the operator following the facility's 2007 safety review, which focused on work on solid plutonium. As part of its facility monitoring activities, IRSN also examined the causes of and lessons learned from a number of incidents that occurred at this center.

As for CEA's Marcoule center, the Institute examined the safety documents for the Marcoule Vitrification Facility, and the safety baseline for the Marcoule Decontamination Facility.

It also began studies on safety review documentation for:
– the tritium extraction facility at CEA's Marcoule center, in particular to rule on the extension of its storage license;
– the naval propulsion fuel production facility at CEA's Cadarache center.

In the area of nuclear-powered vessels, IRSN pursued its examination of safety review documents for the "Rubis" class nuclear attack submarines. In 2009 it focused on:
– in-service monitoring of safety circuits and the containment;
– studying the risk of brittle fracture in the reactor vessel;
– examining the action plan set up after the 1994 failure of a steam line on the "Emeraude", a nuclear attack submarine.
Lastly, with regard to land-based naval propulsion support facilities, IRSN analyzed:
– the documents for the second phase of decommissioning operations of the RNG reactor at CEA's Cadarache center;
– the documents concerning the use of PN-CN packaging for transporting fuel in the nuclear facilities at the Toulon naval base.

Dismantling

As part of the decommissioning and dismantling operations of the UP1 plant at CEA's Marcoule center, IRSN examined the safety baseline proposed by the operator for continuing the dismantling operations, and the safety documents concerning:
– continuation of equipment dismantling in the UP1 plant's Building 100,
– the recovery of "dissolution insolubles" from the hot tanks at the MAR 200 facility,
the recovery and treatment of the deposits found in some equipment at the MAR 200 facility.
In addition, IRSN examined the operator's replies to the requests made by the Waste Management Safety Commission at its March 12, 2008 meeting concerning the same center.

Radioactive material transport

Many documents concerning this subject were examined in 2009:
– requests for the deferment and extension of approvals for transport on public highways;
– applications for the authorization of onsite transport;
– rules for the internal transport of radioactive materials at naval bases;
– proposals for modifications to the IAEA's recommendations concerning the transport of radioactive materials;
– approval applications for packages intended for transporting weapons.
On this last point, IRSN examined the approval applications for the model 81,000 and 81,710 packages in 2009. Its assessment of the approval application for the model 81,000 package was submitted to the Transport Safety Commission. IRSN also examined the additional justifications provided by CEA concerning the model 75654 package, Type C, designed for air transport. Following the assessment of this type of package, which had been discussed at a meeting of the above mentioned commission in 2006, DSND issued the first French approval for a Type-C package containing fissile materials.

Radioactive material packaging.

93 TECHNICAL
ADVICES TO THE SAFETY AUTHORITY FOR DEFENSE-RELATED ACTIVITIES (97 in 2008).

IN THE WORDS OF

MARCEL JURIEN DE LA GRAVIÈRE,
Representative in Charge of Nuclear Safety and Radiation Protection for Defense-related Activities and Facilities

All nuclear activities, whether defense-related or not, must be transparent with regard to their impact on human health and the environment.
It is the way this obligation is met that varies. For defense activities, information procedures are defined in a specific implementing decree of the Act of June 13, 2006 on transparency and security in nuclear matters.
They provide that the DSND should put forward an information strategy, then rely on IRSN's expertise or delegate certain actions to it. This is an area where we have set up an organization with the Institute. It is now running perfectly smoothly, as shown by the various feedback reports."

Onsite emergency plans and drills

In 2009 IRSN took part in the development of scenarios for crisis drills involving the Mont-de-Marsan airbase in southwestern France, on the CEA's Cadarache site and on a transport aircraft. The Institute also took part in three drills, and was invited to take part in an internal Navy drill.

In addition, IRSN provided the DSND with technical advices concerning a number of onsite emergency plans. They covered:
– examination of their operational validity and certain accident situations for onsite emergency plans at CEA's Cadarache center;
– examination of their operational validity and certain accident situations for the onsite emergency plans at CEA's Valduc center;
– a proposal for a model for transport emergency plans.

Lastly, IRSN took part in inspecting the onsite emergency plans of the CEA sites at Cadarache and Marcoule.

Working today to develop the knowledge and resources required to assess risks in the nuclear facilities of tomorrow.

CONDUCTING ASSESSMENTS ON FUTURE FACILITIES

IRSN prepares its future safety assessments

In 2009 IRSN worked to identify the key safety and radiation protection issues connected to the design of fourth-generation reactors likely to be adopted in France, and the related fuel cycle facilities. It also continued its work on ITER. This work represents various stages in the acquisition and development of knowledge, tools, and skills that the Institute will need to carry out its future assessments for public authorities. In 2009 IRSN also conducted an assessment of Andra documentation concerning the search for low-level long-lived waste disposal sites and of the CSM waste disposal facility in Normandy. It also continued its research on geological repositories.

1 – FOURTH-GENERATION REACTORS AND FUEL CYCLES

In preparation for its assessments of future reactors, IRSN is currently endeavoring to acquire the knowledge, tools, and skills required for assessing the most credible designs of fourth-generation reactors and of related fuel cycle facilities.

Fourth-generation reactors

As part of the development of fourth-generation reactors, investigation of the sodium-cooled fast reactor (RNR-Na) option is a priority in France: the goal is for CEA to commission a prototype, known as ASTRID, by 2020.

IRSN has become part of a major international collaboration to optimize future research on this type of reactor and accelerate the definition of relevant joint research programs. It is now involved in three European projects concerning sodium-cooled fast reactors and is a driving force in the OECD's TAREF group, which seeks to identify research and development needs and put forward related experimental programs. Its collaboration with organizations in Japan (JAEA and JNES), Germany (KIT-FzK), and China (CNPE) has been stepped up in the area of the accidents and risks associated with the use of sodium.

ASTRID, a fourth-generation reactor prototype.

IN THE WORDS OF

VICTOR TESCHENDORFF,
Director of Reactor Safety Research, GRS

For various reasons, the research work undertaken by technical safety organizations (TSOs) to support future assessments of fourth-generation reactors requires close collaboration.

One reason is the public's growing demand for transparency. It is no longer considered credible – or acceptable – that research and assessment work carried out on the same topic in different countries should lead to conflicting results.

Another reason is the existence of the Sustainable Nuclear Energy Technology Platform, supported by the EC, in which European TSOs such as Bel V, GRS, and IRSN participate to ensure that safety will be taken into account as a cross-cutting activity in all projects, regardless of the type of reactor concerned. Lastly, TSOs still have much research to complete over the coming years if they are to acquire the necessary assessment capabilities. It is my belief that future research must be based on sharing the valuable experience acquired by each country in the past - for example in Germany on high-temperature, pebble-bed reactors, or in France on sodium-cooled fast reactors."

Czech (NRI) and French (IRSN) teams work together on irradiation experiments at IRSN's IRMA facility in Saclay, near Paris, as part of the FORGE project.

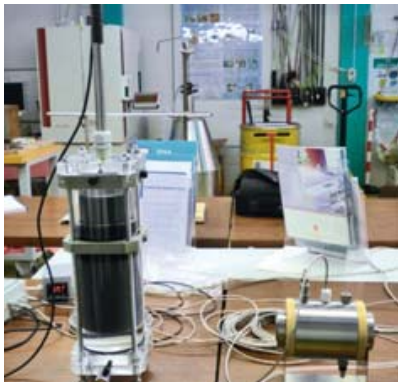
Fuel cycles

In 2009 IRSN took a number of initiatives to identify the major safety and radiation protection issues arising at fuel cycle facilities as a consequence of the different fuel management strategies contemplated for the introduction of fourth-generation reactors. In particular, these initiatives included:

– carrying out preliminary studies on the simulation of scenarios for the deployment of a fleet of fast reactors;

– conducting a preliminary assessment of the effects of these scenarios on present and future fuel cycle facilities, including those designed for waste management;

– gathering data based on operating experience feedback acquired in France and elsewhere, concerning the fabrication and processing of fast reactor fuels.



Experimental set-up used to study gas production by irradiation.

Experimental fusion facility

Progress of ITER studies

Safety studies concerning the ITER facility continued in 2009. These activities included examining the construction license application for the facility, the specific features of which must be considered for building up knowledge and adapting simulation software. They led to the development of a model for studying wall oxidation in the vacuum vessel. The model was implemented in the ASTEC system to make it applicable to accidents arising in connection with the ingress of air or water into the vacuum vessel. At the same time, new models – a turbulence model in particular – were incorporated into DUST, a software application used to process problems involving the movement of dust and the explosion hazard in mixtures of dust (such as beryllium) and gases (such as hydrogen). DUST software qualification tests are scheduled at the Institute's TOSQAN and BISE facilities, located in Saclay, near Paris.

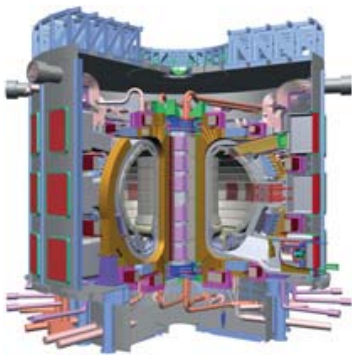
2– GEOLOGICAL REPOSITORIES FOR NUCLEAR WASTE

With regard to geological repositories for nuclear waste, IRSN developped in 2009 national and international collaborations, in readiness for the assessment work required for this type of facility.

Research on geological repositories

Launch of the FORGE project

Started in 2009, the FORGE project is part of the European Commission's 7th Research and Development Framework Program, involving 24 partners including in particular, IRSN, CEA, EDF, and Andra for France.



ITER: cross-sectional view of toroidal magnet.

Taking water samples for geochemical analysis at the front of a chemically inert system, isolating a transmissive fracture in the Tournemire experimental station.

The project is aimed at studying the production and migration of hydrogen resulting from corrosion in a radioactive waste repository. It is divided into five parts focusing on the following topics: consideration of gas transfers in safety studies, gas production, and the effects of gas transfers on seals, on the zone damaged by excavation, and on the rock formation. The Institute is responsible for coordinating the second part (gas production) and conducts irradiation experiments at its IRMA facility in Saclay, near Paris, in partnership with the Czech institute, NRI. The purpose of the experiments is to quantify gas production associated with corrosion caused by radiolysis. The Institute is also taking part in a review of methods used for assessing hazards relative to gas transfer within the repository, and comparison of models. In this field IRSN, it is developing its own computing resources for the study of simultaneous gas and liquid transfers in an argillaceous medium. Experimental results will be compared with modeling results as part of the FORGE project.

TRASSE National Research Group

Radionuclide transfer

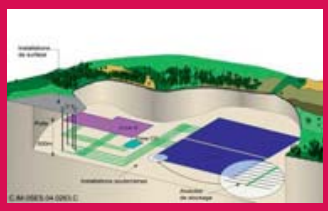
The activities of the national research group, TRASSE, created by the CNRS and IRSN, center on two main themes. Each relies on one of IRSN's two experimental stations, one of which is located on the Chernobyl site, while the other is the Tournemire underground experimental station. In 2009 eight projects involving more than ten CNRS teams were in progress.

Theme No. 1 studies the transfer of naturally-occurring and artificial radionuclides to the soil, ground water, and plants. One of the projects in this area studies bacterial diversity in the soil, along a trench filled with waste from the Chernobyl site, as a function of the physicochemical characteristics of the soil. Two other projects seek to determine the characteristics of water flows and the reactive transport of radionuclides in the unsaturated zone of the soil, and in the water-bearing formation. The goal is to obtain overall water budgets between the surface and the ground water, and to determine the age and origin of the body of water.

Theme No. 2 concerns the study of the confinement capabilities of an argillaceous geological formation. The topics addressed

IN CLOSE-UP

DISPOSAL OF LOW-LEVEL LONG-LIVED WASTE



At ASN's request, IRSN examined Andra documentation concerning sites being considered for use as repositories for disposing of low-level long-lived waste (LLW-LL).

The selected repository could accommodate graphite waste resulting from the dismantling of gas-cooled reactors (in which graphite gas is the coolant), as well as certain types of radium-bearing waste.

In its notice of January 12, 2009, IRSN reported that, at that stage of the project, it had not identified any geological reason for ruling out one or more of the ten priority sites that Andra is considering as a location for a LLW-LL repository.

It noted, however, that the compatibility of these sites with a disposal facility could only be determined on the basis of results from detailed investigations, which have yet to be undertaken.

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concern the presence of faults and their impact on the confinement capabilities of the argillaceous rocks, as well as the effect of aging in repository structures and components on changes in the properties of these rocks. The studies focus in particular on clay/concrete interactions and on a reinterpretation of seismic-exploration data intended to determine whether this technique can be used to locate faults. Lastly, studies are also in progress on the use of natural tracers to investigate the extent and characteristics of the damaged zone around underground structures.

Continuation of work at the Tournemire experimental station

In 2009, IRSN carried out a third sampling campaign as part of its research on geological repositories. The samples are used to study the corrosion of steel and glass when placed in clay. The studies were carried out at the Tournemire experimental station in southern France in collaboration with EDF. Analyses of these samples, embedded about ten years ago and recovered by "overcoring", will supplement those already performed on other samples left in contact with clay for two and six years respectively. Studies concerning fracturing in the damaged zone around the structures (tunnel and drifts) were also carried out, using eight short (6 m) radial boreholes drilled in the south drift in 2008. Three of them were instrumented to monitor time-related changes in hydraulic pressures around the structure. The cores obtained from these boreholes will be tested in the laboratory to determine their geometric characteristics, in collaboration with Clausthal University in Germany.

Development of international collaboration

An increasing proportion of IRSN's research on the safety of geological repositories for radioactive waste is being conducted under international collaboration agreements. In 2009, this trend led the Institute to host several major meetings at its Tournemire site. One example of this was the annual meeting of the IAEA network that brings together the main underground research facilities currently in operation around the world. The network seeks to promote the development of these facilities as tools for training and experimentation for the benefit of all 27 Member States. Within this context, IRSN organized a training course at its experimental center on waste disposal in argillaceous formations. The course was attended by thirteen trainees from twelve different countries.

Safety of waste repositories

Safety of the CSM waste disposal facility

On December 8, 2009, IRSN presented its assessment of the final safety analysis report for the CSM waste disposal facility in Normandy to the competent standing advisory group to ASN. It was the facility's first comprehensive safety review since December 1998. IRSN found that the facility showed no signs of any abnormal change in its confinement capability, and that Andra's monitoring was effective and should be continued. The Institute also examined plans to install a more durable cover over the facility, as the anticipated softening of the slopes of the cover was favorable to the long-term safety of the site. It considered, however, that further information was needed, especially concerning the steps taken to provide a cover drainage system that would last as long as possible. Lastly, concerning the procedures used at Andra to preserve and pass on the memory of the facility, IRSN recommended that data should be gathered and analyzed on a regular basis to validate and, where necessary, add to the information handed down to future generations. This work should be done by experts who are not employed by Andra.

The CSM waste disposal facility in Normandy.

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IN THE WORDS OF

CATHERINE CERTES, Assistant Manager at IRSN's Irradiator, Accelerator, and Waste Management Safety Department

The work carried out with ANCCLI is regular and constructive. It has been strengthened as a result of the Transparency and Nuclear Safety Act, in the sense that local information committees now have a responsibility for information as part of their public-interest mission. In addition to regular exchanges concerning each party's actions, the IRSN/ANCCLI monitoring committee examined a number of topics more closely in 2009. These included the question of the reversible disposal of high-level long-lived waste, as required under the Act of June 28, 2006. Apart from the technical aspects involved, the concept of reversibility raises other issues concerning long-term waste-management, in which the human dimension is prominent. This topic was also the focus of debates on the European "COWAM in Practice" project concerning the involvement of local stakeholders in the governance of radioactive waste management. IRSN, ANCCLI, and the local information committees are involved in this project. Such exchanges with stakeholders have increased awareness among the Institute's experts that they must incorporate a societal dimension in their approach to safety assessment."

Monitoring worker and public exposure to ionizing radiation and measuring radioactivity nationwide.

ENVIRONMENTAL AND POPULATION EXPOSURE

Radiation protection: working towards new monitoring systems

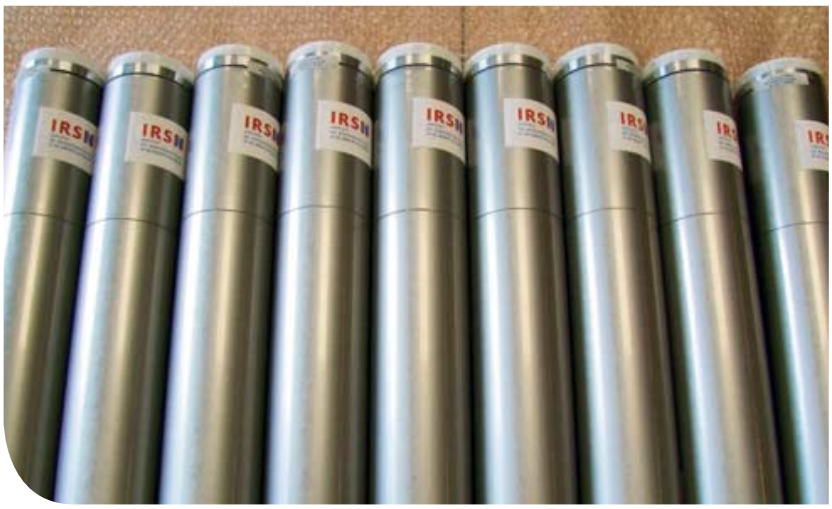
IRSN has begun work to prepare the modernization and redeployment of its monitoring activities in the area of environmental protection. Its operations around mines and contaminated sites have provided it with greater insight into inventories of radionuclides and their transfer to the environment. Regarding radiation protection and human health, it has continued its work to improve personal dosimetry techniques and worker exposure monitoring.

1 – ENVIRONMENTAL MONITORING STRATEGY

Monitoring public exposure to ionizing radiation is a key mission for IRSN. In 2009, it revised its strategy and began work to upgrade resources.

Revising the monitoring strategy

As part of its work to monitor environmental radioactivity, IRSN conducted a review that led to a plan to modernize and redeploy its activities. The plan focuses on:
– optimizing resources for more targeted and flexible regular monitoring to enhance the Institute's responsiveness;
– developing remote monitoring systems for detecting accident situations and monitoring post-accident situations, with the emphasis on protecting populations;
– increasing transparency and involvement from stakeholders in monitoring activities and setting priorities in this area.
The ASN College of Commissioners examined IRSN's plan at a hearing on September 8, 2009, and confirmed that the Institute had made the right choices.
The plan must be carried out through dialogue with decision-makers and the bodies concerned (ASN, government departments, operators), along with the stakeholders involved.
IRSN and ANCCLI (national association of local information commissions and committees) also agreed that one concrete way of sharing information would be to set up "regional radiological surveys". For a given year, these provide a status report on radioactivity in the various environmental compartments of a region and for a wide array of foodstuffs.
The proposed sampling programs for IRSN's 2009 surveys in the Rhône valley and southwestern France were put before the local information committees involved to have their opinion and obtain any local support needed for setting up the program, especially for selecting foodstuffs and sampling locations.
Concerning automatic monitors, IRSN selected new dose rate sensors in 2009 to replace those currently used in the Teleray network.



The new dose rate sensors selected by IRSN.

191 MONITORS
IN THE REMOTE MONITORING NETWORK IN FRANCE (191 in 2008).

IRSN carries out many radiological assessments around industrial sites.

2 – STUDIES ON SITE ENVIRONMENTS

At the request of public authorities and operators, IRSN conducts studies on the impact that industrial activities have on the areas surrounding sites and on the local population.

Radiological assessments

In 2009, IRSN conducted several radiological assessments at the request of public authorities or operators. This work involved studying the distribution of radioactivity in the environment and estimating the potential consequences for the population. Major assessments carried out in 2009 included:

- the Comurhex uranium processing plant at the Malvési site in southwestern France: the assessment was conducted for Areva, completed in April 2009, and presented during a local information committee meeting. It showed that the radioactive substances released by the plant contaminate the soil and vegetation downwind of the site, as well as canals and basins downstream of past and current release points,
- the Tahiti hospital: this assessment was carried out for the French Polynesian government, with a view to setting up a radiotherapy and diagnostic department and, at a later stage, a medical cyclotron producing short-lived radionuclides. IRSN has prepared a reference report on the status of radionuclides in Taaone lagoon, where the outlet (the so-called "radioecological zero point") for liquid effluents from the new hospital will be located. This will be used as a reference to determine the environmental impact of the hospital's activities in the future;
- the Jahouvey agricultural production area in French Guiana: at the request of the Directorate General on Food Safety, IRSN used analyses of foodstuffs grown around Jahouvey, the main agricultural production area in French Guiana, to assess the impact of irrigation on population exposure. It was found that the level of naturally-occurring radioactivity in irrigation water exceeded the reference limit for drinking water.

OPENNESS TO SOCIETY

COLLABORATING WITH LOCAL INFORMATION COMMITTEES ON ENVIRONMENTAL MONITORING

On June 10 and 11, 2009, IRSN and ANCCLI organized a seminar, entitled "Local information committees, from vigilance to responsibility - IRSN works towards more open assessment activity", to share the results of several years of joint action with all local information committees and a large number of IRSN employees. The seminar was attended by 90 people, more than half of whom were from local information committees.

Day one was devoted to environmental radioactivity monitoring, and provided an opportunity to present the results of APEL, a pilot environmental operation in the Loire region, to seminar participants. The report on APEL, which describes the partnership between IRSN and the St-Laurent and Dampierre local information committees to increase public awareness of environmental radioactivity monitoring around the Loire basin, was issued in February 2009. Discussions on the APEL data retrieval method, and the other work presented, also addressed the question of how local information committees could work with territory stakeholders to monitor environmental radioactivity as a complement to existing monitoring activities.

IN CLOSE-UP

DEVELOPING ISO STANDARDS FOR MEASURING RADON

Significant progress was made in 2009 in transposing French standards (AFNOR) into international standards. IRSN initially presented eight standards at a meeting of the Nuclear Energy Technical Committee of the International Organization for Standardization (ISO) in Madrid in 2007. ISO members voted to accept these standards as a new work theme for the radiation protection subcommittee. The standards were then analyzed and appraised by a working group including representatives from the United Kingdom, Germany, Spain, Switzerland, the Netherlands, Japan, and France. A consensus was quickly reached and the standards were submitted to ISO as draft versions of international standards during the year.

Assessments around former mining sites

In 2009, IRSN posted a map on its Internet site of the 210 former uranium mining sites documented in Metropolitan France.

This interactive map was developed as part of the MIMAUSA program, which the French Ministry of Ecology asked the Institute to set up. Its goal is to gather data on former mining sites for government and public consultation.

This map adds to the existing inventory and makes it easier to locate sites, thus answering the public authorities' request that any citizen should be able to learn the past and current status of former mining sites.

At the same time, IRSN has continued work on completing and consolidating certain data. As a result of fieldwork conducted in 2009 in Brittany, it is now possible to locate documented sites precisely, learn more about their current use, identify radioecological anomalies, and even find some undocumented sites. These results highlight the advantages of comparing available data with reality in the field and with local information.

On the subject of repositories for uranium ore tailings, IRSN carried out an assessment in 2009 of the Areva status report, issued as part of France's National Radioactive Materials and Waste Management Plan. The report reviews current knowledge on the long-term impact of these repositories. It discusses the mineralogical and chemical changes in tailings, and their ability to restrict the mobility of the radium and uranium they contain over long periods of time. It also examines the stability of the dykes surrounding some repositories and evaluates the dosimetric impact of repositories in normal scenarios, as well as in certain degraded situations.

In its report, IRSN identified ways of improving environmental protection, and recommended additional studies to confirm the preliminary results submitted by Areva in its documents.

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Managing contaminated industrial sites

In 2009, IRSN conducted an assessment of radioactive contamination in the soil, water and aquatic fauna around the former Orflam-Plast factory in Pargny-sur-Saulx in the east of France. The assessment was requested by Andra, with funds from the French national commission for assistance in the radioactive field. Orfam-Plast was a company that manufactured lighter flints, using ore with a high thorium-232 content. The assessment defined zones that were immediately rehabilitated to reduce the risk of exposure among the population concerned.

IRSN also worked on the former site of Société nouvelle du radium in Gif-sur-Yvette in the Paris region, at the request of ASN. It carried out a historical study to define the boundaries of the area requiring diagnosis, then performed a radiological diagnostic campaign on the plots in the vicinity of the former plant. A public meeting was held in September 2009 to describe the study and present its results to local residents.

IRSN also searched for radiological and chemical soil contaminants at the site of a former radium processing plant in Île-Saint-Denis near Paris, following on from work already carried out there in 2008.

Mechanical auger for soil sampling.

Device for measuring dry deposition of aerosols during experimental campaigns in southwestern France.

3 – EXPANDING AND CONSOLIDATING RADIOECOLOGICAL KNOWLEDGE

The Institute's research on the transfer of radioactive substances to the environment elucidates the behavior of these substances and their effects on ecosystems.

Study of tritium in the Rhône

Significant concentrations of tritium have been measured in the sediments and suspended matter found in the upper Rhône, near the French-Swiss border. This is probably related to the use of tritium by the luminous paint industry, especially for watchmaking, from the 1960s to the early years of the 21st century. A cooperation agreement was signed with the Swiss Federal Public Health Office in 2009 to study the cause of these tritium concentrations.

A joint campaign to sample sediments, plants and fish in the Rhône was conducted in the summer of 2009, near areas thought to be most affected by releases from this type of industry or the related waste management processes (incineration plants, dumps, etc.). The results will be available in 2010.

Dry deposition velocity of submicronic aerosols

In 2009, IRSN developed a novel method for measuring the dry deposition velocity of submicronic aerosols. This work was carried out as part of its studies on atmospheric transfers. The method is based on measuring fluctuations in the atmospheric concentration of aerosols and in vertical wind velocity. It was used to quantify deposition velocity according to weather conditions and aerosol size for three types of rural land cover (grass, corn, bare soil). It was the first time this had been done at an international level. The data from the study will eventually be incorporated in operational models, reducing the uncertainty involved in determining the impact of radioactive effluent release to the atmosphere in accident situations, and enhancing IRSN's assessment capabilities.

Dispersion of radionuclides in Toulon harbor

In 2009, IRSN developed an application to study post-accident radionuclide dispersion in the marine environment of Toulon harbor in the south of France. A model is used to simulate radionuclide release from the quayside or offshore and to calculate the expected concentrations in the water

IN THE WORDS OF

DIDIER GUILLAUME,
President of CLIGEET, the local information committee on the major energy facilities at Tricastin

Since November 2008, CLIGEET has been involved in the work of the monitoring group, jointly organized by IRSN, Areva and health and social services departments (DDASS) in the area, to provide precise data to explain the presence of radioactivity – due to uranium in particular – that has been detected in the ground water at Tricastin.

The work is carried out by a pluralistic expertise group that includes InVS, the French national institute for health surveillance, ASN, DSND, the French nuclear safety authority for defense-related activities, a panel of hydrogeologists, and the local analysis laboratory.

The group sets out to compare the views of various experts, and answer local residents' justifiable concerns about the cause of the pollution and how long it is likely to last.

Organizing the group and defining its mission called for a great deal of energy from the different members, and my goal today is to obtain some initial results before the end of the year. We can say that we have already done our part in setting up the project."

900 AMBIENT
DOSE RATE MEASURING POINTS
(900 in 2008).

and sediments. This is done for various accident scenarios liable to lead to radionuclide release.
At the same time, environmental sensitivity maps, divided into sectors, are used to consider environmental aspects, such as the protection of species, and economic activities, such as tourism or fishing.
In the future, the model's results will be used in combination with the sensitivity maps to rapidly determine the areas most at risk in the event of accidental contamination.

Hydrodynamic modeling for monitoring the marine environment

The radiological impact of Areva-NC's La Hague plant in Normandy on the marine environment is determined from the dilution factor of liquid effluent releases near the coast. This parameter was accurately determined from radionuclide concentrations measured in seawater by IRSN in 2009, in the port of Goury, at the tip of Cape La Hague.
Dispersion simulations conducted by the Institute using hydrodynamic models showed that dissolved radionuclide concentrations could vary significantly close to the release point. Seawater samples were then taken every ten minutes for six days at Goury.
Tritium concentrations agreed with the model's predictions, and could vary by a factor of two in ten minutes or by a factor of four in two hours.

4 – A QUALITY OFFERING IN METROLOGY

In order to fulfill its task of monitoring human exposure and environmental radioactivity as efficiently as possible, IRSN strives to improve the quality and reliability of the tools and methods it uses for measuring ionizing radiation. It also makes its measurement results available to the public.

High-quality metrology

In 2009, IRSN jointly issued, with ASN and the French General Directorate for Health, France's first national status report on the radiological quality of water distributed in the country.
All the natural uranium concentration values in the report were obtained from measurements performed by IRSN, based on its special expertise in the area of natural radionuclide analysis. Over the years, the Institute has become a model for French laboratories measuring radioactivity in environmental samples, foodstuffs, drinking water or industrial or hospital waste.

IRSN measures radioactivity levels in food and drinking water samples.

IN THE WORDS OF

CARL-MAGNUS LARSSON,
of SSM, the Swedish Radiation Safety Authority

Radioecology, a branch of ecology dedicated to studying the transfer of radioactive substances and their effects on ecosystems, provides scientific guidance for decision-making in various situations in which people and the environment are exposed to ionizing radiation, as a result of daily activities, accidents or malicious acts. With the renewed interest in nuclear power in the world, assessing the environmental impact of daily operation and the potential consequences of an accident is a growing activity. Supported by the European Commission, the FUTURAE project has mapped out European radioecology research and set up a cooperative network to share skills and facilities in the area. Eight radiation protection organizations, including IRSN and SSM, signed a memorandum of understanding to create the European Radioecology Alliance. The network is currently defining its strategic agenda by identifying priority issues and assessing the theoretical and experimental work to be carried out, as well as the decision-making and training tools to be created."

Setting up the system for collecting measurement results and the Internet site of the national network of environmental radioactivity measurements

The radioactivity measurement collection system was officially launched in January 2009, bringing to a close the preparatory phase on which IRSN had been working since 2005. The Institute was in charge of the project to develop the IT system of the national network of environmental radioactivity measurements.

As part of this work, it developed various Internet applications to make this information available to the public, as well as to ASN or InVS experts using it in a regulatory context. In addition, the Internet site created for the public in early 2010 is a good example of France's transparency policy, as the site draws on multiple sources of information to keep citizens better informed about the radiological state of their environment.

www.mesure-radioactivite.fr

IRSN monitors workers exposed to ionizing radiation.

5 – RADIATION PROTECTION IN THE WORKPLACE

IRSN monitors the exposure of workers and develops methods and tools for improving accuracy in this area.

Worker exposure monitoring

The information system on the monitoring of occupational exposure to ionizing radiation (SISERI) reached its nominal performance level in 2009. In addition to passive and operational dosimetry data, the system is now able to integrate data concerning the internal exposure of workers and make it available to occupational health physicians. Aircrew exposure is also taken into account. Tools designed to help radiation protection specialists and occupational health physicians to use SISERI are available on a new website, along with regulatory and practical information on worker exposure monitoring. IRSN has also proposed a single classification list of activities and occupations, for use by all those involved in worker exposure monitoring, as a supplement to the information available in SISERI. The list will be useful in drawing up annual exposure statistics. The 2008 report on occupational exposure to ionizing radiation covered 306,629 workers.

www.irsn.fr

Radiation protection for medical staff

IRSN is closely involved in the European FP7 ORAMED contract for the optimization of radiation protection for medical staff, coordinated by the Belgian research center, SCK-CEN. The main purpose of the contract is to develop methods to obtain a more accurate estimate of worker exposure in the medical field and reduce it, if possible. It particularly focuses on: measuring and calculating doses to the extremities and the crystalline lens, and optimizing the use of operational dosimeters, in the field of interventional radiology;
and improving extremity dosimetry in nuclear medicine.

IRSN is involved in all these areas and coordinates work to optimize operational dosimeters. Measurements are currently underway in laboratories and many hospitals and the first IRSN report was issued in 2009.

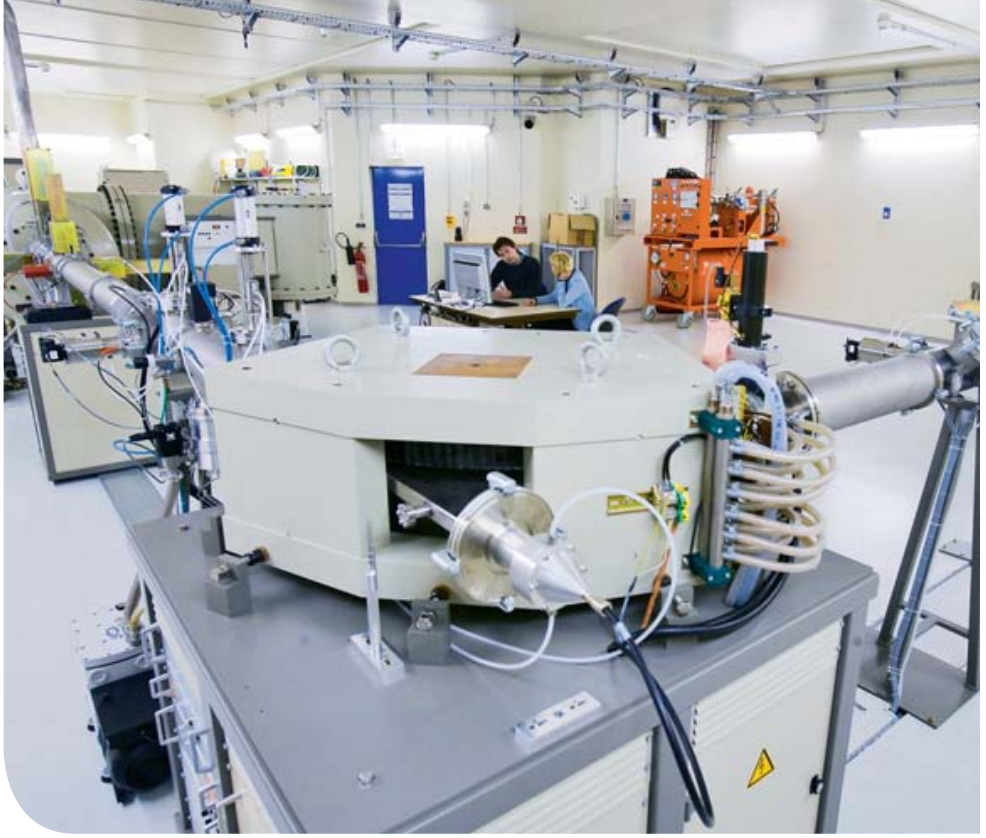
www.oramed-fp7.eu/

Measuring neutron energy

The development of two spectrometers for measuring neutron doses began as part of a thesis, co-funded by IRSN and the French national laboratory for metrology and testing (LNE). The dissertation was defended in 2009. The first system, built with CNRS IN2P3 in Strasbourg, covers the high-energy range. The second, dedicated to lower energies, was built by CNRS

600 SAMPLING
POINTS FOR RADIOACTIVITY MONITORING NATIONWIDE (600 in 2008).

IN2P3 in Grenoble. These instruments use innovative technology to detect secondary particles (protons), making it possible to determine neutron energy.
The two spectrometers will provide IRSN's AMANDE facility with high-performance tools, capable of directly measuring the energy and fluence of neutrons for high-quality metrology. AMANDE provides monoenergetic neutron fields used as national metrological references for neutron dosimetry, as part of a cooperative project between IRSN and LNE.



The AMANDE facility provides metrological references for neutron dosimetry.

On-site worker monitoring

In October 2009, the first whole-body counting campaign was conducted outside Paris, using IRSN's mobile whole-body counting laboratory. This specific monitoring consisted in measuring radioactivity in the lungs. The campaign involved 22 people at the nuclear medicine department of the university hospital in Angers in the west of France. It confirmed the advantages of the mobile laboratory for on-site measurements on workers handling radionuclides that have a half-life too short for normal analyses. Analysis of the measurements showed positive contamination results for the following radionuclides in around 40% of the examined personnel: technetium-99m, iodine-131, and fluorine-18.
This tool helps improve worker monitoring in nuclear medicine departments.

Whole-body counting on women

Personnel working for the nuclear industry and exposed to the risk of lung contamination undergo whole-body countings. Measuring instruments are calibrated using male phantoms, which can significantly bias the interpretation of measurements on women.
In 2009, computer models of the female thorax were developed to compensate for the absence of calibration phantoms. A data library with the most common morphologies, taking bust circumference and cup size as reference criteria, was created using computer graphics software. An initiative was launched at Areva-NC's La

The dosimeters installed in workplaces are designed to measure ambient radioactivity.

The mobile whole-body counting laboratory is used to monitor worker dosimetry at their workplace.

IN THE WORDS OF

SOPHIE JACOB, Research Engineer at the IRSN Epidemiological Laboratory

Last October we launched a study on the risk of radiation-induced cataracts in interventional cardiologists. These professionals are chronically exposed to X-rays and their eyes are prime targets. Such exposure could cause crystalline lens disorders, leading to early development of cataracts.
The study, called O'CLOC, for Occupational Cataracts and Lens Opacities among Cardiologists, compares two groups of cardiologists, one exposed, the other not exposed to ionizing radiation. It is the first study to focus on this profession.
As part of the study, 300 cardiologists from all over France will undergo cataract screening, with the help of ophthalmologists.
The O'CLOC study is conducted by IRSN and supported by the French Cardiology Society and the French Ophthalmology Society. The results are expected in 2011."

Hague plant in Normandy to make corrections and obtain more accurate internal contamination measurements for female personnel, based on their morphology.

New radionuclide data sheets

In June 2009, seven new radionuclide data sheets were put online.
These documents, prepared jointly with INRS, the French national institute for research and safety, are particularly intended for unsealed source users and personnel in charge of radiation protection: radiation protection specialists and occupational health physicians.
IRSN experts oversaw the preparation of these sheets on carbon-14, tritium, iodine-123, iodine-125, iodine-131, phosphorus-32 and technetium-99m. They complete a series of data sheets on the use of radionuclides in unsealed sources, particularly in the field of nuclear medicine.
The most relevant information is listed for each radionuclide along with good radiation protection practices.
www.irsn.fr

Monitoring worker dosimetry

In 2009, IRSN stopped using photographic film dosimeters for monitoring worker dosimetry. It now offers dosimeters using different techniques, such as radio-photoluminescence for dosimeters worn on the chest, thermoluminescence for extremity dosimeters, and track detection for neutron dosimeters. A more advanced neutron dosimeter came into use during the year.
In 2009, the Institute carried out individual monitoring for over 158,000 workers in France and abroad. This represented some 20,000 customers and required the production of around 1.5 million dosimeters.

Uralix columns tested in the United States

Since March 2009, IRSN has marketed a new material for quantifying uranium in urine, used in monitoring workers exposed to the risk of internal contamination.
The material, developed and patented by the Institute, is called Uralix and is intended for nuclear medical analysis laboratories. It is based on the use of calixarene molecules to trap uranium, which is then measured.
In 2009, over 300 Uralix columns were sent for testing to several American radiotoxicological analysis laboratories, upon their request them.
The results of these tests should not only allow the Institute to improve the protocol for using the columns, but also help it develop contacts with American companies to possibly launch Uralix columns on the US market.

Reading neutron dosimeters.

Preventing proliferation of nuclear, biological and chemical weapons and controlling nuclear and radiological security in the face of terrorism.

SECURITY OF NUCLEAR FACILITIES AND MATERIALS

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

IRSN helps control nuclear and sensitive materials and protect facilities against malicious acts, both nationally and internationally. The Institute took part in reviewing regulatory texts in both these areas in 2009. With regard to the control of nuclear and sensitive materials, it continued to carry out its tasks of examining files and escorting inspection teams. Concerning malicious acts, it focused on the security of radioactive sources and on organizing emergency exercises to gain a better understanding of the interfaces between nuclear safety and nuclear security.

A nuclear facility security fence.

1 – PROTECTION AND CONTROL OF NUCLEAR AND SENSITIVE MATERIALS

Physical protection of nuclear materials

In 2009, at the request of the authority in charge of nuclear material control, IRSN examined 172 files on the physical protection of nuclear facilities and materials, as well as nuclear material transport.

Experts from the Institute officially appointed as "nuclear materials inspectors" are mandated by the Senior Defense and Security Official of the Ministry of Energy to conduct inspections at facilities holding nuclear materials, at the Official's request. The experts responsible for this task conducted 45 facility inspections in 2009, one of which was initiated in response to the incident reported by the management of the ATPu facility, operated by Areva at Cadarache in the south of France, as well as 50 inspections during transport operations, and 24 inspections on transport equipment.

Inspections begun in 2008 on information systems involved in physical protection functions continued in 2009, and focused particularly on:

– site and facility access control;
– nuclear material monitoring systems;
– computerized systems controlling protection systems.

Inspections covered checking compliance with technical instructions and with provisions in regulatory standards, and ensuring that equipment meets the objectives defined in the regulations.

In addition, several local exercises were carried out in the presence of nuclear materials inspectors to give local security forces training under real-life conditions.

IRSN has been developing a laboratory for testing physical protection systems (detection, delay, warning) since 2009. In this context, several technical meetings were held with partners experienced in the field of protection, such as STBFT, the French Ministry of Defense technical department for buildings, fortifications and engineering works, and GIGN, the French national gendarmerie intervention group.

An IRSN engineer tests the gamma spectrometry measuring bench.

Nuclear material accountancy and control

In 2009, IRSN examined 144 files and 86 nuclear material inventory reports at the request of the authority in charge of nuclear material control.

Experts from the Institute, designated by the Senior Defense and Security Official from the ministry of Energy as nuclear material inspectors, also conducted 52 inspections on nuclear material accountancy and control in 2009. Some of these inspections included a thorough review of the accountancy of these materials and the measuring devices used.

In 2009, inspection work included verifying checks carried out by operators during shipment and receipt of nuclear materials at major fuel cycle facilities in France. The inspections showed that, overall, the provisions in the regulatory standards had been properly implemented.

IRSN also conducted 12 technical inspections at facilities holding small amounts of nuclear materials that must be declared to the competent authorities.

Interpreting a gamma spectrum.

171 INSPECTIONS
INVOLVING NUCLEAR MATERIAL CONTROL (196 in 2008).

IN CLOSE-UP

CHANGES IN REGULATIONS CONCERNING PROTECTION AGAINST MALICIOUS ACTS

Decree no. 2009-1120 of September 17, 2009 on the protection and control of nuclear materials, introduces the notion of acts aimed at *"modifying nuclear materials, damaging them or spreading them"* and extends the requirements of the previous decree (no. 81-512 of May 1, 1981) *"to facilities where such materials are held"*.

Furthermore, Decree no. 2007-1557 of November 2, 2007, relating to nuclear installations, stipulates that the preliminary safety analysis report of such a facility should describe *"any accidents that may occur, whether due to internal or external causes, including malicious acts"*.

This provision applies to construction license applications for nuclear installations, as well as to periodic safety reviews. This change in regulations, which is aimed at enhancing the protection of facilities against malicious acts, is made in an attempt to standardize regulations concerning a) the protection and control of nuclear materials, and b) the protection of nuclear facilities against malicious acts.

Under the modified regulations, the Institute will carry out more assessments to determine how effectively facilities are protected against malicious acts.

CHALLENGE 4

The CEA Marcoule site in southern France.

Taking nuclear material inventory in an emergency situation

During 2009, the Institute prepared an exercise involving the ATALANTE facility at the CEA Marcoule site, and the LECA-STAR facility at the CEA Cadarache site. At the request of public authorities, IRSN regularly organizes emergency response exercises that involve taking nuclear material inventory at a facility, for the purpose of testing the decision-making chains, and coordinating the various participants, including operators and public authorities. The exercises entail taking a nuclear material inventory at one or more facilities within the space of a few hours to confirm or rule out the existence of any malicious acts, such as theft or diversion of nuclear materials, or acts of sabotage. Fourteen exercises of this type, held annually, have already taken place. They have been used to test emergency response procedures applicable at major French nuclear sites.

International inspections in a non-proliferation context

International inspections of chemical facilities

In 2009, IRSN escorted eight inspections conducted by the Organization for the Prohibition of Chemical Weapons (OPCW) at French industrial sites, compared to ten the previous year. The last two inspections highlighted further problems concerning the confidentiality of information reported to OPCW headquarters, and led to discussions between French authorities and OPCW representatives on how to improve procedures for future inspections in France. IRSN also pursued activities initiated in previous years by actively participating in table-top exercises on challenge inspections, on April 8 and November 17, 2009. The purpose of these exercises was to test the system, defined and set up with the help of the Institute, to prepare for any very intrusive inspections resulting from a challenge inspection called for by a State. The exercises confirmed the operational feasibility of the emergency instructions drawn up and the effectiveness of communications among the various parties involved in the challenge inspections.

International inspections of nuclear facilities

In 2009, the Institute escorted 54 Euratom and IAEA inspections, which represents a 20% increase on the previous year. It should be emphasized that IRSN is strongly committed to this escort task, and to its participation in the numerous meetings with the European Commission, the operator and the French authorities to improve the standard of inspections carried out by international agencies. Activities of particular note included:

12 TECHNICAL INSPECTIONS CONDUCTED IN FACILITIES UNDER THE "DECLARATION" REGIME (15 in 2008).

IN THE WORDS OF

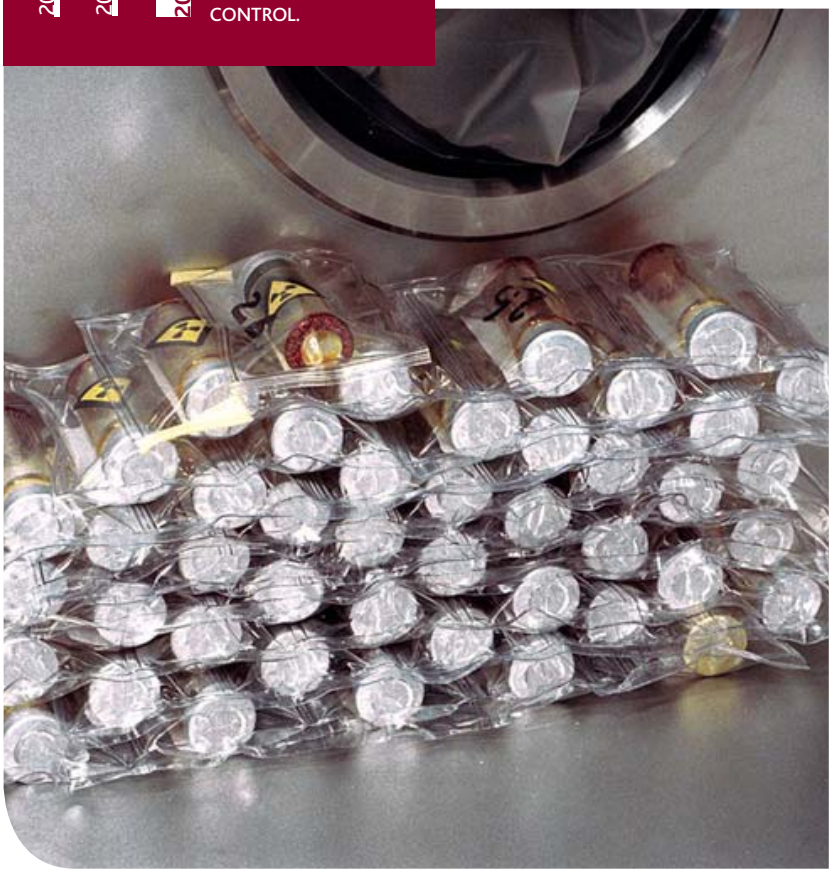
JEAN CARLIOZ,
Head of the Economic and Nuclear Infrastructure Security Department for the Senior Defense and Security Official of the Ministry of Industry

There is a clear separation of roles between the Ministry and IRSN with regard to the implementation of the Chemical Weapons Convention.
While the Ministry is responsible for determining the political action required under this international treaty, it must be able to draw on unquestionable technical expertise. In this respect, IRSN is acknowledged as having a level of expertise that is undisputed and unique in France, bringing together a wide range of skills and experience within an efficient organization.
Regarding our contribution to the implementation of the Chemical Weapons Convention, the Institute is involved in preparing documents on request and escorting routine inspections in the various industries concerned – around ten a year – as well as writing reports. IRSN has a wealth of experience in this area and an excellent level of operational capacity, both of which are crucial for ensuring that inspections proceed smoothly."

– testing new equipment, such as the 3D laser used for rapid detection of material movements between two inventories;participating in negotiations on the reorganization of certain facilities for accountancy purposes, so that more relevant information can be provided to Euratom;
– implementing inspections in waste processing facilities.
IRSN has developed a transcoding application, designed to transpose accounting data based on national accounting standards to Euratom accounting standards, for facilities with limited computer systems.
The application meets the specifications defined in European Regulation No. 302/2005. It generates accounting files such as the inventory change report to be submitted to the European Commission. The operators concerned must also submit accounting documents, such as a physical inventory and a material balance report when they take inventory. IRSN has therefore organized specific training for operators to enable them to generate files using the European Commission's ENMAS Light software application.
The Institute also provided technical assistance to French authorities in several matters, including the application of working principles agreed upon between France and Japan, regarding imports of equipment to be installed on French nuclear sites. At the end of 2009, French authorities approached IRSN for information on exports of depleted uranium from France to Russia, based on international accounting statements.

Nuclear measurement: installing a passive neutron measuring device compatible with the volume of a standard drum.

43 (2007) 45 (2008) 54 (2009) MISSIONS TO ESCORT INSPECTIONS INVOLVING INTERNATIONAL NUCLEAR MATERIAL CONTROL.



Samples for the Euratom inspection.

2 – PROTECTION AGAINST MALICIOUS ACTS

Regulatory text revision

In 2009 IRSN continued to participate in the revision of French regulations on the protection and control of nuclear materials, nuclear facilities and nuclear material transport. Work involved the preparation of Decree no. 2009-1120 of September 17, 2009 to implement Articles L1332 and L1333 of the Code of Defense, and four orders to implement the Decree:
– one relating to the transport of nuclear materials, which groups together general provisions covering different types of transport of nuclear materials, and special provisions on the different modes of transportation (road, rail, sea, air);
– one relating to license application procedures;
– one specifying the procedures for studying the protection of nuclear materials, nuclear facilities and nuclear material transport;
– and, lastly, one defining the physical protection measures to be implemented by the licensee.

Restricted expert groups

The restricted expert group responsible for nuclear reactors met once in 2009 to examine the protection of the Jules

CHALLENGE 4

8 MISSIONS
TO ESCORT INSPECTIONS INVOLVING THE CHEMICAL WEAPONS BAN (10 in 2008).

Horowitz research reactor against malicious acts. This reactor is currently under construction at Cadarache. Work on examining files concerning acts likely to affect either the information systems of the Flamanville 3 EPR reactor or the MAGENTA facility at Cadarache was largely completed in 2009.

Computer image of the MAGENTA facility and its site.

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

In 2009, the Senior Defense and Security Official from the Ministry of Energy asked IRSN to organize the fourth EPEES nationwide security protection and assessment exercise. The purpose of these exercises is to test coordination between nuclear facility operators, who are responsible for site protection, and public authorities, including the Prefect, the state prosecutor, and local and national law enforcement agencies.
The preparatory work with the different entities involved continued throughout the year in several working groups set up by the Institute.

Inspection at production unit no. 1 of the Tricastin plant.

Emergency exercise at the EDF Tricastin plant

In addition to EPEES-type emergency exercises, the relevant authorities (the Senior Defense and Security Official from the ministry of Energy and ASN) decided to carry out an emergency "safety" exercise, initiated by a malicious act. Emergency "security" exercises are mainly intended to test the coordination and intervention of the various stakeholders involved in the response to a malicious act affecting a nuclear facility, while the "safety" aspect is merely simulated.
This approach needed to be completed by organizing an exercise in which intervention would be simulated, to study the interaction between safety and security aspects more closely.
As this type of exercise must not lead to the disclosure of sensitive information concerning the resources available to

IN THE WORDS OF

CLAUDE AZAM, Head of the Department of Defense, Security and Economic Intelligence at the Ministry of Ecology, Energy, Sustainable Development and the Sea

The year 2009 was notable for the fact that the Ministry of Ecology, Energy, Sustainable Development and the Sea took on responsibility for the protection and control of nuclear materials, nuclear facilities and nuclear material transport.
During this period, the Institute provided us with the skills, expertise and personnel required to facilitate our new task.
This support was particularly welcome at a time when we were also tasked with reviewing the regulatory framework for nuclear security. IRSN helped us fully appreciate the technical impact of the measures we planned to take.
We also made progress in drawing up new regulations relating to radioactive sources, thanks to studies the Institute had conducted in advance. These are all subjects that are relatively new to us, and IRSN has amply demonstrated its ability to listen and respond in a way that really addresses our concerns."

IN CLOSE-UP

EXCHANGES WITH THE IAEA CONCERNING ANALYSIS AND INSPECTION

The regulatory changes underway relating to the control of nuclear materials have prompted IRSN to rethink its organization and working methods. Against this background, a meeting was organized in May 2009 with inspectors from the Department of Safeguards at the International Atomic Energy Agency (IAEA). Even though the tasks entrusted to the IAEA and the national authority responsible for the control of nuclear materials do not serve exactly the same purpose, organizing and conducting assessments and inspections are based on very similar principles.
Exchanging experience and good practice is therefore a useful exercise for both parties.
The issues addressed included the link between analysis and inspection procedures, as well as the methods used, and training and supervision of the personnel involved.

the aggressors, or the vulnerability of the facilities, it was presented as a series of degraded conditions at the facility that had to be dealt with.
The actual exercise took place at the EDF Tricastin plant on November 26. IRSN helped define the scenario, set up its emergency response center and dispatched several observers to various points where the exercise took place.
The lessons learned from the exercise will add to the information already gained from previous EPEES exercises.

Security of radioactive sources

In connection with the introduction of national regulations on the security of radioactive sources, the Institute helped draft an order aimed at: 1) defining rules for preparing license applications relating to the security of ionizing radiation sources, and 2) determining protection measures that holders of such sources must implement to prevent malicious acts. With the assistance of public transportation operators, IRSN also continued its work on identifying possible scenarios of malicious acts targeting radioactive sources.

Nuclear material control.

International activities

In 2009, at the request of the IAEA, IRSN participated in training courses organized in Moldova and Mexico on design basis threats. It also took part in advisory missions in Finland and the Netherlands involving physical protection of nuclear materials, and contributed to courses in the Netherlands on physical protection of nuclear facilities. In addition, the Institute was actively involved in a course in Senegal on the security of transport operations.

It also took part in working groups organized by the IAEA involving:
– the document defining fundamental security principles;
– Revision 5 of the circular INFCIRC 225, containing recommendations on protection of nuclear materials and facilities;
– the recommendations document on radioactive source security;
– the document on recovering uncontrolled radioactive materials;
– the structure of texts of IAEA recommendations;
– the document on nuclear and radioactive material control and accountancy;
– the development of a method for identifying and assessing risks that must be covered by implementing regulatory and organizational measures under what is known as a "nuclear security regime".
In addition, in order to improve the recruitment and training strategy for IAEA inspectors, IRSN completed a report, which it submitted to the Agency, defining the behavioral profile required for inspectors in charge of nuclear material inspections.
Lastly, a technical support initiative relating to nuclear material measurements was organized in 2009 with the IAEA, which wishes to set up a database of characteristic reference spectra for a number of materials. The Agency can benefit from IRSN's experience in this field and in managing measurement results. IRSN is also working on nuclear material measurements in the context of cooperation with the U.S. Department of Energy. In 2009, the two organizations began to collaborate for the first time on assessing ways to mitigate the impact of acts of sabotage. Initially this will involve looking at long-range attacks with an armor-piercing weapon.
Finally, in December 2009, the Institute organized a two-day seminar on radioactive source security, which was attended by representatives from Belgium, Spain, the Netherlands and Sweden.

13,500
NUMBER
OF RECORDED MOVEMENTS OF RADIOACTIVE SOURCES (14,000 in 2008).

Developing IRSN's technical response and mobilization capability to face a major radiological emergency.

EMERGENCY RESPONSE

Changes in organization and resources

IRSN has continued to improve its organization and resources in the area of radiological emergency response. Among other things, it has installed a new platform, called C3X, at its Emergency Response Center, for computing radiological and dosimetric effects, and improving its ability to assess an emergency and map the results.

1 – EMERGENCY RESPONSE ORGANIZATION

IRSN is improving its organization to be able to respond more effectively to any radiological emergency, and to assist in the post-accident or media handling of an event.

Developing resources for responding to a radiological emergency

In 2009, IRSN began work on a general mobilization plan in the event of a radiological emergency. The goal is to determine the specific details of IRSN's organization, whether it concerns a radiological emergency, post-accident situation, or an event with a media or political impact. In these situations, IRSN's role is to provide the authorities with technical expertise and issue reports. A communications unit was created within the Emergency Response Center to prepare and deliver information to the public, the media, and IRSN's staff. Concerning IRSN's resources dispatched to the site in the event of an accident, a team of 60 people, trained to implement the recently renovated mobile response unit, was set up, and an on-call system put in place. Ten people are on call every week of the year to carry out IRSN's various tasks locally within the shortest time possible: coordinating measurement and sampling campaigns, analyzing environmental samples, and monitoring internal contamination in humans.

A special team is on call to respond to any emergency.

4 ACTUAL
EQUIPMENT OF THE EMERGENCY RESPONSE CENTER (3 in 2008).

Emergency response guide

As part of the activities of the steering committee in charge of managing the post-accident phase of a nuclear accident or radiological emergency (CODIR-PA), supervised by ASN, IRSN has prepared a draft guide for the local authorities concerned (prefectures and municipal councils) to help them through the emergency phase in the event of a nuclear accident. The guide is open-ended in design and applies only to moderate accidents resulting in short-term release, and liable to occur either at a French nuclear facility or following an accident during the transportation of radioactive materials. It lists the various issues to be addressed during the week after the release ends, taking the results of CODIR-PA work groups into account. During this period, a number of steps essential for long-term management must be taken, such as decontaminating inhabited areas.

Emergency response agreement with Météo-France

In December 2009, Météo-France (the French national meteorological service) and IRSN signed a radiological emergency response agreement. The agreement, which

renews an agreement signed in 1994, specifies the methods IRSN will use to alert Météo-France and how information will be exchanged between the two organizations, including the provision of meteorological data and forecasts by Météo-France. It also specifies the method for determining atmospheric transport of radioactive substances, as well as data that needs to be shared.

2 – DEVELOPING TOOLS

The tools developed by IRSN are used for assessing the radiological impact of an accidental release, estimating the doses received by persons exposed to ionizing radiation, and developing treatment strategies.

A new computing platform for the Emergency Response Center

A new impact measuring and mapping platform, called C3X, was installed at IRSN's Emergency Response Center in 2009. The platform computes the radiological impact of an accidental release of radioactivity to the environment, then displays the results on a map. In a radiological emergency, IRSN will transmit these maps to the appropriate authorities, together with recommendations for managing the situation.
The operational integration of this new platform at the Emergency Response Center involved fully training any employees who might need to use it in an emergency. The platform was used successfully during national emergency exercises in the second half of 2009. The exercises highlighted the platform's ease of use and the speed with which results could be delivered.

Developing emergency tools for PWRs

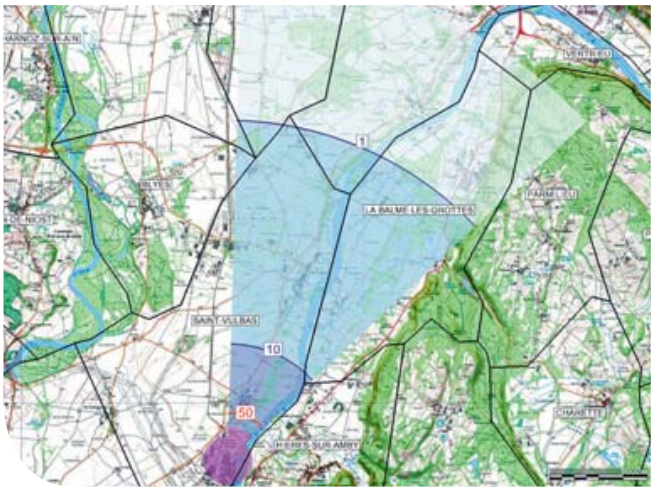
In the event of an accident in a pressurized water reactor, various information technology tools are available at IRSN's Emergency Response Center for assessing

5 NATIONAL
NUCLEAR EMERGENCY EXERCISES EXCLUDING DEFENSE-RELATED ACTIVITIES (9 in 2008).

IN THE WORDS OF

MARIA JULIA MARINISSEN,
Team Leader, International Partnerships and Initiatives, United States Department of Health and Human Services

The Global Health Security Initiative (GHSI) was launched in 2001. It is a cooperative international effort aimed at strengthening preparedness and response among its member countries and organizations with regard to emergency situations arising from nuclear, radiological, or biological agents, as well as pandemic influenza. The GHSI work group on radiological and nuclear risks, chaired by Jean-René Jourdain of IRSN, and for which I manage the executive administrative office, is responsible for increasing preparedness for radiological and nuclear events. Under IRSN's leadership, the group's activities include setting up a network of laboratories for radionuclide measurement, so that GHSI members are able to respond more effectively to radiological emergencies involving a large number of victims. With this in mind, we are currently conducting a study aimed at mapping each country's abilities. The results will be used to build a database of laboratories that could help with sample analysis. Another area of activity is the development of emergency communication protocols between countries, in cooperation with the competent national authorities of IAEA Member States. The group has successfully conducted exercises to ensure that all members can be contacted quickly for mutual assistance if an event with an international impact occurs."



A map made using the Cartx application during the Bugey exercise.

3 NATIONAL
NUCLEAR EMERGENCY EXERCISES INVOLVING DEFENSE-RELATED FACILITIES (4 in 2008).

the status of the damaged reactor, and for sending forecasts of possible changes in this status and any associated radioactive release. IRSN is constantly upgrading these tools to provide the public authorities with effective support.
Those currently available at the Emergency Response Center are based on highly simplified models of complex physical phenomena that give computed results very quickly. The tools were validated by comparing them with the results obtained from more detailed computer codes, such as the Accident Source Term Evaluation Code (ASTEC), developed by IRSN to simulate phenomena likely to occur during a reactor core meltdown. In 2009, taking advantage of the significant increase in available computing power, IRSN began directly integrating certain parts of ASTEC into Emergency Response Center tools. Among other things, this will enable it to equip the Emergency Response Center with a new tool called ETHER in the near future, for evaluating pressure changes in the reactor containment during an accident. This operation, which involves IRSN's teams in charge of ASTEC and its use in safety studies, will allow specific codes to be developed and shared among the members and recent knowledge to be incorporated into emergency response tools.

Using Level 2 PSAs at the Emergency Response Center

IRSN has begun formalizing the knowledge acquired during the development of level 2 probabilistic safety assessments (PSAs) for nuclear reactors, by creating summary sheets available at the Emergency Response Center. The level 2 PSAs performed by IRSN for 900 and 1,300 MWe PWRs – and subsequently for the EPR – identify accident scenarios that could lead to radioactive release and estimate their probability (by calculating their likelihood of occurrence) and the scale of the corresponding release. The content of sheets prepared in 2009 for 900 MWe reactors will be extended to EDF's reactors, all of which must be updated as new knowledge is acquired.

Reconstruction of radiological accidents

In order to define as accurately as possible the treatment strategy to be applied to victims of radiological accidents from exposure to an external radioactive source, it is necessary to know the distribution of doses received by the body. The SESAME application, developed by IRSN for this purpose, reconstructs these dose measurements through the combined use of digital anthropomorphic models (phantoms) and the Monte Carlo MCNPX code.
In 2009, new features of SESAME, developed and validated both experimentally and digitally, were introduced, allowing the morphology and posture of the digital phantoms to be changed. The new version provides a more realistic description

Scoring chromosome aberrations.

Voxelized phantoms are used to reconstruct radiological accidents.

of the victim's posture at the time of the accident and a more accurate reconstruction of the accident.

The many factors behind chromosomal abnormalities

In 2009, IRSN performed the first bibliographic review aimed at identifying physical, chemical, or biological factors liable to produce chromosomal abnormalities that are stable over time, such as translocations. Translocations can be used to assess an individual's exposure to ionizing radiation from a blood sample, long after suspected irradiation. As the rate of translocations in people who may have been exposed is compared to the rate in a control population, the effect of other factors that could cause chromosomal abnormalities must be known, so as to distinguish a posteriori the effect of ionizing radiation from other factors. The results of the bibliographic review completed by IRSN show that the age and gender of individuals, habits such as drinking alcohol and smoking, and occupational exposure, all lead to a significant increase in translocations. This makes it important to know an individual's history to obtain a retrospective assessment of his or her exposure as accurate as possible.

Calixarenes are used to trap uranium.

Use of calixarenes in treating uranium contamination

IRSN has a research program that seeks to limit the number of actinides penetrating the skin in the event of contamination. As part of this program, a thesis, co-funded by the French defense procurement agency, has led to the development of a calixarene-based emulsion. Calixarene is a molecule capable of trapping uranium to decorporate it.
The new emulsion is particularly effective on both healthy and injured skin, reducing uranium absorption through the skin by more than 95%. IRSN has filed a patent application for this innovative product. Other pharmaceutical forms are currently being studied to find appropriate solutions for occupational health physicians having to deal with cases of uranium contamination.

2 DOSE
ASSESSMENTS BY BIOLOGICAL DOSIMETRY (4 in 2008).

IN CLOSE-UP

FOURTH SUCCESSFUL CASE IN CELL THERAPY

Teams from Percy Military Hospital and the French armed forces blood transfusion center worked closely with IRSN physicists specializing in dosimetry and radiopathology to achieve a fo urth success in the treatment of particularly severe radiation burns. In April 2009, an aid mission involving IRSN went to South America at the IAEA's request to examine a patient hospitalized with very severe radiation injuries.

The mission diagnosed very severe irradiation in several areas of the left thigh as a result of accidental handling of a gamma ray source, and recommended that the victim receive emergency treatment at a specialized facility.
The patient was transferred to France and treated according to the protocol used during previous accidents in Chile, Senegal, and Tunisia. IRSN mapped the local surface and deep doses received by the victim and guided the preventive surgical ablation of tissues to prevent any risk of necrosis.
The combined use of cell therapy with mesenchymal stem cells (bone marrow cells that are able to proliferate and develop into many different types of cells) and highly complex plastic surgery made it possible to avoid amputation and restore relatively good motor function.

Mesenchymal stem cells have proved effective in treating radiation burns.

Understanding the effects of chronic low-dose exposure.

EFFECTS OF CHRONIC EXPOSURE

IRSN expands its knowledge

Mindful of the need to deepen its understanding of the effects of chronic exposure to ionizing radiation on human health and the environment, IRSN continued work on various studies in 2009. One such study focused on the effects of external exposure on non-human species and its impact on ecosystems. At the same time, IRSN published the final report on the Alpha-Risk program, which investigates how exposure to alpha emitters affects the risk of cancerous and non-cancerous diseases in the long term. It also continued its work in the EPICE program for the evaluation of cesium-induced pathologies in humans.

Revision of the Environmental Quality Standard for uranium

In order to protect natural environments, the European Water Framework Directive requires member states to determine Environmental Quality Standards (EQSs) for hazardous substances and freshwater ecosystems. For this reason, as part of its work on assessing the environmental risk associated with old uranium mines in the Haute-Vienne area of central France, IRSN conducted a study in 2009, aimed at compiling knowledge related to the behavior and ecotoxicity of uranium in fresh water. The study, which also drew on the results of experimental work within the ENVIRHOM project, helped determine a uranium concentration in water called the "predicted no-effect concentration" or PNEC. As the name indicates, this is the concentration at which the substance concerned has no effect on the aquatic ecosystem. IRSN recommends a value equal to 5 µg/l, while the provisional value currently in force is 0.3 µg/l. The value recommended by IRSN has already been confirmed by an expert from the Canadian Nuclear Safety Commission, and will be submitted to INERIS for approval in 2010 (INERIS is the French national institute for the study of industrial environments and risks) *(also see box on page 78)*.

RESEARCH OUTLET

A REPORT ON THE STATE OF THE ART IN ENVIRONMENTAL AND HUMAN TOXICOLOGY

How do the chemical elements found in the environment, whether they are stable or radioactive, natural or man-made, interact with living beings? What do we know about their possible effects on human health and biodiversity within ecosystems? What resources are available for detecting their presence and dealing with any contamination? These questions are addressed in a joint work entitled *Toxicologie nucléaire environnementale et humaine* (Environmental and Human Nuclear Toxicology) published in September 2009 by Editions Lavoisier. This summary, prepared by CEA and IRSN researchers, highlights the results obtained in their ToxNuc-E (CEA) and ENVIRHOM (IRSN) programs, compared with the international state of the art.

Chronic exposure to radionuclides

In late 2009, IRSN and the State Scientific and Research Institution - Chernobyl Center for Nuclear Safety, Radioactive Waste and Radioecology (SSRI) signed a partnership agreement in the area of nuclear safety and radioecology.

Several projects will be launched in 2010 with the International Radioecology Laboratory (SSRI/IRL) in the Chernobyl region to learn more about the effects of chronic exposure to radionuclides on biodiversity and the functioning of ecosystems. The objectives include:

- identifying differences in radiosensitivity among various species and determining how these species adapt to such an environment;
- assessing the ecological status of the region by studying the decomposition of organic matter and investigating biodiversity, by developing models that distinguish direct effects, such as irradiation and contamination, from indirect effects like prey/predator relations. No team has addressed these aspects to date.

Final results of the European Alpha-Risk project

The European project Alpha-Risk, coordinated by IRSN, came to an end in late

2009. The project brought together eighteen research teams from nine countries, and built on cooperation between teams in various disciplines such as epidemiology, dosimetry, and modeling, to learn more about the long-term effects of exposure to alpha emitters.

Various populations were studied, including uranium miners, workers in the nuclear industry, and the general public. In some cases, the groups studied consisted of several tens of thousands of individuals. The results obtained concern various types of low-level radiation exposure (radon, uranium, plutonium, external exposure) spread out over time, as well as possible interactions between this exposure and the effects of other factors, such as smoking.

A public presentation of the results was organized in Paris in October 2009. The presentation provided an opportunity to discuss the monitoring of populations exposed to radon and its decay products, and to uranium or plutonium. The main conclusions point out that relatively low exposure to radon can lead to a risk of lung cancer. Another important point to emerge was the need for a fuller understanding of the risk of leukemia, brought to light by certain studies. Profitable collaborative research was carried out by epidemiology and dosimetry specialists to calculate individual doses to different organs (lungs, bone marrow, etc.), taking both internal and external exposure into account, over a period of ten years, and under various working conditions. Numerous articles are being prepared or have already been published in scientific journals. The presentation also served to define further activities: continuing to develop expertise in epidemiology, developing collaborative activities with Canada in monitoring uranium miners, increasing studies of workers exposed to uranium and plutonium in Europe, and helping to improve protection against alpha emitters.

www.alpha-risk.org

The Alpha-Risk project examined risks related to alpha-emitter contamination in uranium miners.

Phase 2 of the EPICE program

Following a two-year preparatory phase, phase 2 of the EPICE program for evaluating chronic pathologies induced by cesium contamination began in 2009. This phase of the program will study a population of 18,000 children living in contaminated and

IN THE WORDS OF

MARGOT TIRMARCHE, Director Of Scientific Assessment at IRSN and Coordinator of the ALPHA-RISK project

All our work in the ALPHA-RISK project has been very rewarding. These large-scale, international scientific collaborative activities have succeeded where an isolated initiative would have been destined for failure..

Initiated more than ten years ago through a French-Czech collaborative study on uranium miners, the project has brought together eighteen partners to explore the effects of internal contamination by uranium, radon, radon decay products, and plutonium.

A European network of excellence was recently set up. Internal contamination was one of its themes. Our studies on cohorts of nuclear workers fall within the scope of this radiation protection issue.

Our work confirmed that radon increases the risk of lung cancer, even at relatively low levels of exposure, in both smokers and nonsmokers.

Our results have been used by the WHO and ICRP, which recently reviewed the radon risk to the population at large and to workers."

CHALLENGE 6

Measurement of cesium-137 concentration in the body as part of the research program on the consequences of chronic cesium contamination.

uncontaminated areas of southwestern Russia, to determine how many of them suffer from cardiac arrhythmia that cannot be explained by known factors, such as congenital malformation. IRSN's EPICE program is aimed at identifying a possible link between cesium-137 from the fallout of the Chernobyl accident and certain non-cancerous pathologies among children living in these regions.

A routine cardiac arrhythmia screening campaign began in the field in May 2009 and will last about four years. This operation is being carried out with the clinical and biological diagnostic center of the city of Bryansk, where two medical teams have been assigned to implement the program.

Each child will be given an electrocardiogram and an echocardiogram, and a measurement will be taken of cesium-137 concentration in his or her body. Some children will also have their cardioelectric parameters continuously recorded and the biological parameters of their main plasma cardiac markers examined. IRSN will supervise the interpretation of the results.

All these examinations will be used to establish a diagnosis for each child to detect any heart problems and to identify any causal relationship with cesium-137 contamination. The first results of the study are expected in 2013.

IN THE WORDS OF

MICHÈLE TIXIER-BOICHARD, Scientific Director of Bioresources, Ecology, and Agronomy of the Ministry of Higher Education and Research

In 2009 we worked on developing a national research strategy in toxicology and ecotoxicology.
This followed several observations pointing to the need to increase coordination and research in this area: sector-based consulting groups, the Couty mission, the French Environment Round Table, etc.

A work group made up of research organizations, universities, public institutions, and agencies concerned with this topic was therefore set up under Ministry supervision.
IRSN naturally took part. After taking stock of the situation, we prepared a research agenda defining five strategic lines of research.
These center principally on characterizing contamination and the ecodynamics of contaminants in the surrounding environment, analyzing toxic mechanisms in the low-dose range, taking biological diversity into account when evaluating toxic impact, and lastly, improving risk metrics. This research strategy will then provide a basis for setting up a national coordination committee and defining its organizational structure."

Developing protection against ionizing radiation in the healthcare sector.

PROTECTION IN HEALTHCARE

Improving radiation protection in the healthcare sector

In 2009, IRSN worked in partnership with other organizations to learn more about the side effects of treatments using ionizing radiation in the field of radiopathology. With regard to radiation protection of patients, IRSN was involved in monitoring medical exposure, collecting and updating diagnostic reference levels, and developing more accurate dosimetry techniques to prevent patient under- or overexposure.

1 – RADIOPATHOLOGY

IRSN carries out experimental research aimed at improving knowledge of the mechanisms behind side effects, in order to identify and propose new treatments aimed at preventing or curing these complications.

A new stage in the ROSIRIS program on the side effects of radiotherapy

ROSIRIS is the name of an experimental research program aimed at discovering more about the side effects of radiotherapy. Following a two-year feasibility study, IRSN and Inserm finalized the content of the research program for the next three years during a seminar in July 2009.

Work will focus on the mechanisms that trigger and aggravate radiotherapy complications for organs at risk during abdominopelvic radiotherapy.

The main technological tools required for the program were set up during this feasibility phase.

These studies are part of an experimental initiative to demonstrate a causal relationship between acute effects and delayed effects of radiotherapy.

IRSN is developing research activities for a better knowledge more about the side effects of radiotherapy.

2 – RADIATION PROTECTION OF PATIENTS

In order to provide more effective protection of patients exposed to ionizing radiation, IRSN carries out research to learn more about actual exposure and reduce the risks of overexposure.

Patient information on radiodiagnosis

Following a number of radiotherapy accidents at various French hospitals, IRSN considered how patients exposed to ionizing radiation during medical procedures could be given necessary or useful information.

It conducted this work in collaboration with AVIAM, a French federation of associations providing aid for medical victims, and Le Lien, a health and safety association that works to prevent and study hospital-acquired infections and provide information in this area. The Institute commissioned a study on the information available to patients and health professionals.

The results show that patients receive very little information about the possible health consequences of medical exposure, and this is true for all types of procedures.

The next step is to create a joint work group that will issue recommendations to promote the development of patient information medical consultations.

www.aviamfrance.org
http://lelien.typepad.fr

CHALLENGE 7

IN THE WORDS OF

MARIE-SOLANGE JULIA, President of AVIAM, the French federation of associations providing aid for medical victims

As a patients' association, we find that working with IRSN's experts and scientists definitely helps to convey the users' point of view and experience.
That is why we wished to work together to identify ways of informing patients about the risks involved in exposure to ionizing radiation.
Within this context, we conducted a survey of our members, and found that there was little or no information about these risks.
This situation gives great cause for concern, especially as patients are completely unaware that repeated exposure to diagnostic X-rays is not totally harmless. We must therefore continue our work to inform patients and radiologists alike, and increase their awareness of the issues involved."

Patient exposure levels have been reviewed.

Report on patient exposure

IRSN is involved in monitoring patient medical exposure through the ExPRI information system. The role played by medical practices in population exposure was reviewed in 2009 and knowledge of diagnostic procedures was increased, based on data from examinations performed in 2007.
The more reliable data obtained on the type and frequency of procedures, as well as the related doses, also served to update the estimated annual mean individual dose, and to determine exposure by age and gender, together with the distribution of delivered doses and the number of people actually exposed. A report compiling this data was published jointly with InVS.
Furthermore, a system has been in use since 2004 to collect, validate, and analyze the data used to define diagnostic reference levels (DRLs). A report will be produced drawing on recent data (2007-2008) in 2010. Its results confirm the trends of the previous report and will be used to adapt the regulations associated with diagnostic reference levels.
www.irsn.fr

Changes in patient dosimetry calculations

In nuclear medicine, radionuclides are administered to patients for diagnostic or therapeutic purposes. This means that each organ can become a radiation source, as a result of the energy emitted by these radionuclides in human tissue.
In 2009, IRSN participated in an intercomparison aimed at revising the mathematical models designed to represent human anatomy, and used to calculate the doses absorbed by patients in nuclear medicine. This work helped to reassess the specific absorbed fractions of different organs using new, more realistic models.
The results of IRSN's dosimetry study were validated by comparing them with those obtained by Helmholtz Zentrum München in Germany. These dosimetric studies, which are essential for patient radiation protection, will appear in ICRP Publication 110.

Mini-beam dosimetry

In 2009, IRSN began work on a three-year project aimed at defining and implementing dosimetry techniques adapted to the mini-beams used in radiotherapy.
The project came about following work to investigate the causes of an accident that occurred in Toulouse in 2007, due to a dosimetry error in the very small beams used in stereotaxis.
A work group led by IRSN, in which the *Société française de physique médicale* (the French medical physics society) participated, showed that dose estimations for this type of beam varied significantly from one French radiotherapy center to another. According to an IRSN report published in June 2009, these variations are due to a lack of uniformity in practices, for want of any international consensus on methods and related metrological references. The project will suggest meth-

ods for obtaining reliable, accurate, and reproducible measurements of the dose delivered by the small photon beams used in radiotherapy.

www.irsn.fr

Monitoring overexposed patients

On April 16, 2009, IRSN and AP-HP, the Paris public hospital system, signed a partnership agreement as part of a project called EPOPA.

The project sets up a system for monitoring patients who were overexposed during radiotherapy for prostate cancer at Epinal Hospital. The study sets out to correlate doses received, volumes of healthy tissue irradiated, and the severity of complications observed, with the laboratory and genetic data obtained.

The results will be used to define new tools for diagnosing radiotherapy complications. A clinical research hospital protocol was set up to this end.

By the end of the year, nearly 250 patient cases had been studied. For each of them, blood samples were collected to identify predictive markers for certain complications, such as radiation proctitis and radiosensitivity markers.

Report on uterine dose assessments

From 2004 to 2008, at the request of practitioners, IRSN performed 246 assessments of uterine doses received by pregnant patients during X-ray or CT scan examinations, entailing radiation exposure of the uterus.

The report on these dosimetry assessments, published in 2009, showed that doses were usually less than 35 mGy in conventional radiology.

In CT scanning, they were generally between 15 and 65 mGy, but could exceed 100 mGy (a value below which the ICPR considers that there is no justification for terminating pregnancy). In nuclear medicine, doses were below 10 mGy.

Although average doses are in line with international data, the breakdown of X-ray and CT scan doses by type of examination shows that practices vary, and are sometimes a long way from applicable recommendations.

IN THE WORDS OF

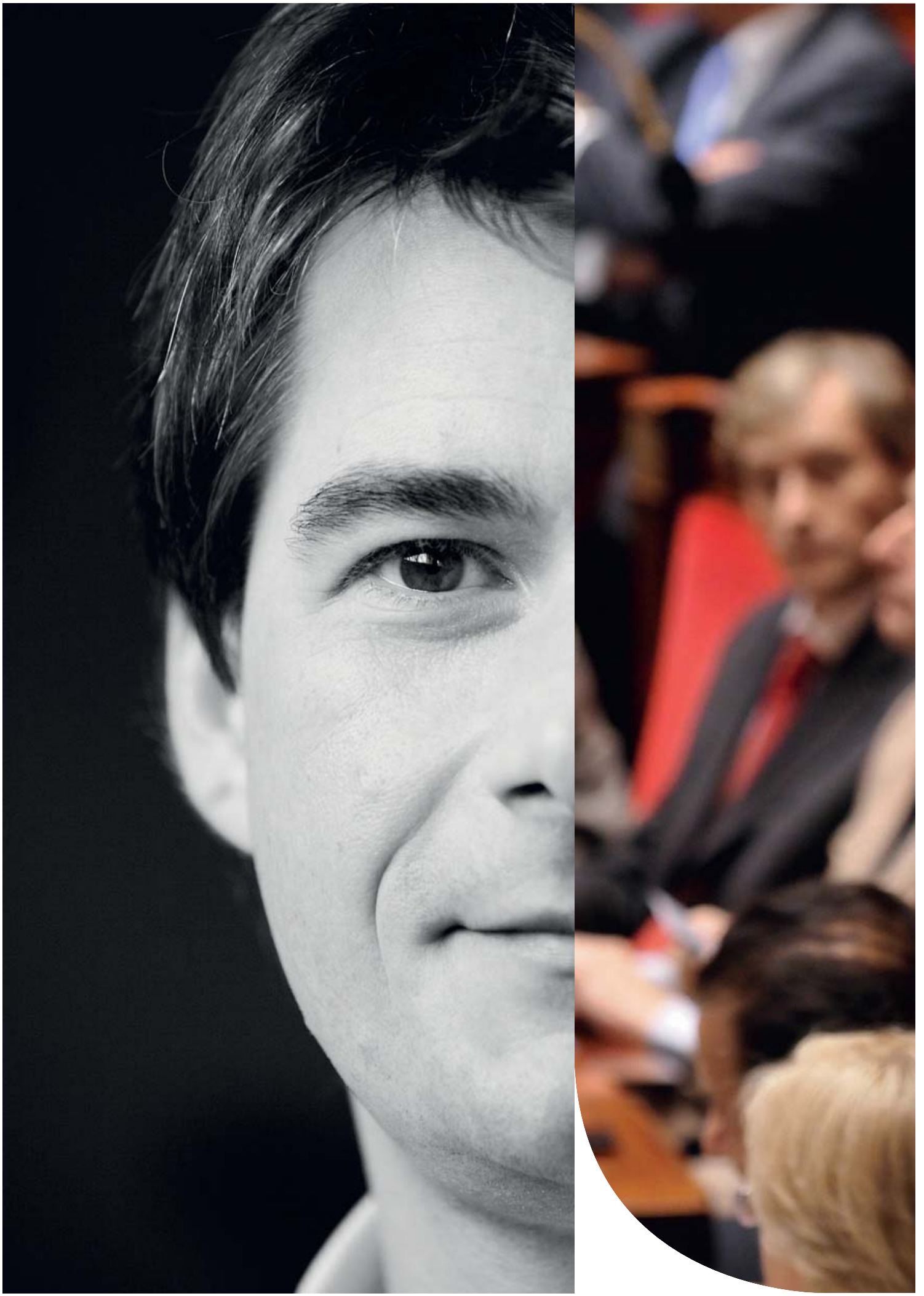
SYLVIE THELLIER, expert in human factors at IRSN's Department for the Study of Human Factors

The Order of January 22, 2009, requires radiotherapy departments a) to analyze the risks of their therapeutic processes to improve safety, and b) to investigate any complications occurring during treatment. These two actions complement one another. IRSN carried out various studies to identify in advance the risk of failing to administer the right dose, to the right place, at the right time, and to the right person. These studies were also aimed at developing analytical tools to meet the requirements of professionals in the field. A thesis, directed jointly by IRSN and the ergonomics laboratory of the *Conservatoire national des arts et métiers* (a center for science and technology research and higher education), showed that risk control is largely dependent on the quality of cooperation among the various specialists involved in the treatment. At the same time, the Institute began a study to learn more about the strategies adopted by radiotherapy departments to meet their obligation to make treatment safer."

Epidemiology in children under five years of age

In 2009, IRSN and AP-HP, the Paris public hospital system, signed an agreement as part of an IRSN study aimed at assessing the risk of secondary cancer or leukemia in children exposed to ionizing radiation during CT scan examinations, under the age of five. The agreement will give IRSN access to data on 23,000 children seen in the radiology departments of the seven AP-HP hospitals taking part in the study. Agreements with the other university hospitals have been prepared to enlarge the cohort.

Improving patient dosimetry is a major concern for IRSN.



« IRSN guides the government and public authorities in their decisions, by providing them with scientific and technical support in the area of nuclear and radiological risk prevention and management. »

LAURENT MICHEL, DIRECTOR GENERAL OF RISK PREVENTION AT THE MINISTRY OF ECOLOGY, ENERGY, SUSTAINABLE DEVELOPMENT AND THE SEA

ENSURING EFFICIENCY

QUALITY

A consolidated, controlled, and effective quality system

In a continuous improvement approach, 2009 was devoted to clarifying the definition of IRSN's quality objectives and preparing the audit for renewal of its ISO 9001 certification.

A clearer focus on lines of improvement

IRSN's management review of June 15, 2009, which set out to identify ways to improve the Institute's quality policy, concluded that it was necessary to clarify the different lines of action required to make this policy more effective. Basically, the IRSN quality policy aims to ensure the satisfaction of partners and customers, both inside and outside the Institute, to strengthen the professionalism of its teams, and to benefit society. For each of these objectives, a process was initiated in a move towards progress.

To satisfy partners and outside customers, the lines of improvement adopted consist of identifying needs more precisely so that partner and customer satisfaction can be measured more closely.

At the same time, IRSN wishes to implement an overall approach to satisfying its customers and partners. Satisfying internal customers consists of providing mutual support among the various divisions. This involves, for example, providing research for an assessment and vice versa, or creating synergy between safety and radiation protection. To evaluate this support process, internal customer satisfaction is measured based on feedback from all staff. Strengthening professionalism involves improving skills management, in correlation with better scheduling of activities. At the same time, systematic analysis of experience feedback and customer opinions are fundamental.

Finally, research was conducted to make a distinction between processes directed toward customers and partners, and those targeting society at large, so that each employee using these processes can measure progress made in a specific area.

10 ISO 17025-ACCREDITED LABORATORIES (10 in 2008).

Preparing an audit.

Certification renewal

Planned for June 2010, the audit for renewal of ISO 9001 certification requires that IRSN demonstrate the ability of its total quality management system to develop a continuous improvement approach. This renewal will rely on a new (2008) version of the ISO 9001 standards (rather than the 2000 version). The new version makes no changes to the quality approach, but strengthens and specifies certain requirements that were implicit until now.

In 2009, IRSN called on the members of its quality network to evaluate the issues raised by the new version and to formalize the changes necessary in its total quality management system to respond to the requirements of the new version of the standard.

In parallel, discussions were initiated to make the internal audit policy more effective by sharing the audit process as much as possible, and preparing an audit program that focuses more closely on the significance of the processes involved as well as the results and frequency of previous audits.

HEALTH, SAFETY, AND ENVIRONMENTAL PROTECTION

Acting as a responsible public organization

Monitoring the conditions in which IRSN's activities are conducted in order to limit their impact on employee health and the environment represents the Institute's goal in the area of hygiene, safety and environmental protection.

Preventing psychosocial risks

In 2009, IRSN contracted with Technologia to perform a study of psychosocial risks at the Institute. This process was engaged after difficult situations in certain units were identified by committees for hygiene, safety and working conditions (CHSCT) and IRSN's inspector general.

The study was performed in two phases: a survey of all employees, which achieved a response rate of 67%, followed by 131 individual interviews conducted at the Institute's three main sites.

The conclusions of the study revealed a situation that is rather positive to the extent that heavy workloads are compensated by an environment that favors personal development.

However, the rising productivity achieved in recent years and certain dysfunctions have placed some employees in situations that they find difficult to handle.

The Institute has therefore made the commitment to prepare a plan of action to deal with these situations and, more generally, to prevent psychosocial risks within its units.

Operation to locate radioactive sources

After the discovery of an unlisted radioactive source in one of its laboratories, IRSN conducted an extensive investigation in 2009 to inventory all radioactive materials held in its facilities. This phase resulted in inspecting 11 sites and more than 1,200 rooms.

A second phase, launched in July 2009, consisted of taking spectrometer measurements to establish a quantitative and qualitative view of products that had not been clearly identified. These operations aim to update the inventory of each unit that holds radioactive sources.

Commitment to sustainable development

In 2009, a discussion group on sustainable development completed an initial analysis of the situation at IRSN. Based on the results, work was organized in three directions:

– "purchasing" policy;
– skills, employment, training and how each person relates to his/her job;
– the environment and pollution.

These directions will serve as the basis for the Institute's commitment to sustainable development and effective application of a corresponding policy in 2010.

IN CLOSE-UP

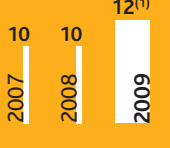
AN OUTSTANDING ADMINISTRATION PLAN FOR THE INSTITUTE

At the Prime Minister's request, forwarded by the Director General for Prevention and Risks, IRSN issued an outstanding administration plan in 2009. This process was initiated in response to the government's policy decision to strongly encourage public services and organizations to set an example in terms of sustainable development.

To achieve this, IRSN has committed itself to:

– reducing paper consumption by 30% by 2012 and using "environmentally responsible" paper;
– limiting the use of personal printers;
– implementing a plan to relocate the Fontenay-aux-Roses site;
– studying its conventional waste and implementing sorted waste collection;
– encouraging the hiring of disabled persons.

A report will be issued annually.



NUMBER OF FACILITIES CLASSIFIED FOR ENVIRONMENTAL PROTECTION IN COMPLIANCE WITH THE ENVIRONMENT CODE.

(1) This figure includes two Cadarache facilities that were declared facilities classified for environmental protection (ICPE) in 2009 following a change in classification and enforcement of an administrative order pertaining to the Cadarache site.

SCIENTIFIC AND TECHNICAL EXCELLENCE

Promoting creativeness, influence, and scientific quality

Fostering exchange between IRSN researchers, encouraging new research, and contributing to training through research were the directions taken in the Institute's policy of scientific and technical excellence in 2009.

Deployment of exploratory research

The program set up to promote development of innovative research projects continued in 2009. Four new exploratory research projects were selected and added to the seven projects initiated in the previous two years. The four new projects concern:

– modeling the phenomenon of vessel embrittlement by liquid metals and assessment of the associated risk in a severe accident situation involving core meltdown on a nuclear reactor;

– measuring heat flux through concrete walls exposed to fire using the reverse method;

– experimental determination of hydride precipitation kinetics in zirconium alloys contained in fuel cladding using synchrotron radiation;

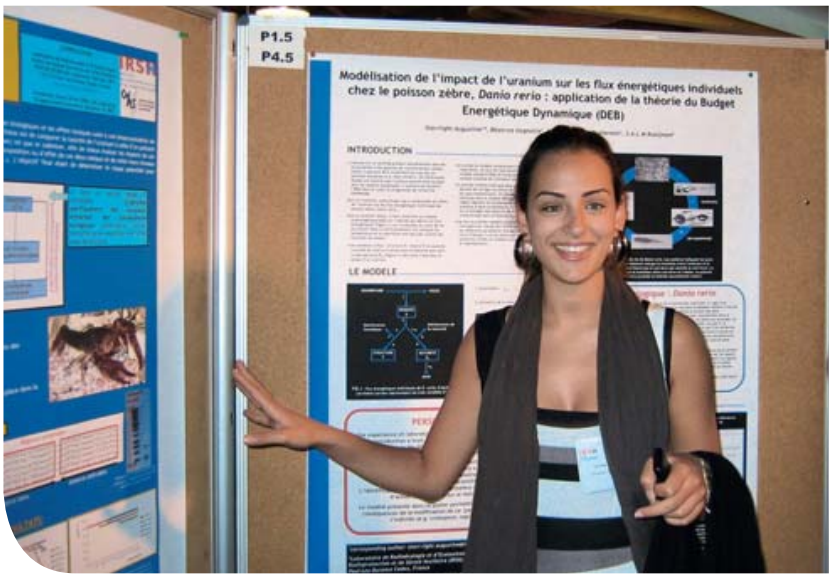
– cataracts induced by radiation in interventional cardiologists.

The first four projects launched in 2007 came to an end in late 2009. Three of them resulted in new research efforts that are part of the Institute's programs for 2010:

– assessment of uncertainty associated with dose determination based on measurements taken to monitor the internal contamination of workers;

– radioactivity found in marine organisms sampled from underwater hydrothermal sources;

– degradation of waste packages by microorganisms.



Dissertation Days in Aussois.

The initial projects also contributed to building internal and external collaborative networks that have reinforced the visibility of IRSN teams.

Cross-disciplinary scientific event

A new cross-disciplinary scientific working group bringing together four of the Institute's divisions was created in June 2009. It is dedicated to droplet flows, a topic of numerous research efforts at IRSN, in particular those concerning the containment spray system used in accident situations in nuclear facilities.

Training through research

The annual training event, IRSN's Dissertation Days, was held from September 28 to October 1, 2009 in Aussois in the east of France. Forty-five doctoral students in their second or third year and five post-doctorate students presented their work to an audience of 178 scientists from the Institute and other organizations (CNRS, universities, engineering schools, industrial partners, etc.). In addition, 26 first-year students presented their results in a poster exhibition.

This year's program brought some innovations. At the opening of the plenary ses-

sions, an introduction to safety, health and environmental issues provided the opportunity to situate IRSN's research in the context of the scientific and technical issues raised by its activity. In addition, to highlight the Institute's relationship with the scientific community, the first day was dedicated to current efforts in exploratory research and a laboratory jointly run by IRSN, the Université de Montpellier, and CNRS, the laboratory on micromechanics and structural integrity (MIST). Finally, a round table devoted to training through research considered the living conditions of doctoral students at the Institute as they prepare their dissertation (revealing the need for a dissertation charter) and their future after their dissertations have been defended.

In 2009, 33 new doctoral students were selected by dissertation commissions and were recruited to work for three years on subjects proposed by the Institute.

The Institute prepares for the Aeres assessment

To prepare researchers at the Institute for evaluation of their work in 2010 by Aeres, the French agency for the evaluation of research and higher education, the Institute's third seminar on scientific and technical excellence, which took place in April, addressed the question of what is at stake for researchers in the Aeres evaluation.

A working group dedicated to preparing the files requested by Aeres was also set up.

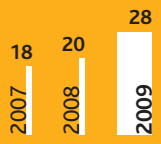
Finally, to be more in line with Aeres' practices, IRSN chose to change its internal assessment program by creating a visiting standing advisory group of outside experts selected for this purpose by the director general.

IN THE WORDS OF

MICHEL SCHWARZ, IRSN Scientific Director

Aeres, the French agency for the evaluation of research and higher education, plans to evaluate IRSN in 2010. This evaluation, carried out at the request of our supervisory ministries, involves the individual research units and the Institute as a whole, covering both the quality of research conducted by our teams and its pertinence in terms of the contract of objectives and the Institute's medium- to long-term plan.

The objective for IRSN is to demonstrate that research is conducted with the necessary scientific rigor and that it provides results that are useful for conducting assessments. The teams are now preparing for the evaluation by compiling a file of results from the past four years, a self-analysis and the unit project for the next four years. This is an extensive effort, which will include the scientific work of researchers: publications, computer codes, etc. In parallel, the functional divisions are preparing a self-assessment of the Institute based on the commitments contained in the contract of objectives."



NUMBER OF DISSERTATIONS DEFENDED.

Contribution to the publication of the ICRP's new general recommendations

IRSN oversaw the translation into French and the publication of new recommendations adopted in 2007 by the International Commission on Radiological Protection (ICRP) that concern protection from ionizing radiation. Experts at the Institute had previously contributed to preparing the recommendations. The new publication ICRP 103 replaces the previous recommendations of ICRP 60, published in 1990, and constitutes the primary reference in this subject area. This document, translated into French, was distributed to business leaders, physicians, and interested organizations: more than a thousand copies were sent out on request and approximately one hundred copies downloaded from the Internet.

www.irsn.fr

Research remains a central part of the Institutes's activities.

3 RESEARCH
SUPERVISOR HABILITATIONS DEFENDED (2 in 2008).

HUMAN RESOURCES

Developing skills in every area

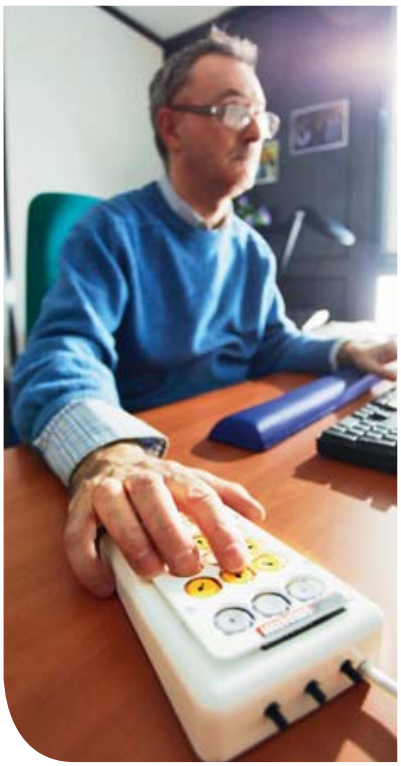
The major directions of IRSN's human resources policy were manifest in three major efforts: implementing skills management at the Institute, expanding best practices and committing the Institute to a policy of solidarity in employment.

Encouraging the hiring of disabled persons

On February 27, 2009, after completing an internal evaluation on disabled employees in 2008, IRSN signed its first agreement with all representative labor organizations to promote hiring the handicapped.
This agreement marks the shared commitment of management and labor unions to developing a proactive and long-term employment policy for the disabled.

Covering three years, the agreement sets precise objectives concerning:
– hiring and retaining disabled employees, with a minimum employment rate of 2% by the end of 2011 and an increase in temporary work and subcontracting with firms in the targeted sector;
– assisting vocational integration of disabled persons with hiring efforts through limited-duration training-through-research employment contracts and internships;
– retaining disabled employees through efforts to prevent their being declared unfit for work by accommodating workplaces and working conditions, in addition to measures for individual support in case of reclassification;
– increasing awareness and knowledge of disabilities in the workplace throughout IRSN staff.

A task force on the disabled was set up at IRSN to support and encourage implementation of the action plan.
It is headed by a task officer from human resources and relies on a dedicated commission composed of an occupational physician, a social worker and employee representatives. The mandatory contribution to Agefiph, the French association for managing a national fund to assist the disabled in securing employment, finances all of these measures and their application.



First agreement signed in favor of disabled persons.

To successfully implement this plan to hire and retain disabled employees, it is essential that all Institute employees abide by it and are able to implement it at all levels.
To this end, the task force on the disabled organized a theatrical performance addressing the issue of disability in the workplace using humorous sketches.
This festive event also provided an opportunity for exchange with staff, which augurs well for the success of the task force's action plan.

Project launched to forecast staff and skills requirements

The year 2009 saw completion of the first phase of the GPEC project to forecast staff and skills requirements, launched in 2008.
This project, which consisted of mapping employment at IRSN, was carried out thanks to the combined efforts of a steering committee composed of representatives from the operational and functional divisions, including the general secretariat, and working groups from each division.
Its deliberations resulted in organizing employment on four levels: professional fields, sub-fields, careers and posts.
The work of defining careers included

IN THE WORDS OF

DENIS BOULAUD, Deputy Director of Environment and Response at IRSN

While the project to predict staff and skills requirements has not yet changed our practices, it has already helped us to refine the definition of careers offered in our division and to situate them within the Institute's overall organization.
While each division has its own specializations, this work has brought to light disciplines that are common to several divisions. This increases the opportunities for employees to move within the Institute.
Staff at all levels was mobilized for this initial work of mapping employment and the exchanges within our division were quite fruitful.
This testifies to the interest in the program which, for some, provided the opportunity to consider careers outside their own department or division.
The expectations of our division, and the department heads in particular, are now focused on the tool that will become available and the assistance it will provide management, especially during regular staff reviews."

describing those requiring specific know-how that may be used in several of the Institute's fields of activity.
To date, around 150 careers have been defined, reflecting the interdisciplinary nature of the Institute.
At the same time, the data collected on skills and activities is being used to set the parameters of a software package for the GPEC project. It will eventually centralize the data required for managing careers, skills, annual reviews and professional training.
Scheduled for implementation by 2011, the project aims to create tools capable of anticipating skills required in the medium to long term and to offer employees clearly identified career paths.

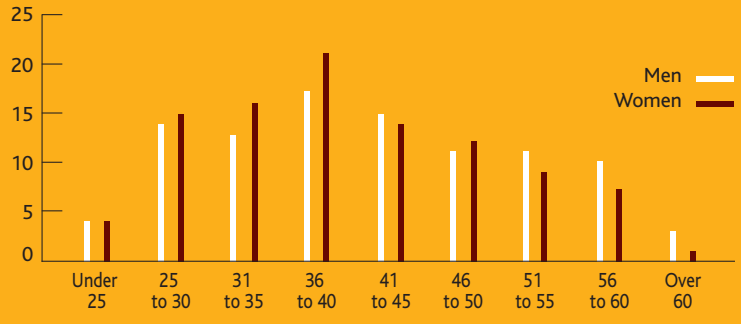
Creation of the Mid-Management Club

Every year since 2005, IRSN has organized management workshops allowing those in charge of laboratories, offices and departments to express their expectations in terms of methods, tools and procedures that may assist them in their daily management tasks.
Beyond the interest of working together to create, change and finalize human resource initiatives, the success of these events basically derives from the quality of the exchanges and the satisfaction of meeting with other supervisors from different sectors and sites.
Over time, the possibility of offering mid-management other occasions to meet has become a primary objective so that they can tackle problems together and exchange best practices.

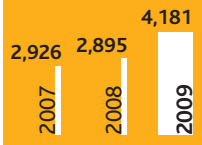
To this end, IRSN launched a mid-management club this year, which meets three times a year. Assisted by a communications consultant, the Institute has designed a half-day exchange program for these managers to express themselves openly on issues relating to management and current events at IRSN. These encounters also give outside participants the opportunity to make presentations on subjects concerning various aspects of managerial responsibility. They are jointly led by the consultant and a member of the human resources staff in charge of internal communication.

Some sixty laboratory and office heads participated in the launch, which took place on September 22, 2009. All appreciated the new meeting format whose informal context fostered a different form of expression.
IRSN's Director General has indicated that he will occasionally participate in some of these meetings to communicate with mid-management staff and review the Institute's viewpoints and events with them.

DISTRIBUTION OF MEN/WOMEN BY AGE BRACKET: (percentage by gender)



€1.99 MILLION
SPENT ON TRAINING
(€1.6 MILLION in 2008).



NUMBER OF PARTICIPANTS IN TRAINING COURSES.

COMMUNICATION

Communications: fostering a culture of transparency at IRSN

In 2009, IRSN's transparency policy resulted in greater availability of information on nuclear safety and radiation protection; the revision of its Internet site, now organized to facilitate access to continuously expanding content for different categories of users; expanded response to media demand for information on current events involving nuclear safety and radiation protection; and the organization of events for the press and the public.

More information accessible online

Facilitating access not only to researchers, industry leaders and health professionals, as well as the public, to information on nuclear and radiological risks, is the objective that has guided the design of the new institutional portal, www.irsn.fr, which went online September 23, 2009. It is organized around subjects to facilitate navigation on a site with more than 4,500 pages, as well as entries for different types of users. The new portal supplements the Institute's specialized sites, including one dedicated to monitoring radioactivity in the environment.

http://environnement.irsn.fr
ou du site SISERI : http://siseri.irsn.fr

In an effort to widely publicize the results of its research, in 2009 IRSN put on line or updated some fifteen topics covering various subjects from the management of radioactive waste and monitoring old mining sites to treating radiological burns and nuclear fusion at the international ITER facility. In addition, the site includes information notices on current events such as IRSN's opinion on the underestimate of quantities of plutonium located in glove boxes at Areva's plutonium technology facility (ATPu) in Cadarache in the south of France, currently undergoing cleanup.

The new website.

In the same vein, and consistent with the objectives of the Transparency and Nuclear Safety Act, throughout the year, the Institute published on line five opinions and twelve executive summaries presented to standing expert groups, as well as six special reports:

– IRSN's viewpoint on the safety of France's nuclear power plant fleet in 2008;
– safety review of 900 MWe pressurized water reactors in preparation of their third ten-year inspection (VD3-900);
lessons learned from incidents reported between 2005 and 2008 at nuclear laboratories and plants, and at nuclear facilities currently being dismantled;
2008 monitoring summary of worker exposure to ionizing radiation;
summary of radiological conditions in France in 2008;
summary of radioactivity monitoring in French Polynesia in 2008.

Publication of the results, the fruit several years of work conducted by experts on very complex topics, produced in an easy-to-understand format that is accessible to non-specialists, was a significant challenge.

A new magazine to bring together IRSN employees and outside readers

The magazine *Repères*, previously intended only for internal distribution, was redesigned in 2009. The new *Repères*, whose first issue was published in February, now contains twenty pages for both external and internal readers, and four pages for Institute employees. It treats subjects as diverse as radiation protection for workers,

Mock-up of a pressurized water reactor at the traveling exhibition.

radioactive waste, environmental monitoring, the EPR reactor and the management of sites contaminated by radiation. With its dual internal and external audience, *Repères* intends to show how IRSN accomplishes its mission of independent expert in the service of society by explaining the reasons and results of the Institute's actions over time and concretely illustrating the quality of its expertise as well as its independent judgment, thus helping to strengthen its identity.
Offered as a free subscription – readers can register online at the Institute's portal www.irsn.fr – the magazine totaled 5,000 readers at the end of 2009.

Steady increase in media contacts and public relations events

IRSN is committed to explaining events relative to safety and radiological protection as fully as possible, both to the press and the public at large. The organization of an increasing number of events – press trips, open-house events, expositions, etc. – contributes to this.
The Institute organized a press visit on June 9-12, 2009 to the Russian nuclear power plant in Kursk, where there are four RBMK-type reactors in operation. On September 12-19, another press visit took place to the Russian and Ukrainian areas that were contaminated by cesium 137 released into the atmosphere during the Chernobyl accident. The purpose of the trip was to present the research work done by IRSN in collaboration with the Russian health authorities as part of the EPICE program to the French media. The goal of this program is to take a census, from a population of 18,000 children, of those affected by heart rhythm disorders that cannot be explained by known factors such as congenital malformation and research a possible causal link with contamination from cesium 137.
For the general public, the Institute updated the traveling exhibition *Nuclear Power and Society: From Knowledge to Control*, which it manages together with ASN, with the inclusion of a new 3D mockup in the nuclear reactor module and the projection of new videos. During 2009 this exhibition in three French cities received almost 5,000 visitors. In mid-October, IRSN also contributed to the open-house days organized by CEA to celebrate the 50th anniversary of the Cadarache site. In the medical field, the Institute participated in Medec and the radiology event *Journées françaises de radiologie*, among others. Finally, IRSN and its German counterpart GRS participated, under the leadership of the Belgian TSO Bel V, in organizing the EUROSAFE Forum of European nuclear TSOs held in Brussels on November 2-3, 2009.

12 CONFERENCES
ORGANIZED (12 in 2008).

4,850 VISITORS (4,000 in 2008).

800 MENTIONS
IN THE PRESS
(1,000(1) in 2008).

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

The Institute organized a press visit on June to the Russian nuclear power plant in Kursk.

TRAINING

Further progress in training activities

As a result of regulatory changes and the development of the Institute's activities outside France, IRSN's training efforts continued to see strong growth in 2009, including training both in radiation protection for health professionals and those qualified in radiation protection as well as nuclear safety. The latter area has seen growth in outside training previously reserved for IRSN's staff in addition to training offered in an international framework.

Radiation protection training course.

3,271
PERSONS
PARTICIPATING IN IRSN'S TRAINING PROGRAMS, INCLUDING THOSE PARTICIPATING IN RADIATION PROTECTION PROGRAMS (1,977 in 2008).

With the number of trainees increasing from 1,977 to 3,271 between 2008 and 2009 and the number of training hours increasing from 2,615 to 3,173, IRSN's training activities have continued to grow significantly, thus increasing demand for the Institute's contributors. Several reasons account for the expansion in training activities, which has been quite evident for several years.

Among them is the recognized value of training provided by IRSN, which contributes to the year-over-year growth in the number of trainees.

The ability of the Institute's contributors to handle the subjects in depth, due to their research experience and expertise, ensures that they convey not only knowledge but also a culture of nuclear safety and security as well as protection against ionizing radiation. In the area of nuclear safety, the Institute has now made available some training previously reserved for specialists from its own staff and that of ASN and CEA.

It has also participated in writing several proposals relating to higher education (initial and continuing) concerning safety in the context of the overall plan administered by Bernard Bigot, Chairman of the CEA, to respond to the strong demand from the nuclear industry related to renewing the age pyramid as well as nuclear power programs in a number of countries.

IRSN's training efforts also contributed to its openness to society.

For example, the Institute responded to a request from the local information committee of Saclay near Paris which sought training in radiation protection for its members and wished to acquire knowledge from an independent, reliable expert.

The 2nd nuclear safety engineers' summer school was held in Cadarache.

2,387 HOURS
OF EDUCATION GIVEN IN 192 TRAINING SESSIONS ON RADIATION PROTECTION (1,676 in 2008 – 139 sessions).

786 HOURS
OF EDUCATION GIVEN IN 21 TRAINING SESSIONS ON NUCLEAR SAFETY (1,015 in 2008 – 20 sessions).

Radiation protection: growth in training efforts driven by diversification

The annual number of training sessions in radiation protection provided to the medical sector continued to grow with more than 2,285 trainees in 152 sessions.
As part of the "radiotherapy roadmap", IRSN in 2009 led an interdisciplinary working group on proposing a training program relating to managing radiotherapy risks with a view to defining a standard in this field. On the basis of the working group's conclusions, the Institute committed to creating a training program that it plans to offer to radiotherapy professionals in 2010. By demonstrating how nuclear safety concepts and methods apply to radiotherapy, including human factors, IRSN has set out to improve, under the leadership of the French national cancer institute and the Ministry of Health, the skills of all radiotherapy professionals in managing risks associated with treatment using ionizing radiation.
In the same vein of radiation protection, the Institute is gradually extending its training efforts to risks related to radon owing to regulatory changes which impose requirements for measuring concentrations of the gas in professional environments, notably for spas and certain underground sites.
It should also be recalled that since mid-2008, IRSN oversees examinations for the certificate for operating industrial radiology equipment (Camari). There has been a strong increase in this area, with the number of candidates for the examination growing from a hundred or so in the second half of 2008 to more than 600 for all of 2009. Owing to the Ministry of Labor's policy, it appears demand from various industrial sectors will continue to grow. In addition, IRSN, at the request of the association of Moroccan manufacturers for non-destructive testing, has engaged in discussions with the latter with a view to signing an agreement for conducting a Camari-type examination in Morocco.

Nuclear safety: IRSN's leading international role

Beyond pursuing its efforts in nuclear safety training through the SARNET Network of Excellence and bilateral agreements, IRSN participated, on behalf of the European Commission and ETSON, in efforts to design training programs on the European Union level. Maintaining its relationships with ETSON and EUROSAFE, the Institute organized in July 2009 the second Summer School for nuclear safety engineers in Cadarache in the south of France. The previous year, it took place in Garching, in the south of Germany.
At the same time, IRSN collaborated with its ETSON partners in preparing a landmark project supported by the European Commission – the European Nuclear Safety Training and Tutoring Institute (ENSTTI) – to get underway in 2010.

IRSN contributed to granting legal status to this entity in which it will also play a leading role. The original aspect of ENSTTI will be to offer a five-week program that will provide tutoring for trainees in addition to training.

IN CLOSE-UP

INTERNATIONAL TRAINING

IRSN regularly provides technical assistance, consulting and training in the area of waste and nuclear facility dismantling. Of the sixteen services provided during 2009, twelve were outside France at the request of the AIEA in the context of European Commission contracts or university Master's programs. They concerned representatives of foreign nuclear safety authorities and nuclear operators as well as students. Some were provided to safety professionals, like three sessions in conjunction with the CEA for the European Commission's Joint Research Centre in Ispra (Italy).
Others responded to the growing need for training, such as the international Master's degree in dismantling strategy at the ENPC, carried out jointly with EDF's Ciden, CEA and AEN.

GLOSSARY

A

AERES
French agency for the evaluation of research and higher education.

AFSSET
French agency for environmental and occupational health and safety.

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.

ASTEC
Accident Source Term Evaluation Code.

B

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 "β")
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.

BNRA
Bulgarian Nuclear Regulatory Agency.

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.

Corium
Agglomeration of fuel and structural elements from a nuclear reactor core, melted and mixed together following a severe accident.

COWAM
Community Waste Management program funded by the European Community.

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).

Dosimetry
Determination of the dose of radiation (radioactivity) absorbed by a substance or an individual through assessment or measuring.

E

EADS
European Aeronautic Defence and Space Company.

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.

EPICE
Name of a program set up to evaluate pathologies induced by cesium contamination.

EPR
European Pressurized water Reactor.

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

Foundation raft
Thick, reinforced concrete foundation providing stable support.

FP7
Seventh Framework Programme for research and technological development (European Union).

Fuel assembly
Bundle of fuel rods assembled in a metal structure, used in nuclear reactors.

G

Gamma radiation (symbolized as " ")
Electromagnetic radiation with high penetration but low ionization, emitted during the transformation of radionuclides. Protection is provided by concrete or lead screens.

GRS
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

HCTISN
French high committee for transparency and information on nuclear safety.

I

IAEA
International Atomic Energy Agency.

ICRP
International Commission on Radiological Protection.

IFREMER
French research institute for exploitation of the sea.

INERIS
French national institute for the study of industrial environments and risks.

INRS
French national institute for research on safety.

InVS
French national institute for health surveillance.

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

ISTP
International Source Term Program.

ITER
International Thermonuclear Experimental Reactor.

J

JAEA
Japan Atomic Energy Agency.

JNES
Japan Nuclear Energy Safety Organization.

K

KIT-FzK
Karlsruhe Institute of Technology – Forschungszentrum Karlsruhe.

kV
kilovolt.

M

MOX
Fuel made from (natural or depleted) uranium and plutonium oxide.

mGy
Unit of radiation absorbed dose used in the international system.

mSv
Unit of equivalent dose used in the international system.

MWe
Megawatt electric, unit of electric power produced. In a pressurized water reactor, the thermal power is about three times greater.

N

NRC
Nuclear Regulatory Commission (USA).

NSC
The Nuclear Safety Center in China.

NSRR
Nuclear Safety Research Reactor (Japan).

O

OECD
Organisation for Economic Co-operation and Development.

P

PEARL
Name of an experimental analytical program on reflooding debris beds.

PRISME
Fire propagation in elementary multiple-enclosure scenarios.

PSA
Probabilistic Safety Assessment.

PUI
Internal emergency plan.

R

Radioelement
Natural or artificial radioactive element.

Radionuclide
Radioactive isotope of an element.

RJH
Jules Horowitz research reactor.

RNR-Na
Fast breeder reactor cooled using sodium.

ROSIRIS
Research program on the radiobiology of integrated systems for optimizing treatment using ionizing radiation and assessing the associated risk.

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.

SCK-CEN
Belgian nuclear research center.

SNETP
Sustainable Nuclear Energy Technology Platform.

STBFT
Technical department for buildings, fortifications and engineering works. Part of the French Ministry of Defense.

T

TAREF
Task Group on Advanced Reactor Experimental Facilities.

TSO
Technical Safety Organization.

U

UJV
Ústav jaderného výzkumu Řež a.s/ Nuclear Research Institute Rez plc – Czech technical safety organization.

V

VVER or WWER
Vodo Vodianoï Energetitcheskyi Reactor or Water-Water Energetic Reactor. Russian-design reactors that operate along the same principle as Western pressurized water reactors.

W

WHO
World Health Organization.

For more information, consult the online glossary at:
www.irsn.fr

APPENDIX

Nuclear Safety and Radiation Protection Research Policy Committee

Members
(as of October 14, 2009)

> PUBLIC AUTHORITIES

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Gabriele FIONI, Director of the DGRI A2 Department of the Directorate General for Research and Innovation, representing the Ministry of 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 / Isabelle TANCHOU, 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

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> EMPLOYEES IN THE NUCLEAR SECTOR

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Jean-Paul CRESSY, FCE-CFDT / Jean-François DOZOL, FO / Claire ETINEAU, CFTC / Daniel LACQUEMANT, CFE – CGC / 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 / Sébastien GENEST, President of France nature environnement / Simon SCHRAUB, Administrator of the Ligue nationale contre le cancer.

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> RESEARCH ORGANIZATIONS

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> EX OFFICIO MEMBERS

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Consult the IRSN website for maps indicating how to reach these different locations.
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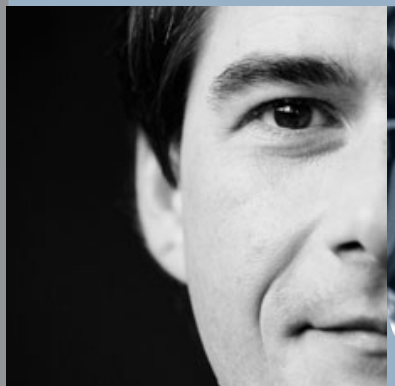
Financial Report 2009



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GENERAL OUTLOOK

The year 2009 saw studies begin for a property program to secure the Fontenay-aux-Roses site and close the Le Vésinet site in the Paris region. The program is scheduled for completion by 2017. The key points reflected in the accounts for 2009 are as follows:
– a significant increase in the public service grant paid by the Ministry of Ecology, Energy, Sustainable Development, and the Sea, under Action 03 of Budget Program 189, to meet the growing demand for assessments from the public authorities;
– a rise in self-generated revenue from co-funding of research programs, and from industrial and commercial activities;
– an increase in the number of staff following a period of several years of stiff competition among nuclear sector operators on the job market;
– re-evaluation of dismantling assets and the corresponding provision made to cover IRSN's obligations regarding remediation and dismantling of the basic nuclear installations (INB) it uses and its classified facilities (ICPE).
June 2009 saw the first payment made under the employee profit-sharing agreement signed with representative trade unions in 2008.

The initial 2009 budget was amended by two modification decisions (DM1 and DM2) presented to the Board of Directors in March and June respectively to take into account:
– investment projects in progress carried over from the previous year, representing €10.2 million, paid into working capital when accounts were closed in 2008;
– part of the expenditure for the CABRI project, financed by drawing from the Institute's working capital, carried over from 2007;
– the Institute's contribution to funds for the remediation and dismantling of the PHEBUS reactor; this involved adding to the sum of €5 million received at the end of 2008 for the remediation and dismantling of nuclear facilities, and paid into the working capital.
Budget execution in 2009 involved a vast investment program totaling €35.1 million after incorporation of operations carried over from the previous year, which covered the following:
– the final phases of programs initiated previously, such as new technology for worker dosimetry monitoring, the renewal of equipment (mobile response equipment, national monitoring and measurement network, etc.);
– the continuation of the program to upgrade the CABRI reactor;
– continued, gradual building of a fund allocated to cover future costs for dismantling and remediation.

Not all of these investments were completed during the fiscal year, and a proposal to carry over €14.5 million for operations in progress will be put forward in a budget amendment (DM1) to modify the projected revenue and expenditure statement for 2010. The proposed amount includes:
– €12.2 million for investments carried over, including €1.4 million in investments for the CABRI project (€3 million completed out of the €4.4 million mentioned in the second budget amendment),
– €2.3 million, consisting of €1.3 million in operating expenditure for the CABRI project (€27.5 million spent out of the €28.8 million mentioned in the second budget amendment), and €1 million for dismantling PHEBUS (€4.55 million spent out of the €5.6 million mentioned in the second budget amendment).

BUDGET BALANCE

Execution (in €M)	2007 (1)	2008 (2)	2009	Difference 2009/2008
Total resources	298.4	255.2	**283.0**	+10.9%
Total expenditure	265.8	281.2	**301,8**	+7.3%
SOLDE	**+32.6**	**–26.0**	**–18.8**	**+27.7%**

(1) Results for 2007 include VAT, increasing resources by €9 million and decreasing expenditure by €12 million, for a total impact on the balance of €21 million.

(2) 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 2009, as in previous years, shows a budget balance that appears to be amplified by the €14.5 million in investments carried over. Recalculating to take into account these operations gives the following results:

Recalculated execution (in €M)	2008	2009
Balance	–26.0	**–18.8**
2007 carryover	+19.6	**–**
2008 carryover	–10.2	**+10.2**
2009 carryover	–	**–14.5**
Special operations	+15.0	**–**
NET BALANCE	**–1.6**	**–23.1**

The year 2009 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 93.6% (compared to 92.5% in 2008), i.e. a difference of €20.8 million, of which €14.5 million corresponds to an offset in the execution of certain investments. If these offsets were excluded, the budget execution rate would be 98.1%.

INCOME STATEMENT ANALYSIS

Revenue

Execution (in €M)	2007	2008	2009	Difference 2009/2008
Sales	31.8	31.8	**37.8**	+18.5%
Grants	190.6	195.5	**216.5**	+10.7%
Other operating revenue	22.7	3.9	**7.5**	+94.9%
Operations sub-total	245.1	231.2	**261.8**	+13.2%
Investment income	4.0	3.7	**1.3**	–62.2%
Extraordinary income	33.4	6.4	**9.1**	+42.2%
TOTAL	**282.5**	**241.3**	**272.2**	**+12.8%**

Operating revenue rose by €30.6 million (+13.2%) compared with the previous fiscal year, reaching €261.8 million, with:
– €212.4 million from the public service grant paid by the Ministry of Ecology, Energy, Sustainable Development, and the Sea. The total in government grants received for Budget Program 189 amounted to €237.4 million, of which €25.0 million was recorded as a capital grant;
– €3.2 million from the agreement signed with the Ministry of Defense as part of Budget Program 212, the same level as in the previous year;
– €0.9 million from other subsidies, including local government authorities, compared with €0.8 million the previous year;
– €37.8 million of self-generated revenue from consultancy services, co-funding of research programs, or other services, representing an 18.5% increase over the previous year;
– €7.5 million in other operating revenue (compared with €3.9 million in 2008). This amount 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 depreciations and provisions (€6.8 million).

> Financial income, which reached €1.3 million, was much lower than in 2008 (-2.4 million euros), reflecting a drop in interest rates.

> Extraordinary income climbed to €9.1 million, compared with €6.4 million in 2008. It consisted, for the most part, of capital grants recorded in the income statement, representing €7.8 million.

Expenditure

Execution (in €M)	2007	2008	2009	Difference 2009/2008
Purchases	107.2	116.1	**132.8**	+14.4%
Personnel	111.9	110.4	**120.0**	+8.7%
Taxes	13.4	12.4	**12.8**	+3.2%
Depreciation	16.5	17.5	**22.8**	+30.3%
Provisions	0.3	1.4	**2.3**	+64.3%
Other	1.6	1.2	**1.5**	+33.3%
Operations sub-total	250.9	259.0	**292.2**	+12.8%
Financial charges	0.4	0.7	**0.5**	–28.6%
Extraordinary charges	0.3	0.3	**0.3**	–
TOTAL	**251.6**	**260.0**	**293.0**	**+12.7%**

Operating expenses for the year amounted to €292.2 million, an increase of €33.2 million or 12.8%.

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

– Personnel charges rose by 8.7% to €120.0 million. This is due to a significant influx of new recruits during the second half of the year, reflecting the Institute's effort to make up for the drop in numbers during the previous year, when tension on the job market in the nuclear sector, where the construction of new power plants is expected to stimulate activity on both the domestic and international markets, led to a large number of employees leaving the Institute. The average number of employees over the year, expressed in full-time equivalent values, is 1669.3, compared with 1633.4 in 2008 and 1674.5, according to initial 2009 budget projections.

– Taxes amounted to €12.8 million, up by €0.4 million.

– Depreciation rose by 30.3%, reaching €22.8 million, whereas provisions, allocated mainly to the employee profit-sharing plan and contingency provisions, rose by €0.9 million compared with the previous year, to reach a figure of €2.3 million.

– Purchasing of goods and services rose significantly by €16.7 million (up 14.4%) to €132.8 million, essentially due to finalization of work on the CABRI experimental reactor and increased subcontracting in "core activities" to support growing demand for assessment services on behalf of ASN.

– Other expenses represented €1.5 million, as opposed to €1.2 million in 2008.

Execution (in €M)	2007	2008	2009	Difference 2009/2008
60 – Purchases	55.0	62.9	**72.0**	+14.5%
61 – Outside services	36.9	35.4	**40.8**	+15.3%
62 – Other outside services	15.3	17.8	**20.0**	+12.4%
TOTAL	**107.2**	**116.1**	**132.8**	**+ 14.4 %**

This table breaks down the year's outside expenses, which amount to €132.8 million. It highlights the steep rise in Purchases (Item 60), Outside services (Item 61), and Other outside services (Item 62), up by 14.5%, 15.3%, and 12.4% respectively, which can be explained mainly by growth in activity (subcontracting, temporary employees, etc.).

> Financial charges fell from €0.7 million to €0.5 million. For the most part, they represent interest paid on loans (€7.2 million + €4.8 million + €5.6 million + €2.0 million) taken out to finance the Institute's new headquarters and new dosimetry technology.

> Extraordinary charges remained steady at €0.3 million.

RESULTS AND FINANCING

Execution (in €M)	2007	2008	2009	Difference 2009/2008
Result	31.0	–18.7	**–20.8**	–11.2%
Cash provided by operations	26.7	–9.3	**–10.2**	–9.7%
Variation in working capital	32.6	–26.0	**–18.8**	+27.7%

The net balance for the year shows a deficit of €20.8 million, compared with a deficit of €18.7 million in 2008. The difference between the most recently revised forecast in the second budget amendment, predicting a deficit of €24.2 million, and the accounts at closing on December 31, 2009 is €3.4 million, which is explained by a favorable balance between:
– a growth in income estimated at €1.2 million;
– a decrease in charges estimated at €2.2 million.
> Cash provided by operations, budgeted at -€17.5 million in the second budget amendment, reached –€10.2 million, a positive difference of €7.3 million, resulting from:
– a €3.4 million improvement in income,
– an increase in the portion of capital grants included in the income statement, representing €4.2 million,
– a depreciation differential of €6.6 million,
– a decline in provision write-backs amounting to€1.5 million.

This €10.2 million deficit in cash was compensated by the portion of the public service grant paid by the Ministry of Ecology, Energy, Sustainable Development, and the Sea allocated to capital grants (€25 million).
The resulting total resources only covered some of the investment and financial charges, which amounted to €33.9 million. The additional €18.8 million required for financing was drawn from working capital.

Furthermore, a sum of €41.1 million (in jobs and resources) must be accounted for to allow the Institute to meet its obligations regarding nuclear facility dismantling operations. This has no impact, however, on the budget balance.

IRSN is responsible for the remediation and cleanup of the facilities it uses, among them the CABRI and PHEBUS research reactors, facilities classified for environmental protection (ICPE), as well

as other equipment with no further use, and considered as radioactive waste. Dismantling assets of €72.1 million have been booked to cover the total projected cost of remediation and dismantling operations. A provision for an equivalent amount has been booked as a liability. A special remediation and dismantling fund has also been set up to fund these operations. IRSN has paid €1.1 million into this fund since 2006, and the French government also contributes additional amounts since the decision was taken to shut down the PHEBUS facility in 2007.

MANAGEMENT BALANCES

In € thousands	2009 Actual	DM2 2009 V15	2008 Actual
Contribution to or withdrawal from working capital	**–18,774**	–31,746	–26,005
Variation in working capital requirements	**–18,951**	–17,053	–49,104
Cash variation	**177**	–14,693	23,099
Level of working capital	**21,754**	8,782	40,528
Level of working capital requirements	**–63,576**	–61,678	–44,625
Cash level	**85,330**	70,460	85,153
– Prefinancing of special fund	**8,600**		
– Recalculated cash level (1)	**93,930**		

(1) Dismantling is "pre-financed" from IRSN cash before being reimbursed via the special remediation and dismantling fund.

Variation in working capital

The variation in working capital projected in the second budget amendment of 2009 was due to a withdrawal of €31.75 million, broken down as follows:

– Withdrawal from CABRI working capital ..... €14.7 million
– Financing of special fund on tax savings 2008 ..... €5.0 million
– Investments carried over from 2008 ..... €10.15 million
– Write-back on profit-sharing provision 2008 ..... €1.2 million
– Write-back on sources ..... €0.7 million

The withdrawal from working capital at the end of 2009 amounted to €18.8 million, an increase of €13 million compared with the second budget amendment. The difference can be broken down as follows:

– Investments not completed in 2009, proposed to be carried over to 2010 ..... + €12.2 million
– CABRI project expenditure, excluding investments .... + €1.3 million
– Expenditure relating to PHEBUS dismantling ..... + €1.0 million
– Provision for profit-sharing plan 2009 ..... + €1.25 million
– Financing via the special fund ..... - €6.4 million
– Other operating savings ..... + €3.7 million

Expenditure relating to investments and specific projects not completed in 2009 is the subject of a carryover proposal in the first budget amendment for the 2010 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). The other differences amounting to €3.7 million mostly correspond to unpaid operating expenses.

In view of the above, the level of working capital at December 31, 2009, estimated at €8.8 million according to the second budget amendment, is actually €21.8 million.

Cash variation

The cash level stood at €85.3 million at the end of 2009, compared with the €70.5 million projected in the second budget amendment. The difference of €14.8 million is mainly due to the €13 million euro difference in working capital between the second budget amendment and execution.

The cash level at the end of 2009 was stable compared with the year-end level for 2008 (€85.2 million), due to the combined effects of the €18.8 million drop in working capital and the €18.9 million rise 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. Of the €6.4 million expenditure projected under the budget amendment for 2009, €5.6 million concerned PHEBUS dismantling costs, €0.6 million concerned Esmeralda, and €0.3 million concerned other operations. Actual expenditure (€4.55 million for PHEBUS) will be reimbursed via the special fund on presentation of documentary evidence, when the 2010 budget is executed. This means that IRSN "pre-finances" dismantling operations from its cash and working capital, owing to the operating principle of the special remediation and dismantling fund.

Variation in working capital requirements

Working capital requirements stood at -€63.6 million at the end of 2009, compared with the figure of -€61.7 million projected in the second budget amendment. The €18.9 million difference in working capital requirements compared with 2008 is due to operations carried over to the end of 2009. This is reflected in an increase in trade notes and accounts payable on the balance sheet.

The trade notes figure (€72 million, with CEA accounting for €52 million) partly explains the cash level.

BALANCE SHEET ANALYSIS

Liabilities

> With a recorded loss of €20.8 million, the net result was down by 27.2%, reaching €55.4 million. Given the additional capital grant recorded, this item rose by €17.3 million. The Institute's long-term capital increased to €194.7 million (compared with a figure of €161.7 million in 2008). This is due to a €36.5 million rise in contingency and loss provisions.

> Short- and medium-term debt, for the amount of Short- and medium-term debt, for the amount of €119.0 million (as against €106.2 million in 2008), rose due to the increase in accounts payable (up by €13.1 million) and in tax and social liabilities (up by €2.1 million). The balance of the variation is explained by the reimbursement of existing loans (-€3.3 million) and other liabilities (+€0.9 million).

Assets

> Fixed assets increased to €184.1 million (up by €48.5 million), due to continued renewal of IRSN facilities and equipment, and incorporation of additional dismantling assets of €41.1 million in the Institute's assets.

> Current assets receded to €129.6 million (compared with €132.3 million in 2008), due mainly to a €3.1 million drop in accounts receivable. Liquidities remained steady at €85.3 million.

Working capital

> Working capital at year end was down by €18.8 million, as against the projected €31.7 million drop. This is mainly because certain investments were carried over to the following year.

> Working capital stood at €21.8 million as of December 31, 2009. Of this amount, €14.5 million will be withdrawn in 2010 as investments carried over, and €1.2 million as a provision for the employee profit-sharing plan. This leaves a balance of €6.1 million in working capital, to be reconciled with the €3.7 million withdrawal planned in the 2010 projected revenue and expenditure statement for CABRI and source write-back provisions. As it has not yet been determined how the 2010 exceptional contribution to the special remediation and dismantling fund will be financed, the projected revenue and expenditure statement for 2010 provides for €5.1 million to be drawn from the working capital.

> Based on the information in the balance sheet on December 31, 2009, working capital requirements are negative (-€63.6 million) as in previous years.

> Cash remains steady compared with the previous year, at €85.3 million (+€0.2 million).

CONCLUSION

The 2009 budget was executed within the forecasted budget balance presented to the Board of Directors.

The withdrawal from working capital amounted to €18.8 million, which includes withdrawals spread out throughout 2010 representing €1.2 million for the employee profit-sharing plan and €14.5 million for carryover of investment projects in progress. The last two operations are movements that will be incorporated in the 2010 budget amendment.

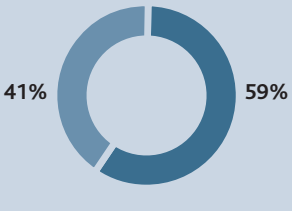
The contribution to the remediation and dismantling fund, set at €1.1 million every year, is now insufficient, given the decision to shut down the PHEBUS experimental reactor, confirmed by the Atomic Energy Committee in November 2007. An initial exceptional contribution of €5 million was made in 2009 to finance work planned for 2009. The remaining amount to be financed to cover work in 2010, 2011, and 2012 is currently estimated at €15.6 million. This means that an additional exceptional contribution will be required.

Balance sheet

ASSETS

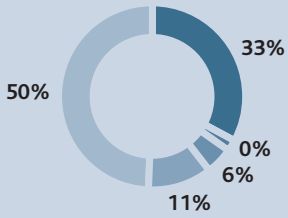
In euros	Gross	Depreciation and provisions (to be deducted)	2009 Net	2008 Net	2007 Net
Intangible assets	18,701,964.02	13,549,709.49	**5,152,254.53**	3,254,384.31	2,136,430.05
Tangible assets	276,369,298.51	109,708,576.18	**166,660,722.33**	127,259,750.21	106,598,15.35
Financial assets	12,264,531.14	–	**12,264,531.14**	5,115,702.80	3,158,525.44
Fixed assets	**307,335,793.67**	**123,258,285.67**	**184,077,508.00**	**135,629,837.32**	**111,893,770.84**
Inventory and work in progress	–	–	**–**	–	–
Prepayments and advances on orders	626,921.85	–	**626,921.85**	431,094.07	3,200,128.34
Accounts receivable	43,711,875.49	61,275.76	**43,650,599.73**	46,709,534.13	73,808,863.09
customer receivables	*28,472,331.09*	*61,275.76*	**28,411,055.33**	*30,497,436.91*	*25,816,309.97*
related receivables	*15,239,544.40*	–	**15,239,544.40**	*16,212,097.22*	*47,992,553.12*
Other receivables	3,689.80	–	**3,689.80**	3,689.80	45,159.22
Investment securities	77,925,874.35	–	**77,925,874.35**	75,854,958.53	49,913,075.86
Cash	7,403,786.48	–	**7,403,786.48**	9,297,888.40	12,140,939.3
Prepaid expenses	–	–	**–**	–	–
Current assets	**129,672,147.97**	**61,275.76**	**129,610,872.21**	**132,297,164.93**	**139,108,165.74**
GRAND TOTAL	**437,007,941.64**	**123,319,561.43**	**313,688,380.21**	**267,927,002.25**	**251,001,936.58**

Assets



Fixed assets **€184.08 million**
Current Assets **€129.61 million**

Current assets

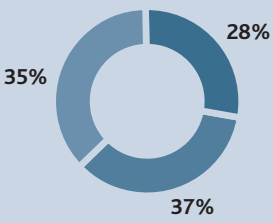


Cash and cash equivalents **€85.33 million**
Prepayments **€0.63 million**
Customer receivables **€28.41 million**
Other receivables **€15.24 million**
Current assets **€129.61 million**

LIABILITIES

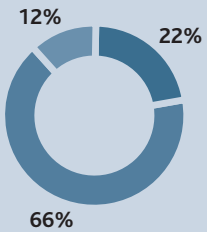
In euros	2009	2008	2007
Allowances	4,183,945.65	4,183,945.65	8,782,859.59
Reserves	90,783,098.42	90,783,098.42	51,083,266.14
Retained earnings	–18,724,287.79	–	–
Fiscal year profit or loss	–20,799,922.06	–18,724,287.79	30,963,852.03
Net position	55,442,834.22	76,242,756.28	90,829,977.76
Capital grants	67,282,860.81	50,013,274.68	35,091,137.98
Equity	**122,725,695.03**	**126,256,030.96**	**125,921,115.74**
Contingency provision	2,666,100.00	1,978,000.00	2,109,000.00
Provision for taxes due	–	177,000.00	177,000.00
Loss provision	69,321,702.00	33,294,000.00	35,011,000.00
Contingency and loss provision	**71,987,802.00**	**35,449,000.00**	**37,297,000.00**
Bank borrowings	11,056,525.76	14,429,135.32	15,183,905.42
Various debts and liabilities	190.50	190.50	190.50
Prepayments and advances on orders	–	–	–
Trade notes and accounts payable	71,948,636.59	58,826,534.14	41,835,202.76
Tax and social liabilities	26,111,320.17	24,015,522.27	23,748,397.96
Other operating liabilities	–	–	130,669.38
Payables to fixed asset suppliers and related accounts	6,045,394.01	7,197,842.14	3,845,582.51
Other liabilities	3,812,816.15	1,752,746.92	2,373,871.64
Prepayments and accrued income	–	–	666,000.67
Liabilities	**118,974,883.18**	**106,221,971.29**	**87,783,820.84**
GRAND TOTAL	**313,688,380.21**	**267,927,002.25**	**251,001,936.58**

Long-term capital



- Net position **€55.44 million**
- Capital grant **€67.28 million**
- Provisions **€71.99 million**

Liabilities



- Tax and social liabilities **€26.11 million**
- Trade payables **€77.99 million**
- Other liabilities **€14.87 million**

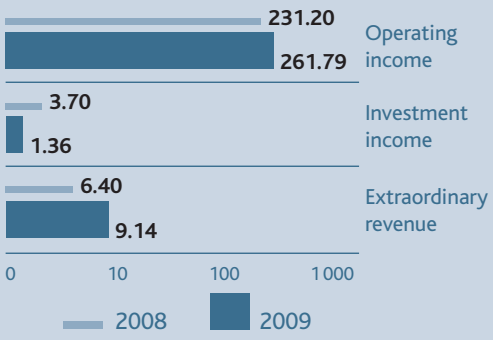
Income statement

In euros before tax	2009	2008	2007
Research work	13,569,471.06	11,165,866.34	11,600,446.57
Service contracts	18,145,983.08	14,937,300.43	14,965,765.23
Other services provided	5,996,863.90	5,720,848.65	5,281,978.47
Net revenue	**37,712,318.04**	**31,824,015.42**	**31,848,190.27**
Operating grants	216,500,738.38	195,447,206.52	190,599,016.47
Write-backs on depreciation and provisions	6,835,490.36	3,270,980.62	18,653,925.36
Expense transfer	147,682.24	128,863.34	206,282.73
Other income	596,141.76	553,067.57	3,782,854.33
Operating income	**261,792,370.78**	**231,224,133.47**	**245,090,269.16**
Outside expenses for the fiscal year	132,765,002.38	116,148,653.80	107,093,251.77
Taxes, duties, and similar payments	12,795,271.46	12,373,634.74	13,397,986.18
Personnel expenses	119,962,166.29	110,426,772.00	111,865,157.14
Depreciation and provisions	25,143,505.80	18,924,712.32	16,806,211.72
Other expenses	1,582,253.46	1,179,411.04	1,618,502.86
Operating expenses	**292,248,199.39**	**259,053,183.90**	**250,781,109.67**
OPERATING INCOME	**–30,455,828.61**	**–27,829,050.43**	**–5,690,840.51**
From controlled entities	–	–	–
Other interest income	26,886.07	24,566.87	26,907.87
Foreign exchange gains	92,325.73	38,754.50	11,803.62
Gains on sales of short-term investments	1,243,941.94	3,627,624.62	4,013,420.35
Investment income	**1,363,153.74**	**3,690,945.99**	**4,052,131.84**
Interest expense	471,602.42	564,466.81	347,426.62
Foreign exchange losses	17,844.88	153,739.95	77,998.99
Losses on sales of short-term investments	–	–	–
Financial charges	**489,447.30**	**718,206.76**	**425,425.61**
FINANCIAL INCOME	**873,706.44**	**2,972,739.23**	**3,626,706.23**
INCOME BEFORE EXCEPTIONAL ITEMS	**–29,582,122.17**	**–24,856,311.20**	**–2,064,134.28**
Gains on sales of assets	–	–	500.00
Capital grants recorded in fiscal year's income statement	7,928,749.89	6,286,126.30	2,427,906.30
Capital grants strictly for the period	–	46,879.34	143,500.00
In operations	1,211,820.71	88,447.78	30,803,312.89
Extraordinary revenue	**9,140,570.60**	**6,421,453.42**	**33,375,219.19**
In operations	316,223.72	222,636.97	311,692.69
Book value of assets sold and other capital losses	42,146.77	66,793.04	35,540.19
Depreciation and provisions	–	–	–
Extraordinary charges	**358,370.49**	**289,430.01**	**347,232.88**
EXTRAORDINARY INCOME	**8,782,200.11**	**6,132,023.41**	**33,027,986.31**
Minimum tax on corporations	–	–	–
Income tax	**–**	**–**	**–**
FISCAL YEAR INCOME	**–20,799,922.06**	**–18,724,287.79**	**30,963,852.03**

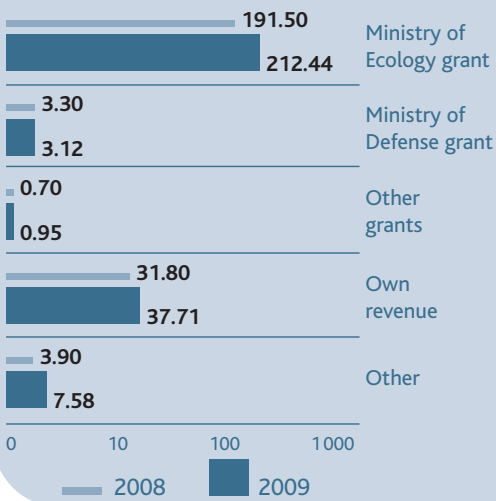
Income statement subtotals

CAPTIONS	31/12/2009	%	31/12/2008	31/12/2007
Sales	37,712,318.04	14.83%	31,824,015.42	31,848,190.27
+ Operating grants	216,500,738.38	85.17%	195,447,206.52	190,599,016.47
FISCAL YEAR PRODUCTION	**254,213,056.42**	**100.00%**	**227,271,221.94**	**222,447,206.74**
– Outside expenses	132,765,002.38	52.23%	116,148,653.80	107,093,251.77
ADDED VALUE	**121,448,054.04**	**47.77%**	**111,122,568.14**	**115,353,954.97**
– Taxes	12,795,271.46	5.03%	12,373,634.74	13,397,986.18
– Personnel expenses	119,962,166.29	47.19%	110,426,772.00	111,865,157.14
OPERATING INCOME BEFORE INTEREST	**–11,309,383.71**	**–4.45%**	**–11,677,838.60**	**–9,909,188.35**
+ Write-backs, expense transfer	6,983,172.60	2.75%	3,399,843.96	18,860,208.09
+ Other income	596,141.76	0.23%	553,067.57	3,782,854.33
– Depreciation and provisions	25,143,505.80	9.89%	18,924,712.32	16,806,211.72
+ Write-back on capital grants	7,845,142.87	3.09%	6,286,126.30	2,571,406.30
– Other expenses	1,582,253.46	0.62%	1,179,411.04	1,618,502.86
OPERATING INCOME	**–22,610,685.74**	**–8.89%**	**–21,542,924.13**	**–3,119,434.21**
+ Investment income	1,363,153.74	0.54%	3,690,945.99	4,052,131.84
– Financial charges	489,447.30	0.19%	718,206.76	425,425.61
INCOME FROM CONTINUING OPERATIONS BEFORE INCOME TAXES	**–21,736,979.30**	**–8.55%**	**–18,570,184.90**	**507,272.02**
+ Extraordinary revenue	1,295,427.73	0.51%	135,327.12	30,803,812.89
– Extraordinary charges	358,370.49	0.14%	289,430.01	347,232.88
EXTRAORDINARY INCOME	**937,057.24**	**0.37%**	**–154,102.89**	**30,456,580.01**
– Income tax	–	–	–	–
FISCAL YEAR RESULT	**–20,799,922.06**	**–8.18%**	**–18,724,287.79**	**30,963,852.03**

Income in detail (in €M)



Operating income (in €M)



Budget versus actual report

INCOME STATEMENT in euros	2009 Budget	2009 Actual
REVENUE		
Service contract sales	39,799,300.00	37,712,318.04
Government grants	216,159,470.00	216,500,738.38
Other operating revenue	3,269,000.00	3,452,798.45
Internal operations	11,823,000.00	14,630,240.25
TOTAL REVENUE	271,050,770.00	272,296,095.12
EXPENDITURE		
Personnel expenses	130,914,040.00	119,962,166.29
Other operating expenses	145,822,260.00	147,948,198.32
Internal operations	18,500,000.00	25,185,652.57
TOTAL EXPENDITURE	**295,236,300.00**	**293,096,017.18**
RESULT (PROFIT)	**–**	**–**
RESULT (LOSS)	***24,185,530.00***	***20,799,922.06***
TOTAL INCOME STATEMENT BALANCE	**295,236,300.00**	**293,096,017.18**

TRANSFER OF RESULT TO CASH PROVIDED BY OPERATIONS in euros	2009 Budget	2009 Actual
RESULT	**–24,185,530.00**	**–20,799,922.06**
– Gain on sale of assets	–	–41,460.25
+ Depreciation and provisions	18,500,000.00	25,143,505.80
– Gains from offsetting depreciation	–	–
– Portion of grants recorded in result	–3,500,000.00	–7,711,142.87
– Write-backs on depreciation and provisions	– 8,323,000.00	– 6,835,490.36
CASH PROVIDED BY OPERATIONS	– 17,508,530.00	– 10,244,509.74

SUMMARY STATE MENT OF CHANGES IN FINANCIAL POSITION in euros	2009 Budget	2009 Actual
CASH PROVIDED BY OPERATIONS	**–17,508,530.00**	**–10,244,509.74**
Acquisition of tangible and intangible assets	35,135,730.00	23,071,919.15
Financial assets	7,400,000.00	7,343,212.84
Long-term debt paid	3,265,000.00	3,420,149.00
TOTAL USES OF CASH	**63,309,260.00**	**44,079,790.73**
Government capital grants	24,980,730.00	24,980,729.00
Other sources (excl. internal operations)	6,583,000.00	277,991.52
Increase in long-term debt	–	47,539.44
TOTAL SOURCES OF CASH	**31,563,730.00**	**25,306,259.96**
CONTRIBUTION TO WORKING CAPITAL	**–31,745,530.00**	**–18,773,530.77**

IRSN certified quality
management system

IRSN
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DE RADIOPROTECTION
ET DE SÛRETÉ NUCLÉAIRE

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