IRSN

INSTITUT
DE RADIOPROTECTION
ET DE SÛRETÉ NUCLÉAIRE

2008
Annual Report

Contents

2008
Annual Report

The Institute will assert its vital role as a world-class expert in nuclear assessment

> “Our mission is based on a unique and diversified quest for quality that makes IRSN one of a kind.”

The annual report gives IRSN personnel the opportunity to review the year’s accomplishments together and reflect on the image that we, as a community, project to those outside our organization.

In 2008 the Board of Directors was renewed. The board members were chosen to comply with requirements in our founding charter, resulting in a constructive balance between the ministries directly involved in IRSN’s mission (including the supervisory ministries), nuclear safety authorities, Institute staff representatives, advisory members, including international scientific experts, and the President of the National Association of Local Information Commissions. By choosing a physician to chair the IRSN Board, public authorities have signaled their intention to reinforce a nuclear culture based on safety in the medical environment, while clearly emphasizing that the essence of the Institute is to serve the public by protecting people from the (harmful) effects of ionizing radiation.

The year 2008 was a particularly busy one for the Institute, especially due to a few minor incidents that had no impact on public health, but sparked widespread media coverage, leaving their mark on our collective consciousness. This situation of living with a constantly perceived, and real, risk means we must be extremely vigilant.

To begin, we must be vigilant in our core activity: in the various emergency situations that occurred in the summer of 2008, the Institute demonstrated its ability to act reliably as the legitimate national expert,

> "The essence of the Institute's mission is to serve the public by protecting people from the effects of ionizing radiation."

through efficient internal organization and the professionalism of its staff. In an era of renewed interest for the nuclear sector on both the national and international scene and the ensuing diversification of parties involved, IRSN must continue to promote a nuclear culture based on safety, conducting its expert mission with uncompromising discipline, as pressure builds on our personnel. We must therefore endeavor to constantly refresh our in-house skills and renew our staff members, keeping in mind the more attractive sources, especially universities, but also encouraging knowledge-sharing within our ranks. We also need to reflect together on how to reorganize our land and building assets, an issue to be confronted in the next few years, as we aim to preserve a coherent balance between scientific facilities and assessment resources in the relevant departments, while keeping in mind the efforts this will require from our staff members.

Vigilant as well in how we communicate, staying aware of the image we create in the public eye. The Transparency Act states that the various nuclear stakeholders must provide the public with sufficient information on nuclear safety and radiation protection so that people are able to assess the risks involved. This represents a tremendous step forward for us as citizens. Transparency also implies making information not only accessible, but also comprehensible, through explanation and instruction.

As a public service institution, we have a major role to play. In this respect, the Institute can call on several instruments to serve this educational objective, such as its analysis reports, which are very complete, precise, and appropriate for widespread publication, now appearing as Internet links in the annual report. The Charter for Openness to Society enacted this year should also contribute to discussion and dialogue between the various stakeholders and represents a very constructive step in the right direction towards openness and transparency in public relations. In parallel, the new governance structure initiated by our supervisory ministries, the Nuclear Safety and Radiation Protection Research Policy Committee, aims to explain our research strategy and invites society to take part in this reflection on the long-term prospects of research in nuclear safety and radiation protection.

The conclusions of this multidiscipline committee will be taken into consideration as the Institute prepares its future strategy plans.

In conclusion, our mission is based on a unique and diversified quest for quality that makes IRSN one of a kind. This pursuit must be supported both inside and outside the Institute, and the annual report is one way of making it known to all of our partners.

Our challenge for the future, in a context of high media visibility open to contrasting viewpoints, is first and foremost to affirm the Institute's image as a vital world-class expert in nuclear safety and radiation protection, an organization that strives to be responsive, rigorous, impartial, proactive and transparent. The Board of Directors will be vigilant in any decisions that could affect the public service mission of the Institute. It will continue to target our goal, essential for society as a whole, to protect people and the environment, the commitment that unites each and every member of IRSN personnel.

Agnès BUZYN
Board of Directors Chairperson

IRSN's sole ambition is to advance the cause of nuclear safety

"We contribute to developing nuclear safety expertise in an increasing number of countries."

The relative confidence that the French people have in the safety of their nuclear power plants is not to be taken for granted, as revealed by the latest IRSN annual public opinion barometer, based on a survey conducted in December 2008. In France, a growing portion of the population (33% compared to 20% in previous polls) question the degree of safety in nuclear facilities, and a majority (53% vs 40% previously) suspect the presence of environmental and health risks in the areas surrounding nuclear sites. Should this be interpreted as the result of the minor incidents, given vast media coverage, that affected several nuclear facilities a few months earlier? Or the tribute to be paid to greater transparency, which leads commentators to constantly fire away at nuclear industry representatives and authorities, generating concern among those who, until now, showed no interest in these issues?

Whatever the case, the survey shows a growing demand for transparency, which is even considered essential if nuclear energy is to be accepted on a long-term basis. Along a different line, the public continues to hold a high opinion of scientific experts, and hopes to see an increasing number of cross-disciplinary structures. This would give experts from various horizons the opportunity to confront their positions clearly, helping to ensure the independence of opinions expressed on safety and radiation protection and, in the final outcome, affirming the validity of decisions made by public authorities.

The expression "nuclear safety" is understood here in the general sense defined in the 2006 legislation: safety of facilities, safeguards against malicious acts, protection from risks related to ionizing radiation.

> “A community of men and women serving the cause of nuclear safety.”

This means transparency is both the problem and the solution!

Given the context, the Institute for Radiation Protection and Nuclear Safety has tailored its action to successfully fulfil its obligations as the national public expert on nuclear safety, an essential mission to serve society as a whole, gaining ever-wider recognition.

The Institute's research programs focus on major questions whose answers will shape nuclear safety in the years to come, while taking advantage of opportunities to cooperate with universities, research institutions, and major nuclear industry stakeholders in France and other countries such as the United States, members of the European Union, Japan, Russia, tomorrow India, and perhaps even China. Created to advise the IRSN Board of Directors, the Nuclear Safety and Radiation Protection Research Policy Committee, whose members will be chosen along the same principles as participants to the Environment Round Table, will consolidate this approach.

IRSN is reinforcing its technical support capability to assist public authorities, within the context of nuclear legislation passed in 2006, focusing its efforts on nationwide radiation monitoring and the ability to respond quickly and efficiently to an accident situation, while ensuring transparency.

By participating in targeted scientific collaborative projects, it aims to contribute to the emergence of a much-needed cross-discipline expert network specialized in nuclear safety and radiation protection, particularly by working with local information committees.
It also contributes to training professionals and keeping the public informed, as witnessed by the success of its Internet sites, where the lengthening list of publications is consulted by an increasing number of visitors.

With the international expansion of nuclear activities, the Institute is called on to accompany government policy by contributing to the development of nuclear safety know-how in a growing number of countries through the French International Nuclear Agency, and by encouraging the emergence of worldwide cooperation between expert organizations specialized in nuclear and radiological risk, a starting point for standardizing good practice.

To conclude, IRSN is also a community of men and women committed to serving nuclear safety, whose efficiency as a group depends on both the quality of its technical resources, and its allegiance to the values incarnated by the Institute: scientific rigor, independent judgment, conservation and transmission of knowledge, respect for the opinions of others.

IRSN's sole ambition is to advance the cause of nuclear safety. This is what appears in the 2008 Annual Report, which I invite you to discover.

Jacques REPUSSARD
Director General

EDITORIAL

Interview with the Deputy Director General in charge of defense-related missions

IRSN's expertise in nuclear and radiological risk applies to all areas of nuclear activity, including those involved in national defense, and all types of risk, such as malicious acts and terrorism.

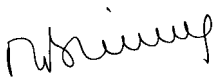
To support public authorities in the specific areas of defense and security covered by the French Code of Defense, the Institute is overseen by the ministries in charge of the corresponding law enforcement agencies (defense, industry, energy). The Institute's founding charter also stipulates certain specific provisions, namely, that there must be a deputy director general responsible for this mission and a nuclear defense expertise division in charge of the corresponding activities within the Institute.

Activities involving the study and analysis of safety and security files, along with facility and transport inspections, are conducted in compliance with defense confidentiality requirements, with priority given to employing the Institute's best scientific and technical resources to serve public authorities.

In 2008, nuclear defense and security assessments, conducted on a national and sometimes international scale, mobilized the equivalent of 130 people, representing nearly 8% of the Institute's activity, described in this report in Challenge 1 (Nuclear Safety, About Defense) and Challenge 4 (Security and Non-proliferation).

- For defense-related nuclear facilities and activities, safety assessments ordered by the Nuclear Defense Expertise Division (DEND) included the nuclear ballistic missile submarine *Le Terrible* under construction, the aircraft carrier *Charles-de-Gaulle*, coming to the end of its maintenance period, and a large number of facilities being built or transformed by CEA, Areva or the French Navy.
- As concerns protection of nuclear materials, facilities and transport against malicious acts or terrorism, the year was marked by the transfer of responsibility for national control from the Ministry of Industry to the Ministry of Energy, with a significant extension of activity for senior defense and security officials. In addition, the decision taken in 2008 to reinforce national regulations on radioactive sources in order to tighten security will also entail new tasks for the Institute.
- With regard to enforcement of non-proliferation treaties in France, the role of the Institute's experts is to accompany international inspection teams to ensure compliance with the terms of these agreements. In 2008 the number of inspections led by the Organization for the Prohibition of Chemical Weapons rose significantly, while Euratom and the IAEA kept up their substantial inspection efforts. IRSN also pursued the development of information system applications to facilitate and secure data exchanges between French industry, the Institute, and international control organizations.

Public authorities who called on the Institute's technical support services in 2008 in the fields of defense and security expressed their satisfaction. Our main objective is to help them fulfil their mission.



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

Activity in 2008: key figures

Activity at the Institute

RESEARCH

46% of IRSN's budget is devoted to research

211 scientific publications

TECHNICAL SUPPORT FOR PUBLIC AUTHORITIES

709 technical opinions submitted to the ASN (excluding defense-related activities)

97 technical opinions submitted to the defense safety authority

439 technical opinions submitted to the national security authority

INTERNATIONAL ACTIVITY

180 bilateral agreements signed with research and assessment organizations

36 countries involved in these agreements

82 international projects in progress

HUMAN RESOURCES

1,701 employees on permanent contracts as of December 31, 2008 (including 77 assigned to the ASN or other institutions)

TRAINING SERVICES

4,301 man-days of training delivered

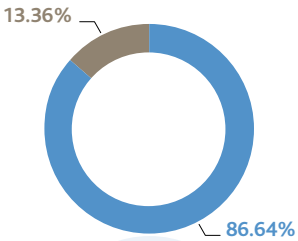
INTELLECTUAL PROPERTY

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

15 patents in force abroad

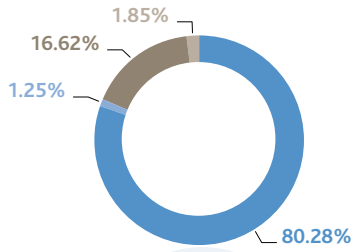
195 software applications and data bases filed (24 co-owned with CEA and 6 placed with the software protection agency APP, co-owned with VUEZ, Slovakia)

The budget breakdown



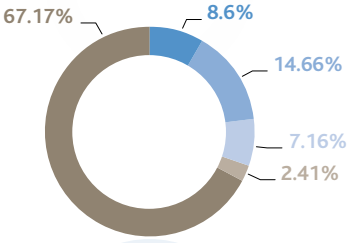
Operating and investment expenditure

- Operating expenses
- Investment



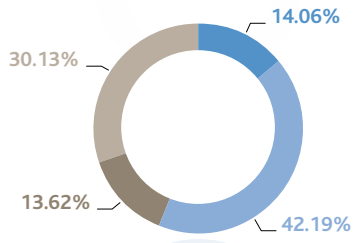
Funding

- Budget Act 189 grant
- Budget Act 212 grant
- Other French funds (aside from Budget Act)
- Foreign funding



French funds (aside from Budget Act)

- State
- EDF
- Areva
- CEA
- Others

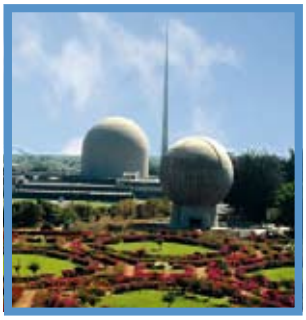


Foreign funds

- European Commission
- Riskaudit
- NRC
- Others

Panorama of 2008

January 15



Development of scientific cooperation between IRSN and India's Bhabha Atomic Research Centre (Barc). After training several Barc engineers on the implementation of computer codes used in safety assessments, the Institute recently signed a licence agreement with the Indian agency for the use of CATHARE, a thermal-hydraulic code used to assess accident situations.

February 5

IRSN's Director General spoke before the Advisory Committee on Reactor Safeguards (ACRS) in Washington on the Institute's long-term research perspectives in nuclear safety.

February 5

Label awarded by the PACA region's *Territorial Risk and Vulnerability Management Cluster* for the COPERNIC joint platform on fire research, led by IRSN. This platform allows companies to call on IRSN's competence and test facilities in areas involving fire hazards.

February 6

IRSN participated in the first meeting held by the executive committee of the SNETP in Brussels. The Institute's Director General represented all the nuclear technical safety organizations (TSOs) in the European Union who are participating in this research platform, established to ensure that the various partners involved develop converging and efficient research strategies.

February 19

Kick-off of the ASAMPSA2 project to conduct probabilistic safety assessments (PSA) on reactors, directed by IRSN. As part of Europe's 7th Research and Development Framework Program (FP7), the project involves optimizing Level 2 PSA methods applied to reactors.

February 22

IRSN's Director General appointed as president of the ETSON network for one year. Created by IRSN and its German and Belgian counterparts, GRS and Bel V, the ETSON network of nuclear technical safety organizations aims to develop more close-knit relationships in research and assessment between European TSOs.

February 26

On-line publication of the complete results of IRSN assessments conducted on radiosurgery accidents at the university hospital in Toulouse. The two reports published by the Institute shed light on the causes and medical consequences of these accidents, which involved 145 patients. Over twenty IRSN experts and researchers worked for several months on this particularly complex assessment.

March 11

IRSN signed a joint agreement with seven other scientific institutions with complementary skills and knowledge in industrial risk control. The purpose of the agreement is to organize research and technology transfer activity within the national industrial risk cluster created by the State in 1998, located in Bourges, France.

March 18

A day of talks between the CNRS and IRSN on the collaborative scientific work they conduct in the field of nuclear safety. This event, a follow-up to the new joint laboratory on micromechanics and structural integrity (MIST), co-founded by the two research institutes and the University of Montpellier 2, is part of a strategy to develop scientific partnerships between IRSN, universities and basic research organizations.

April 11

↘ IRSN and GRS signed a contract with the Bulgarian safety authority for a safety assessment of the future reactor in Belene. IRSN, in partnership with the German TSO GRS and their joint affiliate Riskaudit, will provide the Bulgarian safety authority with their expertise in assessing the preliminary safety report on this reactor.

April 24

A framework cooperation agreement on nuclear safety and radiation protection was signed between IRSN and its Belgian counterpart Bel V. The purpose is to respond to growing demand for assessments in these areas, brought about by development prospects in Europe and throughout the world in civil nuclear energy.

May 9

Creation of AFNI, the French International Nuclear Agency. To assist countries who wish to acquire nuclear power plants, France has created an international nuclear agency, AFNI, to coordinate action taken by French public organizations within these countries. With nuclear safety and radiation protection as the core issues in this initiative, IRSN has been designated as a member of the Agency's executive committee and will provide considerable support to countries seeking to develop nuclear energy facilities.

May 14

IRSN inaugurated CHIP, a new facility designed to quantify and characterize radioactive iodine release in the event of core meltdown in a nuclear reactor. The CHIP experimental program (based on reactor coolant system iodine chemistry), which uses a new test facility located in Cadarache in southern France, aims to broaden the Institute's assessment capabilities in accident prevention and emergency response management with regard to environmental release of radioactive iodine.

June 12

IRSN and the CNRS created TRASSE, a national research group focussing on safety in nuclear waste repositories. The inauguration of the national research group TRASSE, which focuses on the transfer of radionuclides to soil, subsoil and ecosystems, marks a reinforcement of cooperation between IRSN and the CNRS.

June 16

The plenary meeting of Geosaf, the international project team working on geological repository safety demonstration, was held at IRSN headquarters. Organized by the International Atomic Energy Agency (IAEA), the project's objectives are twofold: to report on progress achieved in development of radioactive waste geological repositories; and to take measures to standardize safety demonstrations among various repository projects.

July 1

IRSN designated as the national benchmark laboratory for measuring radionuclides in foodstuffs. The Directorate General on Food Safety (DGAL) from the French Ministry of Agriculture and Fishing, has assigned this new mission to IRSN based on the Institute's experience in radioactivity metrology.

July 8

A special report was published on the IRSN website concerning the incident involving environmental release of a uranium-containing solution at the Socatri plant in Bollène in southern France. This initial communication was quickly followed up by interactive maps of the area surrounding the Socatri plant published on the Internet, giving the public easy access to environment measurement results.

From August 25 to 29

↘ Economic prospecting mission to China. In efforts to develop IRSN's commercial activities on an international scale, this mission presented the Institute's skills to industry representatives in China, where the demand is high for technical knowledge in safety. Similar initiatives began in 2008 in various countries that have shown an interest in IRSN's skills and experience.

September 3

The French Council of Ministers has nominated Agnès BUZYN as Chairperson to the IRSN Board of Directors.
Agnès BUZYN is a physician and professor of hematology at the Necker Children's Hospital in Paris.

September 23

IRSN presented to the HCTISN a report and proposals on water quality in areas surrounding French nuclear facilities.
Exposed before the High Committee for Transparency and Information on Nuclear Safety (HCTISN), the report had been prepared at the request of this committee following the July 7, 2008 incident involving environmental release of uranium-containing effluent by the Socatri plant in Bollène in southern France.

From October 6 to 17

↘ Seminar organized in Beijing on the EPR plant. Organized in partnership with ASN, the French nuclear safety authority, the seminar focused on the main regulatory and technical aspects important for safety on this type of reactor. The event was held in response to a request from China's safety authority, illustrating IRSN's commitment to fulfilling its institutional and international mission. To help new nuclear countries in developing their assessment capability in safety and radiation protection, IRSN has become a participant in the steering committees of the French international nuclear agency, AFNI. In collaborative work conducted with the other European technical safety organizations, the Institute leads activities coordinated through the Sustainable Nuclear Energy Technology Platform (SNETP).

October 9

The Charter for Openness to Society was signed by the directors of the Afsset, Ineris, and IRSN. This charter demonstrates to the public that these institutions are determined to give society easier access to the assessment process.

October 23

Agreement signed between the State and IRSN to enact legislative and regulatory texts on the protection and control of nuclear materials.
The transfer of activities covered by the agreement from the Ministry of Industry to the Ministry of Energy led IRSN to sign a new agreement with the latter, for one year, under the same terms of law. A complete review is scheduled in 2009.

October 31

A protocol between IRSN and the CMVOA (operational watch center to alert the French government of major events) was signed, defining IRSN's contribution to keeping the Ministry for Ecology, Energy, Sustainable Development and Town and Country Planning informed in the event of a radiological emergency.
The agreement specifies what information must be exchanged between the Institute and the CMVOA, as well as communication procedures to be followed.

November 3

General assembly of ETSON (European Technical Safety Organization Network) in Paris. Two new members joined ETSON at the 2008 EUROSAFE Forum, VTT from Finland and UJV from the Czech Republic, a concrete illustration of the trend toward closer cooperation in Europe on safety issues.

November 3 and 4

IRSN organized the 10th edition of the EUROSAFE Forum in Paris, in partnership with GRS from Germany and Bel V from Belgium. Over 400 experts came together for discussions on the theme *Role of Technical Safety Organizations in an International Context of Growing Demand for Safety Assessments*.

November 17

Partnership agreement signed between IRSN and the Paris Fire Brigade.
Cooperation between the contracting parties targets joint initiatives in research, information and training.

December 9

The Institute published a report exposing *IRSN's viewpoint on safety and radiation protection issues relative to French nuclear power plants in 2007*.
IRSN conducts a continuous safety assessment on the existing EDF NPP fleet, keeping the distance necessary to glean pertinent information.
The report published in 2008 helps both stakeholders and the general public ascertain the issues at hand in nuclear facility management, covering progress achieved and remaining shortfalls.

Major reports published in 2008

Human radiation protection

L'accident de radio-chirurgie stéréotaxique au Centre hospitalier universitaire de Toulouse – Évaluation dosimétrique et clinique, analyse de risque *(Stereotaxic radiosurgery accident at the Toulouse university hospital – dosimetric and clinical assessment, risk analysis)*

Published in February 2008
www.irsn.org

Études épidémiologiques des leucémies autour des installations nucléaires chez l'enfant et le jeune adulte : revue critique *(Epidemiological studies of leukemia in children and young adults around nuclear facilities: a critical review).*

Published in March 2008
www.irsn.org

Analyse des données relatives à la mise à jour des niveaux de référence diagnostiques en radiologie et en médecine nucléaire : bilan 2004-2006 *(Data analysis on updated diagnostic reference levels in radiology and nuclear medicine: 2004-2006 report).*

Published in May 2008
www.irsn.org

La radioprotection des travailleurs : bilan IRSN 2007 des expositions professionnelles aux rayonnements ionisants *(Worker radiation protection: 2007 IRSN report on occupational exposure to ionizing radiation).*

Published in December 2008
www.irsn.org

Environmental monitoring

État de la surveillance environnementale et bilan du marquage des nappes phréatiques et des cours d'eau autour des sites nucléaires et des entreposages anciens de déchets radioactifs *(Status report on environmental monitoring and radioactivity detected in groundwater and water courses near nuclear facilities and former radioactive waste storage sites). Report prepared for the French High Committee for Transparency and Information on Nuclear Safety.*

Published in September 2008
www.irsn.org

Bilan de l'état radiologique de l'environnement français en 2007 : synthèse des résultats des réseaux de surveillance de l'IRSN *(2007 report on the radiological state of the environment in France: summary of results from the IRSN monitoring networks).*

Published in November 2008
www.irsn.org

Bilan de la surveillance de la radioactivité en Polynésie française en 2007 : résultats du réseau de surveillance de l'IRSN *(2007 report on radioactivity monitoring in French Polynesia: results from the IRSN monitoring network).*

Published in November 2008
www.irsn.org

Le radon, synthèse des connaissances et résultats des premières investigations en environnement minier *(Radon: overview of knowledge and results of initial investigations in a mining environment).*

Published in December 2008
www.irsn.org

Surveillance de la radioactivité dans l'environnement du bassin de la Loire – n partenariat entre l'IRSN et les Cli de Dampierre-en-Burly et de Saint-Laurent-des-Eaux au service de la vigilance citoyenne *(Monitoring radioactivity in the Loire basin environment – A partnership between IRSN and the Local Information Committees of Dampierre-en-Burly and Saint-Laurent-des-Eaux serving citizen vigilance).*

Published in December 2008
www.irsn.org

Nuclear safety

Incidents de transport de matières radioactives à usage civil : bilan 1999-2007 *(Transport incidents involving radioactive materials for civil applications: 1999-2007 report).*

Published in October 2008
www.irsn.org

Le point de vue de l'IRSN sur la sûreté et la radioprotection du parc électronucléaire français en 2007 *(IRSN's viewpoint on safety and radiation protection issues relative to French nuclear power plants in 2007).*

Published in December 2008
www.irsn.org

Scientific excellence and training

Formation à et par la recherche : bilan 2007 *(2007 report on research training)*

Published in June 2008
www.irsn.org

Rapport scientifique et technique *(Technical and scientific report)*

Published in June 2008
http://net-science.irsn.org

Apport des traceurs à la compréhension des processus de transport au sein de formations argileuses indurées *(Contribution of tracers to the understanding of transport processes in indurated argillaceous formations)*

Published in October 2008
www.irsn.org

IRSN: EXPERT IN NUCLEAR AND RADIOLOGICAL RISK

IRSN in short

FOUNDING THE INSTITUTE

IRSN 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 following the adoption on June 13, 2006 of the Transparency and Nuclear Safety Act.

STATUS

IRSN is a public authority with industrial and commercial activities, placed under the joint authority of the Ministry for Ecology, Energy, Sustainable Development and Town and Country Planning, the Ministry for the Economy, Industry and Employment, the Ministry for Higher Education and Research, the Ministry of Defense and the Ministry for Health and Sports.

DIRECTORS

- **Agnès** BUZYN, Board of Directors Chairperson
- **Jacques** REPUSSARD, Director General
- **Michel** BRIÈRE, Deputy Director General in charge of defense-related missions
- **Jean-Luc** PASQUIER, Deputy Director
- **Jean-François** LACRONIQUE, Advisor
- **Daniel** QUÉNIART, Advisor

PURPOSE

IRSN is the nation's public service expert in nuclear and radiation risks, providing assessments and conducting research to meet the needs of public authorities.

2008 BUDGET*

Revenue: €255 million.
Expenditure: €281 million, including €35 million for equipment investment.

SPECIALIZATIONS

- Monitoring environmental radiation and participating in radiological emergency response situations.
- Human radiation protection.
- Prevention of major accidents in nuclear facilities.
- Reactor safety.
- Safety in plants, laboratories, transport, and waste treatment.
- Nuclear defense expertise.

LINES OF DEVELOPMENT IN THE IRSN CONTRACT OF OBJECTIVES FOR 2006-2009

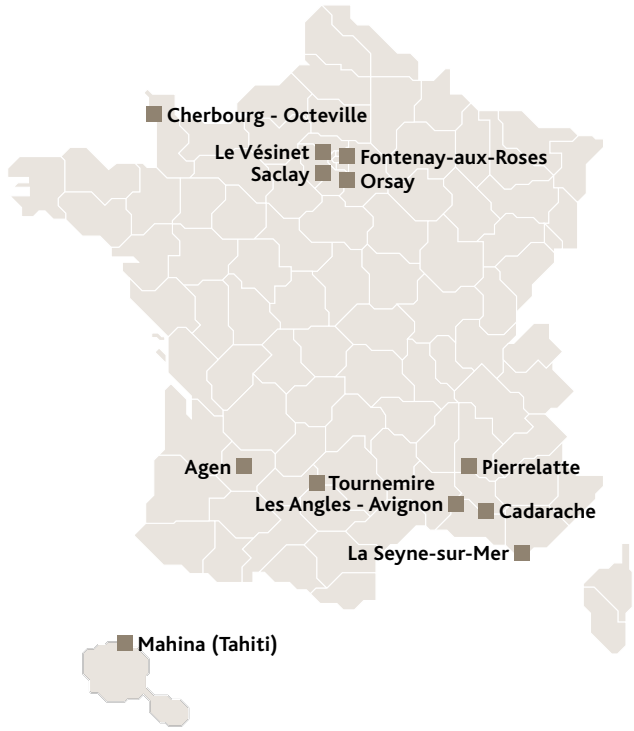
- Rethink the research dynamic.
- Optimize technical support provided to public authorities.
- Provide other social and economic stakeholders with the information, expertise and studies they require.
- Drive activity on the European and international scene.

WORKFORCE AND LOCATIONS

(as of December 31, 2008)

IRSN employs around 1,700 people, including many specialists, engineers, researchers, physicians, agricultural engineers, veterinary surgeons and technicians, as well as experts in nuclear safety, radiation protection and control of sensitive nuclear materials.

North Region: 1,266 employees



South Region: 317 employees

* See Financial Report for further details.

IRSN missions

Amended Order No. 2002-254 of February 22, 2002 relative to IRSN, put forward seven missions for the Institute covering radiation protection, nuclear safety, and nuclear security. These are organized into the three sectors described below.

RESEARCH AND PUBLIC SERVICE MISSIONS

Defining and implementing national and international research programs

IRSN defines and conducts research programs aimed at maintaining and developing the skills necessary for expert assessments in its specializations. It either carries out the programs itself or, in a European or international context, may entrust them to other French or foreign research institutes.

Contribution to training and teaching in radiation protection

As an establishment specialized in research and assessments, IRSN contributes to training and teaching in the fields of radiation protection, nuclear safety and nuclear security. The radiation protection training courses it organizes are directed at professionals working in the health sector and workers exposed to occupational hazards.

Continuous monitoring in the field of radiation protection

IRSN contributes to round-the-clock health surveillance in radiation protection by monitoring environmental radiation, as well as managing and processing dosimetric data for workers exposed to ionizing radiation. IRSN also manages the national inventory of radioactive sources.

Contributing to public information

IRSN informs the public of nuclear and radiation risks via publications, the Internet, exhibitions and conferences.

TECHNICAL AND OPERATIONAL SUPPORT AND ASSISTANCE TO PUBLIC AUTHORITIES

Technical support with regard to nuclear and radiological risks

The scope of IRSN's activity covers nuclear facilities operating in the civilian or defense sector, transport of radioactive substances, enforcement of treaties on control of nuclear and sensitive materials, and the physical protection and safety of industrial and medical applications.

Operational support in the event of a crisis or radiation emergency

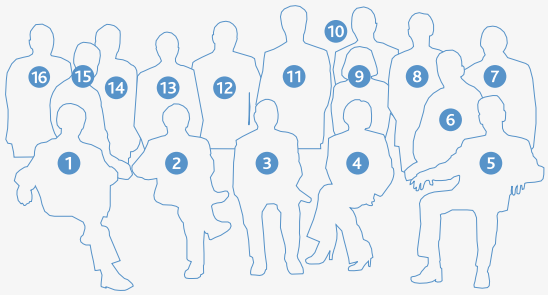
In the event of an incident or accident involving sources of ionizing radiation, IRSN provides guidance to public authorities on the technical, public health and medical measures to be taken to protect the population, workers and the environment, while restoring safety at facilities.

CONSULTANCY SERVICES CONTRACTED FOR EXPERT ASSESSMENTS, RESEARCH AND MEASUREMENTS

Conducting assessments, research, analyses and measurements for public or private organizations

IRSN conducts assessments for public and private organizations in France, Europe, and the international community, and also provides third-party assessment services for industries operating environmentally sensitive facilities outside the nuclear sector.

BOARD OF DIRECTORS (April 2009)



❶ **Jean-Claude MICAELLI**
Prevention of Major Accidents

❷ **Jean-Bernard CHÉRIÉ**
General Secretary

❸ **Jacques REPUSSARD**
Director General

❹ **Marie-Pierre BIGOT**
Communications

❺ **Thierry CHARLES**
Safety of Plants, Laboratories, Transport and Waste

❻ **Martial JOREL**
Reactor Safety

❼ **Jean-Luc PASQUIER**
Deputy Director

❽ **Patrick GOURMELON**
Radiation Protection and Human Health

❾ **Patricia de la MORLAIS**
Human Resources

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

⓫ **Jérôme JOLY**
Nuclear Defense Expertise

⓬ **Didier CHAMPION**
Environment and Response

⓭ **Michel SCHWARZ**
Science

⓮ **Daniel QUÉNIART**
Advisor

⓯ **Michel BOUVET**
Strategy, Development and External Relations

⓰ **Bruno DUFER**
Security and Assets

Organization chart

BOARD OF DIRECTORS

Agnès BUZYN,
Chairperson (nominated by Order of September 3, 2008)

GENERAL MANAGEMENT

Jacques REPUSSARD,
Director General

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

Jean-Luc PASQUIER,
Deputy Director

Jean-François LACRONIQUE, Daniel QUÉNIART,
Advisors

OPERATIONAL DIVISIONS

Nuclear Defense Expertise
Jérôme JOLY, Director
- Defense safety assessments
- 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
- Analysis of risks related to the geosphere
- Environmental sample processing and metrology
- Radiation protection response and support
- Emergency situations and response organization

Prevention of Major Accidents
Jean-Claude MICAELLI, Director
- Studies and experimental research on chemistry and fire
- Studies and experimental research on materials
- Studies and modeling on fuel behavior in accident situations
- Fire, corium, and containment studies and modeling

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 contaminants

GENERAL SECRETARIAT

Jean-Bernard CHÉRIÉ, General Secretary
- Human resources
- Financial affairs
- Commercial relations and legal support
- Information technology systems

FUNCTIONAL DIVISIONS

Strategy, Development and External Relations
Michel BOUVET, Director
- Expert assessment programs
- Research programs
- Openness to society
- International relations
- International development
- Technology watch, forecasting and innovation

Science
Michel SCHWARZ, Director*
- Teaching and training in radiation protection, nuclear safety and security
- Assessment and scientific activities
- Scientific and technical knowledge engineering
- Scientific information resources

Communications
Marie-Pierre BIGOT, Director
- In-house communications
- Information and media relations
- Programs and public relations

Security and Assets
Bruno DUFER, Director and "IRSN Security Officer"
- Security of assets and sites
- Buildings and logistics
- Hygiene, safety and environmental protection
- Sustainable development

Accounting Office
Catherine ALBARET, Accounting Officer

* Position held by Dominique GOBIN up until December 2008.

Board of Directors

Missions

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

Main accomplishments

- **Board of Directors** renewed
- **Creation of the Nuclear Safety and Radiation Protection** Research Policy Committee
- **Creation of the Ethics Commission**
- **Set-up of a profit-sharing** system
- **Employee mobility plan adopted** between CEA and IRSN

Members (as of December 31, 2008)

> 10 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 in charge of the environment
Claire BUÉNO	Head of the Energy, Profit-sharing, Industry and Innovation Office at the Budget Directorate, representing the minister in charge of the budget
Jean-Denis COMBREXELLE	Director of Labor Relations, representing the minister in charge of employment
Dominique GOUTTE	Director of the Department of Chemistry, Engineering Sciences, Nuclear and High-energy Physics, Energy, and Sustainable Development, representing the minister in charge of research
Jean HAMIOT	Inspector General of Armaments, 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
Pascal MATHIEU	Head of the Major Risks Office at the Directorate for Defense and Civil Security, representing the minister in charge of civil security
Stéphane NOËL	Head of the Nuclear Safety and Radiation Protection Mission
Cyrille VINCENT	Deputy Director for the nuclear industry, Directorate General for Energy and Climate, representing the minister in charge of industry

> Six advisory members	
Agnès BUZYN	*Board of Directors Chairperson*, physician and professor of hematology, nominated by the Minister for Health
Serge AUBERT	Air Force Brigadier-General, nominated by the Minister of Defense
Claude BIRRAUX	President of the Parliamentary Office for the Evaluation of Scientific and Technological Options
Jean-Marc CAVEDON	Director of the Division for Research in 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 Commissions, nominated by the Minister for Ecology
Jean-Michel GIRES	Director of Sustainable Development and the Environment for the Total group, nominated by the Minister for Industry

3 meetings per year

24 members

5 -year mandate

> Eight staff representatives
Hervé BOLL, Nicolas BRISSON, François DUCAMP, Thierry FLEURY, François JEFFROY, Yves LE RESTE, Christophe SERRES, Carine STRUP-PERROT

> *Ex officio* or associate members	
Bernard ABATE	Auditor General
Catherine ALBARET	IRSN Accounting Officer
Philippe BOURACHOT	Works Committee Secretary
Michel BRIÈRE	IRSN 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 of IRSN

In the words of

Agnès BUZYN

Board of Directors Chairperson

Specialized in hematology pathologies, practicing at the Necker Children's Hospital, Agnès BUZYN, aged 45, was appointed Chairperson of the IRSN Board of Directors on September 3, 2008, replacing Jean-François LACRONIQUE.

"The fact that I work on pathologies such as leukemia and medullar aplasia was probably what led the Minister for Health to propose my candidature for an institute such as IRSN, whose activities all converge towards human radiation protection. I also had the opportunity to work with the Institute during an exercise that set out to define procedures for treating irradiated victims in a scenario involving a severe accident or terrorist attack. I was impressed by the diversity of skills employed at IRSN and the quality of its teams."

The new chairperson explained her priorities for the Institute: *"The first involves radiotherapy, where IRSN needs to drive the country's effort to introduce a new safety culture in the medical sector, comparable to what has been accomplished in the nuclear power industry. Second, I believe that research work, an absolutely essential part of the Institute's activities, must be made as comprehensible, credible, and competitive as possible, through partnerships with major research institutions. IRSN's new Research Policy Committee is central to this strategy".*

Steering Committee for the Nuclear Defense Expertise Division (CODEND)

Missions

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

Main accomplishments

- **Review of defense and safety aspects of the following:**
  - the DEND 2007 Activity Report and IRSN 2007 Annual Report;
  - Medium- and Long-term Plan;
  - DEND Activity Program for 2009.
- **Definition of policy** on renewal of framework agreements dealing with nuclear defense assessments.

Members (as of December 31, 2008)

Emmanuel SARTORIUS	*Chairman of CODEND*, Senior Defense and Security Official at the Ministry for the Economy, Industry and Employment
Jean-François BACHEROT	Air Force Brigadier-General, nuclear weapons inspector
Philippe COINDREAU	Captain in the French Navy, representing the administrative Secretary General of the Ministry of Defense
Rosine COUCHOUD	Representing the Director of Strategic Affairs, Security and Disarmament at the Ministry of Foreign and European Affairs
Jean-Baptiste FLEUTOT	Chief Medical Officer of the French Armed Forces, renewal of mandate as advisory member in progress
Marcel JURIEN DE LA GRAVIÈRE	Representative in charge of Nuclear Safety and Radiation Protection for Defense-related Activities and Facilities
Georges MOUTON	Rear-Admiral, representative of the Armed Forces Chief of Staff
Serge POULARD	Renewal of mandate as advisory member in progress
Patrick RENVOISE	Engineer General for Armaments, representing the DGA, the French defense procurement agency
Emmanuel ROUSSELOT	Representing the Budget Director

4 meetings per year

10 members

The Scientific Council

Missions

The Scientific Council gives an opinion on IRSN programs. 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. Its advice may be sought on any issue or operation that involves an IRSN commitment.

Main accomplishments

- **Two assessments completed and presented**:
  - research in radiopathology and treatment of irradiation victims;
  - the role of global tests in simulating reactor accidents.

Opinions and the associated assessment reports are available at http://net-science.irsn.org

- **Assessment on "Aging of reactor materials" started in mid-2008.**

2 meetings per year

12 members

Members (as of December 31, 2008)

Michel QUINTARD	*Scientific Council Chairman*, CNRS Research Director at the Toulouse Institute of Fluid Mechanics, nominated by the Minister for Research
Jean-Claude ANDRÉ	CNRS Research Director at the National School of Industrial Chemistry (Ensic) in Nancy, 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
Pierre CATILINA	Physician specialized in occupational pathology and member of the French Commission on Occupational Disease, nominated by the Minister for Labor
Pierre LAROCHE	Chief Medical Officer of the French Armed Forces and Head of the Medical Division of the Armed Forces' Radiation Protection Department, nominated by the Minister of Defense
Philippe LECONTE	Physicist, former Director of CEA's radioactive waste management research program, nominated by the Minister for Research
Ethel-Esther MOUSTACCHI	Scientific Director for the Atomic Energy High Commissioner, nominated by the Minister for Ecology
André PINEAU	Professor at the Paris School of Mine Engineering, nominated by the Minister for Industry
Bernard SEVESTRE	Engineer General for Armaments, Deputy Director of nuclear activities at CEA Saclay, nominated by the Minister of Defense
Victor TESCHENDORFF	Head of Department at Gesellschaft für Anlagen- und Reaktorsicherheit GmbH (GRS, Germany), nominated by the Minister for Ecology
George YADIGAROGLU	Professor of Nuclear Engineering at the Swiss Federal Institute of Technology, nominated by the Minister for Industry


[VISION]
SOUTH KOREA
JAPAN
[COHESION]
[SHARING]

SUMMARY AND OUTLOOK

"A reference in France and around the world"

Contributing to a nuclear culture based on radiation protection, safety and security

In 2008, in a changing national and international context, IRSN played an active role in the development of a nuclear culture based on radiation protection, safety and security in all sectors involving the use of radioactive or nuclear materials and equipment emitting ionizing radiation. As stakeholders in the nuclear sector encounter changing needs, IRSN defines its objectives and priorities accordingly. It has established a long-term vision to guide research efforts and plan investment, and is ready to intervene quickly and efficiently when called on by public authorities to provide support services. IRSN considers nuclear safety and radiological protection to be the concern of all citizens. Consequently, it strives to make the most of its experience, research, and assessment resources, in Europe and internationally.

Analyzing the changing needs of nuclear stakeholders

In keeping with conclusions of the French Environment Round Table, IRSN aims to make the wealth of its knowledge and experience, gained through research and assessment work, available to all nuclear stakeholders. This strategy addresses two issues: strengthening the consultancy capability of the Institute by consolidating experience resulting from work in various fields of application, and providing information so that decisions can be taken based on facts and complete, reliable analyses.

To implement its strategy, IRSN keeps close ties with stakeholders who could benefit from its expertise. In 2008, the Institute continued working in cooperation with ASN, the French nuclear safety authority, towards developing a coordinated approach to managing various priority areas, including construction of the EPR plant in Flamanville (Manche); maintaining a high level of safety in EDF nuclear power plants, given aging facilities and changes in industrial practice; and developing regulations to enforce the Transparency and Nuclear Safety Act.

Following the occurrence of radiotherapy accidents in various French hospitals, in 2008 IRSN developed a safety approach for the medical sector, and for radiotherapy in particular. The approach builds on lessons learned from these accidents, while taking tried and proven concepts and analysis methods from the field of nuclear power generation and adapting them to this sector.

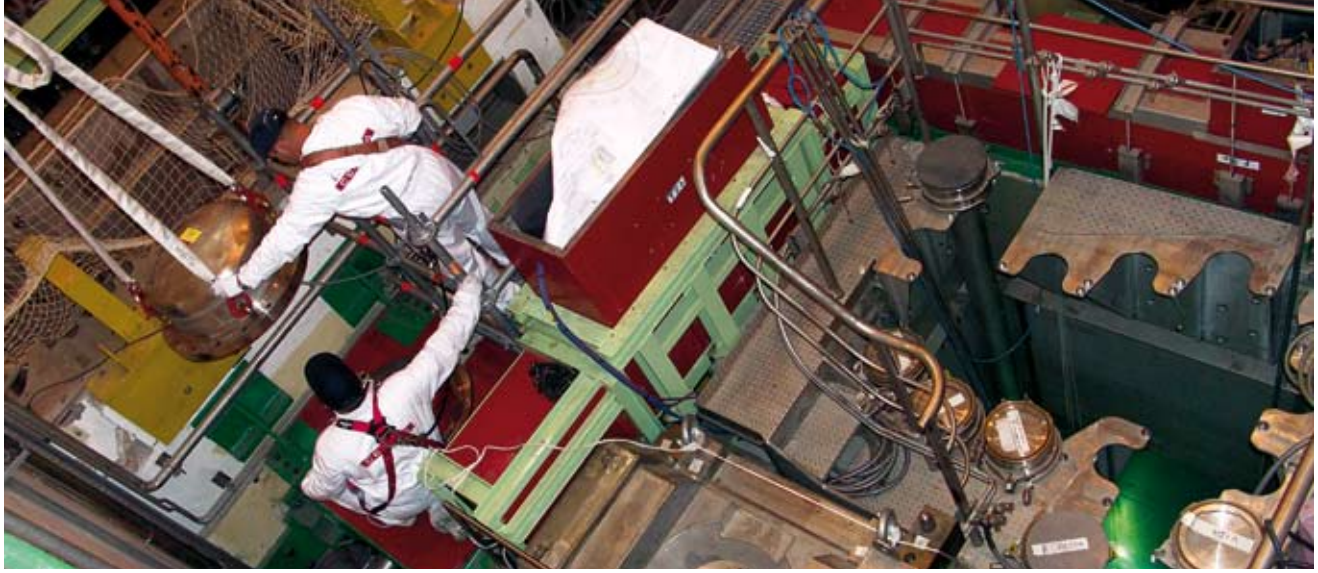
In this way IRSN demonstrates its determination to advance safety and radiation protection in all relevant sectors of activity, particularly with regards to the various French health agencies coordinated by the Ministry for Health within the Health Agency Networking Committee.

In the words of

Jean-François LECOMTE, Alain RANNOU

Senior experts in radiation protection at IRSN

“In 2008, two new advisory committees dedicated to radiation protection were formed to work with ASN: the Medical Advisory Committee for medical matters and the Radiation Advisory Committee for more general issues. Their work agenda covers technical or general questions, such as radon, involving protection of both workers and the public, and management of the post-accident phase of nuclear accidents or emergency radiological situations.It also covers interventional radiology, reference levels for radiology diagnostics and nuclear medicine, good practice and alternative solutions in gammagraphy, as well as lessons learned from incidents. These two new advisory committees are tasked with contributing to the definition of national policy on radiation protection and preparing regulatory changes. They will also contribute to information transparency in this area, since the recommendations of the advisory committees will be published.”



Renovating the CABRI experimental reactor.

Developing a long-term vision to guide research and plan investment

Given the complexity of nuclear safety and protection against ionizing radiation, it is necessary to anticipate the changing needs of different stakeholders, and keep a clear vision of the long-term actions each of them must take. Based on the four pillars[1] of the Contract of Objectives signed with the government for the period 2006-2009, IRSN has outlined a Medium- and Long-term Plan of action to achieve its goals. These actions take into account changes planned by EDF in its nuclear fuel management programs (characterized by higher fuel burnup rates in reactors); facility aging and its impact on nuclear power plant safety; and the protection of humans and the environment against ionizing radiation. In defining its medium- and long-term strategy, IRSN has been led to affirm its research priorities in the following areas:

- **Nuclear safety**: continuation of reactor safety programs in the context of ongoing changes in EDF nuclear fuel management. In this respect, IRSN is committed to forming scientific partnerships with universities and basic research institutions to achieve more rapid results in nuclear safety research. For example, by working with the CNRS in mid-2007 to found the MIST, a laboratory for research on micromechanics and structural integrity, rewarding results on nuclear fuel behavior at microstructural levels were obtained as early as 2008.
- **Protection against ionizing radiation**: continuation of a study in 2008 on the health and environmental effects of chronic contamination at low doses of radioactivity, in the ongoing European ALPHA-RISK research program on the risks of chronic multiple exposure, an important contribution to the European Commission High Level Expert Group, a European and international group tasked ultimately with giving a major boost to studies on the health effects of low doses.

[1] Rethinking the research dynamic; optimizing technical support to public authorities; responding to the needs of other economic and social organizations with regards to information, assessment and studies; playing a key role on the European and international scene.

Inauguration of MIST, a laboratory dedicated to micromechanics and structural integrity.

New governance at IRSN based on the search for efficiency

- The Nuclear Safety and Radiation Protection Research Policy Committee created in 2008
- International Development Division established
- First draft of the Medium- and Long-term Plan prepared
- Inter-Institute Charter on Openness to Society published

IRSN, benchmark laboratory for measuring radioactivity in food.

Ready to provide fast and efficient assessment

IRSN medium- and long-term action-planning builds on experience gained from participation in incident or accident response situations, leading to improvements in its organization, action, and response capabilities in cases such as these. In this respect, the release of uranium-containing effluents into the environment at the Socatri plant in July 2008 was a rich learning experience for IRSN, also demonstrating the Institute's ability to react quickly. Socatri, a branch of the Areva group located in Bollène (Vaucluse), specializes in nuclear equipment maintenance, decontamination and dismantling, as well as effluent and waste management.

This know-how, today recognized as a reference, led organizations such as the French Directorate General on Food Safety, from the Ministry of Agriculture, to designate IRSN as a benchmark laboratory in measuring radioactivity in food in 2008.

In the words of

Didier HOUSSIN

Director General of Health, Ministry of Health and Sports

"For many years, the various French health agencies have held a weekly health security meeting at the Ministry of Health to exchange views on current affairs involving health security and action to be taken, including emergency situations.
At the beginning of 2008, in addition to these operational-oriented meetings, Roselyne BACHELOT-NARQUIN decided to hold strategic meetings designed to reinforce cohesion within the national health security system, with the ministry as its focal point, and enhance transparency of its action.
Since March 2008, the Health Agency Networking Committee has met every two months to discuss medium-term, cross-agency issues such as research, assessment, standardization of referrals, European partnerships etc.
With regards to ionizing radiation, it is essential to bring together specialists in hospital management, medical device vigilance[1] , and radiation protection.
IRSN's role in this process is vital, since the use of ionizing radiation extends throughout several sectors such as radiology, radiotherapy and nuclear medicine."

[1] The purpose of medical device vigilance is to keep a watch on incidents or the risk of incidents that may result from the use of commercially available medical devices. This vigilance system was set up at the same time as new rules governing marketing of medical devices adopted by Member States of the European Union. (www.materiovigilance.org)

Nuclear safety and radiation protection concerns everyone

Since its foundation, IRSN has pursued its policy of sharing the knowledge and lessons learned from its assessment work with a growing number of nuclear professionals as well as associations and the public at large. This desire for transparency and openness, one of the pillars of the Contract of Objectives, is reinforced by the Transparency and Nuclear Safety Act. IRSN considers that the development of "citizen vigilance" is an essential contribution to the correct use of radioactive materials, a necessary complement to its techical skills and independent judgement.

In the same spirit, in 2008 IRSN published a report on the safety of French nuclear power plants and a summary report on epidemiological studies around nuclear sites. In agree-

8.3% **of funds for research programs** come from externally-generated revenue *(11% in 2007)*

IRSN is a member of the joint expert group for the remediation of former mining sites.

ment with the ASN, it also decided to publish summaries of reports presented to advisory committees working for this authority, who in turn published the opinions and follow-up letters of these committees. In October the Institute circulated an Inter-Institute Charter on Openness to Society, co-signed by Afsset and Ineris.

Beyond publishing information, IRSN is committed to exploring new ways of acquiring, sharing and consolidating knowledge. In the context of the environmental pilot project conducted in the Loire region, for example, the Institute, along with local information committees, developed an easily accessible and intelligible presentation concerning environmental radioactivity monitoring data. In the past year IRSN has thus doubled the number of initiatives taken with local information committees. This participatory approach can also be seen in the European COWAM in Practice nuclear waste governance project, designed to improve decision-making processes on future repositories, including concerns in the geographical areas involved. Still in 2008, the Institute contributed to the preparation of a second interim report by the joint expert group in the Limousin area. This group brings together institutions, associations, independent consultants, industry and foreign experts, tasked with bringing to the attention of public authorities the opinions and recommendations resulting from a collaborative assessment of technical documentation provided by Areva NC, relative to monitoring remediated mining sites in the Haute-Vienne area.

This set of measures also draws on studies such as *the Barometer of Public Risk Perception*, or the study jointly conducted with Ineris on contaminated soil management and public relations. IRSN is also preparing to implement proposals made by Georges Mercadal, tasked by the French National Commission on Public Debate, at the Institute's request, to consider initiatives that IRSN could take to reinforce transparency and social openness in its work.

The degree of maturity attained by IRSN in this regard was witnessed by the French High Committee for Transparency and Information on Nuclear Safety (HCTISN), and by the Commission for Information on the Major Energy Facilities at Tricastin (Cigeet), at the time of the July 2008 incident at the Socatri plant in Bollène.

Joint expert groups: the Areva viewpoint

Areva has learned how to lead a joint expert group to success through its participation in the North-Cotentin Radioecology Group and the joint expert group on remediation of former mining sites. The first condition is to formulate each issue plainly and simply, clarifying any vague expression of opposition.
Next, the joint expert group must team up with a public exchange forum, such as a local information committee, to open dialogue with the population.
Finally, functions must be attributed to the various participants in the joint expert group.

In this respect, IRSN has contributed to progress made by Areva by driving the group and acting as the operator's third-party consultant in conducting environmental assessments.

Areva considers it has reaped benefits in two ways from its participation in the joint expert group on mines: first, achieving clarity in its own views through the "mirror effect" of dialogue, which obliges participants to state things clearly; and second, attaining legitimacy by issuing recommendations in the name of the joint expert group, removing the suspicion that usually weighs on the operator alone.

47% **of the budget**
is devoted to technical support and public service programs *(45.5% in 2007)*

85 **people per year**
assigned to international programs
(95 in 2007)

IRSN is increasingly committed to promoting radiation protection.

Making IRSN research and assessment count in Europe and internationally

"A nuclear safety problem anywhere is a problem everywhere" says Ashok Thadani, former director of the US Nuclear Regulatory Commission's Office of Nuclear Regulatory Research, at the 2002 EUROSAFE Forum, underlining the inevitable interdependence of nations in matters of nuclear safety. IRSN, which fully subscribes to this point of view, is engaged in a growing drive towards both bilateral and multilateral international cooperation. The Institute is therefore promoting a culture of nuclear safety and security, including radiation protection, to standardize technical practices in these fields, to create as much research synergy as possible and to support partners who call on the knowledge it has gained through research and assessment. This campaign took place in 2008 in a global context where new nuclear power projects were starting up and various countries, for the first time, began considering the nuclear power alternative for generating electricity.

Promoting nuclear safety and radiation protection

IRSN has continued to work alongside the IAEA, especially through the Consultant Meeting chaired by the Institute's Director General, designed to continue the work begun in April 2007 during a conference organized by the Agency in France, in conjunction with IRSN. The objective is to reach a clearer definition of the scientific and technical support function in the area of nuclear safety, thereby consolidating the purpose and missions of institutions that, like IRSN, are responsible for providing this type of assistance to safety authorities. At the same time, the Institute contributed

In the words of

Aleš JOHN

Chairman of the Board of the Nuclear Research Institute Řež PLC

"Over a year ago, UJV, a Czech technical safety organisation, began discussions with IRSN, Bel V and GRS on the possiblity of joining ETSON. These talks led to the signing of an agreement on November 3, 2008 during the EUROSAFE Forum. For UJV, becoming a member of ETSON offers several advantages, starting with the visibility acquired by becoming a member of the TSO network and the consideration we receive from regulatory authorities. This makes it easier to exchange information regarding our respective programs, or projects conducted by our regulatory authorities and questions of method. As concerns the necessary independence of inspections and assessments carried out by TSOs, being a member of ETSON means UJV can call on its counterparts to conduct assessments on its behalf and vice versa, since our institutions cover a large range of activities."

In the words of

Brian SHERON

Director of the Office of Nuclear Regulatory Research at the US Nuclear Regulatory Commission

"To bring its research and regulatory work to a successful conclusion, the US NRC has signed bilateral agreements with various countries, the most far-reaching being the convention signed with IRSN. The agreement covers several areas, such as severe accidents, fission product release, the behavior of nuclear fuel in an accident situation, fire (through the PRISME program), as well as other fields covered by IRSN research. Our cooperation takes the form of bilateral meetings such as the one held for two days in Washington last September, where an IRSN delegation came to meet our regulatory research teams to provide them with information and answer their questions. NRC, in turn, has sent several staff members to France to participate in experiments conducted in IRSN research facilities. This type of collaborative work helps us achieve a better understanding of risks, gives us greater confidence in the reliability of our assessments and helps us explain to the public the risks associated with nuclear power."

to several other IAEA projects, including the new Basic Safety Standards (BSS), guidelines designed to replace those in force since 1996, as well as work conducted with the IAEA Commission on Safety Standards (CSS). It was also involved in a twofold way in the changes made to international principles of radiation protection. First, it played an active role in updating work conducted by the International Commission of Radiological Protection (ICRP) and by the OCDE's Nuclear Energy Agency (NEA). It also collaborated with the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), with the European Commission (during revision of the European directives on radiation protection), after the latest ICPR publication 103.

Contributing to standardizing technical nuclear safety practices

From November 3 to 4, 2008, IRSN organized the EUROSAFE Forum in Paris, bringing together 400 experts on nuclear safety and radiation protection from several countries, around the topic *The role of TSOs in the context of increasing demand for safety expertise*.

Debate among experts from the nuclear community and representatives of civil society at the 2008 EUROSAFE Forum.

On this occasion, the European ETSON network of technical safety organisations (TSO), chaired by IRSN in 2008, was joined by two new members, VTT of Finland and UJV of the Czech Republic. As newcomers join with the founders (IRSN, its German counterpart GRS and the Belgian Bel V), Europe demonstrates more tight-knit cooperation aimed at standardizing technical nuclear safety practices.

This objective was illustrated by the active role played by IRSN, within the ETSON network, in preparing safety guidelines that focused on human factors and organizational issues, analysis of incidents and their warning signs, severe accidents, and others.

115 occasions for IRSN to participate in international expert groups *(112 in 2007)*

21 European projects in progress *(18 in 2007)*

782 visits from foreign scientists *(495 in 2007)*

The Berlaymont Building, headquarters of the European Commission.

Making IRSN's competence count internationally.

Achieving synergy in research

IRSN is very involved in collaborative research projects supported by the European Commission. At the executive committee meeting of the Sustainable Nuclear Energy Technology Platform (SNETP) on February 6, 2008 in Brussels, the Institute represented the nuclear technical safety organizations that belong to this research organization. Its purpose is to maintain European excellence in the field of nuclear fission, by preparing, implementing and financing coherent and effective research strategies for the various partners.

In 2008 IRSN replied to several requests for proposals issued by the European Commission with regards to the 7th Research and Development Framework Program. IRSN is involved in five of the 18 projects accepted by the Commission.

The efforts of the Institute and its partners have seen a satisfactory success rate, particularly in areas involving severe reactor accidents (SARNET 2 Project), behavior of gases in radioactive waste geological repositories, and radiation protection.

Transferring precious expertise in research and assessment

In 2008 IRSN promoted its skills and experience in the economic value chain by developing institutional partnerships and consultancy services:

- in the context of the French International Nuclear Agency (AFNI), where IRSN received delegations from several North African countries, the Middle East and Asia;
- through Riskaudit – a joint venture created with GRS, the Institute's German counterpart, providing consultancy services in nuclear safety and environmental protection to the European Union, as well as national and international organizations (safety authorities, etc) – it contributed to the *Instrument for Nuclear Safety Cooperation,* a European program open to non-European countries such as Jordan and Egypt, offering them access to the same type of assistance provided through the Phare and Tacis programs;
- actions conducted in a bilateral context included talks with the United States (NRC) on revising safety criteria for nuclear fuel, as well as EPR seminars organized for China and Ukraine.

Other bilateral agreements are also in effect, for example with the Republic of South Africa for the Safari research reactor in Koeberg, and for a research facility designed to study radioactive waste disposal. Finally, radiation protection consultancy services have been provided to Mongolia, Jordan, Namibia and Angola for their mining operations.

Growth in France and abroad

Radiation protection training for health professionals and those who may be professionally exposed is one of the roles assigned to IRSN by its founding charter. Beyond this, training in the fields of safety and radiation protection responds to specific needs expressed by certain professional disciplines, both nuclear and non-nuclear, consistent with the Institute's approach to sharing knowledge with society. In total, around 2,000 people took IRSN training courses in 2008.

There is a strong demand for nuclear safety engineers today in France due to growth in the number of nuclear power plants and the needs expressed by French export industries. IRSN is therefore committed to cooperating with institutes of higher education, particularly the French National Institute for Nuclear Science and Technology, either by contracting out experts to give classes on demand, or participating in educational projects. Given that demand is comparable in most other countries operating nuclear power plants, IRSN has made international training a priority.

Developing international training in nuclear safety

IRSN is engaged simultaneously in various programs. In response to a specific request from the European Community, it is transforming an in-house safety training program entitled *Safety Principles, Practices and Topics* to develop, in partnership with its German counterpart GRS, a three-month training course in nuclear safety that will combine the experience of both partners in this area. The Institute is also pursuing other international training initiatives, such as one on severe accidents, in the context of the SARNET network of excellence, or another on radiation protection for a manufacturer in Morocco.

1,015 hours of teaching
given in 20 sessions on nuclear safety
(728 in 2007)

Training in radiation protection: an expanding activity

In training for health professionals, which represents half of the people trained by IRSN in patient radiation protection, the year 2008 ended with an increase of more than 50% compared to 2007.
IRSN also observed a strong increase in demand for introductory training of radiation protection specialists, as well as a drop in demand for refresher courses (mandatory every five years).
In parallel, the Institute has sought to develop training in other fields than patient radiation protection, particularly in industry, research and services, and has implemented its first training course on regulations pertaining to radioactive material transport.

2,170 hours of teaching
outsourced to IRSN staff *(1,927 in 2007)*

1,676 hours of teaching
in 139 radiation protection training courses
(1,435 in 2007)

IRSN, national test center for the Camari certificate

In 2008, in its role as consultant to public authorities, IRSN became the national test center responsible for awarding the Camari aptitude certificate for operating industrial radiology equipment.

It has organized one test session per month since July:

- five written test sesions and four oral test sessions organized up to the end of December 2008;
- an average of 20 candidates present at the last written exam sessions;
- the oral examination panel consists of three people, one IRSN staff member and two people from outside IRSN ;
- 30 IRSN staff members may be called on to serve as panel members;
- the failure rate on written exams is 40% to 60%.

This figure prompted IRSN to alert public authorities regarding the insufficient level of knowledge of test candidates.

LESSONS LEARNED

Incident at the Socatri plant in Bollène: putting IRSN rapid-response capability to the test

As a result of a dysfunction in the Socatri plant in Bollène (Vaucluse), environmental release of uranium-containing effluent led to a large-scale mobilization of Institute teams from July to September 2008. Management of this emergency situation also offered valuable lessons that enhanced IRSN responsiveness to post-accident situations, as Didier CHAMPION, Director of the Environment and Response Division, explains.

What happened at the Socatri Plant on the night from July 7 to 8, 2008?

Socatri, a subsidiary of Areva, specializes in cleaning components contaminated by uranium and reprocessing certain waste materials from Andra. On the night of July 7 to 8, there was an incident at its Bollène plant involving environmental release of a solution containing uranium.

How did IRSN intervene in this situation?

The following day, as well as on subsequent days, IRSN teams were on the spot taking water samples in the vicinity for analysis purposes. Monitoring results very rapidly established evidence of groundwater contamination by uranium pre-dating the incident and therefore not attributable to it. The presence of this uranium had already been highlighted by IRSN in a report submitted a few days before the incident to the Commission for Information on the Major Energy Facilities at Tricastin. Given the numerous inquiries resulting from this incident, the Minister for Ecology, Energy, Sustainable Development and Town and Country Planning, Jean-Louis Borloo, referred this case to the High Committee for Transparency and Information on Nuclear Safety (HCTISN), chaired by Henri Revol. The High Committee sought the support of the Institute which, on September 23, delivered a report on the radioecological state of the environment at nuclear sites and in the groundwater.

Water samples for analysis.

How did the Institute manage this emergency situation?

We first sought to evaluate the consequences of the release through regular sampling and measurement campaigns – in addition to those conducted by the operator – covering water, sediment and varieties of flora and fauna in the groundwater and the vegetable foodstuffs found in irrigated plots. While these measurements were being taken, the local State authority in the Vaucluse area banned pumping and consumption of water.

These bans paralyzed local agriculture...

This determined our second priority: to allow authorities to assess risks resulting from different types of water usage, and authorize a return to normal water usage in the Tricas-

20 recommendations
were made by IRSN to local and national authorities in the context of this incident

Interactive map of test measurments

tin area, particularly for agricultural activity, which had been affected by the usage restrictions imposed by the local authority. On the basis of measurement results and assessment findings from IRSN, the restrictions on water use for drinking, fishing, bathing and irrigation were completely lifted on July 22, with the exception of certain individually-owned wells where persistent contamination of the groundwater was noted.

What role did IRSN play in keeping the public informed?

Throughout the summer, members of the Institute were mobilized, along with the High Committee for Transparency and Information on Nuclear Safety, to answer questions from journalists and individuals, particularly those living in the area, as well as the Cigeet. The Director General of IRSN took part in a press conference conducted by the Minister Jean-Louis Borloo, who gave a review of the situation and announced the government's intention to cast as much light as possible on groundwater conditions around French nuclear sites. This government initiative led the HCTISN to issue a report demonstrating that the situation around these sites had been correctly identified and that the contamination observed in the environment was low and decaying.

Moreover, IRSN very rapidly made available to the public, via its website, a special file containing informative materials allowing visitors to easily access measurement results through interactive maps, as well as assessments given by the Institute.
www.irsn.org

Did the Socatri incident test IRSN's response-readiness in emergency situations?

The incident brought us face-to-face with an unexpected situation and led us to provide assessment capacity and information to the many parties who called on our support. In this respect, it has been a valuable learning experience in terms of developing the Institute's ability to manage post-accident situations.
www.irsn.org

In the words of

Henri REVOL
President of the High Committee for Transparency and Information on Nuclear Safety (HCTISN)

"On July 7, 2008, when uranium-containing effluent was accidentally released to the environment at the Socatri plant in Bollène, I summoned the HCTISN for an emergency meeting held on July 16, in which we heard testimony from the operator, ASN and IRSN. The following week the Minister Jean-Louis BORLOO instructed the High Committee to produce a report on radioecological monitoring of water in areas surrounding nuclear facilities and the management of former radioactive waste storage sites. Not being an expert itself, the HCTISN turned to IRSN for advice, asking it to provide measurement and monitoring results for basic nuclear installation sites and waste repositories; to report on the state of environmental monitoring at these sites and any water courses revealing radiation contamination; and finally, requested that IRSN conduct a public information campaign. I wish to commend both the strong turnout of IRSN teams at the height of the summer holiday period, and the thoroughness and accuracy of the assessment submitted to the Committee on September 23, 2008. I also commend the efforts made by the Institute to keep the public fully informed."

Event timeline

> In the night from July 7 to 8, 2008: release incident at the Socatri plant.

> July 8: beginning of IRSN sampling around the plant.

> July 11: IRSN published an interactive map presenting measurement results on its web site.

> July 22: water restrictions lifted, except for certain individually owned wells.

> September 23: IRSN delivered a report to the HCTISN on the radioecological state of the environment at nuclear sites and in groundwater.


[EXPERTISE]
[RESPONSIVENESS]
[FORESIGHT]

ACTIVITIES

"Research serving assessment services"

CHALLENGE 1 2 3 4 5 6 7

ENSURING HIGH-LEVEL SAFETY AND RADIATION PROTECTION AT EXISTING FACILITIES UNTIL THE END OF THEIR SERVICE LIFE

Preparing the future while securing the present

In 2008, at the request of nuclear authorities, IRSN conducted several safety assessments involving new nuclear facilities, such as the EPR reactor in Flamanville or the Georges Besse II uranium enrichment plant, as well as new nuclear fuel management methods. In parallel, the Institute closely monitored safety in existing civil facilities, such as EDF's nuclear power plants, or in defense-related installations.
To fulfil its mission the Institute acquired new equipment for simulating reactor operation, while pursuing research and experimentation, working frequently through international partnerships. The year 2008 was marked by significant progress in understanding fire, severe accidents, and the prevention of naturally-occurring and industrial hazards.

Monitoring facilities and transport

To contribute to high-level safety and radiation protection in new or existing facilities, IRSN, providing support services to the French nuclear safety authority, the ASN, assess files submitted on reactors, fuel cycle facilities, and transport of radioactive materials.

EDF REACTORS

Preparing for the ten-year outage program

The outage program for the third ten-year inspection on 900 MWe reactors is part of the safety review initiated in 2003. Periodic safety reviews are required in the Transparency and Nuclear Safety Act. Reviewing safety on EDF reactors aims to ensure they are fit to operate for another ten years under satisfactory operating conditions, and to implement changes designed to enhance safety up to the level achieved on more recent reactors, such as the EPR plant. These changes will be implemented on the thirty-four 900 MWe pressurized water reactors currently in operation, during outages scheduled for the third ten-year inspection program in the next ten years.

In 2008, IRSN examined the objectives proposed by EDF, along with all the design studies completed. The review covered new safety requirements to be taken into account, as well as changes decided subsequent to these studies. Additional studies were required on severe accident management, risks related to fire and explosion, internal and external hazards (especially naturally-occurring hazards), and aging of equipment and structures.

Analysis conclusions were presented before the competent standing group in November 2008, where IRSN considered that, in general, the safety review and ensuing changes would confirm or improve the safety level of 900 MWe reactors. This is particularly true for certain aspects of systems (such as the change in the pressure setpoint on safety valves to reduce the risk of overpressure in vessels under cold conditions), for reinforcement of some civil works in terms of seismic resistance, and for reactor containment (modification of the equipment access hatch fasteners to avoid containment loss in a severe accident situation).

With regards to fire and explosion risks, IRSN considered that EDF should take measures to protect hydrogen-containing equipment against corrosion and vibration phenomena, and should improve its analytical approach to explosion hazards in rooms that are important for safety.

IRSN also considered that EDF should provide further support material, or even take additional measures when necessary, to ensure that all objectives set for the review are completely fulfilled.
www.irsn.org

Openness to society

Information on problems related to steam generator clogging

For several years the Institute has been addressing the major challenge of making its assessment work comprehensible for all stakeholders, including civil society, public authorities, and operators. In this context, on June 11, 2008, before the national association of local information committees, IRSN presented the common clogging problem on the tube support plates of steam generators in pressurized water reactors operated by EDF, along with the results of its studies and the recommendations it submitted to the ASN. The presentation was accompanied by an explanatory brochure written for the public at large. The meeting held with Ancli, as well as another held with the Local Information Committee at Cruas-Meysse in southern France on June 13, 2008, gave way to constructive dialogue with local stakeholders, encouraging IRSN to continue with this type of approach.

www.irsn.org
(see p. 34 of the report)

In 2008 IRSN published a report entitled *IRSN's Viewpoint on Safety and Radiation Protection Issues Relative to French Nuclear Power Plants in 2007*.

Experience feedback on reactor operation from 2003 to 2005

Every three years, operating experience feedback on pressurized water reactors is examined by the competent advisory committee, as part of the continuous improvement plan. The assessment conducted in 2008 by IRSN to prepare this review involved safety topics covering the period from 2003 to 2005. Conclusions gave way to recommendations on the following points: taking into account international experience feedback by EDF; lessons learned from system configuration errors and control incidents involving core reactivity and the water inventory in an outage situation; overpressure incidents on the reactor coolant system; and communication and cooperation problems between employees.

Reports were also presented on radiation protection incidents, instrumentation and control equipment for 1,300 MWe reactors, and operating experience feedback on ventilation systems.

17 advisory committees meetings
to review IRSN's report (21 in 2007)

IRSN supports advisory committees

The ASN bases its decisions on opinions and recommendations issued by advisory committees working under its Director General. The members of these committees are experts appointed for their competence, selected from IRSN, universities, and commercial operations, who express their opinion on technical problems related to reactors, other basic nuclear installations, radioactive waste repositories, or transport of radioactive materials. To shed light on debate within these committees, IRSN assesses the technical files submitted for examination. The assessment results are written up in IRSN reports presented by the Institute's specialists and are discussed during meetings.

Advisory committees meetings held in 2008

January 17	Examination of French and foreign PWR operating experience feedback over the period 2003-2005 (second meeting)
January 24	Examination of the preliminary safety analysis report for the Jules Horowitz Reactor
March 27	Examination of EDF's maintenance policy
April 24	Examination of pressurized water reactor safety management in a context of market competition
May 21	Examination of dismantling conditions of INB 80 at the UP2 400 plant in La Hague (high-oxide-activity unit)
June 4	Examination of transport package TN 112
June 4, 19, 25 and 26	Examination of the preliminary safety analysis report for the Jules Horowitz Reactor
June 11	Examination of the intermediate safety analysis report on the Georges Besse II uranium enrichment plant based on centrifugation
June 12	Examination of the new GALICE fuel management program for 1,300 MWe reactors
October 2, 22 and 23	Safety review on the CABRI reactor, including the pressurized water loop
November 19	Examination of the ICEDA preliminary safety analysis report
November 20	Examination of the safety review conclusions on 900 MWe pressurized water reactors in the context of their third ten-year inspection
November 27	Severe accidents on pressurized water reactors

Reactor operation with the plant in service can be studied using the renovated simulator.

Upgrade for the IRSN pressurized water reactor simulator

IRSN has a PWR nuclear reactor simulator used for studies and training. Since September 2008, the simulator has been integrated into a configuration dedicated to 1,450 MWe reactors. This facility is a new addition to the configurations dedicated to 900 MWe and 1,300 MWe reactors, set up in August 2006 and October 2007, respectively, and marks the completion of the joint simulator upgrade process engaged by the Institute and Areva NP. In parallel, IRSN and Areva NP began work to improve the models run on the various configurations.

In 2008, the simulator was used in its various configurations for in-house and external training in reactor physics and reactor operation, and for development of emergency scenarios and safety studies.

709 technical opinions submitted to the ASN (excluding defense-related activities) *(724 in 2007)*

In the words of

Pierre WIROTH

Inspector General for Nuclear Safety, EDF

At the end of 2008, IRSN published its "viewpoint on safety and radiation protection issues relative to French nuclear power plants". What is your opinion on the conclusions of the report and its publication by the Institute?

"In reading this first report written by IRSN on the state of nuclear power plants in France, I found a certain number of themes presented in our own studies. I appreciated the Institute's efforts to present the technical description and analysis of events in an educational manner. This document was prepared with the general public in mind, a commendable effort worth mentioning. We share the same goal of transparency, which means being capable and willing to explain matters to the public. I am curious, however, to know why this report was published at this time, and why other stakeholders in the system produced the same type of document on complementary topics."

In the words of

Monique SÉNÉ

Vice-President of Ancli

"In my opinion this analysis is very interesting because it gives an idea of the in-depth work accomplished by IRSN in terms of safety, the environment, and radiation protection. It takes an objective view of current trends, but also focuses on important issues, such as events that occurred in the past year or more general problems, and describes the relevant action taken. In this respect, it also highlights EDF's responsiveness to these events.
This type of analysis is particularly useful for members of local information committees. It allows them to understand the approach and enrich discussions with EDF by asking the right questions."

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During inspections conducted by the ASN, IRSN experts detected cases of non-compliance on the EPR worksite.

Follow-up on construction of the Flamanville-3 EPR plant

In its role as technical consultant to the French nuclear safety authority, the ASN, IRSN participates in inspections conducted at the EPR worksite in Flamanville (on the English Channel), led by ASN inspectors. ASN requests resulting from observations made during inspections are taken into account by EDF, the contracting authority, who implements corrective action and reinforces supervision of construction work on the reactor.

To support ASN efforts, IRSN has defined an inspection method and schedule applied to safety-related structures, depending on the construction phase. In 2008, construction progressed on EPR infrastructures, namely the foundation raft of the nuclear island that will support the reactor building. During monthly inspections carried out at the worksite, IRSN experts pointed out instances of non-compliance with specifications: unacceptable cracking in the foundation raft concrete, insufficient reinforcement in the concrete structure, changes in the steel liner welding procedure. The Institute's investigation of non-compliance revealed organization problems with the prime contractor and insufficient worksite supervision by EDF.
This led the operator to take corrective measures: filling the foundation raft cracks with resin, improving the concrete mix, and, in general, reinforcing the construction supervisory teams.

In November 2008, IRSN pointed out to the ASN that cold joints at the base of the containment where it joins the foundation raft had not been treated correctly. This matter was written up in a specific report, with a view to improving the quality of construction work. Likewise, recommendations were made regarding welding operations on the reactor's steel liner to ensure the required level of quality in fabrication.

Lastly, the organization of civil engineering design was reviewed in December, with particular focus on measures taken to ensure that safety requirements were met during the design phase, and on procedures implemented to follow up contractor quality.

International

IRSN and GRS support the Bulgarian safety authority

On April 11, 2008, IRSN, its German partner GRS, and their joint affiliate Riskaudit signed a draft agreement with the Bulgarian safety authority BNRA. The agreement stipulates that the two technical organizations will lend their expertise in all areas concerning safety (except for probabilistic safety analyses) presented in the preliminary safety analysis for the new VVER-1000 reactor to be built at the Belene site in Bulgaria.

Assessment work began in November 2008 and will last one year. It includes a complete analysis of the PSAR, a verification to ensure compliance with safety rules (mainly IAEA rules), and in-depth studies on certain safety-related issues.

EXPERIMENTAL REACTORS

Safety review on the CABRI facility

In 2008, IRSN presented its safety assessment of the CABRI facility (reactor operated by CEA to study severe accidents) to the competent standing group, based on the safety report established on the non-renovated facility. IRSN focused its attention on the new criteria proposed by the operator to ensure that the reactor core fuel rods remain sealed during experiments. On this concern, the Institute conducted a study to check that the new criteria were consistent with the results of tests carried out in the United States and Japan on similar fuel rods. To validate its analysis, IRSN asked its Belgian counterpart, the AVN, to perform an independent review of certain aspects of CEA's demonstration. In its final conclusions, IRSN considered that the new criteria were acceptable for the case of CABRI core fuel rods.

The Institute's assessment nonetheless led CEA to change the computer code that it had planned to use to demonstrate compliance with these criteria. CEA will also carry out some improvements on the reactor protection system to reinforce reliability.

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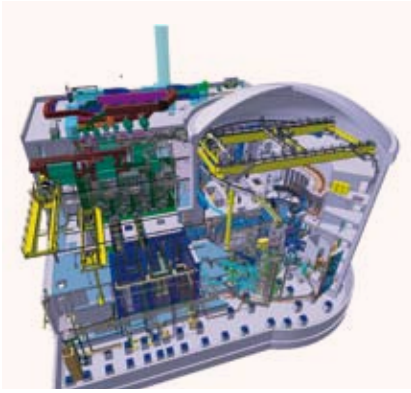
Design review on the Jules Horowitz Reactor

IRSN completed its preliminary safety analysis report on the Jules Horowitz Reactor, to be built at the CEA Cadarache site in southern France, and presented it to the competent standing group in 2008.

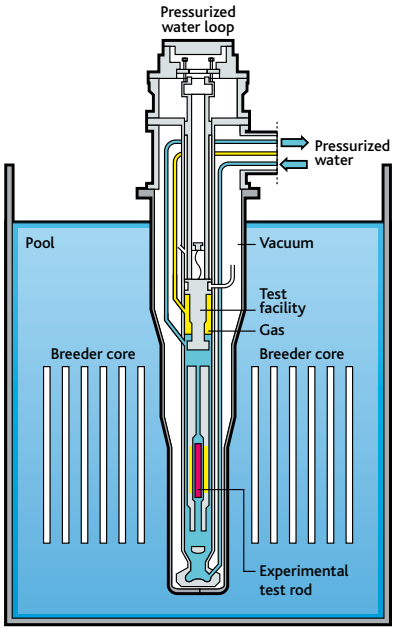
In preparation for this assessment, IRSN began a study program back in 2002 with the Karlsruhe Institute of Technology (Germany) to assess the potential consequences of an explosive reactivity accident (referred to as a "BORAX accident"). Preliminary results led CEA to reassess maximum overpressure in the facility containment, which could be reached in this type of accident.

IRSN's assessment also pointed out that failure of a single control rod drive mechanism (used to control reactivity in the reactor) could lead to a BORAX accident. Significant focus was therefore given to rules on the design, fabrication, and operation of the control rod drive mechanisms used to control reactor reactivity.

Among other points reviewed, IRSN closely examined the reactor core cooling system. CEA needs confirm that a complete break would not lead in a severe core damage.



The Jules Horowitz Reactor is designed to test the behavior of new fuels and materials under irradiation for 3rd and 4th generation reactors.



The CABRI reactor will be used to test irradiated fuel rod behavior in the pressurized water loop when a rapid power change occurs, under operating conditions representative of a pressurized water reactor.

In the words of

Jean-Marie ROUSSEAU

IRSN's spokesman at the standing group meeting on "Management of PWR Safety in a Competitive Market Context".

"The standing group for reactors organized a meeting on PWR safety management in a competitive market context when the market for electricity opened to competition. The purpose was to study the organizational measures implemented by EDF to correctly take into account safety requirements in the daily work of its employees. Our analysis required 150 interviews with EDF personnel and 35 days of on-the-job observation in ten EDF nuclear power plants. Beyond the conclusions on the ways EDF can advance faced with the difficult choices to be made every day between different obligations (safety, radiation protection, environment, costs, etc.) and on the vulnerability induced by the massive renewal of skills or aging installations, this standing group meeting confirmed that there are legitimate reasons for IRSN to examine managerial and organizational aspects. It also stimulated debate on sensitive issues such as the pressure placed on managers or how to deal with cultural changes. This work may continue when it comes time to examine the role of an independent safety sector or the organizational experience feedback at EDF."

The George Besse II plant for uranium enrichment, using ultracentrifugation to produce nuclear fuel.

FUEL CYCLE

Safety at the Georges Besse II plant

The uranium enrichment company *Société d'enrichissement du Tricastin*, a subsidiary of Areva, is building the Georges Besse II plant at the Pierrelatte site in the south of France, which will use ultracentrifugation to enrich uranium for nuclear fuel. This facility will replace the existing Eurodif plant, which used the gaseous diffusion enrichment process. The change in technology will considerably reduce the amount of gaseous uranium hexafluoride in the process, lower power consumption, and will not require intake of water from the environment for process cooling. From July 2007 to May 2008, IRSN examined the safety report, the general operating rules and on-site emergency plan presented by the operator, along with operating experience feedback from comparable plants in other countries. This review called on several specialists in containment, instrumentation and control, criticality, human factors, fire protection, radiation protection, etc. The conclusions presented by IRSN before the competent standing group in June 2008 highlighted the fact that the measures chosen by the operator significantly enhanced safety.

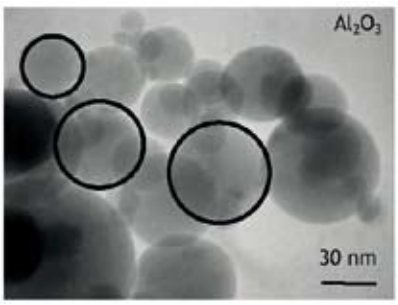
Research outlet

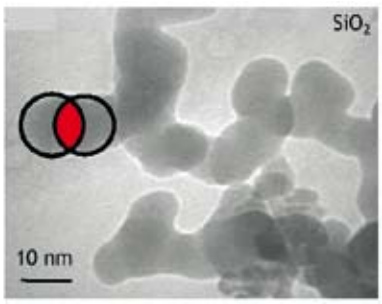
From metrology to containment, IRSN research on nanoparticles

The recent development of nanotechnologies raises new issues in health and environment risk control. Risk prevention in this field requires the ability to accurately measure nanoparticles, particularly in the form of aerosols, as well as to master containment techniques.

IRSN is conducting research in this area, working in cooperation with INRS, Areva, CEA and Onera on certain projects:

- **metrology**: development and evaluation of characterization techniques applied to nanoparticle geometric surface area, with a view to finding new approaches in assessment of occupational exposure; characterization of the fractal morphology of nanoparticle aggregates, for a better understanding of how they behave and change in processing, from fabrication and filtering to packaging, or in the event of fire; characterization of nanometric particle emissions produced by new processes, such as laser ablation used for cleanup operations in nuclear facilities;
- **transfer and containment**: studying the efficiency of dynamic containment barriers at workstations and of different types of filters used to filter or sample aerosols.





Dismantling the high-oxide-activity unit at the La Hague plant.

The Bugey site in eastern France.

Dismantling the high-oxide-activity unit at the La Hague plant

The UP2-400 plant was the first irradiated fuel reprocessing plant commissioned at La Hague. At the end of 2003, Areva NC decided to shut the plant down. After conducting the decommissioning operations required to prepare for dismantling, the operator applied for authorization to dismantle the high-oxide-activity unit at the plant. This operation entails significant risks and technical challenges. IRSN appraised these points and presented its conclusions to the competent standing group on May 21, 2008. The Institute found that the safety and radiation protection measures retained by Areva NC were appropriate. It nonetheless considered that the operations planned in the two main cells of the unit must be examined closely. The operator must also provide additional information on the initial radiological state of certain equipment items and the targeted cleanup objectives. The ASN will stipulate how these recommendations are to be applied after the decree authorizing decommissioning and dismantling of the facility has been issued, some time in 2009.

Creation of the ICEDA facility

In November 2008, IRSN presented its opinion to the competent standing group with regards to safety of the activated waste conditioning and storage facility, ICEDA, that EDF plans to build at the Bugey site in southeast France, based on a new version of the corresponding preliminary safety analysis report.

Before ruling on the performance of facility buildings in any given situation, particularly in the case of an earthquake, the Institute considered it necessary to ask EDF for more information on the definition of the foundation system chosen, as well as design justifica-

International

Initial experiments in the MIRTE criticality program

After four years of preparation, the first experiment in the MIRTE criticality program (to validate criticality computer codes for structural materials) was carried out on December 8, 2008 at CEA Valduc Centre on Apparatus B assembly. This experimental program is cofinanced by IRSN, Areva, Andra, and the US Department of Energy (US-DOE). The purpose is to contribute to the qualification of criticality computer codes for various structural materials used to pack nuclear fuel for transport or used in facilities that process nuclear fuel. The MIRTE program features 42 critical experiments based on one or several fuel assemblies, surrounded or separated by different screens made of metal (nickel, zirconium…), glass or concrete (with different water contents).
The experimental facility was designed to be modular and flexible, so that all the different experiments in the program can be carried out in roughly one year.

View on equipment test tank B at CEA Valduc where the MIRTE experiments are being conducted.

The TN 112 package.

tions. It also held that additional data would be required to demonstrate risk control with regards to alteration of the waste packages, which will be subject to thermal and radiolysis phenomena.

TRANSPORT

Fuel assembly transport

IRSN assessed safety on the TN 112 waste package model developed by Areva TN International, designed mainly to transport MOX-type irradiated fuel assemblies (containing an initial mixture of uranium and plutonium). Technical information exchanged during the assessment process led Areva TN International to change certain components in the initial concept to guarantee package leak integrity, especially after the regulatory drop tests. IRSN presented its conclusions before the competent standing group in June 2008. The group ruled that the package model complied with transport regulations on fuel rods assumed to be sealed before shipping. It formulated recommendations based on the Institute's proposals, in particular with regards to transport of fuel rods that have lost their seal.

IRSN also conducted a cross-analysis of events involving the transport of radioactive materials occurring in France between 1999 and 2007, which identified directions for improvement that would reinforce safety in this area.

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Fuel safety

Nuclear reactor operators are changing fuel management procedures used in nuclear reactors, mainly for economic reasons. These changes raise questions on the fuel safety criteria initially retained, requiring that IRSN conduct research and assessments on the fuel management plans under consideration.

GALICE: a new fuel management plan for 1,300 MWe reactors

Changes in fuel management scheduled by EDF to improve reactor performance through more intensive fuel use require a complete revision of safety report studies to demonstrate that the new management principles and any accident situations that may occur meet safety requirements. The assessment conducted by IRSN involving the safety file for the GALICE fuel management (featuring a limited increase in fuel irradiation during operation) was presented to the competent standing group in 2008.

The GALICE fuel management differs from the one currently in use in that it calls for increased enrichment in uranium-235, a higher fuel burnup rate, and use of the M5® alloy for cladding and the surrounding structure.

IRSN's assessment did not reveal any points that totally disqualified implementation of the GALICE fuel management. The Institute did, however, ask EDF to conduct additional studies on a few points, such as fuel rod behavior in the event of a main steam line break at power.

International

Cooperating with NRC on fuel safety criteria

In the last two years, IRSN has been cooperating with the US Nuclear Regulatory Commission's Office of Nuclear Regulatory Research to study the behavior of nuclear fuel in accident situations.

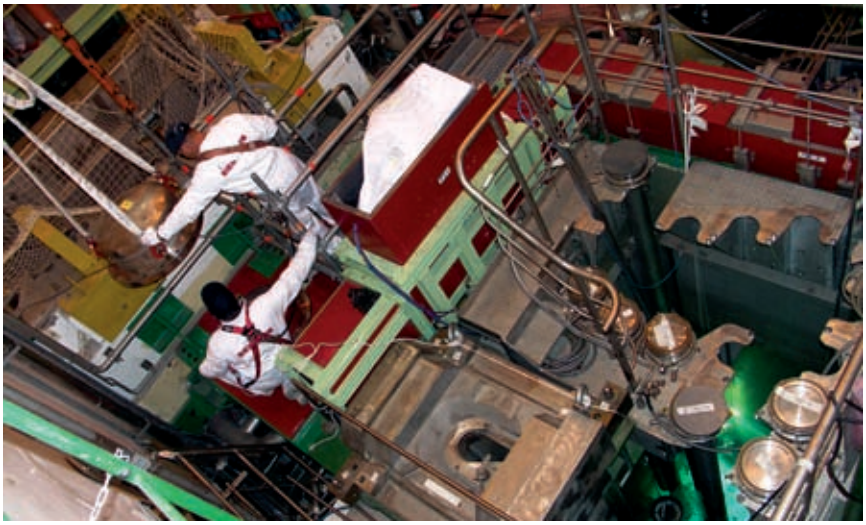
This research focuses on reactor runaway and loss of coolant accidents, and in the long term could lead to changes in the associated safety criteria.

On September 24 and 25, 2008, NRC organized a public debate on this subject, where the Institute was invited to present its position as an international expert. This invitation marks NRC's recognition of the relevance of work conducted by IRSN researchers and specialists in this area.

At the end of debate, the two organizations set out the major themes of future reflection, agreeing on the need to base future safety criteria on a solid scientific foundation to ensure their continuity in the context of rapidly changing nuclear fuels and fuel management policies.

SCANAIR software qualified for safety analysis on the core of the CABRI experimental reactor

As part of the safety review on the CEA CABRI test reactor, the SCANAIR computer code, developed by IRSN, was used as a reference tool. The software evaluates thermal-mechanical behavior of fuel rods in the core of a pressurized water reactor during a reactivity injection accident. This was accomplished by developing and integrating into the software new models adapted to the specific conditions of the CABRI reactor, which is a "pool"-type reactor.



The CABRI reactor core analyzed by SCANAIR.

Among the physical phenomena occurring during a reactivity injection accident, changes in the temperature of the fuel rod cladding play a predominant role, since they have a considerable impact on the mechanical performance of the rods, especially their tensile strength. That is why a specific model on heat exchange between the fuel rod cladding and the reactor coolant was developed and integrated into the SCANAIR software. This innovative model was qualified on both the CEA PATRICIA facility and in more global tests conducted during campaigns run on Japan's NSRR experimental reactor.
It was thus possible to use the software to assess the new safety criteria proposed by CEA for operation of the breeder core on the CABRI reactor.

A day of exchanges on joint scientific research projects conducted by IRSN and the CNRS at Cadarache.

More details

First results from MIST in the field of nuclear safety

Since July 2007, IRSN, the CNRS and the Mechanical and Civil Engineering Laboratory at the University of Montpellier 2 have united their research units within MIST, a laboratory designed to study micromechanics and structural integrity. In their "virtual" laboratory, engineers and researchers from various entitites come together to reinforce synergy between basic and applied research in their relevant fields of specialization.

In 2008, innovative experimental techniques revealed the fundamental mechanisms underlying cracking in materials with a complex microstructure, such as the cladding on nuclear fuel used at high burnup rates.

In parallel, substantial progress was achieved in modeling and simulation. These advances make it easier to understand diverse phenomena such as sedimentation, spreading of contaminants in rivers, or the behavior of nuclear fuel in an accident situation.

All these results were published in scientific journals and a paper submitted to the French Academy of Science.

https://gforge.irsn.fr/gf/project/mist (continue with this website)
http://net-science.irsn.org

Fire protection

Fire is one of the accidents that can lead to significant release of radioactivity from nuclear facilities. Research is currently underway to better ascertain propagation phenomena and improve assessment of any subsequent radioactive release. This work is also applicable outside the nuclear sector.

Electrical equipment failures

Working in close cooperation with the US-NRC, IRSN carried out four tests to improve knowledge on the failure conditions of various types of electrical cable, in conditions representative of a fire inside a nuclear facility. These tests were conducted as part of the OECD PRISME experimental program, which sets out to study the propagation of fire smoke in confined and mechanically ventilated enclosures.

The possible failure modes of electrical equipment (cables, relays, printed circuit boards) during a fire must be taken into consideration during nuclear facility risk assessments. This type of dysfunction may cause the failure of instrumentation and control systems that are critical to facility safety. From a technical viewpoint, an electrical cable failure is generally the result of short-circuits caused by thermal deterioration of cable components. It depends on the type of materials used for cable sheathing, the number and size of conductors, and the intensity of the electrical current transmitted by the cable. To determine what type of failures occur and when, the Sandia National Laboratory in the US, working on behalf of NRC, allowed IRSN to use two of their test facilities, the Surrogate Circuit Digital Unit and the Insulation Resistance Measurement System. These two units were designed specifically by the SNL to detect and characterize short-circuits in energized cables placed inside an experimental oven capable of applying significant "thermal stress".

During the four PRISME tests, eight cables provided by different program partners were tested under real fire conditions. The "thermal stress" caused dysfunctions in the cables with the highest heat resistance, thereby revealing their operating limits.

In the words of

François-Xavier OUF

Research engineer at the IRSN Laboratory of Aerosol Physics and Metrology

"All our research work on particle suspension during a fire will help determine which parameters are significant and will allow us to describe how emitted particles behave depending on parameters such as the amount of energy, the type of medium, particle size, particulate matter stability, etc. This experimental data will serve as support material for assessments on facility safety in the event of fire.

Work conducted in 2008 first concentrated on implementing the experimental facility on a small scale (modified cone calorimeter) to determine the coefficient of suspended particles in a fire situation.

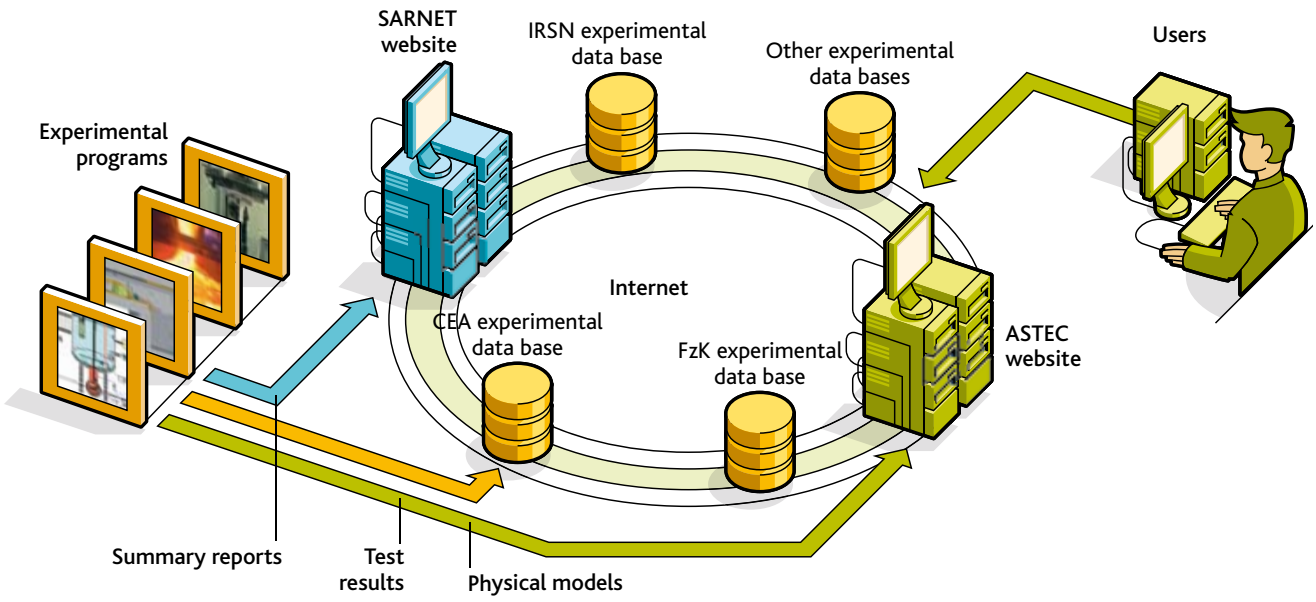
We then began analytical tests on a small scale, simulating the various conditions of thermal deterioration. The tests were based on the polymers used in glove boxes (PMMA and Lexan) and other non radioactive aerosols (alumina and cesium iodide). The first tests were finalized in 2009."

Research outlet

FLUMILOG Program for fire risk assessment

In 2008, IRSN joined a research group built around the FLUMILOG Program, studying flux emitted by a fire in a logistic storage area. The program unites technical research centers (CNPP, Ineris, CTICM), professionals from the transport sector, industrial storage, and the construction industry (Afilog, GSE Acelor, Michelin, Kuehne-Nagel, etc.), as well as state authorities. It aims to produce methods and calculation tools for fire risk assessments.

Nine instrumented tests were performed in a small building (100 m^2) to study the influence of the fuel load on flame geometry and, through experimentation and measurements, to validate the model used to calculate the maximum distance reached by the thermal effects of a fire. For example, one of the tests conducted at the request of IRSN involved plastic waste drums, similar to those used for incineratable waste from the nuclear industry. Analysis of these tests and the resulting data will serve to validate the calculations methods used, to achieve a more realistic assessment of fire risks.



The SARNET Network of Excellence.

Severe accidents

Research on reactor core meltdown aims to improve knowledge on the phenomena involved, so that the risks of environmental release of radioactive materials can be ascertained more accurately. These studies contribute to improving safety measures taken to avoid accidents or limit their consequences. They also strengthen IRSN's assessment capabilities in an emergency response situation.

SARNET: conclusions on a network of excellence

The SARNET Network of Excellence, set up as part of the 6th Framework Program of the European Commission and supervised by IRSN, was brought to an end in September 2008. Its research focused on core meltdown accidents in water reactors.

Along with aspects relative to network management, sharing research results and dissemination of knowledge, the main lines of research involved corium behavior, containment, release, the ASTEC computer code, and probabilistic safety studies. In four and a half years of existence, SARNET involved 250 researchers from over 50 different European and Canadian institutions, financed by the European Commission on a budget of €6 million.

General opinion has found the experience to be a positive one. SARNET provided participants with the opportunity to share and analyze a wide range of experiment results collectively. New members of the European Union were also able to join this scientific community specialized in severe accidents. SARNET helped improve and promote the ASTEC severe accident computer code (codeveloped by IRSN and its German counterpart GRS) on an international scale. The network also achieved a European consensus on the directions to be taken in research on core meltdown accidents in the years to come.

Among the highlights of 2008, a training session on core meltdown accidents was held in Hungary, bringing together 50 participants and 18 lecturers. Likewise, the third international European Review Meeting on Severe Accident Research (ERMSAR), which welcomed over 100 participants, was organized in Bulgaria, providing the occasion to draw conclusions on the major achievements of the SARNET experience. Lastly, the success of the proposal submitted for the 7th Framework Program on fission research will allow the network of excellence to pursue its efforts in the SARNET 2 program. Coordinated by IRSN, SARNET 2 will run for four years, financed by the European Community to the amount of €5.75 million.

www.sar-net.org
http://net-science.irsn.org

The growing success of ASTEC

The SARNET Network of Excellence and safety studies conducted by IRSN in France contributed substantially to the enhancement of ASTEC. Designed to simulate core meltdown accidents in water reactors, focusing mainly on pressurized water reactors (PWRs), this application was developed jointly by IRSN

and GRS. Applied to a wide range of accident scenarios, the software has successfully demonstrated its ability to simulate both Western PWRs and Russian VVERs. Work conducted to qualify this application, consisting of comparing its results against vast experimental data obtained through various research programs, such as the PHÉBUS-PF international program, produced a very positive outcome.

Roughly forty user licence agreements were signed with partners from Europe, Canada, China, India, and others. Three commercial licences were granted, one within France (EDF) and two internationally (United Kingdom and South Africa).

The scope of application for ASTEC is gradually growing. The feasibility of incorporating two of the modules in the SESAME4 application, used by the Institute to advise public authorities in an accident situation, has been demonstrated. SARNET partners have shown that Version V1 can already be applied partially to boiling water reactors and Canadian-design heavy water reactors (CANDU). Moreover, the South African manufacturer PBMR uses this same version to study the release of radioactive substances in the event of a severe accident affecting a high-temperature reactor (HTR).

The software is currently being adapted to study accidents that could have an impact on the ITER facility.

More details

Study on iodine behavior

The CHIP program aims to determine the amount of gaseous iodine that will reach the containment in a nuclear pressurized water reactor in the event of a severe accident.

The CHIP-LP experimental line is designed to reproduce the reactions that occur during iodine transport, from the time it leaves the reactor core to the moment it arrives in containment, and to quantify the fraction of volatile iodine as a function of the elements present and ambient conditions (type of gas, residence time, temperature). Priority is given to studying cesium, molybdenum, and boron.

The experimental facility consists of an open circuit in which reagents are injected at an absolute pressure of approximately 2 bar. They are transported separately to a kiln heated to high temperature (1,500-1,600°C), where they are mixed in the gaseous state. They then cross through a tube representing the reactor coolant system, in which iodine can react with the other elements or with the walls. The transport tube has two sampling lines: one at high temperature (700 to 900°C), another at a lower temperature (about 150°C), simulating the reactor coolant system hot leg and cold leg, respectively.

The sampling devices collect aerosol particulates condensed on the filters and trapped volatile species, which serve in further analyses.

CHIP-LP experiment line.

Temperature-gradient oven in the CHIP experimental facility.

First test runs for ISTP

The International SOURCE TERM Program (ISTP) aims to reduce uncertainty relative to the environmental release of radioactive substances that could occur following a core meltdown accident in a nuclear reactor. Using a test bench specially designed for this purpose, the CHIP project within this program sets out to identify any chemical elements that could change the amounts of gaseous iodine entering the containment through a break in the reactor coolant system. The chemical elements under study are representative of the degradation products from fuel, control rods, and reactor structures. The first tests were conducted in 2008, to qualify the thermal-hydraulic behavior of the experimental facility.

This work was performed in close cooperation with CNRS laboratories, in particular in the context of doctorate theses on the identifica-

Openness to society

Analysis of the seismic resistance report for the Fessenheim nuclear power plant established by Resonance

In October 2008, in a presentation to the Local Monitoring Commission at Fessenheim in northeast France, IRSN gave its analysis of a seismic resistance report on the EDF plant, prepared in 2007 by the engineering firm Resonance.
Commissioned by the Swiss cantons of Basel and Jura, the report concluded that the seismic risk assessment retained in 2002 in preparation for the third ten-year inspection of the power plant was underestimated. This conclusion was based on a critical analysis of the seismic risk assessment method used in France.

In its presentation before the CLS, the Institute explained why the choices made in 2002 were consistent with the state of knowledge at that time, while pointing out that various recent scientific breakthroughs could justify a revision of certain assumptions, and that a joint working group formed by IRSN, EDF and the ASN was currently examining this issue. Analysis of the Resonance report conclusions emphasizes the relevance of R&D performed by IRSN and speaks in favor of periodic safety reviews to take into account new knowledge.

Fessenheim nuclear power plant.

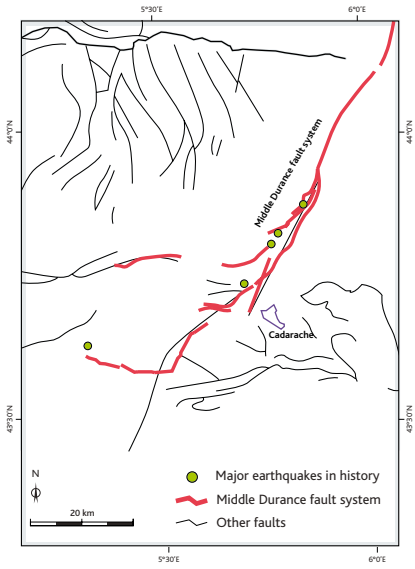
tion and speciation of the formed aerosols and the collection of basic data on the kinetics of the main reactions involved.

Naturally-occurring hazards

Earthquakes, floods and heat waves are naturally-occurring hazards that IRSN studies in its research and assessments to more accurately ascertain the risks associated with these hazards for safety in nuclear facilities.

Earthquake: improving knowledge on how a terrestrial fault system functions

The Middle Durance fault system is a complex system that links the region around Aix-en-Provence to the Alps in Upper Provence, passing just a few kilometers away from the nuclear site at Cadarache in southern France. It is the seat of moderate seismicity that regularly produces earthquakes, some of which have caused extensive damage (in 1509, 1708, 1812 and 1913). Several nuclear facilities are nonetheless located in this area.



The Middle Durance fault and major earthquakes in history.

In 2008, IRSN concluded nearly fifteen years of geological, seismological, and geodesic research on this fault system. The objectives of this research work involved both methods (validation of computer codes) and applications (determination of fault segmentation, locating microearthquakes and determining their depth, evaluating the maximum magnitude of earthquakes originating from the fault, etc.). This work was conducted in cooperation with the University of Aix-Marseille, the University of Nice, CNRS, Collège de France, CEA, and Geoter, an engineering consultancy. A dozen international publications on this research have rewarded the results obtained by IRSN, in addition to the advances achieved.

To conduct this research program, the Institute relied on a seismological and geodesic measuring system featuring 18 stations that is unique in Europe for a region with moderate seismicity. The data collected made it possible to accurately locate any recorded microearthquakes. Research demonstrated that current fault activity is located mainly in the sedimentary cover, at a depth of 0 to 4 km.

Geodesic data clearly indicated that displacements along the fault are slow (approximately 0.1 mm/year). These results, associated with several geophysical and geological studies (analysis of seismic profiles provided by the oil industry and geological map publishers) conducted by IRSN since the beginning of the 1990's, make it possible today to reconstruct the fault system structure and locate its various segments in three dimensions. The outcome of this work establishes a maximum earthquake magnitude due to fault displacements at 6.3 to 6.5 on the Richter scale, based on the size of these segments. The results have been used to establish the earthquake design criteria for nuclear facilities built in the region.

International

Study of seismic hazards for the Krško power plant site

IRSN participated in field investigations and a probabilistic seismic hazard assessment as part of the project to build a second train at the Krško nuclear power plant site in Slovenia.

Consultancy services were provided to the GEN-Energia electricity generating group, in partnership with BRGM and Slovenian geological and civil engineering institutes.

The first phase consisted of identifying any faults that could lead to a surface rupture in the event of an earthquake. IRSN participated in a geological survey on a gash and helped interpret new geophysical data that could reveal the location of any such faults. Another question involved the possibility of local amplification of seismic displacements due to the characteristics of the site's geological environment. A campaign to measure ground vibrations under the effect of seismic displacements was initiated in response to this question. The results will serve to establish a seismic risk calculation model, scheduled for 2009.

Characterization of geological environments

Working in Chili, in cooperation with the University of Santiago, IRSN is studying the possibility of using recordings of ambient vibrations in the ground to identify specific land configurations that could amplify displacements caused by an earthquake and use this information to obtain a more accurate assessment of the local seismic risk. Results published in 2008, based on a comparison with damage observed following an earthquake that occurred in 1985, show that the method reveals variability in callows. But it is not enough to predict the amplifications observed locally. A more detailed characterization of the geological environment appears necessary.

Research outlet

Seismic risk regulations revised

As part of a review of regulations on earthquake resistance, the Minister for Ecology, the ASN, BRGM and IRSN formed a joint working group to ensure that rules applicable to conventional buildings, "special risk" facilities (where consequences may reach beyond the limits of the installation) and nuclear facilities formed a coherent regulatory system, while seeking to identify any problems that could occur in enforcement. IRSN contributed its knowledge on questions concerning seismic hazards and facility vulnerability. The Institute presented examples of how current or projected earthquake resistance regulations could be applied to different types of facility located in the same area. This required calculations to compare the reaction to ground displacements that would be obtained for a nuclear facility, a classified facility, or conventional buildings (firehouse, school, agricultural buildings, etc.).

Setting up measuring equipment for characterization of the geological environment in Chili.

Integrating naturally-occuring hazards in PSAs

In 2008, the risk assessment working group of the Committee on the Safety of Nuclear Installations (CSNI) of the Nuclear Energy Agency (NEA) presented its conclusions on integrating naturally-occuring hazards, such as earthquakes, in probabilistic safety assessments (PSA) for nuclear power plants in Member States of the NEA. Finland, France, Germany, the United States, and Taiwan participated in this working group, tasked with reviewing the methods used and results obtained, and studying development prospects. IRSN was responsible for establishing the list of methods used.

To date, there are few PSAs that cover naturally-occurring hazards other than earthquakes. Yet all NEA Member States would like to have complete PSAs that cover this type of event, and for new reactors they must be taken into consideration systematically. The consequence of CSNI's work on this question was a recommendation for greater research activity on the impact of climate change (contingencies, consequences for facilities), and integration of naturally-occurring hazards in PSAs.

www.nea.fr

The *Charles-de-Gaulle* aircraft carrier.

Assessing the safety of military nuclear systems, basic nuclear installations and defense-related transport

IRSN carried out missions in this area as part of a technical support agreement with the French General Directorate for Nuclear Safety and Radiation Protection for Defense-related Activities and Facilities, an authority operating under the aegis of the Ministry of Defense and the Ministry for Industry.

Safety of submarines, aircraft carriers and defense-related military or civilian facilities.

IRSN assessment of facilities operated by the Ministry of Defense, the CEA, Areva or EADS covers their entire life cycle, from design and construction to operation and finally, dismantling. It also involves any major transformations on these facilities brought about by changes in their activity.

Design and construction

In 2008, IRSN examined the compliance files of the reactor and the first core of the new-generation nuclear ballistic missile submarine *Le Terrible* before the DSND sends the authorization to conduct pre-commissioning tests to the General Delegation for Armament.

IRSN also reviewed safety issues involving the following:

- the future Areva NC reprocessing facility for solid radioactive waste at Pierrelatte in southern France;
- the future waste storage building for the CEA/DAM center at Valduc in northeast France;
- the future alpha waste packaging unit at the Marcoule site in southern France;
- facilities at the Ile Longue naval base on the northwest coast, such as the extension of the spent fuel pool for the onboard nuclear steam supply system and overhaul of the waste treatment station;
- outfitting of the Laser Megajoule experiment hall at the CEA/DAM CESTA center in southwest of France.

More details

Temporary authorization to operate the nuclear submarine *Le Terrible*

The reactor in the nuclear ballistic missile submarine *Le Terrible*, the fourth and last of the series, diverged for the first time on September 10, 2008. Before this event, the culmination of a long industrial process, IRSN presented its assessment of the safety files submitted by the General Delegation for Armament before the Reactor Safety Commission, as part of the process required to obtain an authorization from the defense safety authority to proceed with the first loading of the reactor core, and to initiate reactor divergence.

Equipment design on *Le Terrible* is slightly different from the three other submarines in this series, in particular the main instrumentation and control system for the reactor, which IRSN is still examining for performance assessment purposes.

More details

Waste management safety commission meeting for the basic nuclear installation at Marcoule

On March 12, 2008, this commission met at the request of the defense nuclear safety authority, to examine waste management at Marcoule. In this context, IRSN analyzed the storage conditions and reprocessing strategy for old waste, the conditioning process planned for waste resulting from dismantling of facilities at the site, and the processing capacity of the waste packaging shops and waste storage areas, given the volume to be processed. This analysis revealed that, in general, substantial improvements had been achieved in waste management and in reducing the risks of environmental release of radioactive substances. Moreover, reprocessing of certain types of waste, especially those where elimination channels are available, is expected to accelerate.

Operation

As part of the safety improvement plan for the Valduc basic nuclear installation (CEA/DAM) dedicated to tritium activities, IRSN examined the safety of new equipment designed for isotope separation.

In the same center, the Institute examined the safety baseline of the building, designed for criticality tests, to prepare for its next safety review.

As regards the CEA/DAM center at Bruyères-le-Châtel in the Paris region, IRSN examined the possible impact that the explosion of the boiler of the center would have on the nuclear facilities located at this site.

As for nuclear reactors, the Institute pursued its analysis of the first scheduled downtime for maintenance and repairs of the aircraft carrier *Charles-de-Gaulle*, focusing on the following aspects:

- seismic behavior of the ship's dock and associated port facilities at Toulon in southern France;
- refueling the ship's two nuclear steam supply systems with new nuclear fuel assemblies.

For land-based naval propulsion support facilities, IRSN analyzed:

- docking at the port in Cherbourg and loading of nuclear fuel in the nuclear submarine *Le Terrible*;
- the general operating rules for the basic nuclear installation Missiessy at the port of Toulon;
- general operating rules for the Azur reactor, installed at the Cadarache site in southern France, used to qualify new fuel assemblies designed for nuclear propulsion.

At CEA Marcoule site, in 2008 the Institute examined the question of whether or not to continue operation of the site's liquid waste treatment plant (assessment presented before the Laboratory and Plant Safety Commission on February 7), waste management at the site (assessment presented to the Safety and Waste Management Commission on March 12, explained in "More details" opposite), and, for the spent fuel monitoring facility, receiving and processing of spent fuel pins from PHÉNIX and non-irradiated assemblies from SUPERPHÉNIX.

The Institute also began the assessment of the Marcoule vitrification unit safety review file in 2008.

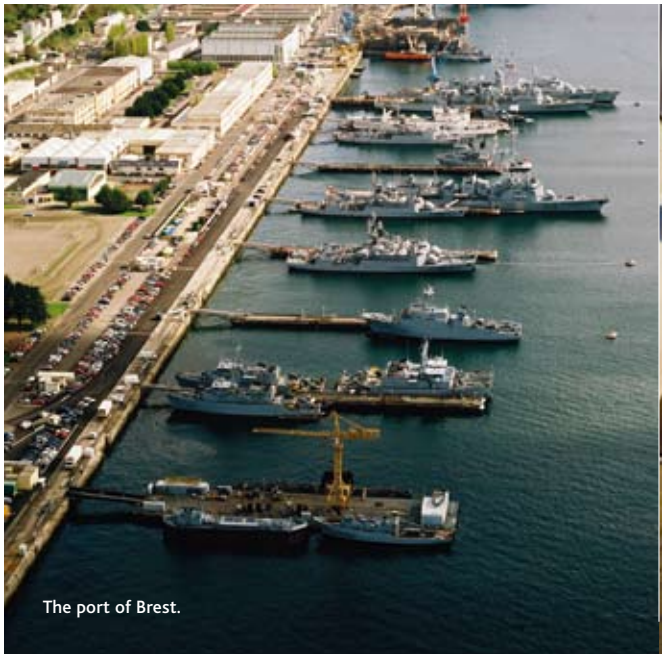
As part of the general follow-up of the facilities, IRSN examined the circumstances surrounding several incidents that occurred on nuclear installations at CEA/DAM Valduc as well as the actions taken. It also studied operating experience feedback from CEA/DAM research centers (Valduc, Bruyères-le-Châtel, Cesta) for the period covering 2004 to 2006.

Dismantling

For decommissioning and dismantling operations at the CEA UP1 plant in Marcoule, IRSN:

- examined disassembly of equipment used in the extraction cycles, bitumen work around annular tanks and the safety baseline for dismantling operations;
- continued or started reviewing files relative to decontamination of tanks, equipment, and a ventilation duct, and removal of stored ash and waste.

For this same center, the Institute examined the starting of a waste conditioning unit in the decladding shop and acceptability of the safety baseline for the decladding shops and the MAR 400 facility.



The port of Brest.

Storage of a spent fuel transport package assembly (packages are stored empty).

At the Areva NC plant in Pierrelatte, in 2008 IRSN continued its review of dismantling operations in the URE plant and examined safety conditions during certain dismantling operations for equipment in the gaseous diffusion plants.

Radioactive materials transport

Several files were examined in this area in 2008, involving applications for certification of transport provided on public roadways, applications for transport authorizations for movements within sites, radiation protection programs for CEA/Cesta and CEA Ripault, and rules for internal transport of radioactive materials, particularly for the Areva site at Tricastin and the CEA Marcoule site.
Cross-disciplinary issues were also studied including stowing packages, qualifying the system used to test neutron absorber efficiency, and operating experience feedback from safety records involving transport of packages containing radioactive materials.

IRSN was also involved in assessing component of nuclear weapons transport files. In 2008 considerable work was accomplished in this area on files dealing with safety options and qualification test programs for certification of four new types of package.

Effluent release and water intake permits, on-site emergency plans and exercises

In 2008 IRSN assessed the on-site emergency plans of several establishments operating defense-related facilities. This involved the operational part of the emergency plans at CEA Valduc and Areva's Pierrelatte sites. IRSN also participated in five defense-related emergency exercises:

- four nationwide emergency exercises involving a defense-related transport, the Ile Longue operational naval base, and the Valduc and Marcoule sites, where IRSN was responsible for preparing the scenarios and supervising the exercises;
- two exercises organized by the French Navy involving a submarine nuclear steam supply system in the port of Toulon, and the aircraft carrier calling at the Ile Longue operational naval base.

3 meetings of defense safety technical commissions
to review IRSN reports *(5 in 2007)*

97 technical advices submitted
to the defense safety authority *(129 in 2007)*

4 nationwide emergency exercises involving
safety on defense-related facilities *(3 in 2007)*

CHALLENGE 1 **2** 3 4 5 6 7

WORKING TODAY TO DEVELOP THE KNOWLEDGE AND RESOURCES REQUIRED TO ASSESS RISKS IN THE NUCLEAR FACILITIES OF TOMORROW

Today's research leading to better assessments for tomorrow

In 2008 IRSN directed some of its research efforts towards understanding the risks associated with future reactor design concepts, such as sodium-cooled fast breeder reactors, and geological repositories for radioactive waste. To gain access to a tool appropriate for conducting research on accidents, especially severe accidents, the Institute expressed its wish to join the Jules Horowitz Reactor consortium, which is building a research reactor at CEA Cadarache in southeast France. By participating in this joint effort, the Institute would be able to conduct the tests required to fulfil its mission in the study of reactor accident situations. In parallel, IRSN performed new experiments at the Tournemire station near the Pyrenees to prepare for the safety assessment report on the project to build a geological repository for radioactive waste storage, which is due to be submitted by Andra in 2015.

Reactors

To prepare for safety assessments on next-generation reactors, IRSN is defining action to be taken (research programs, tool development, etc.) to adequately fulfil its mission when the time comes.

FOURTH GENERATION REACTORS

State of knowledge on sodium-cooled fast breeder reactors

In 2006, the French government decided to build a fourth-generation prototype reactor by 2020, aiming for industrial deployment towards 2050. Among the different technologies considered, the sodium-cooled fast breeder reactor (FBR) has been given priority, since it is the most advanced in terms of technical maturity, given operating experience from the PHÉNIX and SUPERPHÉNIX reactors (the latter shut down in 1998).
For IRSN, this implies getting ready to define the safety options to be chosen for the prototype by 2012 and preparing for safety assessments, based on previous work. IRSN will turn to the substantial R&D work conducted on sodium-cooled FBR safety from 1970 to 2001 by IPSN, the precursor to IRSN, within vast international collaborative projects.

In 2008, working with CEA, the Institute took inventory on the state of knowledge and calculation tools relative to core meltdown accidents and sodium-related risks. Two summary reports were established.

With regards to the core meltdown accidents considered (uncontrolled rod withdrawal, complete and instantaneous plugging of an assembly, pump shutdown with no rod drop), the summary report summarizes knowledge acquired from experimental facilities such as CABRI or SCARABÉE, and describes the main calculation tools developed for accident simulation. As for sodium-related risks, the report has gathered available information on sodium fires, the behavior of the aerosols produced, interaction between sodium and concrete, detection and monitoring of sodium

In the words of

Véronique ROUYER

Head of IRSN's Neutron Research Cluster

"Created in 2008 by IRSN, the Neutron Research Cluster is the answer to those wishing to unite the Institute's skills in an area involving the fundamentals of nuclear reactor operation and safety as well as the nuclear fuel cycle. The purpose is to develop fundamental knowledge and conduct R&D research to prepare for assessments on the reactors and fuel processing facilities of the future, in both normal operation and accident situations. Future designs requiring IRSN technical assessment in terms of robustness and demonstrated safety, as they are perceived today, are more complex and diversified. Studies will require tools to process a wide range of diversified variables. This cross-disciplinary project covers two aspects: one involving fundamental data and computation tools, and the other the impact of uncertainty on systems with a large number of parameters."

leakage, and reactions between sodium and water. The report provides an accurate picture of current knowledge, pointing out those questions that remain unanswered. They will help orient future R&D work to be conducted by IRSN, for safety assessments on sodium-cooled FBRs.

In the words of

Hamid Aït ABDERRAHIM

Director of the Institute of Advanced Nuclear Systems at SCK-CEN in Belgium and coordinator of the SNETP strategic agenda

"Successful preparation, in 2008, of the strategic agenda for research on the Sustainable Nuclear Energy Technology Platform was made possible by true and sincere efforts of an entire community, who saw what was to be gained in this project. This work mobilized over 160 scientists and engineers from 60 organizations – safety authorities, research institutions, TSOs, industry, and universities.

Within this group, the TSOs completely fulfilled their role as independent technical specialists. They also helped match desires on one side, and obligations on the other, coming up with a structured research program that takes into account inevitable priorities such as legal obligations or the increasing service life of nuclear power plants.

Within TSOs, IRSN took responsibility for the nuclear safety workgroup. Its expertise and the size of the French nuclear power plant fleet made it an essential stakeholder in any reflection involving nuclear energy in Europe. The Institute also contributed to promoting the innovative idea of sharing sources of future research funding, by clearly identifying safety research work that addresses the public's concerns, which must be financed through State funds." **www.snetp.eu**

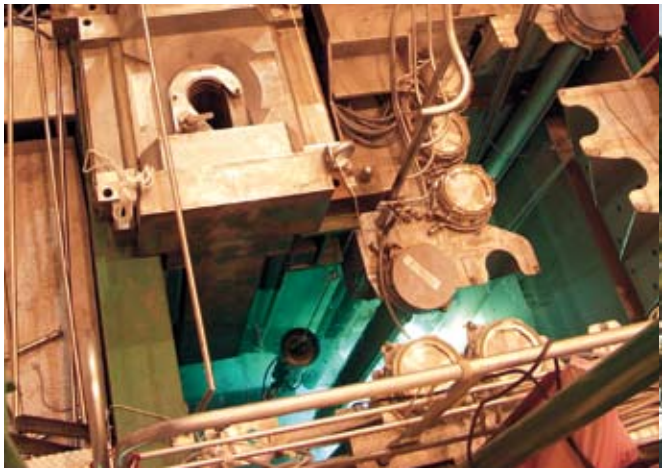
EXPERIMENTAL REACTORS AND REACTORS FOR EXPERIMENTATION

The Jules Horowitz Reactor: a future instrument to serve nuclear safety research

The Jules Horowitz experimental reactor, which CEA has started to build at its Cadarache site, is expected to be ready for operation in 2015 to study the safety of current and future nuclear reactors.

Along with the CABRI experimental reactor, it will be used to study the behavior of new nuclear fuels in accident situations, and to test various materials subject to high thermal or mechanical stress, or substantial doses of neutron radiation.

In 2008, IRSN examined how this reactor could serve to acquire knowledge on water reactor safety. This study confirmed that the Jules Horowitz Reactor would be capable of running certain tests initially planned for the PHÉBUS experimental reactor to study core meltdown (severe accidents).
It also covered experimentation relative to loss-of-coolant accidents on pressurized water reactors. It now appears certain that it would be possible to conduct experiments of this type in a simplified configuration (a single fuel rod or an assembly with just a few rods), while additional work is still required to examine the feasibility of testing with a larger number of assemblies. To date, conclusions are still positive enough for IRSN to work with CEA to define the contractual and technical conditions in which it could use this tool in the coming years.



Transfer pool in the CABRI reactor area.

Illustration of the future Jules Horowitz Reactor.

Geological repositories for radioactive waste

To prepare for assessment of Andra's project involving a geological radioactive waste repository, the Institute is conducting research work to gain the knowledge necessary to establish a substantiated assessment in this area.

Research on the safety of storing radioactive waste in a deep geological formation

The safety of radioactive waste storage in a deep geological formation is a field that justifies significant efforts to expand knowledge at IRSN. Research and numerical modeling conducted by the Institute aims to develop a better understanding of phenomena that are only partially explained by current scientific knowledge, and to confirm the values given in data submitted by Andra. This work must approach certain complex phenomena from a perspective that is different from the designer's viewpoint. For example, activity released by the repository into water-bearing formations is checked using the MELODIE software application developed by IRSN.

Studies requiring experimentation are being conducted at the IRSN Tournemire station near Roquefort (in Aveyron), covering various subjects: the recognition and characterization of argillaceous rock to validate certain data important for repository safety; interaction between the different materials that make up the repository; and the most important parameters required to control the efficiency of processes used to seal cavities bored in the rock.

The meeting of the Atomic Energy Committee held on November 5, 2008 emphasized the importance of concluding these research programs within the deadlines scheduled by Andra for commissioning of the geological repository.

The MELODIE software application developed by IRSN is used to model radionuclide transfers.

Tournemire experimental station

Excavation of 170 meters of new galleries was completed at the Tournemire station in southwest France in June 2008. The new galleries will provide IRSN with the space required to pursue its research and begin an experimental program to assess the long-term safety of the technology designed to seal the disposal cells containing radioactive waste. The program aims to test various types of plugs to determine their effectiveness and strength over time, and to prepare for assessment of the project that will be presented

In the words of

Hubert FLOCART

Director of the PACEN program at CNRS

"In 2008, cooperation between IRSN and CNRS on radionuclide transfers led to the creation of a national research group covering soil, subsoil and ecosystems (TRASSE), planned to last four years. This project is part of a broader interdisciplinary program called PACEN, focusing on the downstream part of the nuclear energy cycle. The purpose of TRASSE is to stimulate research initiatives by organizing requests for projects every year, in areas involving radionuclide transfers that are not sufficiently covered by academics, starting with surface transfers and hydrogeology. CNRS and IRSN have a mutual desire to share their respective skills and search for complementarity. TRASSE offers research teams a chance to work at two exceptional experimental sites: the Tournemire station near Roquefort in Aveyron and the T 22 waste trench at Chernobyl in Ukraine. The T 22 trench provides a unique opportunity to study the transfer of radioactive contamination to the biosphere and the environment in general."

Tournemire experimental station: a space dedicated to IRSN research.

by Andra in 2015, the date set by the legislative act of June 28, 2006.
The station was also extended to continue studies on damage caused by excavation work in argillaceous rock. An ascending borehole drilled in 2008 from the roof of the tunnel towards the surface crosses through all the upper levels of the clay formation. Continuous measurements and analysis of rock samples taken during excavation will be used to trace the origin and history of water contained in the various clays.

A "thermal-osmosis" experiment has been set up to explain the origin of abnormally high hydraulic pressures observed at the center of certain clay formations (the IRSN Tournemire experimental station, Andra's underground laboratory at the Bure site, and the Swiss Mont Terri laboratory). Conducted for the first time *in situ*, the experiment consists of causing a water transfer in the argillite under the effect of a thermal gradient. The goal is to determine whether this type of transfer may be the cause of the abnormal pressure values observed.

Openness to society

Tournemire opens its doors to the public

On September 28, 2008, the Tournemire experimental station organized its second "open-house". Organized for elected officials, the local press, and the public at large, the purpose of this event was to explain to visitors the research work conducted by the Institute at the site, in answer to the public's questions on this subject, and to calm concerns regarding the construction of waste repositories. Over 500 people responded to the Institute's invitation, giving them a better understanding of the reasons behind the research conducted on the high-level, long-lived waste repository in a deep geological formation.

CHALLENGE 1 2 **3** 4 5 6 7

MONITORING WORKER AND PUBLIC EXPOSURE TO IONIZING RADIATION AND MEASURING RADIOACTIVITY NATIONWIDE

Protecting people and the environment from ionizing radiation

With ionizing radiation being found in such wide-ranging applications as power generation, welding inspection and nuclear medecine, radiation protection for workers and the public is an essential aspect of IRSN's activity. In 2008, the Institute therefore focused significant efforts on upgrading the instruments used to measure worker exposure in order to improve monitoring results. It also updated its strategy on environmental monitoring, along with the associated equipment, as well as methods used to measure contamination after an accident. In other studies, the Institute furthered its knowledge on the behavior of radioactive substances in the environment and their transfer mechanisms. It also took the necessary organizational measures to respond to issues raised by local populations concerning the quality of their environment.

Environmental exposure

IRSN ensures widespread monitoring of the public's exposure to ionizing radiation. In 2008, measures were taken to upgrade the monitoring system.

Optimizing environmental monitoring

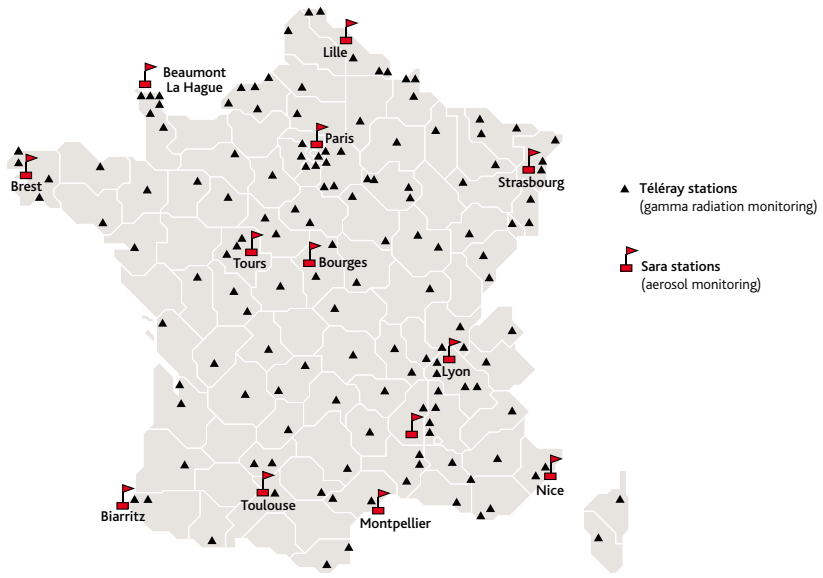
The effectiveness of the nationwide monitoring system depends on having the right number of automatic aerosol monitors in the right places. This was achieved in a three-step approach.

The first step, accomplished in 2007, consisted of establishing a database of potential accidents that could occur on a nuclear reactor. Studies were conducted to simulate large-scale atmospheric dispersion of fallout subsequent to this type of accident, considering each EDF power plant site, and all the different types of meteorological conditions that could possibly occur within a year.

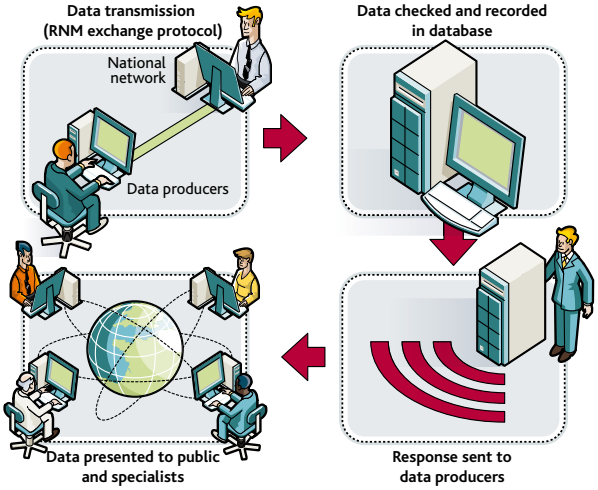
The second step, completed in 2008, consisted of determining the optimum number of monitors and the best locations. With this in mind, IRSN developed a method to evaluate the network's ability to produce an accurate representation of atmospheric dispersion based on the number of monitors and their location. The method showed that within France, the quality of the network's response improves as the number of stations increases, up to a "ceiling" of 70 stations.

The third step will consist of evaluating the network's response capability for accidents that may occur in foreign countries. Monitors will be deployed gradually in the coming years, with priority given to achieving good response capability in the first year.

In this context, a new generation of radioactive aerosol monitors for sampling and measurements is currently under development to improve detection and characterization of widespread accidental atmospheric contamination.



Atmospheric radioactivity remote monitoring networks currently in service that will be upgraded in the coming years.



Procedure followed by the national network of environmental radioactivity measurements (RNM).

Receiving samples before analysis.

Measuring radionuclides in foodstuffs

In 2008 the French Directorate General on Food Safety (DGAL) appointed IRSN as the national benchmark laboratory for measuring radionuclides in foodstuffs. Since then, the Institute has taken over the mission previously entrusted to the French agency for safe food consumption (AFSSA), co-financed by the Ministry of Agriculture and the Ministry for Health.

As the national benchmark laboratory, the Institute will supervise the network of laboratories certified by the DGAL by validating their measuring methods, organizing interlaboratory aptitude tests, and training their staff. IRSN will respond to any requests for scientific and technical assessments requested by the two supervisory ministries.

In June 2008, IRSN organized a seminar with the laboratories belonging to the network to conduct the first interlaboratory exercise consisting of determining the cesium-137 and cobalt-60 content in milk.

National network of environmental radioactivity measurements

As the contracting authority for the development and technical management of the national network of environmental radioactivity measurements, IRSN supervised design of the network's information system and its Internet site in 2008. The website will display environmental radioactivity measurement results produced by the various certified organizations.

Delivery of the data collection tool was an important step, which required opening a test platform for the various providers of environmental data. In parallel, the steps required prior to opening the data production platform were accomplished, so that data could start being collected at the beginning of 2009.

At the same time, the Institute continued its dialogue with the two local information committees in the Loire watershed region to determine the best way to render information on environmental radioactivity. This approach provided food for thought on how to organize information on the future Internet site.

191 monitors
in the national remote monitoring network *(191 in 2007)*

600 sampling points
throughout the country *(600 in 2007)*

In the words of

Jean-Marc BOURNIGAL
Director General in charge of the Food Industry, Ministry of Agriculture

"Cooperation with IRSN in 2008 covered, first of all, establishing the function of national benchmark laboratory for radionuclide measurements. Until then, this mission has been carried out by the French agency for Food Safety, AFSSA, who wished to discontinue this mission. The agency wished to focus its analytical activity on other specializations, since the resources required to keep skills up to date in the field of radionuclides were excessive. It is essential for our ministry to be able to refer to a national benchmark laboratory. This implies developing, optimizing, and validating analysis methods, as well as supervising the national network of certified laboratories. IRSN organized the first interlaboratory comparison exercise for this purpose. The national benchmark laboratory also conducts test analyses and engages a scientific and technology watch for the DGAL. This is what led us to consult the Institute in July concerning the irrigation of small commercial farms in the vicinity of the Socatri plant in southern France. The scientific and technical support provided by IRSN also includes restructuring the radionuclide monitoring plan, established in 1987, to achieve greater efficiency."

Radiological surface mapping at the Ile Saint-Denis site.

Openness to society

Comrisk

IRSN has confronted the difficulty of establishing dialogue with a population concerned by radioactive contamination in tasks where it conducts risk assessments on contaminated sites, such as the Marie Curie School in Nogent-sur-Marne in the Paris region. Other institutions in charge of managing sites chemically contaminated by past industrial activities are also confronted with these difficulties. The Comrisk study was conducted by Ineris and IRSN, at the request of the French agency for energy control, Ademe. Its purpose was to collect the results of research work and feedback on the involvement of populations in contamination situations and then propose an appropriate management approach.

The study was conducted in cooperation with a multidisciplinary follow-up committee consisting of professionals and citizen associations. Since May 2008, the study documents have been made available to all persons involved, i.e. those who are in contact with contaminated locations, government agencies, and other services interested in opening up dialogue with communities touched by contamination.

The results can easily be applied to any contaminated site and demonstrate that by providing a better response to stakeholders, site managers can be more thorough in their action, thereby improving the quality of site management.

www.comrisk.fr

Studies on site environments

In response to requests from industry and government agencies, IRSN conducts studies on the impact of industrial activities on the environment and population.

State of knowledge on tritium

With associations denouncing a possible tendancy for tritium to accumulate in living organisms, and consequently an underestimation of its effects on human health, IRSN has initiated work to determine the state of knowledge on tritium behavior in the environment.

Tritium comes from both natural and anthropogenic sources, and is one of the radionuclides the most frequently released from nuclear facilities and found in the environment. A hydrogen isotope, it follows the water cycle, thereby finding its way into living organisms.

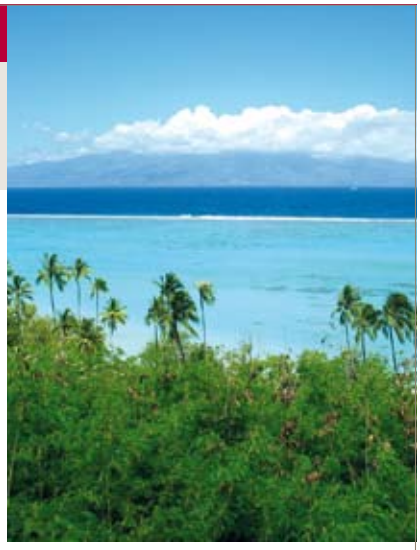
The analysis in progress features several phases. The first consists of describing tritium behavior in the environment, based on the mechanisms involved in the water cycle and measurements taken regularly to determine concentration. The second phase involves finding out what is known about the effects of this radionuclide on animal and vegetable species. IRSN will then consolidate the current state of knowledge and identify any gaps. It will propose research actions to achieve a better understanding of the behavior and impact of tritium on humans and the environment.

Managing industrial sites contaminated by radionuclides

The Ministry for Ecology and the ASN asked IRSN to revise the guidebook on "Managing industrial sites that may be contaminated by radioactive substances", issued in 2001. The purpose is to incorporate changes made by the Ministry in February 2007 with regards to the general approach to characterization and management of contaminated sites.

More details

Pollution observatory created for Polynesian lagoons



In 2008, IRSN helped create a pollution observatory for Polynesian lagoons, in partnership with locally established national research institutes, i.e. Ifremer, CNRS and the French Directorate for the Environment. The vulnerability of the lagoon ecosystems, Unesco's classification of certain atolls as biosphere reserves (Fakarava in 2006), and their designation as World Heritage sites all pointed to the need for this observatory.

The purpose is to collect data on hydrological, climatic, chemical, and radioactivity parameters common to the various sites selected in the five Polynesian archipelagoes. At Tahiti IRSN is gradually reorienting its radioactivity monitoring strategy by changing the target of its monitoring network from human health to the environment.

The new version will be published at the beginning of 2010.
Work on the guidebook began in the fall of 2008, by setting up a working group composed of experts from the Institute, specialized in the study of soil pollution and radiological impact studies, as well as representatives of the ASN, the French Directorate General for Risk Prevention, the Ministry for Ecology, and Ineris. The first step consisted of collecting feedback on the current guidebook from various users in the relevant organizations.

In this respect IRSN gained considerable experience from working at polluted sites, particularly those contaminated through industrial use of radionuclides – especially radium 226 – during the first half of the 20th century. In the last 20 years, the State and industry have begun remediation operations at these sites.

The Institute conducted work at six of these sites in 2008. At one site, this work involved creating a "green district" in Ile Saint-Denis in the Paris region, where a radium extraction plant once stood. The Ministry for Ecology asked IRSN to conduct a radiological characterization campaign on this site, covering roughly 10 hectares, to determine whether it was compatible with the land development project in view and adapt it as necessary. IRSN's support was also requested by the Haute-Normandie public authority in charge of land development for the "Friche Bayard" project at Saint-Nicolas-d'Aliermont on the northern coast of France. This former clock factory site was partially rehabilitated in the 1990's, when over 800 m^3 of earth was removed to comply with cleanup requirements set at that time by the Ministry for Health. Implementation of new regulations has led IRSN to propose additional measures to prepare the site for reconversion to an amusement park.

Setting up samples in the measuring system.

27,600 environement samples taken per year *(31,000 in 2007)*

3 exceptional radiological events detected by radioactivity monitoring networks *(4 in 2007)*

Transfer and behavior of radioactive substances in the environment

IRSN is working to improve models on the transfer of radioactive substances in the environment by developing two major lines of action: validation of models designed to quantify radionuclide behavior within ecosystems; and justifying the transfer parameter values used in these models.

Carbon-14 transfers in the environment

Carbon-14, like tritium, is a radionuclide that has the particular feature of being found in every compartment of the environment chain, which explains why the study of 14C transfer within ecosystems is of major interest. IRSN has created an *in situ* experiment workshop, located downwind from the Areva NC plant at La Hague, designed to validate the relevant transfer models. In 2008 this workshop monitored radionuclide flux as it migrated between the different elements of a prairie (air, rainwater, grass, soil), according to weather conditions and prairie farming practices. Comparison of the first measurement results against estimated carbon-14 concentrations showed that the model used as such underestimated carbon-14 concentrations in grass by about 15%. For carbon-14 concentrations in the air, the model is being improved to achieve a better representation of the change dynamics in time. Transfers to mammals (in this case cows), as a function of diet will be studied at a later time, along with tritium transfers.

Radionuclide transfers in the biosphere

The year 2008 saw the end of the IAEA's EMRAS working group (Environmental Modeling for Radiation Safety), coordinated by IRSN for four years. The purpose of this group was to update the international handbook of parameter values for the prediction of radionuclide transfer in temperate environments (TRS 364).
After compiling a bibliography, consulting data bases, and drafting the different chapters, updating was completed at the beginning of 2008. The final version submitted to the IAEA at the end of 2008 should be published in 2009.

International

First international conference on radioecology

Co-organized by IRSN and its Norwegian counterpart NRPA, the international conference on Radioecology and Environmental Radioactivity took place from June 16 to 20, 2008 in Bergen, Norway. A merger of two radioecology events, this three-yearly international conference brought together 500 representatives from research, industry, associations, and public authorities. The subjects covered included environmental monitoring activities, transfer of radioactivity to biological organisms, and the effects of chronic and accidental contamination. Discussions touched on laboratory experiments and the developent of practical methods and calculation tools applicable to monitoring an environment exposed to regulated release or accident fallout involving significant amounts of contamination. Participants also focused on the effects of persistent, low-level, radioactive contamination in ecosystems.

In the words of

Jean-Christophe GARIEL

Deputy Director of Environment and Response at IRSN

"Initiated in October 2006 and supervised by IRSN, the coordinated European action FUTURAE (a future for radioecology in Europe) presented its conclusions in October 2008. The purpose of FUTURAE was to study the feasibility of a European network of excellence in radioecology research. At the end of this reflection, it appears not only feasible, but essential to create a network of this type. The radioecology community will soon be confronted with several major challenges: keeping European competence in radioecology up to grade; preparing response capability for the expected growth in nuclear energy and the issues raised by new facilities such as ITER, as well as questions on waste... That is why, at the end of 2008, IRSN took the initiative of creating a group uniting several of the main European stakeholders in radioecology, so that, under the best possible conditions, they could prepare a response to the Request For Proposals to create a network, which should be issued at the end of 2009."

The new photon-beta-neutron dosimeter distributed by IRSN.

155,494 workers
whose individual dosimetry is monitored by IRSN *(164,732 in 2007)*

19,993 radiotoxicological
analyses *(19,319 in 2007)*

254 whole-body countings
(225 in 2007)

Radiation protection in the workplace

For workers exposed to radiation on the job, IRSN conducts research and proposes tools designed to improve knowledge of occupational exposure to ionizing radiation for better control of this risk.

Monitoring worker dosimetry

IRSN processes the largest number of dosimetry files in Europe on workers exposed to ionizing radiation, with over 155,000 workers in various sectors of activity, including healthcare, research and industry.

Since the beginning of 2008, the Institute has been distributing an enhanced-performance dosimeter to replace the previous "film-based" one. Based on radio-photoluminescence (RPL), the new dosimeter is capable of measuring very low doses or very high doses with great accuracy, for both personal and environmental monitoring. It provides accurate information on the type of radiation involved in any accident situation.

In the words of

Isabelle VABRE
Head of Dosimetry Department at the Orsay Nuclear Physics Institute, CNRS

"The dosimetry department, as a technical service of CNRS, monitors external exposure to ionizing radiation using passive dosimetry. We keep files on 3,000 people, including CNRS staff members and close scientific partners. Up until now, we used radiographic film for photon and beta dosimetry, which represents 80% of our activity.

This technique has become obsolescent and no longer meets the latest regulatory requirements. Its detection threshold is too high for dosimeters worn for three months. To replace it, we surveyed the various techniques used by other organizations who perform dosimetry in France.

We then put out a request for proposals in which the technical criteria consisted of meeting the performance requirements specified by French regulations and identifiying the technology that most closely matched our needs. We wanted the most fully integrated and automated system possible, for greater flexibility in use, capable of interfacing with our current data base.
We chose the RPL technology, recently adopted by IRSN, which demonstrated the best technical and functional characteristics. This choice provided us with better performance and reduced operating time."

Promoting a nuclear culture based on radiation protection in healthcare is a major priority for the Institute.

Operation of this new dosimeter required setting up a laboratory equipped with sophisticated automation. At the end of 2008, over 180,000 RPL dosimeters were sent out to various customers.
They were manufactured using the new DOSIP computer application, released in September 2008 after five years of design and development.

The year 2008 also saw the completion of work conducted by the Institute to improve performance on its neutron dosimeter. This new, more sensitive device features functions that are convenient for assessments, offering greater accuracy on the type of exposure. It is also well adapted to the various neutron spectra that workers may be exposed to.
www.irsn.org/dosimetre

SISERI consolidates its potential

Since 2005, the SISERI database has centralized and archived all the results on individual monitoring of worker exposure to ionizing radiation in France, in compliance with the mission assigned to the Institute by the Labor Code. Occupational physicians and radiation protection officers can access this information through the IRSN website. Operational development of SISERI made considerable progress in 2008. IRSN boosted the resources allocated to this application to solve integration problems related to the poor quality of certain data sent in. This effort allowed the Institute to achieve an integration rate greater than 95% for passive dosimetry data and complete integration of operational dosimetry data. The data transfer protocol for monitoring internal contamination was also established. Meanwhile, the Institute has continued recording old data in order to compile the complete dosimetry history of each worker that has been exposed to radiation in France.

Studying workplaces in the medical field

Given the growing demand for personnel to assist radiation protection officers in industry and the medical field, in 2008 IRSN developed consultancy services to study workplaces. This service is based on the know-how developed by the Institute over the years and is consistent with its mission to promote a nuclear culture based on radiation protection in the healthcare sector. An example of the Institute's work can be found at the Roanne Hospital Center in the radiology service and radiotherapy service, which operates particle accelerators. Workplace studies define radiological zones and classify personnel functions to determine which types of operational and passive dosimeters are the most appropriate for monitoring each staff member.

Raised exposure to "naturally-occurring" radiation

Certain industrial activities such as the production of refractory ceramics, the combustion of coal in thermal power plants or the processing of ores (to produce tin, aluminum, etc.) involve the use of raw ma-

1,428,178 personal dosimeters
were read to monitor worker dosimetry
(1,491,118 in 2007)

214 people participated
in intercomparison exercises
(143 in 2007)

aluminum, etc.) involve the use of raw materials that naturally contain radionuclides. These operations may significantly increase exposure of workers or the local population. This type of exposure is regulated by the Order of May 25, 2005 relative to occupations working with raw materials that naturally contain radionuclides, but where the process does not involve exploiting the radioactive properties of these materials. To address this issue, IRSN published a document in 2008 for professionals responsible for conducting impact studies required by regulations. The Institute also established assessment criteria to facilitate examination of these studies by the territorial divisions of the ASN (the French national safety authority). An in-depth analysis was conducted by IRSN on the assessment of doses received by workers in coal-fired thermal power plants. The year 2008 was also dedicated to analyzing data presented in the nearly 80 files submitted by industry: 88% of the doses calculated for workers and 100% of the doses calculated for the population were less than the reference value of 1 mSv^{-1} per year, the limit for public exposure.

Research outlet

AMANDE

Open to outside users since 2007, IRSN's AMANDE facility ran 24 weeks of irradiation operations to satisfy various needs:

> **five weeks** for external service contracts, half of which involved work conducted in cooperation with CNRS, the other half for companies that manufacture radiation protection devices;

> **ten weeks** for calibration of IRSN detectors, including the new PN3 personal neutron dosimeters, as well as cell irradiation for experiments in radiobiology;

> **nine weeks** for IRSN's own R&D studies.

The AMANDE facility generates monokinetic neutron fields that serve as the national metrological standards for neutron dosimetry, established jointly by IRSN and the French national laboratory for metrology and testing, the LNE. In addition to setting standards, the AMANDE facility can now be used to calibrate or test detector response as a function of neutron energy.

The AMANDE facility.

Staying alert to prevent malicious use of nuclear energy and radioactivity

In addition to providing round-the-clock security control at nuclear facilities, 2008 was marked by the transfer of responsibility for nuclear security from the Ministry of Industry to the Ministry of Energy. IRSN assisted the two senior defense and security officials from these two ministries during this transfer.

Maritime transport of nuclear materials.

Protection and control of nuclear and sensitive materials

Physical protection of nuclear materials

In 2008, at the request of the authority in charge of nuclear material control, IRSN examined about 150 files on the physical protection of facilities and nuclear 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 Industry to conduct inspections at facilities holding nuclear materials, at the Official's request. Nuclear materials inspectors conducted 55 facilities inspections in 2008, two of these being initiated in response to particular events, as well as 60 inspections during transport operations and 18 inspections on transport equipment (Categories I and II).

Certain on-site physical protection systems are connected to computerized systems that participate in video surveillance, remote control of protection systems and alarm acknowledgement and analysis.

In this context, inspections carried out in 2008 focused particularly on:

- computerized systems involved in access control;
- nuclear materials monitoring systems;
- management of protection system inhibition.

Inspections covered checking compliance with technical instructions and ensuring that equipment meets the desired objectives, taking into consideration plant layout (distance between buildings, location of the central alarm station, surface area of the zone to be monitored, etc.).

Nuclear material follow-up and accountability: assessment and inspection activities

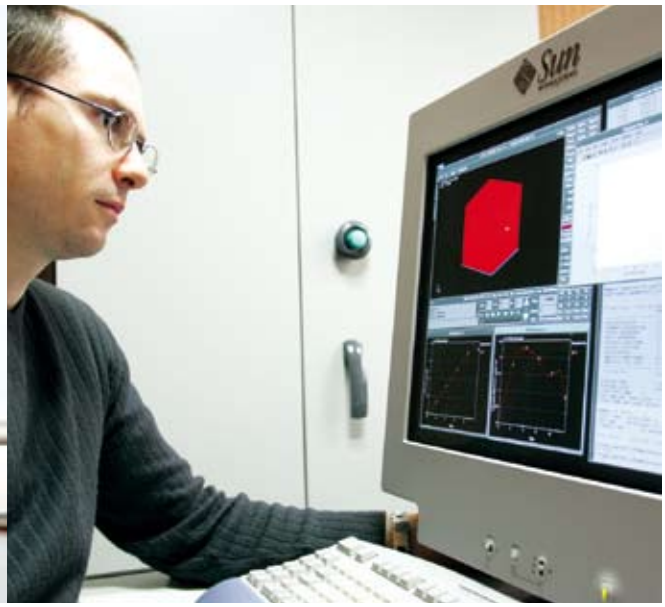
In 2008 IRSN carried out 168 files analyses and 121 analyses of nuclear material inventory reports, at the request of the authority in charge of nuclear material control.

IRSN specialists, designated by the Senior Defense and Security Official as nuclear materials inspectors, also conducted 63 inspections on nuclear material follow-up and accountability in 2008. Some of these inspections included specific examination of the accountability of these materials and the associated measuring devices.

Efforts made during the last few years to

15 **technical inspections conducted** in facilities under the "declaration regime" *(10 in 2007)*

Exercise in taking nuclear material inventory in an emergency situation.



Development of assessment tools for physical protection of facilities.

improve the content of licensing and control files were pursued in 2008. These documents are now operational and are used during inspections.
IRSN also conducted 15 technical inspections in facilities holding small amounts of nuclear materials that are under the so called "declaration regime".

Taking nuclear material inventory in an emergency situation

At the request of public authorities, IRSN regularly organizes emergency response exercises that involve taking nuclear material inventory at a facility. The purpose of these exercises is to test decision-making chains and coordination of the various participants (operators, public authorities). They consist of 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 (theft or misuse of nuclear materials or acts of sabotage).
In 2008 this exercise was conducted at the Areva NC plant at Pierrelatte in southern France. The exercise scenario, prepared by IRSN in conjunction with the operator, simulated a blackmail attempt threatening radioactive contamination. The emergency response teams at the Ministry of Industry, Areva and IRSN were all activated. The exercise took place over approximately eight hours and involved over thirty people.
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.

More details

Training Areva personnel in nuclear material control

The need to train personnel in the quite specific area of nuclear material control was identified at Areva, who asked IRSN to organize a customized training program for the corporation's operators. This program involved nuclear material accountability and covered the regulatory framework, stakeholders involved, principles, and technical procedures.

Training dealt with international inspections, conducted in France by the European Commission and the IAEA, and national inspections recently placed under the authority of the Ministry of Energy.

After the first test session in December 2007, three sessions were conducted in 2008, with 15 participants taking part in each one. Feedback based on immediate reactions at the end of training has been positive, and three more sessions have been scheduled for 2009. Discussions are underway to widen the range of training classes to cover more technical aspects for more specialized employees.

196 **inspection missions**
relative to national nuclear material control *(171 in 2007)*

1 **exercise on nuclear material inventory**
in an emergency situation *(1 in 2007)*

International

Establishing the qualification profile for IAEA inspectors

As part of the French support program to the IAEA, IRSN has initiated action to establish the behavioral profile required for inspectors in charge of nuclear material inspections. The purpose is to improve the recruiting and training strategy for these inspectors.

The Institute's proposal, based on a method developed for skills management, is receiving serious consideration due to the Institute's experience and the fact that the method can be easily adapted to suit the needs of the IAEA.
The selected approach consists of drawing on knowledge from both nuclear material control and human resource development and using these skills in a complementary way.

This project is taking on considerable importance as the IAEA seeks to replace the more experienced inspectors who are leaving, while the Additional Protocol extends the scope of their activity and changes the required skills profile.

This activity also gives IRSN the opportunity to approach an area that is not yet covered in the French Safeguard Support Program.

10 missions to escort inspections involving the chemical weapons ban *(4 in 2007)*

45 missions to escort inspections involving international nuclear material control *(43 in 2007)*

Samples for the Euratom control.

International inspections in a non-proliferation context

In 2008, IRSN continued to provide technical support to authorities, in a context where control organizations (OPCW, Euratom and the IAEA) are increasing their inspection efforts in French chemical and nuclear industrial facilities.

www.irsn.org/non-proliferation

International inspections of chemical facilities

In 2008, IRSN escorted 10 inspections conducted by the Organization for the Prohibition of Chemical Weapons (OPCW) at French industrial sites, compared to six conducted on an average basis in previous years. During one of these missions, samples were taken and chemical analyses were then carried out in the Institute's mobile laboratory.

IRSN also participated in interministerial working groups on challenge inspections, to prepare for any very intrusive inspection resulting from a call of defiance issued by a State. Based on its experience of routine inspections, the Institute has proposed documents and methods that can serve as the basis for an inspection escort policy, which will be tested during future exercise inspections.

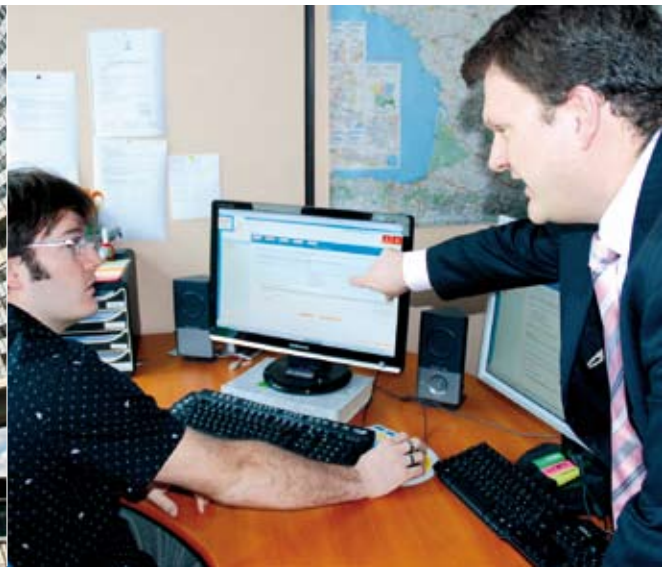
At the beginning of 2008, IRSN created a secured web portal where industry can submit its declarations. Used by 83% of the organizations who must declare their chemical products, a survey showed that 80% of the users were satisfied with the web site.

International inspections of nuclear facilities

In 2008, IRSN escorted 45 inspections conducted within the framework of the Euratom Treaty and IAEA inspections of French facilities, compared to 43 the previous year. This increase is explained mainly by negotiations between France, the IAEA and Euratom regarding inspection procedures for the Georges Besse II plant and by requests from Euratom involving certain facilities that require clarification on specific points.

The Institute participated in an exercise on what is referred to as a "notification of complementary access", specified in the Additional Protocol. This allowed IRSN to test the emergency instructions and the various documents prepared for this purpose. A later exercise conducted internally at the Institute confirmed that the system implemented is operational and has reached maturity.
In 2008, the PIMENT portal, developed by IRSN, was deployed in facilities belonging to the Areva group. This tool is used to declare

International organizations intensify their action.



Ioda: a special site for declaring nuclear materials electronically.

imports and exports of nuclear materials to IRSN electronically using a secured Internet connection and electronic certificates. Its helps to simplify information processing at IRSN.

In the same year the Institute also continued work on its computer systems (processing and retransmission) to take into account format changes in the statements required by Euratom regulations and used by two of the three main nuclear operators in France.

IRSN provided technical assistance to French authorities in processing several cases, namely in defining the scope of application and the means to be invested to protect the information contained in a certain number of sensitive documents sent to Euratom for inspection purposes. IRSN also participated actively in the definition and practical application of measures agreed between France and Japan regarding imports of certain equipment designed for installation in French plants.

Protection against malicious acts

Regulatory text reviews

In 2008 IRSN continued to participate in the revision of French regulations relevant to malicious acts involving nuclear materials, transport and facilities. Work involved the draft decree to implement Articles L1332 and L1333 of the Code of Defense and two orders to implement this decree, one related to provisions to ensure accounting for and control for nuclear materials, the other on transport, which grouped together general provisions covering different types of transport of nuclear materials and special provisions on the different modes of transportation (road, rail, sea, air).

Restricted expert groups

Consultation of the restricted expert groups responsible for examining the technical aspects of protecting facilities from acts of sabotage resumed in 2007, but no meetings were held in 2008. Examination of the EPR project with regards to malicious acts continued in 2008, while examination of the same issue began for the Jules Horowitz Reactor at Cadarache.

In the words of

Christine BAMIÈRE

Project leader reporting to the Director of State Protection and Security at SGDN

“IRSN’s support to SGDN basically covers two areas. The first is related to security and defense issues: security of radioactive sources and nuclear materials, protection of facilities, physical protection and national accountability of nuclear materials.
In this area, the Institute’s action covers both work on regulatory texts and research on how to improve the protection of sources against malicious acts.
On a European scale, IRSN applies its competence with regards to radioactive sources in work conducted to reduce radiological risk. Likewise, the Institute also participates in the Global Initiative to Combat Nuclear Terrorism (GICNT).
The second area of collaboration involves diagnostics and treatment for people who have been irradiated. The scientific and medical skills available at IRSN are essential, especially in setting up the plan to deal with victims in France.”

In the words of

Anita NILSSON

Director of the IAEA Office of Nuclear Security

"The IAEA plays a major role in building nuclear security for tomorrow by identifying long-term goals that are consistent with legal instruments such as the conventions on physical protection and nuclear terrorism or UN Security Council resolutions, and by managing the heritage resulting from past neglect of security issues.
To fulfill our commitments, we work with Member States and particularly appreciate the competence, expertise, and assistance provided at various levels by France, and especially by IRSN. For example, the advisory group on security can rely on the recommendations of IRSN's Deputy Director in charge of defense-related missions to formalize a well-organized program.
An IRSN specialist contracted out to the IAEA helps us in our daily work, while others provide support on how to approach specific aspects or write special directives.
In 2008 the Institute contributed to many of our activities, such as ensuring complementarity between safety and security approaches, or removing high-activity sources contained in unused equipment from sensitive places. IRSN also helped us publish roughly ten security guidelines."

Security of radioactive sources

The study program aimed at tightening up security against malicious acts targeting radioactive sources continued in 2008 with the identification of possible aggression scenarios and assessment of the corresponding radiological consequences.

Assessment of the most sensitive scenarios is still in progress, and will determine the medical and sanitary response to be implemented both during and after the accident situation.

In this type of work, IRSN relies on its own skills in radiation protection, security, and emergency response management. Contacts have also been made with the Paris Fire Brigade and public transportation operators.

Lastly, as part of the organization that the State is setting up to reinforce security around radioactive sources, IRSN has proposed to extend its operational expertise to include source security and offer a complete support capability that covers all safety, radiation protection and security issues.

SIGIS database development

IRSN's SIGIS database includes information on radioactive sources and the terms of the corresponding authorizations. In January 2007, the ASN, who already had access to this database, expressed the idea that this tool should be extended to its regional divisions. The result gave way to two major changes: first, the network architecture was modified to integrate the SIGIS database into the IRSN computer network in a domain open to ASN users; second, the application was changed to allow the regional divisions of the ASN to

Repeating exercises for better responsiveness in an emergency.

grant authorizations according to the required procedures, while maintaining the confidentiality of data in the database. Once the various entities of the ASN had received appropriate training, they were given access to the system at the beginning of 2009.

International activities

In 2008, at the request of the IAEA, IRSN participated, as an instructor or lecturer, in international courses covering design basis threats (South Africa), physical protection of research reactors (Congo), and the basis of physical protection for nuclear materials and facilities (Morocco). The Institute also participated in an advisory mission in the Netherlands involving physical protection of nuclear materials.

Elsewhere, IRSN took part in working groups involving:

- the IAEA document on fundamentals 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 structure of texts in IAEA recommendations;
- some technical documents (on information systems security, protection of radioactive sources, and transport of nuclear materials, for example).

Moreover as part of measures taken to develop a nuclear security culture, the European Commission asked IRSN to participate in several missions (in Brussels, Singapore, Jordan, Morocco) to assess the relevance of developing European training centers or networks (through centers of excellence, for example), in several countries outside the European Union (in Asia, the Middle East, and Africa).

IRSN also participated in the development of methods to assess the potential consequences of a malicious act in the context of cooperation with the US/DOE (characterization of the source term).

Cattenom nuclear power plant.

Develop IRSN's technical response and mobilization capabilities to handle a radiological emergency of malicious origin

In April 2008, a meeting to collect feedback on the EPEES 03 nationwide exercise (which took place at the Cattenom power plant in Moselle in November 2007) was organized by the Senior Defense and Security Official from the Ministry of Industry, in the presence of all the participating entities and with the technical support from IRSN. The observations recorded by assessment specialists from each entity pointed out lines of improvement that will be taken into account by each stakeholder in the next exercise.

The purpose of EPEES exercises is to test coordination between nuclear facility operators, who are responsible for site protection, and public authorities: the Prefect, the state prosecutor, local and national police forces. In 2008, IRSN began organizing the next exercise, EPEES 04, which will continue to prepare major operators (EDF, CEA and Areva) for management of an emergency situation of malicious origin at a nuclear site.

1,400 movements
of radioactive sources recorded in the SIGIS database *(1,100 in 2007)*

Openness to society

Policy document on safety vs security

As part of its mission to protect nuclear facilities from malicious acts, IRSN is producing a policy document that compares the safety approach and the security approach. These two are quite similar in terms of principles, but nonetheless feature specific points that require different implementation procedures. The policy document will reinforce complementarity between the safety analyses and security analyses that IRSN submits to the relevant authorities in these two fields.

DEVELOPING IRSN'S TECHNICAL RESPONSE AND MOBILIZATION CAPABILITY TO FACE A MAJOR RADIOLOGICAL EMERGENCY

Studying emergency situations and their consequences to improve readiness

Aiming to improve its assessment and operational capabilities in the event of a radiological accident, IRSN achieved significant progress in 2008 in three areas. First, it contributed to the definition of national policy relative to post-accident situations by preparing new accident scenarios to serve as a basis of reflection for the steering committee in charge of managing the post-accident phase of a nuclear accident (Codir-pa). Second, It consolidated its own emergency response organization by implementing new mobile measuring units. Third, it developed new tools to further its knowledge on exposure to ionizing radiation and improve treatment of patients irradiated accidentally.

National policy

IRSN is involved in work aiming to establish a national policy for management of nuclear post-accident situations.

Participation in Codir-pa work

Since 2005, IRSN has been strongly committed to preparing a national policy on management of nuclear post-accident situations. In 2008 a total of more than 20 specialists at the Institute participated in work conducted by the steering committee for management of the post-accident phase of a nuclear accident (Codir-pa), set up by the ASN in 2005.

In addition to being present in nine of the eleven thematic groups, two created in 2008, IRSN led two groups, one responsible for evaluating the radiological and dosimetric impact on the environment and humans, and the other responsible for choosing the assumptions on which predictive assessments would be based.

IRSN presented a new accident scenario to the steering committee, where plutonium was released to the environment, in order to test the first policy measures proposed in 2007 for assessment and management of

International

Welcome extended to Norwegian and Russian observers

In collaborative work conducted by IRSN and the Norwegian Radiation Protection Agency (NRPA), a physician from the Russian radiation protection agency (FMBA), an engineer from FMBC (the Russian technical support agency) and an engineer from the NRPA were invited to observe the national emergency response exercise held on October 7, 2008; both in the field and at the IRSN Emergency Response Technical Center. The exercise simulated an accident at the Saint-Laurent-des-Eaux nuclear power plant in the center of France, leading to environmental release of radioactivity.

The purpose of the visit was to help FMBA improve its local organization within the framework of a bilateral project between FMBA and NRPA. This organization will be tested during an exercise scheduled at Gremikha (Russia) during the summer of 2009, where IRSN observers will be invited.

The Emergency Response Center responds to any radiological emergency situation.

the immediate consequences of radioactive fallout from an accident involving people, buildings, and agricultural production.

The Institute also began unique research to construct a severe accident scenario where substantial release occurs over a long period (two weeks). This new scenario, presented in spring 2009, will be used to test and adapt the approaches proposed by Codir-pa, which until now had only considered short-duration accident scenarios with a moderate impact.

In parallel to national-level work, IRSN has continued to improve its organization and emergency response assessment methods in terms of:

- its ability to predict the radiological and dosimetric consequences occurring immediately after accidental release;
- mobilization in the field with regards to gathering samples, measurement results, and contextual information used to refine preliminary assessments.

Consolidation of emergency response organization

IRSN is constantly improving the ways and means it employs in a radiological emergency so that it can respond appropriately in any situation.

Developing emergency response teams and equipment

In 2008, the Institute continued its efforts to reinforce the selection of people capable of taking part in an emergency, either at the Emergency Response Center to help with assessments, or in the teams sent out in the field to measure radioactivity.

Even if the number of team members had already reached over 300 people, the Institute wished to take an exhaustive inventory of all its employees that could hold a function in an emergency, in order to ensure rapid mobilization of all competent specialists at all times and maintain operational teams on a long-term basis.

As regards the Emergency Response Center, the 2008 inventory pointed out the need to add more people for situations affecting laboratories, plants, experimental reactors, and defense-related facilities. In the field, it appeared necessary to reinforce measurement coordination functions at the operations control center set up by the local authorities (40 people) and to add mobile units for taking measurements in the environment and on people (about 80 people).

In the words of

André-Claude LACOSTE
ASN Chairman

"Since 2005, the ASN has led reflections on a national policy for post-accident management of a nuclear accident situation. This effort is based on work accomplished by the steering committee for management of the post-accident phase of a nuclear accident or radiological emergency situation (Codir-pa).
About 130 people from national and local government agencies, local public authorities, various specialized institutes, such as IRSN and InVS, and associations participate in work conducted in the 11 working groups set up by the Codir-pa steering committee.
A report on their preliminary results was submitted to the government last March and was published on the ASN website. IRSN took an active part in these discussions, where it was necessary to deal with numerous complex technical questions and come up with practical answers. Some of the Institute's important contributions included defining the notion of "post-accident", making a distinction between the different operational phases, and clarifying the role of each stakeholder. From a technical viewpoint, the Institute conducted specific studies to confirm strategic thinking with regards to the possible consequences of different types of scenario.
The first phase of reflection was closed at the end of 2007, with an international conference held in Paris and a progress report submitted to the government at the beginning of 2008. Our next milestone is set for 2010, when we aim to hold another international conference and submit a final report to the government at the end of the year."

www.asn.fr

The dosimetric properties of the plastic used on phones are tested using electron paramagnetic resonance.

A special effort focused on integrating IRSN sites in areas outside the capital into the emergency response structure, to reduce the time required to intervene in the field.
Theoretical training started in 2008 will be followed up by practical training in 2009. Skills will be kept up to date through participation in national emergency exercises or specific internal exercises.

In parallel, the program to upgrade IRSN's mobile operational units resulted in delivery of two trucks equipped for taking measurements in the environment. To move its teams and implement radiological measurement systems in an incident situation, IRSN now has emergency vehicles, laboratories on wheels, and a control center vehicle. These vehicles have been positioned at Avignon (southeast France), Fontenay-aux-Roses (Paris region) and Agen (southwest).

3 units added
to the Emergency Technical Center
(2 in 2007)

4 dose assessments
through biological dosimetry *(7 in 2007)*

Developing tools

To improve treatments applied to victims of accidental irradiation, IRSN is working to develop dosimetry tools and therapeutic treatments for radiation-induced lesions.

New materials for retrospective dosimetry

To improve its ability to measure doses received by victims of accidental irradiation, IRSN is studying the dosimetric properties of materials such as glass, plastic, and even the electronic components in objects found on most people (mobile phones, watches, glasses, plastic buttons, etc.). These studies are based on various techniques, such as electron paramagnetic resonance (EPR) spectrometry, thermo-luminescence, and optically stimulated luminescence.

In 2008, dosimetric properties were studied on a wide range of samples. As an example, the glass used in liquid crystal screens was found to be the most promising material for measurements using EPR. Most glass of this type produces a radiation-induced signal that is steady and intense enough for dose measurements of a few grays several weeks after an accident. Among the different plastics tested, very few appeared appropriate for accident dosimetry, given the instability in the radiation-induced signals they produce. Although luminescent techniques are more sensitive on electronic components, their use remains limited due to signal instability. Additional work is in progress to take into account this phenomenon.

International

IRSN operates in Tunisia

On March 23, 2008, an irradiation accident occurred at an industrial site in Tunisia, subsequent to a malfunction on a gamma radiography device used for weld inspections, equipped with an iridium-192 radioactive source. IRSN immediately recommended that the patient, with hand burns, be transferred to the Percy Hospital in Clamart (in the Paris region), a center highly specialized in the treatment of serious radiation burns. When Tunisia called for assistance, the IAEA asked France to take charge of the patient for medical treatment. The ASN gave a positive reply to this request and the patient was transferred to the Percy Military Hospital on the evening of May 1.
The patient was treated using the new therapeutic approach conceived by IRSN for treating radiation burns, applied previously after accidents that had occurred in Chili and Senegal. Skin grafts were combined with local administration of mesenchymatous stem cells.
A retrospective dosimetry assessment was conducted by IRSN based on bone samples.

Analyzing chromosome abnormalities in samples from an irradiated patient.

Automation of biological dosimetry

If a large number of people are exposed to radiation in an accident situation, it is important to classify the victims according to the actual dose received. The aim is to identify those who have received the greatest exposure so that therapeutic treatment can begin as quickly as possible.

The dose received by each victim can be assessed by taking blood samples to count the dicentric chromosome abnormalities caused by irradiation. This reference technique provides results in a few days for a limited number of victims (less than 10), but would require extensive resources if the assessment involved a large number of people. A variation of this technique was tested after an irradiation accident involving 63 potential victims in Dakar in August 2006. In 2008, certain steps in recognition of chromosome abnormalities were successfully automated. This new method reduced the required analysis time by a factor of three and correctly identified 96% of the persons exposed.

Treatment using adipocyte stem cells

Treating radiation-induced skin lesions is extremely complex and delicate. Since 2006, accidentally irradiated patients have been successfully treated by IRSN and the Percy Military Hospital in Clamart through cell therapy, including techniques based on the injection of mesenchymal stem cells.

IRSN's research programs aim to improve the clinical conditions of using cell therapy to treat skin lesions. In this aim, the Institute is examining the therapeutic potential of other types of stem cells through experimental models. Preliminary results obtained in 2008 showed that the administration of stem cells present in adipose tissue (ASC) improves healing of a wound on irradiated skin. These cells are capable of stimulating cell regeneration in the epidermis and lead to the formation of new blood vessels, which is essential for a wound to heal correctly. The remarkable plasticity of adipose stem cells and the fact that they are easily taken from adipose tissue make them a promising solution for the treatment of radiation-induced skin lesions. This work is being conducted under a contract with the French armament procurement agency, DGA, which runs from October 2008 to October 2011.

4 nationwide nuclear emergency exercises
involving defense-related activities
(3 in 2007)

9 nationwide nuclear emergency exercises
excluding defense-related activities
(9 in 2007)

In the words of

Philippe VOISIN
Head of the Radiobiology and Epidemiology Department at IRSN

"In 2008 we conducted an intercomparison study on results obtained from four laboratories participating in the national biological dosimetry network. This exercise, based on a blood sample, confirmed that the network is operational for rapidly sorting a large number of people suspected of being potentially irradiated, in the event of a malicious act or a large-scale accident at a nuclear power plant.

The national network consists of the IRSN biological dosimetry laboratory, two CEA cytogenetic laboratories, and a laboratory at the French National Natural History Museum. The network was formed through a government-sponsored R&D program associated with the effort to combat nuclear, radiobiological, biological, and chemical terrorism, coordinated by the Secretary General of National Defense. The network may soon be reinforced by a laboratory being created within the military health service."

Better quantification of risk related to low-level radiation doses to optimize radiation protection

In 2008, IRSN pursued its ENVIRHOM research program divided into two parts: the environment, with research on the genetic adaptation mechanisms of invertebrates in response to chronic exposure to uranium; and humans, with new knowledge gained on how chronic exposure to uranium affects the human organism. In parallel, the Institute published a report on cases of infant leukemia observed near nuclear facilities and concluded a three-year study on worker exposure to radiation in the nuclear sector, conducted within the ALPHA-RISK project.

ENVIRHOM Program

Since 2001, the IRSN ENVIRHOM program has increased knowledge on how chronic exposure to ionizing radiation affects the environment and humans. In 2008 this work focused on exposure to uranium.

ENVIRHOM and adaptive phenomena in the environment

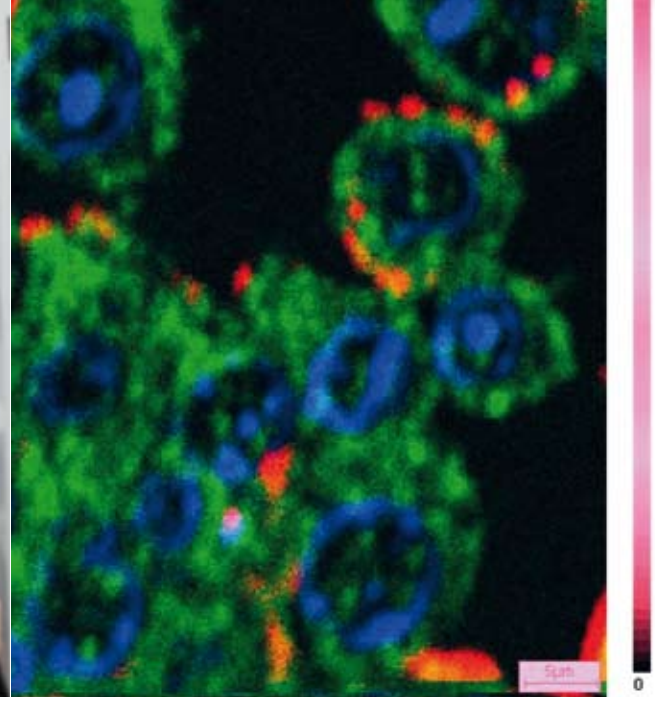
Work conducted for the ENVIRHOM program continued in 2008 with research on uranium, to improve assessment of the risk involved when ecosystems are chronically exposed to this radioelement. Understanding adaptive mechanisms is an important phase in identifying the ecological consequences of exposing plant and animal populations to a contaminant.

Experiments have demonstrated that aquatic invertebrate populations exposed to uranium are capable of rapid genetic adaptation.

After eight generations, the test populations consisted of individuals showing rapid growth and high fertility, comparable to that of unexposed populations. In fact, the higher the uranium concentration, the faster adaptation was achieved. At high concentrations, however, the response is not proportional to the contamination level. Other results show that while these populations adapt to uranium, they are also more vulnerable in a new environment. This observation is extremely important, since it implies that if environmental chages take place quickly and frequently, populations that have adapted to a particular environment may tend to disappear. Continued research

Visualizing the stage of development of living organisms.

Laboratory experiment on the ecotoxic effects of chronic exposure to uranium on living organisms for the ENVIRHOM project.



Initial results on uranium distribution in parts of the cell were obtained through SIMS ion microscopy. This analysis showed that uranium accumulates in the membrane of liver cells in the rat.

in this area will confirm whether the same results may be observed in the natural environment.

Impact of uranium on the rodent reproductive system

The year 2008 was dedicated to studying the consequences of chronic ingestion of small amounts of depleted and/or enriched uranium on the physiology of reproduction.

In the female mouse, several months of ingestion of water contaminated by depleted uranium (the reference radionuclide in the ENVIRHOM program) caused structural modifications in ovocytes, although uranium did not accumulate in the ovaries. A diversification of ovocyte anomalies was observed for the higher concentrations tested.

In the male rat, ingestion of water contaminated by enriched uranium disturbed the metabolism of certain sexual hormones. These effects were not observed with depleted uranium, indicating radiological toxicity of uranium rather than chemical toxicity in these studies.
Research is still in progress to determine whether these effects of uranium cause problems in the reproduction function.

In the words of

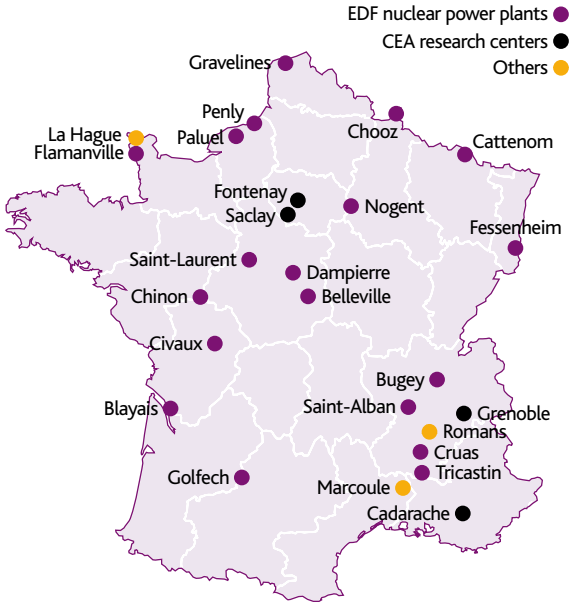
Wolfgang WEISS

Chairman of the High-level Expert Group on European Low-dose Research

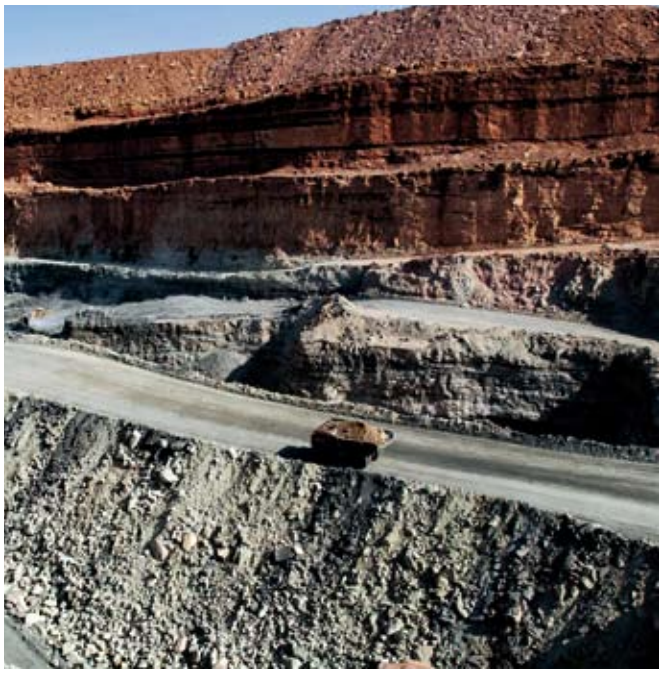
“For over 40 years radiation protection has been founded on the assumption that there is no mimimum limit below which exposure to ionizing radiation has no effect on human health; but 40 years of research have shown that men and women, young and old, from various ethnic groups react differently to the same amount of exposure.

This implies that we do not have quantitative proof to answer the question of whether or not we provide people from all categories – workers in the nuclear sector, physicians, the general public – with an adequate level of radiation protection. Yet a question as fundamental as this demands a scientific consensus, which is why a high-level expert group (HLEG) on European low-dose research was formed, to define a European-wide, common, transparent policy on risk quantification. French organizations, especially IRSN, are the most active in conducting research in this area and contribute considerably to the high-level expert group’s work. In 2008, the group asked eight internationally recognized specialists to outline European research strategy in terms of the fundmental questions that can no longer be left unanswered. Management of such a long-term project is too complex to be placed under the individual responsibility of scientists or institutions.

Cooperation and integration of research work must therefore be conceived on a European scale. I am therefore inviting IRSN and other members of the high-level expert group to contribute their knowledge, competence, and resources to a multidisciplinary initiative on low-dose research, and to create a long-term, operational framework for European research on risks in this area.”



Locations of civil nuclear facilities in France.



An open-pit uranium mine.

Chronic risks

IRSN is conducting epidemiological studies to measure the effects of chronic human exposure to ionizing radiation from the workplace, the environment, accident situations or medical treatments.

Knowledge on the risk of leukemia

Many studies have attempted to explain the local excess of childhood leukemia around certain nuclear facilities. Most of the studies encounter methodological limitations that make it difficult to demonstrate a causal link. In 2008 IRSN conducted a critical review on all epidemiological data available on the risk of infantile leukemia occurring in the vicinity of nuclear facilities.

Based on over 400 international publications, the review revealed a great amount of diversity in the studies, approaches and choice of methods.

Conclusions point to a local excess of childhood leukemia cases close to the reprocessing plants in Sellafield and Dounreay in Great Britain, and near the Kruemmel nuclear power plant in Germany.
In another IRSN analysis based on multi-site studies, including France, the frequency of leukemia cases was not higher in persons aged from 0 to 24 in the vicinity of nuclear sites. The observation reported in a German publication at the end of 2007 showing a

International

The PROTECT Project: conclusions and recommendations

The PROTECT project for coordinated action ended in October 2008.
Carried out as part of the 6th Framework Program, the PROTECT project was a joint effort of the British Centre for Ecology and Hydrology (CEH), the Swedish Radiation Protection Authority (SSM), the Norwegian Radiation Protection Authority (NRPA) and IRSN. This consortium issued several recommendations of international scope, consistent with UNSCEAR and ICRP work accomplished in environmental radiation protection. The use of statistical methods, already applied to chemical substances and adapted by IRSN for working with radioactive substances, is preferred over expert opinions in determining the criteria to be applied to protecting the biodiversity of ecosystems.
To ensure protection of the structure and functioning of ecosystems, the consortium recommended that a dose rate equivalent to 10 µGy/h over the ambient background noise should not be exceeded. Research to define criteria specific to different plant and animal species is encouraged. Construction of a radiation protection system for the environment will be pursued in the IAEA EMRAS II program.

www.ceh.ac.uk/PROTECT

greater risk of leukemia in children aged from 0 to 4 living less than 5 km from a nuclear power plant in Germany has not been backed up by studies carried out in other countries. IRSN's critical review also showed that it is difficult to determine the causes of the excess incidence of leukemia observed locally mainly due to insufficient knowledge of the risk factors contributing to infantile leukemia.

ALPHA-RISK: conclusions after three years

IRSN is coordinating the European ALPHA-RISK project, organized under the 6th Framework Program. Initiated in 2005, the purpose of this project is to compile knowledge on the quantification of risks associated with multiple chronic exposures of workers to ionizing radiation. Particular focus has been given to the effects of internal contamination caused by alpha-emitting radioelements (uranium, radon, and its decay products). ALPHA-RISK brings together 18 partners from nine different countries.

The project covered cohorts of uranium miners from France, the Czech Republic, and Germany, for a total of over 50,000 miners. The study examined several topics, such as risks other than lung cancer, quantification of the risk of lung cancer associated with radon (factoring in tobacco smoking), and improvement of dose assessments on organs in miners, with help from dosimetry specialists.

ALPHA-RISK also studied workers in the nuclear industry concerned about internal contamination. Continuation of this study will focus on monitoring a cohort of workers potentially exposed to uranium in France and England.

The ALPHA-RISK project has already issued roughly 15 publications. The final report will be published at the end of 2009.
www.alpha-risk.org

More details

The EPICE Program studies possible effects of cesium contamination

The consequences of the Chernobyl accident are followed up on a population of children living in Russian contaminated territories.

In 2005, IRSN initiated a program called "EPICE" to examine pathologies induced by cesium contamination, more specifically oriented towards determining whether or not there is a link between chronic contamination by cesium-137 and the occurrence of non-cancerous pathologies in children living in Russian contaminated territories by fallout from the Chernobyl accident. In 2008, a pilot study confirmed feasibility of the program and enabled IRSN to continue with the study of cardiac arrhythmia on roughly 18,000 children living both on contaminated and uncontaminated territories in the Bryansk oblast in Russia. The study seeks to compile data on the frequency of cardiac arrhythmia and explore a possible link with chronic ingestion of food contaminated by cesium-137. After a year dedicated to establishing the protocol and procuring equipment, the screening campaign should begin in 2009, with the support of local teams.

Developing a nuclear culture based on radiation protection in the healthcare sector

Given the growing use of ionizing radiation for medical purposes and recent radiotherapy accidents, IRSN reinforced its work in this area in 2008. The Institute has developed new research approaches devoted to complications in radiotherapy treatments, prepared several assessment reports on accidents that have occurred in the hospital environment (including one on the contribution of human factors and organization to accidents), and continued developing a national database on the patient exposure, working in cooperation with the InVS.

Radiopathology

IRSN is conducting research to advance understanding of the mechanisms that cause complications suffered by certain patients following radiotherapy treatment.

Implementation of the ROSIRIS program

Radiotherapy has become an extremely complex field, with new technologies that call on particle accelerators. To define criteria capable of measuring the risk for the patient and optimize current radiotherapy protocols, the medical world needs a better understanding of the effect and severity of complications related to these treatments. The ROSIRIS experimental research program was conceived to advance knowledge on the mechanisms that cause the side effects of radiotherapy treatments. To meet this challenge, Inserm and IRSN have combined their skills in radiobiology, radiopathology, radiotherapy and physical dosimetry. In 2008, a feasibility study was initiated in two directions: first, mathematical modeling of the path traced by ionizing radiation and radiation-induced damage to tissues; second, the study of functional disturbances in irradiated tissues or organs.

Assessments in the medical field

Knowledge gained by IRSN has contributed to improving the conditions of patient exposure to ionizing radiation .

Assessment on the radiosurgery accident at the university hospital in Toulouse

This complex assessment on the impact of overexposure on patient health, requested by the ASN, was conducted by Institute experts and researchers in dosimetry, ionizing radiation physics, and radiopathology of the central nervous system. First the dosimetric impact of the calibration error on organs at risk was established for each patient, one at a time. Specialists searched for any correlation between overexposure and the clinical symptoms observed on certain patients. IRSN then compared the data from the "Toulouse cohort" with data described in scientific publications on complications observed after treating various types of pathology. The patients' overall impressions were analyzed through a questionnaire prepared by international scientific advisors.

International

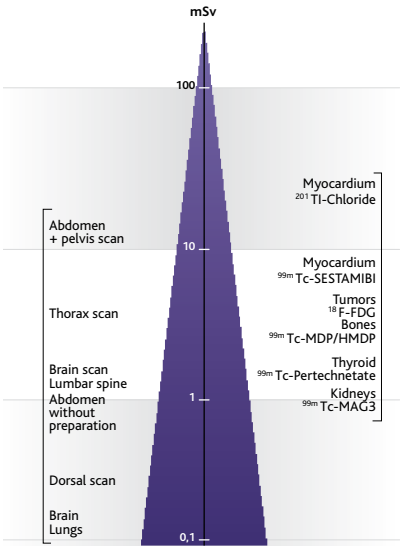
Kick-off of the CARDIORISK project

Since 2008, IRSN has been participating in the European CARDIORISK project, coordinated by the University of Munich (Germany) as part of the 7th Framework Program.

Its main goal is to study the physical and pathological mechanisms of cardiovascular diseases resulting from low-dose external exposure.

In recent epidemiological data, it appears that exposure to a cumulative dose of less than one Sievert could lead to a significant risk of cardiovascular disease. There is currently controversy over this data.

The CARDIORISK project will provide complementary experimental results on non-cancerous pathologies related to low-dose external exposure.



Order of magnitude of the effective dose (mSv) in medical imaging.

An observatory was created to compile more complete data on patient exposure in France.

This work was described in a report where IRSN expressed its recommendations on the medical follow-up of patients, changes in radiosurgery practices, and scientific follow-up of the patient cohort.
www.irsn.org

Radiotherapy treatments

In 2008, IRSN led discussions to identify what type of studies and research could be initiated to improve radiotherapy treatments in the medium term. Interviews were conducted with healthcare professionals involved in administering these treatments and several accidents were analyzed.

The conclusions of this work pointed to four lines of development:

- adapt the concepts and methods used for safety analysis in nuclear facilities to the field of radiotherapy;
- study how work organization can contribute to making sure the doses delivered comply with the doses prescribed;
- ascertain how computerization and automation affect the control that professionals exercise over treatment parameters;
- examine how the conditions in which technical devices are received and implemented have an influence on safety.

This work may contribute to discussions engaged in the "road map" project initiated in 2007 by the Ministry for Health, following several accidents that occurred during radiotherapy treatments. The goal is to define what actions could be taken in the short term to improve the safety of patients treated using this technique.
www.irsn.org

Analysis of diagnostic reference levels

Diagnostic reference levels (DRLs) serve to optimize diagnostic practices in radiology and nuclear medecine. They are established for standardized examinations and typical patients. According to the Order of February 12, 2004, IRSN is entrusted with periodically updating DRLs. For this purpose, IRSN analyzed data on doses received by patients, submitted by healthcare establishments between 2004 and 2006.
The analysis results were sent to the ASN and the Ministry for Health in March 2008 and will serve as a basis for updating DRLs.
www.irsn.org

ExPRI, an observatory for patient exposure

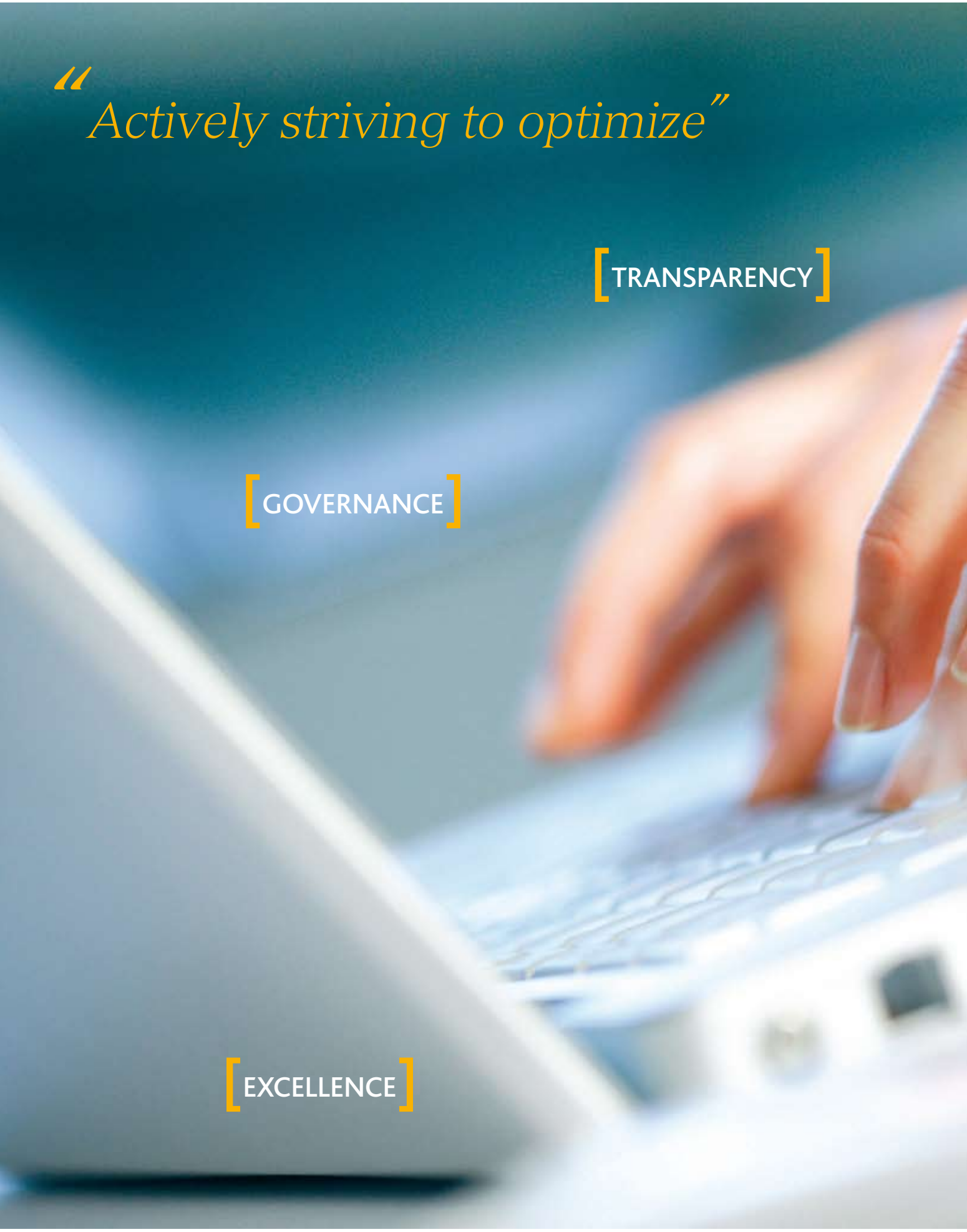
To further knowledge on medical exposure to ionizing radiation, IRSN and the InVS have spent four years working towards the creation of a national observatory named ExPRI. While information on patient examinations carried out in the private sector can be accessed through the national health insurance system, this data is not available for those treated through the public health sector.
IRSN and the InVS initiated a survey in the public sector in 2008. The results will be used to update the assessment of the average annual individual dose, to specify the distribution of delivered doses, and to establish the number of people actually exposed.

In the words of

Dominique MARANINCHI
Chairman of the French National Cancer Institute

"The radiotherapy accident that occurred at the hospital in Épinal triggered an in-depth reflection on radiotherapy in France, in terms of organization, human resources, and safety awareness. IRSN played an essential role in these discussions. Its multidisciplinary research program is designed to limit the after-effects suffered by over-irradiated patients. The aim is to reduce, or even prevent, the toxicity of radiotherapy, in both the acute phase and in the medium to long term. The program is part of a general approach to optimizing received doses by taking into account individual diversity.

In terms of training, our priority is to stimulate greater awareness among professionals of the risks involved in radiotherapy. The continuous training program conceived by IRSN will allow them to detect, report, and manage minor incidents before they can occur again."


"Actively striving to optimize"
TRANSPARENCY
GOVERNANCE
EXCELLENCE

ENSURING EFFICIENCY

A concept, an organization, a method, an outlook

After being certified in July 2007 for its quality policy based on the ISO 9001 standard (version 2000), IRSN devoted 2008 to creating and optimizing its program of total quality management.

Goals

- **To satisfy IRSN customers and partners.**
- **To maintain an excellent level of service.**
- **To benefit all members of society.**

IRSN's certification comes up for renewal in 2010, when it will need to demonstrate not only that its "quality" documentation is complete and updated regularly, but above all that its total quality management program is operating at all levels of the organization.

Getting personnel involved

The total quality management system must give each employee the incentive to improve IRSN's performance and operation. In 2008, significant efforts went towards making the entire quality system operational so that its ability to drive continuous improvement would appear to employees as clearly as the role played by the operational and functional goals set out in the Contract of Objectives.

Implementation of the Medium- to Long-term Plan in 2008 provided the opportunity to test the robustness and efficiency of the total quality management system. A large-scale project was initiated to consolidate the total quality approach within all IRSN activities. In this context, various procedures were rolled out, such as systematically listening to customer's needs, analyzing dysfunctions and complaints, writing up improvement sheets, conducting internal audits, and creating a group of accredited laboratories to standardize good practices.

More efficient and transparent practices

All process reviews were completed and the results used to prepare annual activity programs. Moreover, on the basis of experience acquired over previous years, the IRSN governance process was completely revised to incorporate actual practices, while making them more efficient and transparent.

In parallel, reflection on certain concepts in the total quality approach, such as the benefits to society, was brought to maturity.

News brief

IRSN was audited twice by LRQA, a certification authority, and no major or minor cases of non-compliance were detected.

Each employee contributes to the Institute's performance.

10 accredited laboratories
according to the ISO 17025 standard
(7 in 2007)

Setting an example

Over the past years, IRSN has pursued efforts concerning health, safety and environmental protection. At the end of the year, this process resulted in the implementation of a sustainable development project.

Goal

To ensure that anyone employed at an IRSN location is able to work under safe conditions that preserve human health.

Computerized management of radioactive sources

The year 2008 saw the implementation of a computerized application called ASISA for monitoring radioactive sources and electrical equipment, dedicated to:

- ensuring compliance between authorizations issued by authorities and the actual radioactive sources (sealed or unsealed) or electrical equipment emitting ionizing radiation held by IRSN units;
- tracing any movements of radioactive sources and electrical equipment (loan, use outside of IRSN facilities, transfer, disposal).

Reducing electric hazards

Following the accidental death by electrocution of a technician working for a subcontractor at the Fontenay-aux-Roses site on April 25, 2008, IRSN reviewed its electrical certification program. Each activity requiring electrical certification was carefully analyzed to reassess the required certification level and the associated training needs, and propose any necessary changes to existing preventive measures.

In the words of

Séverine ZALECKI

Head of IRSN's sustainable development project

"The goal of the "sustainable development" project that IRSN undertook at the end of 2008 is to provide the Institute with feedback on the impact of its work and improve its contribution to society and the environment. As a public authority, it is normal for IRSN to invest in this area so that concern for sustainable development is reflected in all of its efforts over the long term.
This project began with an initial diagnosis performed by a workgroup made up of employee representatives and members of all divisions. The proposals (policies, commitments, efforts and operational organization) that result will then be validated by the executive committee before implementation in 2010."

Renovation of the main building at the Fontenay-aux-Roses Research Center

Despite significant work completed since 2006, the main building of the Fontenay-aux-Roses site was in disrepair and out of compliance with safety regulations. Since the building structure itself was also concerned, an overall renovation plan was prepared in 2008 and presented to the Board of Directors.

News brief

IRSN defined a new policy on shared responsibility for buildings. The new rules define the geographical boundaries in which directors of research units exercise their delegation of power and responsibility regarding health, safety and the environment.

10 facilities classified for environmental protection in compliance with the Environmental Code *(10 in 2007)*

SCIENTIFIC AND TECHNICAL EXCELLENCE

Setting the benchmark in science and technology

Initiated in 2003, IRSN's policy of scientific and technical excellence aims to achieve the highest possible level in the field and have this excellence recognized by both the scientific community and IRSN partners.

Goal

To reach the highest possible scientific and technical level in all IRSN research and assessment activities, based on three major criteria of excellence:

- **scientific and technical quality of teams and results;**
- **relevance of the subjects covered;**
- **efficient organization of scientific and technical activities (methods, collaborative work, etc.).**

Cross-disciplinary scientific interaction

Two new cross-disciplinary scientific interaction groups were created in 2008 (Aerosols Club and Statistics Group). These groups provide the opportunity for IRSN researchers working on the same topics to exchange their points of view.

Exploratory research gets underway

In 2008, three research projects exploring new vistas reaching beyond established programs were added to the four initiated in 2007. A mid-point review has shown the success of these four projects, two of which will be followed up by new actions that have already been included in the IRSN programs for 2009, the two others revealing promising results. The program has established a path towards scientific excellence for IRSN and a workshop was conducted in 2008 to perpetuate and broaden its range in the coming years.

Pursuing scientific and technical assessment process

The year 2008 was marked at IRSN by the publication of the *Scientific and Technical Assessment Guide*, which specifies the basic principles and different procedures involved. The purpose is to have IRSN activities audited by experts chosen for their competence and independence, based on standard criteria, i.e., scientific quality, relevance and efficiency.

Two assessments were completed in 2008, which covered:

- work conducted by the laboratory of measurement of radioactivity in nuclear materials;
- the review conducted on "reliability of the spent fuel pool cooling system in the fuel building of EDF reactors".

Seven other assessments were also started on neutron metrology, the use of R&D on fires in probabilistic safety assessments, the influence of extreme climatic events on the distribution of radionuclides in the environment, "Radionuclide" sheets, airborne contamination, impact of probabilistic safety assessments on operator risk evaluation practices, and reflooding the reactor core in an accident situation.

Another aspect of this policy consisted of organizing the first thematic scientific council. Consisting of 11 outside experts, including nine foreigners, it met for the first time to audit IRSN's source term research.

Training through research

Recruiting of doctorate students and post-doctorate students was strengthened in 2008 with deployment of a selection system for

News brief

> In 2008, the French National Research Agency (ANR) opted to finance three of the 13 research projects proposed by IRSN. These projects involve biology, the environment and radioactive waste storage, and earthquake risk. Since its creation in 2005, the ANR has funded a total of 13 IRSN cross-disciplinary research projects, aiming to produce new knowledge while encouraging interaction between public and private laboratories by forging research partnerships.

> The 2007 Scientific and Technical Report was published in June 2008.
http://net-science.irsn.org

> On November 6, 2008, IRSN organized a science day devoted to nuclear and radiological risk.
http://net-science.irsn.org

86 doctorate students *(85 in 2007)*

50 post-doctorate students *(31 in 2007)*

20 theses defended *(18 in 2007)*

Dissertation Days at Vogüé in southern France.

College of Experts at Aix-en-Provence.

subjects and candidates. For doctorate theses, after examining the research subjects, candidates were selected by a commission formed by members from both inside and outside the Institute. In total, 25 new doctorate students joined IRSN for three-year training in various fields (ecotoxicology, radiobiology, nuclear safety, etc.). In the case of post-doctorate students, the numerous requests from research teams in 2008 made it necessary to set up a commission to select subjects in adequation with IRSN's goals to achieve scientific excellence. The number of post-doctorate students retained (30 annual full-time equivalents) corresponds to the supervision capacity of the laboratories.

The success of Dissertation Days continues to be confirmed every year. In 2008, the event brought together nearly 160 participants from IRSN, universities, CNRS, and industry, in the village of Vogüé in southern France.

Reinforcing the College of "Experts"

A second nomination campaign to elect members to IRSN's College of "Experts" added 17 experts and seven senior experts, bringing the number of members to 48.

The new members were welcomed in October in Aix-en-Provence at a College of Experts seminar where they were briefed on the previous year's work, learned about how the college operates, and defined a work program.

39 persons qualified
to supervise research
(41 in 2007)

175 publications
in scientific journals with review committees
(123 in 2007)

360 lectures
at conferences *(350 in 2007)*

In the words of

Jacques VENDEL
IRSN Senior Expert

"At IRSN we have three cross-disciplinary scientific interaction groups on Monte Carlo methods, aerosols, and calculating uncertainty, with a fourth group on droplet flow underway. The purpose of these groups is to bring together IRSN employees interested in a scientific or technical subject, whether they are experts or simply people who "need to know". Interaction during meetings allows experts to transmit knowledge by answering the questions posed by non-specialists, while also encouraging exchanges among specialists. This is an effort supported and led by the members of IRSN's College of Experts. They seek out the topics that are the most likely to interest several IRSN departments, analyze the relevance of these topics, and then drive the group dynamics. Today, these groups help spread and further knowledge at IRSN."

Supporting tomorrow's experts

At a time when the nuclear power sector is expected to expand, the generation of engineers who helped design, build, and operate current reactors and facilities is retiring, while engineering schools are having problems meeting the increasing demand for people with scientific and technical qualifications. In this context, IRSN is particularly vulnerable and must be proactive and creative to recruit and retain staff.

Goals

- **To anticipate the skills IRSN will need in the coming years and take action.**
- **To encourage the development of individual competence and pool skills to promote collective action.**
- **To ensure constructive relations between management and personnel.**

For the human resources team that proposed actions to respond quickly to changes in the job market and highlight IRSN's advantages, 2008 was an innovative year.

Participation in career fairs

After analyzing the needs of the various operational units, the Institute adopted a policy of extensive participation in "career fairs". IRSN participated in forums organized by the National Institute for Nuclear Science and Technology and the National Employment Agency for Managerial staff (Apec), as well as events such as Pollutec or the science fair held in Marseille. Efforts were focused on creating a stand that was both attractive and welcoming, to give IRSN an image that matched the expectations of potential candidates. Staff from all divisions were available to take visitors' questions and discuss careers at IRSN. Through these events and the involvement of IRSN officials in candidate selection, 103 candidates were offered positions in 2008.

New pay plan

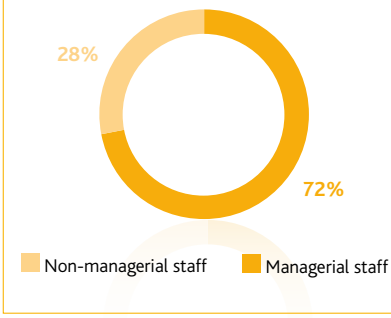
IRSN undertook important negotiations to implement a new pay plan that meets employees' expectations in terms of career advancement and the frequency and quality of recognition.
An agreement modifying the classification and pay scale for managerial staff was signed with four labor unions on April 1, 2008. According to the terms of the agreement, all staff members with managerial status can request an annual raise on an individual basis.
Supervisors can choose from a range of individual pay increases to recognize employee performance. This system, more flexible and easier to understand than the previous one, should reflect an employee's career development more adequately by facilitating recognition for accepting technical or other responsibility.

A profit-sharing agreement was signed on June 26, 2008, correlating employee compensation with IRSN's financial results and improving their overall income.
Compensation is calculated according to IRSN's activity, based on indicators representing scientific production, influence within European research, maintaining ISO-9001 certification, developing IRSN's own sources of revenue, and customer satisfaction.
For this first agreement, IRSN received permission from its supervisory ministries to provide a budget allowance representing 2% of the total gross payroll.

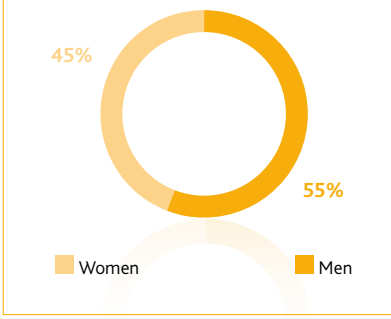
Professional training on the rise

Aware of the importance of developing the skills of their staff members, supervisors have made sure that measures in the training plan have been fully implemented, or, when neces-

Proportion of managerial/ non-managerial staff



Proportion of men/women



28% of staff composed of technicians and technical and administrative support staff *(28 % in 2007)*

103 employees recruited on permanent contracts *(90 in 2007)*

€1.6 million in training costs *(€1.3 million in 2007)*

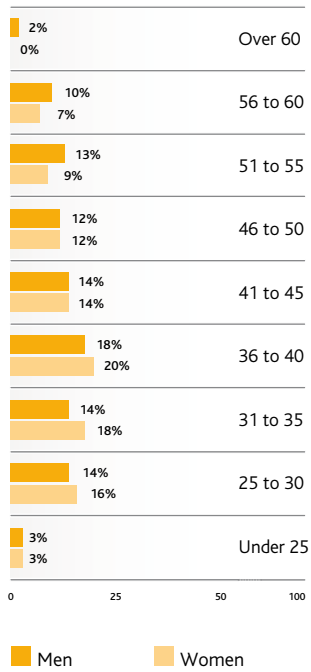
Training to develop staff skills.

sary, replaced by others that are more pertinent to actual needs. Thus, for the first time since its foundation, IRSN has used all the funds allocated to the training budget, with 48,357 hours of training taken by 2,895 staff members.

Finally, IRSN has taken a major decision regarding forecasting activities designed to preserve its skills base and provide employees with clear career paths by confirming a project to predict staff and skills requirements, which should be implemented within the next two years.

IRSN personnel contracted out or seconded (as of December 31, 2008)

Age pyramid



48,357 hours of training *(52,773 in 2007)*

2,895 training programs completed *(2,926 in 2007)*

72% of staff are engineers, researchers and managers *(72% in 2007)*

In the words of

Élisabeth CARON

Director of Human Resources, INERIS

« For almost ten years, about fifteen human resource directors from public authorities pursuing industrial and commercial activities have come together four times a year for informal discussions on best practices for developing human resources. During these meetings, we deal with problems we have in common by taking advantage of each other's experience in all aspects of our functions – career management, skills development, mobility, training, salary, etc. It was in this context that IRSN presented us with its College of Experts. The advantage of this approach is to enhance technical and scientific expertise by proposing non-managerial career prospects. This is an issue that concerns us all, since experts are what gives purpose to these public authorities. Today, after a meeting with IRSN's human resources team, we are working internally to set up a similar project adapted to the needs of our institution. »

Transparency, education, responsiveness, visibility and global presence

Risk prevention begins with information. IRSN's communication efforts in 2008 were therefore directed at providing better information to those working in the nuclear sector as well as the general public who are interested in issues involving nuclear safety, nuclear security, and protection from ionizing radiation.

Goals

- To provide the media with transparent and detailed information.
- To present more instructive and accessible information to the public.
- To improve responsiveness in communication and information in emergency situations.
- To give greater visibility to IRSN research conducted to support assessment activity.
- To promote IRSN's international activities.

Better communication for greater transparency

As an independent public expert, IRSN is committed to communicating as openly as possible, expressing the viewpoint of a technical safety organization in coordination with other nuclear stakeholders, including government authorities, safety authorities, industry, etc. With this in mind, IRSN has expanded the content of its website to include current events and major topics (more than 70 current events, along with over 30 press releases and information notices published in 2008). In coordination with the French nuclear safety authority (ASN), in 2008 IRSN also decided to give Internet coverage to summaries of technical opinions that it delivered to standing expert groups in which it participates, while complying with the applicable rules of confidentiality.

Open-house at Fontenay-aux-Roses.

Providing comprehensible information

Information must not only be transparent, but also comprehensible to be useful to the ordinary citizen. IRSN's communications department therefore sought to enhance the educational aspect of its materials. In reports on the incidents at Socatri, results of environment measurements were presented using maps for easier interpretation.

Traveling exhibition on *Nuclear Power and Society, from Knowledge to Control*

4,000 visitors
(4,400 in 2007)

IRSN likewise planned to completely revise its Internet site in 2009, building it around major topics (nuclear facilities, environment, health, etc.) and user profile (general public, professionals, scholars, etc.) to respond more effectively to the needs of its different audiences.

1,100,000 pages
consulted on the IRSN website
(900,000 in 2007)

205,000 pages
consulted on IRSN's scientific website
(135,000 in 2007)

Exhibition at the Grand Palais in Paris.

Inform more quickly

In the context of increased media coverage of events such as radiotherapy accidents and the effluent release incidents at the Socatri plant, IRSN has endeavored to collect, organize and circulate reliable and detailed data and analyses very rapidly to respond to requests from government authorities, safety authorities, associations, and the media. At the same time, IRSN has also processed about one thousand requests for information received throughout the year via its Internet contact link, keeping a line open with the public on a daily basis. These changes reflect the growing importance of current events and public questions, which today represent an increasing portion of IRSN's communication effort.

Explain the knowledge gained by IRSN from research

Illustrating the relationship between research and assessment activities at several of its facilities or during various public events was the main theme of IRSN's communication efforts in 2008. During a science fair, IRSN invited the public to visit its laboratories at Fontenay-aux-Roses, and organized open-house events in the Tournemire experimental center to demonstrate the experiments performed there. At Vésinet it presented work in progress at its new laboratory for radiophotoluminescent dosimetry.

Support for IRSN's efforts abroad

In 2008, the IRSN communications department served IRSN's increasing international development by promoting the standardization of technical safety practices through the EUROSAFE Forum of nuclear safety experts, organized by the Institute in Paris the same year.

12 conferences organized *(8 in 2007)*

4 trade fairs or public events where IRSN participated *(3 in 2007)*

270 press requests processed *(200 in 2007)*

1,000 press mentions *(720 in 2007)*

Selected events in 2008

> **November 6**: Presentation at the Institut Henri Poincaré in Paris of IRSN's main research programs on nuclear and radiological risk management.

> **November 14-16**: IRSN's contribution to the European City of Science at the Grand Palais in Paris in the context of the French presidency of the European Union.

> **November 21-22**: IRSN participated in the Marseille Science Fair, under the French presidency of the European Union.

IRSN also took part in the traveling exhibition *Nuclear Power and Society: from Knowledge to Control* (in Saint-Germain-en-Laye, Lyon and Auch), organized in conjunction with the ASN, and many trade fairs such as Pollutec, Medec and the radiology event *Journées françaises de radiologie*.

Glossary

_ A

ADEME
Agence de l'environnement et de la maîtrise de l'énergie (French agency for the environment and energy control)

AFNI
Agence France Nucléaire International (French international nuclear agency)

AFSSA
Agence française de sécurité sanitaire des aliments (French agency for safe food consumption)

AFSSAPS
Agence française de sécurité sanitaire des produits de santé (French agency for the safe use of health products)

AFSSET
Agence française de sécurité sanitaire de l'environnement et du travail (French agency for environmental and occupational health protection)

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)

ANCLI
Association nationale des commissions locales d'information (French national association of local information committees)

ANDRA
Agence nationale pour la gestion des déchets radioactifs (French national radioactive waste management agency)

ASTEC
Accident Source Term Evaluation Code

AVN
Association Vinçotte nucléaire (Vinçotte nuclear association, Belgium)

_ 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

BRGM
Bureau de recherches géologiques et minières (French institution for research in Earth sciences)

_ C

CABRI
Test reactor used by IRSN (CEA) to study nuclear fuel safety

CANDU
Canadian deuterium-uranium reactor

CATHARE
Thermal-hydraulic computer code used to study the behavior of pressurized water reactors during accident situations

CELLULAR PLASTICITY
The ability of a cell to change into another type of cell

CESIUM (Cs, atomic number 55)
Toxic rare metal with characteristics comparable to those of potassium

CESTA
Centre d'études scientifiques et techniques d'Aquitaine (center for technical and scientific studies in Aquitaine) (CEA)

CHIP
CHIP: Program to study the chemistry of gaseous phase iodine in a PWR reactor coolant system in a core meltdown accident situation

CIGEET
Commission for information on the major energy facilities at Tricastin

CNPP
Centre national de prévention et de protection (French national center for prevention and protection)

CONTAINMENT OR REACTOR BUILDING
Sealed concrete structure containing the

reactor vessel, reactor coolant system, steam generators and safety-related auxiliaries for a pressurized water reactor

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

CTICM
Centre technique industriel de la construction métallique (French industrial technical center for metal construction)

CYTOGENETICS
Biological technique used to study chromosome anomalies in cells

_ D

DIVA
Facility used to study fire, ventilation and airborne contamination

DOE
Department of Energy (USA)

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

DOSIP
Passive individual dosimetry

_ E

EADS
European Aeronautic Defense 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

EPR
European Pressurised water Reactor

ERMSAR
European Review Meeting on Severe Accident Research

ETSON
European Technical Safety Organisations Network

EURATOM
European atomic energy community

EUROSAFE
International conference co-organized by IRSN and its German and Belgian counterparts, GRS and Bel V, to promote the standardization of technical safety practices in Europe

_ F

FMBA
Federal Medical Biophysical Agency – Russian radiation protection agency

FMBC
Federal Medical Biophysical Centre. Provides technical support to the Russian FMBA

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

GALICE
Management system featuring a limited increase in fuel irradiation during operation

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

GP MED
Radiation protection standing committee for medical and forensic applications of ionizing radiation

GP RAD
Radiation protection standing committee for industrial and research applications of ionizing radiation

GRS
Gesellschaft für Anlagen- und Reaktorsicherheit (German technical safety organization)

GWd/t
Fuel burnup unit. Gigawatt-hours per metric ton of fuel. Commonly used unit of measure giving the level of irradiation of fuel assemblies, expressed as energy output by the assembly in the reactor per ton of the initial uranium

_ H

HAO
High activity oxide workshop at the UP2-400 plant in La Hague

HCTISN
Haut comité pour la transparence et l'information sur la sécurité nucléaire (French high committee for transparency and information on nuclear safety)

HLEG
High-level Expert Group on European low-dose research

_ I

IAEA
International Atomic Energy Agency

ICRP
International Commission on Radiation Protection

IFREMER
Institut français de recherche pour l'exploitation de la mer (French research institute for exploitation of the sea)

INB
Basic nuclear installation

INBS
Basic nuclear installation classified as confidential for defense purposes

INERIS
Institut national de l'environnement industriel et des risques (French national institute for the study of industrial environments and risks)

INRS
Institut national de recherche et de sécurité (French national institute for research on safety)

InVS
Institut national de veille sanitaire (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

_ K

kV
KiloVolt

_ L

LRQA
Lloyd's Register Quality Assurance Ltd., a certification organization

_ M

M5®
Type of fuel cladding used in pressurized water reactors, with alloy developed by Areva

MEDICAL DEVICE VIGILANCE SYSTEM
Monitoring of incidents and incident risks that may result from the use of commercially available medical devices. It accompanies the implementation of new rules on marketing medical devices adopted by the Member States of the European Union

MELODIE
Modèle d'Évaluation à LOng terme

des Déchets Irradiants Enterrés (model for long-term assessment of buried radioactive waste)

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

mGy (milliGray)
Unit of radiation absorbed dose used in the international system

MSC (mesenchymal stem cells)
Cells taken from bone marrow that can multiply and differentiate into a variety of cell types

mSv (milliSievert)
Unit of equivalent dose used in the international system

MWe
Megawatt electric

_ N

NEA
Nuclear Energy Agency (OECD)

NPP
Nuclear power plant

NRC
Nuclear Regulatory Commission (USA)

NRPA
Norwegian Radiation Protection Authority

NSRR
Nuclear Safety Research Reactor (Japan)

NUCLEAR FUEL
Material capable of undergoing fission used in a reactor to develop a nuclear chain reaction. Nuclear fuel that has been irradiated in and permanently removed from a reactor core is referred to as "spent fuel"

_ O

OECD
Organisation for Economic Co-operation and Development

OPCW
Organisation for the Prohibition of Chemical Weapons

ONERA
Office national d'études et de recherches aérospatiales (French national office of aerospace studies and research)

_ P

PATRICIA
Loop for the study of thermal-hydraulic materials related to propulsion reactors (CEA)

PBMR
Pebble Bed Modular Reactor, high-temperature reactor technology and name of the company that designed it

PCR
Radiation protection specialist

PHÉBUS
Experimental reactor

PRISME
Fire propagation in elementary, multiple-enclosure scenarios

PROTECT
Protection of the environment from ionizing radiation in a regulatory context

PSA
Probabilistic Safety Assessment

PSI
Paul Scherrer Institut, Villigen (Switzerland)

PUI
Internal emergency plan

_ R

RADIOELEMENT
Natural or artificial radioactive element

RADIONUCLIDE
Radioactive isotope of an element

RADIATION PROTECTION
Any action taken to protect the population and workers against sources of ionizing radiation

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

SESAME4
Accident situation progression plan and assessment methods, an information system developed by IRSN for its emergency response center

SIGIS
Système d'Information et de gestion de l'inventaire national des sources de rayonnements ionisants (French information system used to manage the national inventory of radioactive sources)

SISERI
Information system for monitoring exposure to ionizing radiation

SNETP
Sustainable Nuclear Energy Technology Platform

SSM
Swedish radiation safety authority

_ T

TACIS
Technical Assistance for the Commonwealth of Independent States (European program)

TSO
Technical Safety Organisation

_ U

UF_6
Uranium hexafluoride

UJV
Ústav Jaderného Výzkumu Řež a.s. (Czech nuclear safety research institute)

UNSCEAR
United Nations Scientific Committee on the Effects of Atomic Radiation

_ V

VTT
Valtion Teknillinen Tutkimuskeskus (engineering research center in Finland)

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

_ Z

ZIRCALOY-4
Alloy used for fuel assemblies in pressurized water reactors

ZIRLO
Alloy developed by Westinghouse

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

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IRSN

INSTITUT
DE RADIOPROTECTION
ET DE SÛRETÉ NUCLÉAIRE

2008
Annual Report

Contents

Management report

1 _GENERAL OUTLOOK

The year 2008 focused on deployment of the Medium- and Long-term Management Plan, prepared in concert with all of IRSN's partners. Important milestones were reached in terms of our economic objectives:

- special measures were taken to allocate €5 million to the fund for remediation and dismantling of nuclear facilities, following the decision to shut down the PHÉBUS experimental reactor;
- investment was pursued to renew and optimize environmental monitoring equipment and to acquire mobile units for emergency response operations;
- state property located in Fontenay-aux-Roses, referred to as "the Annex", was recorded in the Institute's accounts, representing a total surface area of 33,227 m², subsequent to the grant attributed by the government on November 29, 2006, published officially on December 29, 2006.

In another area, an employee profit-sharing agreement was signed in 2008 with labor unions representing Institute personnel. According to the terms of the agreement, the first payment will be made in June 2009.

Lastly, the Board of Directors was renewed and a new president nominated.

The initial 2008 budget was modifed by an amendment (DM1) presented to the Board of Directors in June to take into account the following:

- investment projects in progress carried over from 2008, representing €19.6 million, paid into working capital when accounts were closed in 2007;
- adjustment of the grant allocated by the Ministry of Ecology, concerning both the change in the precautionary reserve level, and Amendment II 23 voted by the National Assembly;
- a change in expediture for the CABRI project, financed by drawing from the Institute's working capital;
- beginning of dismantling of the PHÉBUS reactor, which revealed the need to accelerate financing for remediation and dismantling of nuclear facilities.

Budget execution in 2008 involved a vast investment program totaling €42.9 million, including operations carried over from the previous year, which covered the following:

- the final phase of changing the technology used in worker dosimetry monitoring;
- continuation of the equipment renewal program (mobile emergency units, national monitoring and measurement system, etc.) and upgrading of the CABRI reactor (IRSN equipment);
- continued, gradual building of a fund allocated to financing future costs for dismantling and remediation, the total cost of which is currently being revised. The result of this revision will be incorporated in 2009 accounts by updating the provision created for this purpose and adjusting the corresponding dismantling asset.

All of these investments were not completed during the fiscal year, and a proposal to carry over €10.2 million for operations in progress will be proposed in a budget amendment to modify the projected revenue and expenditure statement for 2009.

The accounts closed in 2008 recorded two exceptional operations that had no impact on the income statement:

- the Fontenay-aux-Roses site was added to the Institute's assets, representing a grant for a value of €4.2 million (see above);
- an unallocated grant of €8.8 million appearing on the transfer balance sheet when IPSN became IRSN, was transferred to reserves.

2 _BUDGET BALANCE

Execution (in € millions)	2006[1]	2007[2]	2008[3]	Difference 2008/2007
Total resources	306.9	298.4	255.2	–14.4%
Total expenditure	301.7	265.8	281.2	+5.8%
Balance	+5.2	+32.6	–26.0	–179.8%

[1] Results for 2006 include €31 million in dismantling expenditure balanced by a provision for the same amount in revenue.

[2] 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.

[3] 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 surplus of €5 million added to the dismantling fund on the other.

Budget execution in 2008, as in previous years, shows a budget balance that appears to be magnified by the €10.2 million in investments carried over, minus the impact of the net withdrawal of €15 million from this year's grant. Recalculating to take into account these operations gives the following results:

Recalculated execution (in € millions)	2007	2008
Balance	+32.6	–26.0
2006 carryover	+15.2	-
2007 carryover	–19.6	+19.6
2008 carryover	-	–10.2
Special operations	–21.0	+15.0
Net balance	+2.2	–1.6

In spite of the special operations involving a value-added tax adjustment and the fund dedicated to dismantling, which distort the budget comparison, the year 2008 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 92.5% (compared to 93.1% in 2007), i.e. a difference of €24.4 million, of which €10.2 million corresponds to an offset in the execution of certain investments. Not including these offsets, the budget execution rate would be 95.6%.

3 _INCOME STATEMENT ANALYSIS

3.1 _Revenue

Execution (in € millions)	2006	2007	2008	Difference 2008/2007
Sales	35.1	31.8	31.8	0%
Grants	233.4	190.6	195.5	+2.6%
Other operating revenue	3.3	22.7	3.9	–82.8%
Operations sub-total	271.8	245.1	231.2	–5.7%
Investment income	1.6	4.0	3.7	–7.5%
Extraordinary revenue	2.0	33.4	6.4	–80.8%
Total	275.3	282.5	241.3	–14.5%

> Operating revenue dropped by €13.9 million (–5,7%) in comparison with the previous fiscal year, reaching €231.2 million, with:

- €191.4 million from the public service grant paid by the Ministry of Ecology. The total in government grants received for Budget Program 189 reached €212.6 million, of which €21.2 million was recorded as a capital grant. The difference with the grant appearing in the initial Budget Act was the result of a €15 million reduction allowed to adjust the value-added tax recorded the previous year, to the amount of €20 million, minus an additional allowance granted to accelerate financing of the fund dedicated to remediation and dismantling of nuclear facilities. This operation occurred too late in the year to be invested, so the €5 million for this special fund was accounted for in working capital and will be recorded differently in the 2009 budget;
- €3.3 million from the agreement signed with the Ministry of Defense as part of Budget Program 212, the same level as in 2007;
- €0.7 million from other subsidies, including local government authorities, as compared with €0.8 million in 2007;
- €31.8 million of self-generated revenue from consultancy services, co-funding of research programs, or other services, steady as compared to 2007;
- €3.9 million in other operating revenue (€22.7 million in 2007), equivalent to 2006. This amount includes fees paid for industrial property (€0.1 million, steady), other operating income (€0.6 million, declining) resulting from adjustments

made in previous years, as well as write-backs on depreciation and provisions (€3.3 million). The sharp decline in the last item is explained by the fact that early retirement expenses entailed by the Capron agreement and risks related to the Institute's financial situation with regards to the business tax no longer appeared in this year's budget.

> Financial income, which reached €3.7 million, was slightly lower than in 2007 (–€0.3 million).

> Extraordinary revenue declined significantly to €6.4 million, compared to €33.4 million in 2007. It consisted mainly of capital grants recorded in the income statement to the amount of €6.2 million. The exceptional peak recorded in 2007 was due to tax adjustments.

3.2 _Expenditure

Execution (in € millions)	2006	2007	2008	Difference 2008/2007
Purchases	125.5	107.2	116.1	+8.3%
Personnel	109.6	111.9	110.4	–1.3%
Taxes	11.1	13.4	12.4	–7.5%
Depreciation	15.3	16.5	17.5	+6.1%
Provisions	7.0	0.3	1.4	+366.7%
Others	1.0	1.6	1.2	–25.0%
Operations sub-total	269.5	250.9	259.0	+3.2%
Financial charges	0.3	0.4	0.7	+75.0%
Extraordinary charges	0.6	0.3	0.3	-
Total	270.5	251.6	260.0	+3.3%

> Operating expenses for the year amounted to €259 million, up by €8.1 million, or +3.2%. This variation was concentrated mainly in purchases, and breaks down as follows:

- personnel charges decreased by 1.3% to €110.4 million. This reduction is the result of controlled pay rises combined with the considerable structural impact of new recruits who joined the Institute during the year. This recruiting effort, particularly strong at the beginning of the year, is explained by tension on the job market in the nuclear sector, as the construction of new power plants is expected to stimulate activity on both the domestic and international market. A large number of employees also retired in 2007 (through the Capron agreement), entailing extraordinary charges amounting to roughly €2 million. In spite of the economic downturn, at the end of the year the workforce totaled 1,478 employees on permanent contracts, slightly higher than the 1,476 employees recorded at the end of 2007;
- taxes amounted to €12.4 million, down by €1 million, due to the declining tax base for the employment tax;
- depreciation rose by 6.1%, reaching €17.5 million, whereas provisions, allocated mainly to the employee profit-sharing plan, increased by €1.1 million compared to 2007;
- purchasing of goods and services rose significantly by €8.9 million (up 8.3%) to €116.1 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 €1.2 million, as opposed to €1.6 million in 2007.

Execution (in € millions)	2006	2007	2008	Difference 2008/2007
60 - Purchases	68.0	55.0	62.9	+14.4%
61 - Outside services	39.3	36.9	35.4	–4.1%
62 - Other outside services	18.2	15.3	17.8	+16.3%
Total	125.5	107.2	116.1	+8.3%

This table breaks down the year's outside expenses, which amount to €116.1 million. It highlights the following:

- the steep rise in Purchases (Item 60) and Other outside services (Item 62), up by 14.4% and 16.3% respectively, resulting mainly from growth in activity (subcontracting to CEA, temporary employees, etc.);
- the slight decline in Outside services (Item 61), down by 4.1%, explained by efforts to control costs on operations included under this heading, not directly involved in carrying out the Institute's mission (general subcontracting, maintenance, rentals, etc.).

> Financial charges progressed from €0.4 million to €0.7 million due to interest paid on loans (€7.2 million + €4.8 million + €5.6 million + €2 million) to finance the Institute's new headquarters and new dosimetry technology, along with losses on currency exchange operations, in particular those involving the Japanese yen and the American dollar.

> Extraordinary charges remained steady at €0.3 million.

4 _RESULTS AND FINANCING

Execution (in € millions)	2006	2007	2008	Difference 2008/2007
Result	4.9	31.0	–18.7	–160.3%
Cash provided by operations	22.4	26.7	–9.3	–134.8%
Variation in working capital	5.2	32.6	–26.0	–179.7%

> The net balance for the year shows a deficit of €18.7 million, as compared to profits of €31 million in 2007. The difference between the revised forecast in the budget amendment, predicting a deficit of €25.8 million, and the accounts at closing on December 31, 2008 is €7 million, which is explained by a favorable balance between:

- a decline in income estimated at €12.6 million, resulting from the €15-million reduction in the public service grant allocated by the Ministry for Ecology on one hand, and the €2.6 million of revenue generated by the Institute on the other, partially compensated by a €1-millon increase in financial income and a €4-million rise in extraordinary revenue (write-back on capital grants);
- a decrease in charges estimated at €19.6 million, resulting from a combined drop in personnel charges and purchases for a total amount of €19.6 million, with fluctuations in other items cancelling each other out. Part of this operating budget, amounting to €4.6 million, was transferred to the investment budget.

> Cash provided by operations, budgeted at –€14.3 million in the budget amendment, reached –€ 9.3 million, a positive difference of €5 million, resulting from:

- a €7-million improvement in income;
- an increase in the portion of capital grants included in the income statement, representing €3.7 million,
- a depreciation differential of €1.4 million;
- a decline in provision write-backs amounting to €0.3 million.

This €9.3-million deficit in cash was compensated by the following payments:

- outside resources (€2.3 million), including a €2.1-million loan to finance deployment of the new dosimetry technology;
- the portion of the public service grant paid by the Ministry for Ecology allocated to capital grants (€21.2 million).

The resulting total resources only covered part of investment and financial charges, which amounted to €40.1 million. The additional €26 million required for financing was drawn from working capital.

Investment projects in progress, for a total amount of €45.4 million, including the €4.6 million transferred from the operating budget, were executed up to 77.5% (€35.2 million). The difference of €10.2 million was carried over to fiscal year 2009, which will be proposed in the 2009 budget amendment.

5 _BALANCE SHEET ANALYSIS

5.1 _Liabilities

> During the period, two adjustments were made to "Allowances", the first being the €8.8 million allowance transferred from CEA accounts to "Reserves", and the second being the Fontenay-aux-Roses site written into the Institute's assets to the amount of €4.2 million. After recording these movements, with an €18.7-million loss, the net result was down by 16.1%, reaching €76.2 million. Given the additional capital grant recorded (see para. 3.1 above), this item rose by €14.9 million. Since contingency and loss provisions were reduced to €1.9 million, the Institute's long-term capital declined only slightly to €161.7 million, as compared to the €163.2 million figure of 2007.

> Short- and medium-term debt, for the amount of €106.2 million, as opposed to €87.8 million in 2007, rose due to the increase in accounts payable to suppliers (up by €20.3 million). The rest of the variation is explained by reimbursement of existing loans (–€0.8 million), tax and social liabilities (+€0.3 million), other liabilities (–€0.7 million) and prepaid income (–€0.7 million).

5.2 _Assets

> Fixed assets increased to €135.6 million (up by €23.7 million), due to continued renewal of IRSN facilities and equipment, and incorporation of the Fontenay-aux-Roses site in the Institute's assets (see para. 5.1 above).

> Current assets receded to €132.3 million, compared to €139.1 million in 2007, subsequent to clearing tax debt, which amounted to €41 million last year, for VAT payable for the period from 2005 to 2007, counterbalanced by a €23-million rise in liquidities. The rest of this fluctuation consists essentially of a rise in "customer receivables" for €4.7 million and a drop of €2.7 million in advances on orders.

CONCLUSION

> The 2008 budget was executed within the forecasted budget balance presented to the Board of Directors.

> Liquidity movements decided after revising the Institute's fiscal situation have now been completed, with the withdrawal recorded at the end of 2008.

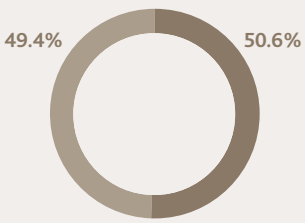
> The withdrawal from working capital amounted to €26 million, which includes withdrawals spread out throughout 2009 representing €5 million for the special remediation and dismantling fund, €1.2 million for the employee profit-sharing plan and €10.2 million for carryover of investment projects in progress. The last two operations are movements that will be incorporated in the 2009 budget amendment, the withdrawal for the special remediation fund appearing already in the initial budget.

> The contribution to the dismantling and remediation fund, set at €1.1 million every year, is now insufficient, given the decision to shut down the PHÉBUS experimental reactor, confirmed by the Atomic Energy Committee. The first exceptional contribution of €5 million was carried out in 2008 to finance work planned for 2009. The remaining amount to be financed to cover work in 2010, 2011 and 2012 is currently estimated at €20.5 million, which will require another exceptional contribution as soon as possible.

Balance sheet

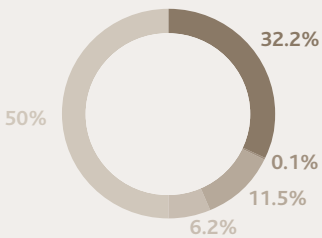
> ASSETS

In euros			2008	2007	2006
	Gross	Depreciation & provisions	Net	Net	Net
Intangible assets	15,180,181.45	11,925,797.14	3,254,384.31	2,136,430.05	2,618,231.40
Tangible assets	216,343,972.77	89,084,222.56	127,259,750.21	106,598,815.35	94,405,259.93
Financial assets	5,115,702.80	-	5,115,702.80	3,158,525.44	2,139,011.49
Fixed assets	**236,639,857.02**	**101,010,019.70**	**135,629,837.32**	**111,893,770.84**	**99,162,502.82**
Inventory and work in progress	-	-	-	-	-
Prepayments and advances on orders	431,094.07	-	431,094.07	3,200,128.34	142,937.41
Accounts receivable	46,732,526.49	22,992.36	46,709,534.13	73,808,863.09	26 478,214.01
customer receivables	*30,520,429.27*	*22,992.36*	*30,497,436.91*	*25,816,309.97*	*24,546,800.04*
related receivables	*16,212,097.22*	-	*16,212,097.22*	*47,992,553.12*	*1,931,413.97*
Other receivables	3,689.80	-	3,689.80	45,159.22	-
Investment securities	75,854,958.53	-	75,854,958.53	49,913,075.86	85,092,342.32
Cash	9,297,888.40	-	9,297,888.40	12,140,939.23	5,254,892.15
Prepaid expenses					
Current assets	**132,320,157.29**	**22,992.36**	**132,297,164.93**	**139,108,165.74**	**116,968,385.89**
GRAND TOTAL	368,960,014.31	101,033,012.06	267,927,002.25	251,001,936.58	216,130,888.71



Assets

- Fixed assets €**135.6 million**
- Current assets €**132.3 million**

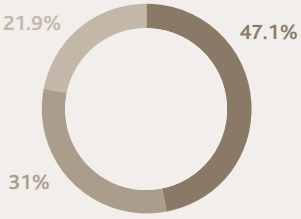


Current assets

- Cash and cash equivalents €**85.2 million**
- Prepayments €**0.4 million**
- Customer receivables €**30.5 million**
- Other receivables €**16.2 million**
- Current assets €**132.3 million**

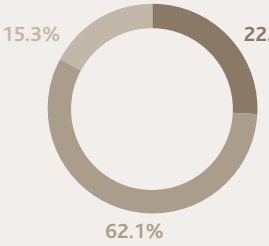
> LIABILITIES

In euros	2008	2007	2006
Allowances	4,183,945.65	8,782,859.59	8,782,859.59
Reserves	90,783,098.42	51,083,266.14	46,222,746.95
Retained earnings	-	-	-
Fiscal year profit or loss	–18,724,287.79	30,963,852.03	4,860,519.19
Net position	**76,242,756.28**	**90,829,977.76**	**59,866,125.73**
Capital grants	50,013,274.68	35,091,137.98	6,547,264.28
Equity	**126,256,030.96**	**125,921,115.74**	**66,413,390.01**
Contingency provision	1,978,000.00	2,109,000.00	2,013,000.00
Provision for taxes due	177,000.00	177,000.00	15,375,369.57
Loss provision	33,294,000.00	35,011,000.00	38,285,000.00
Contingency and loss provision	**35,449,000.00**	**37,297,000.00**	**55,673,369.57**
Bank borrowings	14,429,135.32	15,183,905.42	11,012,752.99
Various debts and liabilities	190.50	190.50	190.50
Prepayments and advances on orders	-	-	2,432,850.45
Trade notes and accounts payable	58,826,534.14	41,835,202.76	44,716,299.49
Tax and social liabilities	24,015,522.27	23,748,397.96	24,085,228.42
Other operating liabilities	-	130,669.38	-
Payables to fixed asset suppliers and related accounts	7,197,842.14	3,845,582.51	9,042,920.05
Other liabilities	1,752,746.92	2,373,871.64	2,753,887.23
Prepayments and accrued income	-	666,000.67	-
Liabilities	**106,221,971.29**	**87,783,820.84**	**94,044,129.13**
GRAND TOTAL	267,927,002.25	251,001,936.58	216,130,888.71



Long-term capital

- Net position €**76.2 million**
- Capital grant €**50 million**
- Provisions €**35.5 million**



Liabilities

- Tax and social liabilities €**24 million**
- Trade payables €**66 million**
- Other liabilities €**16.2 million**

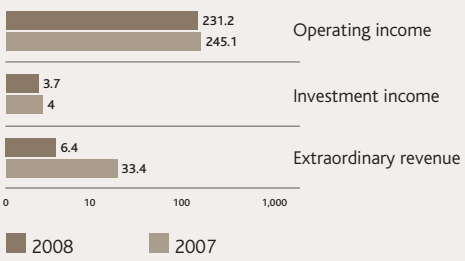
Income statement

In euros	2008	2007	2006
Research work	11,165,866.34	11,600,446.57	12,331,633.33
Service contracts	14,937,300.43	14,965,765.23	17,816,377.00
Other services provided	5,720,848.65	5,281,978.47	4,946,515.75
Net revenue	**31,824,015.42**	**31,848,190.27**	**35,094,526.08**
Operating grants	195,447,206.52	190,599,016.47	233,413,984.22
Write-backs on depreciation and provisions	3,270,980.62	18,653,925.36	2,770,683.10
Expense transfer	128,863.34	206,282.73	24,721.71
Other income	553,067.57	3,782,854.33	457,815.11
Operating income	**231,224,133.47**	**245,090,269.16**	**271,761,730.22**
Outside expenses for the fiscal year	116,148,653.80	107,093,251.77	125,464,361.29
Taxes, duties, and similar payments	12,373,634.74	13,397,986.18	11,117,320.62
Personnel expenses	110,426,772.00	111,865,157.14	109,618,595.41
Depreciation & provisions	18,924,712.32	16,806,211.72	22,295,556.87
Other expenses	1,179,411.04	1,618,502.86	1,053,293.40
Operating expenses	**259,053,183.90**	**250,781,109.67**	**269,549,127.59**
OPERATING INCOME	–27,829,050.43	–5,690,840.51	2,212,602.63
From controlled entities	-	-	-
Other interest income	24,566.87	26,907.87	52,762.66
Foreign exchange gains	38,754.50	11,803.62	12,011.51
Gains on sales of short-term investments	3,627,624.62	4,013,420.35	1,506,850.89
Investment income	**3,690,945.99**	**4,052,131.84**	**1,571,625.06**
Interest expense	564,466.81	347,426.62	319,792.03
Foreign exchange losses	153,739.95	77,998.99	3,627.22
Losses on sales of short-term investments	-	-	-
Financial charges	**718,206.76**	**425,425.61**	**323,419.25**
FINANCIAL INCOME	2,972,739.23	3,626,706.23	1,248,205.81
INCOME BEFORE EXCEPTIONAL ITEMS	–24,856,311.20	–2,064,134.28	3,460,808.44
Gains on sales of assets	-	500.00	-
Capital grants recorded in fiscal year's income statement	6,286,126.30	2,427,906.30	1,958,340.98
Capital grants strictly for the period	46,879.34	143,500.00	28,163.26
In operations	88,447.78	30,803,312.89	26,822.62
Extraordinary revenue	**6,421,453.42**	**33,375,219.19**	**2,013,326.86**
In operations	222,636.97	311,692.69	263,442.72
Book value of assets sold and other capital losses	66,793.04	35,540.19	350,173.39
Depreciation & provisions	-	-	-
Extraordinary charges	**289,430.01**	**347,232.88**	**613,616.11**
EXTRAORDINARY INCOME	6,132,023.41	33,027,986.31	1,399,710.75
Minimum tax on corporations	-	-	-
Income tax	-	-	-
FISCAL YEAR INCOME	–18,724,287.79	30,963,852.03	4,860,519.19

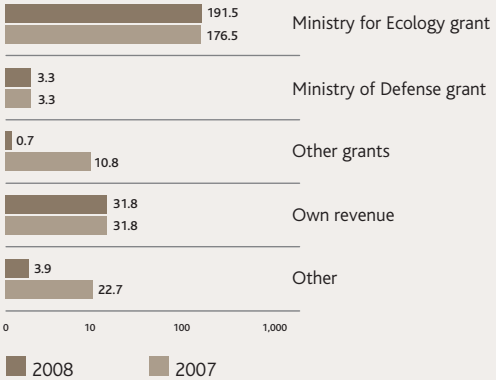
Income statement subtotals

CAPTIONS	31/12/2008	%	31/12/2007	31/12/2006
Sales	31,824,015.42	14.00%	31,848,190.27	35,094,526.08
+Operating grants	195,447,206.52	86.00%	190,599,016.47	233,413,984.22
FISCAL YEAR PRODUCTION	**227,271,221.94**	**100.00**	**222,447,206.74**	**268,508,510.30**
–Outside expenses	116,148,653.80	51.11%	107,093,251.77	125,464,361.29
ADDED VALUE	**111,122,568.14**	**48.89%**	**115,353,954.97**	**143,044,149.01**
–Taxes	12,373,634.74	5.44%	13,397,986.18	11,117,320.62
–Personnel expenses	110,426,772.00	48.59%	111,865,157.14	109,618,595.41
OPERATING INCOME BEFORE INTEREST, DEPRECIATION AND AMORTIZATION	**–11,677,838.60**	**–5.14%**	**–9,909,188.35**	**22,308,232.98**
+Write-backs, expense transfer	3,399,843.96	1.50%	18,860,208.09	2,795,404.81
+Other income	553,067.57	0.24%	3,782,854.33	457,815.11
–Depreciation & provisions	18,924,712.32	8.33%	16,806,211.72	22,295,556.87
+Write-back on capital grants	6,286,126.30	2.77%	2,571,406.30	1,986,504.24
–Other expenses	1,179,411.04	0.52%	1,618,502.86	1,053,293.40
OPERATING INCOME	**–21,542,924.13**	**–9.48%**	**–3,119,434.21**	**4,199,106.87**
+Investment income	3,690,945.99	1.62%	4,052,131.84	1,571,625.06
–Financial charges	718,206.76	0.32%	425,425.61	323,419.25
INCOME FROM CONTINUING OPERATIONS BEFORE INCOME TAXES	**–18,570,184.90**	**–8.17%**	**507,272.02**	**5,447,312.68**
+Extraordinary revenue	135,327.12	0.06%	30,803,812.89	26,822.62
–Extraordinary charges	289,430.01	0.13%	347,232.88	613,616.11
EXTRAORDINARY INCOME	**–18,724,287.79**	**–8.24%**	**30,456,580.01**	**–586,793.49**
–Income tax	-	-	-	-
FISCAL YEAR RESULT	**–18,724,287.79**	**–8.24%**	**30,963,852.03**	**4,860,519.19**

Income in detail (in €M)



Operating income (in €M)



Budget vs actual report

INCOME STATEMENT in euros	2008 Budget	2008 Actual
REVENUE		
Service contract sales	34,830,178.00	31,824,015.42
Government grants	210,211,344.00	195,447,206.52
Other operating revenue	2,830,000.00	4,508,204.02
Internal operations	6,025,690.00	9,557,106.92
TOTAL REVENUE	253,897,212.00	241,336,532.88
EXPENDITURE		
Personnel expenses	121,856,255.00	110,426,772.00
Other operating expenses	141,140,305.00	130,643,930.40
Internal operations	17,500,000.00	18,990,118.27
Precautionary reserve	-	-
TOTAL EXPENDITURE	280,496,560.00	260,060,820.67
RESULT (PROFIT)	-	-
RESULT (LOSS)	**26,599,348.00**	**18,724,287.79**
TOTAL INCOME STATEMENT BALANCE	280,496,560.00	260,060,820.67

TRANSFER OF RESULT TO CASH PROVIDED BY OPERATIONS in euros	2008 Budget	2008 Actual
RESULT	**–26,599,348.00**	**–18,724,287.79**
+Loss on sale of assets	-	65 405.95
+Depreciation & provisions	17,500,000.00	18,924,712.32
–Gains from offsetting depreciation	-	46 879.34
–Portion of grants recorded in result	2,500,000.00	6,242,826.30
–Write-backs on depreciation and provisions	3,525,690.00	3,270,980.62
CASH PROVIDED BY OPERATIONS	–15,125,038.00	–9,294,855.78

SUMMARY STATEMENT OF CHANGES IN FINANCIAL POSITION in euros	2008 Budget	2008 Actual
CASH PROVIDED BY OPERATIONS	**–15,125,038.00**	**–9,294,855.78**
Acquisition of tangible and intangible assets	40,755,509.00	35,163,169.38
Financial assets	2,136,800.00	2,107,438.88
Long-term debt paid	2,000,000.00	2,861,967.41
Dismantling assets	-	-
TOTAL USES OF CASH	60,017,347.00	49,427,431.45
Government capital grants	21,164,964.00	21,164,963.00
Other sources (excl. internal operations)	3,630,000.00	150,261.52
Increase in long-term debt	2,000,000.00	2,107,197.31
TOTAL SOURCES OF CASH	26,794,964.00	23,422,421.83
CONTRIBUTION TO WORKING CAPITAL	**–33,222,383.00**	**–26,005,009.62**

IRSN certified quality management system

IRSN
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