IRSN

INSTITUT
DE RADIOPROTECTION
ET DE SÛRETÉ NUCLÉAIRE

Annual Report 2007

Contents

Annual Report 2007

IRSN'S EXPERTISE in nuclear safety recognized in France, Europe, and around the world.

Jacques REPUSSARD.

The year 2007 closed the first five-year cycle in the lifetime of the Institute, the term of office defined for members of the Board of Directors. These five years have been marked by the noticeable effort, definitely noticed, made by all our employees to establish the Institute as an independent public enterprise, while producing the required scientific and technical results daily, especially in their expert assessments. I wish to extend my thanks and recognition to all our staff for their dedication to our public mission and the drive they have demonstrated in an exceptionally complex regulatory and administrative context.

> "A scientific institution recognized for what it is: France's public expert on nuclear and radiation risks"

Beyond the functional operations implemented through IRSN's various units and processes, this period is best characterized by the definition of a vast corporate project supported by steadfast commitment. This project is founded in the political vision emanating from work in Parliament, a vision that forged the initial decision to create the Institute and inspired the definition of its missions, as well as the strategic orientations validated in 2006 when the first Contract of Objectives was concluded with the government.

The corporate project has gradually taken shape through constructive dialogue with our employees, built on the basis of shared values, and through the development of active partnerships with major participants in nuclear safety, including nuclear authorities, operators, Local Information Commissions, as well as major foreign partners, the European Commission, and international agencies such as the IAEA and OECD/NEA, as defined by the law of July 2006 concerning nuclear transparency and safety.

This project has also succeeded in building a positive image of IRSN in the media and throughout society at large, not as a "trademark", but as a scientific institution recognized for what it is: France's public expert on nuclear and radiation risks, whose

high-quality assessments are perceived as a major component in the credibility of the nation's nuclear safety system. For the Institute's customers and partners, this quality is demonstrated not only in the service provided, but also through the ISO 9001 certification awarded in 2007, and the broad international renown achieved by IRSN. Taking this policy even further, the Institute has engaged in a constant effort to open up to society. This has materialized in a rapidly growing supply of useful information provided to the public via the Internet, as well as greater transparency in working procedures and their results. Fostering openness has led us to develop professional exchanges with experts from civil society, especially in work accomplished through Local Information Commissions and their federation, the ANCLI.

As this period comes to its term, I would like to pay a tribute to our Chairman, Jean-François Lacronique, and all the other Board members, who have been responsible for representing IRSN in relations with our supervisory ministries, with major customers (predominantly the ASN, the French nuclear safety authority), and with our eminent partner, the CEA. The personal commitment of each and every member of the Board has contributed significantly to the Institute's consolidation.

Turning towards the future, as our country reasserts its nuclear strategy, and as several other nations display new ambitions in this area, expressing their desire to acquire nuclear power plants, IRSN is faced with a triple challenge that will drive our forces and creativity.

First of all, the procedures enforced to keep French nuclear facilities at the highest level of safety, requiring submittal of safety reports to IRSN for any construction projects or changes to nuclear facilities, are creating a growing demand for scientific expertise. If a new nuclear operator were to appear on the scene, a competitor to EDF, this would mark a turning point in the history of IRSN, which, from its foundation, has absorbed a continuously rising workload mainly by achieving gains in productivity. New solutions would need to be found and implemented to adjust assessment capability to meet demand, probably within a relatively short time span.

Second, in the wake of initiatives led by France, recognized for its expertise in nuclear technology, there is a growing demand for IRSN services coming from foreign countries (in Europe, Asia, the Middle East, and Africa), who call on the Institute's experience and expertise in managing safety and radiation protection as they invest in large nuclear projects. IRSN has more than one reason to consider that it is of strategic importance to meet this demand, working with other organizations in scientific and technical support networks that TSOs are endeavoring to establish, with support from the IAEA. These activities will naturally be financed essentially by the entities requesting our services, but the rapid growth expected implies that IRSN must promote new senior consultants from within its own ranks. A realistic outlook, this approach nonetheless implies that IRSN must remain an attractive choice in the persistently competitive job market for scientists and engineers in the nuclear sector.

Finally, rapidly changing nuclear technology and society's concomitant demand for the best available techniques to ensure risk prevention and manage the consequences of accidents obliges IRSN to pursue its considerable achievements in research, working as much as possible in partnership with institutions recognized internationally in these fields. The importance of this goal was emphasized recently by Jean-Louis Borloo, the Minister of Ecology, Energy, Sustainable Development and Territorial Development. IRSN allocates nearly half of its financial resources to research, in compliance with the contract of objectives signed with the government, contributing to France's position in the trio of OECD countries leading the research effort in nuclear safety and radiation protection. A ratio of 50% may appear high at first, but this includes the very heavy expenses required to operate infrastructures such as nuclear reactors. It is also necessary to keep in mind that IRSN's research effort is the mainstay supporting the relevance and credibility of the consultancy services it provides to major operators throughout France (especially in radiation protection) and worldwide. This effort must be maintained on a long-term basis. Completing consolidation of its Medium- and Long-Term Plan and forming a policy committee to advise the Board of Directors on research matters will help IRSN focus on those programs involving the most strategic issues and clarify the ultimate goals of research in nuclear safety and radiation protection.

I hope you will enjoy reading this IRSN annual report, which we try to improve year after year to provide you with all the information you have come to expect, in keeping with the terms of our quality policy.

Jacques REPUSSARD, Director general

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

The Institute's defense- and security-related activities concern three sectors that come under direct State supervision.

SAFETY AND RADIATION PROTECTION OF MILITARY NUCLEAR SYSTEMS AND SECRET BASIC NUCLEAR INSTALLATIONS

This activity covers the prevention of accidents or incidents that might affect:

- the twelve nuclear steam supply systems aboard submarines or the aircraft-carrier;
- some sixty installations, in particular the facilities located in the four nuclear ports and five nuclear airbases, in addition to the industrial sites dedicated to the life cycle of nuclear weapons and naval propulsion fuel;
- the transport of nuclear and/or radioactive materials used in defense-related activities (weapons, fuel, components for steam supply systems, waste).

IRSN contributes its high-level expertise when examining files submitted by the Ministry of Defense or the CEA to the Nuclear Safety Authority for defense-related matters, seeking to maintain high safety and radiation protection standards, while keeping in mind that this equipment serves a military purpose and that, as part of the nation's nuclear deterrent force, it must meet stringent availability requirements.

The on-going modernization of this force has led to an increased demand for expert assessments in a number of areas: building new submarines and preparing their weapons, adapting and upgrading aging military and industrial facilities, and dismantling complex facilities over a long time period. IRSN must respond to this growing demand and, in the field of expert assessment, this response relies primarily on competent human resources. In carrying out its scientific and technical assessment activities, the Institute has a dual objective:

- ensure that the planned operating conditions have no impact on safety and radiation protection, especially in the event of change;
- ensure that key safety and radiation protection issues are consistent at the national level.

PHYSICAL PROTECTION OF NUCLEAR MATERIALS, FACILITIES AND TRANSPORT IN FRANCE

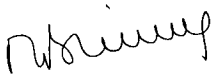
The issue of terrorism is central to the concerns of the international community today. As the trend towards greater use of nuclear power spreads around the world, security and safety issues tend to converge, since risks to the population and the environment must be controlled, whether the initiating event giving rise to radiological impact is due to a natural hazard, an unintentional error, or a malicious act.

IRSN's task is to provide unfailing technical assistance and support to public authorities in their efforts to enforce regulations relative to the protection and control of nuclear materials, protection of nuclear facilities and transport, and tracking of radioactive sources.
IRSN's experts conduct technical inspections, monitor transport under operational conditions, and manage national accountability of nuclear materials.

MONITORING NON-PROLIFERATION OF NUCLEAR AND CHEMICAL WEAPONS IN FRANCE

IRSN's activities in this area are based on two agreements, one signed with the CEA (on implementation of international nuclear material inspections), and another with the Senior Defense and Security Official at the French Ministry of Defense (on implementation of the chemical weapons ban agreement). Under the terms of these agreements, IRSN:

- provides technical assistance to French authorities to help them honor their commitments under the terms of international treaties on the non-proliferation of weapons of mass destruction;
- assists and advises French industrial corporations subject to compliance with international inspection measures;
- escorts international inspections, as delegated by the French authorities, to ensure that inspection methods are consistent with the terms of the relevant treaties and agreements.



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

A short description of IRSN

FOUNDING THE INSTITUTE

IRSN was set up under Article 5 of French Act No. 2001398 of May 9, 2001 and by implementing 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 Act on nuclear transparency and safety.

STATUS

IRSN is an industrial and commercial undertaking (EPIC), placed under the supervision of five ministries: the Ministry of 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, Youth, Sport, and the Voluntary Sector.

DIRECTORS

- **Jean-François LACRONIQUE**, Chairman of the Board of Directors;
- **Jacques REPUSSARD**, Director General;
- **Michel BRIÈRE**, Deputy Director General, in charge of IRSN defense-related missions;
- **Philippe JAMET**, Deputy Director General in charge of general operations (left IRSN at the end of February 2007);
- **Jean-Luc PASQUIER**, Deputy Director General (as from June 1, 2007).

ASSESSMENT AND RESEARCH

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

AREAS OF ACTIVITY

- environment and response;
- human radiation protection;
- prevention of major accidents;
- reactor safety;
- safety of plants, laboratories, transportation, and waste;
- nuclear expert assessment relating to defense.

FOUR LINES OF DEVELOPMENT

- re-engineer the research process;
- optimize technical support for public authorities;
- provide other socio-economic stakeholers with the information, expertise, and studies they require;
- be a driving force on the European and international scene.

2007 BUDGET

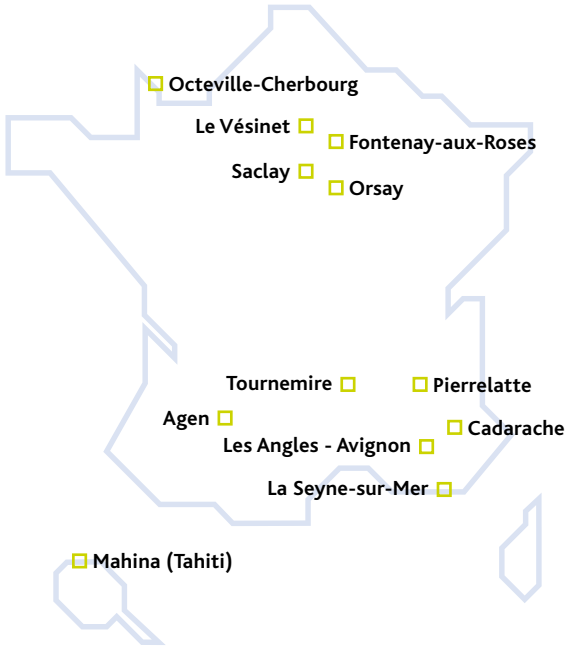
- revenue: €299 million;
- dexpenditure: 266 million, including €28 million in equipment investments.

WORKFORCE

IRSN employs around 1,700 people, including many specialists, engineers, researchers, physicians, agronomists, veterinary surgeons and technicians, experts in nuclear safety and radiation protection and in the field of controlling sensitive nuclear materials.

SITES

North Region: 1,254 employees



South-east Region: 320 employees

IRSN Missions

Order No. 2002-254 of February 22, 2002, amended on April 7, 2007, relative to IRSN, set out seven missions for the Institute concerning radiation protection and nuclear safety. These are organized into three fields, as 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 appraisals in its fields of activity. It either carries them out itself or entrusts them to other French or foreign research institutes. Some programs are carried out within a European or international framework.

Contribution to training in radiation protection

As an establishment carrying out research and expert assessments, IRSN has a duty to contribute to teaching in its field of expertise: nuclear safety and security, and radiation protection. The radiation protection training courses it organizes are directed at professionals working in the health sector and people exposed to hazards in their jobs.

Continuous monitoring in the field of radiation protection

IRSN carries out continuous monitoring in the field of radiation protection by assisting in monitoring environmental radiation, managing and processing dosimetric data for workers exposed to ionizing radiation and managing the inventory of ionizing radiation sources.

Contributing to public information and transparency

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

TECHNICAL SUPPORT AND ASSISTANCE FOR PUBLIC AUTHORITIES

Technical support with regard to nuclear and radiation risks

IRSN provides technical support to the appropriate public authorities in the field of nuclear and radiation risks. Its scope covers civilian nuclear facilities, facilities classified as secret, the transportation of radioactive substances, the application of treaties on controlling 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 ionizing radiation sources, IRSN suggests technical, public health and medical measures for public authorities, aimed at protecting the population, workers and the environment, and restoring safety at the facilities.

CONTRACTUAL EXPERT APPRAISAL, RESEARCH AND MEASUREMENT SERVICES

Carrying out expert appraisals, research and studies for public or private organizations

IRSN carries out the services of appraisal, research and studies - analysis, measurement and dosing – under contract for French, European and international organizations in the public and private sectors. The Institute also provides third-party expert assessments for industrial operators of classified facilities for the protection of the environment outside the nuclear sector.

ACTIVITY 2007 key figures

The Institute's activities

RESEARCH

47% of IRSN budget devoted to these activities

141 scientific publications

TECHNICAL SUPPORT FOR PUBLIC AUTHORITIES

724 technical notices to the ASN, the nuclear safety authority (excluding defense-related activities)

129 technical notices to the ASN for defense-related activities

440 technical notices to the ASN

INTERNATIONAL ACTIVITIES

143 bilateral agreements with research and appraisal organizations

33 countries concerned by these agreements

72 international projects in progress

HUMAN RESOURCES

1,686 people on permanent contracts on 31/12/2007 (including 90 assigned to the ASN or other institutions)

IRSN'S INTELLECTUAL ASSETS

16 french patents in force (including 1 co-owned with the CEA)

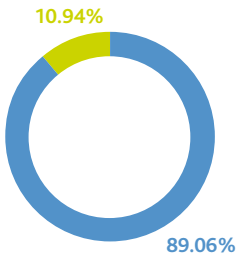
12 patents in force abroad

195 software and databases listed (24 of which are co-owned with the CEA and one of which is placed with the APP (a software protection agency) and with VUEZ (Slovakia))

SERVICE CONTRACTS

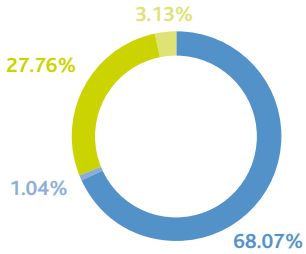
35 third-party appraisals or critical analyses of hazard studies

The budget and its breakdown



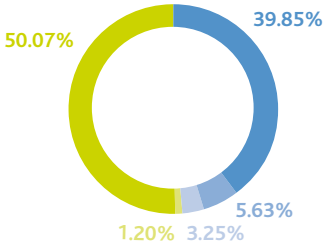
Operation/ investment expenditure

- Operation
- Investment



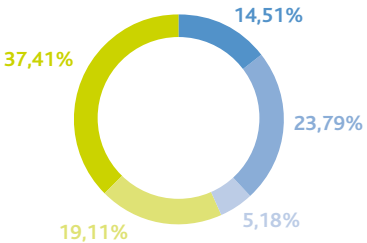
Financing sources

- LOLF 189 program subsidy
- LOLF 212 program subsidy
- French resources (aside from financing law)
- Foreign resources



French resources (aside from financing law)

- Public
- EDF
- Areva
- CEA
- Others



Foreign resources

- CCE
- Riskaudit
- GRS
- NRC
- Others

Nota : For further information, see detailed analysis of these items in the Financial Report.

KEY EVENTS 2007

January

8
IRSN published a report on severe accidents and put it online. Produced in collaboration with the CEA and with support from EDF, the document reviews current knowledge and research work carried out in France and abroad. It shows that significant uncertainties remain concerning a number of phenomena at the center of ongoing experimentation programs.
(see Challenge 1)
www.irsn.org

16
IRSN organized a human-factor awareness seminar for operating personnel at the Phenix facility.

February

14 and 15
ERICA *(Environmental Risk from Ionizing Contaminants: Assessment and Management)*, a European FP6 project organized by IRSN, came to an end. The goal of the project was to set up a method for assessing the environmental risk associated with radionuclides.

26
Jacques REPUSSARD, Director General of IRSN and Marie-Claude DUPUIS, Director General of Andra, the French national radioactive waste management agency, signed a general memorandum of understanding to organize scientific and technical cooperation between the two organizations.

March

5
The IAEA Board of Governors approved the appointment of Philippe JAMET as Director of the Agency's Nuclear Installation Safety Department.

8
The Minister of Health, Xavier BERTRAND, tasked IRSN with assessing radiotherapy practices at Epinal Hospital (Vosges), in response to the cases of overexposure that occurred there between 2001 and 2006. The report was submitted to the Minister on March 23.
www.irsn.org

13
IRSN presented its contributions to the IAEA's efforts to promote the security of nuclear materials and facilities to Anita NILSSON, Director of the IAEA Office of Nuclear Security.

14
Having joined the ICSI (Institute for an Industrial Safety Culture), IRSN appointed its representative on the steering and evaluation committee of the organization, which was set up in Toulouse following the accident at the AZF plant. IRSN is particularly interested in the ICSI's multidisciplinary make-up and the participatory approach it adopts.

April

9
IRSN mobilized its emergency response center, at the ASN's request, to monitor the development of the situation at the Dampierre NPP affected by two electrical failures.

23-27
The IAEA, with IRSN support, organized an international conference in Aix-en-Provence on the challenges facing Technical Safety Organizations (TSOs) in their efforts to reinforce nuclear safety. The conference provided the Institute with an opportunity to share with the rest of the world its views on the purpose, tasks and conditions governing the efficiency of TSOs and to discuss the challenges involved.

25
IRSN renewed its cooperation agreements for another five years with the Chinese nuclear safety authority (NNSA) and its technical support organization (NSC).

27
Peter B. LYONS, Commissioner of the US Nuclear Regulatory Commission, visited IRSN's Cadarache site as part of an initiative to develop cooperation between the two organizations.

May

2
CNRS Research Director, Dominique GOBIN, was appointed as Director of the Institute's Department for Scientific and Technical Assessment and Quality.

22-24
IRSN organized the 2s international conference of ESARDA in Aix-en-Provence. ESARDA is an association of European organizations devoted to research and development in the field of nuclear non-proliferation and the related international inspections. At the conference, attended by nearly 300 specialists, IRSN presented eight publications giving an account of its experience in the field of nuclear materials control.

22 may-15 june
IRSN submitted to its supervisory ministries its results for 2006 compared with the objectives specified in the Government-IRSN contract of objectives.

July

11
IRSN obtained ISO 9001 certification for all its sites and activities, including its research laboratories.

11
The IRSN radiotoxicological medical analysis laboratory received COFRAC accreditation for measuring X-ray and gamma emitters in urine samples.

IAEA Board of Governors.

Signature of the framework agreement for cooperation with the French Army health services.

The IAEA conference in Aix-en-Provence

July-October

IRSN participated in the French Environment Round Table (*Grenelle de l'Environnement*) as part of Group 5: "Constructing ecologically-responsible democracy: institutions and governance".

August

6

A memorandum of understanding was signed with South Africa's National Nuclear Regulator, allowing it to benefit from IRSN expertise.

15

IRSN moved its Head Office from Clamart to Fontenay-aux-Roses (Hauts-de-Seine). Adjacent to the Institute's chief site, the new offices accommodate more than 1,000 operational and functional department employees.

September

1

Jean-Bernard CHÉRIÉ was appointed General Secretary of IRSN. Mr. CHÉRIÉ was formerly Deputy Director in charge the Strategy, Development and External Relations Department and Head of the International Relations Division.

7

Following the discovery of another series of radiotherapy incidents at Epinal Hospital, French Minister of Health, Roselyne Bachelot-Narquin, asked IRSN to assess the possible clinical impact on patients treated at the hospital between 1989 and 2000.

21

A conference was held in Brussels to launch the European Technology Platform for nuclear fission. The platform brings together the principal stakeholders (industry, research and technical support organizations) concerned with long-term research strategy in the field.

26

IRSN signed a cooperation framework agreement with the Armed Forces Medical Corps. Under the agreement, the two parties will pool their resources to improve the organization of emergency response and treatment of people in the event of radiological or nuclear incidents.

October

15

Michèle FROMENT-VÉDRINE, Director General of the French Agency for Environmental and Occupational Health Safety (AFSSET) and Jacques REPUSSARD, Director General of IRSN, signeda four-year framework agreement on collaboration and appraisal activities.

16

IRSN submitted to the French Nuclear Safety Authority (ASN) a preliminary assessment report on exposure cases that occurred in April at the public hospital in Toulouse. The assessment aimed to search for any technical reasons that could explain the accelerator used anomaly and to check that the calibration protocols complied with the manufacturer's procedures and applicable recommendations.

17

Jacques REPUSSARD, Director General of IRSN and André-Claude LACOSTE, Chairman of the French Nuclear Safety Authority (ASN), signed a new five-year framework agreement concerning IRSN's technical support activities for the ASN.

22-26

IRSN took part in the 15th PATRAM (Packaging and Transportation of Radioactive Materials) symposium in the United States. IRSN received the AOKI Award for the best poster, for its paper on the quality of safety analysis reports submitted by applicants.

November

2

A nuclear safety cooperation framework agreement was signed by IRSN, GRS and BNRA, the Bulgarian Nuclear Regulatory Authority, for a safety assessment of the Belene plant in Bulgaria.

22

The Atomic Energy Committee, co-chaired by the Minister of Ecology and the Minister of Research, consolidates IRSN's research role in the field of nuclear safety and radiation protection. Jean-Louis BORLOO and Valérie Pécresse decided to set up a steering committee devoted to research into nuclear safety and radiation protection, working with the IRSN Board of Directors and open to "stakeholders", based on the French Environment Round Table model.

December

12

A consortium was set up by the BRGM (France's leading public institution in the earth science field), IRSN, Geoloski Zavod Sloveijne (the Geological Survey of Slovenia) and Zavod za Gradbenistvo Slovenije (the Slovenian National Building and Civil Engineering Institute). The consortium was selected to carry out geological surveys and a probabilistic study of the seismic hazard in Slovenia in connection with plans to build a second reactor on the Krško NPP site.

19

Riskaudit, the IRSN-GRS subsidiary, had its ISO 9001 certification confirmed following the December 2006 annual audit.

STANDING ADVISORY GROUP meetings in 2007

In 2007, IRSN assessment reports were presented and discussed at the meetings of the following standing groups: standing group for nuclear reactors, standing group for basic nuclear installations apart from radioactive waste disposal facilities and standing group for radioactive waste disposal facilities.

March

21 et 22
Examination of site protection against external flooding
See Challenge 1 Naturally-occurring hazards

28
Examination of the preliminary safety analysis report for the MAGENTA project (Cadarache)

May

23
Examination of the safety analysis report before the final commissioning of the ATALANTE facility (INB 148, Marcoule)

June

19 and 26
Examination of the amendment to Fundamental Safety Rule RFS III.2.f on the deep geological disposal of radioactive waste
See Challenge 2 Deep disposal facilities

20, 21 and 28
Examination of the preliminary safety analysis report for the Jules Horowitz Reactor (RJH)
See Challenge 2 Future reactors

27
Safety examination on the CERN Large Hadron Collider (LHC) and its injectors
See Challenge 1 Monitoring facilities

July

5
Examination of the "safety cost-benefit method" presented by EDF
See Challenge 1 Monitoring facilities

October

11
Seismic report and inspection of the High Flux Reactor (INB 67, Grenoble)
See Challenge 1 Naturally-occurring hazards

24
Safety examination of the decommissioning procedure on the Bugey 1 reactor, now shut down (INB 45)

November

28
Safety review of the liquid effluent management zone of the STELLA facility (INB 35, Saclay)

29
Examination of the preliminary safety analysis report for the Jules Horowitz Reactor (RJH)
See Challenge 2 Future reactors

December

19
Safety review of workshops at the STE 3 facility (INB 118, La Hague) and the project for conditioning sludge produced by STE 2
See Challenge 1 Monitoring facilities

20
Examination of French and foreign PWR operating experience feedback over the period 2003-2005 (1st meeting)

ORGANIZATION CHART
(December, 2007)

BOARD OF DIRECTORS

Jean-François LACRONIQUE,
Chairman

GENERAL SECRETARIAT

Jean-Bernard CHÉRIÉ, General Secretary
- Financial affairs
- Human resources
- Commercial relations and legal support
- Asset management and corporate services
- Information systems administration

FUNCTIONAL DIVISIONS

Strategy, Development and External Relations
Michel BOUVET, Director
- Research programs
- Expert appraisal programs
- Openness to society
- International relations
- Secretariat for Standing Groups

Scientific and Technical Assessment and Quality
Dominique GOBIN, Director
- Teaching and training in radiation protection, nuclear safety and security
- Assessment and scientific activities
- Quality management
- Hygiene, safety and environmental protection
- Scientific and technical knowledge engineering
- Scientific information resources

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

Jean-Claude DALE, Accountant

Yves NORMAND, Central Security Officer

GENERAL MANAGEMENT

Jacques REPUSSARD,
Director General

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

Jean-Luc PASQUIER,
Deputy Director General

OPERATIONAL DIVISIONS

Nuclear Defense Expertise
Jérôme JOLY, Director
- Defense safety assessment
- Nuclear facility security
- Implementation 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
- Sample processing and metrology for the environment
- Radiation protection response and support
- Emergency situations and crisis organization

Prevention of Major Accidents
Michel SCHWARZ, Director
- Studies and experimental research on accidents
- Experimental instrumentation and engineering
- Fuel studies and modeling in accident situations
- Fire, corium, and containment studies and modeling

Human Radiation Protection
Patrick GOURMELON, Director
- Radiation protection studies and expertise
- 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, core and operation of facilities
- Severe accidents and radiological consequences
- Human factors

Safety of Plants, Laboratories, Transport and Waste
Thierry CHARLES, Director
- Fuel cycle transportation and facilities
- Laboratories, irradiators, accelerators and decommissioned reactors
- Radioactive waste
- Industrial risks, fire and containment
- Criticality
- Air dispersion of pollutants

BOARD OF DIRECTORS

Missions

In accordance with Order no. 2002-254 of February 22, 2002, amended on April 7, 2007, the Board deals with IRSN business through its proceedings. More specifically, it discusses the general conditions governing the organization and running of the establishment, the Institute's programs and the annual report. In terms of finance, it approves the budget, decisions involving changes, year-end financial statements and income appropriation.

IRSN's Board of Directors is made up of 24 members:

- *10 government representatives*
- *Six advisory members, appointed by Order and chosen for their skills in the Institute's areas of activity, including a Member of Parliament or a Senator from the Parliamentary Office for the evaluation of scientific and technological options*
- *Eight elected IRSN staff representatives.*

The Board of Directors proposes one of its members as Chairman, who is appointed by Order based on the Supervisory Ministers' report.
The term of office for members of the Board of Directors is five years, which can be renewed only once for the six advisory members.
The Board of Directors meets at least four times a year.

COMPOSITION (December 31, 2007)

Government representatives:

Jocelyne BOUDOT, Assistant Director for the Management of Environmental Risk, representing the Minister of Health;

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

Dominique GOUTTE, Director of the Department for Energy, Transport, Environment, Natural Resources, representing the Ministry of Research;

Jean HAMIOT, Weapons inspector, in charge of missions relating to nuclear security, representing the Minister of Defense;

Pascal MATHIEU, Head of the Major Risks Office at the Department for Defense and Civil Security, representing the Minister of Civil Security;

Guillaume SAINTENY, Director of Economic Studies and Environmental Assessment, representing the Minister of Ecology and Sustainable Development;

Cyrille VINCENT, Branch manager for the nuclear industry, General Directorate for Energy and Raw Materials, representing the Minister of Industry;

The representative of the Budget Department has yet to be appointed;

Marcel JURIEN de la GRAVIÈRE, in charge of nuclear safety and radiation protection for defense-related activities and facilities;

Stéphane NOËL, Head of the nuclear safety and radiation protection mission.

Advisory members:

Jean-François LACRONIQUE, Professor of Medicine, nominated by the Minister of Health, Chairman of the Board of Directors;

Claude BIRRAUX, President of the Parliamentary Office for the evaluation of scientific and technological options;

Jean-Marc CAVEDON, Director of the Division for Research into Nuclear Energy and Safety at the Paul Scherrer Institute in Switzerland, nominated by the Minister of Research;

Georges LABROYE, Director General of the Institute of Industrial Environments and Hazards, nominated by the Minster of Ecology and Sustainable Development;

Maurice LAURENT, former French National Assembly Head of Department, nominated by the Minister of Industry;

Jean RANNOU, Air Force General, nominated by the Minister of Defense.

Staff representatives

Mireille ARNAUD, Hervé BOLL, Betty CATANIA, Jean-Marc DORMANT, Thierry FLEURY, François JEFFROY, Dominique MARTINEAU, Xavier MOYA.

Ex officio or associate members

Laurent MICHEL, Director of Pollution and Risk Prevention and Government Commissioner;

Daniel METAYER, State Controller;

Jacques REPUSSARD, Director General;

Michel BRIÈRE, Deputy Director General in charge of IRSN's defense-related missions;

Jean-Claude DALE, Accountant;

Philippe BOURACHOT, Works Committee Secretary;

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

When Annie Sugier retired in 2007, the IRSN Board of Directors, at the initiative of Member of Parliament Claude Birraux, paid tribute to her contribution to radiation protection and transparency in the nuclear field.

IN THE WORDS OF...

Annie SUGIER,

Advisor to IRSN's Director General

"I took this tribute to be a message addressed to IRSN's experts to encourage them to reconcile competence with a more open attitude to society. That's what guided me in my career. Having worked at the CEA in waste research and then in nuclear facility decommissioning, my first task was to acquire specific scientific knowledge in radiation protection – a field that was quite new to me. When my foreign colleagues elected me to the Main Commission of the ICRP, I saw it as a sign that I had really become part of the international community of experts.

My appointment by the government as Chairperson of the Nord Cotentin Radioecology Group, a pluralistic expert group, not only marked a milestone in my personal career, it also marked the beginning of IRSN's initiative to open up to society.
This group stimulated scientific debate by bringing together various associations, industry and experts to consider the impact of nuclear facilities. It was a novel, socially aware and collective initiative that led to the creation of a second group, this time focusing on uranium mines. When IRSN was created, a special division was set up, devoted to «openness to society» to reinforce pluralistic expert activities.

Our involvement in technical issues should not allow us to overlook the fact that we are also part of society and have a role to play. This led me to give special attention to the issue of gender equality and I wrote up a report on this for the Minister of Women's Rights. I also initiated the Institute's Animal Experimentation Ethics Committee, which makes sure that everything possible is done to minimize animal suffering."

THE STEERING COMMITTEE for the Nuclear Defense Expertise Division

Missions

The Steering Committee for the Nuclear Defense Expertise Division (DEND) at IRSN examines this Division's program of activities before it is submitted to the Institute's Board of Directors. It is consulted when the Board of Directors is called upon to make decisions relating specifically to the organization or running of this Division. It also guides the Board of Directors in this area.

The committee is made up of 10 members. It has met 16 times since it was set up in 2003. It met three times in 2007.

COMPOSITION (December 31, 2007)

President
Emmanuel SARTORIUS, Senior Defense and Security Official at the Economy, Finance and Employment;

Marcel JURIEN DE LA GRAVIÈRE, in charge of nuclear safety and radiation protection for defense-related activities and facilities;

Brigadier-General Jean-François BACHEROT, nuclear weapons inspector;

Rear-Admiral Georges MOUTON, representative of the Armed Forces Chief of Staff;

Engineer General Jean HAMIOT, representing the DGA, the French defense procurement agency;

Emmanuel ROUSSELOT, representing the Budget Director;

Captain Philippe COINDREAU, 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;

Serge POULARD, advisory member;

Chief Medical Officer of the French armed forces Jean-Baptiste FLEUTOT, advisory member.

THE SCIENTIFIC COUNCIL

Missions

IRSN has a Scientific Council whose responsibilities are defined in Order no. 2002-254, dated February 22, 2002, amended on April 7, 2007. The Council expresses its opinion on IRSN programs, assesses results and can make recommendations on the Institute's future activities. Its opinions and recommendations are submitted to the Board of Directors and the Institute's supervisory ministries. It expresses an opinion on the Institute's Annual Report and can be consulted by the Chairman of the Board or by the Supervisory Ministers on any subject within its fields of expertise. Its advice may be sought on any issue or operation to which IRSN is committed.
In 2007, the Scientific Council held two plenary meetings, one in May and one in November.
It also began to work on two specific assessments in 2007, concerning:
- *the Institute's research work on radiopathology and treatment of irradiation victims;*
- *the role of global tests in simulating reactor accidents.*

In each case, the assessment committees set up are composed of Scientific Council members and outside personalities. The assessments should be completed during the first half of 2008.

COMPOSITION (December 31, 2007)

Chairman
Michel QUINTARD, CNRS Research Director at the Toulouse Institute of Fluid Mechanics, on the proposal of the Minister of Research;

Bernard SEVESTRE, Engineer General for Armaments, Deputy Director at the CEA, on the proposal of the Minister of Defense;

Pierre LAROCHE, Chief Medical Officer of the French Armed Forces and Head of the Medical Division of the Armed Forces' Radiation Protection Department, on the proposal of the Minister of Defense;

Ethel-Esther MOUSTACCHI, Scientific Director for the Atomic Energy High Commissioner, on the proposal of the Minister of Ecology;

Victor TESCHENDORFF, Head of Department at Gesellschaft für Anlagen und Reaktorsicherheit GmbH (GRS, Germany), on the proposal of the Minister of Ecology;

André AURENGO, Professor of Medicine and Head of Department at Pitié-Salpêtrière Hospital, on the proposal of the Minister of Health;

Dietrich AVERBECK, CNRS Research Director, Radiation Protection Manager in the Curie Institute Research Division, on the proposal of the Minister of Health;

George YADIGAROGLU, Professor of Nuclear Engineering at the Swiss Federal Institute of Technology, on the proposal of the Minister of Industry;

André PINEAU, Professor at the Paris Ecole des Mines, on the proposal of the Minister of Industry;

Philippe LECONTE, Physicist, former Director of the CEA's radioactive waste management research program, on the proposal of the Minister of Research;

Pierre CATILINA, a doctor specializing in occupational pathology and member of the French committee on occupational diseases, on the proposal of the Minister of Labor;

Jean-Claude ANDRÉ, Scientific Director of the INRS, the French national research and safety institute, on the proposal of the Minister of Labor.

IRSN in 2007
Report and outlook

THE STRATEGIC APPROACH for implementing IRSN missions

At a time when the nuclear sector is seeing a revival around the world and ionizing radiation applications are being used more frequently and in an ever wider range of areas, IRSN is increasingly concerned with guaranteeing the safety of existing and future nuclear facilities and promoting radiation protection, especially in the medical field.

While the year 2006 was marked by changes in French nuclear safety and security laws, 2007 saw IRSN focus its attention on its strategic policy and consolidating its tools for managing its contract of objectives with the government.

AN EVENTFUL YEAR AT HOME AND ABROAD

On November 22, 2007, the Atomic Energy Committee held a meeting on research into nuclear safety and radiation protection in France. IRSN took the opportunity to present the main lines and organizational structure of its research activities and, in particular, its strategy regarding experimental resources. At the end of the meeting, which confirmed the Institute's role in nuclear safety and radiation protection research, the Ministers of Ecology and Research decided to set up a steering committee devoted to research into nuclear safety and radiation protection to advise IRSN's Board of Directors in the area. The committee will be open to "stakeholders" following the French Environment Round Table model.

Another key event in 2007 was, in fact, the Environment Round Table, to which IRSN contributed as an expert in risk prevention. Although the Round Table did not address nuclear issues, the Institute's experience and initiatives to open up to society, involve stakeholders and promote pluralistic expertise, not to mention its policy of research in support of public policy-making, were acknowledged.

IN THE WORDS OF...

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

"For the IRSN to accomplish its expert assessments properly, it must have the opportunity to put newly gained knowledge into practice.
It is therefore essential for IRSN to maintain a high level of research and pass its knowledge on to young teams in order to gain and keep the trust of authorities and the public.
This was clearly illustrated at the radiotherapy hearing organized on November 15, 2007 by the Parliamentary Office for the Evaluation of Scientific and Technological Choices, in which IRSN took part alongside a number of important figures from the medical world and other institutions.

The purpose of the hearing was to present new radiotherapy technologies, their contribution to cancer treatment, and the procedures implemented to ensure the quality and safety of treatment. It also enhanced awareness of the importance of radiation protection, radiological monitoring, and nuclear safety."

At the Environment Round Table, IRSN intervened as the expert in risk prevention.

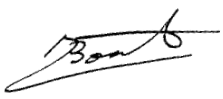
Following the irradiation accident that occurred at Epinal Hospital (*see Challenge 7*), IRSN specialist teams were called in by the public authorities to appraise the situation, drawing on the latest results of the Institute's research. An event of this type, occurring on such an unprecedented scale, highlights how expert appraisal and research must work together and interact.

On the international stage, the work carried out to set up a European "fission" platform and the IAEA conference on the role of technical safety organizations (TSOs) confirmed the role these organizations had to play in the platform. It was also demonstrated that technical appraisals on risk prevention by at least two organizations were required for all projects.

IMPLEMENTATION OF MANAGEMENT TOOLS

The first progress report on the contract of objectives was submitted to the Supervisory Ministers in 2007, in accordance with the Institute's undertakings. The report sets out results obtained, alongside the objectives stipulated in the contract.
In addition to this, the Institute's teams set about preparing the Medium- and Long-Term Plan (MLTP), the aim of which is to define the resources required to take up the challenges mentioned in the contract of objectives. The MLTP provides a long-term view of the Institute's activities, based on the main lines of strategy defined in the contract of objectives. It is one of IRSN's key management tools. Lastly, the annual activity program, submitted to IRSN's Board of Directors every year, was changed in 2007 to bring the presentation of projects for 2008 into line with the MLTP and the contract of objectives.

All the activities formed part of the Institute's quality initiative, which was rewarded in July 2007 by ISO 9001 certification for all IRSN sites and activities.



Michel BOUVET,
Director of Strategy, Development, and External Relations Division

IN THE WORDS OF...

Nicole NOTAT,
Chairperson of Environment Round Table Group 5 "Constructing ecologically-responsible democracy"

"In view of the seriousness of sustainable development issues, the public decision-making process must be overhauled and real meaning given to the notion of ecologically-responsible democracy.
It is now crucial to ensure that everything is done to promote a clearer understanding of these issues that are of direct concern to citizens and consumers. The public decision-making process must be geared to this objective by making information and expert appraisal more readily accessible, promoting public debate and consulting stakeholder organizations.
IRSN has already begun this work.
It is against this backdrop that access to expert appraisals built on scientific precision and a multidisciplinary approach really comes into its own. By its very nature, pluralistic appraisal sparks debate and presents issues from various perspectives that should be considered during the decision-making process.
It was with this in mind that the group recommended setting up a nation-wide framework for pluralistic appraisal – to raise the quality of the existing appraisal system and make it more democratic.
At the same time, companies with an environmental impact must also promote sustainable development and incorporate it into their governance."

Re-engineer the research process

2007, A DECISIVE YEAR FOR RESEARCH

Apart from the progress made in the Institute's research activities, 2007 also saw IRSN confirm its research objectives and strategies, propose new management tools for research in the field of safety and radiation protection, and reach decisions concerning the future of its experimental resources.

RESEARCH MANAGEMENT TOOLS

IRSN made efforts to further clarify its research activities in 2007. Its activities cover a very wide range of fields, from the mechanical behavior of materials to cell biology and human factors. The many partnerships set up as part of national and international programs have led to the creation of program-specific management bodies.

In particular, the Institute presented the underlying principles and objectives of all its research programs to the Atomic Energy Committee on November 22, 2007, evoking the related issues and explaining how the different management tools worked together. Ministers Jean-Louis Borloo and Valérie Pécresse, convinced that the Institute has a vital role to play on the research scene, decided to set up a steering committee for research that will work hand in hand with IRSN's Board of Directors. They also expressed the wish that the French Nuclear Safety Authority (ASN) should be kept regularly informed of progress and results in research in the field of nuclear safety and radiation protection.

THE FUTURE OF EXPERIMENTAL RESOURCES

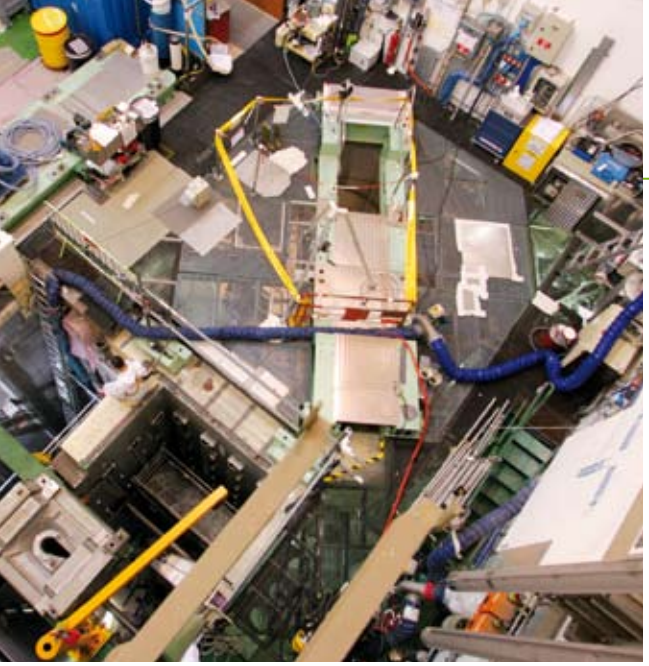
The nuclear and radiological fields are about to enter a period of far-reaching technological progress. This, together with budgetary restrictions, means that IRSN must choose its research programs carefully if it is to acquire the knowledge and skills so vital for its appraisal activities in the future. Within this context, the Institute believes it will need to step up its research activities considerably in areas such as I&C software reliability, human and organizational factors and the properties of certain materials, for example.

IN THE WORDS OF...

Nathalie MESSER,
Coordinator for IRSN Safety Research Programs

"The decisions taken by the Atomic Energy Committee on November 22 are the result of an IRSN study on the future of French experimental resources and, more especially, the CABRI and PHEBUS reactors.
These reactors belong to the CEA and are available for use by IRSN, which bears all the related costs.
Large-scale renovation work has begun on CABRI in preparation for the CABRI-CIP international program. Although costs are somewhat higher than expected, it does seem essential to continue renovation work on this experimental reactor, which is used for studying the behavior of fuel in the event of a reactivity accident.
An international group of experts has investigated the various types of work for which the PHEBUS reactor might be useful. Following this investigation, and in view of the reactor's operating costs, continued operation does not seem justified by currently planned test projects, especially since other facilities could be adapted to carry out such tests."

11%
of program funding comes from external revenue.
(15% in 2006)



CABRI reactor: pursuing renovation.

At the same time, it must maintain its scientific and technical skills in other areas relating to its appraisal activities. During the meeting, the Atomic Energy Committee reached a consensus on the following points proposed by IRSN:

- the CEA should continue to make the CABRI reactor available in the long term, which implies continuing its renovation in preparation for the CABRI-CIP international program;
- operation of the PHEBUS reactor should cease under the CEA/IRSN agreement, even though it has proven to be a unique and valuable instrument for studying core cooling accidents in water reactors;
- the Appareillage B facility should continue to be used for the qualification of criticality computing tools;
- IRSN will no longer use the SILENE reactor for research into criticality accidents.

The work carried out for this Atomic Energy Committee meeting will be included in the Institute's Medium - and Long-Term Plan (MLTP), which will be adopted in 2008.

IN THE WORDS OF...

Laurent MICHEL,
Government Commissioner

"We have assigned IRSN an important task in asking it to prepare a Medium- and Long-Term Plan, or MLTP. It is a task that will channel the Institute's activities in keeping with its missions and must be sustained over time. As supervisory bodies, we are extremely attentive to the preparation of this plan, which should be completed some time in 2008. Among other things, we expect the MLTP to be consistent with IRSN's contract of objectives and annual activity program and provide a concerted, strategic view of research and appraisal activities.
For example, today's research projects must serve tomorrow's appraisal activities. Similarly, information, transparency and opening up to the public are other developments to be fostered. Among the challenges facing IRSN are its ability to bring to the fore research projects, fields of knowledge and skills that pave the way for the appraisal of future facilities. Radiation protection of workers and protection against ionizing radiation for healthcare applications are also priority themes."

IN THE WORDS OF...

Gilles BLOCH,
Director General of Research and Innovation from the Ministry of Higher Education and Research

"Both the Pact for Research and the Programming Act restate that appraisal activities are among the main goals of research. This makes IRSN one of France's foremost institutions, for it is directly concerned with appraisal and research. This twofold culture, which results from a deliberate choice by the country's lawmakers when they set up the Institute, seeks to guarantee its high scientific standards as well as its position as an independent expert appraisal organization in a booming sector. We would like to see this seamless culture and cross-fertilization between research and appraisal activities at the service of the public authorities expand. We now expect IRSN to become part of the general move to promote scientific excellence in France and to continue its initiative to open up to other research organizations at home and abroad. This initiative should be set out in the Institute's Medium- and Long-Term Plan."

Optimize technical support for public authorities

TECHNICAL SUPPORT: adapting organization and resources

Technical support for public authorities and public service missions are one of the lines of development set out in the contract of objectives between the French government and IRSN for the period 2006-2009. The Institute is managing its organizational structure and resources to adapt to changes in the nuclear and radiology field in France and to developments among its partners (safety authorities, ministry directorates, institutes, health agencies and so on).

ADAPTING TECHNICAL SUPPORT CONTRACTS AND AGREEMENTS

In 2007, IRSN signed a five-year agreement with the French Nuclear Safety Authority (ASN). The agreement provides a framework for the rules and conditions governing the Institute's technical support for the ASN, which was set up in 2006. It defines the operating framework, the type of activity carried out, request procedures, the exchange of information on work performed and ownership rules. It also stipulates how the resources set aside for technical support to the ASN are defined each year. These activities are funded by the government grant that IRSN receives via the Minister of Ecology, under program 189 of the constitutional bylaw on budget acts (LOLF). An annual agreement sets out the technical priorities for the coming year and allocates the related resources to the main fields of activity.
IRSN provides similar support for the DSND, the French safety authority in the defense sector. This activity is governed by an agreement signed in 2004, for which there is an additional annual agreement (signed last June).

IRSN has also strengthened its ties with the AFSSET, an agency with a growing role, by signing a four-year framework agreement in 2007. The agreement should promote the exchange of information and scientific cooperation between the two organizations in the field of occupational and environmental health. It also specifies the support the Institute can provide in terms of appraisal.
Lastly, events on the environmental front have led IRSN to provide technical support for the Ministry of Ecology and, more especially, the Directorate for Pollution and Risk Prevention (DPPR). These activities concerned regulatory issues and appraisal of situations such as the radiological impact of facilities classified for environmental protection (ICPEs) or procedures for managing contaminated soil. The agreement with the DPPR was renewed for another five years in these areas.

45.5%
of budget
allocated to technical support and public service missions
(44.8% en 2006)

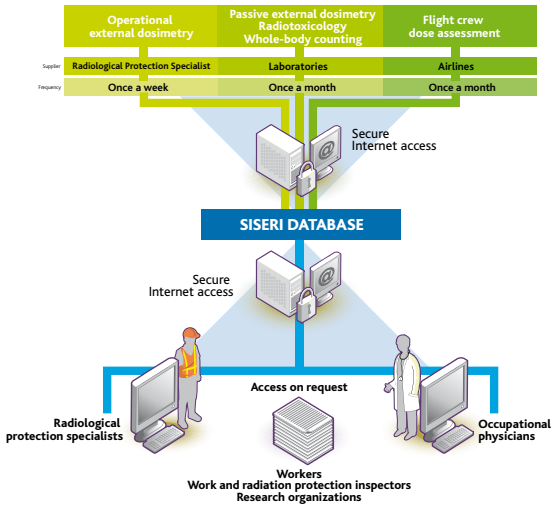
IN THE WORDS OF...

Michelle AGARANDE,
Coordinator of IRSN's appraisal programs

"IRSN has begun talks with three health agencies with which it works in each of their respective specialist fields. The talks are aimed at setting up agreements governing collaboration requests (for appraisals or research) made by these agencies, whether they directly concern the Institute itself or its experts under contract. One such agreement was signed with the AFSSET on October 15, 2007 in the healthcare and environmental field. Talks on food-related radiological risks are still in progress with the AFSSA. Negotiations with the AFSSAPS, however, have been postponed as this agency's health policy missions are being transferred to the ASN. These talks with healthcare agencies also reflect the growing demand for appraisals in the public healthcare field in France."

PUBLIC SERVICE MISSIONS TAKE PRIORITY

As part of the missions assigned in the Order that created it, IRSN is responsible for continuous monitoring in



Exposed worker dosimetry data maintained in a centralized, consolidated database.

the field of radiation protection, in particular by managing and processing dosimetric data concerning workers exposed to ionizing radiation. One of its priority missions for 2007 was to centralize, consolidate and store the personal dosimetric data of workers exposed to ionizing radiation (*see Challenge 3*). In order to meet the requirements of this mission, the Institute added to its resources to improve operation of the information system on the monitoring of occupational exposure to ionizing radiation (SISERI). This system pools the personal exposure measurements of about a million workers for statistical or epidemiological analysis or for reconstructing career-long radiology profiles under the required conditions of confidentiality. Two years after the system was set up, the report issued by IRSN in 2007 was positive. The Institute also determined the changes to be implemented to improve the centralization of some three million data items transmitted every year by laboratories. Working with the Ministry of Labor, it set up a platform to incorporate these changes into the system.

One of the main objectives is to make the system assimilate the different types of data it encounters more quickly.

As part of its environmental radiation monitoring activities, the Institute took stock of existing resources, then set up a major project to change its monitoring strategy. It also prepared a long-term plan to boost and modernize its networks – especially its remote air-monitoring system.

IN THE WORDS OF...

Marcel JURIEN de la GRAVIÈRE,

In charge of nuclear safety and radiation protection for defense-related activities and facilities

"IRSN is our chief technical support organization, bringing us its expertise in the event of any crisis affecting defense-related facilities: reactors, whether at sea or on land, laboratories, plants, transport operations and so on. The Institute steps in as soon as it learns of an event. We then work hand-in-hand to diagnose and understand the situation and predict how it is going to develop. Through this in-depth knowledge of the event, we are able to estimate the impact on human health and the environment and specify the measures to be implemented according to predefined scenarios. I then have all the information I need to advise the authorities – Prefects, Ministers – as to the steps to be taken to manage the crisis effectively. This is a smooth-running system that draws on the same expertise, communication and decision-making circles as civil facilities."

Provide other socio-economic players with the information, expertise and studies they require

Driving OPENNESS TO SOCIETY

As emphasized during the Environment Round Table, public decisions involving health and the environment are now to be examined on a pluralistic basis. IRSN has adopted this approach, conducting appraisal work prior to decision-making as openly as possible so that all stakeholders in public debate – civil society, public authorities, operators – can form their own opinion after reaping as much knowledge on the subject as possible.

In 2007 IRSN continued to develop various actions taken in concert with civil society, and also published reference documents for a broad public audience in order to explain its research and assessment work to all participants in the decision-making process, thus expanding knowledge on these subjects throughout society at large. Working in cooperation with the Local Information Commissions in the Loire region on environmental radiological monitoring or the Institute's involvement in the pluralistic expert group on uranium mines in the Limousin region are examples of

IN THE WORDS OF...

François ROLLINGER,
In charge of the Openness to Society Division at IRSN

"The action taken in 2007 at Montbéliard is a unique example of how we can open our scientific and technical expertise to society, since this region has no nuclear facilities. This initiative, taken by the CAPM (metropolitan community of the Montbéliard region), set out to further public awareness on radiation protection issues, and improve protection of the population in areas concerning medicine and radon in homes. We have been working with the CAPM for three years. The main event for 2007 was the opening ceremony for the exhibition entitled "Did you say radiation protection?", organized in partnership with the CEPN (center for the study of nuclear protection appraisals). Conceiving this project was a very rewarding experience, where the views of artists and scientists came together. The exhibition has produced offshoots including a DVD featuring the films presented during the exhibition, and a collaborative project involving several high schools that began in the fall of 2007. We would like to take this valuable form of teamwork further with a local community, and maybe even expand to other regions."

On-going cooperation with the Loire local information commission on environmental monitoring.

how participants on both sides were able to learn new ways of sharing knowledge.

But for this open approach to become a long-term reality, profound cultural changes are necessary for all persons involved, both inside and outside the Institute. To accompany and drive these changes, IRSN has developed new forms of action.

IN-HOUSE CAMPAIGN

The Institute has begun preparing a charter to lay down the principles of its commitment to opening its work to society. A vast in-house study was conducted throughout 2007, with the participation of over two hundred people representing different professions within IRSN. The participants exchanged their views on the basis of real-life experience, then debated the values and principles of action involved in promoting openness to society. This process was carried out using two special management instruments: the internal stakeholders network, which analyzes lessons learned from previous actions taken in opening up to society and proposes new forms of action, and the Openness to Society Committee, a management organization dedicated to implementing the Institute's line of strategy in this area. The conclusions of these debates have been collected and analyzed, and will serve as a basis in preparing the charter on openness to society.

PURSUING DIALOGUE OUTSIDE THE INSTITUTE

In the fall of 2007 discussions were engaged with local information committees and their federation, Ancli, concerning their roles and expectations, including their views on sharing expertise in a more open and transparent assessment and decision-making process.

Discussions initiated at the end of 2005 with Afsset, InVS, Ineris and Inrets on the role of national appraisal institutes faced with changes in the governance of activities and situations involving risks to human health and the environment were pursued in 2007 along three lines: identification of shared values serving as the basis for opening the appraisal process to society; the instruments required to achieve openness; and the ways of communicating with society on the health impact of diffuse risks. Information on this work was submitted to the Health/Environment and Ecological Governance working groups of the Environment Round Table in the fall of 2007.

IRSN has also requested advice from the National Public Debate Commission on procedures recommended to reinforce transparency in the Institute's work.

IN THE WORDS OF...

Jean-Claude DELALONDE,
President of Ancli

"For local information commissions, the June 2006 law on nuclear transparency and safety marked their legislative recognition and defined the framework in which they are to function. Although the orders enforcing this law have yet to be published, it represents a crucial step in the advancement of concerted decision-making and the active watch that civil society must keep around nuclear facilities. IRSN, as the public expert, has an important role to play in surveillance. Because IRSN has the scientific and technical knowledge that local information commissions so often lack, it is one of Ancli's major partners for nuclear safety and radiation protection matters. By helping us provide information and training to local information commissions and the general public, IRSN contributes constructively to an open debate, not on whether or not nuclear facilities should exist, but on how these organizations can contribute to ensuring that these facilities operate safely."

Be a driving force on the European and international scene

A standard reference AROUND THE WORLD

In keeping with its international development strategy, IRSN pursued its on-going European and international activities in a context marked by a nuclear energy revival in certain countries.

EXPANDING BILATERAL RELATIONSHIPS

The Institute was asked by Chinese and British nuclear safety authorities to participate in training programs in various areas of appraisal such as reactor safety, fuel cycle processing facilities, and emergency response procedures. Several other countries who wish to acquire nuclear power plants (such as Vietnam and the United Arab Emirates) have asked IRSN to work in parallel with European industrialists to design in safety from the beginning of these new reactor projects.

IRSN continues to accompany the French nuclear safety authority internationally on work including a project conducted in cooperation with South Africa involving probabilistic safety assessments on pressurized water reactors.

With regards to research, the international Source Term program has welcomed Canada as a new partner, and intensive discussions are underway with the US Nuclear Regulatory Commission (NRC) to expand bilateral cooperation on nuclear safety and radiation protection.

CONSULTANCY SERVICES TO EAST EUROPEAN SAFETY AUTHORITIES

In 2007 the Institute pursued its efforts to improve nuclear facility safety in East European countries through the TACIS program. As this program comes to an end, it will be replaced by the Instrument for Nuclear Safety Cooperation program involving Russia, Ukraine, and Armenia, as well as other nuclear countries with limited resources.
Other new types of activities also began for IRSN in 2007:

- providing technical support in the context of the G8 worldwide effort against terrorism and the proliferation

95
man-years
in time spent on international projects
(120 in 2006)

112
IRSN participants
in international expert groups
(58 in 2006)

18
European projects
in progress
(18 in 2006)

IN THE WORDS OF...

Édouard SCOTT-DE-MARTINVILLE,
Director of the IRSN International Relations Division

"In 2007 the European Commission supported the creation of a technological platform designed to bring together major players in nuclear fission and industry to establish a 'strategic agenda' for research and discuss ways to achieve this objective. Participants first agreed on a shared vision of the future covering the next 40 years. The platform, initially launched by industrial corporations and their technical support teams, finally welcomed technical safety organizations through negotiations led by IRSN, supported by its partners. IRSN urged the platform to give greater consideration to subjects that it deems essential, including facility safety, protection against ionizing radiation, waste management, and governance of risks related to nuclear energy. The platform was officially launched on September 21, with the first meetings of the Board of Directors and Executive Committee held on October 29 and 30.
The objective is to prepare a draft version of the 'strategic agenda' by the end of 2008."

of weapons of mass destruction: Russian projects to dismantle radioisotope thermoelectric generators and nuclear maintenance support ships, and remediation of former nuclear naval bases;
- consultancy services funded by East European safety authorities: as part of the RiskAudit program, appraisal of the safety report for a VVER-1000 nuclear power plant that Russia plans to build at Belene (Bulgaria).

PARTICIPATION IN INTERNATIONAL ORGANIZATIONS

In April 2007 IRSN and the IAEA joined forces to organize a conference on the role of technical safety organizations (TSOs), which provide technical support to national safety authorities. The conference demonstrated the importance of these appraisal organizations in maintaining a high level of safety in nuclear activities on an international scale. Following the conference, the IAEA entrusted IRSN with coordinating work that aims to define the purpose and tasks of TSOs.

The Institute was also involved in updating the international radiation protection system created through cooperation between several international organizations. After participating in the analysis of UNSCEAR work and contributing new ICRP recommendations in 2007, the process continued with a review of the IAEA's basic standards as well as European Community standards.

STRENGTHENING TIES WITH MAIN EUROPEAN PARTNERS

Pursuing its tasks within EUROSAFE, IRSN, along with its German and Belgian counterparts, began work to define joint research projects and prepare a guide on safety assessments. This work was conducted within the recently designated European TSO Network (ETSON).

Aside from its participation in EC research projects in its own specializations, IRSN was also asked to coordinate a new project on Advanced Safety Assessment Methodologies, Level 2 (ASAMPSA2) for nuclear reactors.

The Institute also initiated discussions on European research on radioactive waste management.
Other actions led by IRSN gave TSOs the opportunity to work on the definition of fission technology platform objectives (SNE-TP) and then participate in the startup and organization of the platform. The Institute led discussions between TSOs to facilitate information exchange and share responsibility within the platform (*see interview below*).

IN THE WORDS OF...

Tomihiro TANIGUCHI,
Deputy Director General of the IAEA and head of the Nuclear Safety and Security Department

"Nuclear safety approaches need to adapt to the 'renaissance' of this form of energy and its globalization. In the midst of a changing environment, technical safety organizations (TSOs) have a crucial role to play in supporting regulators by providing the scientific and technical knowledge acquired through intelligent pooling of R&D resources and sharing information and feedback. The development of partnerships between the IAEA and TSOs, such as IRSN, is a clear indication of the trend towards closer collaborative efforts that aim to harmonize safety approaches concerning both new-generation and existing facilities. IRSN consultants Philippe Jamet, Didier Louvat, and Hassan Abou-Yehia provide the IAEA with their experience in these matters by holding managerial positions within the Agency's secretariat. The first international conference on the challenges with which technical and scientific support organizations are faced to reinforce nuclear safety, organized by IRSN on behalf of the French government from April 23 to 27, 2007 in Aix-en-Provence (France) proved to be a very effective way of promoting cooperation among TSOs around the world. Like the other participants, the IAEA is convinced ofthe utility of a vast TSO network to further pacific use of nuclear technologies in the current nuclear 'renaissance' context, where the development of this form of energy in emerging countries represents a tremendous challenge."

TRAINING at the service of risk prevention: significant growth in 2007

IRSN provides training in radiation protection, nuclear safety and security to fulfill its public service objectives and capitalize on the Institute's knowledge in all its fields of specialization.

STRONG AND STEADY GROWTH IN DEMAND FOR TRAINING

Demand for training in radiation protection and nuclear safety is increasing regularly. This rise follows a steady trend as a result of regulations requiring that medical staff be trained in the radiation protection of patients, and the pressing need to develop a culture that fosters safety and radiation protection in the medical environment (see article on radiotherapy accidents).

This trend is also supported by the global revival of the nuclear power industry. Demand is sustained not only by domestic needs, but also by countries who wish to acquire or develop civil nuclear technology.

In 2007 IRSN's activities in basic or advanced training grew significantly, with a strong rise in the number of radiation protection courses, especially in the medical sector, the first training sessions open to an international audience, new training topics, and the development of exchange programs with universities, engineering schools, and the INSTN (national institute of nuclear science and techniques) for basic training needs.

www.irsn.org

GROWTH IN RADIATION PROTECTION TRAINING

From the outset there has been high demand for the program designed to train radiation protection specialists,

1,435
hours of education given in 104 training sessions on radiation protection
(725 in 2006)

1,415
people trained in radiation protection
(900 in 2006)

1,927
hours of training given by IRSN outside the Institute
(1,610 in 2006)

IN THE WORDS OF...

Bernard BIGOT,
High Commissioner for the French Atomic Energy Commission (CEA)

"We are entering an era where employers in the nuclear field have high expectations with regards to education, whether it is basic or advanced training.
The construction of new reactors such as the EPR or Jules Horowitz Reactor and the expanding use of radiotherapy equipment in hospitals implies a search for new skills and a rising demand for the relevant training programs. It is therefore essential to renew and update the supply-side of training in nuclear safety and radiation protection.
In France, IRSN and CEA are two public institutions whose competence is recognized worldwide in research and assessment activities related to nuclear development and the ensuing areas of safety and radiation protection. We both wish to coordinate our efforts to propose a coherent, operational, and sustainable offering in terms of training.
Work is currently underway to reinforce IRSN and CEA partnership within the INSTN (national institute of nuclear science and techniques), the educational center that sets the standard in our field, operating under the Ministry for Higher Education and Research and the Ministry for the Economy, Industry and Employment."

Rapid growth in demand for training in radiation protection.

especially in the medical field. Regulations stipulate that these specialists are responsible for ensuring the safety of workers subject to exposure in establishments using ionizing radiation. IRSN accommodated nearly 200 trainees in 11 sessions in 2007, while only four sessions were initially scheduled.
A large number of public or private health institutions also requested training for personnel obliged to comply with regulations on radiation protection of patients in the course of their duties. The number of sessions organized in 2007 was therefore doubled as compared to the previous year.

NEW TRAINING PROGRAMS

In the field of nuclear safety, IRSN has created an international course on the physics of severe nuclear reactor accidents as part of the SARNET European excellence network (*see Challenge 1, p. 43*). This course has been given to 38 trainees from 10 different countries. Having demonstrated the demand for training on this subject, the course will continue to be scheduled in 2008. IRSN gave another international training course in 2007 in Morocco, for professionals from the steel industry who may be exposed to ionizing radiation in the workplace.

2007 was also the year for a new version of the four-module initiation course offered to IRSN's newly recruited safety engineers, now entitled "Principles, Issues, and Practices in Nuclear Safety", which can also be offered to trainees from outside the Institute. The first session welcomed 48 participants, including two foreign trainees.

New advanced training programs developed in 2007 include courses on radioecology and radioactive materials transport. The training program on radiological inspection methods applied to drinking water has been completely revised.

In 2007, 200 IRSN employees also gave courses through basic or advanced training programs developed by universities or engineering schools in the Institute's fields of specialization. This significant contribution represents 2,000 hours of lectures and discussion.

MORE DETAILS

New industrial fluoroscopy and radiography regulations

The French Labor Code relevant to worker protection against ionizing radiation (Article R.231-91) was modified by Order no. 2007-1570 dated November 5, 2007 to attribute the responsibility for organizing aptitude testing for operating industrial fluoroscopy and radiography equipment to IRSN starting in 2008. This responsibility was previously assigned to regional authorities for work, employment and occupational training. Every year an average of 400 people apply to take this aptitude test for certification to operate industrial fluoroscopy and radiography equipment. The new order dated December 21, 2007 defines a more detailed and stringent procedure for certification testing. At the end of a mandatory training session, the applicant takes a written examination and must spend at least three months in apprenticeship within a company, working under the responsibility of a duly certified professional. The applicant must then write a report presented before a jury, demonstrating the ability to apply the knowledge gained. The aptitude certificate delivered by IRSN is valid for five years (instead of nine), and must be renewed after passing another examination that focuses on a professional report covering the previous period. A ruling by the French Nuclear Safety Authority defines the list of devices requiring a certified operator, which now includes particle accelerators for industrial use.

728
hours of education given in 17 training sessions on nuclear safety

214
people trained in nuclear safety

IRSN in 2007
Activities

Help ensure a high level of safety and radiation protection of existing facilities until the end of their service life

SAFETY of existing facilities

Maintaining a high level of safety on existing nuclear facilities is crucial to guarantee the long-term future of reactors and provide the operating experience feedback essential for safety assessments.
This explains why continuous monitoring of existing facilities and experience feedback analysis are considered unavoidable. It is through such work that improvements can be identified and research geared to implementing new safety systems to limit the risk of accidents with the possibility of serious consequences. Internationally, in 2007, many countries confirmed their intention to launch or reactivate large-scale civil nuclear programs. This move comes with a strong call for convergence in terms of safety requirements in the different countries concerned. IRSN's many collaborative projects with its counterparts and partners abroad contribute to this.

MONITORING FACILITIES

IRSN carries out safety and radiation protection appraisals for the ASN on an ongoing basis. These activities concern both existing and future facilities, such as reactors, fuel cycle facilities, other facilities where ionizing radiation is used, as well as the transportation of radioactive materials. Given the volume of work to be dealt with and the technical complexity of the questions raised, these activities employ a large number of highly qualified personnel.

REACTORS

EPR SAFETY ASSESSMENT

On April 10, 2007, the French government issued the building permit for the Flamanville 3 EPR (European pressurized water reactor). Its decision was based largely on IRSN's safety assessment of the project, completed in 2006.

From late 2006 to early 2007, IRSN joined with EDF and the ASN in preparing a detailed technical assessment program prior to the next step in the regulatory procedure – the commercial operating license for Flamanville 3. EDF expects commercial operation to begin in autumn 2011.

IRSN's tasks within this program included examining technical specifications in the following areas:
- safety equipment classification;
- general I&C architecture;
- control procedures in accident situations,
- detailed design of the nuclear island base slab.

In addition, IRSN experts provided ASN inspectors with assistance in a number of areas and, more particularly, on site during the initial stages of nuclear island construction.

www.irsn.org

STEAM GENERATOR CLOGGING

EDF investigations carried out after several incidents on two reactors at the Cruas plant (in Ardèche) revealed that steam generators (SGs) in French reactors suffered from a generic defect, namely tube support plate clogging (see More details).

In February 2006 this defect was the cause of an unscheduled outage in reactor no. 4 at the Cruas plant, caused by

Construction of the Flamanville facility in December 2007.

104
radiation protection services delivered, providing holders of radioactive sources and waste with operational technical support *(108 in 2006)*

a rapidly growing crack resulting from vibration fatigue in an SG tube, detected by a change in primary-to-secondary side leakage.
In 2006, IRSN recommended that special measures and inspections be carried out before restarting this reactor. In 2007, the Institute examined whether it would be advisable to carry out preventive plugging of some of the SG tubes and step up in-service monitoring of these tubes as proposed by EDF.

In addition, it emphasized the need to assess all the safety implications of tube support plate clogging, rather than concentrating only on the risk of tube damage. On this subject, IRSN showed that clogging could lead to significant mechanical stress on tube support plate fasteners, obstruct the natural flow of water and steam in SGs and affect the flow rate required for correct SG performance. It also carried out numerical simulations, demonstrating that in the event of significant clogging, SG water levels could fluctuate under certain operating conditions. IRSN analyses showed that this SG problem needed to be dealt with urgently. In the meantime, the operating power of 900 MWe and 1,300 MWe reactors has been reduced.
www.irsn.org

ANALYSIS OF CHANGES TO FACILITIES

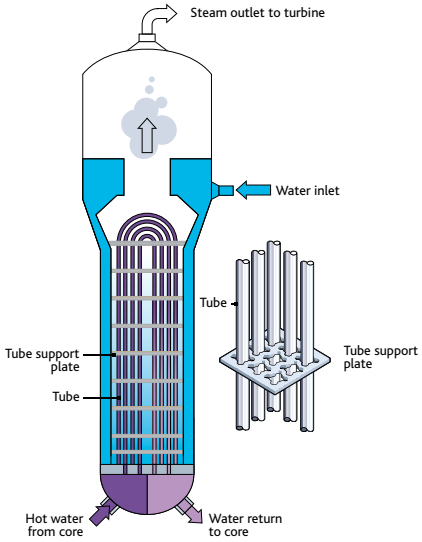
In 2005, EDF presented a method for prioritizing foreseeable changes to be made to its facilities during future safety reviews. The method takes into account both cost and benefit for safety. The ASN wanted the method to be examined by the standing advisory group for nuclear reactors. Within the safety review context, the method would help to define priorities and reach decisions concerning improvements to be made to reactor safety. In 2007, IRSN analyzed the method proposed by EDF for application to the third 10-yearly inspections for 1,300 MWe reactors (VD3 1,300). The analysis was submitted to the above-mentioned standing group meeting on July 5, 2007.

During the meeting, IRSN reported that a method of this type was acceptable in theory, but stressed that it should only be used for defining priorities and decision-making in association with more conventional analyses – and with caution. IRSN's examination of the method proposed by EDF pointed to the need for a number of changes that EDF should propose before the method could be used for VD3 1,300 inspections.

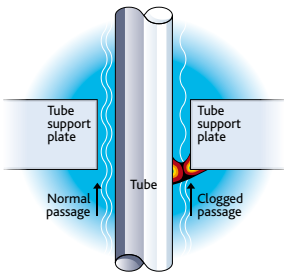
MORE DETAILS

Steam generator clogging

Clogging is a phenomenon that affects steam generator (SG) tube support plates. These allow heat exchange between the reactor coolant, heated to a temperature of 325°C in the reactor core, and the secondary system coolant, which the SGs transform into steam to drive the turbine.



Each SG contains around 3300 inverted-U-shaped tubes that the tube support plates help to keep in place.



In 2005, it was reported that the passages left to allow water and steam to flow between the tubes and the tube support plates had, in some steam generators, become gradually clogged with oxide – mainly magnetite – deposits

724
Technical notices to the nuclear safety authorities (excluding defense-related activities)
(690 in 2006)

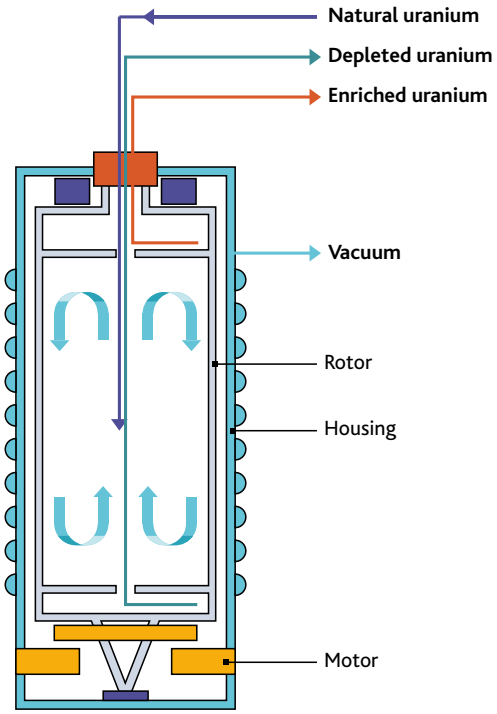
Help ensure a high level of safety and radiation protection of existing facilities until the end of their service life

FUEL CYCLE

SAFETY APPRAISAL OF THE GEORGES BESSE II PLANT

The Tricastin enrichment company, a subsidiary of AREVA, is building a uranium enrichment plant, called Georges Besse II, on the Pierrelatte site (Drôme). The new plant will use the centrifugation method and replace the existing plant, where the gaseous diffusion enrichment method is used. The centrifugation process, already employed by URENCO in other European countries, significantly reduces the amount of gaseous UF_6 in the facility and, therefore, diminishes the impact of any accident that might occur. Furthermore, the design of the new plant integrates a defense-in-depth approach that is aimed at reducing the likelihood and consequences of internal risks associated with the process used (criticality, spread of radioactive materials, exposure to ionizing radiation, fire, etc.).

In 2007, IRSN began its appraisal of the provisional safety report for the plant with a view to its partial commercial operation. This report follows on from the preliminary safety analysis report presented in 2005. In particular, it focuses on how plant design takes into account the location of the site and the related risks of external hazards (such as earthquakes, flooding, aircraft crashes or explosions).



Centrifuge uranium enrichment (Georges Besse II).

OPENNESS TO SOCIETY

The Forsmark incident presented to the Gravelines Local Information Committee

On May 4, 2007, IRSN submitted its analysis of the incident that occurred at the Forsmark plant in Sweden in July 2006 to the Gravelines (Nord) Local Information Committee (CLI): the plant had suffered a loss of offsite power (LOOP) following a short-circuit. As the plant is relatively different from French NPPs, the Institute described the electrical protection systems used at both types of plant. It also gave an account of the corrective action that was taken after the incident and that could be applied immediately to French plants. In addition, it presented the specifications for the in-depth studies requested from EDF.

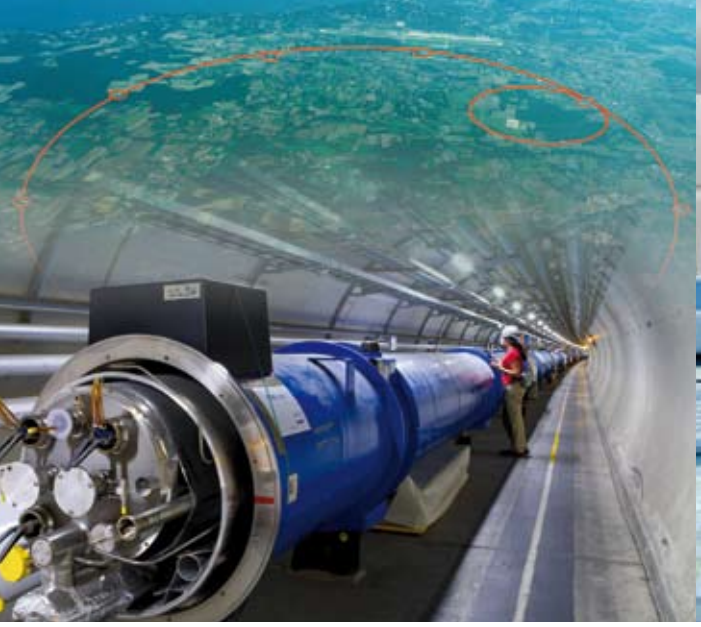
Those attending the meeting appreciated the technical details and explanations provided by IRSN. Local Information Committees are to become increasingly involved in such technical issues further to Act no. 2006-686 of June 13, 2006 on nuclear transparency safety , which provides the committees with the necessary resources to function and seek a second opinion.

www.irsn.org

FIRST PERIODICAL SAFETY REVIEW OF THE STE3 FACILITY

In preparation for the December 2007 meeting of the standing group for laboratories and plants, IRSN carried out a safety assessment of the STE3 facility at La Hague (Manche) on the basis of documentation submitted by AREVA NC. The plant bituminizes chemical coprecipitation sludge resulting from the treatment of liquid effluents. Protective measures against the risk of fire and explosion came under particularly close scrutiny. IRSN gave an unfavorable opinion for the conditioning of old sludge from the STE2 facility, now shut down, as proposed by AREVA NC.

The Institute found that the proposed monitoring and extinguishing systems were inadequate, especially in view of uncertainties concerning possible exothermal reactions between this sludge and the bitumen. It recommended developing another conditioning method.



CERN equipment safety appraised by IRSN.

New tools developed for better radiation protection.

ACCELERATORS

SAFETY OF CERN'S FUTURE LARGE ACCELERATOR

In June 2007, IRSN gave its opinion on the safety of CERN's different facilities to the relevant standing group. This included the Large Hadron Collider (LHC) before it begins to operate. Several of this international organization's facilities – including the LHC – straddle the border between France and Switzerland. One of the original features of the LHC has to do with the type of particles it will accelerate (protons up to 7 TeV). It will also be the most powerful particle accelerator in the world.
IRSN's safety assessment of CERN equipment is carried out under an agreement signed by this organization with France, providing for the inspection of its equipment by the ASN. In particular, the Institute carried out radiation protection counter-calculations using specific Monte-Carlo codes to model the transport of particles and radiation resulting from proton-matter interactions.

IRSN and the Swiss Federal Public Health Office also submitted to the Swiss and French authorities their report giving the results of samples and measurements taken in the vicinity of CERN. As far as dose is concerned, the impact on the population and environment is far slighter than that of natural radioactivity. A reference state, termed the "radioecological zero point" has been determined before the LHC is started up.

GROWING EXPERTISE IN LINEAR ACCELERATORS

The year 2007 saw a great deal of expert appraisal activity on linear accelerators in the medical field. IRSN looked closely at the safety provisions made to control access to areas at risk when this type of machine is in operation, as well as the sizing of the related radiation protection systems. In order to build up its expertise in this field, the Institute also began to develop new tools for improved characterization of the X-ray spectrum emitted when charged particles are slowed down. This would allow radiation protection systems to attenuate radiation more finely.

IN THE WORDS OF...

Pierre CHEVALLIER,
Chairperson of the standing group for plants (GPU).

"IRSN technical assessments are vital for the standing group's work on several counts. First of all, the Institute possesses the range of specialist skills required to carry out a facility safety assessment, covering physics, chemistry, civil engineering, geology, containment, radiation protection, fires and explosions.

At the same time it ensures that all these different aspects are brought together to form a coherent whole. IRSN also possesses a nuclear culture that other organizations lack and will never acquire, because the teaching of radioactivity has virtually disappeared. IRSN's cross-disciplinary skills and deep-seated nuclear culture are such that GPU meetings could not be held without the Institute's technical support. When the group prepares its recommendations, the Institute provides precious assistance in prioritizing the points raised during the assessment.

Many recommendations are accepted during a preliminary meeting between IRSN and the facility operator and no longer have to be examined by the standing group."

620
participations in basic nuclear facility inspections
(630 in 2006)

21
standing group meetings with an IRSN report
(22 in 2006)

Help ensure a high level of safety and radiation protection of existing facilities until the end of their service life

CROSS-DISCIPLINARY ACTIVITIES

WORK ON IEC STANDARDS

The International Electrotechnical Commission, or IEC, publishes many documents, including design standards for nuclear power plant I&C systems and, in particular, for programmed systems designed to protect the reactors. In France and other countries, these standards are considered as the de facto reference and changes in the regulatory framework may make them mandatory in Europe in the medium term.

IRSN therefore does everything to ensure that they contain technical requirements that can be verified on the product. This is a different approach from that adopted by other organizations, which place the emphasis on quality assurance procedures. IRSN believes that this approach does not present a sufficient guarantee for the design of highly complex systems.

In 2007, the Institute presented the IEC with a series of technical arguments to prepare a new standard on complex electronic components. IRSN is project manager for this work and leads the associated technical working group.

DEVELOPING TECHNICAL APPRAISALS AROUND THE WORLD

IRSN's involvement in support activities for foreign nuclear safety authorities has been growing since 2007 and is not limited to European contracts.

For example, in April 2007, a fuel cycle safety specialist for the first time was appointed to take part in a safety assessment during operation of a fuel fabrication plant in Resende, Brazil, as part of the first "Safety Evaluation During Operation" mission organized by the IAEA. The plant operator, Indústrias Nucleares do Brasil, was extremely open and determined to improve the safety of its facility. The mission was a real success and should open the door to new missions, in particular in Romania, Argentina and Sweden.

IRSN also provided technical support for South Africa's National Nuclear Regulator (NNR) to examine a change to the pressurizer safety valves that the Koeberg NPP operator planned to implement in August 2007. The NNR took into account all of IRSN's technical conclusions regarding the change. This work was carried out under an IRSN-NNR agreement signed in August 2007.

FUEL SAFETY

IRSN's research in the field of nuclear fuel is aimed at acquiring expertise and tools that can be used effectively in technical evaluations of nuclear reactor core behavior under accident conditions. Most of the Institute's research activities now relate to changes planned by plant operators to reduce the cost of generating electricity.
They are particularly concerned with experiments carried out as part of the international CIP program using CABRI, a CEA-operated reactor currently undergoing renovation and safety review.

UPGRADING OF THE CABRI REACTOR'S MEASURING INSTRUMENTS

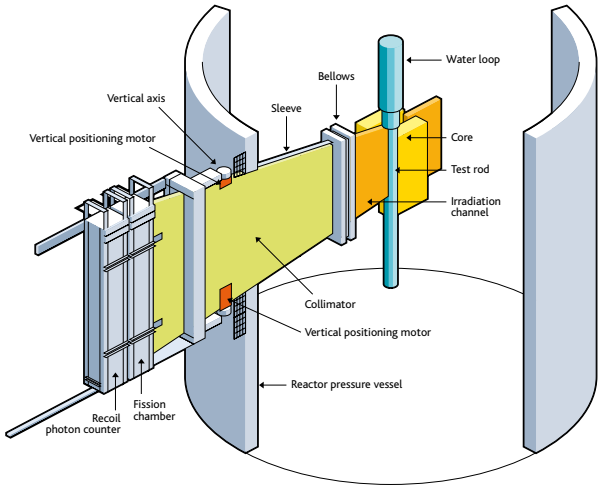
IRSN is taking advantage of the current CABRI reactor outage to modernize two measuring devices for which it is responsible: the hodoscope and the radiography, imaging and spectrometry unit (IRIS). The hodoscope is the only instrument of its kind in the world. It is used to take real-time measurements of the movement of fuel inside the test rod placed at the centre of the reactor core and subjected to a power excursion. The renovation should improve the performance of the acquisition system and make the data analysis tool more practical to use.

IRIS is used for nondestructive examination. It characterizes the condition of the rod before and after testing using radiography, tomography and gamma spectrometry. Modernization work on this instrument began in 2007. Major changes are being made to the mechanical system used

INTERNATIONAL

Collaboration with the NRC

IRSN and the US Nuclear Regulatory Commission (NRC) have decided to strengthen their research partnership on nuclear reactor fuel safety. Changes in fuel operating conditions and the use of new cladding materials, combined with R&D results obtained in recent years, justify the continuing research effort in fuel behavior in accident situations. The first decision made was to set up an advisory body to implement and follow up an action plan.



The hodoscope is used to take real-time measurements of fuel movements inside the test rod.

to move the rod during examination and new calibration instruments are being designed. The programmable controller used to control the various components of the instrument and the electronic acquisition modules are also being replaced by recent, lasting systems. Lastly, a high-performance X-ray generator is to be installed to offer optimum image quality.

FIRES

Experimental research into fires at IRSN aims to increase the Institute's knowledge of the phenomena involved and to develop tools to make a scientifically-based assessment of risks concerning the release of radioactive materials in the environment. Results serve in the assessment of facility safety and are widely used beyond the nuclear context.

TEST CAMPAIGN COMPLETED ON SMOKE PROPAGATION THROUGH DOORS

Carried out under the aegis of the OECD, the PRISME experimental program investigates heat and smoke propagation in the event of fire in a confined and mechanically ventilated facility. The 800 measurements taken during each test show the changes in the main physical parameters observed in the DIVA experimental facility during a fire. The only one of its kind in the world, this 700 m3 experimental setup comprises five mechanically ventilated chambers. The engineering division at IRSN contributed its experience and competence to the design and construction of this research facility.

The Institute used this unique experimental data to compare the different computational software applications used by the ten or so French and foreign organizations who are partners in the program. The PRISME Door test campaign, which took place in 2007, led to the modeling and characterization of heat and smoke propagation between two

IN THE WORDS OF...

Robert PEYROUX,

Assistant Director of MIST, the Micromechanics and Structural Integrity Laboratory

"After working together for several years on the thermomechanical behavior of materials, the CNRS-University of Montpellier 2 mechanical and civil engineering laboratory (LMGC) and IRSN wanted to reinforce and ensure the longer-term future of their joint scientific projects. This led to the creation of MIST, a joint micromechanics and structural integrity laboratory on July 7, 2007.
The activities of this «open» laboratory follow a four-year action plan which defines the pooled human (20 staff/year) and financial resources. IRSN contributes its expert knowledge of the behavior of nuclear materials such as nuclear fuel, particularly in accident situations, as well as its expertise in numerical simulation.
LMGC contributes its skills in the field of experimental analysis and, more specifically, the couplingof mechanical loads and changing energy levels. MIST's job is to understand and predict the behavior of materials and structures subjected to combinations of physical phenomena such as those observed during nuclear reactor accidents. The methods developed to deal with these nuclear situations should be applicable to situations encountered in other sectors of industry."

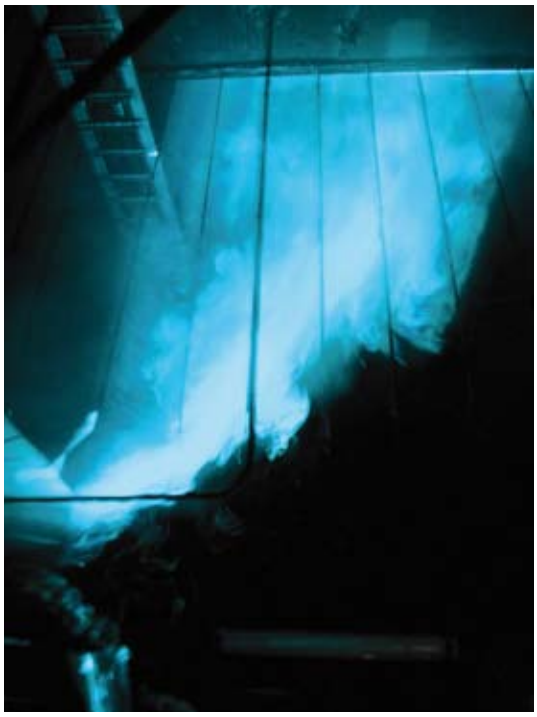
Help ensure a high level of safety and radiation protection of existing facilities until the end of their service life

rooms (wall, door, ventilation). A thesis based on this work is in progress, using laser tomography measurement validated on models at the University of Marseille.

CALCULATING THE HEAT RELEASE RATE OF A LARGE FIRE

At the INTERFLAM 2007 conference in September 2007, IRSN and Ineris presented a new experimental approach to calculate the heat release rate of a large fire using laboratory measurements taken during the combustion of inflammable materials.

The idea is to make a material burn as intensively on a small scale as it would on a large scale, either by overheating it using a radiant panel heater or by hyper-oxygenating combustion during lab tests. The tests used to develop this technique resulted in the classification of test materials into several categories according to their combustion behavior. This method has been developed jointly by the two institutes since 2005 and aims to achieve cost-effective characterization of a material's combustion behavior when the type of material is known. An on-going theoretical analysis will support material classification efforts in 2008.



Test campaign on smoke propagation through doors (PRISME Door).

RESEARCH OUTLET

Behavior of containment and compartmenting equipment in a fire

IRSN is investigating leak air flow and mechanical strength on equipment used to contain or compartment fires in nuclear facilities. In 2007 investigations on electrical and mechanical penetrations supplemented those already completed on others elements (dampers, doors, filtration units, HEPA filters). Tests representing the severe thermal and air flow conditions which may occur as a result of fire in nuclear facilities were carried out in the STARMANIA facility (Saclay), with AREVA NC taking part of some test runs. The resulting knowledge has been used for facility safety assessments. IRSN also carried out tests on glass behaviour in the framework of the French national fire engeneering program (PNISI). This applied research program aims to develop knowledge in France of modern methods for analyzing building security in the event of fire. **http://pnisi.cstb.fr/pnisi**

The STARMANIA station.

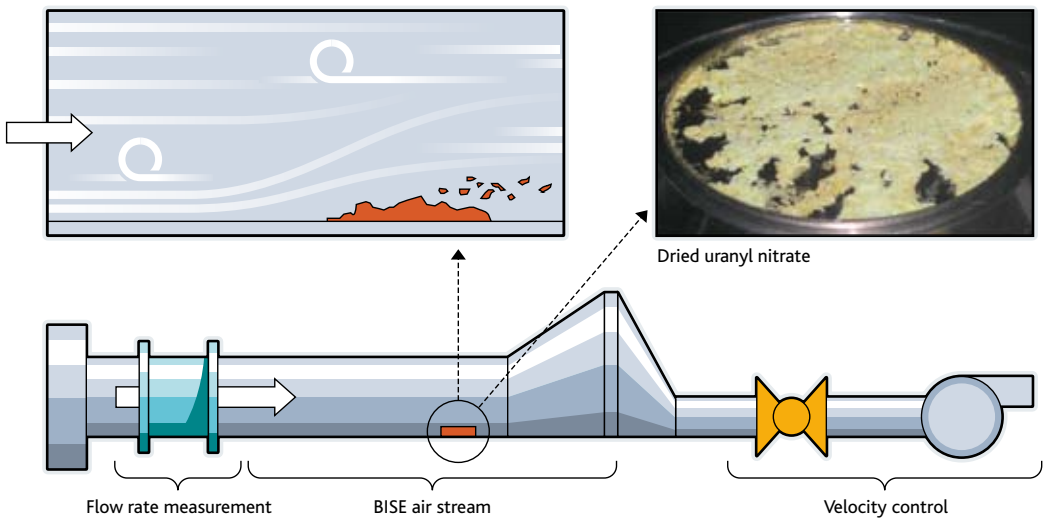


Diagram of BISE setup at Valduc (Côte-d'Or).

WHAT'S NEW IN AEROSOLS

Since 2004 IRSN has been conducting experimental research on resuspension of contaminants from liquid sources for different accident scenarios inside facilities. This work was described in a thesis defended in 2007 on aerosol emissions caused by the impact of droplets on solid or liquid surfaces and served as a basis for characterization of how fine particles may form aerosol contaminants from a dripping leak.

Another study was made on the effect of air flow on dried uranyl nitrate or plutonium residues. Preliminary results showed considerable differences in aerosol resuspension obtained from these two types of residue. The results were used in 2007 for containment assessments carried out at several nuclear facilities. They resulted in better assessment of the risks of radioactive release inside buildings or to the environment in accident situations and also served to establish an appraisal on early detection and impact-limiting measures proposed by facility operators.

IN THE WORDS OF...

Nicolas RIBEIRO,

Head of olfactometry at IRSN

"The origin of olfactometry at IRSN lies in the knowledge acquired by Institute researchers concerning dispersion of elements in the air.

We are currently involved in two projects co-funded by ADEME. The first began in January 2007 and concerns validating the use of electronic noses to monitor odor emissions from slaughterhouses. The second project began at the end of 2007 and concerns a study to validate and adjust a dispersion model of odors released by organic waste composting sites, which can be used to monitor compliance with odor pollution control objectives. IRSN's involvement in projects such as these demonstrates that knowledge gained from nuclear research can be applied in other fields."

Help ensure a high level of safety and radiation protection of existing facilities until the end of their service life

High Flux Reactor core.

NATURALLY-OCCURRING HAZARDS

IRSN conducts research on hazards caused by natural phenomena - earthquakes, floods, heat waves – to ensure that this type of risk is assessed correctly in designing and operating nuclear facilities.

REINFORCING HIGH FLUX REACTOR SEISMIC RESISTANCE

During the periodic safety review for the High Flux Reactor operated by the Institut Laue-Langevin in Grenoble, IRSN stressed that it was necessary to reinforce certain internal structures of the reactor building and nearby buildings to reinforce seismic resistance.

In 2007, IRSN analyzed the adequacy of work carried out on building structures for this purpose.

The investigation showed that in the event of an earthquake, the modifications guarantee the stability of the reactor building and reactor internals, that no leaks will occur in either the reactor cavity or the spent fuel storage channel, and that there is no risk of neighboring buildings damaging the facility.

PROTECTING FACILITIES AGAINST EXTERNAL FLOODING

Over the past few years, IRSN has been closely involved in reassessing the protective measures taken by nuclear operators in their facilities against external flooding based on lessons learned (Le Blayais in 1999, the Rhone valley in 2003).

In March 2007, the Institute presented its appraisal results to the standing groups on reactors and plants, concerning:

- the method applied for periodic safety review of nuclear power plant protection against external flooding developed by EDF following partial flooding of the Blayais NPP (Gironde) at the end of 1999, and how to implement this method at the 19 EDF sites;
- measures to protect the Tricastin (Drôme) facilities (other than the nuclear reactors) against flooding of the Rhone, collapse of the Donzère-Mondragon canal dike, and heavy precipitation;
- protection of facilities other than the EDF reactors for sites located at Chinon (Indre-et-Loire), Saint-Laurent-des-Eaux (Loir-et-Cher), Bugey (Ain), Chooz (Ardennes), Marcoule (Gard), Grenoble (Isère), Romans-sur-Isère (Drôme), and Cadarache (Bouches-du-Rhône).

This assessment concluded that the method developed by EDF was globally satisfactory while requiring a few improvements and some additional research.

IN THE WORD OF...

Jacques DUCAU,
Civil engineering specialist at IRSN

"Even if France is not located in a high-risk seismic zone, it is essential to take into consideration events such as earthquakes when dealing with nuclear facilities. Based on its research programs, IRSN conducts assessments in this field for design phases and periodic safety reviews. One aim is to ensure that the proposals submitted by operators establish or maintain acceptable margins concerning the risk of damage due to an earthquake and take into account the aging of facilities. In addition to the High Flux Reactor work, in 2007 IRSN investigated the CEA's paraseismic safety measures for the new Jules Horowitz reactor, placing special focus on the durability of the elastomer pads laid between the ground and buildings, designed to last throughout the 60-year lifetime of the facility. IRSN consultants also participated in certain missions organized by the IAEA and the French association for earthquake engineering following the Niigata earthquake on July 16, 2007."

www.irsn.org

IRSN considered, moreover, that other operators should adopt measures against external flooding consistent with those implemented by EDF.
Finally, in preparing the "flooding" guide for all nuclear facilities, the work accomplished in 2007 led to the creation of a list of phenomena to take into consideration and an inventory of methods used to characterize the rare or extreme events resulting from these phenomena.
www.irsn.org

EDF REACTORS AND HEAT WAVES

During heat waves, EDF may need to reduce the power production of certain reactors to comply with the approved general operating rules and administrative orders regarding effluent discharge and water sampling. In 2007, IRSN examined the EDF "extreme high temperature" reference system, conceived to ensure that facilities continue to operate correctly under temperatures that exceed design specifications.

IRSN concluded that applying this reference system will indeed improve reactor safety in the event of high temperatures. It did, however, highlight shortcomings in terms of the temperature values used to test materials resistance, as well as accident situations to be investigated under high temperature conditions.
www.irsn.org

SEVERE ACCIDENTS

IRSN work conducted on core meltdown accidents reveals the advantages of taking measures to reduce the probability or impact of such accidents on reactors in operation or under construction. This knowledge is essential to IRSN in fulfilling its mission as advisor to public authorities in a crisis.

UNDERSTANDING THE INTERACTIONS BETWEEN CORIUM AND CONCRETE

In a core meltdown accident, corium could melt through the reactor pressure vessel, spread over the subjacent concrete structures and cause the concrete to melt. Significant progress was made in 2007 in understanding and modeling corium-concrete interaction as a result of analyzing and interpreting small-scale tests carried out in one-dimensional geometry (ARTEMIS1D) with materials simulating corium, and larger-scale tests using real materials (VULCANO, MCCI-OECD). Thanks to the work accomplished by the Institute, progress has been made in understanding how the corium resulting from core melt ablates the concrete structures in the reactor. This research has also contributed to qualification of ASTEC, the major accident computing code designed to simulate a nuclear reactor core meltdown accident.

STUDY ON FUEL CLADDING AIR OXIDATION COMPLETED

The IRSN experimental program MOZART was concluded at the end of 2007 after nearly 200 tests. It began in 2004,

IN THE WORD OF...

Guillaume WACK,
Director of the ASN nuclear power plant division

"National and international events regularly remind us that it is absolutely essential to provide for natural hazards such as earthquakes, heat waves, fires, etc. These risks are taken into account when designing the facilities, and also during their operational lifetime via preventive measures and incident response guidelines. At the same time, an increasing knowledge base and experience feedback gained by analyzing events in French and foreign facilities regularly lead us to reconsider these issues, particularly during periodic ten-year reviews. Updating and creating new guidelines is thus an ongoing task, principally involving ASN and IRSN, but also operators. Assessment of the EDF heat wave reference system and preparation of guidelines on external flooding are also in progress. For these projects, we are working closely with IRSN on both the creation of doctrine documents, research into certain technical issues encountered during inspections, and expanding national and international operating experience feedback."

Help ensure a high level of safety and radiation protection of existing facilities until the end of their service life

setting out to study the kinetics of air oxidation on the zirconium alloys used to manufacture fuel cladding. MOZART was part of the international Source Term program and provided a large database for modeling the process of fuel cladding degradation in the event of an accident in the presence of air (core meltdown with an air inlet, fuel assembly handling accident, dewatering accident on spent fuel pools).

Three industrial zirconium alloys were investigated: Zircaloy-4, M5® and Zirlo. Some of the samples were pre-treated to simulate their condition after serving in the reactor (steam corrosion, hydrogen absorption by materials).

The results clearly showed a form of accelerated cladding degradation associated with the formation of zirconium nitride, which could cause the oxidation reaction to snowball. These effects will be taken into account when modeling severe accidents using the ASTEC software.

NEW FACILITIES TO STUDY THE BEHAVIOR OF IODINE

CHIP is one of the research areas covered by the Source Term international program involving partnership with EDF, CEA, the European Commission, the US Nuclear Regulatory Commission (US-NRC), the Canadian research organization AECL, the Paul Scherrer Institute (Villigen, Switzerland) and Suez-Tractebel. Its purpose is to provide data that will serve to reduce uncertainty with respect to radioactive iodine release in the event of a nuclear core meltdown accident. Since 2005, IRSN, together with the CNRS and the Finnish institute VTT, has led projects to create two test facilities for the CHIP program:

- the first, installed in the laboratory of materials and process science and engineering in Grenoble (Isère), is designed to collect basic data regarding chemical reactions between fission products and control rod parts, including the kinetics of these reactions at different temperatures;

IN THE WORD OF...

Emmanuel RAIMOND,
Head of PSA 2 at IRSN

"The past few years have seen great progress in France regarding Level 2 Probabilistic Safety Assessments (PSA 2) with both EDF and IRSN conducting studies on 900 MWe pressurized water reactors and initiating equivalent studies for 1300 MWe reactors and the EPR. This work is based on the results of various research programs conducted on severe accidents and owes much to the competence of those research teams. Today, PSA 2 can be used to define priorities when it comes to improving facilities. Since severe accident risk assessment is a common concern in European countries, IRSN does all it can to contribute to European efforts regarding PSA 2 harmonization, for example, in work carried out for the SARNET network of excellence. The Institute has also been tasked with coordinating an FP7 project that aims to provide a guide of best practices in terms of developing and implementing PSA 2."

MORE DETAILS

PSA, a safety assessment tool

The probabilistic safety assessment (PSA) gives an overall assessment of the risks associated with a facility and provides a tool for identifying potential weaknesses in its design and operation. It is also used to define priorities when scheduling improvements. With PSA, accident scenarios can be investigated in a systematic way. A level 1 PSA identifies the accident sequences that could lead to core meltdown and determines their frequency. A PSA 1 may be limited to equipment failures and human errors, or can also take into consideration hazards such as fire, flooding and earthquakes. A PSA 2 includes assessment of the nature, scope and frequency of radioactive release outside the reactor containment vessel for the accident sequences involving core meltdown identified by PSA 1.
In France, PSAs are developed by operators to demonstrate safety, and by IRSN as a tool to support its assessment missions.

Assembly of the reactor (bottom) and furnaces (top).

- the second, set up at the Cadarache site, will reproduce the complex chemistry of gaseous and condensed phases in the reactor primary circuit with mixtures close to those occurring in a core meltdown.

The end of 2007 saw the conclusion of a complex task involving design, R&D, construction and validation of these facilities.

SARNET: REPORT AND OUTLOOK

SARNET is a network of excellence dedicated to research on nuclear reactor core meltdown accidents. This network, coordinated by IRSN, has been funded by the European Commission from 2004 to 2008 as part of FP6. It fosters close collaboration between more than 50 partners from 18 European countries and Canada. Its purpose is to optimize resources, to work collaboratively to define severe accident research priorities, share findings and build on the results in what is becoming the European reference in terms of severe accidents: the ASTEC code, used by 30 SARNET partners.

After functioning for four years, the overall result of SARNET is very positive. Thematic groups encourage exchanges between researchers. Shared interpretation of experimental data has led to significant improvements in the ASTEC software models. Research priorities for the coming years have been clearly established. Two conferences (ERSMAR), two severe accident training sessions (see In the words of...) and the financing of researcher and student contracts have contributed considerably to disseminating knowledge. A reference book is in progress, with distribution scheduled for 2008.

The success of SARNET has led the European Commission to offer this network additional funding through FP7 for another four years.

AN INTERNATIONAL EXERCISE TO COMPARE MODELING COMPUTATIONS

Within the framework of the SARNET network, IRSN coordinated the comparison of computations carried out to model two experiments conducted in the TOSQAN facility. These experiments aimed to achieve a small-scale reproduction of thermal exchanges and gas mixtures which could occur in the reactor containment in the event of a severe accident when water-sprinkling devices are used. Ten teams of different nationalities participated in the exercise using their own computational methods. The exercise demonstrated the importance of using multidimensional models to correctly describe evaporation phenomena that play an important role in controlling risks of explosion.

STATE OF PROGRESS IN SEVERE ACCIDENT R&D

The physical phenomena set in motion during a severe accident are extremely complex. Research aims to achieve a better understanding of these phenomena and reduce the associated uncertainties. At the beginning of 2007, IRSN published a report on its web site describing the state of

IN THE WORD OF...

Jean-Marie MATTÉI,
Head of IRSN assessment and scientific activities

"In March 2007 IRSN initiated and organized the first training program on assessment of a nuclear reactor core meltdown situation in a pressurized or boiling water reactor, on behalf of the European network of excellence, SARNET. It was aimed at specialists likely to be called upon to advise public authorities in this type of situation. Our aim was to give them all the necessary information concerning how a severe accident may evolve in terms of the physical phenomena, related kinetics and uncertainty. Lectures were given by twenty national and international consultants. The 38 participants came from European countries, Canada and South Africa and worked in research organizations, safety authorities, or manufacturing corporations. Future sessions will deal with other reactors including VVER, CANDU and Generation III reactors (such as EPR, AP1000, SBWR...). One of the outcomes of this first program was that three foreign organizations requested an ASTEC license contract."

Help ensure a high level of safety and radiation protection of existing facilities until the end of their service life

Laser velocimetry measurements in the TOSQAN facility.

progress in severe accident knowledge and research work underway in France and abroad. The report was produced in collaboration with the CEA and supported by EDF.

It starts by presenting severe accident scenarios that are conceivable in Pressurized Water Reactors operated in France. Details are then provided concerning the different physical phenomena that could occur in the reactor pressure vessel and containment, as well as the ensuing chain of events and measures to mitigate their impact. For each phenomenon, the most important recent experiments – either in progress or planned for a future date – and the main models and computer codes used to simulate the phenomenon are described and the state of current knowledge is reported, in order to give an approximate idea of the expected reliability of predictions.

The report shows that significant uncertainties subsist, in particular concerning reflooding a damaged core and the erosion rate of the containment foundation raft. As regards fission products, uncertainties remain, especially with regards to the behavior of iodine in the reactor coolant system and containment. Experimental programs involving these issues are underway, particularly in the international Source Term program *(see page 42)*.

www.irsn.org

RESEARCH OUTLET

Providing services to the gas industry

Since 2003, regulations concerning risk management associated with industrial facilities classified for environmental protection have prompted industry to carry out probabilistic studies on dangerous phenomena that could occur during operations.
Implementation of this initiative has demonstrated that generic databases cannot be used to obtain consolidated values in calculating the probability of initiating events and security barrier failures. In 2007 IRSN performed several consultancy contracts for the gas industry with regards to these issues, including:

- critical analysis of the database concerning equipment failure probabilities developed by ARKEMA for the chemical industry;
- an inventory of measures existing in the LPG sector to collect data on security equipment reliability;
- recommendations on methods or specific issues provided as a third-party consultant specialized in hazard studies (Primagaz, Totalgaz, Butagaz).

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 (DSND), an authority operating under the aegis of the ministries of Defense and 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 (design, operation, decommissioning, dismantling). It also covers all the important modifications of these facilities induced by the development of their activity.

Design and construction

In 2007 IRSN investigated the safety of:

- the future AREVA NC facility at Pierrelatte (Drôme) for uranium recovery;
- the future extension of tritiated water storage at the CEA Valduc facility (Côte-d'Or); the decision to build this extension was the outcome of the periodic safety review conducted on this facility in 2006;
- certain units at the Île Longue (Finistère) operations base where considerable modifications to electrical systems and the fuel storage pool for nuclear steam supply systems are planned;
- a new waste storage facility which currently has no disposal system in the MAR400 building at Marcoule (Gard).

The Institute also studied the answers communicated by the CESTA CEA center (Gironde) as a follow-up to its commitments regarding construction of the Laser Méga-Joule (LMJ).

Operation

Facility safety depends not only on design and construction criteria, but also on principles governing operation and maintenance. It was in this context that IRSN analyzed the case of the aircraft carrier Charles-de-Gaulle's first scheduled downtime for maintenance and repairs in the port of Toulon (Var).

This investigation covered the safety of support equipment and tools, the systems hydrotest program, and preventive and corrective maintenance.

In preparation for aircraft carrier refueling, IRSN also looked into how the new naval propulsion fuel transport packaging is used in the CEA Cadarache facility (Bouches-du-Rhône), dedicated to producing new fuel for naval propulsion systems.

The Charles-de-Gaulle aircraft carrier.

3 national emergency exercises to ensure safety of defense-related facilities *(4 in 2006)*

5 meetings held by defense-related safety committees *(8 in 2006)*

Help ensure a high level of safety and radiation protection of existing facilities until the end of their service life

MORE DETAILS

Periodic safety review

A large part of the facilities contributing to the nuclear deterrence effort were built in the '60s. Periodic safety reviews assess the safety of these facilities taking into consideration both the evolution of their activities and related modifications, in addition to advances in knowledge and changes in doctrine.

In 2007, following a CEA report, IRSN reviewed the safety of the CEA Valduc center (Côte-d'Or) which handles plutonium and uranium. This review showed that experience feedback from operations is incorporated appropriately and that staff exposure to ionizing radiation is kept well under control. The operator plans to implement new measures to reinforce building compartmenting in the event of fire and enhance availability of dynamic containment of nuclear materials. IRSN made recommendations regarding the support structure in the event of fire and stressed the importance of human and organizational factors which are potential sources of incidents. Finally, earthquake hazards and the modifications planned in operations to reduce the associated risks were also thoroughly investigated.

In the context of periodic safety reviews, IRSN also studied the fast attack nuclear submarine (SSN) classification of systems important to safety for the nuclear steam supply system, and the approach to analyzing internal hazards and the radiological impact of accident situations.
IRSN also examined the general operating rules of the submarine support and maintenance workshop at the Cherbourg naval base (Manche) and the possibility of accommodating SSNs at Dock no. 8 at the Brest naval base (Finistère).

As part of cleanup operations at the CEA Marcoule center, IRSN reviewed the safety of recovery and repackaging operations on bituminized waste drums stored in bunkers and undertook investigative operations concerning high-level waste.

In the same center, IRSN also studied modifications to the liquid effluent treatment station required to accommodate effluents from the CEA Cadarache center.

Still at CEA Marcoule, IRSN examined the center's general safety document to assess risks associated with this site that could impact the safety of facilities.
Lastly, in the context of periodic safety reviews, IRSN investigated the safety of a building at the CEA/DAM Valduc center (see More details).

32
operational radiation protection referrals
(22 en 2006)

129
technical notices to the safety authorities for defense-related activities
(107 in 2006)

CEA Marcoule center (Gard).

Dismantling
IRSN continued to examine dismantling of the CEA Marcoule UP1 plant in the course of 2007. Analysis gave special focus to equipment and vessel cleanup operations, reconditioning of ash waste resulting from alpha waste incineration, and the conditions in which cerium IV is used to decontaminate equipment during cleanup operations.

Radioactive materials transport
Among the numerous files examined, IRSN reviewed a request for certification of the new PNCN package, designed to transport new fuel elements for naval propulsion, and extension of the TNSN package used to transport startup sources, and the BK 15 package used for irradiated fuel elements.

Internal emergency plans
In 2007 IRSN assessed the internal emergency plans of several establishments containing defense-related facilities. This concerned the operational part of the internal emergency plans of sites at CEA Marcoule and Bruyères-le-Chatel, as well as SODERN (Limeil-Brévannes, Val-de-Marne).

Elsewhere, a tripartite group including the French Navy, DSND and IRSN, created in the second half of 2006 to help the Navy rewrite its internal emergency plan, met nine times during 2007 to prepare for updating the four plans covering the Toulon naval base.

Radioactive sources
In 2007 IRSN recommendations concerning ionizing radiation sources in defense-related facilities operating under the aegis of the Ministry of Industry were issued mainly to those CEA centers with military applications divisions. Following these recommendations, CEA/DAM Ripault, Bruyères-le-Chatel, Valduc, Marcoule and CESTA received their authorizations. In fact, the DSND must deliver a specific authorization allowing these facilities to hold and use radioactive sources. Twice a year IRSN provides DSND with an updated list of the ionizing radiation sources used by the roughly twenty facilities operating under DSND authority.

MORE DETAILS

Fuel element transport: IR 800

CEA applied for certification of the "IR 800" package to be used to transport irradiated fuel elements from naval propulsion reactors. For this package, the study concentrated on criticality risks related to the presence of water (barrier sealing, draining and drying procedures, etc.). IRSN sent its safety assessment report for this package to the French transport safety commission (CST). In its meeting on January 26, 2007, the commission validated package compliance with regulations and made recommendations based on the Institute's proposals. Operations to reduce the associated risks were also thoroughly investigated.

IR 800 irradiated fuel element transport package.

Radiological monitoring of buildings being dismantled at the Pacific Experimental Center
Since the summer of 2007 and at the request of DSND, IRSN has been carrying out radiological inspections on the remains of buildings at the Pacific Experimental Center before their demolition. These inspections have been completed on the atolls of Pukara, Reao and Mangareva, where the buildings have now been demolished.

Begin working today to develop the knowledge and resources required to assess the risks posed by the nuclear facilities of tomorrow

CONDUCTING assessments on future facilities

In 2007, IRSN's research work was dedicated to expanding its knowledge base, pursuing research programs, and developing partnerships with entities such as the CEA, Andra, Areva, ITER and the European Community in areas covering future reactors, plants and radioactive waste repositories.

FUTURE REACTORS

IRSN's involvement in future reactor projects aims to acquire further knowledge and essential tools for making a qualified safety assessment when the time comes, and also to prepare the appropriate safety objectives.

PRELIMINARY STUDIES ON FOURTH-GENERATION REACTORS

In March 2007, IRSN published the results of its internal discussions on safety, radiation protection and security issues involved in the six "systems" (reactors and related fuel cycle facilities) selected by the Generation IV International Forum.

In comparison with previous reactor generations, the industrial community decided that these fourth-generation reactors should meet the following objectives:

- reduce the volume and radiotoxicity of waste produced;
- generate the same amount of energy while using far less uranium;
- continue to improve reactor safety and security;
- reduce proliferation risks.

As a result of orientations decided in France, IRSN studies concern mainly sodium- or gas-cooled fast breeder reactor technologies. Preference has been given to these technologies in accordance with the 2006 law relative to sustainable management of radioactive materials and waste, which plans for technological choices to be finalized in 2012 and construction of a prototype to be launched in France with a view to commissioning in 2020.

Working in partnership with interested parties, IRSN will continue, however, to keep a technological watch on high or very high temperature reactors, in spite of the decision to abandon them in France because of their "open" cycle (where actinides are not recycled).

As mentioned above, fast breeder reactors can call on two distinct technologies:

- sodium-cooled reactors, which have already been built in France on an industrial scale (Creys-Malville plant); subsequent projects have undergone preliminary investigation within a formal national context (1500 MW fast breeder reactor) or informal multilateral framework (European Fast Reactor);
- gas-cooled reactors, which so far have not been constructed either in France or abroad.

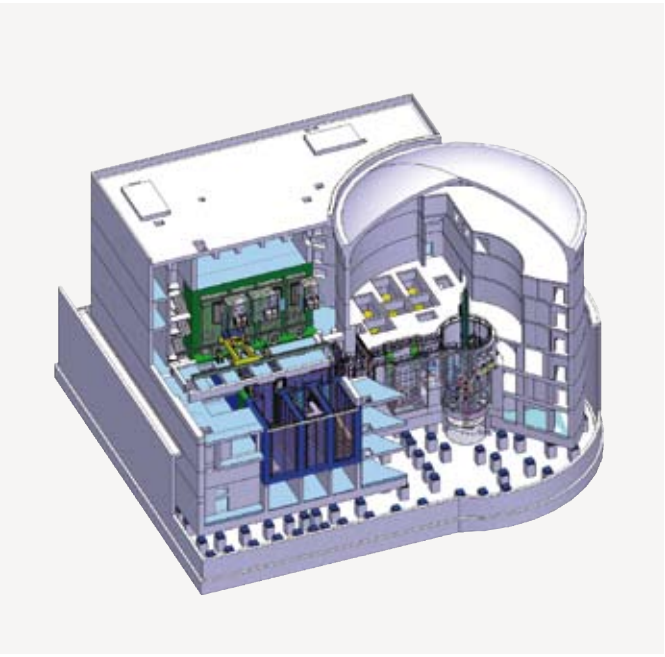
As regards the sodium-cooled alternative, IRSN has highlighted specific points that need to be studied in greater detail before 2012: reactor core characteristics, prevention of core meltdown accidents, and online monitoring of various components (especially reactor internals).

www.irsn.org

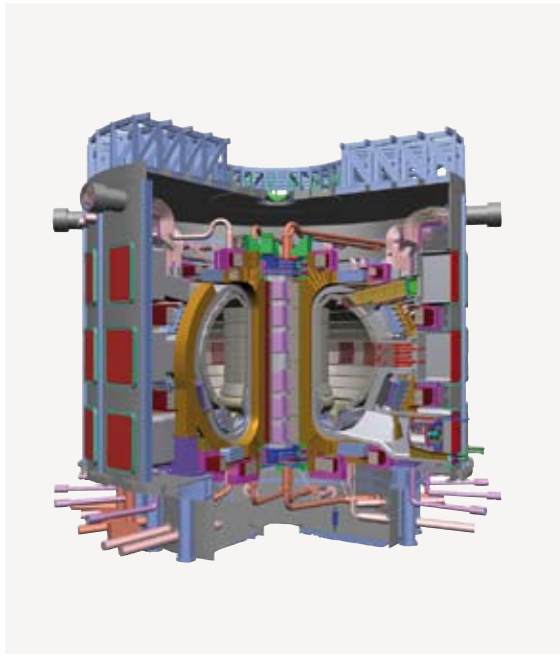
THE JULES HOROWITZ REACTOR FOR EXPERIMENTAL WORK ON FUTURE SYSTEMS

Experimentation inside the reactor will be required to test new equipment or materials for future reactors. For this purpose, the CEA is building a new reactor called Jules Horowitz (JHR) on its Cadarache site (Bouches-du-Rhône) for commissioning in 2014.

In reviewing the preliminary safety analysis for this new reactor, IRSN was particularly attentive to measures taken by the CEA with respect to a borax-type reactivity accident, a determining factor in designing the reactor containment. IRSN carried out studies for this purpose using the MC3D and SIMMER applications, the latter being initially dedicated to sodium-cooled fast breeder reactors and adapted in 2006 to research reactors using water-cooled uranium- and aluminum-based fuel. As a result of these studies, the CEA modified the design criteria for the Jules Horowitz reactor containment.



IRSN reviewed the preliminary safety report for the new RJH Reactor.



ITER: sectional view of toroidal magnet.

ITER: RESEARCH ON NUCLEAR FUSION

IRSN has been preparing for an in-depth safety assessment for ITER since the decision was made to build this experimental facility on the Cadarache site in France. The first step involved building knowledge in nuclear fusion, which led to training IRSN consultants on the Tore Supra tokamak experimental facility at Cadarache, dedicated to thermonuclear fusion controlled through magnetic confinement.

In 2007 technical discussions with the operator mainly concerned possible accident scenarios, safety issues related to plasma behavior, confinement of radioactive materials, and the use of automated systems for transferring components.

ÏAt the same time, various research activities began whose results will make a significant contribution to the ITER assessment mission. These activities concern risks related to the presence of hydrogen, activated dust or tritium.

Another task concerns the severe accident simulation software ASTEC, used for PWR reactors, which will be adapted for use on the ITER facility in a multiyear work program. This includes developing new models to study oxidation of the materials used to build the ITER vacuum vessel walls (beryllium, carbon, tungsten) and validating the software on fusion-specific experiments like ICE and LOVA (Japan).and validating the software on fusion-specific experiments like ICE and LOVA (Japan). It will then be possible to compute accident scenarios and compare results with those obtained using the MELCOR software, the American equivalent of ASTEC, which is used by the operator.

www.irsn.org

DEEP RADIOACTIVE WASTE REPOSITORY

To get ready for the safety assessment of deep radioactive waste repository in clay formations, IRSN organised to gather all the knowledge and the skill it may need. In this aim, il conducts studies and research with both national and intenational partners.

RESEARCH ACTIVITY AND PARTNERSHIPS

Throughout 2007 IRSN continued its research into the safety of deep geological repositories so that it has the competence necessary to conduct assessments before the deadlines fixed by the 2006 law, calling for licensing to create a repository in 2015 and commissioning in 2025.

IRSN signed an agreement with Andra in 2007 to analyze water samples collected through boring campaigns in its Bure underground research laboratory (Meuse/Haute Marne). These analyses will allow IRSN to establish an independent opinion on the origin of these waters and their permeation rate through the geological layers from the infiltration zones. Backed up by a geochemical interpretation, this work will thus contribute to confirming or refuting the hypotheses advanced by Andra in its safety reports.

Instances of hydraulic overpressure observed in the clay formation studied by Andra at the Bure facility were confirmed by investigations made at the IRSN Tournemire (Aveyron) experimental center. In 2007 IRSN acquired boring equi-

Begin working today to develop the knowledge and resources required to assess the risks posed by the nuclear facilities of tomorrow

pment capable of measuring hydraulic pressure changes in clay. This equipment and clay samples taken during the boring campaign will help IRSN clarify the reasons for the observed overpressure and describe the respective differences between the various transfer mechanisms that may impact the safety of a future deep geological repository.

An additional task involved studying the area around a tunnel dug through the rock which showed signs of damage. IRSN and the French public works research laboratory (Laboratoire Central des Ponts et Chaussées) developed an experimental protocol to investigate the damage. Using specific geophysical techniques, this protocol made it possible to characterize the damaged area in various configurations (measurements taken from the tunnel cladding or slab, directly in contact with the clay or in the presence of a concrete coating).

Also in 2007, an agreement was signed with the French oil institute (IFP) to set up an experiment to measure clay rock deformation due to interstitial fluid pressure. The agreement concerns the use of samples from the Tournemire experimental center, demonstrating its value for the study of clays, not only in the context of waste repository research, but also in its capacity to improve modeling of formations overlying oil reservoirs.

REVISION OF THE BASIC SAFETY RULE ON GEOLOGICAL REPOSITORIES

The projected update of Basic Safety Rule No. III.2.f relative to a deep geological radioactive waste repository was examined in detail on June 19 and 26, 2007 by the standing group for waste management. Work on this update began several years ago to take into account progress in knowledge and practices over the past fifteen years. It was conducted by a working group with members from Andra, the French Nuclear Safety Authority (ASN), the standing group for waste management and IRSN.

The changes under discussion were the result of research and safety assessments carried out by IRSN at various milestones throughout development of the Andra project. They also took into consideration work published by international organizations (IAEA, NEA, ICRP...) as well as French legislation, including Program Law No. 2006-739 of June 28, 2006 relative to sustainable management of radioactive materials and waste.

The major changes reviewed concerned the notion of reversibility, the definition of safety functions, radiation protection, the characteristics required of waste packages, and the repository monitoring program.

INTERNATIONAL

Incorporating the Tournemire experimental center into the IAEA Network of Centers of Excellence

July 30, 2007 marked the incorporation of the IRSN experimental center at Tournemire in the Network of Centers of Excellence set up by the IAEA to promote training and experimentation in underground research facilities dedicated to waste disposal. This network links research platforms from the 27 member countries and encourages the transfer of knowledge and skills to those States who are not equipped with the appropriate facilities. The invitation extended to the Tournemire center to join this network marks the recognition of IRSN research and assessment efforts targeting safety in high-level waste geological repositories and encourages the promotion of this experimental platform on an international scale.

Experimental gallery in the Andra underground laboratory at Bure (Meuse/Haute-Marne).

IN THE WORD OF...

Sébastien SAVOYE,

IRSN project leader for radioelement migration in clay formations

"The year 2007 saw the end of a forced ventilation experiment in the Mont-Terri (Switzerland) experimental center.
It was carried out as part of a European project to study the effects of ventilation on the properties of the surrounding geological formation, which appear to be limited. By participating in the research conducted at Mont-Terri, IRSN was able to collect results that served to complement those obtained at Tournemire.
For example, the Mont-Terri laboratory can conduct experiments using radioactive tracers, a possibility that is not offered at Tournemire. The Mont-Terri clay characteristics are also slightly different from those at Tournemire, which broadens our knowledge of these formations, making it easier to extrapolate the results to the waste disposal conditions prevalent at the future Andra site in the Meuse/Haute Marne area."

OPENNESS TO SOCIETY

Participation in Europeanwork on radioactive waste management

Radioactive waste management is a sensitive subject in France and throughout Europe, where citizens are regularly up in arms against the creation of new sites.

Efforts to better understand this opposition resulted in the European COWAM programs, which aim to encourage the involvement of all parties concerned. "COWAM in Practice" carries out work in five national groups: France, Spain, Great Britain, Romania and Slovenia, supported by a group of European social science consultants.

IRSN's involvement in "COWAM in Practice" consists of participating in the consultancy group and in the French working group, coordinated by a representative of the French national association of local information committees (Ancli).
This participative research program gives the Institute the opportunity to exchange ideas and information on best practices concerning stakeholder involvement and to discuss them with all the French players concerned (civil society, authorities, operators) in a context outside any decision-making processes.

Monitor exposure levels of both workers and the public to ionizing radiation and monitor radioactivity in France

RADIOLOGICAL MONITORING of people and the land in France

Part of IRSN's public service role is to provide a continuous radiological watch, involving both radiological monitoring of the environment and assessment of the exposure levels of workers and the public to ionizing radiation. IRSN is equipped with the resources necessary to detect abnormal levels of radioactivity in the environment. It is also expanding its knowledge of radionuclide transfer mechanisms in the environment and exposure in the workplace.

ENVIRONMENTAL EXPOSURE

Radiological monitoring in France aims to ensure that activities using ionizing radiation comply with current regulations and that, in general, radiological conditions within the country remain satisfactory. It is also designed to detect and characterize any situation in the environment that might result from a radiological or nuclear incident or accident in France or abroad.

191
beacons in the remote monitoring network in France
(210 in 2006)

1,000
ambient dose rate measuring points
(1,000 in 2006)

600
sampling points throughout the country
(600 in 2006)

MODERNIZATION OF IRSN'S RADIOLOGICAL ALERT NETWORK

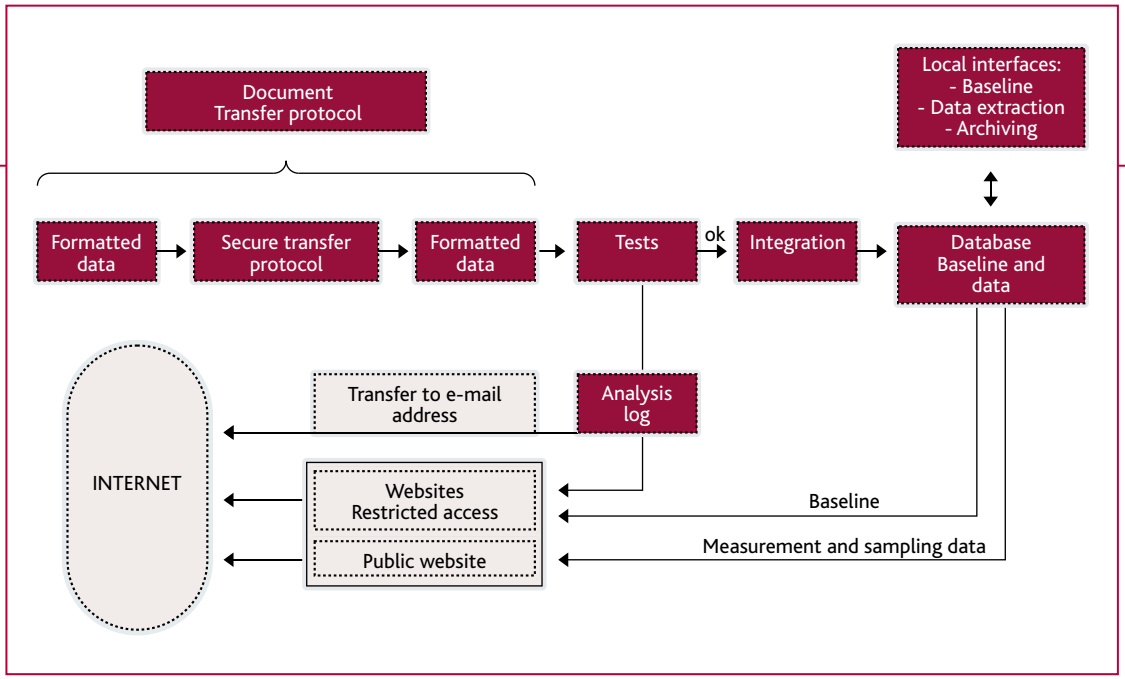
The purpose of modernizing the ambient radioactivity remote measuring networks is to improve the Institute's ability to detect and appraise accidental radioactive contamination in the air. This calls for improving data acquisition by upgrading the entire system, from the sensors installed across the country to the monitoring software. More efficient beacons also need to be installed. As part of this plan, different detectors for measuring the ambient gamma dose rate were tested in 2007, and a call for tenders was launched to develop a prototype for continuous measurement of aerosol radioactivity. Finally, IRSN has configured a supervision software package designed to centralize and report all the data collected on the remote monitoring networks.

In parallel, a review of the geographical location of the detectors was conducted to reinforce monitoring close to nuclear facilities and populated areas.

Platform used to assess ambient gamma does rate measuring instruments selected to modernize the Téléray network.

PUBLIC INFORMATION ON ENVIRONMENTAL MONITORING

In 2007, IRSN began renovating its Internet portal on environmental monitoring to provide better information to the public. A home page explaining IRSN's role now



Architecture diagram of the national network of environmental radioactivity measurements (RNM)

guides web users to two main sections presenting annual radiological assessments and data collected on a daily basis by the Institute through its measuring networks. An "aerosol link" has been added to the second section to report the results of IRSN's daily monitoring of these elements, where radioactivity is measured at 69 points throughout France. The purpose of aerosol monitoring is to evaluate the impact of human activities that use radionuclides on ambient air and to detect any abnormal increase of radiation in the air.
www.irsn.org

NATIONAL NETWORK OF ENVIRONMENTAL RADIOACTIVITY MEASUREMENTS

IRSN is in charge of development and technical management for the French national network of environmental radioactivity measurements (RNM), directed by the French Nuclear Safety Authority (ASN). In 2007 the Institute published the second report on RNM management, summarizing the steering committee's work and the state of progress of various projects underway.

These projects include the future RNM information system, designed to publish on the Internet environmental radioactivity measurements taken by various certified organizations. In 2007, IRSN developed a protocol for information exchange between the data producers and the network's new central database, and created the data reporting form. These two tools are necessary for electronic data exchange with the various data sources.

Following a call for tenders launched in the spring, IRSN chose the company who will be tasked with preparing the technical specifications for the new IT system. The document describes the database functionalities and the principles for reporting this information on the new RNM website. System development will take place during 2008.
www.mesure-radioactivite.fr

PUBLICATION

Publication of the book *Les conséquences de l'accident de Tchernobyl sur le territoire français (Fallout in France from the Chernobyl accident)*

In 2007, 20 years after the Chernobyl accident, IRSN published a survey of radioactive fallout in France.
This new edition gives the most up-to-date information and interpretations since the first edition appeared in 1999.
A survey of what is known about the transfer of radioactive substances released after the accident into the air, soil and foodstuffs explains the levels of radioactive contamination observed in France from 1986 to 2006, and evaluates the exposure of the French population to fallout from the accident. The book presents what has been learned from the disaster in terms of knowledge and the development of scientific programs, radiological monitoring and the management of nuclear crises in France.

Philippe RENAUD, Didier CHAMPION, Jean BRÉNOT, *Les retombées radioactives de l'accident de Tchernobyl sur le territoire français – Conséquences environnementales et exposition des personnes*, Lavoisier, coll. "Tec&Doc", Paris, 2007.
www.tec-et-doc.com

31,000 **environmental samples** taken per year *(31,500 in 2006)*

100,000 **radiological analyses** conducted *(100,000 in 2006)*

143 **participants** in intercomparison exercises *(137 in 2006)*

4 **individual radiological events** detected by radioactivity monitoring networks *(3 in 2006)*

Monitor exposure levels of both workers and the public to ionizing radiation and monitor radioactivity in France

Filter cartridges with traces of radioactive iodine to be sent to laboratories participating in intercomparison test.

Checking instruments anchored on the South Roustan buoy (mouth of Rhone River) for the EXTREMA project.

944
services to analyze drinking water, foodstuffs and other substances *(888 in 2006)*

2,847
reference standards produced by IRSN for calibrating radioactivity measuring instruments which 1,046 were associated with an internal request for special sources to check whole-body counting systems *(1,808 in 2006)*

35,000
samples analyzed (samples from the environment, foodstuffs, other substances, etc.) *(35,000 in 2006)*

RADIOACTIVITY IN CAMARGUE SANDS

In 2007, IRSN published its final report covering the results from studies conducted at the request of the French Ministry of the Environment on sands in the Camargue area, which present unusually high radioactivity levels in certain locations. The report confirms that the radioactivity in these sands is natural in origin, and that its increase is attributable to naturally radioactive minerals from rock erosion in the Massif Central and the Mont Blanc massif. These minerals are carried to the Rhone by watercourses and disperse in the Mediterranean Sea before collecting on the coast through natural sedimentation processes. Calculation of the additional annual effective dose in reasonably conservative exposure scenarios gave a value of 1 mSv. This result does not call for special measures to protect the public.

www.irsn.org

INTERCOMPARISONS BETWEEN MEASUREMENT LABORATORIES

Once a year IRSN organizes five intercomparison tests to certify French laboratories specialized in the measurement of environmental radioactivity. To demonstrate the competence of the participating laboratories, these tests must represent normal measuring conditions as closely as possible. In 2007, to meet this requirement the Institute prepared a set of special protocols for four of the five tests. These unique exercises involved measuring the following:

- radioactive compounds trapped in an activated carbon filter;
- carbon-14 in a sodium hydroxide solution;
- total alpha radioactivity deposited on an aerosol sampling filter;
- ambient gamma dose equivalent.

TRANSFER AND BEHAVIOR OF RADIOACTIVE SUBSTANCES IN THE ENVIRONMENT

To assess population exposure, it is first necessary to determine what type of natural and artificial radioactivity may be present in the environment, entailing population exposure. This is achieved by characterizing the sources and stores of radioactivity in the environment as accurately as possible, and any probably changes in space and time.

EXTREMA: A RESEARCH PARTNERSHIP

The EXTREMA research project began in February 2007. Funded by the French National Research Agency and directed by IRSN, the project aims to analyze the consequences of extreme climatic events on the distribution and transfer of contaminants in the environment. The year 2007 was devoted to setting up instrumentation at the mouth of the Rhone to collect experimental values to be used in validating a radionuclide dispersion model for the Gulf of Lion.

The EXTREMA project studies the environmental transfer of radioactive contaminants of interest to IRSN, as well as metal and organic pollutants that interest other partners in the project such as IFREMER, the universities of Aix-Marseille, Perpignan and Toulouse, and the Midi-Pyrenees Observatory.

The diversity of the scientific partners involved in the EXTREMA project, the complementarity of their areas of competence, and the investigative resources they each contribute constitute the strong points for a project of this

scale, which none of them could have achieved individually. The EXTREMA project is recognized by two competitiveness clusters in the Provence-Alpes-Côte d'Azur (PACA) region: the "risk and vulnerability management" cluster, and the "PACA Sea" cluster.

http://net-science.irsn.org

MODELING TRANSFERS OF RADIOACTIVITY IN THE ENVIRONMENT

IRSN is taking part in the SYMBIOSE project, which aims to determine the dosimetric impact of environmental radioactive contamination on humans. This innovative project, co-funded by EDF, has set out to develop a modeling and simulation platform designed to host models or codes to compute the transfer of radioactivity in different environments (in the air, on land, in water) for any type of release (into rivers, the sea or the air, during normal operation, incidents or accidents). Following a build phase that began in late 2005, IRSN delivered the first version of the tool to EDF in November 2007. A demonstration revealed just how powerful this tool was for computing impact on complex environments.

OPENNESS TO SOCIETY

A participative research project to manage contaminated regions

The kick-off meeting of the PRIME project, directed by IRSN, was held in September 2007 in the Drôme region. This regional project will organize concerted efforts between experts, decision-makers and regional representatives to develop a multicriteria method to characterize a region that may have been contaminated after an accident involving radioactive substances. The chosen method will consist of ranking the radioecological sensitivity factors of a specific region with regards to radioactive contamination by seeking the answers to questions such as: which parameters are important in terms of the influence they may have on the dose received by humans and how should they be ranked? Which parameters should be used for decision-making? The area under study lies within a radius of approximately fifty kilometers of the Tricastin-Pierrelatte site and extends southwards to the mouth of the Rhone and the Mediterranean coastline.

STUDIES ON SITE ENVIRONMENTS

The Institute's expertise in radiological monitoring often leads utility operators to request that IRSN teams study the impact of their activities on the environment and population.

ENVIRONMENT SURROUNDING NUCLEAR FACILITIES

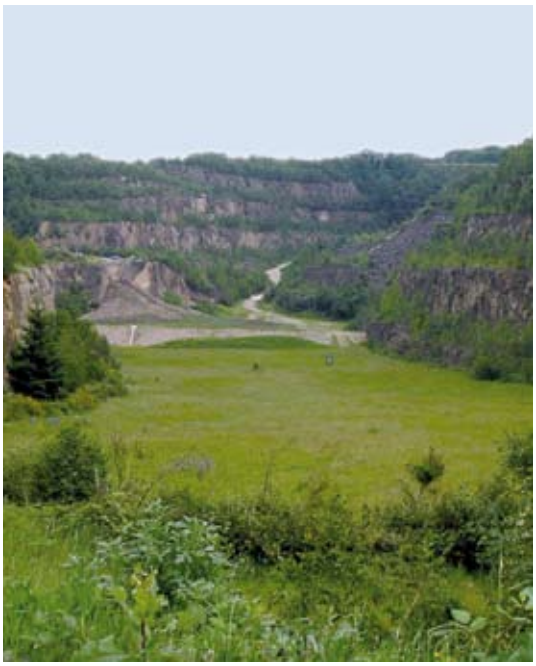
Following a European call for tenders in 2007, IRSN was chosen by EDF to provide radioecological monitoring around 12 nuclear power plants until 2017. This contract continues a partnership that has lasted for more than 20 years. The service consists of updating shared knowledge of radioactivity levels around power plants, interpreting the origins of this activity, and monitoring any changes over time. This involves annually monitoring traces of radionuclides that may come from nuclear power plant effluents by taking measurements from around forty locally produced foodstuffs and biological indicators (moss, algae and lichens) that are known to concentrate radioactivity. Similar samples are taken from rivers upstream and downstream the power plants for comparison purposes. The Institute publishes a full report for each power plant once every ten years, based on data collected over the period, including the results of special measurements taken on samples to broaden the detection target to all measurable radionuclides in the environment. Two ten-year reports were sent to EDF in 2007: one for Saint-Laurent-des-Eaux (Loir-et-Cher) and one for Chinon (Indre-et-Loire).

This approach, which also provides reference values that can be used in the event of an accident resulting in the release of radioactivity to the environment, is also of interest to other nuclear operators. The Institute has signed a similar annual contract for the Comurhex site at Malvési (Aude) and for the power plant being decommissioned at Creys-Malville (Isère).

FOOD SURVEY AROUND THE TRICASTIN-PIERRELATTE SITE

In 2007, the results of a food survey carried out in the vicinity of the Tricastin-Pierrelatte plant were made public at the meeting of the commission for information on the major energy facilities at Tricastin on March 21st. This survey, carried out by IRSN at the request of AREVA NC, provided the opportunity to assess the food rations of people living close to the site and to determine precisely what portion consists of locally produced foods. It confirmed the food consumption hypotheses used to calculate local population exposure. More surveys based on the same principle will be carried out near other EDF sites in 2008.

Monitor exposure levels of both workers and the public to ionizing radiation and monitor radioactivity in France



Inventoried obsolete mining sites.

NATIONAL INVENTORY OF URANIUM MINING SITES

The MIMAUSA program, initiated by the Ministry for Ecology, is tasked with collecting complete information on closed uranium mining sites in France and making it available to government administrations and the public.

In 2007, it produced the second edition of the national inventory of these sites. Compared with the first edition, the new inventory includes around thirty additional sites, and makes it easier to locate the sites and identify the watercourses concerned. Development of a database giving the history of the sites and their administrative and environmental status is currently underway to complete the information in the inventory.

www.irsn.org

ASSESSMENT OF THE SAINT-PIERRE SITE

IRSN has continued expert assessment of the radiological condition of the environment around the closed mining site at Saint Pierre (Cantal) and has presented a summary of its investigations to the local information committee. The report includes a map of the gamma dose rate at locations near the rehabilitated site (obtained using the automated SOCRATE device designed by IRSN), as well as results of environmental sampling campaigns and analyses. Special focus was placed on water flowing from the site, traces found in sediments of the Combret River and at the inlet to the municipal lake, and analyses of low-level radioactivity in the food chain. The CRIIRAD, invited to participate in this inventory by the local information committee, also presented its results. The results of this investigation will contribute to a series of proposals to improve monitoring and reduce impact on the population, planned for 2008.

www.irsn.org

OPENNESS TO SOCIETY

IRSN's contribution in Limousin

As a driving force in the creation of the joint expert group on uranium mining sites in Limousin (GEP Limousin), IRSN continues to participate actively in the group's activities and contributes to on-going debates.
The GEP Limousin group is tasked with providing a critical analysis of the situation resulting from obsolete mining operations, from an environmental and health point of view, based on documents produced by AREVA NC and the assessment of these documents by IRSN. It also proposes improvement action where necessary.
In 2007, GEP Limousin pursued its work, publishing two progress reports and the first series of recommendations, some of which were quickly implemented by AREVA NC. Fulfilling the role assigned by public authorities, it has also reported its conclusions to local organizations involved in concertation (the local information and monitoring committee at Bellezane and the Haute-Vienne departmental council for health and technological risks and the environment). Meanwhile, IRSN has carried out a detailed analysis of the available data, used by experts taking part in the work.

www.irsn.org

IRSN monitors worker exposure to ionizing radiation.

RADIATION PROTECTION OF WORKERS

In the field of worker radiation protection, IRSN's work aims to provide public authorities and employers with the knowledge and tools they need to control the risks associated with ionizing radiation in normal situations and in the event of accidental exposure.

DEPLOYMENT OF A NEW DOSIMETER

IRSN currently supplies dosimeters to more than half the exposed workers in France. The project to replace the photographic dosimeter used up until now with a radiophotoluminescence (RPL) dosimetry technique, begun in 2006, made important progress in 2007.

Following validation of the RPL dosimeter prototype, work required to set up the new dosimeter operating laboratory was carried out at the Vésinet site (Yvelines). The automated systems required to accommodate dosimeter operation were designed, built and installed in the new locations. According to plan, the first RPL dosimeters were sent to customers in December and the technology transfer is expected to be complete by the summer of 2008.
IRSN now has a high-performance dosimeter operated in a laboratory with a level of automation that has significantly improved service efficiency, particularly in terms of the quality of the results and the time required to obtain them.

In parallel, with a constant focus on customer satisfaction, delivery and deployment of the new dosimeter will be accompanied by reinforced customer relations.

www.irsn.org

Radiophotoluminescent dosimeter.

MONITORING AND ANALYSIS OF PROFESSIONAL EXPOSURE

In 2007, IRSN set up a special unit to develop and operate the SISERI system (information system for monitoring professional exposure to ionizing radiation). The database for this system enables IRSN to centralize and conserve data on worker dosimetry in France, in accordance with its role as defined by the Labor Code. The unit is also responsible for monitoring and recording radiological events and incidents of any origin. The data collected is analyzed and presented in a panoramic view of worker radiological exposure.

WORKER EXPOSURE TO RADON IN UNDERGROUND ENVIRONMENTS

In 2007, IRSN validated a special method for characterizing radon levels in underground locations. It takes account of the various configurations of these environments and their specific characteristics (temperature, humidity, etc.).

57
radiation protection service contracts
for regulatory inspections, searching for radon in buildings, studying sites contaminated with radiation or natural radioactivity augmented through an industrial process.
(66 in 2006)

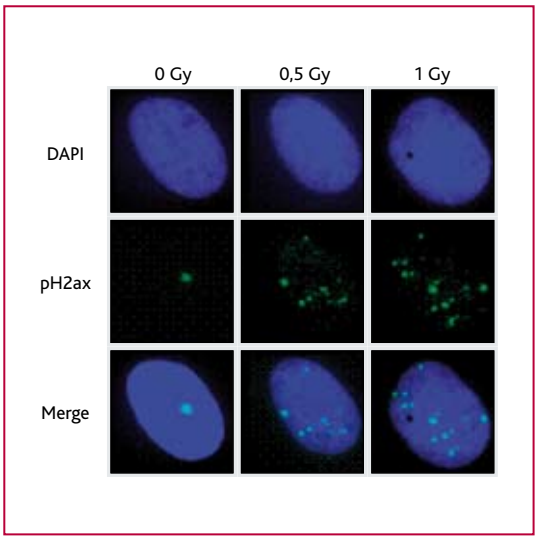
Monitor exposure levels of both workers and the public to ionizing radiation and monitor radioactivity in France

At the request of the ministries of Culture and Agriculture, the method was used by IRSN in about fifteen underground sites throughout the country during three campaigns to measure radon activity by volume. These studies, which provided an estimate of worker exposure to radon, covered everything from decorated caves to mushroom beds and cheese cellars. IRSN's studies will provide the basis for changes to regulations governing occupations carried out in underground locations.

NEUTRON EXPOSURE

To maintain a high standard of expertise in neutron dosimetry, IRSN is developing an irradiation platform that can reproduce all types of neutron field. In 2007, the Institute performed the first calibration services with the AMANDE facility, which produces monokinetic neutrons. Work has continued to develop measuring instruments to serve as standards that can be used for complete facility qualification. The irradiation platform was also used in a research project into the biological effects of ionizing radiation on cells, carried out in collaboration with INSERM.

The neutron spectrometry systems useful in workstation studies were improved to make them suitable for taking measurements in the presence of a high-photon component or for measuring high-energy neutrons. The first measurements were taken to assess the impact of secondary neutrons produced in radiotherapy facilities on worker exposure.
Lastly, EDF called on IRSN neutron expertise to compare different operational dosimeters.



Effect of neutrons on cells visualized using immunofluorescence.

SUPPORT FOR WORKSTATION DOSIMETRY STUDIES

IRSN has published a practical guide for the various agencies involved in the worker radiation protection that suggests an approach to conducting studies on doses received at workstations where there is a risk of exposure to ionizing radiation. The publication draws on experience acquired by IRSN in this field over many years, and is aimed principally at directors, radiation protection officers and occupational physicians. It suggests a method for collecting dosimetry data, deciding how to classify workers and delimiting work

RESEARCH OUTLET

New COFRAC accreditation

In 2007, IRSN obtained COFRAC accreditation for its work on the identification and dosage of gamma/X-emitting radionuclides in urine. This recognition of the Institute's professionalism and skill marks the realization of its quality policy, which bases radiotoxicological analyses on the NF EN ISO 17025 standard: General Instructions on the Competence of Test and Calibration Laboratories.

This success has encouraged the Institute to pursue its accreditation program in the field of radiotoxicology. Accreditation for measuring beta-emitting radionuclides by liquid scintillation has also been scheduled.

A new IRSN publication appears in the Technical Sheets section.

Using calixarenes to analyze actinides in urine.

areas. Additional sheets explain how the method can be adapted to the different fields of activity concerned. The first edition of the guide contains two sheets relevant to medical activities: conventional radiology and interventional radiology. New sheets will be added later to complete the publication.

www.irsn.org

CALIXARENES: FIRST TESTS IN MEDICAL ANALYSIS LABORATORIES

IRSN is directing a research program in the field of radiotoxicology analysis aimed at improving nuclear worker monitoring. This research has led to the development of a new method for analyzing actinides (uranium, plutonium, americium) in urine that calls on molecules from the calixarene family to form extraction columns used to isolate these radionuclides.

The development of this method leapt forward in 2007, giving way to an application for an international extension of the IRSN patent filed in 2005, as well as implementation of the first tests of these extraction columns using calixarenes under real conditions, i.e. in medical analysis laboratories.

In 2007, these trials were conducted by IRSN's medical radiotoxicology analysis laboratory, confirming the method's potential. Plans are to extend implementation to other medical analysis laboratories in the private sector and to environmental sample analysis laboratories. In parallel, research has begun on manufacturing calixarene-based extraction columns for commercial use, to meet demand from users both in France and abroad.

INTERNATIONAL

Review of ICRP recommendations

At the end of a nine-year open process including two rounds of Internet consultation, in March 2007 the International Commission on Radiation Protection (ICRP) adopted new recommendations on radiation protection. With updated scientific content, the Recommendations present significant advances for the management of radiological risk. The same approach now applies to all exposure situations (scheduled, emergency or existing).
In emergencies, the system recommends optimizing exposure below a reference level decided in advance according to the nature of the situation. The ICRP also gives more emphasis to environmental protection and recommends setting up strategies that apply in emergency or existing exposure situations (natural or post-accident exposure).
These Recommendations are the result of a collective international effort in which IRSN played a large part. The process is continuing with an update of the international basic safety standards for radiation protection published by the IAEA and Euratom.

164,732 **workers** monitored by dosimetry *(152,028 in 2006)*

19,319 **radiotoxicological analyses** *(21,978 in 2006)*

225 **whole-body counting measurements** *(247 in 2006)*

1,491,118 **personal dosimeters** provided and used *(1,518,412 in 2006)*

Help prevent the proliferation of nuclear, biological and chemical weapons, and control nuclear and radiological security in the face of terrorism

NECESSARY VIGILANCE in the field of nuclear security

In addition to ensuring round-the-clock control of security at nuclear facilities, key activities in 2007 for IRSN involved reviewing security regulations and a major overhaul of the nuclear materials accountability system.

PROTECTION AND INSPECTION OF NUCLEAR AND SENSITIVE MATERIALS

PHYSICAL PROTECTION OF NUCLEAR MATERIALS

Officially designated experts from IRSN are appointed by the Senior Defense and Security Official at the Ministry of the Economy, Finance and Employment (HFDS/MINEFE) to carry out inspections of facilities holding nuclear materials at the official's request. In 2007 the nuclear materials inspectors carried out 53 inspections, including one "reactive" inspection following an incident that occurred while closing the MASURCA facility at Cadarache (Bouches-du-Rhône).

During 2007, inspections focused particularly on:
- protection measures taken outside working hours;
- remote monitoring;
- access control.

Inspections cover checking compliance with technical instructions and ensuring that equipment meets the desired objective, taking into consideration plant layout (distance between buildings, location of the security control center, surface area of the zone to be monitored, etc.).
Site physical protection systems are making more widespread use of IT systems to ensure video surveillance, operate protection systems on complex sites, report alarms centrally and analyze any alerts. In 2007 IRSN developed and began testing a special security assessment tool for the IT systems dedicated to protection.

171
nuclear material control inspections
(172 in 2006)

43
missions to escort international inspectors in nuclear and sensitive material inspections
(45 in 2006)

NUCLEAR MATERIAL FOLLOW-UP AND ACCOUNTABILITY

Expert assessment and inspection activities

In 2007 IRSN carried out 138 analyses of files and 122 analyses of nuclear material inventory reports, at the request of the HFDS/MINEFE.

IRSN experts also audit nuclear material follow-up and accountability procedures at nuclear facilities. Nuclear materials inspectors conducted 59 inspections in 2007 at operator facilities that are required by the regulation to

MORE DETAILS

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 to test decision-making chains and coordination of those involved (operators, public authorities). These exercises consist of taking a nuclear material inventory at one or more facilities within the space of a few hours to confirm or rule out any theft or misuse of these materials.

The exercise carried out in October 2007 was the first for EDF. The exercise scenario prepared jointly by IRSN and EDF simulated a malicious act concerning a fuel assembly of the type used at EDF power plants. The emergency response units of EDF, IRSN and the HFDS/MINEFE went into action. The exercise took place over approximately eight hours and involved over thirty people.

Twelve exercises of this type, held annually, have already taken place. They have been used to prepare and test emergency procedures applicable at major French nuclear sites.

Equipment for measuring plutonium quantity in waste drums.

submit an authorization file. Some of these inspections included a specific audit of material measurements and accountability. Efforts made during the last few years to improve the content of licensing and inspection files were pursued in 2007. These documents are now operational and are used during inspections.
The inspectors also conducted ten technical inspections at facilities required by the regulation to file a declaration on their activities.

Nuclear material metrology
For nuclear material follow-up and accountability, IRSN is developing measuring systems for quantitative and qualitative characterization of nuclear materials.

Throughout 2007 efforts focused particularly on plutonium quantification using a passive neutron counter. Experiments were conducted to qualify new data acquisition tools as part of an international cooperation project at the European Commission's Joint Research Center in Ispra (Italy). In parallel, efforts have been made to achieve better results in using Monte Carlo codes to model neutron emission and the behavior of neutron counters. These Monte Carlo codes are used to develop and qualify new measuring systems and also to assess equipment already in operation at nuclear facilities.

During 2007 a study was also conducted in collaboration with the Mathematical Computation Society (SCM) to develop the use of statistical tools to evaluate code performance in determining the isotopic composition of plutonium based on gamma emission spectra. These codes play an important role in nuclear material follow-up, particularly when it comes to measuring uranium enrichment. Through studies of this kind, IRSN keeps a watch on the quality of results provided by commercial codes used for nuclear material inspections.

IN THE WORDS OF...

Camille GRAND,

Deputy Director of Multilateral Issues and Disarmament, Department of Strategic Affairs, Security and Disarmament, Ministry of Foreign and European Affairs

"IRSN is our regular contact on matters concerning implementation of the Chemical Weapons Convention. The Institute is involved in preparing for, welcoming and escorting inspection teams from the Organization for the Prohibition of Chemical Weapons (OPCW). It is a key player in ensuring these inspections are conducted correctly.
IRSN is also involved in training courses given by the French training center for the prohibition of chemical weapons and provides its expertise to the French delegation at OPCW meetings and conferences and during consultations with our foreign partners. Finally, the Institute plays an essential role as an interface with industry. Its knowledge of reality in the field, gained in particular by escorting inspections, ensures the necessary balance between compliance with Convention obligations and the protection of our industrial interests."

2
meetings
of restricted expert groups (malicious acts)
(0 in 2006)

1
crisis situation
nuclear material inventory exercises
(2 in 2006)

Help prevent the proliferation of nuclear, biological and chemical weapons, and control nuclear and radiological security in the face of terrorism

INTERNATIONAL INSPECTIONS IN A NON-PROLIFERATION CONTEXT

In 2007 IRSN developed two secure Internet portals – IODA (for chemical data) and PIMENT (for nuclear data) – so that French corporations could submit the chemical product declarations required by the Chemical Weapons Convention (CWC) and the import/export notifications for nuclear materials declared under Euratom Regulation 302/2005 in electronic format, allowing IRSN and inspection authorities to process this information more efficiently.

International inspections of chemical facilities

IRSN escorted four inspections requested by the Organization for the Prohibition of Chemical Weapons (OPCW) at French civil facilities in 2007. The OPCW did not issue any comment following these inspections relative to compliance with the provisions of the CWC in France. The Institute has also carried out several initiatives to prepare industrial corporations that may be inspected, where procedures call for on-site sampling and analyses.

In accordance with the CWC, States Party to the Convention are obligated to accept challenge inspections from another treaty partner. This type of inspection has never been used, however, although some countries have conducted exercises to this effect. IRSN took part in the last challenge inspection exercise organized by the Netherlands in Delft in September 2007. Because the French Ministry of Foreign and European Affairs wishes to organize a similar exercise in France in the near future, IRSN participated in a challenge inspection working group, preparing documents that would be used to host this type of check in France and coordinating the working group responsible for logistics.

IRSN has also led several of the new training courses on escorting OPCW inspections, set up by the French training center for the prohibition of chemical weapons, for the benefit of national authorities in other countries.

International inspections of nuclear facilities

The European Commission has announced its intention to set up regular annual meetings with operators to discuss inspection procedures and results. Consequently, in addition to escorting 43 inspections, including one audit exercise at the Eurodif facility in Pierrelatte (Drôme), IRSN played an active role in the eight plenary meetings organized in 2007 at the plants of major French operators. Regarding the transmission of information about nuclear facilities when inspections are hosted in France, IRSN has assessed the Commission's requests to remove a certain number of sensitive documents.
The operators and French authorities had approved these requests, provided that the methods agreed upon by all parties were used to transmit the information so as to ensure that this information was adequately protected.
Because new accountability declaration formats defined by Euratom Regulation No. 302/2005 will soon be introduced, IRSN has made a special effort to advise operators and assist them in their relations with the Commission.
Finally, IRSN played an active role in discussions with operators, French authorities, Euratom and the IAEA on the application of international inspections at the Georges Besse II plant. The IAEA announced that it would inspect the facility according to the same principles as the other three European centrifuge enrichment plants.

OPENNESS TO SOCIETY

Information on non-proliferation

In early 2007 IRSN launched a new website on nuclear, chemical and biological non-proliferation. It was set up to provide information to a specialist audience on IRSN's non-proliferation-related activities, and also to explain to operators of chemical or nuclear facilities subject to these regulations their obligations regarding declarations and inspections.

The site presents the historical development of non-proliferation regimes and also presents the three main international organizations (Euratom, IAEA and OPCW) responsible for enforcing non-proliferation treaties. Operators can use the site to download the declaration documents (forms and handbooks) and prepare for inspections. IRSN has been congratulated by several corporations for the information and clarity of this site.

www.irsn.org/non-proliferation

PROTECTION AGAINST MALICIOUS ACTS

REGULATORY TEXT REVIEWS

EIn 2007 IRSN participated in the review of French regulations relevant to malicious acts involving nuclear materials, transport and facilities.
The draft regulations include a decree to enforce Articles L.1332 and L.1333 of the French Defense Code, and ten orders.

MORE DETAILS

Mobile laboratory provided for inspectors

IRSN has developed a mobile laboratory unit made available to inspectors from the Organization for the Prohibition of Chemical Weapons (OPCW) when they are conducting inspections involving sampling and analysis.

The OPCW just recently conducted inspections of this type at chemical sites handling Table 2 chemicals in about fifteen countries including France. Table 2 chemicals are dual-use chemicals that can be used by industry for the manufacture of medicines, ink, etc. but also as a precursor to chemical warfare agents.

The OPCW inspectors used the mobile laboratory (*Figure 1*) fitted with their own analysis equipment to fulfill inspection requirements by performing analyses (*Figure 2*) without disrupting activity at the site (where inspector access is limited to what is strictly necessary in the laboratory and operations buildings). The mobile laboratory offers a secure working environment while protecting the confidentiality of industrial research, development and operations.
The mobile laboratory was also shown to members of IRSN's board of directors in October, and to the armed forces radiation protection service (SPRA) and representatives from CEA in November

1: Mobile laboratory unit.

2: OPCW inspector analyzing a sample in the mobile laboratory.

These texts concern applications for authorization to engage in activities involving nuclear materials, the associated justification studies, provisions to ensure physical follow-up and accountability of materials, and provisions to ensure their physical protection within a facility and during transport in public areas.
Regarding transport, the new regulations are based on a general order, supplemented by separate orders that take into account the specific features of road, rail, sea and air transport.
These orders specify the approval procedures for means of transport used for categories I and II nuclear materials, the obligations of authorization holders (transport plans, advance notice and execution procedures) and the role of IRSN transport control center.

Meetings to present the draft texts of these orders have been organized by the HFDS/MINEFE with the main operators concerned.

MEETINGS OF RESTRICTED EXPERT GROUPS

The restricted expert groups tasked with examining the technical aspects of protecting nuclear facilities against acts of sabotage, for which IRSN is both spokesperson and secretary, met twice in 2007.
The first meeting relaunched the restricted expert groups consultation process. It focused mainly on how they would function, their missions and their work programs.
The second meeting looked at how potential malicious acts would be taken into account in the EPR reactor project.

SECURITY OF RADIOACTIVE SOURCES

The study program aimed at tightening up security against malicious acts targeting radioactive sources continued in 2007. The Institute put forward a series of measures involving facilities and transport which aim to reduce the opportunities for malicious use of those sources identified as the most sensitive. A progress report was sent in early 2007 to

Help prevent the proliferation of nuclear, biological and chemical weapons, and control nuclear and radiological security in the face of terrorism

the various ministerial departments that may have a role to play in this area. Work continued with the identification of plausible malicious act scenarios, based on radioactive sources use to evaluate the associated radiological impact. The next step consists of proposing measures to improve the medical and healthcare response, where necessary, for a few selected scenarios considered to be representative of malicious acts involving radioactive materials. A working group of representatives from HFDS/MINEFE, the Nuclear Safety Authority (ASN) and IRSN was set up in the summer of 2007 to decide whether it would be appropriate to reinforce current legal provisions.

INVENTORY OF RADIOACTIVE SOURCES IN FRANCE

To implement the decree that founded IRSN on the public health code, IRSN manages the French national inventory of radioactive sources. In 2007 the number of authorizations issued by competent authorities was approximately 8000, 6000 of which were for industrial or research applications and 1650 involved the medical field. In addition, 11,000 movements of radioactive sources were recorded in the SIGIS database, which now contains nearly 32,000 registered sources. In the first ten months of 2007, IRSN processed 4,300 requests for supply of sealed sources. There was strong growth in the sector of lead detection in paint using X-ray fluorescence, with more than 3000 devices in service and diagnostics being soon extended to rental real estate.

IN THE WORDS OF...

Yann BILLARAND,
Head of IRSN's Source Assessment Unit

"IRSN's help has been requested by the IAEA for a project to set up an international catalogue of radioactive sealed sources, since the Institute is responsible for managing the French national inventory of radioactive sources. This role is explicitly described in the decree that founded IRSN, and the Institute has consequently developed a source inventory information and management system (SIGIS) that contains all information concerning authorizations relevant to sources (holding, use, import, export, etc.) and the movements of these sources. The work requested by the IAEA involves crosschecking data submitted to the international organization by French industrial corporations, manufacturers and suppliers (regarding the type of source, equipment containing sources, suppliers, etc.) against information held in the French database. A meeting was held with the IAEA in December 2007 where a new version of the catalogue was presented."

CONSEQUENCES OF A MALICIOUS ACT AFFECTING NUCLEAR MATERIAL TRANSPORT

IRSN has produced a summary of the possible consequences of remote weapon-fire on a vehicle carrying plutonium oxide or irradiated fuels. The study assessed any mechanical damage to the protection, packaging and internal structures, as well as potential release into the environment, depending on the type of weapon used. Release is characterized by the composition, mass and granulometry of the materials discharged, and the radioactivity present.
As part of its assessment of the potential consequences of a malicious act, IRSN financed a study by the Institut Faunhofer and GRS (Germany) on the dispersion of powder in a container subject to an impact from a high-speed object. Work consisted of conducting academic experiments to identify the physical phenomena that cause the powder to move, which then served as a basis for establishing a model.

International activities

In 2007, at the request of the IAEA, IRSN participated, as an instructor or lecturer, in international courses covering design basis threats (Morocco), physical protection of research reactors (Serbia and Congo), and the basics of physical protection for nuclear materials and facilities (Morocco and Indonesia). The Institute also took part in a mission on Radiation Safety and Security of Radioactive Sources Infrastructure Appraisal (RaSSIA) to evaluate the security of radioactive sources in Niger.

IRSN participated in various working groups to revise IAEA circular INF/CIRC/225 containing recommendations for the protection of nuclear materials and facilities, and also worked on the structure of IAEA recommendation texts.
In May 2007 the Institute organized the 29th annual meeting of the European Safeguards Research and Development Association (ESARDA) in Aix-en-Provence (Bouches-du-Rhône), which was attended by some 300 experts in nuclear security and non-proliferation from European operators and national and international control organizations. On this occasion, IRSN presented its expertise in nuclear materials control, illustrated by eight publications and a display of transportable equipment used during inspections.

Carborundum micrography used in testing powder resuspension.

ESARDA conference at Aix-en-Provence (Bouches-du-Rhône).

The group responsible for coordinating studies conducted in cooperation with the Department of Energy (United States) met for the first time in 2007. Current work involves determination of the isotopic composition of plutonium using gamma spectrometry, and numerical simulation used for the quantification of plutonium in MOX fuel.

MORE DETAILS

Nuclear safety and security: IRSN evaluates potential synergies

As part of its mission to protect nuclear facilities against malicious acts, IRSN conducted a comparative analysis of safety and security procedures, identifying similarities, the specific features of each, and the synergies existing between the two areas. The analysis was presented at the international conference on research reactors, held in Sydney in November 2007.

Develop IRSN's response and mobilization capabilities to face the risk of a major radiological emergency

Radiological, nuclear and post-accident EMERGENCIES

In the event of a radiological or nuclear emergency, IRSN is tasked with assessing the impact on the population and the environment. This predictive assessment after the event helps public authorities make the necessary decisions. To improve its responsiveness and efficiency, the Institute is constantly updating its crisis organization and assessment resources.

NATIONAL POLICY

IRSN advises public authorities in defining accident situation management policy, particularly with regards to iodine prophylaxis and the management of post-accident situations.

2
actions
taken by the emergency response center
(0 in 2006)

9
national nuclear emergency exercises
(excluding defense-related activities)
(10 in 2006)

7
dose assessments
by biological dosimetry.
(77 in 2006, IRSN has intervened following accidents in Dakar, Chile and Belgium.)

HARMONIZATION OF PRACTICES FOR ADMINISTERING STABLE IODINE

In 2006 the French Nuclear Safety Authority was tasked by the Ministry of Health with developing a new policy on stable iodine prophylaxis in the event of a nuclear accident. IRSN took part in two working groups set up by the Authority, one national and the other international with several neighboring countries. Proposals aimed at harmonizing the pharmaceutical form, dose, and the level of intervention associated with stable iodine administration in the countries consulted were sent to the Ministry of Health. IRSN contributed to this work by specifying the hypotheses used to evaluate thyroid dose through inhalation in the event of an accident, as well as the health benefits to be expected by lowering the current level of intervention associated with administration.

NATIONAL POLICY ON THE MANAGEMENT OF NUCLEAR POST-ACCIDENT SITUATIONS

In 2007 IRSN pursued its contribution to work being conducted by the Executive Committee to manage the post-accident phase of a nuclear accident (CODIR-PA), set up by the French Nuclear Safety Authority in 2005. The Institute participated widely in the thematic groups that were organized. It coordinated two of them, one responsible for evaluating the radiological and dosimetric impact on the environment and humans, and the other responsible for choosing the hypotheses on which predictive assessments would be based.

In an accident situation, taking stable iodine tablets stops radioactive iodine from entering the thyroid gland.

The operational recommendations that came out of the first phase of CODIR-PA's work on managing the immediate impact of an accidental radioactive release in terms of regions, property and population, were given in a progress report.

These recommendations were based on data taken from two scenarios calculated by IRSN for medium-sized accidents affecting a pressurized water reactor.

MORE DETAILS

Emergency response: the 2007 update

Coping with emergency situations quickly, professionally and efficiently is the task of IRSN's response teams. Operations are conducted jointly with public authorities and local command centers (local government representatives, police forces, fire department, etc.).

In 2007 a response team from the Institute was deployed on three occasions:

- in April 2007, in La Fère-Champenoise (Marne) following a road traffic accident involving a vehicle carrying a type B package containing a cesium-137 source (80 TBq);
- in September 2007, in Lapalud (Vaucluse) following a road traffic accident involving a vehicle carrying sources used in nuclear medicine (74 packages);
- in November 2007 in Paris, at the 8th district police station, to identify and secure a strontium-90 source (5 MBq) left by a private individual.

Each time, the duty engineer at IRSN sent out an alert to mobilize the response team. Within a few hours, the team reached the site and proceeded to secure it, gather information, repackage and, if necessary, remove objects or packages.

IRSN's emergency response center was also called upon to respond on two occasions in 2007. It spent two weeks in March conducting a full assessment of radiotherapy practices at Epinal hospital, and on the night of April 9, 2007, was called in following the loss of train A on reactor 3 at the Dampierre nuclear power plant (Loiret).

Traffic accident in Lapalud (Vaucluse) involving a vehicle carrying radioactive materials.

CONSOLIDATION OF EMERGENCY RESPONSE ORGANIZATION

IRSN is improving its emergency response organization and resources to ensure that it is able to act rapidly in the event of a radiological or nuclear emergency.

ACCREDITATION OF IRSN'S BIOLOGICAL DOSIMETRY

In July 2007 IRSN's Biological Dosimetry Laboratory received ISO 17025 accreditation for its assessment of irradiation dose using cytogenetic tools. This accreditation covers investigations where the dose is assessed several months after the event that may have entailed exposure.

It is the result of four years' work during which many technical validations were necessary. The Institute's Biological Dosimetry Laboratory is only the second in the world to receive accreditation for this activity.

FOUNDING A NATIONAL BIOLOGICAL DOSIMETRY NETWORK

In cases of accidental exposure to ionizing radiation, it is important to assess the received dose as quickly as possible so a diagnosis can be made. To deal with situations where there are more victims than a single laboratory can handle, the IRSN has organized a national biological dosimetry network. Laboratories run by the CEA and the French Natural History Museum are part of this network. In 2007 the Institute organized two intercomparisons to check that the working methods of all those involved in the network were correctly harmonized.

MODERNIZING IRSN'S MOBILE RADIOLOGICAL RESPONSE EQUIPMENT

In 2007 IRSN acquired new mobile radiological response equipment. For environmental measurements, a laboratory vehicle is used to take radiological measurements and establish characterizations based on samples of water, soil, air, rock, plants and other materials taken on site.

1 **emergency exercise** related to the security of facilities *(0 in 2006)*

3 **national emergency exercises** related to the safety of defense-related facilities *(1 in 2006)*

Develop IRSN's response and mobilization capabilities to face the risk of a major radiological emergency

For measurements in humans, a mobile whole-body radiation counting laboratory has been built, specially designed for measuring complex cases of contamination. To complete the response system, particularly in the post-accident phase, a command vehicle has been designed to immediately deploy the appropriate teams and measuring equipment in the field.

IMPROVING TOOLS

The tools used in an emergency situation require the reconstruction of radiation doses, and an experimental methodology platform is currently being developed to improve the necessary techniques. This project also covers tools used to assess accident situations at facilities and their environmental impact, and to provide support for post-accident management.

USING CELL THERAPY TO TREAT RADIATION-INDUCED INJURIES

Two very serious cases of accidental irradiation that occurred in Chile and Senegal were successfully treated by injecting mesenchymal stem cells (MSCs) into the lesions. This treatment, based on experimental work by IRSN conducted in cooperation with the Percy Armed Forces Teaching Hospital and used on the Chilean patient, is a world first. Medical follow-up of this patient over a period of more than 18 months has shown that the treatment administered prevented the recurrences characteristic of radiation burns. In the case of the Senegalese patient, the seriousness of the injury resulting from exposure to a dose of nearly 50 Gy left little hope of a successful recovery after traditional surgery. A combination of complex surgical techniques and repeated local MSC injections over a period of time led to a positive outcome for the patient and avoided amputation of the arm.

These encouraging results prompted the team to attempt therapeutic trials on a compassionate basis on two patients suffering from serious rectitis following overexposure at Épinal hospital (Vosges). With the use of cell therapy, new hopes are emerging for the treatment of tissue injuries caused by accidental irradiation or radiotherapy. Research work will continue to consolidate and develop these results.

DIAGNOSIS OF RADIATION BURNS

The research program to improve the diagnosis of burns caused by radiation, supported by the French Armament Procurement Agency, came to an end in 2007. Coordinated by IRSN, the program brought together clinicians from Percy Hospital, radiopathologists from IRSN and the Army Health Service research center, and physicists from the Instrumentation, Signals and Systems Research Laboratory at Paris XII University. One particular feature of this program was the development of a measuring device that uses the skin's optical properties as an aid in the diagnosis of radiation burns. A patent has been filed for this device (*see Research outlet*).

STUDY ON CONTAMINATED WOUNDS

Internal contamination from uranium can occur accidentally in the nuclear fuel cycle industry by inhalation, ingestion, injection or absorption through intact or injury skin. An experimental study, which ended in 2007 and was conducted as part of an IRSN/AREVA NC common interest project, has made it possible to model different types of injury. Results show that the kinetics of uranium incorporation through a wound depend on the chemical or physical agent that caused the wound. The data obtained have provided useful information for improving the immediate treatment of contamination through injuries.

IN THE WORDS OF...

Lionel HUGARD,
General Practitioner, Deputy Director of Scientific and Technical Activities at the French Army Health Service

"The framework agreement signed in 2007 between IRSN and the French Army Health Service fulfills a shared desire to pool skills and resources to respond to the population's needs in emergency situations. This is an area in which our respective roles in protecting the population are complementary. The cooperation agreement covers providing support for diagnostics, screening and prognosis, ensuring dosimetry, treating the injured, and providing mobile response equipment. It allows us to harmonize our procedures and prepare to respond in an emergency. It also covers joint research, with special focus on the regeneration of irradiated tissues. The agreement is a follow-up to a series of actions taken over the years. It should strengthen, optimize and sustain their effectiveness."

Microlocation of uranium (in brown) in the skin (in blue) after contamination.

MANAGING A CONTAMINATED URBAN OR AGRICULTURAL ENVIRONMENT

Designed by IRSN, ICAR is a computer tool that compares strategies for managing contaminated urban or agricultural environments on the basis of radiological criteria (population exposure, doses to response teams, contamination of agricultural products, etc.) and non-radiological criteria (timescales and resources for operations, waste produced, etc.). The first version of the application was finalized in 2007.

DEVELOPMENT OF EMERGENCY TOOLS

In an emergency situation, IRSN must be able to make assessments in order to provide effective support to public authorities. For this purpose, the Institute is developing and upgrading the resources used to assess the condition of a facility and the radiological impact of the situation.

In 2007 the first two software applications for the new version of the SESAME system (version 4) were released. The first is used to recover the main parameters for the facility concerned, in the event of an accident affecting an EDF reactor; the second calculates any release that could result from the accident. In parallel, new tools are being developed to improve computing efficiency for accidents involving steam generator tube rupture and pressure changes in containment, and to achieve more accurate assessments on the impact of an accident that would lead to reactor core meltdown. The PDS application, developed in partnership with EDF, is used to determine how a loss of offsite power affects the different systems in a nuclear reactor. A version for 1300 MWe reactors was installed in the emergency response center in 2007. Its extension to 900 MWe reactors began in 2007 and should be completed in 2008.

Development of a new platform for computing and mapping (C3X) radiological impact continued, and is scheduled to replace the system currently in use in the emergency response center in the course of 2008:

- the functionalities of the operational version of the KrX tool, used to compute radiological impact, have been defined;
- the graphics post-processing tool cartX has been developed to generate clearer maps more quickly;
- development of the reportX tool for presenting results has been completed.

RESEARCH OUTLET

Two patent applications in radiopathology

Research findings in radiopathology due to high dose exposure have led to practical outlets for which IRSN has filed two patent applications. The first involves using adipose-tissue cell fractions to regenerate tissue after irradiation. This patent is the outcome of collaborative scientific work carried out by researchers at the Institute and at the CNRS. The second patent covers the invention of a device that assists with the diagnosis and prognosis of physiopathological changes in tissues after irradiation, resulting from research conducted by IRSN in partnership with the French Armament Procurement Agency.

ABOUT DEFENSE

FACILITY PROTECTION EXERCISES

A national security exercise was run in November 2007 at the Cattenom plant (Moselle), involving around 200 people. The aim was to test coordination between EDF, responsible for the physical protection of the site, and public authorities: the Prefect of Moselle, the Public Prosecutor of Thionville, and police forces. Acting on behalf of the Senior Defense and Security Official from the Ministry of the Economy, Finance, and Industry, IRSN took part in the preparation of this exercise, writing the scenario in consultation with EDF and national police forces. The exercise was directed by a representative of the Senior Defense and Security Official and supervised by IRSN staff, with observers from the Institute in attendance. In general, the Institute coordinates a working group tasked with learning lessons from security exercises.

Understand the effects of chronic low-level exposure

Chronic EXPOSURE

To improve our knowledge of the effects of chronic low-level contamination on humans and the environment, IRSN is carrying out research on whole organisms, as well as studies of pathologies associated with the chronic exposure of populations living in contaminated regions, and risk assessments based on epidemiological studies.

ENVIRHOM PROGRAM

The ENVIRHOM program is studying the impact of chronic exposure to low-dose radionuclides on human beings and the environment. In 2007 research specific to the environment focused on the transfer of selenium and uranium to soil, and the effects of low concentrations of uranium on aquatic organisms. In research on humans, progress was made in understanding the impact of chronic ingestion of cesium-137.

EFFECTS OF THE CHRONIC INGESTION OF CESIUM-137

Following on from work done on sleep, the intestine, and the metabolism of vitamin D and cholesterol, studies on the effects of chronic ingestion of cesium-137 in rats have continued on three other physiological systems. This decision was guided by the purported increase in the incidence of certain pathologies in populations living in regions contaminated after the Chernobyl accident.

The effects of experimental chronic ingestion of cesium-137 on the immune system, particularly the thymus, were studied in 2007. The thymus is the organ that produces the main constituents of the immune system during fetal development. Various parameters reflecting the functioning of this organ were measured. No differences were observed between the control groups and the contaminated groups. The preliminary result suggests that cesium-137 has no major influence on the formation of the immune system. The study of its effects on the cardiovascular system in rats revealed an increase in markers for cardiac problems, a reduction in blood pressure, and changes in the production of proteins involved in vascular tonus and potassium transport. Tissue analysis and the ECG, however, did not reveal any structural or functional damage to the heart.

IN THE WORDS OF...

Isabelle DUBLINEAU,
Head of IRSN's Experimental Radiotoxicology Laboratory

"I presented work on the human aspect of the ENVIRHOM program to the Cadarache local information committee. This work, carried out at the committee's request, followed a similar study of the effects on the environment of chronic exposure to low-dose radionuclides. My presentation concerned IRSN's work on the chronic effects of the ingestion of uranium or cesium-137 on non-cancerous pathologies in rats. The conclusions showed that, for uranium, the effects observed had no pathological consequences.
For cesium-137, our conclusions were similar in that roughly the same doses as those delivered following the Chernobyl accident had no pathological effects on healthy adult animals. We now need to study more sensitive populations, such as children.
These results aroused a lot of interest in the audience and confirmed that civil society expects us to provide more accessible and less technical information than scientific publications. These are very valuable exchanges for the Institute because they help to apprehend the public's questions about the environment."

In 2007 the effects of chronic ingestion of cesium-137 were studied on various physiological systems.

Finally, chronic contamination from cesium-137 causes changes in the way steroid hormones are metabolized. These initial results show that chronic ingestion of cesium-137 does produce certain biological effects. However, no pathological impact was found in healthy adults (*see interview*).

CHRONIC RISKS

The purpose of epidemiological studies is to observe the deferred effects of exposure to ionizing radiation and quantify the risks associated with exposure originating from a professional, medical, environmental, or accidental situation.

NEW EPIDEMIOLOGICAL INVESTIGATIONS ON WORKERS

To study the possible carcinogenic effects of internal contamination in workers in the French nuclear industry, in 2007 IRSN carried out a pilot study at the AREVA NC establishment at Pierrelatte (Drôme). The aim was to develop a method that could be used to evaluate internal exposure to the uranium and chemicals used at this plant. To begin, occupational health and safety experts drew up the list of substances to be considered, and traced changes in the workstations between 1960 and 2006.

The study covered 353 volunteers, all workers at the Pierrelatte site who were still working or retired, and who took part in the assessment of exposure levels at different workstations. This group work led to the creation of a database known as the "job exposure matrix". It describes the exposure of each of the workers to 22 agents defined as carcinogenic, mutagenic or toxic for reproduction, at 79 different workstations over the period 1960-2006.

LUNG CANCER, RADON AND SMOKING IN URANIUM MINERS

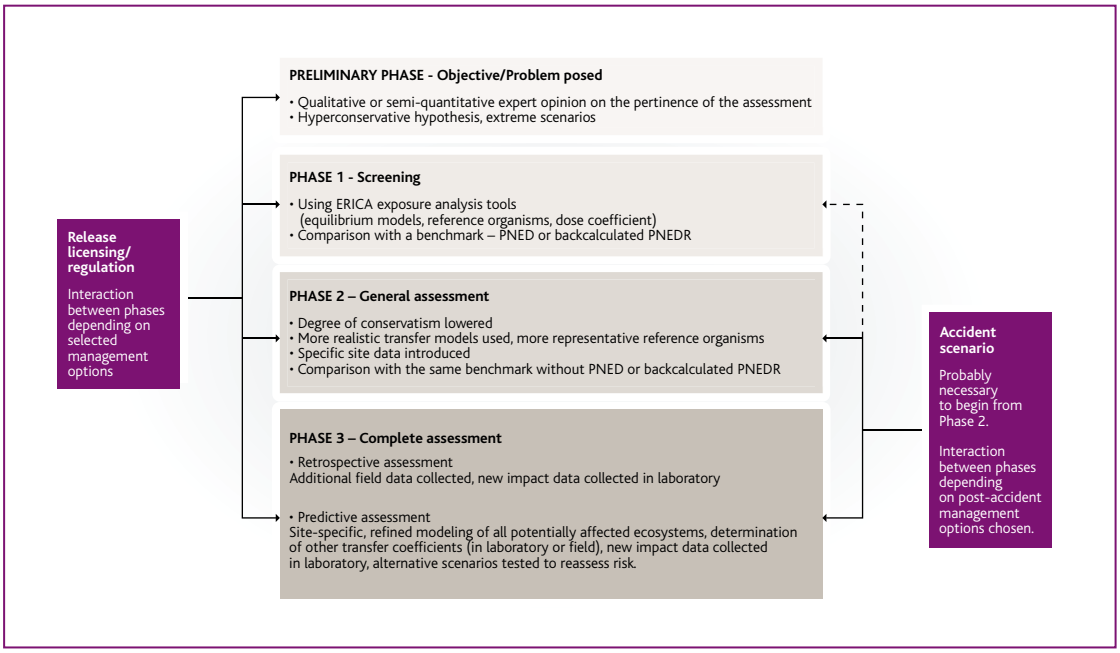
As part of the epidemiological study on the mortality of French uranium miners, IRSN has revealed an increase in the risk of lung cancer associated with cumulative exposure to radon. To take into account the effects of tobacco, a special study was carried out to reconstruct data on the smoking habits of part of the population of miners. The results show that even when smoking habits are taken into consideration, there is still a correlation for miners between radon exposure and the risk of dying from lung cancer. The risk coefficients resulting from this study, published in the international journal *Health Physics* in 2007, are consistent with those in the international scientific literature.

POSITIVE ASSESSMENT OF ERICA AND CONTINUATION OF PROTECT

The European ERICA project (*Environmental Risk from Ionizing Contaminants: Assessment and Management*) came to an end in February 2007. This Euratom FP6 project, initiated to develop a method of environmental risk assessment for radionuclides, involved 15 partners from seven countries over three years. Its achievements included:

- updating the database that records the effects of ionizing radiation on non-human organisms;
- using this database to suggest criteria for protecting ecosystems;

Understand the effects of chronic low-level exposure



Approach chosen for the environment radiological risk assessment method in ERICA, adapted from ERICA 2005.

OPENNESS TO SOCIETY

Assessing the impact of nuclear facilities on human health

People living close to nuclear facilities have many questions about the impact of these facilities on their health. Local information committees and their national association, Ancli, regularly pass on these questions to IRSN. The Institute proposed to review these questions from a general perspective, in collaboration with InVS, and to find suitable ways to answer them, focusing on two areas:

- establishing an assessment of the health situation of the population living in the vicinity of a nuclear facility;
- creating a model to produce a quantitative assessment of the risks to human health associated with living near a facility.

The first topic was given priority and led to the Ancli/IRSN/InVS working group, which aims to develop a guide on the benefits and limitations of health assessment tools depending on the actual local situation.

- conceiving a method for characterizing ecological risk that incorporates analysis of the exposure of fauna and flora as well as impact analysis.

The project team examined various issues related to risk management and decision-making, and consulted more than 50 potential users from industry, research and the regulatory sector.

Following on from the ERICA project, the Euratom FP6 initiative PROTECT (*Protection of the Environment from Ionizing Radiation in a Regulatory Context*, 2006-2008) aims to compare current regulations governing environmental protection with regards to chemicals and radionuclides.

ENVIRONMENTAL RISK ASSESSMENT METHODS

As part of its contribution to the pluralistic assessment group on uranium mining sites in Limousin (GEP Limousin), IRSN has suggested adapting the ecological risk assessment method developed for the European ERICA project to the study of the environmental impact of mining activities. Data on radionuclide concentrations measured since 1993 as part of AREVA NC's environmental monitoring program have been used to assess the concentrations of uranium and its descendants in water, sediment, fauna and flora. Data on exposure have been combined with data on the effects of ionizing radiation on non-human live species to calculate a risk index for ecosystems. This indicator can be

used to determine whether or not exposure induces any harmful effects on the ecosystems. The conclusions of this study could lead to recommendations on environmental monitoring.

The above methods, developed as part of the ERICA project, have also been applied to the OSPAR committee's work on radioactive substances. At the request of the General Directorate for Energy and Raw Materials, IRSN has proposed a method for assessing to what extent reducing human-induced radionuclides in the Northeast Atlantic would lower doses delivered to non-human organisms. Based on concentrations measured in the environment (water, sediment, seaweed, fish, molluscs), a representation of the marine ecosystem is used to calculate the doses organisms receive depending on their degree of exposure. The results were presented in December 2007 at an OSPAR committee working group meeting.

Sampling water downstream from a uranium mine.

INTERNATIONAL

The CORE health program in the district of Chechersk, Belarus

The purpose of the CORE health program coordinated by IRSN is to help reduce health hazards in the Chechersk district, which was heavily contaminated by the Chernobyl accident.
The program is divided into three parts: conducting a medical and dosimetric assessment of children in the district, taking action to improve the radiological quality of foodstuffs, and working with the population on problems relevant to these issues.

A cooperation agreement was signed between IRSN and the Chechersk district hospital. Medical and dosimetric assessments of more than 2500 children were carried out in 2006 and 2007, and results are currently being analyzed.
During 2007, the Nuclear Protection Assessment Study Center (CEPN) and the Association for Measuring Radioactivity in the West (ACRO) began working on improving the radiological quality of foodstuffs in the district.

Develop protection against ionizing radiation in the healthcare sector

PROTECTING patients

IRSN's assessment and research activities involving the protection of patients aim to help medical staff improve practices while fostering a culture that encourages radiation protection. These activities are based on two main principles: acting with justification and making protection as effective as possible. They also aim to provide support to authorities regarding the risks associated with medical practices that use ionizing radiation.

RADIOPATHOLOGY

Every year in France 180,000 patients are treated by external radiotherapy. Radiotherapy can cause side effects in 10 to 15% of cases when healthy tissue is present in the irradiated area.

STUDY ON COMPLICATIONS ASSOCIATED WITH RADIOTHERAPY

The IRSN's partnership with the Institut Gustave Roussy has provided an opportunity to explore the biological mechanisms that cause radiotherapy side effects and to suggest new treatments for these complications.

In 2007 research focused on the importance of the role played by the vascular system in one of these cases: radiation enteritis. A study of the mechanisms involved identified key molecules such as the growth factor (TGFβ), which encourages healing, and the profibrosis factor (PAI-1), which increases as radiation-induced lesions become more severe. The role played by PAI-1 in radiation damage is currently being studied.

Prevention and management of these complications would require a combined therapeutic approach, where healthy tissue is treated differently from tumorous tissue.

MORE DETAILS

Diagnostic reference levels: preliminary results

Since 2004 regulations on diagnostic reference levels (DRLs) require that any establishment using radiology or nuclear medicine must submit information to IRSN on the doses delivered to 20 patients, for at least two types of examination. These are chosen from a list of the most common examinations performed using conventional radiology, scanners or nuclear medicine, or those delivering the highest doses. In 2007 the Institute prepared a preliminary report on this information for the period 2004 to 2006. It has been submitted to the French Nuclear Safety Authority and will serve to update current regulations with regards to DRL values. In radiology, where less than 10% of the medical services concerned have submitted their dosimetry information, the results are close to the European DRLs currently used as the reference. In nuclear medicine, where nearly 65% of the services concerned have submitted their data, analysis shows that there is poor compliance with DRLs for examinations using technetium-99, particularly for thyroid scintigraphy, where 94% of the services exceed the DRLs.

Reconstruction of the irradiation dose after the Epinal accident.

TREATMENT OF RADIATION-INDUCED LESIONS BY CELL THERAPY

The complications linked to cancer treatments using radiotherapy can cause lesions in healthy tissues surrounding the tumor, known as radiation-induced lesions. To treat these lesions, IRSN proposes an innovative therapeutic strategy that uses mesenchymal stem cells (MSCs) from bone marrow. In 2007, as part of its experimental research, the Institute demonstrated the benefits of using MCSs to regenerate epithelial tissue in the intestine after radiation. The Institute has consecrated significant research to studying the mode of operation of these cells in order to use them as effectively as possible in treating radiation-induced lesions.

EXPERTISE IN THE MEDICAL FIELD

Several times throughout 2007 the Minister of Health and the French Nuclear Safety Authority called on IRSN's competence in radiopathology and the treatment of highly irradiated tissues to conduct health assessments.

ACCIDENTS IN THE HEALTHCARE SECTOR

Following the overexposure accident at Jean Monnet Hospital in Épinal in October 2006, the Minister of Health asked the Institute for a second appraisal in March 2007 on abnormalities in conformational radiotherapy practices for prostate cancer from 2001 to 2006 at this establishment. Approximately 400 patients were identified as having been systematically overexposed by 8% and a 24th victim of the first accident was reported. In September, IRSN was asked to "*conduct an evaluation of the possible clinical consequences for all patients treated from 1989 to 2000*" in Épinal. For this evaluation, the Institute worked closely with a group of experts from the French Radiotherapy and Oncology Society, the French Society of Medical Physicists, and the InVS. The risk of secondary complications for the patients was assessed as a function of the level of overexposure identified by IRSN.

Elsewhere, following calibration errors of radiosurgery equipment at Toulouse University Hospital that led to the overexposure of 145 patients, in June the Institute was asked to find the technical causes of the problem. It also checked that the new calibration procedure had corrected the error that had caused the problem. In the report submitted to the French Nuclear Safety Authority in December, the Institute made a number of recommendations, such as carrying out statutory quality inspections and introducing national intercomparisons. The expert assessment will continue to evaluate the risk of neurological complications for each individual patient.

Another assessment in the summer of 2007 concerned the aftermath of an accident during an interventional cardiology operation (using ionizing radiation) at a hospital in Lyon. IRSN was asked by the French Nuclear Safety Authority to give the closest possible assessment of the doses received by the patient. The Institute took several approaches to this dosimetry reconstruction. It gave its opinion on the coherence between the patient's clinical symptoms and the doses actually received.

www.irsn.org – News 12/20/2007

IRSN in 2007
Ensuring efficiency

Total quality MANAGEMENT

The ISO 9001 certification audit of IRSN was carried out from May 25th to July 4th in 2007. Obtaining certification marked the end of several years' work and a commitment to a continuous improvement approach.

OBJECTIVES

- Implement the quality policy by focusing on three main lines of improvement: customer satisfaction, professionalism, and benefits to society.
- For each type of activity led by the Institute, identify, quantify, and ensure follow-up of objectives using the most appropriate indicators for each specific area.

The auditors from the certifying authority (LRQA) particularly appreciated the staff's professionalism and motivation, the Institute's ability to communicate, and its commitment to quality. They also took into consideration initiatives to bring IRSN's Total Quality Management (TQM) system into compliance with the ISO 9001 standard by setting targets, measuring indicators, introducing trend charts, etc.

Unit	Field of activity
Aerosol Physics and Metrology Laboratory	Measuring air contamination
Laboratory for the Experimental Study of Containment, Air Cleaning and Ventilation	Protection against radioactive contamination
Environmental Sample Processing and Metrology Department	Analysis of radioactivity in samples from the environment and foodstuffs, laboratory intercomparisons
Ionizing Radiation Dosimetry Laboratory	Calibration in the field of photon radiation
Neutron Metrology and Dosimetry Laboratory	Calibration in the field of neutron radiation
Radiotoxicological Medical Analysis Laboratory	Identification and dosage of gamma- and x-ray-emitting radionuclides in urine
Biological Dosimetry Laboratory	Biological dosimetry using conventional cytogenetics

IRSN units with ISO 17025 accreditation (December 2007).

NEWS BRIEF

IRSN has launched a new quality project for the next three years. It will focus mainly on improving how processes are managed within the Institute and simplifying the TQM system to make it more user-friendly.

7
ISO 17025-accredited laboratories
(6 in 2006)

The auditors issued 37 observations, and IRSN's ability to address them will be reviewed during the half-year follow-up audits that will take place until the certification renewal audit in the summer of 2010. All these observations had already been reported during internal audits conducted by the Institute.

IN THE WORDS OF...

Jean-Maurice CROZET,
Deputy Director General of Lloyd's Register Quality Assurance*

"In 2007 IRSN earned ISO 9001 certification for the Institute and all its specializations. This success crowns a long-term endeavor supported by LRQA* as international certifying authority. The merit behind this result is all the more outstanding knowing that IRSN is a focus point for matters related to protecting the safety of people and property, which are sensitive issues in public opinion, in everyday life and in technology.
The fulfillment of a three-year effort, ISO 9001 certification constitutes a commitment to the Institute's partners and customers. Certification is just the first step. While reaching this level of quality has required effort, quality must be maintained on a daily basis.
LRQA will be visiting at regular intervals to check that the Institute is upholding this level of quality throughout its pursuits."
www.lr.org

(*) LRQA, a member of the Lloyd's Register group, is the world leader in auditing and certification of corporate management systems.

PRELIMINARY REPORT of the College of experts

The College of experts set up in 2005 is gradually becoming established within the Institute, with its specific mode of organization as an alliance of equals.

OBJECTIVE

- To create a group of consultants within IRSN that is independent of management in order to encourage scientific and technical discussions and debate on matters involving the Institute's activities, and provide opinions and recommendations.

2007 was chosen as the year for experimenting two different ways of running the College of experts.
In terms of individual contributions, the experts are involved in evaluation and consultancy processes within the Institute, such as coordinating an evaluation of R&D on fires, entrusted to a senior expert. Members of the College have also been asked to participate in appraisals of the Institute's activities and to provide their opinions and recommendations.
More collaborative efforts have also been organized to draw on the strength of united skills. For example, 21 exploratory research projects were appraised and ranked, with seven of them selected to receive funding (see text on scientific excellence on p. 80). The College also initiated or participated in various inter-disciplinary scientific events organized by IRSN.

College of experts seminar at Cadarache, November 15 and 16, 2007.

IN THE WORDS OF…

Jean-Christophe SABROUX et Nathalie MICHIELSEN,
members of the College of experts at IRSN

"The College consists of 24 IRSN experts from research or assessment, appointed by the Director General for four years. The purpose is to apply our knowledge and experience in a particular field to meet specific needs both within and outside the Institute. This innovation in career development is an alternative to hierarchical promotions.

After its first year in existence, the IRSN College of experts met in November 2007 to review its achievements. While requests for support from individual experts have been fulfilled, tasks to be addressed on a collective basis need greater focus. For example, we have proposed to participate in the evaluation of dissertation subjects or in the selection of applicants for doctorate posts. We have also started to look at the ethical and legal aspects of consultancy work. Lastly, we will be organizing a seminar on aerosols "from source to man", a cross-disciplinary subject that involves all the Institute's operational divisions."

Enhancing SCIENTIFIC AND TECHNICAL EXCELLENCE

To sustain diversity in team skills over the long term and provide opportunities to build knowledge, the Institute has implemented a specific policy dedicated to scientific and technical excellence since 2003.

OBJECTIVE

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

- scientific and technical quality of teams and results;
- relevance of the subjects covered;
- efficient organization of its scientific and technical activities (in methods, collaboration, etc.).

85
doctorate students
(79 in 2006)

31
post-doctorate students
(26 in 2006)

18
dissertations defended
(14 in 2006)

41
PhDs or persons qualified to direct research
(39 in 2006)

CONTINUATION OF THE SCIENTIFIC AND TECHNICAL ASSESSMENT PROCESS

Pilot assessments in the following areas were completed in 2007:

- the VERCORS research program (release of fission products from fuel pellets in a severe accident situation);
- the reorientation of the CHIP program (chemistry of iodine in the reactor coolant system);
- international collaborative programs with Eastern European countries (radioecology as part of the Franco-German initiative for Chernobyl, development of two computer codes concerning safety);
- the team from the Biological Dosimetry Laboratory;
- an assessment requested by the French Nuclear Safety Authority on release to the environment in the event of an earthquake affecting the ATALANTE facility.

A review conducted at the end of 2007 on actions taken in response to recommendations by consultants reported satisfactory results.

In mid 2007, the in-house committee on scientific and technical excellence chose eleven new assessment targets in the following areas:

- development of computer codes for safety or radiation protection;
- neutron metrology;
- research on fires;
- research on the environment;
- safety assessments.

DEPLOYMENT OF EXPLORATORY RESEARCH

In implementation of the decision taken in 2006, the Institute set up an exploratory research program. Four research projects exploring new avenues outside established programs were launched during 2007. These projects will require a feasibility study for the first two years, taking up a relatively modest amount of resources.

Discussions have also begun on how to develop this system so it is more flexible and responsive. From now on the cross-disciplinary and collaborative aspects of projects will be given greater weight in the selection process.

NEWS BRIEF

The 2006 Scientific and Technical Report was presented at the French National Library (BNF) on June 20, 2007.
www.net-science.irsn.org

The number of visits to the Institute's net-science-irsn.org website increased by 50% between 2006 and 2007.
www.net-science.irsn.org

27 new theses were started in October 2007. Three new people were qualified as research directors.

Dissertation Days at Aussois (Savoy, October 2007).

TRAINING THROUGH RESEARCH

Training through research activity in 2007 focused on two main areas: collecting and evaluating subjects and applications for theses and post-doc posts, and organizing "Dissertation Days". For each thesis application, external and internal advisers evaluate the research topic and the applicant's scientific file, then the applicant goes before an interview panel that includes experts from outside the Institute.

Each year the "Dissertation Days" event brings together the Institute's doctorate students to present their research at a resident seminar. In 2007 the event was attended by about 160 people from IRSN as well as outside organizations (academics, industrial partners, etc.). 66 doctorate students in the second or third year of their thesis presented the state of progress of their research.

Efficient teamwork between doctoral student and tutor.

123 publications in scientific journals, with review committees *(119 in 2006)*

350 conference communications *(350 in 2006)*

IN THE WORDS OF...

Michel QUINTARD,

President of the IRSN Scientific Council

"The IRSN Scientific Council was created to give opinions on scientific subjects at the request of the Institute or its supervising ministries. It looks at IRSN's research activity from the outside.

We undertook two assessments in 2007, and our conclusions will be published in 2008. The first concerns research on radiopathology and therapy of irradiated people, where we have been asked to issue an opinion on the coherence and quality of work achieved.

The second assessment concerns the role of general tests in the simulation of reactor accidents, particularly those conducted using the Phebus and Cabri reactors.
We are also involved in various scientific evaluation activities, such as committees that award scholarships or the Dissertation Days event.
Although this responsibility represents an extra workload, most of us believe that peer evaluation is part of our role as a researcher or teacher."

HUMAN RESOURCES
serving the Institute

The human resources policy pursued by the Institute since its beginning led to the expansion in 2007 of support for staff and managers through the enhancement of resources and tools allocated to managing jobs, developing skills and management.

OBJECTIVES

- To anticipate the skills required at IRSN and meet these needs in a context of strong competition due to revival of the nuclear industry.
- To encourage the development of individual competence and pool skills to promote collective action.
- To ensure constructive relations between management and personnel.

72%
engineers,
researchers and
managerial staff
(71% in 2006)

28%
technicians
technical
support and
administrative
staff
(29% in 2006)

89
employees
recruited
on permanent
contracts
(76 in 2006)

COLLECTIVE AGREEMENTS SIGNED

2007 was an active year for collective negotiations, with four major agreements being signed.

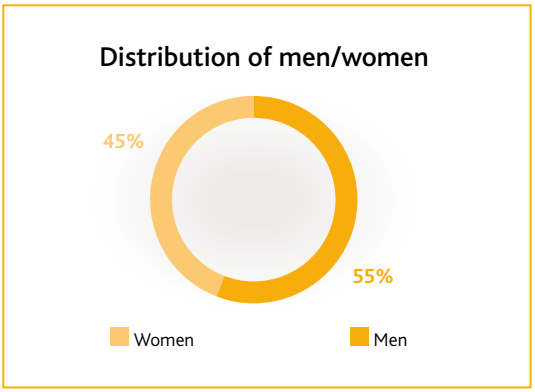
The first was on gender equality in the workplace; the second paved the way for a collective pension scheme; the third made it possible to receive payment for days in the overtime savings scheme in the form of various savings plans. The last one involved forecasting jobs and skills and the management of personnel nearing retirement, for whom a series of measures are planned that will ensure better management of their career opportunities and will develop the sharing and transfer of their skills.

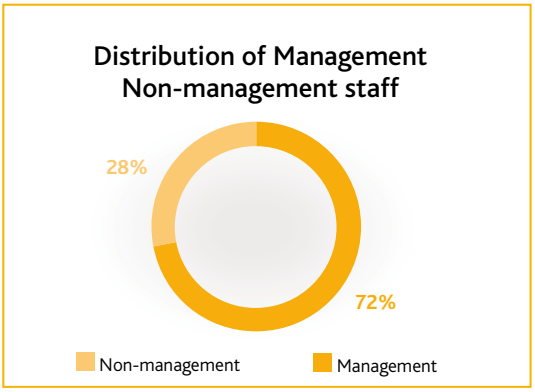
MANAGEMENT CHARTER

In the field of employee management, following the introduction of a complete training curriculum for all supervisory staff, a charter was written in cooperation with representatives from different management levels to formalize the Institute's expectations and support managers in their role.

STRENGTHENING THE CONSULTANCY CIRCLE

The Consultancy Circle set up in 2005 conducted its second campaign to recruit consultants and senior advisors in 2007. The consultant selection committee was expanded





on this occasion to include two figures from outside the Institute, the radiation protection manager from the research department at the Institut Curie, and a professor of nuclear engineering from the Swiss Federal Institute of Technology. The committee selected 24 new consultants including 9 senior consultants.

Development of the Consultancy Circle represents a major challenge not only for the Institute, but also for the consultants themselves, both individually and as a group. Management's involvement in realizing this objective is an irrefutable key to success.

By pooling essential skills in IRSN's various areas of activity, from both consultants and management, this strategy is expected to establish the Institute's authority on new and complex issues requiring a cross-disciplinary approach.

EXPANDING COMPETENCE

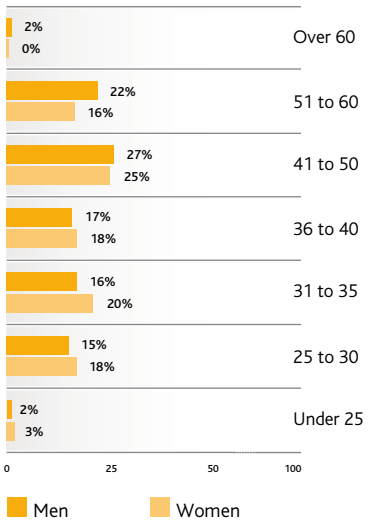
Every year IRSN accepts over 120 university students on internships. It has redefined its recruitment procedure in response to the needs of operational units, aiming to attract students from eminent engineering schools. Internship remuneration is now at the same level as offerings by comparable institutes, and the student population base considered by the Institute has been expanded.

To provide employees with diversified choices in career opportunities, the Institute participated in the definition of a charter for mobility between public industrial and commercial establishments (EPICs) in France, which was signed last fall. These organizations include IFP, Cnes, Ineris and BRGM, for example.

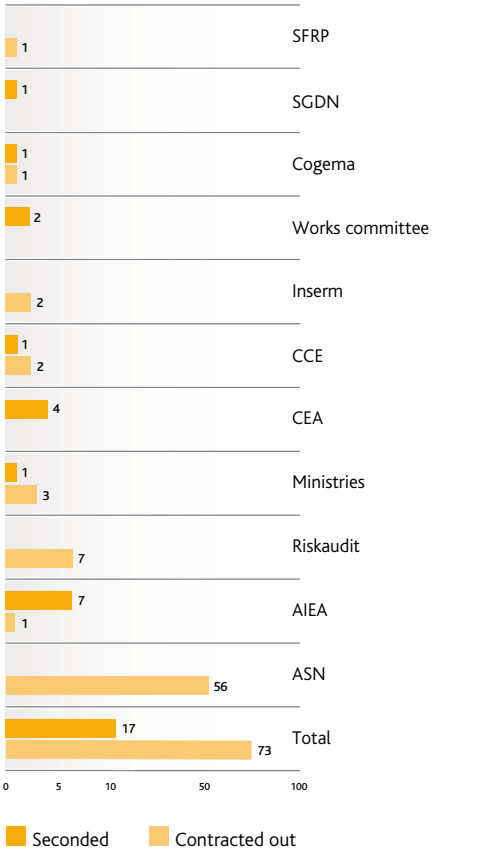
NEWS BRIEF

Professional training courses involved 52,773 hours of training given to 2,926 trainees. About forty courses were requested under the Individual Right to Training scheme, in application of the agreement signed last year.

Distribution of men/women by age bracket:



IRSN personnel contracted out or seconded (as of December 12, 2007)



€1,302 M
spent on training
(€1,364 M in 2006)

52,773
hours in training
(45,947 in 2006)

2,926
participants in training courses
(2,922 in 2006)

Recognizing and preventing NUCLEAR RISKS

To fulfill its mission as information provider on nuclear risks and radiation protection, IRSN endeavored to formalize all its operating procedures throughout the year 2006. Audited in 2007, these procedures have now received ISO 9001 certification. The year was also marked by concentrated efforts to keep public opinion informed on safety issues, with special focus on radiotherapy accidents.

PUBLIC RELATIONS OBJECTIVES

- Educate the public on nuclear and radiological risks through widespread publication of the Institute's knowledge and appraisal results.
- Promote IRSN as the public expert that sets the standard in nuclear safety and the protection of human health and the environment.
- Keep an open dialogue with the public to ensure transparency, and respond to any questions.

"Nuclear Energy and Society: from Knowledge to Control" traveling exhibition

4,400 visitors *(4,500 in 2006)*

2 towns visited *(2 in 2006)*

8 conferences organized *(5 in 2006)*

1,000 requests for information processed via the contact box "contact@irsn.fr" *(761 in 2006)*

Throughout 2007 IRSN aimed to keep the public informed on the work and conclusions of its consultants, called on to answer various questions on nuclear safety and radiological risks.

RADIOTHERAPY ACCIDENTS

The discovery of overexposed patients who had received radiotherapy treatment at the Jean Monnet hospital in Epinal led the Minister of Health to call on IRSN to conduct several appraisals involving the patients' state of health, dosimetry assessment, and risk assessment. The appraisals, which sought to improve the subsequent healthcare administered to the patients, calm their troubles, and reinforce safety in radiotherapy treatments in general, were covered in several reports, with conclusions made public on the IRSN website. **www.irsn.org – News 12/10/2007**

The Institute's work received vast media coverage, with over 146 articles published in regional, national, and international newspapers.

ONLINE GUIDE TO DIAGNOSING IRRADIATION ACCIDENTS

IRSN took the initiative of publishing a practical guide to diagnosing an irradiation accident induced by industrial radioactive sources, made available to doctors on its website. The purpose is to provide more efficient healthcare to victims of these accidents, which are often difficult to diagnose since they are rare, and may entail serious consequences.

IRSN RESEARCH PROGRAMS PRESENTED TO THE PUBLIC

The publication of its 2006 Scientific and Technical Report gave IRSN the opportunity to organize a public presentation of its three most important research and development programs: new methodological approaches and risk assessment tools for ecosystems; dosimetry R&D; and the preliminary results of experiments conducted within the Phebus Fission Product program.

TRANSPARENCY AND NUCLEAR SAFETY

The IRSN website, **www.irsn.org**, which continued to draw a growing number of visitors in 2007, is an essential channel for broadcasting the Institute's scientific information. Information for the public, including reports on public service missions, such as the annual report on environmental radioactivity monitoring in France (published on December 19, 2007, based on 2006 data), is systematically posted

The Medec : an exhibition highly appreciated by professionals.

The traveling exhibition in Tours (Indre-et-Loire).

on the website. To enhance availability of environmental monitoring data, IRSN plans to expand its Internet portal on environmental radioactivity in 2008.

INTERNATIONAL COVERAGE

The future of energy within the European Union, and confrontation with major changes, including the recent entry of new countries such as Bulgaria and Romania, who operate Soviet-designed reactors, were in the news in 2007. IRSN invited its experts and the press to a conference marking the 50th anniversary of the Euratom treaty, and reported on its implications for the Institute.

A press trip to Lithuania gave French reporters the opportunity to learn about specific design features of an RBMK reactor, which have been modified since the Chernobyl accident, with the support of EU funding. Accompanied by an IRSN consultant, reporters were able to appreciate the Institute's role as an expert in nuclear safety.

From May 22 to 24, 2007, IRSN organized the 29th Annual Conference of the European Safeguards Research and Development Association (Esarda) in Aix-en-Provence. The conference brought together 300 consultants specialized in nuclear non-proliferation from the IAEA, the European Commission, and 30 different countries. IRSN illustrated its know-how in eight presentations and an exhibit displaying portable equipment used during facility inspections to measure the amount of plutonium contained in waste drums. From April 23 to 27, IRSN also organized a conference on the theme "Nuclear Safety and the Role of TSOs", in partnership with the IAEA.

INFORMATION FOR PROFESSIONALS

IRSN participated in professional trade fairs in France, with a particular focus on the medical field during the Medec exhibition or the radiology event *Journées françaises de radiologie*.

RADIOACTIVITY GETS EXPOSURE

Several IRSN experts contributed their knowledge on radioactivity and radiation protection to a scientific project conducted in cooperation with the Metropolitan Community of the Montbéliard Region, producing an original exhibition entitled "Did You Say Radiation Protection? The Story on X-rays, Radioactivity, and More". On display from October 15, 2007 to April 27, 2008 at the Montbéliard Science Pavilion, this exhibition combined the scientist's view with the free interpretation of several artists, inviting the public to discover a singular vision of the complex history of radioactivity, from Marie Curie to the present. Reconciling art and science, the exhibition placed considerable historical and scientific information within public reach, available in the illustrated exhibition catalogue.

In parallel, the IRSN & ASN traveling exhibition entitled "Nuclear Energy and Society: from Knowledge to Control" continued its tour of France, setting up in Fontainebleau, then in Tours. Two modules, *Radioactivity and Human Health and Human-induced Radioactivity and the Environment* have been renovated, and the exhibition website, **www.irsn.org/expo**, also has a new look.

2,000,000 visits to the IRSN website *(1,400,000 in 2006)*

675,000 visits to the scientific website *(438,000 in 2006)*

4,000 information booklets distributed *(4,700 in 2006)*

3,500 copies of the Annual Report distributed *(5,500 in 2006)*

3
participations
in professional trade fairs or public events
(3 in 2006)

200
press requests
processed
(230 in 2006)

730
mentions
in the press
(600 in 2006)

IN-HOUSE COMMUNICATION OBJECTIVES

- Unite the rich variety of professions and skills at the Institute in a shared identity and culture.
- Listen more, exchange better.

In-house communication in 2007 was marked by three events.

AN IN-HOUSE OPINION BAROMETER SEES THE DAY

To adapt in-house communication policy and instruments to employee needs and expectations, IRSN has set up an in-house opinion barometer to survey employee views on subjects such as working conditions, professional training, careers, management, communication, and the Institute's mission and identity.

Results of the first poll revealed personnel satisfaction on several points, including working conditions, work environment, and discipline-specific training. Employees consider there is room for improvement with regards to information provided by management, development of a "corporate culture", and career management.

THE IRSN COMMUNICATION AUDIT

In 2007 IRSN's communication procedures were audited for ISO 9001 certification purposes. The audit report concludes that IRSN is considered as a reference in terms of communication in its fields of specialization.

EMERGENCY RESPONSE CENTER CELEBRATES ITS 25TH YEAR

In 2007 IRSN's Emergency Response Center celebrated 25 years of service. This center is the core of the crisis management system created by the Institute to provide technical support to public authorities and distribute health and medical care to protect the population, workers and the environment in a radiological emergency.

Board members visit the Emergency Response Center.

Health, safety, and environmental PROTECTION

IRSN reinforced its policy on safety and environmental protection in 2007 by allocating new tools and human resources to this purpose.

OBJECTIVE

- To ensure that anyone employed at an IRSN location, either by the Institute, a subcontractor, or a temporary employment agency, is able to work under safe conditions that preserve human health.

KEEPING A WATCH ON HEALTH, SAFETY, AND ENVIRONMENT REGULATIONS

Initiated in 2007, this tool is based on the list of regulatory texts applicable to IRSN facilities and activities. It serves to periodically check the Institute's compliance with regulations.

The periodic update of this list, required to comply with ISO 9001, ISO 14001, and OSHAS 18001, has been assigned to specialized legal consultants who provide continuous support to IRSN in this effort.

The first assessment conducted using this instrument at most Institute locations provided the operators with enhanced knowledge of their facilities, pointing out the need for some improvements to ensure compliance with standards on fire hazards and electrical hazards. The verification also indicated certain areas where technical documentation, drawings, and the life-cycle files for a few of the older facilities required updating or amending.

RADIATION PROTECTION SPECIALISTS AT WORK

In 2006 radiation protection specialists were recruited at the Fontenay-aux-Roses site (Hauts-de-Seine) and at Cadarache (Bouches-du-Rhône), in compliance with regulations. The work they accomplished in 2007 resulted in the revision of 40% of the workstation radiological risk assessments and 30% of radiological zoning within the facilities.

In parallel, roughly one-fourth of the radiation protection inspection programs (to be conducted by in-house inspectors or outside certified organizations) have been defined. Action initiated in 2007 will continue in 2008.

NEW RESPONSIBILITIES IN SAFETY AND THE ENVIRONMENT

Since December 30, 2006, the building referred to as the "Annex" at the CEA site in Fontenay-aux-Roses, which has accommodated part of the Institute since its foundation, has been allocated strictly to IRSN . This implies that the Institute must now take over responsibilities previously assumed by the CEA in terms of building infrastructures, health, safety, site protection, and the preservation of scientific and technical assets.

These new responsibilities also include release of gas and liquid effluents from the site, administrative procedures relevant to the operation of facilities classified for environmental protection, the road system, and the organization of emergency response in the case of an accident.

In parallel, IRSN continues to assume responsibility in these areas for its other sites, under the same conditions as at Fontenay-aux-Roses, or in addition to those assumed by the host institution. It is therefore important to ensure that all these actions are led according to a coherent plan. In this context, as of 2008 the Institute intends to create synergy between the "site safety", "building", and "work safety" aspects, for efficient management of these situations, by uniting the various units in charge of these matters under a single functional division, the Safety and Assets Division.

(*) Through an order dated November 29, 2006, published in the Journal Officiel dated December 29, 2006.

10
facilities classified for environmental protection in compliance with the Environment Code
(26 in 2006)

GLOSSARY

A

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

AECL
Atomic Energy of Canada Limited.

AFSSA
Agence française de sécurité sanitaire des aliments (French agency for the safe consumption of foods).

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 health protection in the environment and workplace).

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).

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

ASTEC
Accident Source Term Evaluation Code.

ATALANTE
Alpha radiation unit and analysis laboratory for the study of transuranians and reprocessing, a CEA R&D facility used to study reprocessing and waste.

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.

Beta radiation (symbolized as "β")
Radiation consisting of electrons with a positive or negative charge. Propagation can be stopped by leaving a separation of a few meters or using a simple sheet of aluminum foil.

BNRA
Bulgarian Nuclear Regulatory Agency.

Borax
Boiling Water Reactor Experiment.

BRGM
Bureau de Recherche Géologique et Minière (French institution for research in Earth sciences).

C

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

CABRI-CIP
CABRI International Program featuring a pressurized water loop.

Calixarene
Cyclic chemical compound used to trap radioactive elements (such as actinides).

CANDU
Canadian deuterium-uranium reactor.

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

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

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.

CRIIRAD
Commission de Recherche et d'Information Indépendante sur la Radioactivité (independent commission for research and information on radioactivity operating in France).

Criticality risks
Risks associated with uncontrolled fission phenomena in fissile materials.

Cytogenetics
Biological technique used to study chromosome anomalies in cells.

D

Diva
Facility used to study fires, ventilation, and airborne contamination.

DOE
Department of Energy (USA).

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

E

ECCOREV
A joint research project on continental ecosystems and environmental risks conducted by several organizations in the Provence-Alpes-Côte d'Azur region in France.

ENSRA
European Nuclear Security Regulators' Association.

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.

ESARDA
European Safeguards Research and Development Association.

ETSON
European Technical Safety Organisations Network.

Euratom
European Atomic Energy Community.

EXTREMA
Research program dedicated to the study of weather and climatic events, and the redistribution of sedimentary masses and associated pollutants within a coastal system.

F

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.

Fzk
Forschungszentrum Karlsruhe (German center of studies in Karlsruhe).

G

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

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

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

I

IAEA
International Atomic Energy Agency.

ICRP
International Commission on Radiation Protection.

INB
Basic nuclear facility.

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

INRETS
Institut national de recherche sur les transports et leur sécurité (French national institute for research on transport and transport safety).

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).

IPER
First scheduled downtime for maintenance and repairs.

ISIS
Computer code that simulates in detail how fire, gas, smoke, and structures evolve in an enclosed, ventilated space in any type of geometrical configuration.

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.

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.

MASURCA
Model of a fast breeder reactor, used for research (CEA).

MC3D
A multi-component, three-dimensional software application used to compute the interaction between corium and water or vapor explosion.

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

MIMAUSA
Program on the heritage and impact of obsolete uranium mines in France, created for analysis and archival purposes.

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

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).

NNR
National Nuclear Regulator (South Africa).

NNSA- NSC
National Nuclear Safety Administration – Nuclear Safety Center (China).

NPP
Nuclear power plant.

NRC
Nuclear Regulatory Commission (USA).

Nuclear fuel
Fissionable 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.

OSPAR
(Oslo-Paris) Commission for the Protection of the Marine Environment of the North-East Atlantic.

P

PCR
Radiation protection specialists.

PHEBUS
Experimental reactor.

PRIME
Fire propagation in elementary multiple-enclosure scenarios.

PRISME
Fire propagation in elementary multilocal scenarios.

Prophylaxis
Method of disease prevention.

PSI
Paul Scherrer Institut, Villigen (Switzerland).

PUI
Internal emergency plan.

R

Radioelement
Natural or artificial radioactive element.

Radiation protection
Any action taken to protect the population and workers using ionizing radiation sources.

Radionuclide
Radioactive isotope of an element.

RFS
Basic safety rule.

S

SARNET
Severe Accident Research NETwork of excellence, a European research project to study core meltdown accidents on water reactors.

SIMMER
Multiphase, multicomponent thermohydraulic software coupled with a space-dependent neutron model.

SKI
Statens Kärnkraftinspektion, Swedish nuclear safety authority.

SSI
StatensSträlskyddsinstitut, Swedish radiation protection authority.

STARMANIA
Station for airborne contamination transfers and mechanical strength applied to incidental and accidental pollution.

SYMBIOSE
Systemic Approach for Modelling the Fate of Chemicals in Biosphere and Ecosystems.

T

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

TOSQAN
IRSN experimental program to validate models on reactor containment water vapor condensation in a severe accident situation.

TSO
Technical Safety Organisation.

U

UNSCEAR
United Nations Scientific Committee on the Effects of Atomic Radiation.

V

VTT
Technical 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.

Z

Zircaloy-4
First-generation alloy.

Zirlo
Alloy developed by Westinghouse.

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

EDITORIAL COORDINATION
Strategy, Development and External Relations Division

STEERING COMMITTEE
President : Michel BOUVET
Michel BAUDRY
Patrice DESCHAMPS
Emmanuelle MUR
François ROLLINGER
Édouard SCOTT de MARTINVILLE
Yves SOUCHET
Sylvie SUPERVIL

EDITORIAL COMMITTEE
Supervision : Emmanuelle MUR & Sylvie SUPERVIL
Jocelyne AIGUEPERSE
Françoise BRETHEAU
Stéphanie CLAVELLE
Patrick COUSINOU
Jean COUTURIER
Aleth DELATTRE
Didier DEMEILLERS
Agnès DUMAS
Dominique FRANQUARD
Anne-Marie GIRARDIN
Bernard GOUDAL
Jean JALOUNEIX
Pascale MONTI

WRITTEN BY
IRSN, with support from Camille JAUNET (*La Clé des mots*) and Jean-Christophe HEDOUIN (HIME)

PRODUCTION COORDINATION
Communication Division - Marie-Line de HEAULME (CPRP)

GRAPHIC DESIGN AND PRODUCTION
TroisCube

TRANSLATION
Provence Traduction

PRINTING
Idéale Prod

PHOTO CREDITS
Cover: Olivier SEIGNETTE/Mickael LAFONTAN – Xavier BELLANGER
Xavier BELLANGER: pages 13 - 20 - 22 - 24 - 26 - 40 - 42 - 43 - 64 - 70 - 71 - 79 - 81
CEA: pages 46 - 49 › CERN page 35 › EDF Médiathèque/Ph. ERANIAN: page 32
Gettyimages/Muriel de Seze – Gettyimages/Amana productions inc: pages 16 - 30
Graphix Images: page 51 › ILL/J.L. BAUDET : page 40 › IRSN: pages 38 - 43 - 47 - 52 - 54 - 56 - 59 - 65 - 67 - 69 - 73 - 75 - 79 - 81 › Iter: page 49 › Stéphane JUNGERS: pages 33 - 34 - 37 - 39 - 58
Marine Nationale/Nathalie NOCART: page 45 › Laurent MIGNAUX-MEDAD: page 19
Olivier SEIGNETTE/Mickael LAFONTAN: pages 4 - 9 - 18 - 21 - 23 - 23 - 24 - 25 - 29 - 35 - 39 - 44 - 50 - 54 - 57 - 58 - 61 - 63 - 65 - 66 - 85 - 86 › Laurent STÉFANO: pages 23 - 53 - 72

This Annual Report is printed on 100% recyclable and biodegradable chlorine-free, coated paper using vegetable-based ink.

ISSN No.: 1762-0600

Sites coordinates
Maps for accessing IRSN sites
are available on our Internet site **www.irsn.org**

IRSN Head Office
Fontenay-aux-Roses
31, avenue de la Division-Leclerc
B. P. 17 – 92262 Fontenay-aux-Roses Cedex
Tel.: +33 (0)1 58 35 88 88

Agen
BP 27
47002 Agen
Tel.: +33 (0)5 53 48 01 60

Cadarache
BP 3
13115 Saint-Paul-lez-Durance Cedex
Tel.: +33 (0)4 42 25 70 00

Cherbourg-Octeville
Rue Max-Paul Fouchet
BP 10
50130 Cherbourg-Octeville
Tel.: +33 (0)2 33 01 41 00

La Seyne-sur-Mer
Centre Ifremer de Méditerranée
BP 330
83507 La Seyne-sur-Mer Cedex
Tel.: +33 (0)4 94 30 48 29

Le Vésinet
31, rue de l'Écluse
BP 40035
78116 Le Vésinet Cedex
Tel.: +33 (0)1 30 15 52 00

Les Angles – Avignon
550, rue de la Tramontane – Les Angles
BP 70295
30402 Villeneuve-lez-Avignon Cedex
Tel.: +33 (0)4 90 26 11 00

Mahina – Tahiti
S. P. 91524
00229 Armées
Tel.: +689 54 00 25

Orsay
Bois-des-Rames (bât. 501)
91400 Orsay
Tel.: +33 (0)1 69 85 58 40

Pierrelatte
BP 166
26702 Pierrelatte Cedex
Tel.: +33 (0)4 75 50 40 00

Saclay
Centre CEA de Saclay
91191 Gif-sur-Yvette Cedex
Tel.: +33 (0)1 69 08 60 00

IRSN certified quality management system

IRSN
INSTITUT
DE RADIOPROTECTION
ET DE SÛRETÉ NUCLÉAIRE

Head Office
31, avenue de la Division Leclerc
92260 Fontenay-aux-Roses
RCS Nanterre B 440 546 018

Telephone
+33 (0)1 58 35 88 88

Correspondence
BP 17
92262 Fontenay-aux-Roses Cedex

IRSN website
www.irsn.org

IRSN

INSTITUT
DE RADIOPROTECTION
ET DE SÛRETÉ NUCLÉAIRE

Financial Report 2007

Didier DEMEILLERS,
Finance Director

Contents

Management report

1 > GENERAL OUTLOOK

Certain events that took place in 2007 will have important consequences on Institute operation.

- In July IRSN received ISO 9001 certification for all its fields of specialization. This recognition of excellence in IRSN team practices rewards the continuous efforts deployed since the foundation of the Institute.
- At the end of August the head office was transferred from Clamart to Fontenay-aux-Roses, uniting over 1,000 staff members at a single location and promoting greater operating efficiency among the different operational and functional divisions.
- At the Atomic Energy Committee meeting held on November 22, presided by the ministries of Ecology and Research, the decision to shut down the Phebus experimental reactor was confirmed. The Committee also proposed to create a committee to guide research orientations in nuclear safety and radiological protection.

The initial 2007 budget was amended by two modification decisions presented to the Board of Directors in March and June 2007 to take into account:

- investment projects in progress carried over from 2006, representing €15.2 million, paid into working capital when accounts were closed in 2006. This carry-over was almost completely wound up during the fiscal year, except for multiyear projects such as the new technology for dosimetry monitoring;
- the Ministry of Ecology (Medad) grant was divided up into an investment grant of €28.1 million and an operational grant for the remaining €201.1 million, minus the precautionary reserve. This change in method complies with the accounting principles applicable to the grant for public service charges defined in the circular on operator budget preparation.

Budget execution in 2007 included a vast investment program totaling €53.0 million after incorporation of operations carried over from the previous year, including the following:

- finalization of the head-office transfer from Clamart to Fontenay-aux-Roses;
- continuation of the technological change program for worker dosimetry monitoring;
- continued, gradual building of a fund allocated to financing future costs for dismantling and remediation, estimated at €31.0 million.

All of these investments were not completed during the fiscal year, and €19.6 million for operations in progress were carried over to 2008.

The accounts closed in 2007 incorporated a significant change in the Institute's management of value-added tax, since activities were divided into sectors that were either subject to VAT, not subject to VAT, or a combination of both. This modification resulted in:

- a request for reimbursement of €12.0 million, issued in January 2008, for VAT declared during 2007; and
- a request for reimbursement of €29.0 million, issued in October 2007, for VAT paid in 2005 and 2006, which generated extraordinary income in the 2007 income statement.

Budget balance

Execution (in €M)	2005 (1)	2006 (2)	2007 (1)	Change from 2006 to 2007
Total resources	287.6	306.9	298.4	–2.8%
Total expenditure	268.1	301.7	265,8	–11.9 %
Balance	+19.5	+5.2	+32.6	+526.9%

(1) *Results for 2007 incorporate VAT, increasing resources by €9.0 million and decreasing expenditure by €12.0 million, for a total impact on the balance of €21.0 million.*

(2) *Results for 2006 incorporate €31.0 million in dismantling expenditure balanced by a provision for the same amount in revenue.*

Like previous years, budget execution in 2007 shows a budget balance that appears overestimated due to the investment carry-over of €19.0 million, in addition to the impact of the change in the VAT system in 2007, for €21.0 million. Recalculating to take into account these operations gives the following results:

Recalculated execution (in €M)	2006	2007
Balance	+5.2	+32.6
2005 carry-over	+12.2	
2006 carry-over	–15.2	+15.2
2007 carry-over		–19.6
VAT 2007		–21.0
Net balance	+2.2	+7.2

In spite of the relative change in VAT which interferes in the budget comparison, the year 2007 shows the following characteristics:

- results match the balance figures given in the projected revenue and expenditure statement approved by the Board of Directors;
- a budget execution rate of 93.1% (compared to 94.3% in 2006), without the VAT effect, i.e. a difference of €21 million, of which €19.6 million corresponds to an offset in the execution of certain investments. Not including these offsets, the expenditure execution rate would be 99.5%.

2 > INCOME STATEMENT

2.1. Revenue

Execution (in €M)	2005	2006	2007	Change from 2006 to 2007
Sales	36.1	35.1	31.8	–9.4%
Grants	240.2	233.4	190.6	–18.3%
Other operating revenue	2.2	3.3	22.7	+587,8%
Operations sub-total	278.5	271.8	245.1	–9.8%
Investment income	1.2	1.6	4	+150%
Extraordinary income	4.2	2	33.4	+1,570%
Total	283.9	275.3	282.5	+2.6%

Operating revenue dropped by €26.7 million in comparison with 2006 (-9.8%) to €245.1 million, with:

- €176.5 million from the grant for public service charges paid by the Ministry of Ecology. The total allowance allocated as part of Program 189 amounts to €207.5 million, given the €20.0 million reduction for the change in the VAT system. The difference of €31.0 million is accounted for as a capital grant, as requested by the supervising ministries (*see above*);
- €3.3 million from the agreement signed with the Ministry of Defense (Mindef) as part of Program 212, up by €0.4 million;
- €0.8 million from other grants, including local government authorities, as compared with €0.3 million in 2006;
- €10 million representing a portion of the revenue from the tax on basic nuclear installations. This measure, initially voted in the 2005 amendment to the appropriations law for the amount of €4.0 million for the year 2006, was renewed for 2007 and increased by €6.0 million;
- €31.8 million of own revenue generated by consultancy services provided by the Institute, co-funding of research programs, or other services, down by €3.5 million in comparison to 2006, due mainly to postponement in the execution of services in this sector, and the unfavorable trend in exchange parity between the euro and the dollar;
- €22.7 million of other revenue, as compared to €3.3 million in 2006. This amount includes fees paid for industrial property (€0.1 million, steady), other operating income (€4.04 million, rising) provided by adjustments made in previous years, write-backs on depreciation and provisions (€18.6 million, a steep rise) corresponding to the cost of early retirement expenses (Capron agreement) and adjustments

in the Institute's fiscal situation with regards to business tax.

■ Investment income, which rose to €4.0 million, was up from 2006 (+€2.4 million) due to early payment of 80% of the Ministry of Ecology grant.

■ Extraordinary income saw a steep rise to €33.4 million, against €2.0 million in 2006. This consists mainly of capital grants recorded in the income statement (€2.4 million) and an exceptional internal transaction (€30.8 million) for the 2005 and 2006 VAT adjustment. This rise in revenue should be considered keeping in mind the €20.0 million cutback in the Ministry of Ecology grant.

2.2. Expenditure

Execution (in €M)	2005	2006	2007	Change from 2006 to 2007
Purchases	128.7	125.5	107.2	–14.6%
Personnel	103.6	109.6	111.9	+2.1%
Taxes	3.3	11.1	13.4	+20.7%
Depreciation	13.4	15.3	16.5	+7.8%
Provisions	8.3	7	0.3	–95.7%
Others	2.1	1	1.6	+60%
Operations sub-total	**262.9**	**269.5**	**250.9**	**–6.9%**
Financial charges	0.1	0.3	0.4	+33.3%
Extraordinary charges	0.4	0.6	0.3	+50%
Total	263.4	270.5	251.6	–7%

■ Operating expenses for the year amount to €250.9 million (down by €18.6 million, or 6.9%). This variation is close to that of revenue, and is concentrated mainly in purchasing, proportional to the change in VAT rules.

This account can be broken down as follows:

- Personnel expenses rose by 2.1% (€111.9 million). This variation is partially due to a moderate rise in salaries, occasional expenses due to personnel taking retirement, compensated by a write-back on provisions for the same amount (*see above*) and a structural effect due to personnel transfers, amplified by job market tension in the nuclear sector.
- Taxes rose by €2.3 million (to €13.4 million) due to the wage and salary tax adjustment, real estate tax, and business tax.
- The depreciation allowance rose by 7.8% (to €16.5 million), while provisions, allocated to fiscal use in the last few years, have practically disappeared.
- Purchases of goods and services dropped significantly (-€18.3 million, or 14.6%) to €107.2 million. This reduction is explained mainly by the decrease in non-recoverable VAT.
- Other expenses represent €1.6 million, as opposed to €1.0 million in 2006.

Execution (in €M)	2005	2006	2007	Change from 2006 to 2007
60 - Purchases	69.1	68	55	–19.1%
61 - Outside services	41.1	39.3	36.9	–6.1%
62 - Other outside services	18.4	18.2	15.3	–15.9%
Total	128.7	125.5	107.2	–14.6%

This table breaks down the year's outside expenses, which amount to €107.2 million. It shows the following:

- There is a considerable reduction in items 60-Purchases and 62-Other outside services, resulting partly from the decrease in non-recoverable VAT.
- A less-significant reduction appears for item 61-Outside services, due to the larger proportion of activities that do not benefit from the reduced VAT rate in operations itemized here.
- Financial charges increased from €0.1 million to €0.4 million due to loans (€7.2 million + €4.8 million + €5.6 million) to finance the new head office location and the new dosimetry technology.
- Extraordinary charges dropped from €0.6 to €0.3 million, corresponding to €0.1 million in contributions and €0.2 million in penalties.

3 > INCOME AND FINANCING

Execution (in €M)	2005	2006	2007	Change from 2006 to 2007
Income	20.4	4.9	31	+532.6%
Cash provided by operations	37.8	22.4	26.7	+19.2%
Variation in working capital	19.5	5.2	32.6	+526.9%

The net balance for the year shows a positive income of €31.0 million, as compared to €4.9 million in 2006. The difference between the most recently revised budget forecast, i.e. –€9.8 million, and income on closing as of December 31, 2007, is €40.8 million. This is explained by:

- the improvement in investment income (€1.3 million),
- increasing provision write-backs (€14.7 million),
- the presence of extraordinary income (€3.8 million),
- the €9.0 million difference between the grant reduction and the VAT reimbursed for 2005 and 2006,
- VAT savings in 2007 to the amount of €12.0 million.

Cash provided by operations, budgeted at €1.5 million in the most recent budget forecast, reached €26.7 million, a difference of +€25.2 million, resulting from:

- a €40.8-million improvement in income,
- an increase in the share of capital grants included in the income statement, representing €0.6 million,
- a depreciation differential of €0.2 million,
- a rise in provision write-backs amounting to €14.7 million.

In addition to the €26.7 million in cash provided by operations, income also includes:

- outside resources (€5.9 million), including a €5.6-million loan to finance deployment of the new dosimetry technology,
- the portion of the grant for public service charges paid by the Ministry of Ecology, accounted for as a capital grant.

This revenue financed investments and long-term debts to the amount of €31.0 million, while contributing €32.6 million to working capital.

Investment projects in progress, for a total amount of €51.8 million, representing approximately €47.8 million adjusted for VAT, have been completed to 59%, i.e. €28.2 million. The €19.6-million difference has been carried over to 2008.

4 > EVALUATION OF BALANCE SHEET ITEMS

4.1. Liabilities

■ With income at €31.0 million, the net situation has progressed by 51.6%, to €90.8 million. Taking into consideration the portion of the grant for public service charges accounted for as a capital grant (*see above*), this item increased by €28.5 million. Contingency and loss provisions have been reduced to €18.4 million, bringing the Institute's long-term capital to €163.2 million, up from the €122.1 million figure of 2006.

■ Short- and medium-term debt, for the amount of €87.8 million, as opposed to €94.0 million in 2006, decreased due to the decline in accounts payable to suppliers (€11.1 million), partially compensated by a complementary loan for €5.6 million to finance the new dosimetry technology. The balance of the variation is explained by reimbursement of existing loans (€1.4 million) and prepaid income (€0.7 million).

4.2. Assets

■ Fixed assets increased to €111.9 million, a rise of €12.7 million, due to continued renewal of IRSN facilities and equipment.

■ Current assets also rose, reaching €139.1 million, as the €41.0 million reimbursement for VAT due from years 2005 to 2007 was accounted for as receivable from the French Treasury, counterbalanced by a €28.3-million drop in cash assets. The balance of the variation consists of the VAT on unbilled payables and down-payments to suppliers.

> CONCLUSION

■ The 2007 budget was executed within the forecasted budget balance presented to the Board of Directors.

■ The Institute's fiscal situation now stands clear in terms of how the corporate income tax is to be applied, and the manner in which VAT will be recovered on purchases and costs.

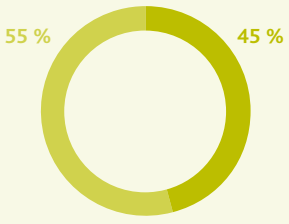
■ A contribution of €32.6 million was made to working capital, including the €19.6 million carry-over of investments in progress, reinforcing the Institute's cash position, placed under a certain amount of stress by the reduced grant allocated in 2007 and the time-lag imposed before the VAT reimbursement expected in 2008.

■ The contribution to allocations for dismantling and remediation operations, fixed at €1.1 million every year, is now insufficient, given the decision to shut down the Phebus experimental reactor, confirmed by the Atomic Energy Committee. The resulting short-term financing needs, and the increase in funds required to finance the updated list of eligible operations, will make it necessary to call for an exceptional contribution as soon as possible.

Balance Sheet

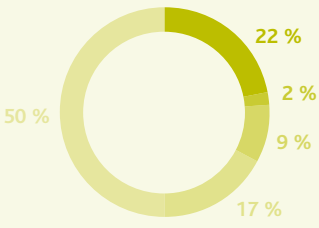
ASSETS

Euros			2007	2006	2005
	Gross	Depreciation & provisions	Net	Net	Net
Intangible assets	12,183,297.08	10,046,867.03	2,136,430.05	2,618,231.40	1,597,325.37
Tangible assets	180,078,409.40	73,479,594.05	106,598,815.35	94,405,259.93	59,558,191.36
Financial assets	3,158,525.44		3,158,525.44	2,139,011.49	1,314,180.01
Fixed assets	**195,420,231.92**	**83,526,461.08**	**111,893,770.84**	**99,162,502.82**	**62,469,696.74**
Current assets					
Inventory and work in progress					
Prepayments and advances on orders	3,200,128.34		3,200,128.34	142,937.41	140,499.71
Accounts receivable				26,478,214.01	26,716,089.71
customer receivables	*25,840,390.59*	*24,080.62*	*25,816,309.97*	*24,546,800.04*	*24,984,581.97*
related receivables	*47,992,553.12*		*47,992,553.12*	*1,931,413.97*	*1,731,507.74*
Other receivables	45,159.22		45,159.22		
Investment securities	49,913,075.86		49,913,075.86	85,092,342.32	65,313,646.29
Cash	12,140,939.23		12,140,939.23	5,254,892.15	1,905,219.84
Prepaid expenses					
Current assets	**139,132,246.36**	**24,080.62**	**139,108,165.74**	**116,968,385.89**	**94,075,455.55**
GRAND TOTAL	334,552,478.28	83,550,541.70	251,001,936.58	216,130,888.71	156,545,152.29



Assets

- Fixed assets **€111.9 million**
- Current assets **€139.1 million**

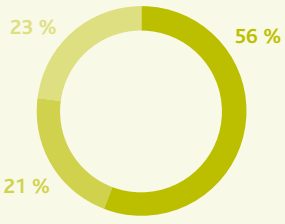


Current assets

- Cash and cash equivalents **€62 million**
- Prepayments **€3.2 million**
- Customer receivables **€25.8 million**
- Other receivables **€48.1 million**
- Current assets **€139.1** million

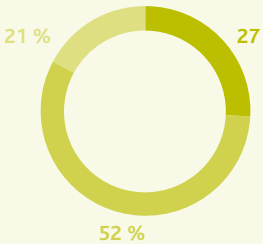
LIABILITIES

Euros	2007	2006	2005
Allowances	8,782,859.59	8,782,859.59	8,782,859.59
Reserves	51,083,266.14	46,222,746.95	31,844,160.61
Retained earnings (loss)			– 6,045,350.60
Fiscal year profit	30,963,852.03	4,860,519.19	20,423,936.94
Net position	**90,829,977.76**	**59,866,125.73**	**55,005,606.54**
Capital grants	35,091,137.98	6,547,264.28	8,505,605.26
Equity	**125,921,115.74**	**66,413,390.01**	**63,511,211.80**
Contingency provision	2,109,000.00	2,013,000.00	1,278,000.00
Provision for taxes due	177,000.00	15,375,369.57	9,250,369.57
Loss provision	35,011,000.00	38,285,000.00	9,806,000.00
Contingency and loss provision	**37,297,000.00**	**55,673,369.57**	**20,334,369.57**
Bank borrowings	15,183,905.42	11,012,752.99	7,283,771.11
Various debts and liabilities	190.50	190.50	190.50
Prepayments and advances on orders		2,432,850.45	2,468,724.45
Trade notes and accounts payable	41,835,202.76	44,716,299.49	31,459,617.08
Tax and social liabilities	23,748,397.96	24,085,228.42	20,529,969.47
Other operating liabilities	130,669.38		
Payables to fixed asset suppliers and related accounts	3,845,582.51	9,042,920.05	9,306,807.42
Other liabilities	2,373,871.64	2,753,887.23	1,650,490.89
Prepayments and accrued income	666,000.67		
Liabilities	**87,783,820.84**	**94,044,129.13**	**72,699,570.92**
GRAND TOTAL	251,001,936.58	216,130,888.71	156,545,152.29



Long-term capital

- Net position **€90.8 million**
- Capital grant **€35.1 million**
- Provisions **€37.3 million**



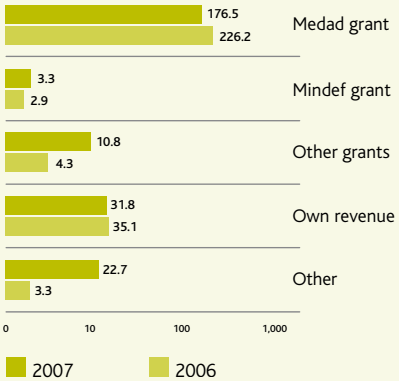
Liabilities

- Tax and social liabilities **€23.8 milli**
- Trade payables **€45.7 million**
- Other liabilities **€18.3 million**

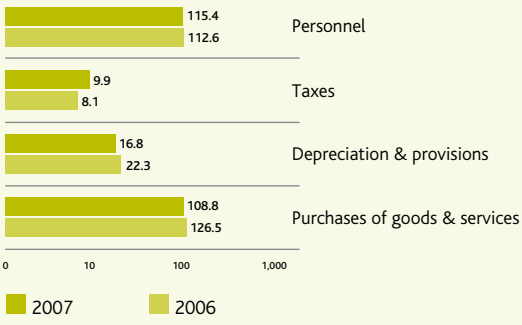
Income Statement

Euros, excl. VAT	2007	2006	2005
Research work	11,600,446.57	12,331,633.33	16,291,682.37
Service contracts	14,965,765.23	17,816,377.00	14,995,334.80
Other services provided	5,281,978.47	4,946,515.75	4,795,015.10
Net revenue	**31,848,190.27**	**35,094,526.08**	**36,082,032.27**
Operating grants	190,599,016.47	233,413,984.22	240,153,038.38
Write-backs on depreciation and provisions	18,653,925.36	2,770,683.10	522,051.53
Expense transfer	206,282.73	24,721.71	54,410.88
Other income	3,782,854.33	457,815.11	1,721,596.47
Operating income	**245,090,269.16**	**271,761,730.22**	**278,533,129.53**
Outside expenses for fiscal year	107,093,251.77	125,464,361.29	132,158,168.96
Taxes, duties, and similar payments	13,397,986.18	11,117,320.62	3,302,586.05
Personnel expenses	111,865,157.14	109,618,595.41	103,617,061.44
Depreciation & provisions	16,806,211.72	22,295,556.87	21,734,857.59
Other expenses	1,618,502.86	1,053,293.40	2,140,338.06
Operating expenses	**250,781,109.67**	**269,549,127.59**	**262,953,012.10**
OPERATING INCOME	– 5,690,840.51	2,212,602.63	15,580,117.43
Investment income	**4,052,131.84**	**1,571,625.06**	**1,190,690.45**
Financial charges	**425,425.61**	**323,419.25**	**99,153.11**
FINANCIAL INCOME	3,626,706.23	1,248,205.81	1,091,537.34
INCOME BEFORE EXCEPTIONAL ITEMS	– 2,064,134.28	3,460,808.44	16,671,654.77
Extraordinary revenue	**33,375,219.19**	**2,013,326.86**	**4,146,552.62**
Extraordinary charges	**347,232.88**	**613,616.11**	**375,520.45**
EXTRAORDINARY INCOME	33,027,986.31	1,399,710.75	3,771,032.17
Income tax			**18,750.00**
FISCAL YEAR INCOME	30,963,852.03	4,860,519.19	20,423,936.94

Operating income (in millions of Euros)



Operating expenses (in millions of Euros)



Income Statement Subtotals

CAPTION	Dec. 31, 2007	%	Dec. 31, 2006	Dec. 31, 2005
Sales	31,848,190.27	14.32 %	35,094,526.08	36,082,032.27
+ Operating grants	190,599,016.47	85.68 %	233,413,984.22	240,153,038.38
FISCAL YEAR PRODUCTION	**222,447,206.74**	**100.00**	**268,508,510.30**	**276,235,070.65**
– Outside expenses	107,093,251.77	48.14 %	125,464,361.29	132,158,168.96
ADDED VALUE	**115,353,954.97**	**51.86 %**	**143,044,149.01**	**144,076,901.69**
– Taxes and duties	13,397,986.18	6.02 %	11,117,320.62	3,302,586.05
– Personnel expenses	111,865,157.14	50.29 %	109,618,595.41	103,617,061.44
OPERATING INCOME Before Interest, Depreciation and Amortization	**– 9,909,188.35**	**– 4.45 %**	**22,308,232.98**	**37,157,254.20**
+ Write-backs, expense transfer	18,860,208.09	8.48 %	2,795,404.81	576,462.41
+ Other income	3,782,854.33	1.70 %	457,815.11	1,721,596.47
– Depreciation & provisions	16,806,211.72	7.56 %	22,295,556.87	21,734,857.59
+ Write-back on capital grants	2,571,406.30	1.16 %	1,986,504.24	4,057,270.75
– Other expenses	1,618,502.86	0.73 %	1,053,293.40	2,140,338.06
OPERATING INCOME	**– 3,119,434.21**	**– 1.40 %**	**4,199,106.87**	**19,637,388.18**
+ Investment income	4,052,131.84	1.82 %	1,571,625.06	1,190,690.45
– Financial charges	425,425.61	0.19 %	323,419.25	99,153.11
INCOME FROM CONTINUING OPERATIONS Before Income Tax	**507,272.02**	**0.23 %**	**5,447,312.68**	**20,728,925.52**
+ Extraordinary revenue	30,803,812.89	13.85 %	26,822.62	89,281.87
– Extraordinary charges	347,232.88	0.16 %	613,616.11	375,520.45
EXTRAORDINARY INCOME	**30,456,580.01**	**13.69 %**	**– 586,793.49**	**– 286,238.58**
– Income tax				18,750.00
FISCAL YEAR INCOME	**30,963,852.03**	**13.92 %**	**4,860,519.19**	**20,423,936.94**

Budget vs. Actual

INCOME STATEMENT in Euros	2007 Budget	2007 - Actual
REVENUE		
Service contract sales	36,078,980.00	31,848,190.27
Government grants	220,008,257.00	190,599,016.47
Other operating revenue	2,800,000.00	38,844,581.79
Internal operations	5,774,000.00	21,225,831.66
TOTAL REVENUE	264,661,237.00	282,517,620.19
EXPENDITURE		
Personnel expenses	117,264,390.00	111,865,157.14
Other operating expenses	134,937,476.00	122,875,041.67
Internal operations	17,000,000.00	16,813,569.35
Precautionary reserve	5,208,716.00	
TOTAL EXPENDITURE	274,410,582.00	251,553,768.16
RESULT (Profit)		**30,963,852.03**
RESULT (Loss)	**9,749,345.00**	
TOTAL INCOME STATEMENT BALANCE	274,410,582.00	282,517,620.19

TRANSFER OF RESULT TO CASH PROVIDED BY OPERATIONS in Euros	2007 Budget	2007 - Actual
RESULT	**– 9,749,345.00**	**30,963,852.03**
+ Loss on sale of assets		3,498.42
+ Depreciation & provisions	17,000,000.00	16,806,211.72
– Portion of grants recorded in result	1,858,000.00	2,427,906.30
– Write-backs on depreciation and provisions	916,000.00	18,653,925.36
CASH PROVIDED BY OPERATIONS	1,476,655.00	26,691,730.51

SUMMARY STATEMENT OF CHANGES IN FINANCIAL POSITION in Euros	2007 Budget	2007 - Actual
CASH PROVIDED BY OPERATIONS	**1,476,655.00**	**26,691,730.51**
Acquisition of tangible and intangible assets	51,771,780.00	28,224,883.59
Financial assets	1,230,000.00	1,274,020.09
Long-term debt paid	1,413,000.00	1,535,165.29
Dismantling assets		
TOTAL USES OF CASH	54,414,780.00	31,034,068.97
Government capital grants	28,071,780.00	30,971,780.00
Other sources (excl. internal operations)	1,122,000.00	255,006.14
Dismantling provision	5,600,000.00	5,706,317.72
TOTAL SOURCES OF CASH	34,793,780.00	36,933,103.86
CONTRIBUTION TO WORKING CAPITAL	**– 18,144,345.00**	**32,590,765.40**

IRSN certified quality management system

IRSN
INSTITUT
DE RADIOPROTECTION
ET DE SÛRETÉ NUCLÉAIRE

Head Office
31, avenue de la Division Leclerc
92260 Fontenay-aux-Roses
RCS Nanterre B 440 546 018

Telephone
+33 (0)1 58 35 88 88

Correspondence
BP 17
92262 Fontenay-aux-Roses Cedex

IRSN website
www.irsn.org

Crédits photos : IRSN / Olivier Seignette - Mikaël Lafontan