IRSN

INSTITUT
DE RADIOPROTECTION
ET DE SÛRETÉ NUCLÉAIRE

Annual report 2003

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Contributing to training in radiation protection

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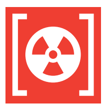
Technical support in matters of nuclear and radiological risk



Operational support in the event of a crisis or radiological emergency

Contractual services of expertise, research and measurement

Carrying out expert appraisals, research and works for public or private organisations.

* These pictograms appear before articles in the section "Activities in 2003" to indicate the missions corresponding to the activity discussed. The description of these missions appears on page 5 of this document.

IRSN's fields of competence

- Defence nuclear expertise
- Environment and response
- Prevention of major accidents
- Human radiation protection
- Reactor safety
- Safety of plants, laboratories, transportation and waste

Research and public service missions

- Defining and implementing national and international research programmes
- Contributing to training in radiation protection
- Permanent monitoring in matters of radiation protection
- Informing the public

Collaborations:

- European and International collaborations: European Commission, GRS, BfS (Germany), NRPB, HSE (England), NRC (USA), Nupec and Jaeri (Japan), Kurtchatov Institute (Russia)
- For the drawing up of technical standards: ICRP, ICRU, IEC, IAEA, Unscear, ISO, OECD/NEA...
- In France: CEA, CNRS, universities, engineering schools, BRGM, IFREMER, INRA, Ineris, research hospital structures, agencies (Afssaps, InVS...)

Missions of technical support and assistance for public authorities

- Technical support in matters of nuclear and radiological risk
- Operational support in the event of a crisis or radiological emergency

for: • DGSNR • DSND • High Civil Defence Servant for Industry • DPPR • DRT • CEA (Department for International Relations) • DGEMP • Afssaps...

Contractual services of expertise, research and measurement

- Carrying out expert appraisals, research and works for public or private organisations

for: • Local information commissions • Industrials • European Commission

A short description of the **IRSN**

Creation

■ Created by article 5 of the law of May 9, 2001 instituting the French Agency for Environmental Health and Safety, for which the implementing decree was signed on **February 22, 2002** (Official Journal of February 26, 2002).

Status

■ A public establishment of an industrial and commercial nature placed under the joint authority of the Ministries of Defence, Ecology and Sustainable Development, Industry, Research, Health and Social Affairs.

Directors

■ Jean-François Lacronique, Chairman.
■ Jacques Repussard, Director General.
■ Michel Brière, Assistant Director General in charge of defence-related missions.
■ Philippe Jamet, Assistant Director General in charge of general matters.

Missions

Set down in Decree 2002-254 of February 22, 2002 relating to the Institute for Radiological Protection and Nuclear Safety.

■ Defining and implementing national and international research programmes.
■ Contributing to training in radiation protection.
■ Permanent monitoring in matters of radiation protection.
■ Informing the public.
■ Technical support in matters of nuclear and radiological risk.
■ Operational support in case of crisis.
■ Carrying out expert appraisals, research and works for public or private organisations.

Positioning

■ **Public expert** in research and expertise related to nuclear and radiological risk.

Lines of development

■ Optimising support missions for public authorities.
■ Reinforcement of its research process in consultation with its main partners.
■ Opening up its expertise to take the expectations of society into account.
■ Developing its European and international dimension.

Fields of activity

■ Nuclear expertise relating to defence.
■ Environment and response.
■ Prevention of major accidents.
■ Radiation protection of human beings.
■ Reactor safety.
■ Safety of plants, laboratories, transportation and waste.

Budget 2003

■ **250 M€** of which 210 M€ is provided by government subsidies and 40 M€ by revenues from contracts with other organisations, especially international bodies. 50% of the total budget is devoted to research.

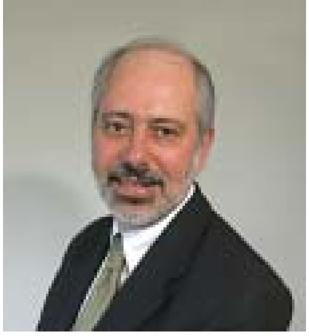
Staff

■ IRSN employs **1,500 specialists:** engineers, researchers, physicians, agronomists, veterinarians and technicians, experts competent in nuclear safety and radiological protection, and control of nuclear and sensitive materials.

Sites

■ Head office: **Clamart**
■ Agen ■ Angers ■ Beaumont – La Hague
■ Cadarache ■ Fontenay-aux-Roses
■ La Seyne-sur-Mer ■ Le Vésinet
■ Les Angles – Avignon ■ Mahina (Tahiti)
■ Octeville – Cherbourg ■ Orsay
■ Pierrelatte ■ Saclay

Jean-François Lacronique,
Chairman.



Jacques Repussard,
Director General.

2003, a year of consolidation for the IRSN

During its second year of existence, the Institution had to address three main issues:

- **Ensuring continuity in the performance of its expertise and response mission involving the provision of technical support to the different authorities concerned, as well as the other missions with which it was entrusted by way of the Decree of February 2002** (research, radiological surveillance of the environment and population, nationwide monitoring of radioactive sources, keeping national records of nuclear material, training, informing the public about nuclear and radiological risks) and continuing to provide contract services to its French and international customers. This report gives an account of the results achieved, showing the Institution's continued involvement in major issues relating to nuclear safety and security, radiation protection of people and the environment at national or international level.
- **Restoring its economic equilibrium,** in a particularly difficult budgetary context, in accordance with instructions from the Minister of the Budget. This mission was also accomplished, as the accounts published in this report show. This was achieved without undermining the scope of action of the IRSN or sacrificing any priorities, but by postponing investments and rescheduling research programmes that are however essential from a medium-term angle.
- **Finally, a great deal of work relating to the creation of the IRSN as a public establishment,** recognised for the quality and independence of its expertise, had to be undertaken, and as far as possible completed: i.e. creating bodies for governance and industrial relations; establishing personnel statuses; coming to agreements with the CEA; unifying the accounting; reorganising departments in October 2003 so as to actually merge the IPSN and the OPRI, and make the Institute more efficient and clear-cut; renegotiating a large number of international agreements signed by the CEA/IPSN; implementing framework agreements with the main administrations that receive the Institute's technical support.

At the same time, it was also necessary to develop new tools to facilitate synergies within the Institute: a communications charter, an in-house newspaper, budget management, a quality policy, a global study on scientific excellence and the development of assessment practices, etc.

The efforts of one and all led to a great deal of work being accomplished and we would like to thank all those involved. As a result, we can now assert that the IRSN is in full working order.

Naturally, some of these projects have not been completed and others have only begun to take shape. To name but a few - drawing up the future contract of objectives between the State and the Institute, defining the major strategic programmes which will influence the evolution of the Institute's scientific knowledge and expertise capacity during the coming decade, creating a decision-making information system to facilitate the running of the Institute, plus other projects of more limited scope but of equal importance, i.e. reorganising the Internet sites, creating a periodical for the Institute's general public

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and reviewing the format of the future annual report which will be more detailed. Therefore, we shall pursue our efforts at a steady pace. They will be structured by four main objectives presented to the Institute's partners at the end of 2003:

- **Optimising technical support for public authorities:** Apart from operators, the IRSN is the only body to have the necessary material and human resources to allow it to monitor and assess risks independently, especially in emergency situations, to carry out in-depth assessments of the conformity of facilities and to ensure that France adheres to international nuclear non-proliferation undertakings. Therefore, efficient action and high-quality coordination with the public authorities in charge of risk management is essential if public action and economic operators are to succeed.
- **Basing research activities on strict scientific excellence:** to remain pertinent, IRSN expertise must be supported by a great effort in terms of research on which the Institute devotes half of its resources. This research effort must be pursued by anticipating problems related to society, by cooperating with the best teams worldwide so as to establish poles of reference capable of fuelling expertise potential as technological progress is made.
- **Opening up the expertise of IRSN to take account of the expectations of society.** More specifically, the Institute must to be portrayed as an exemplary centre of public expertise and recognised as credible by most of the parties involved. Indeed, if the desired transparency is to be developed, it is first necessary to have access to high-quality and multi-source expertise. Thanks to greater collaboration with CLI (local information commissions), the IRSN is gaining more experience in the management of this type of situation, as illustrated in the results obtained in the Nord-Cotentin a few years ago. Moreover, the IRSN must become more involved in education and radiation protection training in collaboration with universities.
- **We must ensure that the Institute's developments become part of an international context** in terms of research (this is already the case, more or less), expertise – especially with a view to gradually harmonising practices within the enlarged EU – and strategic bilateral collaboration (Germany, USA, Japan, China, Russia especially).

This is the grand design of IRSN - anticipating and integrating scientific and technical transformations as well as changes in society so as to improve the service rendered to national authorities in terms of nuclear and radiological risk control and thereby ensuring the safety of facilities and the protection of people and the environment. In this way the Institute can honour the trust that these same national authorities placed in it when they appointed it as public expert in nuclear and radiological risk.

Michel Brière,
Assistant Director General in charge of defence-related missions.

In 2003, the IRSN strengthens its organisation to enhance the nuclear safety and security of defence

In 2003, while ensuring the operational continuity of its missions involving nuclear safety and security of defence, the IRSN started to implement an organisation dedicated to these missions. This concerned the Institute's general management and its operational departments. Thus, a post of Assistant Director General in charge of missions related to defence and a department dedicated to nuclear defence expertise (DEND) was created.

Nuclear defence expertise is now well identified and supported by the public competences of nuclear safety and radiation protection grouped together within the Institute. Therefore, it can fully benefit from the scientific knowledge and experience that France has at its disposal in these fields. Thanks to agreements clearly identifying the tasks and processes entrusted to the IRSN, the missions of assistance and technical support for authorities in charge of the nuclear security and safety of defence are carried out in such a way as to respect their legal and if necessary their confidential nature.

They concern three main fields: protecting and controlling nuclear and sensitive material within the national framework and in accordance with France's commitments in this field; protecting nuclear facilities and the transport of radioactive and fissile material from malevolent acts, ensuring the safety and radiation protection of facilities and nuclear activities related to defence.

More than ever, public authorities can depend upon IRSN competence, organisation and commitment to ensure the nuclear security and safety of defence.

IRSN **missions**

IRSN missions are set down in Decree 2002-254 of February 22, 2002 relating to the Institute for Radiological Protection and Nuclear Safety. In this context, the IRSN carries out seven types of missions that can be classified into three categories:

Research and public service missions

Defining and implementing national and international research programmes

IRSN defines research programmes aimed at maintaining and developing the skills necessary for expertise in its fields of activity. It either carries them out itself or entrusts them to other French or foreign research institutes.

Contributing to training in radiation protection

The IRSN provides training in radiation protection to health professionals and people exposed to risk in their jobs.

Permanent monitoring in matters of radiation protection

The IRSN carries out permanent monitoring in matters of radiation protection by assisting in the radiological monitoring of the environment and by managing and processing dosimetric data concerning workers exposed to ionising radiation and managing the inventory of ionising radiation sources.

Public information

The IRSN informs the public of nuclear and radiological risks via publications, the Internet, travelling exhibitions jointly organised with the DGSNR, conferences, etc.

Missions of technical support and assistance for public authorities

Technical support in matters of nuclear and radiological risk

Public authorities that request the services of IRSN are provided with technical support in the field of nuclear and radiological risk, whether it be for civil nuclear facilities, secret classified facilities, the transport of radioactive substances, the application of non-proliferation treaties or the safety of industrial and medical applications. Among other things, it carries out safety tests, research, development, experimentation and develops models, codes and safety tools.

Operational support in the event of a crisis or radiological emergency

In the event of an incident or accident involving ionising radiation, the IRSN carries out measures of a technical, health and medical nature for public authorities, in order to ensure the protection of the population, workers and the environment, and restore the security of the facilities.

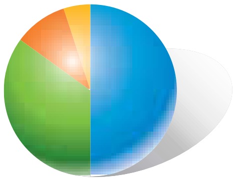
Contractual services of expertise, research and measurement

Carrying out expert appraisals, research and works for public or private organisations

The IRSN carries out contractual services of expertise, research and works – particularly analysis, measurement and dosing – for French, European and international organisations in the public and private sector. In addition, the Institute carries out third-party expertise services for ICPE outside the nuclear sector.

The challenges facing IRSN

Budget allocation 2003 for each category of mission



- **50%** Research
- **35%** Support
- **10%** Services
- **5%** Other missions (excluding research)

IRSN is a public establishment of an industrial and commercial nature (EPIC) created by article 5 of the law of May 9, 2001, instituting the AFSSE. It has an annual budget of 250 M€ divided out as indicated in the diagram. The technical missions previously undertaken by the IPSN and the OPRI have been confirmed or renewed for IRSN. Missions involving training in radiation protection and public information have also been reinforced. This new scope of responsibility has led to the Institute repositioning itself in the institutional and social landscape.

One of the challenges facing IRSN is to play a leading role in an evolution which has seen the emergence of a fourth set of players, usually described as the stakeholders, the three traditional nuclear players being industrialists, safety authorities and research and expertise bodies.

IRSN strategy: report on 2003 and prospects for 2004

In order to carry out its missions effectively and to enhance its credibility, IRSN set itself four institutional and organisational objectives for 2003.

1. OPTIMISING ITS SUPPORT MISSIONS FOR PUBLIC AUTHORITIES

■ Encouraging discussions between the public authorities and the Institute and formalising them in framework agreements

In 2003, IRSN and the administrations that receive its support or technical assistance (DGSNR, DSND, HFD Industrie, DPPR, DRT, etc.) started to redefine the conditions of its intervention. In 2004, this work will lead to the signing of agreements between the Institute and the administrations concerned. These agreements describe the missions of the two parties to the agreement and how the missions will be carried out - they have to be planned but at the same time allow IRSN to respond to new requests. They also touch upon questions of ownership and information regarding the results of the Institute's actions.

■ Putting the quality assurance system into general use and establishing outcome indicators

In 2003, IRSN did a considerable amount of work to develop a methodology that would enable their action to be controlled and their supervising authorities to be kept informed. This work includes a study on programme follow-up (drawing up the new nomenclature of activities) and the budget. This requirement is carried out in accordance with the organic law relating to finance laws (LOLF). At the same time, IRSN is developing a suitable information system called the Decision-making Information System which will enable detailed analytical follow-up of the Institute's various activities, consolidation and synthesis needed for talks with its partners. One of the first budget modules should be available in 2004.

■ Signing a contract of objectives with the controlling authorities

IRSN is drawing up the foundations for a contract of objectives which should be finished by the end of 2004. This contract will enable us to record the expectations of the Institute's contacts and position the Institute in relation

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to the national, European and international challenges linked to its main fields of action.

2. REORGANISING ITS RESEARCH PROCESS IN CONSULTATION WITH ITS MAIN PARTNERS

■ Carrying out an internal study on the challenges that radiation protection, safety and security represent

The research mission represents 50% of the Institute's total budget and is included in the decree of February 22, 2002 in the same capacity as expertise. This investment should be pursued in order to build the Institute's expertise upon the best knowledge available and the skills of its experts and researchers. Therefore, the Institute is carrying out important research programmes in matters related to safety, security and radiation protection. In particular, it is playing a leading role in programmes like PHEBUS and CABRI, which are being carried out with European and international partners who share the same safety concerns and wish to pool resources. In 2003, IRSN launched a study on the Institute's medium-term strategies in the fields covered in its missions: safety, radiation protection, security. This study, which associates the whole of the Institute and should contribute to the contract of objectives with public authorities, will end with a seminar in September 2004.

■ Implementing a determined policy of training through research

Taking in doctorands or post-doctorands is essential if we want to carry out active and high-quality research. IRSN has decided to increase the number of these young researchers in the coming years. This will help revitalise the research carried out, create closer links with universities and enhance credibility and recognition at national and international level. Therefore, IRSN is developing a partnership policy with universities and Grandes Ecoles which will involve training through research, post-doctoral courses or scientific collaboration. This policy will concern generic research in fields applicable to the Institute's activities, interpares comparison of work carried out, and the development of scientific communication.

■ Promoting scientific and technical excellence

For IRSN, scientific and technical quality is a necessity because it enhances its credibility in the eyes of the controlling ministries, requestors and partners in the same way as dynamic research does. The Institute intends to improve its ability to assess the scientific and technical quality of the programmes it hopes to undertake. The process implemented by the Department in charge of scientific and technical evaluation and quality aims to assess both the programmes and the researcher's activities.

An in-house seminar on Scientific Excellence organised in the middle of March 2004, attempted to bring forth in a collective manner the orientations of the Institute in the fields associated with the recognition of scientific and technical excellence.

Initiating discussions and informing "stakeholders"

In January 2003, the Institute organised a seminar in Ville-d'Avray to initiate discussions on high-risk facility consultations. The participants came from very different horizons in the nuclear and non-nuclear fields – industrialists, experts, institutions, associations. On January 31, 2003, it signed a cooperation agreement with ANCLI. Under the terms of this agreement it will provide scientific and technical support in the fields of radiation protection and nuclear safety. In addition to a three-day training course held in May, the content of which was recorded on a CDROM and circulated among ANCLI members, information campaigns and studies have been carried out by IRSN for several CLI. A meeting with ANCLI was held on November 20, 2003 to take stock of the action taken within the framework of the agreement and to examine what action could be taken in 2004 to strengthen the cooperation. At this meeting, it was decided to include the launching of pilot initiatives in the shared programme, i.e. on issues related to the monitoring of waste and the ageing of power stations.

3. OPENING UP ITS EXPERTISE TO TAKE INTO ACCOUNT THE EXPECTATIONS OF SOCIETY

Becoming a public expert

In addition to the support it gives public authorities, IRSN intends to make its expertise available to society via local information commissions (CLI), associations, etc. To organise its action in this field, IRSN has created a mission called Stakeholders. Within this framework, the mission coordinates the Institute's action on themes of local interest and takes part in national and international networks involved in the governance of high-risk activities.

Thus, in January 2003, IRSN organised a seminar on the concerted approach, signed a cooperation agreement with the National Association of Local Information Commissions (ANCLI) and organised a training course by members of the CLI.

Contributing to public information

Contributing to public information is an important mission laid down in the decree of February 22, 2002. The Institute actively circulates information via its reports, Web site, conferences, joint exhibitions with the ASN, the preparation of a CDROM on nuclear risk and participation in exhibitions like Pollutec, Medec and the Eurosafe Forum co-organised with its opposite number in Germany, GRS, and other organisations that carry out technical expertise. In addition, the Institute has for many years been using a barometer to measure the general public's perception of risks.

In this way, it helps give concrete form to the principles of public access to information on the environment and health. These principles were set out in the Aarhus Convention and in the draft law on nuclear transparency.

Developing the Institute's activities

The Institute encourages operational unit teams to develop skills and know-how in their fields of activity, provided that the markets they target are sustainable and of high added value and that they do not lead to ethical problems but rather promote the expertise and image of IRSN. Naturally, the Institute makes sure that these teams do not neglect their main missions, particularly the important, top-priority programmes. The right balance between State subsidies and outside revenue must be sought.

This, for example, is the case with expertise and studies of non-nuclear, technological risks. The recent adoption of new and more restrictive legislation is generating a great demand for third party expertise and IRSN know-how can be effectively implemented to prevent risks.

4. DEVELOPING ITS EUROPEAN AND INTERNATIONAL DIMENSION

European and international action is one of IRSN's main priorities. In 2003, it created a Department dedicated to strategy, development and outside relations (DSDRE) which included a Division for international relations. It also strengthened its international team by appointing executive staff to develop the Institute's bilateral relations and a Europe section within the DSDRE. IRSN's international development policy has four objectives.

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■ **Helping create the European Research Arena**

In the spirit of the European Council of Lisbon of March 2000 and the European Union's FP which aim to reinforce the integration of research in Europe, IRSN contributes – often in collaboration with GRS, its opposite number in Germany – to about forty projects concerned with the management of nuclear power plants and the extension of their life-cycle, the safety of the fuel cycle, radiation protection, the management of crises outside of facilities, the transport of radioactive material in the environment, etc. In addition, the Institute is a driving force behind the creation of Sarnet, the network of excellence, dedicated to identifying and treating the most relevant research subjects in the field of severe accidents.

■ **Promoting the convergence of technical practices in safety expertise in Europe**

IRSN, in collaboration with GRS and other European, technical expertise bodies, encourages the convergence of technical practices in safety. This process has two aims. The first aim is to create a network of European expertise via the action of Eurosafe for example: an annual Forum, a journal and a Web site. The second aim is to establish common expertise practices by drawing up shared recommendations on the expertise process and on technical subjects of common interest.

■ **Helping improve nuclear safety in Eastern Europe**

IRSN, in partnership with its opposite number in Germany, GRS, plays an active role in the implementation of European Commission programmes like PHARE and TACIS which are aimed at improving the safety levels of nuclear facilities in Central and Eastern Europe. IRSN carries out expertise and provides support to the CENS which groups together the safety bodies of these countries. The aim of this is to strengthen their own expertise abilities.

■ **Strengthening bilateral and multilateral relations**

To date, IRSN has entered into about one hundred cooperation agreements with research bodies and technical and scientific expertise bodies from 29 countries, carrying out research programmes and/or operating nuclear power plants. These agreements are related to all the Institute's fields of competence, whether they involve research or expertise. IRSN is drawing up a master plan of its international initiatives in order to ensure the coherence of its action, its missions and its objectives. Finally, the Institute intends to make a greater contribution to task groups who, under the control of international organisations, draw up recommendations or directives like guidelines and standards for radiation protection and nuclear safety and security. In 2003, for example, it helped step up measures aimed at preventing radiological terrorist acts, in accordance with the decisions taken by the G8 at the Evian Summit.

Throughout 2003, IRSN had special relations with China, Finland and the United States

In 2003, IRSN strengthened its collaboration with the Chinese expertise body (BINE) in matters of safety analysis, and with the Chinese safety authority (ANSN) regarding the reassessment of facility safety and physical protection. In Finland, the decision to build a new European Pressurised water Reactor (EPR) stimulated collaboration between IRSN and the Finnish safety authority (STUK) with whom an agreement was concluded. In addition, IRSN pursued its collaboration with the American safety authority (NRC) by signing of an agreement focusing on experimentation and modelling with regard to fire.

Philippe Jamet,
Assistant Director General in charge of general matters.

IRSN **organisation**

Interview with Philippe Jamet.

What are the founding principles behind IRSN organisation?

IRSN, organised around a small general management, operational departments, staff departments and an accounting office, pursues two main objectives:

- organising the operational departments in such a way as to promote synergies between the Institute's different activities and skills;
- organising the staff departments in such a way as to be able to deal with the new requirements that have arisen since IRSN became an independent body.

How are skills and operational teams integrated into this new Institute?

One of the main objectives of this organisation is to federate the teams from the ex-IPSN and the ex-OPRI according to skills and fields of activity. This has been done in the Department for the human radiation protection and the Department for the environment and response. Grouping together different activities into these departments also encourages interaction between research, expertise, studies and response activities. In the fields of nuclear safety and security, the departments also closely integrate activities involving studies, expertise and research related to a specific field: reactors, fuel cycle, activities related to defence. The purpose of bringing these activities together is to forge a common language between experts and researchers via the sharing of study activities.

How are the staff departments organised?

There are four of them, plus the accounting office: the General Secretariat, the Communications Department, the Department for Strategy, Development and External Relations (DSDRE) and finally the Department for Scientific and Technical Assessment and Quality (DESTQ). The General Secretariat groups together all the administrative and logistic functions of IRSN; a new unit in charge of managing real estate holdings and corporate services has been integrated into this department to deal with the many requirements resulting from the creation of IRSN.

What new objectives have been set at the DESTQ and the DSDRE?

One of the main challenges for IRSN is to rapidly position itself as a leading scientific and technical institute. To achieve this, it was decided to highlight the Institute's knowledge capital and its experience in methodology. This is carried out by a unit in charge of promoting the quality of IRSN's scientific and technical production, of assessing this production and attaining outside recognition. This is one of the main roles of the DESTQ. Another basic challenge for IRSN is to acquire real institutional existence by establishing its reputation and creating direct and independent relations with its controlling authorities, members of parliament, prime contractors, its opposite numbers, stakeholders, etc. This is one of the main missions of the DSDRE which is also in charge of building the Institute's strategy and using it as a basis to draw up a contract of objectives which will link it to its five controlling ministries. The DSDRE is also in charge of facilitating and supervising the formalisation of IRSN's policy, using its capital of experience, so that in the future the Institute can draw on a baseline which is structuring, visible and clear both inside and outside the Institute. In addition, the appointment of directors for strategic programmes within the DSDRE introduces a project dimension to IRSN by encouraging as much multidisciplinary interaction as possible in an effort to contribute to major programmes.

I would like to conclude by saying that the DESTQ and the DSDRE mutually confirm the pertinence of their action. Indeed, the filter of scientific and technical evaluation confirms the strength of the proposals made by the Department for strategy which in turn checks that a project, regardless of its scientific and technical quality, is coherent with IRSN strategy.

IRSN **organisation chart** April 2004

BOARD OF DIRECTORS
Jean-François Lacronique
Chairman

GENERAL MANAGEMENT

Jacques Repussard, Director General
Michel Brière, Assistant Director General in charge of IRSN missions related to defence
Philippe Jamet, Assistant Director General in charge of general matters

OPERATIONAL DEPARTMENTS

Department for Nuclear Defence Expertise – Jérôme Joly, Director
- Application of international controls
- Technical support and studies
- Defence safety assessment
- Safety of nuclear facilities

Department for the Environment and Response
Didier Champion, Director
- Study of radionuclide behaviour into ecosystems
- Study and monitoring of radioactivity in the environment
- Analysis of geosphere-related risks
- Sample processing and metrology for the environment
- Response and assistance in radiation protection
- Emergency situations and crisis organisation

Department for the Prevention of Major Accidents
Michel Schwarz, Director
- Studies and experimental research on accidents
- Experimental engineering and instrumentation
- Fuel studies and modelling in accidents
- Fire, corium and confinement studies and modelling

Department for Human Radiation Protection
Patrick Gourmelon, Director
- Radiation protection studies and expertise
- Radiobiology and epidemiology
- External dosimetry
- Internal dosimetry

Department for Reactor Safety – Martial Jorel, Director
- Pressurised water reactors
- Gas-cooled, fast neutron and experimental reactors
- Equipment and structures
- Systems and risks
- Thermo hydraulics, cores and monitoring of facilities
- Severe accidents and radiological consequences
- Human factors

Department for Safety of Plants, Laboratories, Transportation and Waste – Thierry Charles, Director
- Fuel cycle transportation and installations
- Laboratories, irradiators, accelerators and decommissioned reactors
- Radioactive waste
- Confinement, fire, and industrial risks
- Criticality
- Air dispersion of pollutants

STAFF DEPARTMENTS

Department for Strategy, Development and External Relations
Jean-Christophe Niel, Director
- Strategic programmes
- Relations with institutional partners
- Management tools and follow-up of strategic objectives
- Study and research programmes
- International relations
- Policies and synthesis
- Promoting and supporting operations
- Relations with stakeholders
- Secretariat for standing advisory groups
- Risk management

Department for Scientific and Technical Assessment and Quality
Joseph Lewi, Director
- Radiation protection lessons
- Scientific evaluation and activities
- Quality management
- Hygiene, security and environmental protection
- Scientific and technical knowledge engineering
- Scientific information resources

Communications Department – Marie-Pierre Bigot, Director
- In-house communications
- Information and relations with the medias
- Programmes and relations with the public

General Secretariat – Jean-Baptiste Pinton, General Secretary
- Financial business
- Human resources
- Commercial relations and legal support
- Managing real estate holdings and corporate services
- Managing information systems

Accounting Office – Jean-Claude Dale, Accountant

Board of Directors of IRSN

April 2004

Chairman of the Board of Directors

Jean-François Lacronique

State representatives

Patrick Audebert	Manager of the national support Mission for nuclear risk management, representing the Minister for Civil Security
Jean-Denis Combrexelle	Director of Labour Relations, representing the Minister for Employment
Marie-Claude Dupuis	Head of the Industrial Environment division of the Department for the Prevention of Pollution and Hazards, representing the Minister for the Ecology and Sustainable Development
Florence Fouquet	Branch manager of the nuclear industry, General Directorate for Energy and Raw Materials, representing the Minister for Industry
Bernard Frois	Director of the "Power, transport, environment, natural resources" division at the Technology Department, representing the Minister for Research
Marcel Jurien de la Gravière	Delegate for nuclear safety and radiation protection for activities and installations concerned by national defence provisions
André-Claude Lacoste	Director General of Nuclear Safety and radiation protection
Thierry Michelon	Deputy director of environmental risk management, General Directorate for Health, representing the Minister for Health and Social Affairs
Marc Prévôt	Head of the Armament Inspectorate, representing the Minister of Defence
Nicolas Vannieuwenhuyze	Office manager, Budget Department, representing the Minister for the Budget

Qualified personalities

Claude Birraux	Member of the Parliamentary Office for scientific and technical choices
Dominique Goutte	Director of the major heavy ion accelerator, at the instigation of the Minister for Research
Jean-François Lacronique	Professor of medicine, at the instigation of the Minister of Health
Maurice Laurent	Former department head at the National Assembly, at the instigation of the Minister of Industry
Jean Rannou	Air Force General, at the instigation of the Minister of Defence
Jacques Vernier *	Mayor of Douai, at the instigation of the Minister of the Ecology and Sustainable Development

Personnel representatives

Mireille Arnaud	Thierry Fleury
Hervé Boll	Dominique Martineau
Betty Catania	Xavier Moy
Jean-Marc Dormant	François Rollinger

Personalities present by right

Thierry Trouvé	Government Commissioner and Director of pollution and risk forecasting
Daniel Racinet	State Controller
Jacques Repussard	Director General
Michel Brière	Assistant Director General, in charge of defence-related missions
Jean-Claude Dale	Accountant
Marie-Catherine Poirier	Secretary of the Works Committee
Jean-Baptiste Pinton	Board Secretary

** Resigned at the time of publication of the report.*

Activity 2003
Key figures

Research
- **50%** of IRSN budget.
- **745** researchers.
- **16** current themes of study and research (PWR fuel; probabilistic safety analyses (PSA); human factors; thermal-hydraulics; core fusion and steam explosion; behaviour of the containment building; behaviour of fission products; fire; criticality; technology of materials used in facilities; transportation of nuclear materials; storage of waste; radioecology; dosimetry; radiopathology; epidemiology and risk management).
- **6** current European contracts:
  - Radiation protection: EURANOS, ERICA.
  - Safety: SARNET, EURAC, NF-PRO, COWAM 2.
- **53** theses in progress.
- **15** post doctoral trainees per year totally financed by IRSN.
- **34** state or qualified doctors supervising research.
- **2,375** hours of teaching.
- Several hundred scientific publications and communications.
- Approximately ten conferences organised.

Public service missions

Radiation protection of persons
- **260,000** workers listed in the Siseri database.
- **20,000** adiotoxicological analyses.
- **8,000** source movements registered.
- **214** anthropogammametries.
- **7** dose evaluations using biological dosimetry.

Environmental analysis and monitoring
- **40,000** samples taken per year.
- **700** sampling points throughout the whole territory.
- **214** beacons making up the territory's remote monitoring network.
- **100,000** radiological analyses carried out.

Technical support for public authorities
- **10** nuclear crisis exercises nationally.
- Approximately **200** civil or defence-related nuclear facilities underwent expertise by the Institute to monitor safety, security and radiation protection.
- **850** technical notices were transmitted to safety authorities including **100** concerning the safety of transport.
- **20** meetings held by the standing advisory groups based on 15 IRSN reports on the safety of nuclear facilities
- **150** support missions carried out by Basic Nuclear Installation (BNI) inspectors.
- Approximately **200** inspections of nuclear materials.
- **32** support missions carried out by international inspectors to check nuclear and sensitive materials.
- **88** inspections on accounting follow-up of nuclear materials.
- **53** inspections on physical protection, 10 of which concerned malicious actions.

Services
- **19,300** customers or partners.
- **1.9** million personal dosimeters supplied and used.
- **50** third-party expertise studies on the hazards of listed environmental protection facilities (technological risks outside of the nuclear sector).

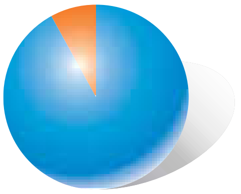
Communication and information
- **Travelling exhibition** *Keeping a Close Watch on Nuclear Energy.*
  - 4,339 visitors, 1,248 of whom were school children.
  - 3 towns: Givet (Ardennes), Arles (Bouches-du-Rhône), Uchaud (Gard).
  - 9 conferences organised.
- Web Site: **430,000** log-ons.
- **6,000** information booklets for the general public distributed (collection of 6 booklets).
- **12,000** copies of the annual report distributed.

International activities
- Almost **100** bilateral agreements with research and expertise bodies from **29** countries
- Over **80** international projects in progress.
- The time spent amounts to **100** persons per year.

** Ministry for Ecology and Sustainable Development*

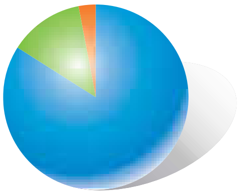
Search

2003 budget for operating/investment costs



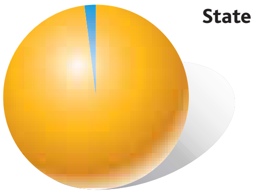
92% Operating costs
8% Investment costs

2003 budget – origin of funding



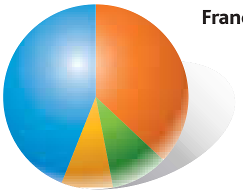
84% State
13% France
3% Foreign

State



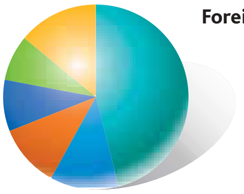
98% MEDD *
2% Others

France



37% EDF
10% COGEMA
9% CEA
44% Others

Foreign



46% RISKAUDIT
12% GRS
11% CCE
9% EPRI
8% NRC
14% Others

Source: IRSN budget 2003.

Main **events**

JANUARY

■ **3.** Decree ratifying the appointment of members of IRSN board of directors (excluding representatives of personnel).

■ **13.** Mr. Taniguchi (Assistant General Manager of the IAEA, in charge of the Department for nuclear safety and security at the IAEA) visited IRSN.

■ **16.** The standing advisory group for nuclear reactors was given a presentation of the report on the evaluation of the generic studies carried out by EDF as part of the safety reassessment of 1,300 MWe nuclear reactors.

■ **21.** Decree ratifying the appointment of Jean-François Lacronique, a professor of medicine, to the post of Chairman of the Board at IRSN (published in Official Journal no. 19 of January 23).

■ **21-22.** IRSN organised a seminar on "high-risk facility consultations" which brought together about fifty participants (industrialists, experts, institutions and associations).

■ **23.** Election of representatives to the Works Committee.

■ **31.** ANCLI and IRSN signed a cooperation agreement, the aim of which is to provide scientific and technical support to ANCLI and its members.

FEBRUARY

■ **13.** Start of the Carmela Bis and Carmelo test campaign on electrical cabinet fires.

■ **19.** Signing of a cooperative agreement on nuclear safety and radiation protection with the National Centre for Nuclear Energy, Sciences and Techniques (CNESTEN), Morocco.

■ **25.** First Works Committee meeting.

■ **27.** Signing of a cooperation agreement on nuclear safety and radiation protection with the Vinçotte Nuclear Association (AVN), a body that was approved by AFCN, the Belgian authority for nuclear safety and radiation protection.

MARCH

■ **3-14.** IRSN chaired a meeting of experts from 45 States in Vienna (Austria) under the auspices of the IAEA, to prepare the strengthening of the convention on physical protection of nuclear material.

■ **10-13.** IRSN took part in the International Conference on the security of sources in Vienna (Austria). Chaired by Mr. Spencer Abraham, the American secretary of energy, this conference was co-sponsored by the governments of the Russian Federation and the United States and organised by the IAEA in cooperation with the European Commission (EC), the World Customs Organisation (WCO), the International Criminal Police Organisation (ICPO-Interpol) and the European Police Office (Europol).

■ **11-14.** IRSN took part in the MEDEC medical forum for professionals in Paris, as it does every year.

■ **12.** The Pierre Isoard prize was awarded to Laure Alloul-Marmor for her thesis on particulate re-suspension carried out at IRSN.

■ **17.** Decree ratifying the appointment of Jacques Repussard to the post of Director General of IRSN (published in Official Journal no. 66 of March 19).

■ **18.** Sabrina Hassoun, a pharmacy intern at the IRSN Internal Dose Assessment and Modelling Laboratory, was awarded third prize in the Paris Public Hospital system's pharmacy internship competitive examination for her study entitled Analytical ion microscope study of the thyroid distribution of iodine in rats born of mothers suffering from a stable-iodine deficiency and contaminated with iodine 129.

■ **21.** Creation of three CHSCT for the sites of Vésinet (Yvelines), Fontenay-aux-Roses (Hauts-de-Seine) and Cadarache (Bouches-du-Rhône) and their associated sites.

APRIL

■ **16.** The appointment of qualified personalities to the Panel Steering Group of IRSN department dedicated to nuclear defence expertise.

■ **22-29.** A delegation from Minatom (Russia) visited the Fontenay-aux-Roses site as part of the CEA/IRSN/MINATOM collaboration on crisis management, including accidents that occur during transportation of radioactive and nuclear materials.

■ **24.** The standing advisory group for nuclear reactors was presented with the report on the safety options of the Jules Horowitz reactor installation project.

MAY

■ **4-8.** IRSN took part in the CSARP conference on severe accidents organised by the NRC in Washington.

■ **6-7.** A consensus meeting on the treatment of irradiated persons, organised by IRSN in Vaux-de-Cernay, with the participation of the main French haematologists and radio pathologists concerned.

■ **19-21.** IRSN gave a specially designed, three day training course to ANCLI members, to provide them with basic knowledge and enable them to take part in technical discussions.

■ **23.** Inauguration of IRSN branch in Angles (Gard).

■ **29.** Signing of the IRSN company-wide agreement.

JUNE

■ **2-4.** IRSN organised an ISP 47 meeting (International Standard Problem) steered by the OECD (Committee on the Safety of Nuclear Facilities - CSNI) dealing with the thermal hydraulics of a reactor containment in the event of a severe accident.

■ **12-18.** The standing advisory group for nuclear reactors was presented with the report on guidelines to follow for the safety reassessment of 900 MWe plants

Search

associated with the third ten-yearly outages (VD3 900).

■ **19.** The standing advisory group for nuclear reactors was presented with a report on the commissioning of the two Chooz B national power generating plants.

■ **20.** Signing of the IRSN/CEA agreement on IRSN's use of the CABRI and PHEBUS test reactors for its research programmes, after three years of discussion between the two organisations.

■ **23-25.** Jacques Repussard visited Moscow for meetings with the Gosatomnadzor (Russian safety authority), his technical support the SEC-NRS and the Kurchatov Institute.

■ **24.** The standing advisory group of experts on installations intended for long-term storage of radioactive waste was presented with the evaluation of the 2001 ANDRA dossier on clay formations that considers the feasibility of storing high-level radioactive waste in the Bure clay formations.

■ **24-26.** PHEBUS FP - fifth international seminar: almost 174 participants, 80 of whom were foreign. Lessons from the first tests were consolidated and the first applications supporting French safety studies were presented.

■ **26.** The standing advisory group for nuclear reactors was presented with a report on qualification of nuclear power plant material with regard accident conditions.

■ **30/06 to 4/07.** Sixth international conference on fundamental and applied radiobiology From radiobiology to the clinic organised in Batz-sur-Mer, (Loire-Atlantique).

JULY

■ **2-4.** As part of the Franco German "Health" programme for Chernobyl, IRSN organised an inter-comparison of the diagnosis of 326 histological slides of thyroid cancer, including 1 from Ukraine and Byelorussia. This inter-comparison took place in the department of pathologic anatomy and cytology at the Ambroise Paré Hospital and was directed by Professor Brigitte Franc who took part in this inter-comparison with Ukrainian and Byelorussian anatomical pathologists.

■ **8.** Decree ratifying the appointment of Michel Brière to the post of Assistant Director General of IRSN (published in the Official Journal no. 158 of July 10).

■ **15.** Claudie Haigneré, the minister in charge of Research and New Technologies invited Philippe Busquin, the European Commissioner in charge of research, to discover the Cadarache site and visit the PHEBUS facility.

■ **17.** Nicolas Lecrux from IRSN was awarded the Jacques Gaussens prize for his work on the Amande accelerator for metrology and neutronics applications for internal dosimetry.

■ **19-20.** The Technical Crisis Centre (CTC) was authorised to field monitor the pulling down of the G1 chimney at Marcoule and the atmospheric sampling.

■ **30.** Jacques Repussard, Director General of the IRSN, and Geneviève Berger, Director of the CNRS signed a scientific cooperation framework agreement, thereby strengthening the existing relations between the two organisations.

■ **31.** The European partners made their first assessment of the Evita and Coloss projects (5th FP) on the qualification and reactor calculation of the integrated Astec code (co-developed by IRSN and GRS).

■ Replacement of about forty low back-ground beta counters as part of the renovation of the counting room at the Vésinet site.

AUGUST

■ **18.** The agreement on the mobility of employees between CEA and IRSN was signed.

SEPTEMBER

■ **8.** The cooperation agreement with the Bulgarian Institute for Nuclear Research and Nuclear Energy (INRNE) was signed. It concerns nuclear safety and radiation protection.

■ **15-20.** IRSN took part in the Entretiens de Bichat (Paris) for the first time: IRSN organised a round table on The medical management of victims of accidental irradiation.

■ **16.** IRSN organised an exercise on the inventory of nuclear material in emergency situations. This exercise was carried out simultaneously at the COGEMA in the Hague (Manche) and the CEA in Cadarache (Bouches-du-Rhône).

■ **16-17.** IRSN organised a training through research days at the Maison de la Chimie.

■ **18.** The standing advisory group for nuclear reactors was presented with a report on the safety of the FPT-3 test that is to take place in the PHEBUS reactor in Cadarache in 2004.

■ **19.** First meeting of the Panel Steering Group for the department dedicated to nuclear defence expertise (CODEND).

■ **22-24.** IRSN hosted a meeting for the American Committee, composed of twelve experts from different countries who have been asked by the American academies of science and technology to investigate waste management with a view to improving regulatory practices and the waste management of low level radioactive waste in the USA. Experts from Europe and Asia took part in these discussions.

■ **25.** Eight representatives from the personnel were elected to the Institute's board of directors.

■ **30.** Meeting of the Observatory to study opinions on risks and safety. The theme was Actual risks and perceived risks: application to risks and territories. It was held at the Fondation Pour la Recherche Médicale (Foundation for Medical Research) in Paris.

■ IRSN helped prepare the 2nd call for proposals for the EURATOM 2004 Programme of Work.

OCTOBER

■ **1.** An amendment was signed enabling the transfer of the IPSN/NUPEC agreement to IRSN/JNES (Japan Nuclear Energy Safety), a technical body that consults the safety authority on commercial industrial and nuclear facilities in Japan.

■ **15.** The new organisation was implemented at IRSN.

■ **20-24.** The IRSN took part in the annual NRC conference on research into the safety of water reactors (NSRC) in Washington. On this occasion, Jacques Repussard met commissioners from NRC and the proposed PHEBUS STLOC programme was presented to NRC, DOE and EPRI.

■ **24.** Restart of tests in the Diva facility on the spread of fire in ventilated premises.

■ **31.** The repatriation to France of an irradiator loaded with 8 sources of caesium 137 (residual activity 740 TBq) was completed under the responsibility of the Institute. It came from the University of Cocody in the Ivory Coast.

■ Completion of work at the Vésinet site – the land was cleaned up and the boiler was upgraded further to the oil spill of March 5.

NOVEMBER

■ **3-14.** IRSN took part in the meeting of signatories of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.

■ **10.** IRSN signed a cooperation agreement on fire modelling with NRC (United States).

■ **13-14.** Supporting the Directorate for Nuclear Defence Facility Safety (DSND), IRSN took part in the crisis exercise involving a nuclear weapon at an air base.

■ **17.** The new organisation and corporate identity of IRSN was presented to the Institute's partners.

■ **17-19.** The scientific committee for the ENVIRHOM programme held a meeting in Cadarache: presentation of the first, particularly interesting results concerning the effects of acute uranium exposure on persons and the environment.

■ **20.** Installation of the Epicur irradiator which provides IRSN with a powerful research tool to study the behaviour of iodine during a severe accident at a pressurised water reactor.

■ Signing of the agreement between CEA and IRSN relating to the terms of transfer of assets, rights and obligations from CEA to IRSN.

■ **21.** An agreement with the European Commission and the organisations concerned, on the content of the SARNET network of excellence project, relating to severe accidents. This network, coordinated by IRSN, groups together about fifty European research organisations.

■ **22.** The Vésinet town council visited IRSN site.

■ **25-26.** The EUROSAFE symposium on the theme: Contributing to the convergence of nuclear safety technical practices in Europe, at the Palais Brongniart, in Paris.

■ **28.** IRSN teams intervened at Roissy after a parcel containing bottles of iodine 125 were crushed.

DECEMBER

■ **2-3.** The Technical Crisis Centre (CTC) was authorised to intervene following torrential rain that caused the rate of flow of the Rhone to rise. As a result and as a preventive measure the operators of the Cruas and Tricastin power stations and the BCOT set off the internal emergency plans of these facilities. Teams were sent to the area to take samples and measurements downstream from the nuclear sites.

■ **2-5.** IRSN was present at the Pollutec exhibition (Villepinte Conference Centre, Paris) where it organised the Risk Forum in collaboration with INERIS and BRGM.

■ **3.** A visit from Jean-Jacques Gagnepain, director of technology at the Ministry of Research and New Technologies.

■ **3-4.** The CSNI of the OECD/NEA approved the final report on ISP46 organised by the IRSN and devoted to the calculation of the PHÉBUS FPT-1 test. Thirty three organisations and twenty three countries participated.

■ **4-11.** The standing advisory group for nuclear reactors was presented with a report on the ageing of EDF's pressurised water reactors in nuclear power plants.

■ **5.** IRSN and the Japan Atomic Energy Research Institute (JAERI) signed a cooperation agreement on nuclear safety and radiation protection.

■ The Ukrainian safety authority signed an assistance contract with a view to commissioning two VVER 1,000 reactors at the Rovno and Khmelnitsky sites in the Ukraine.

■ **8-12.** A coordination meeting for the IRSN/BARC cooperation was held and a technical seminar on the ASTEC code was organised at the Bhabha Atomic Research Centre (India).

■ **17.** IRSN and Paris Tech signed a scientific cooperation agreement concerning three types of collaboration: partnership research programmes, IRSN involvement in the teaching at these schools, doctorands and trainees to be received by IRSN.

■ **18.** Standing advisory group devoted to radiation protection in EDF power plants: first meeting of the standing advisory group for nuclear reactors specifically related to radiation protection.

■ Finland's decision to build an EPR will lead to closer relations between IRSN and STUK (Finnish safety authority).

■ Circulation of a progress report on the first ten tests in the CABRI REP-Na programme (carried out from 1993 to 1998) which highlights the importance of cladding material and fission gases in the resistance of the fuel rods of pressurised water reactors in the event of a reactivity accident (ejection of a control rod).

■ **19.** The signing of a technical services contract involving efficiency tests on filtering elements and iodine traps and experimental expertise on ventilation at the Nuclear Research Centre facilities in Maâmora, Morocco.

■ An agreement between CEA IRSN and the Archives de France was signed.

■ **27.** The Official Journal published the order of October 24, 2003 concerning the transfer of assets from OPRI to IRSN.

Activities in 2003

Safety of civilian installations, transportation and waste

Search

Contributing to ensuring the safety of civilian installations, radioactive material transportation and radioactive waste calls for technical support actions for authorities, studies and R&D work that IRSN conducts in its own laboratories or in partnership:

- safety analysis of installations (waste disposal, thematic files on instrumentation and control software, ageing of power plants, etc.) and radioactive material transportation packages;
- studies and research work (testing, development of models and codes) on the operation of pressurised water reactors, reactor accidents (severe accidents, reactivity accidents), criticality risks associated with transportation, fire, seismic hazard, and the behaviour of rocks as regards waste disposal, etc.

MANON loop: Study of horizontal transfer and settling at the bottom of the reactor building.

MISSIONS

see cover flap

Risk of blockage of PWR containment sumps

In order to obtain a better appreciation of certain measures regarding the cooling of pressurised water reactors in the event of an accidental break on the primary system, IRSN launched a programme in 1997, the results of which were published in 2003. This entailed making a closer study on how the operational condition of the fuel cooling system pumps was affected by such an accident.

Safeguard systems

In the event of an accidental break on a PWR primary system, continued cooling of the reactor is ensured by the safety injection system (RIS). In parallel, the containment spray system (EAS) is started up in order to reduce the pressure in the reactor containment (or building). This system is also used to inject soda in order to reduce gaseous radioactive iodine discharges. At a first stage, the water injected by the pumps of these two systems is drawn from a tank containing approximately 1,600 m^3 of borated water at 2,000 ppm (RWST). When this tank is empty, the RIS and EAS systems operate in closed circuit mode, drawing in water collected in the sumps situated in the lower section of the containment and which has a pH of about 9.3. Fuel cooling can be ensured for long periods with the systems in this configuration. In this case, clogging of the prefilters or sump filtration grids constitutes a failure mode which could affect all the trains [1] of the safeguard systems. In fact, debris produced in the containment by the impact of the jet from a break on equipment and structures (heat insulators, dust, concrete and paint particles) could reach the sump filtration grids. Owing to the nature of the water flows in the reactor building, the blocking of these grids would lead to an increase in pressure drops on the suction side of the pumps, possible air intake and, therefore, the risk of malfunction of the pumps.

(1) ***Train:*** *set of components (pump, valve, pipes, etc.) performing a specific function. In the case of the RIS and EAS safeguard functions, the system comprises two redundant trains.*

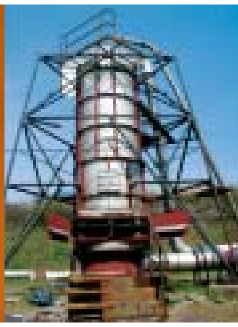
A study and research programme

In the absence of studies on French power plants making a convincing attempt to draw on the lessons provided by the accident at the Barseback power plant (Sweden) in 1992, IRSN started a programme in 1997 aimed at assessing the operability of the pumps of the RIS and EAS safeguard systems in recirculation phase. In particular, IRSN studied the case of the 900 MWe which have the most sensitive characteristics among French nuclear power plants. It should be noted that the French nuclear power plants were designed in accordance with the instructions of the Regulatory Guide 1.82, revision 1, published in 1985.

This risk assessment was conducted taking into account all foreseeable breaks on the primary system and was based on the estimation of the quantities of debris, their size distribution, their crushing modes and the means of vertical transfer of that debris in the containment and its horizontal transfer at the bottom of the reactor building. The first studies conducted identified the main relevant parameters and an experimental programme was conducted for those parameters:

- Vertical transport of debris and its crushing on the gratings in the containment (IVANA loop, Vuez Institute, Slovakia);
- Speeds of horizontal transport and settling at the bottom of the reactor building (VITRA loop, Erect Institute, Russia);
- The behaviour of filters and their prefilters (MANON loop, Vuez Institute, Slovakia). The tests conducted made it possible to better assess the sizes of primary breaks which could lead to blockages.
- The efflorescence of fibrous debris due to the effect of temperature, pH and water characteristics (ELISA loop, Vuez Institute, Slovakia).


RIS sump, Civaux nuclear power plant (Vienne).


Tests on the IVANA loop allowed a better assessment of the behaviour of filters.

Search

Main results

- In a few minutes, 90% of the dislodged heat insulator at the location of the break is crushed by the spraying force and transformed into medium sized fibres (0.5 mm);
- The horizontal transport speeds observed are about 4 cm/s for heat insulator debris. The speed of transport of paint debris is estimated at 14 cm/s;
- The prefilters can be clogged in a very short time, resulting in the dewatering of the filtering grids located downstream and, as a consequence, an air intake into the pumps;
- Temperature plays an important part in the chemical degradation of the heat insulator debris. At 60°C (temperature of the sump water) for example, 30% of the dislodged heat insulator at the location of the break is dissolved in 96 hours;
- The presence of the particles transported to the filtering screens has a significant effect on the porosity of the fibrous layer deposited and, therefore, on the pressure drop on the suction side of the pumps.
- The nature and characteristics of the water and of the thermal insulation play an important part in the formation of precipitates which, in the medium term, modify the porosity of the fibrous layer fixed on the grids and thus significantly increases the pressure drops;
- There is a very significant increase in the pressure drop on the filters of the trains in operation when one train is shut down due to the migration of the fibrous layer formed on the grids of the shut-down train. In view of the results obtained, IRSN considered that, depending on the size of the breaks, satisfactory cooling of the reactor could not be demonstrated. The problem exists to varying degrees for all French nuclear power plants.

A detailed description of the risks and of the conclusions drawn by IRSN was put before the Standing Advisory Group for Nuclear Reactors on June 12 and 18, 2003. This group concluded that the problem should be examined and dealt with as a matter of priority. That opinion was taken up by DGSNR in October 2003. In a letter dated December 24, 2003, EDF indicated its intention to make the necessary modifications on all French nuclear power plants as from 2005. The studies and research work described above clearly illustrates the importance of conducting research to provide objective data for debate. In the case in point, the studies and research conducted at the initiative of IRSN in support of its expert appraisal work convinced the various parties concerned of the necessity of re-examining the design of sumps in the light of the results of those studies and research.

International collaboration

The results of the above-mentioned work also aroused the interest of the US Nuclear Regulatory Commission (USA) working on a revision of the *Regulatory Guide* 1.82, of the Finnish safety authority (STUK), of the Vinçotte nuclear association (Belgium) and of Gesellschaft für Anlagen und Reaktorsicherheit (Germany) with whom technical meetings were held in 2003.
The continuation of these discussions and the OECD/CSNI congress in Albuquerque, USA, in February 2004, on the state of the art in the field allowed progress to be made towards establishing a common view of the uncertainties that remain with regard to:

- the magnitude of the effects caused by a jet from a break on equipment and structures,
- the chemical effects in the fibrous layer deposited on the sump filters due to the formation of precipitates, in alkaline solution, which could result in significant change in the time for pressure drop to occur on the filters.

A programming error in an electrical component caused the explosion of the Ariane 501 launcher, shown here during launch from the Guyana Space Centre.

Recovery of components of Ariane 501 near Kourou on June 4, 1996.

MISSIONS

see cover flap

Assessment of instrumentation and control software

In the context of its expert appraisal work and technical support for safety authorities, IRSN is called upon to assess the safety of software packages, which may be new developments, renovations or modifications.

Constant development

IRSN began assessing the safety of critical software (i.e. software directly contributing to reactor safety) in the 1980s when EDF made the choice of developing a digital protection system for its 1,300 MWe power plants. Since then, the use of software has increased and now concerns most instrumentation and control equipment in the N4 standardised plant series (Chooz, Ardennes and Civaux, Vienne power plants) as well as experimental reactors and on-board reactors.

This has been a global trend that has followed the very rapid technological progress in this field. As a result, the latest computers installed are much more powerful than those used for the 1,300 MWe power plant protection system. However, this gain in performance has gone hand in hand with increased complexity of the functions performed by software packages and, consequently, an increase in the difficulties of checking that software. In this respect, the Fundamental Safety Rule II.4.1.a (adopted in 2000), which defines the conditions in which these software packages are acceptable from the safety point of view, states that conducting tests on a software package is not enough in itself to ensure that the software complies with its specifications. These difficulties in terms of assessment will further increase for the following reasons:

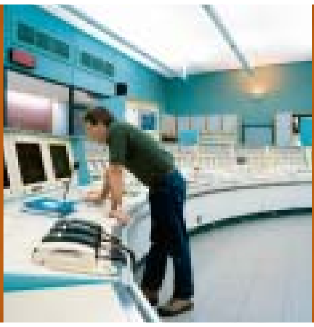
- the almost inevitable use of programmed electrical components performing complex functions with software that is also complex,
- EDF's choice of using TELEPERM XS for the protection system for an EPR type reactor. This product uses technical solutions which have not yet been implemented in critical systems which should mean that IRSN will have to adopt new methods to analyse the demonstration of safety that EDF may put forward, if the EPR reactor project is actually started.

Involvement in the field of regulation and standardisation

To obtain highly reliable software, there must be requirements applicable to the development process (including verification and validation, in particular) and to the software itself. For this reason, IRSN contributes to the regulation and standardisation of this software.

In the context of the International Electrotechnical Commission (IEC), the Institute is contributing to the revision of standard 60880 regarding critical software. It is also playing a part in furthering two other projects regarding standards 62138 concerning less critical software and 62340 which establishes requirements to prevent failures of common causes in computerised instrumentation and control systems.

IRSN also plays a part in the Task Force on Safety Critical Software of the Nuclear Regulatory Working Group set up by the European Commission. For the purpose of European harmonisation, this body discusses topics as varied as diversification, requirements to be taken into account for safety demonstrations, and the introduction of relevant feedback for programmed systems.



Agent at the control console in the Le Blayais power plant control room (Gironde).

Locked-out electrical cabinets in the electrical building of plant unit 2 of the Civaux power plant (Vienne).

Assessment work

In particular in 2003, IRSN assessed the project to revise the Design and Construction Rules for electrical equipment of nuclear islands (RCC-E) by introducing a new section on programmed electrical components (sensors and actuators). In its analysis, IRSN notes that it is difficult to control their technical characteristics and considers that the operator must make more effort to identify the means of qualifying these components.

In addition, since 1999, IRSN has examined the various stages of the renovation of the neutron measurement system of the Bugey (Ain) and Fessenheim (Haut-Rhin) power plants with a digital system. It studied, in particular, the pertinence of the tests performed by the manufacturer to validate the software. Other work has been conducted on the maintenance of software packages and their parameters. Critical software of the N4 standardised plant series comprises more than 13,000 parameters per plant unit and some of them vary according to how far the fuel is spent. EDF has taken action to ensure the continuation of its competencies in PWR software and has drawn up reference documentation on those parameters.

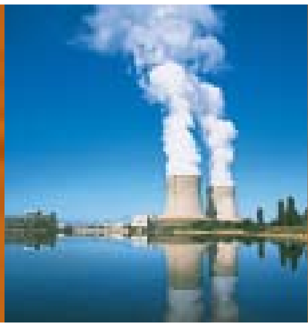
IRSN has also started examining modifications of the software of the N4 standardised plant series protection system planned by EDF in the context of establishing the end-of-series state, to verify that the steps taken to manufacture them does not impair safety. Using innovative static and dynamic analysis tools, IRSN revealed memory overflows in one of the software packages. For its part, EDF found other programming errors. The effects of these errors are currently being examined by EDF and IRSN. In spite of the importance of regulations, standards and codes (RCC-E), it has to be admitted that the requirements they contain do not provide the precise instructions that are found, for example, in regulations and standards applicable to mechanical engineering. Indeed, the provisions set out organisational rules and not manufacturing procedures as they are, de facto, more concerned with design than manufacture. The assessment of software must therefore entail examining the source and executable programs, and not remain limited to checking compliance with the requirements of standards.

Testing tools

Tools are needed if assessments of this type are to be conducted completely independently. For this reason, IRSN defines and conducts studies to find such tools or have them developed.
It is by means of this process that the CLAIRE microprocessor simulator was developed with CEA. This tool allows IRSN to run the actual executable program of critical system software on its own premises.

Another CEA tool (GATeL) currently being tested tackles, in a formal manner, the tricky problem of the cover provided by functional tests: how to be sure of covering a software package's full range of behaviours by running only a limited number of tests? Convincing results and pertinent test cover criteria have been obtained in the context of a European project.

Work on the numeric precision of software is also in progress in co-operation with CEA. A prototype named FLUCTUAT calculates and propagates rounding errors in floating point calculations. In this way, the user knows the calculating error deviation that may be applicable to each variable at each point in the program for all its possible execution modes. This tool has been tested on actual cases and gives very pertinent results.



Nuclear power plant
at Saint-Laurent-des-Eaux (Vienne).

Servicing work on power plant steam
generator tubes.

MISSIONS

see cover flap

Ageing of pressurised water reactors and safety assessment for third 10-yearly outage programmes

In May 2003, the French parliamentary Office for Evaluation of Scientific and Technological Options delivered its report on the operating life of nuclear power plants and new types of reactors. According to its authors, the report was aimed at answering fundamental questions concerning electricity generation in France, such as: "What phenomena may limit the service life of nuclear power plants? What steps can be taken to combat their ageing, at what price and in what safety conditions?". In the perspective of the third 10-yearly outage programmes for 900 MWe reactors (VD3 900 MWe) which will start in 2008, IRSN studied the safety reassessment programme for these reactors for the purpose of implementing improvement by that deadline and the manner in which ageing is taken into account.

Ageing of components, structures and systems

Degradation due to various ageing phenomena can affect the availability of components, structures of systems which have an important role with regard to normal or excellent operating safety of installations. In some cases, components or structures are not replaceable (embrittlement of tanks, loss of prestress of containment concrete) or the cost of their replacement may be considered prohibitive by the operator (ageing of electric cables, loss of toughness of some moulded components of primary systems). The effect of excessive ageing cannot be corrected by repairs or replacements: it therefore directly affects the service life of plant units. In other cases, i.e. for all other components playing a part in the installation's safety, there are means of dealing with degradation but in-depth defence, and thus safety, may be diminished to a varying extent and for a varying duration.

Safety reassessment of 900 MWe reactors with regard to third 10-yearly outage programmes

In France, safety reassessments are conducted periodically (about every 10 years) for nuclear reactors. During these reassessments, the condition of the reactors is analysed and their level of safety is reconsidered in the light of lines of thought developed in the intervening period or applied to more recent or planned installations. A safety reassessment starts with proposals by EDF of topics to be covered, that are examined by IRSN on the request of DGSNR. The conclusions of this examination are generally presented to the Standing Advisory Group for Nuclear Reactors (GPR).

In this context, in June 2003, IRSN put forward, to GPR, its evaluation of the approach and range of studies proposed by EDF to prepare the safety

Turbogenerator set, overhaul at the Le Blayais power plant (Gironde).

Floods in December 1999 inside the Le Blayais power plant: indication of the rising water level in the premises housing the spray system heat exchanger in the fuel building.

Search

reassessment for the third 10-yearly outage programmes for the thirty-four 900 MWe reactors. These studies will be used to define the modifications to be made to the installations so that they can continue to be operated in satisfactory conditions after the third 10-yearly outage programmes.

IRSN proposed that the safety reassessment should study the applicability of the safety requirements for the EPR project to 900 MWe reactors so that their level of safety would be as close as possible to that for the most recent reactor project, when technically feasible and when there is a significant improvement in safety.

IRSN also made sure that the content of the safety reassessment covered a wide enough scope, in keeping with international practices. In particular, it emphasised fields where little information is provided by feedback, such as accidents or hazards (forest fires, extremely high winds and high air and river water temperatures, etc.). A seismic reassessment will also be conducted on the installations in order to consider the development of technical knowledge in that field. IRSN also recommended that an in-depth study should be made of all explosion risks. These risks concern the disposal and utilisation of pressurised gases, such as hydrogen and acetylene.

Role of probabilistic safety analyses (PSA) in safety reassessment

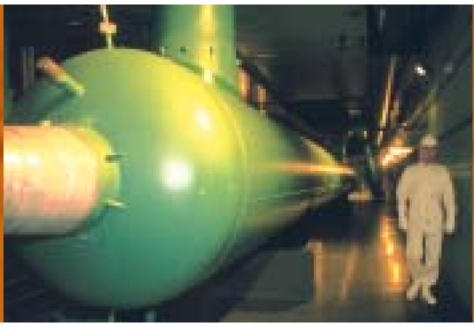
PSAs have undergone major developments at EDF and IRSN since the second 10-yearly outage programmes. Consequently, the VD3 900 MWe safety reassessment will be based on updated level 1 PSAs in order to allow for the latest hardware modifications implemented in the installations. It will also draw on the fire PSA and the level 2 PSA developed by IRSN. It should be borne in mind that PSAs facilitate the appraisal of measures adopted by the operator thanks to their systematic investigation of accident scenarios. In particular, they help to gauge the importance from the safety point of view of problems identified during design or operation. The level 1 PSA identifies scenarios leading to core meltdown and determines their frequencies. It is completed by the fire PSA which integrates the risks related to that hazard. The level 2 PSA can be used to evaluate the nature, extent and frequency of radioactive discharges outside the containment.

Service life of nuclear power plants

The designers of French nuclear power plants adopted a theoretical service life of 40 years for the design of main components. This is the case for the reactor vessel and the containment. However, the actual service life of a nuclear power plant must make allowance for three main factors:

- **The normal wear** of components and systems, sometimes referred to as ageing, depends in particular on age, operating conditions and the maintenance actions carried out by the operator.
- **The required level of safety** varies according to new requirements adopted in the context of safety reassessments.
- **Cost-effectiveness** must remain satisfactory compared with that of other production means.

According to EDF, there are many reasons to favour the smoothing of the renewal of nuclear power plants in service over 20 to 30 years, which would require a significant extension in the service life of some reactors to beyond 40 years. This only appears achievable if permitted by their safety level which is reassessed every 10 years.



Damage caused by floods in December 1999 inside the Le Blayais power plant: premises housing the spray system heat exchanger in the fuel building.

Maintenance operation on a turbine at the Dampierre-en-Burly power plant (Loiret).

Ageing-related risks

In the perspective of the third 10-yearly outage programmes, EDF started work in 2001 on the control of risks associated with nuclear power plant ageing phenomena. These phenomena can lead to deterioration of the physical properties of materials and cause, for example, decreases in mechanical strength resulting in loss of integrity or tight sealing of containment barriers, or reduced component or system reliability.

IRSN conducted an assessment of EDF's method and organisation regarding the control of ageing. One of the difficulties identified concerns the assurance of the existence of satisfactory possibilities for the replacement of worn or obsolete components or equipment after the third 10-yearly outage programmes. Indeed, ageing-related risks could be the result of lack of foresight in identifying and understanding ageing mechanisms and of inadequate or unsuitable preventive maintenance measures, or even shortcomings in the preparation of remedial maintenance.

IRSN also examined the problems raised by the ageing of the personnel responsible for operating nuclear power plants and the considerable renewal of competencies that is expected over the period 2010 to 2020.

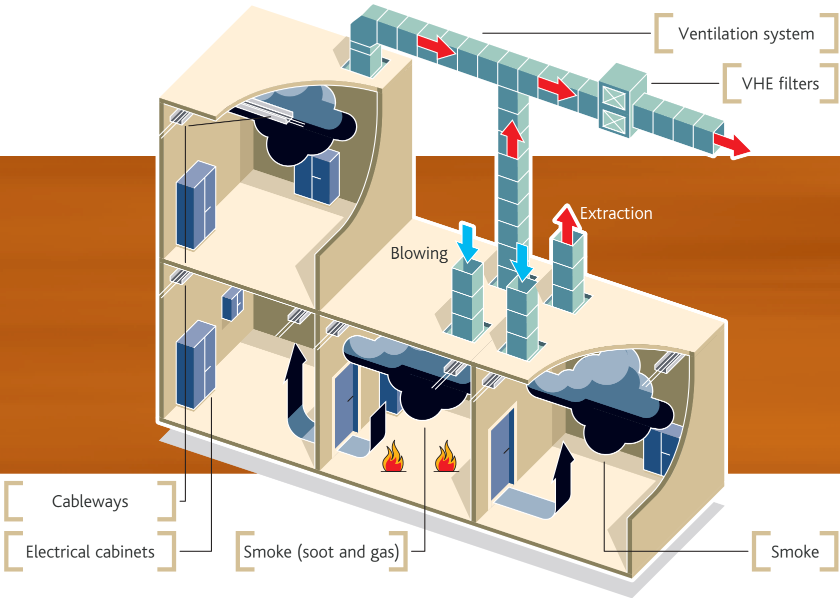
The conclusions of the assessment conducted by IRSN were put to the Standing Advisory Group for Nuclear Reactors on December 4 and 11, 2003. While EDF's method and organisation for ageing management appear to be globally suitable to maintain the safety level of reactors, the Standing Advisory Group, in response to IRSN's proposal, adopted a number of recommendations concerning, for example, the in-depth analysis of feedback, the forward planning of studies on the repair and replacement of some equipment and the allowance for ageing in component, system and structure surveillance and maintenance programmes.

Ageing analysis reports

The main point of the approach proposed by EDF is the drawing up of ageing analysis reports. These reports are based on the systematic analysis of safety-related components, structures and systems and ageing degradations which may affect them. Each of these reports, of which there are 450, are currently analysed by the operator in various ways:

- Is the feared ageing mechanism adequately controlled (knowledge, kinetics and consequences)?
- Are the maintenance and periodic inspections provided for in maintenance programmes (nature and frequency) suitable for sufficiently early detection of any degradation?
- Are preventive measures (reduction of causes, repair, replacement) provided for?

The results of this analysis, which must be completed in the course of 2005, will be taken into account in the preparation of the third 10-yearly outage programmes for plant units and, for the most important cases, will give rise to specific files demonstrating suitability for continued operation prior to the third 10-yearly outage programmes.




Test of the CARMELA program for studying the combustion of electric cabinets.

Experimental programmes on fire

The experimental programmes currently being conducted at IRSN on fire are intended to further knowledge on two subjects which are major preoccupations for the assessment of fire risks in nuclear installations: electrical cabinet fires and the propagation of a fire from one room to neighbouring rooms through ventilation systems or openings. These programmes are also of interest beyond the nuclear industry.

MISSIONS
see cover flap

Electrical cabinet fires

The CARMELA and CARMELO programmes are aimed at preparing a simple model describing electrical cabinet fires. Owing to the complexity of this type of fire, a two-stage experimental approach was adopted:

- A first step of an analytical type with the CARMELA programme followed by CARMELA bis comprising a total of about 30 tests, 11 of which were conducted in 2003. The electrical cabinet is represented by a steel box filled with a variable number and arrangement of tiles of Plexiglas, PVC or polyethylene simulating the electric components in the cabinet. At the end of these tests, it was possible to construct a simple empirical model which could be used to determine the development of the fire's power according to the cabinet's geometric characteristics;
- A second stage conducted in 2003 with two global tests on relay cabinets which were representative of actual cabinets. Using the results, the reliability of the model prepared during the previous stage can be tested and perfected with reference to real cases.

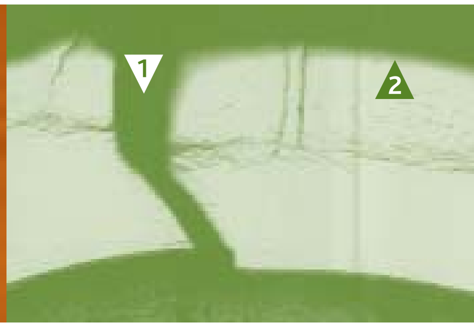
Fire propagation to adjacent rooms

The test campaign performed in 2003 in the DIVA device was aimed at studying the consequences of a fire of the oil slick type in a room for neighbouring rooms and the coupling between the fire and the ventilation. In particular, its purpose was to study the change in the pressure of gases at the various points of the installation and the propagation of heat and smoke within the experimental configuration. This campaign comprising nine tests was also used to assess the effect of calibrated leaks under doors between rooms and sectorisation components used in the nuclear industry such as fire dampers that close automatically at a temperature threshold (70°C). The large volume of experimental data obtained is currently being analysed and will be used to improve the computer code FLAMME_S-SIMEVENT.

Definition of new programmes

In the course of 2003, existing experimental data was analysed as were the plausible scenarios for fire propagation in nuclear installations. This work led to the definition of two new multi-year programmes: **PRISME,** on the reactor side, to study the mechanisms of smoke and heat propagation in configurations comprising several rooms with ventilation; **PICSEL,** on the plant side, to study the consequences of an electrical cabinet fire on the clogging of very-high-efficiency (VHE) filters, on negative pressure levels in rooms and on components involving radioactive material.

View of the pit and the CABRI core, at the CEA installation at Cadarache (Bouches-du-Rhône).



1 – Crack in clad.
2 – Hydride concentration in the Zircaloy-4 fuel rod clad used for test REP Na 8.

MISSIONS

see cover flap

CABRI REP-Na programme

The purpose of the CABRI REP-Na programme is to acquire knowledge on the behaviour of fuel rods highly irradiated during a reactivity accident. It was initiated by IRSN to compensate for the lack of any experimental validation of the safety criteria used so far for this type of accident, in the case of fuels with high burnup or MOX fuels used in French PWRs. It was conducted in the sodium loop of the CABRI reactor in co-operation with EDF and with financial support from the US-NRC (Nuclear Regulatory Commission).

The programme's major objectives were to identify the physical phenomena that could lead to rod failure and the ejection of fuel during the first phase of the accident, characterised by a high mechanical interaction between pellet and clad. The programme comprised eight tests with UO_2 fuel rods and four tests with MOX fuel rods. The following parameters were explored: burnup fraction, clad corrosion and energy injection (speed and maximum energy).

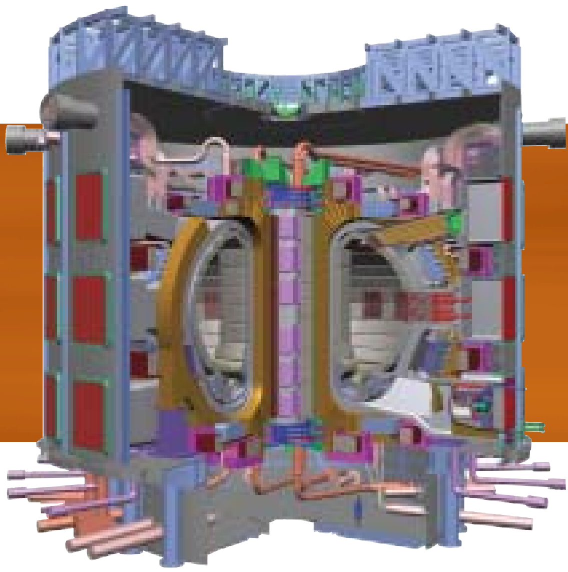
Main results

The clad failures observed on some fuel rods, for relatively low maximum average fuel enthalpy values, between 30 and 113 cal/g, confirmed the need for change in the safety criteria used so far and drawn up for fresh or slightly irradiated fuel. The following main points were deduced after detailed interpretation of the tests:

- High level of clad corrosion with the presence of hydride concentrations (for example: due to spalling of the zirconium outside layer formed during operating conditions) has a damaging effect on the mechanical strength of the cladding;
- The fission gases present at grain boundaries (large quantities in the peripheral area of UO_2 pellets with a high fuel burnup and in plutonium rich agglomerations of the irradiated MOX fuel) lead to fine fragmentation of the fuel and considerable gas release (increasing with the burnup fraction) along with the possibility of additional mechanical loading of the clad for MOX fuel.

A new international programme: CABRI CIP

Owing to the characteristics of the sodium loop, the CABRI REP-Na tests cannot reproduce all the phenomena that can result in failure of the fuel rod clad and its consequences. Questions remain on the behaviour of fuel rods in the advanced phase of the transient for conditions representative of the reactor (after heating of the clad), on the fuel-coolant interaction after clad failure, and on the quantification of the role of fission gases (a subject which will be examined in analytical tests). It is for this reason that IRSN initiated the CABRI CIP programme in the context of broad international collaboration under the auspices of the OECD (11 participant countries) and in co-operation with EDF. After renovation of the installation and the setting up of a water loop in the CABRI reactor, the aim of future tests in the context of the international CABRI CIP programme will be to obtain, in fuel rod cooling conditions representative of those in a pressurised water reactor, better knowledge on the behaviour of fuels with a high burnup during a reactivity accident.



Experimental thermonuclear fusion installation (ITER).

MISSION

see cover flap

Examination of safety options for the ITER installation

The French site of Cadarache is the European candidate to host an experimental thermonuclear fusion installation called ITER. In the context of the definition of this installation's safety options, IRSN was required to examine the file drawn up by CEA.

The definition of the safety options that would be adopted in the event of ITER being set up on the Cadarache site (Bouches-du-Rhône) was conducted under CEA responsibility with, in particular, the preparation of a safety options file. On the basis of the document issued by the Joint Central Team (JCT) and in liaison with the international team, CEA made the modifications and additions necessary to adapt the ITER design to the Cadarache site (allowance for earthquakes, in particular) and to take into account specific French practises regarding safety (such as the management of low level waste – LLW). The safety options file was examined by IRSN, which reported the results of its examinations to the standing advisory group for plants (GPU).

Acceptable safety options

The risks of workers being exposed to ionising radiation associated with tritium, neutrons and neutron-activated materials constitute the major hazards of this installation. They led CEA to provide for containment systems and radiation protection screens, as well as the use of robotic tools to perform maintenance and inspection operations. The inventory of activated materials must, however, be extended so that, when the time comes, it will be possible to ensure optimal design of the installation and precisely identify the characteristics of the waste.
To prevent the risks of pulmonary tumours related to the inhalation of beryllium dust, CEA has made plans for the installation of containment systems and the periodic cleaning of the areas concerned. This dust will be produced by the impact of particles created by nuclear fusion on the walls which recover the high energy of the neutrons in the form of heat. It will be mixed with tungsten and carbon dust, the other materials from the walls eroded by the flow of particles. The conditions for this mixture to explode must be examined.
As regards seismic risks, CEA has planned to design the installation on the basis of ground movements calculated in accordance with the most recent French regulations which are stricter than those adopted for the generic site. This is a satisfactory approach. The design of structures and equipment will, of course, be subject to subsequent examination. Furthermore, the main portion of the waste produced during operation and during the subsequent dismantling of the installation will constitute waste with a very low, low or moderate level of activity, and its management modes will have to be specified at future stages in the examination process. In conclusion, the safety options proposed by CEA appeared to be appropriate: there is nothing to prevent the project moving ahead. If it is decided to set up the ITER installation on the Cadarache site, the operator must transmit a support specifying the technical solutions adopted prior to any works. This report will be thoroughly examined by IRSN as part of the Government's decision on a construction authorisation.

The ITER installation

The aim of ITER is to demonstrate, scientifically and technically, the control of fusion energy by experiments lasting around 400 seconds with a power of approximately 500 MW. The design studies for this installation were conducted by Japan, the Russian Federation and Europe. In 2001, the Joint Central Team (JCT) submitted the resulting document describing the main points of the installation on a generic site.

Search

Seismological station for the Durance array.

MISSIONS

see cover flap

Research on the Middle Durance fault

Continuing its research work on the seismicity of the Middle Durance fault, IRSN's aim is to generally improve knowledge of the activity of an active fault in the French seismotectonic context. The goal is to obtain a better assessment of the seismic hazard in France and, in particular, for dwellings and installations at risk in the Provence-Alpes-Côte d'Azur region.

South-East France is a region of moderate seismicity compared with Japan and California. However, destructive earthquakes have occurred: the Lambesc earthquake in June 11, 1909, left 40 dead, and 600 were killed in the earthquake in the Gulf of Genoa in 1887. In Provence, the Middle Durance region is classified as the highest level hazard in the French regulatory seismic zoning system in force in 2003. The Middle Durance fault system, known more simply as the "Middle Durance fault", produced a major earthquake a few thousand years ago (order of magnitude of 6.5), significant historic earthquakes every century since the 16th century (order of magnitudes of between 5 and 5.5) and it is the seat of regular microseisms detected by seismometers.

Research conducted on the Middle Durance fault system

IRSN has been studying the Middle Durance fault between Meyrargues and Saint-Arnoux since the beginning of the 1990s. The Institute set up an array of instruments consisting of 12 velocimeters and 19 accelerometers capable of recording both very small earthquakes as well as powerful earthquakes. This array is completed by a geodesic system (permanent GPS) which continuously measures the relative sliding of two blocks bordering the fault.

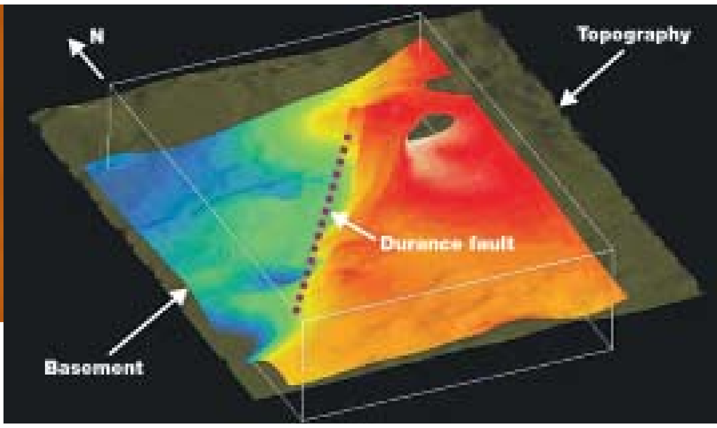
The research is aimed at obtaining better characterisation of the fault's seismic potential and has been in progress for about 10 years in collaboration with the Universities of Orsay (Essonne), Aix-Marseille III (Bouches-du-Rhône) and Sophia Antipolis (Alpes-Maritimes). Five doctorate theses have been written on this topic.

In more detail, the research is aimed at:

- Specifying the magnitude and depth of the earthquakes occurring in this fault system;
- Specifying the fault's geometry and location on the surface and deep underground;
- Estimating the relative rate of displacement of the blocks separated by the fault system;
- Studying past major earthquakes by means of paleoseismic studies;
- Estimating the maximum size of the earthquakes that can occur in the fault system, by means of empirical methods or numeric modelling.

Contribution of research results for expertise

Assessing seismic risk for a nuclear organisation obviously means knowing the seismic hazard associated with the site concerned. The seismic hazard is, for a given location and a given period of time, defined by the maximum seismic movements considered



View of a 3D model of the Middle Durance fault on the basis of geology and seismic profiles. This model can be used to locate seismicity more precisely. The difference in colour represents the variation in the depth of the crystalline crust vertically offset by the fault (deep areas in blue, shallow areas in red).

to be plausible during the installation's service life. In general, each fault which may cause significant earthquakes should be pinpointed and its geometry and its instrumental and historic seismic activity, or its paleoseismic activity, should be known. The rates of geological and geodesic deformations along the fault must also be estimated.

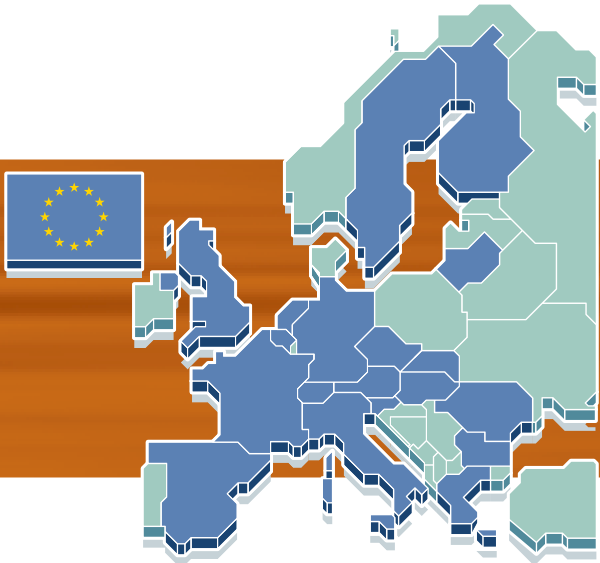
The seismic hazard corresponding to a fault is then specified at a second stage when all the above-mentioned parameters can be used to define the magnitude, location and return period of the earthquakes to be considered.

In the case of the Middle Durance fault system, the whole of this approach is directly applicable and the feedback resulting from its study takes into account "slow" active faults for the definition of the seismic hazard for installations at risk (nuclear and chemical) and conventional installations in the French seismotectonic context.

Over the years, the position and geometry of the Middle Durance fault have been specified. The characteristics of historic earthquakes and paleoseismic characteristics have been studied. Using the results of these studies, it has been possible to establish a seismic hazard assessment that is independent of that by the CEA, in accordance with the statutory procedure updated in 2001 (Fundamental Safety Rule 2001-01) for the Cadarache centre (see box). Finally, the progress made in the field of seismic instrumentation has made it possible to catalogue the instrumental seismicity associated with this fault system. In 2003, a map plotting the fault and the uncertainties associated with geological knowledge was published, and the seismicity catalogues were published between 1999 and 2002. All these results and research studies can also be used to better assess the seismic hazard for dwellings and installations at risk in the Provence-Alpes-Côte d'Azur region.

Seismic hazard at Cadarache

The research conducted on active faults in Western Europe and, in particular, the Middle Durance fault reveals some occurrences of major earthquakes in the distant past (paleoseismic earthquakes). To assess the seismic risks associated with new or existing installations on the Cadarache site, a paleoseismic earthquake associated with the Middle Durance fault system, located a few kilometres to the west of the site, should be taken into account. It is also considered that historic earthquakes in the region (Manosque in 1708, Lambesc in 1909) may also reoccur near the site along the Middle Durance fault system as well as on the Trévaresse faults near Lambesc or the Luberon mountains. On the basis of the research conducted, the depth and magnitude of those historic earthquakes and the position of the faults can be specified. These parameters have made it possible to determine the seismic movement to be taken into account for the safety of the Cadarache nuclear installations.



SARNET
Severe Accident Research NETwork

- 19 countries
- 49 organisations
  - 18 research organisations
  - 10 universities
  - 11 manufacturers
  - 4 electricians
  - 6 ASM or technical safety organisations

MISSIONS
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SARNET, European network of excellence for severe accidents

On the occasion of its 6th Framework Programme (for Research and Technological Development), the European Commission encouraged large research organisations to create "networks of excellence" in order to give new impetus to research in Europe and to create a "European research area". It is in this context that IRSN initiated the setting up of a network of excellence in the field of severe accidents affecting light water reactor (accident involving reactor meltdown). The objective is to optimise the use of available research means in this important field regarding nuclear safety.

About 50 European organisations (research centres, technical safety organisations, safety authorities, electricians and manufacturers) combined their efforts at the beginning of 2003, under the leadership of IRSN, to prepare a network project in the field of severe accidents affecting pressurised water reactors (accidents involving reactor core meltdown).The objective is to optimise the use of available research means in this important field regarding nuclear safety. This project was submitted to the European Commission in April 2003. It was selected following a hearing by assessors in July 2003, known as SARNET, this project was formally adopted in February 2004 with a budget of € 6 M over four years.

A network to progress, co-operate and perpetuate

The network's definition is based on three goals:

- Improve scientific knowledge in the field of severe accidents and thus reactor safety;
- Define and conduct research programmes by making optimal use of complementary laboratory facilities;
- Perpetuate achievements, preserve the memory of what has been done, and disseminate knowledge throughout Europe. The activities carried out in the context of the network will be co-ordinated by IRSN until March 31, 2008, when the contract with the European commission ends. The network will continue to exist beyond that date, independently from the Commission, on the basis of an operating mode yet to be defined.

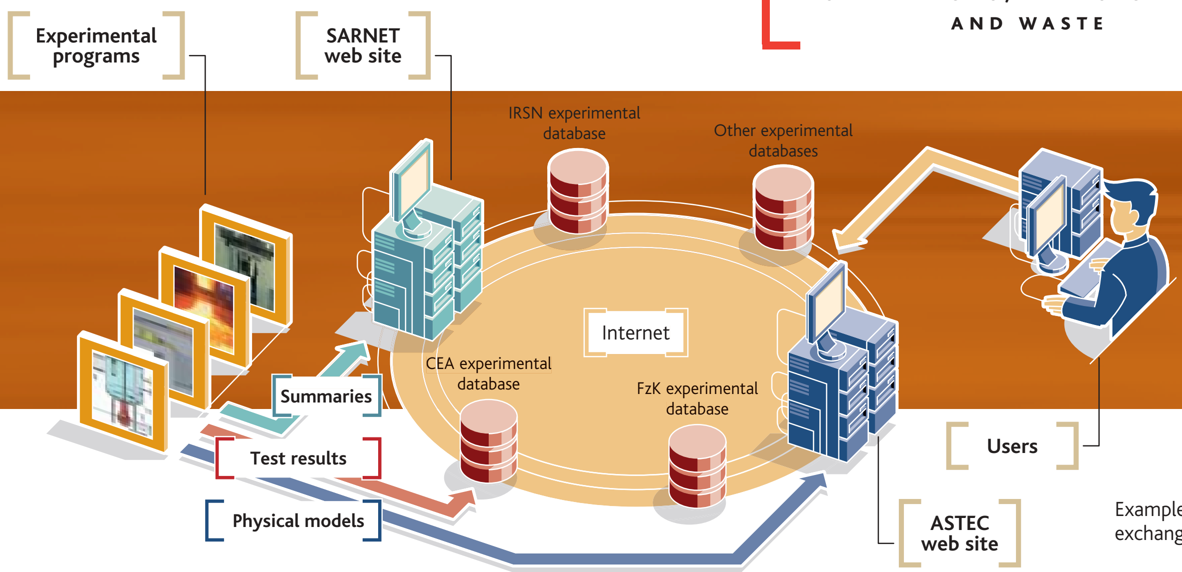
Four types of activities are planned in the context of the network, as follows:

Analysis of needs and drawing up of research programmes

The main guidelines that European research programmes must follow in order to respond to the main questions in the field of accidents with core meltdown are periodically redefined in line with the EURSAFE conclusions stated in the frame of the 5th Framework Programme. The projects themselves will be drawn up taking into account existing programmes and seeking to make best use of the competencies of the various laboratories.

Knowledge report and summary

This activity, pursued along the high-priority lines defined by EURSAFE and periodically updated by SARNET, will have the purpose of supplying state of the art reports and recommendations in terms of modelling.



Example of information exchanges within SARNET.

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The following four fields will be covered:

- the degradation of the core in the reactor vessel (kinetics of hydrogen production, reflooding of a degraded core, etc.);
- the behaviour of corium – a mixture of materials produced by core meltdown – once the vessel has been perforated (ejection, reaction between corium and concrete, cooling of a layer of debris, etc.);
- the strength of the containment (possible detonation of hydrogen, steam explosion, etc.);
- the behaviour of the radioactive products released from the degraded core (from MOX fuels or fuels with high burnup fraction, chemistry of the iodine in the primary system and the containment, etc.).

Preparation of tools and reference methods

The integrated ASTEC code, jointly developed by IRSN and GRS (Germany), will be placed at the disposal of network members who will contribute to its qualification. ASTEC will gradually incorporate the models constructed within the network and will be adapted to users' needs for their interpretation work and their applications to reactors. Capitalising the knowledge produced by the network, adapted to the characteristics of the various types of reactors existing in Europe (including Russian designed reactors) and widely distributed, the ASTEC code will become the European reference for severe accident codes. In the field of applications to reactors, an effort will be made to develop a reference method for the level 2 probabilistic safety analyses (probabilistic studies of the consequences of accidents with core meltdown). Furthermore, all the experimental results obtained and used by the various partners will be collected together, in accordance with the same protocols, on a controlled access databases network.

Knowledge transmission

The transmission of knowledge is among the objectives of SARNET. In addition to training in the use of ASTEC and making it available for applications to reactors, it is planned to pursue the transfer of knowledge through three types of action:

- A conference every 12 to 18 months on the progress accomplished within the network, attended by international participants and of the same level as those organised by the US Nuclear Regulatory Commission in this field (Cooperative Severe Accident Research Program, MELCOR Code Application and Maintenance Program);
- Training courses organised periodically for students and young researchers;
- The writing of a book on "Severe Accidents" for the scientific community during the first three years of the network's operation.

The network will be controlled by a structure comprising two levels:

- the Governing Board, a decision-making body responsible for defining the strategic orientations and action plans on the basis of proposals from the Management Team;
- the Management Team responsible for operational control, directed by the network co-ordinator.

The SARNET network will gradually modify the landscape of research on severe accidents in Europe. It will become a reference for the definition of research priorities in this field which will necessarily have an impact on the orientation of national programmes. Gradually, a major part of research activities on severe accidents will become co-ordinated by the network, so strengthening the complementary facilities of the various laboratories.

Check on the radioactivity of nuclear waste disposal drums at the Nogent-sur-Seine power plant (Aube).

Layout of galleries and instrumentation in bores to analyse the impact of excavation of the Tournemire tunnel (Aveyron) in the argillaceous medium.

MISSIONS

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Search

Expertise in the field of geological disposal of radioactive waste

In the context of its technical support missions for public authorities, IRSN is developing and applying its expertise in the field of the safety of radioactive waste management and, in particular, the geological disposal of high-level and longlife waste. Indeed, while the law of December 30, 1991, gave an open framework for the research into ways of managing this waste (transmutation, interim disposal, long-term disposal), the skills already required by IRSN in the safety of nuclear installations led it to focus its efforts on questions raised by the safety of possible geological disposal.

In this way, IRSN conducts research centred mainly on the study of clayey environments in keeping with the surrounding environment of the underground Bure laboratory (Meuse) which is the responsibility of ANDRA. On-site tests in Tournemire (Aveyron) and the laboratory, modelling operations and methodological exercises to analyse the impact of disposal are being conducted in the context of European contracts or bilateral co-operations in France (ENSMP, engineering schools, universities, CEA) and in Europe (CEN·SCK in Belgium, University of Bern and NAGRA in Switzerland, ENRESA in Spain).
In addition, on request from DGSNR, IRSN is evaluating the progress of ANDRA's work on the feasibility of possible geological disposal at Bure.

Actions undertaken at Tournemire

The Tournemire experimental station, a former railway tunnel 2 km long dug more than a century ago, provides direct access to a clayey Toarcian formation which makes it possible to conduct testing within a clay layer with a covering of 250 meters of sedimentary rock. These clays have enough similarities with those on the Bure site to allow IRSN to carry out suitable research programmes to further its expertise.
The possible existence of natural fractures and the role they may play in transfer mechanisms represent important points with regard to the safety of a disposal. For this reason, IRSN has conducted a major multi-disciplinary programme with the aim of testing methods of identifying and characterising such discontinuities. The nature and characteristics of the natural fractures which may affect a clay massif are now better known. It still remains to determine the role such fracturing plays in the transfer times for fluids and aqueous solutions through a clay layer on the scale of geological time.

Furthermore, the excavation of wells, galleries and tunnels in a clay formation causes modifications in the state of the massif's initial stresses with the appearance of a disturbed area around the engineering works. Locally, this disturbed area significantly modifies the massif's intrinsic hydraulic properties (permeability, porosity, etc.) as well as the direction of flow. It must therefore be covered in the context of the long-term safety assessments of such a disposal facility. In 2003, IRSN constructed two new instrumented galleries, 40 m and 15 m long respectively, with a semicircular section 5 m in diameter in order to study the hydromechanical disturbances caused by excavation. The interpretation of this experiment, especially for the validation of flow analysis models developed in the past, is planned for the three coming years.

Head of the roadheader excavating machine.

Excavation of the main gallery in the experimental installation at Tournemire (Aveyron) in 2003.

Search

International collaboration

IRSN is participating in a gallery ventilation test in the context of the international Mont-Terri project (canton of Jura, Switzerland). The aim of this test is to follow the progress of the desaturation front in the rocky massif around a micro-tunnel under a controlled atmosphere. This process will take place during the construction of a disposal facility and may facilitate the propagation of cracks in the massif in the vicinity of galleries.

Furthermore, the development of thermal gradients in a clay massif can lead to considerable hydraulic and mechanical modifications. Since 1995, IRSN has been participating in the international DECOVALEX project on the effects of THM (Thermal, Hydraulic and Mechanical) coupling on the circulation of water in fractured media.

Assessments conducted in 2003

Among IRSN's expertise activities concerning the disposal of radioactive waste, the evaluation of the "clay file 2001" drawn up by ANDRA was an important step in the follow-up of the progress of work regarding the feasibility of a high-activity waste disposal in argillaceous geological formations. This document summarises the knowledge acquired by ANDRA up to the end of 2001 concerning the hydrogeological, geochemical and geomechanical characteristics of sedimentary formations at the Bure site, describes the design options for a possible disposal installation and sets out an initial approach to the assessment of the safety of such an installation.

The IRSN assessment was presented to the standing group of experts for installations for the long-term disposal of radioactive waste in June 24, 2003. IRSN laid special emphasis on evaluating how the approach developed by ANDRA identified and took into account the remaining uncertainties, regarding in particular the site's natural properties, the methods of constructing the disposal structures and the incidence of disturbances of thermal, hydraulic, chemical and mechanical types on the installation's overall safety. Models of the long-terms transfers of radioactive substances put forward by ANDRA were also assessed allowing, in particular, for the various operations of the same type in which IRSN has participated (especially the SPA and BENIPA projects included in the European Commission's research framework programmes).

Actions undertaken on the site in the east of the Paris basin

The studies carried out by IRSN on the sedimentary formations in the east of the Paris basin were articulated, between 1999 and 2002, with the National Hydrological Research Programme (PNRH) 99/35 of CNRS which involved various public organisations (INSU, ANDRA and Gaz de France). As from 2003, the work, conducted in co-operation with CNRS, has been focused on improving the understanding of the geometry of the Saint-Diez fault system in the region containing the Bure site.

In the context of an agreement reached with ANDRA, the Institute is also conducting analyses of argillaceous rock and water taken during sinking of the wells for the Bure laboratory and surrounding bores. The aim of these analyses is to identify the chemical and isotopic compositions of the water for the local area.

The data acquired in the context of this work as well as data available in the public domain is input into a geological, hydrogeological and hydrogeochemical database on the Paris basin (BPDATA) set up by IRSN in 1998. This database is used in collaboration with the Ecole Nationale Supérieure des Mines de Paris in order to understand and reconstitute the various possible flow patterns in the east of the Paris basin.

Transportation of spent fuel on the *Pacific Teal* at La Hague (Manche).

Loading a ship transporting MOX fuel packages, between Japan, La Hague and Cherbourg (Manche).

MISSIONS
see cover flap

European project on allowance for the criticality risk in packages transporting actinides

Under current regulations on the transportation of radioactive materials, only three fissile isotopes are subject to limitations for the prevention of criticality risks: uranium 235, plutonium 239 and plutonium 241. Other isotopes in the actinide family can lead to an uncontrolled chain action. Such isotopes are found, in particular, in small quantities in fuels removed from nuclear power plants. Until now, only a recommendation in appendix to the IAEA regulations deals with the problem raised by the transportation of such fissile isotopes and alerts the relevant authorities of the need to assess the criticality risk when significant quantities of those isotopes are present.

The studies conducted by IRSN in co-operation with EMS (Sweden) and SERCO (Great Britain) in the context of a contract with the European Union have furthered knowledge of the criticality risks regarding these isotopes and have made it possible to propose a change in the regulations on the transportation of these isotopes.

Basic knowledge on actinides

The first phase of the studies consisted in collecting all the existing data and obtaining basic knowledge on actinides: half-life and capability of maintaining a fission chain reaction on their own. Then, to appreciate the criticality risks for the various isotopes, it was necessary to determine the "critical" parameters, especially their minimum critical masses below which there is no criticality risk whatever the form and concentration of the material. Owing to the fact that some nuclear data regarding these isotopes had not been qualified, criticality calculations were performed using various nuclear databases from the United States, Europe and Japan. The results of these calculations show that, depending on the isotopes, the minimum critical mass is between a few tens of grams (californium 251) and several tens of kilograms. By comparing the values obtained with the various assessments of nuclear data and with various design codes, it is possible to evaluate knowledge on the various isotopes and the uncertainties associated with their minimum critical masses.

Transportation configurations

Owing to the very small quantities of actinides that are generally transported, one way to avoid unnecessarily penalising all transportation units containing actinides is to determine, for each isotope, the mass per package below which the combination of a large number of packages does not entail any criticality problem.

For example, under the current regulation, any package in which the mass of fissile isotopes is less than 15 g can be approved without a criticality study. This limit mass is drawn from calculations formed in the 1960s, based on the assumption of a maximum number of 250 transported packages. In the latest revision to the IAEA regulations (1996), an additional requirement was introduced, limiting the total mass of fissile isotopes per shipment to half the minimum critical mass of the mixture of fissile isotopes.
This requirement limits the criticality risk in the event of an accident situation resulting in the fissile material from several packages being thrown together.

International transportation regulations

The various national regulations on the transportation of radioactive materials share a common technical basis: the international transportation regulation issued by the IAEA. The latest edition of this regulation dates back to 1996 (revised edition in 2000).

Transportation of spent fuel packages at the Valognes (Manche) railway terminal.

Search

The calculations performed in the context of the European project were able to determine, according to the number of packages transported, the maximum permissible mass of isotopes per package for which subcriticality is demonstrated on the basis of the same safety principles as those used for the usual packages transporting fissile materials.

Proposal for change in regulations

Using the data obtained during the project, IRSN and its partners drew up, for all fissile isotopes, limit masses per package and per group of packages below which packages are considered to be "fissile excepted" packages: they can then be transported without any need to specifically substantiate their subcriticality. These limits make allowance for uncertainties in the nuclear data, by means of safety factors applied to the limit masses.
In this way, provided that a maximum number of simultaneously transported packages is ensured and subject to compliance with the maximum limit masses per package as defined in the project, it is possible to consider that "fissile excepted" packages transporting actinides will, as far as the criticality risk is concerned, be transported with the same level of safety as usual fissile packages.

Conclusions

The studies conducted during the project increased the available knowledge on actinides and on the values of their "critical" parameters. Furthermore, the results obtained could be used to establish, by applying a general method, exemption criteria for packages containing low masses of fissile isotopes.

IRSN's work will form the basis of proposals for modifications to the IAEA regulations. A working meeting was held in France in March 2004 with the aim of reaching international consensus on a change in the definition of "excepted" fissile materials.

This regulation requires the demonstration of subcriticality in order to prevent any criticality risk during the transportation of N packages containing fissile materials.

■ In a normal situation, for the grouping of 5N packages (with the packages being considered in their state after tests representative of normal transportation conditions), the smallest outside dimension of the package must not be less than 10 cm.

■ In an accident situation, for the grouping of 2N packages (with the packages considered in their state after tests representative of accident transportation conditions).

Human and Environment Protection

Search

The IRSN actions with regard to human and environment protection are organised in four areas:

- radiation protection of workers, patients and population in general, more especially including the management of radioactive sources inventory, the study of biological effects from ionising radiation, the analysis of health impact of radioactive releases to the environment, external dosimetry, internal dosimetry, etc.;
- study and monitoring of radioactivity in the environment, study of radionuclide behaviour in ecosystems and analysis of geosphere-related risks, etc.;
- response and support for radiation protection;
- operational support for public authorities in case of crisis.

The members of the ENVIRHOM Scientific Council held from November 17 to 19, 2003, in Cadarache (Bouches-du-Rhône).

Experimental study of the uranium effect on the growth of unicellular green algae.

The uranium bioaccumulation is studied out for bivalve and crayfish.

Chronic risks and radioactivity

Among the environmental disturbances most often mentioned as a possible cause for an increase in certain pathologies, the case of radioactivity requires clear replies. This is the reason why IRSN initiated the ENVIRHOM program, which was positively assessed in 2003 by the Scientific Council after a 2-year period intended for testing the feasibility of the selected options.

MISSION

see cover flap

Assess the radioecological risk

The purpose of ENVIRHOM is to allow impact assessments based on validated scientific data, processing the path and effects of radionuclides from their introduction into the environment to human beings and other exposed organisms in the biosphere. For this purpose, it is necessary to establish an access indicator, usable in situations when the radioactive agent is largely scattered, with low concentrations, in synergy with other agents, and keeping impacts in time. These are very clearly additional situations to those covered by the Sievert, an indicator for which the risk representativity is strongly established only for medium exposures, delivered for a short time and most often via external exposure. Furthermore, the study not only covers accesses resulting in cancers. With regard to animal and vegetal populations, impacts on reproduction or other performances of individuals are essential, as any stress may in time result in a selective pressure and thus to a bio diversity reduction.

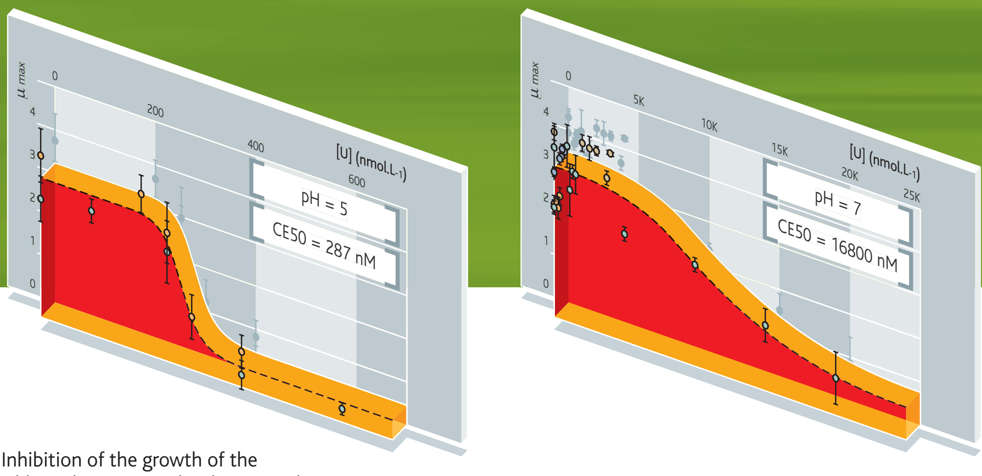
In this context, the researches of the ENVIRHOM program basically cover two topics: first the kinetics of transfers and the accumulation and inhomogeneity factors and second, actual impacts, for instance on the evolution of animal populations or on the behaviour of affected individuals.
During the feasibility phase, the program basically covered the case of uranium, a radioactive element being omnipresent in the environment with sometimes noticeable concentrations.

Transfer, accumulation and inhomogeneity factors

For this first topic, rats were chronically contaminated during two years. It could be recorded that the uranium incorporation and elimination are clearly differing from the admitted values for a contamination over a very short period. It could also be recorded that the uranium distribution among organs is not identical to the contamination resulting from a one-time contamination. Finally, within the same organ, high deviations were recorded with regard to the homogeneous distribution assumption, which is used in the current models. These observations were made not only with the rat, but also with high different organisms like fresh water bivalves.
It can thus be stated, and this represents a first essential result of ENVIRHOM, that chronic contamination is governed by laws being noticeably different from the laws applicable to acute contamination. The confirmation of non-homogeneity justifies more in-depth analysis of the program, as noticeable local concentrations are possible especially in an inhomogeneity situation, even when the total amount of contaminant is relatively low. This probably also applies to all radionuclides that may

Assessment of the ENVIRHOM program

In November 2003, the date of assessment by the Scientific Committee, the ENVIRHOM program had generated 16 publications and 29 presentations during congresses. 16 doctorate thesis students and postdoctorands contributed to this first phase. 36 researchers and technicians are involved in this program, which is conducted in Cadarache (Bouches-du-Rhône), Pierrelatte (Drôme) and Fontenay-aux-Roses (Hauts-de-Seine) laboratories, with in addition now the Cherbourg (Manche) marine radioecology laboratory. The same teams participate in the FASSET and ERICA European research programs intended for gathering and developing knowledge being applicable to the environmental risk assessment.



Inhibition of the growth of the *Chlamydomonas reinhardtii* green algae after 120 hrs of exposure to uranium, at pH 5 and 7.

Search

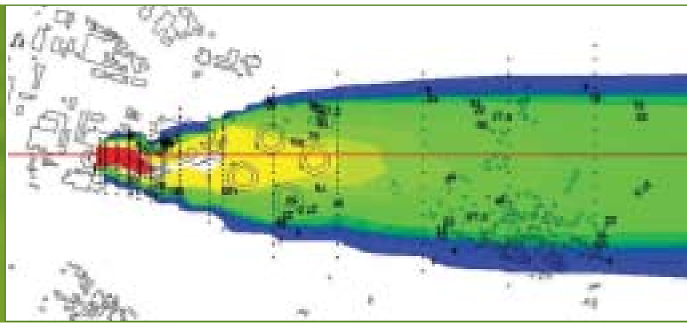
be involved in chronic contaminations. In this respect, it will be necessary to determine whether a coincidence may exist between the accumulation areas and areas being more sensitive to the presence of contaminant. With regard to transfers to the environment, the relationship between the bioavailability and the chemical speciation was studied out. It was more especially established that variations in pH or variations in the concentrations of other elements may have a noticeable impact on transfers. This result, which was expected, has a high practical importance: in addition to the specifically biological concentration mechanisms, this is one of the reasons for environmental inhomogeneity, as any inhomogeneity for a parameter generates cascading inhomogeneity for others. This also means that a local radioactivity measurement can be fully usable only when other local parameters are known.

Actual effects

For this second topic, IRSN evidenced, for example, the effects of uranium concentration in water with regard to the survival of microscopic seaweed populations. An important impact was recorded, not only for the total uranium concentration, but also for concentrations of the various chemical forms it may take. Other original results with regard to behaviour were established, such as the impact of the uranium concentration on the bivalve opening times, on the rat sleep and on their performances in labyrinth.

These are promising results, but they emphasise the magnitude of works to be conducted before it is possible to conduct actual assessments of impact on human beings and on the environment for chronic exposure situations. It should be noted that with regard to chemical toxic materials, regulations and assessment guidelines are available at the European level. The works of the ENVIRHOM program should contribute to prepare the same type of documents for radioactivity.

Physical model of the Bugey site (Ain).



Reconstitution of iso-concentrations based on ground measurements for a release assumed to be due to direct leaks from the reactor building.

MISSIONS

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Crisis management

The missions delegated to IRSN by the decree from February 22, 2002, specify that, in case of nuclear or radiological accident, this body should be capable of advising the Public Authority and propose technical, medical and health measures that can best ensure the protection of populations, workers and environment, and to restore the facility safety. In order to conduct these missions, IRSN implemented a specific organisation including a warning system, a Crisis Technical Centre (CTC) and a set of intervention and radioactivity measurement resources for human beings and the environment.

The MIRA project

In order to improve its expertise resources, and more especially those dedicated to the assessment of radiological consequences of accident situations, IRSN is conducting research and development projects. For example, the Institute initiated in 2002 a reflection with regard to its atmospheric dispersion models for radioactive releases and the use of data assimilation techniques to improve predictions of the modelisations. The current developments cover the emergency stage of an accident situation and its possible "short distance" effects (up to 30 km).

These works should result in the implementation, in the CTC, of a new operational tool for assessing the atmospheric dispersion and doses in taking into account radioactive measurements in the environment, this tool should replace the current system. This project, called MIRA, should also allow a better interpretation of the radiological measurements conducted in the environment during an accident situation.

Direct modelling and "inverse" modelling

During an accident situation, IRSN performs an assessment of the radioactive atmospheric release and the associated radiological consequences based, first on observations and weather forecasts and secondly, on estimated current or potential releases. The new "direct" model will allow incorporating physical phenomena not processed with the current tools, such as disturbances induced by buildings and relief-related effects.

Reciprocally, the interpretation of environmental contamination measurements conducted during and after a release should especially allow confirming or invalidating the release estimates performed based on the more or less reliable knowledge of the accident sequence in the facility. The MIRA project thus includes the development of an "inverse" model which, coupled with the direct model, will allow better assessing certain parameters of the accident situation (release characteristics, weather data, etc.).

Physical models and validation

In order to test the new models, a series of experiments were conducted. A wind tunnel diffusion experiment was specifically conducted on a 1/500 scale model of the Bugey (Ain) nuclear power plant; various tests were performed in order to measure the concentrations resulting from a release filtered by the chimney and a non-filtered release ("direct" leaks from the containment building). A first comparison between the test results and the results obtained with the model currently being developed allowed observing a satisfactory compliance.

During an exercise in the crisis management technical centre of Fontenay-aux-Roses (Hauts-de-Seine).

Search

National crisis exercises during year 2003

The national crisis organisation is tested every year through about ten exercises, in accordance with a schedule defined by the Public Authority. IRSN is systematically involved in such exercises as an actor and also contributes to the preparation of technical scenarios.

As for the previous years, the 2003 exercises basically covered the EDF plants.

The exercise in Chooz B (Ardennes), allowed more especially testing the relationship between France and Belgium, with IRSN and its Belgian counterpart (AVN) jointly working.

IRSN also took part in two exercises concerning facilities in the Saclay (Essonne) and Romans-sur-Isère (Drôme) nuclear sites, and in an exercise concerning a transport of radioactive materials in the Eure-et-Loir department. Finally, for the first time in 2003, IRSN took part in an exercise concerning an air base, as a support to the "Defence" safety authority (DSND).

Events during year 2003

IRSN implemented its crisis organisation during two actual events:

- **On July 19 and 20, 2003,** the CTC was installed in a restricted configuration, to monitor in live the destruction and tilting of the chimney of facility G1 in the Marcoule (Gard) COGEMA plant. It was in connection with the "Defence" safety authority, with COGEMA via audio-conference, and with an Institute team, which performed radiological measurement on the site.
- **On December 2 and 3, 2003,** the weather conditions that affected the Rhône valley led the operators of the Cruas (Ardèche) and Tricastin (Drôme) plants, as well as the operators of the BCOT (Tricastin operational hot base) facility to preventively activate their internal emergency plan (PUI). In order to provide a technical support to the safety authorities (DGSNR and DSND), IRSN first activated the CTC during 36 hours, during which the various teams provided a turnover and second, deployed on site teams that performed water sampling and measurement downstream of the nuclear sites.

The MIRA project stages

- A first feasibility stage (2002-2003) allowed selecting an inversion method and identifying the improvement lines for the current dispersal model.
- Based on the prevailing physical phenomena to be retained, the direct dispersal model is currently being developed (2004).
- The inverse model is built as the direct model progresses. A validation stage of the operational tool thus developed is planned (first half of 2005).
- The final stage will consist in developing an easy-to-use interface for experts and producing guidelines with regard to the measurement interpretation methods. The production start of the MIRA tool in the CTC is planned by the end of 2005.

This project is conducted jointly with the Fluid mechanic and acoustics Laboratory of the Ecole Centrale in Lyon and the Centre for education and research in atmospheric environment of the Ecole Nationale des Ponts et Chaussées.

Gammagraphy equipment.

MISSIONS

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Workers and public supervision
with regard to radiation protection

The regulation in radiation protection activities was deeply modified and incorporated into the public health code and the labour code during the recent years, within the scope of the transposition to the French law of European Directives relating to radiation protection. In 2003, IRSN actively participated in the preparation of this new regulatory system, as a support to the relevant Ministries. Furthermore, for applying this regulation, IRSN conducts multiple activities concerning the use of ionising radiation sources, the protection of public, workers and individuals being exposed for medical purposes.

European Directives

Three European Directives with regard to radiation protection were incorporated into the French regulation in 2003:

- 96/29 Euratom Council directive, from May 13, 1996, setting the basic standards related to health protection of the population and workers against the dangers resulting from ionising radiation;
- 97/43 Euratom Council directive, from June 30, 1997, relating to the health protection of individuals during medical exposures;
- 98/83 Euratom Council directive, from November 3, 1998, relating to the quality of waters intended for human consumption.

Use of ionising radiation sources

The modifications applied to the public health code by decree No. 2003-462, concerning the radiation protection of populations, generated deep changes in the management of ionising radiation sources(1), and resulted in the creation of the Source Expertise Unit (UES) in April 2002, within IRSN. The mission of this unit is to provide a technical support to the authorities (DGSNR, DSND, AFSSAPS, DPPR, prefects) delivering the clearances to suppliers, distributors and users of such sources in the industrial, medical, research and defence activities. The UES published 50 recommendations for these authorities in 2003. It is also in charge of the national inventory of ionising radiation sources, via a monitoring of stocks and movements of sources through registration procedures.

A national inventory of ionising radiation sources

Since February 2002, IRSN centralises and maintains all information relating to the holding clearances and registrations of source movements. The national database, called SIGIS, allows controlling the regular movement of sources. It also provides statistics on stocks and flows. Beside its control function, SIGIS basically is a monitoring and information tool with regard to the use of sources by the various actors involved (users, authorities, etc.).

*(1) **Ionising radiation sources:** any device, radioactive material or facility that may generate ionising radiation or radioactive material.*
***Radioactive material:** any material containing one or more radionuclides, the activity or concentration of which cannot be ignored from the radiation protection viewpoint.*

Radioactive sources in France in 2003

200
suppliers

5,000
users

1,350
clearances delivered or renewed

30,000
sealed sources kept

3,800
sealed sources distributed to users

2,700
sealed sources returned to suppliers

5,400
movement registration forms

Device for radium 226 measurement via emanation, used for radiological control of drinkable waters.

Search

Assessment of public exposure to ionising radiation

The public health code specified the creation of a national network for environmental radioactivity measurements to be managed by IRSN whose mission is to contribute to the estimate of doses to which the population is exposed due to the whole of nuclear activities. This network gathers:

- all the results of environmental radiological analyses, contained in the regulatory programs intended for supervising the impact of releases due to nuclear activities subject to clearance or declaration;
- all the results of environmental radiological analyses conducted on request from territorial communities, government agencies and public bodies or associations.

The Ministerial order from October 17, 2003, specified the operating modes of the national network and the approval methods for laboratories participating in the network. The IRSN role is explained:

- The Institute performs the network management, whose guidelines are defined by DGSNR after recommendation from the steering committee, basically comprising representatives from the relevant Ministries (Health, Environment, Consumption, Agriculture, Defence) and welfare agencies (AFSSA, AFSSE, InVs). IRSN is in charge of technical tasks for network operation and published a yearly report on the radiological status of the environment...;
- IRSN is a member of the laboratory approval commission and implements yearly comparison programs between laboratories.

The works required for the operational implementation of the national network continue in 2004, in order to specify the organisation and resources to be provided for an efficient operation of the network, especially with regard to the availability of the collected results to the public.

The radiological supervision of drinkable waters

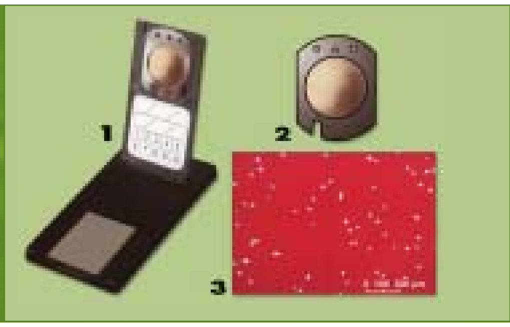
Within the scope of Directive 98/83/CE, decree 2001-1220 from December 20, 2001, specified the type and mode of radiological measurements that water distributors should now conduct in drinkable waters. This decree included a transition period for its application, until December 24, 2003. In addition, the radioactivity analyses were included in the parameters to be provided when preparing the file for creation of a Drinkable Water Supply (AEP). From now, these analyses should also be conducted periodically on the operational pick-ups. Due to all these dispositions, IRSN observed a high increase in the number of drinkable water analyses requested in 2003.

At present, IRSN is one of the few laboratories authorised to perform such measurements. The measuring strategy applied by IRSN is as follows:

- in a first stage, measurements of the tritium activity and of the overall activity of alpha and beta emitting radionuclides are conducted;

Increase in the requests for analysis of drinkable waters

Year	Supply waters	Supply waters after low water period
2000	117	
2001	97	
2002	139	
2003	312	20



(1) Example of dosimeter fitted for radon detection, consisting of a film (2) being sensitive to particles emitted by radon, which print traces, the automatic count of these traces (3) on the film provides the measurement.

- if the measured volume activities are less than 100 Bq/l, 0.1 Bq/l and 1 Bq/l respectively, the total indicative dose, as defined in the above-mentioned decree, is considered as less than 0.1 mSv per year;
- otherwise, additional analyses are conducted in order to identify the radionuclides, whether natural (uranium, radium, etc.) or artificial, being responsible for these excessive values;
- finally, a dose calculation is performed, based on the results thus obtained, for an adult consumption of 730 liters of water per year, applying for each radionuclide the dose factors specified by the above-mentioned decree. This dose is then compared with the 0.1 mSv/year defined by the Euratom directive, based on the WHO recommendations.

Control of radon exposure

The regulation now covers the radon exposure in public locations (art. L. 1333-10 and R.1333-15 and 16 of the public health code) and in working places (art. L.231-7-1 and R.231-115 of the labour code), but it does not yet apply to private housing.
The order concerning the approval of bodies authorised to conduct radon measurements in public locations was published on July 15, 2003: among the new provisions, IRSN is a member of the approval commission and has implemented for 2004 a training program with regard to radon metrology, required to obtain the approval unless a field-acquired skill may be demonstrated. Two other orders under preparation involved IRSN in 2003: the order concerning the management methods for radon-related risks in public locations and the order specifying the list of professional activities concerned.

Furthermore, the Institute conducted in 2003 the revision of AFNOR standards with regard to the radon and its decay products measurement and initiated the preparation of a standard for radon in water. In addition to these actions taken within the regulation scope, IRSN continued in 2003 works aimed at better understanding the radon entry and removal mechanisms into buildings: measurement campaigns in buildings, study of the radon behaviour under various conditions and the contribution of building materials, on the Kersaint (Finistère) experimental site. The Institute also published a new series of

Dose measurements conducted in 2003

by IRSN for supervision of workers exposed to ionising radiation.

X and gamma external exposure

17,548 companies
214,815 supervised workers
1,872,240 photo dosimeters

External exposure to neutrons

200 companies
20,000 supervised workers
50,000 neutron dosimeters

Internal exposure: whole-body gamma measurement

214 examinations

Internal exposure: routine supervision

430 companies
4,139 supervised individuals
6,834 biological samples
20,000 analyses (urine, stools)

IRSN ensures the dosimetric supervision of workers exposed to ionising radiation.

Whole-body gamma measurement: detection of external and/or internal radionuclides in the Blayais (Gironde) plant.

Search

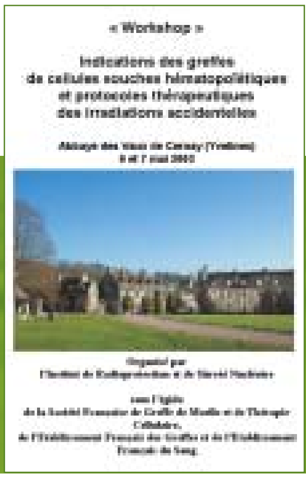
description data sheets on French buildings in which reduction techniques were applied, and defined a radon measurement protocol in spa facilities.
With regard to the improvement of knowledge on the health effects of radon, the European project coordinated by IRSN and concerning the modelling of radon-related risk was completed in 2003 and the results of the epidemiologic survey conducted by IRSN on French populations exposed to radon will soon be published in the *Epidemiology* magazine.

Protection of exposed workers

As for the application of decree No. 2003-296 concerning the radiation protection of workers, IRSN took part in the preparation of five Ministerial Orders, under the responsibility of the Work Ministry. In particular, one order specifies the modes for accessing dosimetric information on workers, the rules for transmitting such information and the contents of the individual medical supervision form; its implementation will require amendments to the SISERI system, managed by the Institute, and which centralises at a national level all the dosimetric data on exposed workers. The same decree and the associated application orders involve IRSN in the dose measurement, the organisation of cross-comparisons, the approval of dosimetry laboratories, the radiation protection training, the study of workstations and support to industrial medical officers. IRSN also prepares every year, for the Work relationship directorate, a statement of worker exposure to ionising radiation in France.

Protection of exposed individual in the medical environment

Decree No. 2003-270 from March 24, 2003, concerning the radiation protection of patients gives IRSN a major role in the optimisation of medical practices. To conduct this mission, IRSN created in 2003 a medical radiation protection expertise unit (UEM), which is involved in the definition of dose diagnostic reference levels and in the creation of a statement of patient exposures. The UEM is consulted by the authorities and health professionals to issue recommendations with regard to the justification and optimisation of practices, participate in the preparation or orders or guidelines for the prescription of acts and examinations involving an exposure to ionising radiation. It is often questioned by practitioners who want a confirmation of doses received by patients during a radiodiagnostic. This unit is also in charge of questions concerning the radiation protection of workers in medical environment. Consisting of experienced individuals, the UEM is involved in a number of training programs for radiation protection in medical environment.


« Workshop »

Indications des greffes de cellules souches hématopoïétiques et protocoles thérapeutiques des irradiations accidentelles

Abbaye des Vaux de Cernay (Yvelines) 6 et 7 mai 2003

"Workshop" - Indications for transplant of hematopoietic stem cells and therapeutic protocols for accidental exposures.

MISSION

see cover flap

Medical management of a large number of accidentally exposed individuals

One of the IRSN missions is the technical support to hospitals that have to treat exposed individuals. In this respect, and on the Institute initiative, a consensus with regard to the medical support strategy regarding large numbers of exposed individuals was defined by about fifty specialists in hematology, radiopathology and dosimetry, who met on May 6 and 7, 2003. The meeting was organised by the French transplant agency, the French blood agency and the French Society of marrow transplant and cellular therapy, supported by experts from the French Armed Forces Medical Branch.

Until now, in case of high dose global acute exposure of a large number of individuals, the therapeutic strategy to be applied was a problem. Indeed, despite the variety of available therapeutic methods that may have a certain efficiency (cytokines, allotransplants, expansion of stem cells, etc.), no real consensus was met with regard to the definition of a consistent scheme for treating medullar aplasia (drop in the production of blood cells) being radio-induced in case of accident situations. The scarcity of accidental exposures worldwide, and the fact that the therapeutic management of victims was often influenced by experts with widely diverging opinions, explain this lack of consensus, especially with regard to the indications on hematopoietic stem cell transplants.

Medical management of accidental exposures

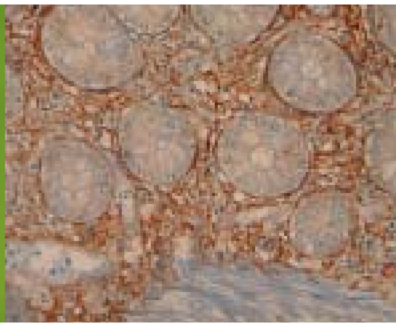
Hematopoiesis involves all mechanisms allowing a limited number of stem cells to generate cells of various types existing in blood: granulocytes and lymphocytes (organism defence), red blood cells (oxygen transport) and platelets (hemorrhages control). Hematopoiesis occurs in the bone marrow.
By destroying the bone marrow, ionising radiation induces high risks for opportunistic infections (destruction of white blood cells) and hemorrhages (destruction of platelets).

However, accidental exposures are heterogeneous in most cases. Considering the distribution of bone marrow, such heterogeneity results in leaving medullar areas more or less protected against exposure, containing hematopoietic cells capable of restoring the whole bone marrow of the individual.

This residual hematopoiesis after an heterogeneous exposure especially complexifies the treatment of a victim suffering from a medullar attack. Indeed, in such conditions, it is highly hasardous to perform a bone marrow transplant, as residual hematopoiesis may be sufficient to reject the transplant, which may be especially dangerous for the victim. Furthermore, exposure generates a severe aplasia stage with high infectious and hemorrhagic risks for the patient, requiring transfusions and a strong antibiotic therapy, with no immediate evidence for hematopoietic restoration.

General principles of the consensus

The consensus obtained is involving an operational medical consensus and a series of recommendations.



CTGF* super-expression, displayed by a brown colour in the radic tissue, on the left normal intestine and on the right radic enteritis mucosa.
*CTGF: Connective-Tissue Growth Factor (factor involved in tissue fibrosis).

The medical consensus includes two parts. The first part concerns the sorting criteria resulting in a simple operational distribution of victims into three classes according to the absence of lethal risk, the presence of a lethal risk, or the presence of a supra-lethal risk, depending on a set of symptoms recorded during the first years following exposure. The second part covers the treatment of medullar aplasia for which the indication for bone marrow transplant is postponed by three weeks, involving in the meantime a residual hematopoiesis stimulation treatment by injecting a cytokine called G-CSF. An information booklet describing the actions to be taken in case of accident and intended for practitioners, will be prepared based on this consensus.

Recommendations for the future, especially with regard to research, were issued. In particular, it is recommended to continue applied researches on cytokine treatments, bio-indicators of radio-induced damages, and treatment of the organ multiple failure syndrome, especially through transplant of mesenchymatous stem cells (non differentiated). These research areas are already being studied by IRSN.

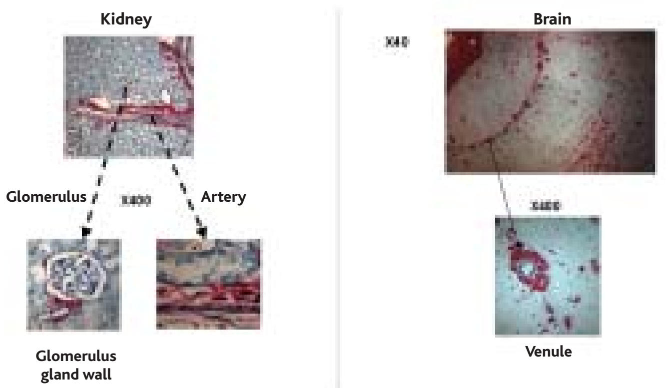
Experimental research in cellular therapy

Within the scope of the consensus, researches conducted by IRSN with regard to the application of cellular therapy principles to the treatment of accidental exposures, have a major interest. For several years, various works have allowed developing techniques with regard to expansion, transfer of marker gene for the future of reinjected cells and transplant of mesenchymatous stem cells (CSM). These cells are interesting, as they have a differentiation capability for muscular, cartilaginous, or adypocytar cells, but they also have a plastic capability, i.e. a capability to generate cells from other lineages like neural cells, hepatic cells, or endothelial cells. This plastic capability might allow compensating for radio-induced cell deficits.

During a first series of works, CSM's were sampled from the bone marrow of primates, then developed ex vivo, marked with a marker gene and transplanted to animals exposed in a mixed gamma-neutron flow. The results demonstrated that CSM's have a high implantation capability, as they were detected

IRSN ethics committee for animal experiments

During the year 2003, the ethics committee assessed nine new research topics and 27 experimental protocols, with regard to the observance of basic ethic principles concerning laboratory animals: replacement of animals with another study model, reduction in the number of animals and attention placed on the implemented procedures.
In parallel, the guidelines for the ethics committee activity, its communication and the enrichment of its works were defined.



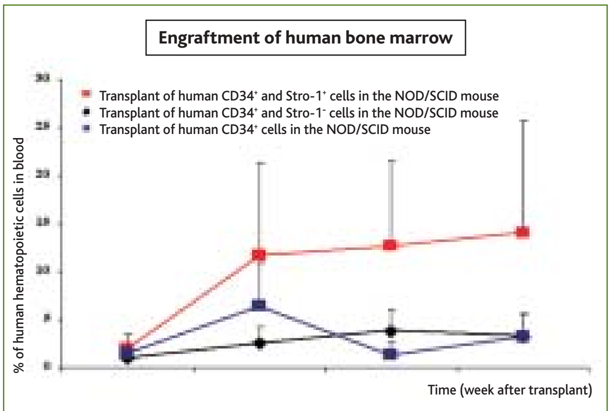
Red specific color of human cells implanted in murine tissues.

Implantation of human mesenchymatous stem cells in the exposed immunotolerant mouse.

in various organs, such as muscles, skin, intestine, stomach and bone marrow. In addition, the results demonstrated a preferred CSM implantation into the sites of most severe lesion, in correlation with lesions generated by the neutron component of the exposure flow. A second study conducted within the joint IRSN-CHU Saint-Antoine (UPRES EA 1638) used an immunodeficient mouse model, the NOD-SCID mouse, to conduct co-transplants of human CSM's and human hematopoietic stem cells.

This study allowed demonstrating that CSM's are not only capable of implanting into the mouse bone marrow but that they are also capable of performing a physiological function supporting hematopoiesis. Indeed, hematopoietic cells experienced a better implantation and generated twice to four times more mature blood cells when being co-transplanted with CSM's. These works in fact represent one of the first demonstrations for the functional capability of CSM's after a transplant.

Co-injection of DC34$^+$ cells with CSM Stro-1$^+$ or Stro-1$^-$



Two sub-populations (Stro-1$^+$ and Stro-1$^-$) of mesenchymatous stem cells (CSM) are injected, with hematopoietic cells (CD34$^+$) to the human transplant immunotolerant mouse after exposure. The human engraftment with the animal is followed in time. This experiment demonstrates the increased support of the engraftment by CSM's, Stro-1$^-$ mature type. These cells might be used for improving bone marrow transplants after exposure.

Bio distribution of CSM Stro-1$^+$ and Stro-1$^-$ into the NOD/SCID mouse tissues

Tissues	Cells Stro-1$^+$	Cells Stro-1$^-$
Spleen	8 ± 5	1.5 ± 1
Bone marrow	13 ± 7	6 ± 3
Brain	4 ± 5	4 ± 0.6
Heart	1.6 ± 1.1	2 ± 2
Liver	0.6 ± 0.4	0.4 ± 0.6
Lung	2 ± 3	7 ± 11
Kidney	2.9 ± 1.9	1.9 ± 1.7
Muscle	2 ± 2	0.2 ± 0.3

Human cells per 10,000 murine cells for each tissue

Two sub-populations (Stro-1$^+$ and Stro-1$^-$) of CSM's are injected to the human transplant immunotolerant mouse after exposure. Implantation of human cells into the tissues affected by exposure is searched on the animal. This experiment demonstrates the capability of human immature CSM's (Stro-1$^+$) to engraft into numerous tissues. These cells might be used for tissue restoration after exposure.

Electronic dosimeter in the Bugey plant (Ain).

Cloth contamination inspection when exiting a controlled area.

MISSION

see cover flap

Radiation protection assessment in EDF nuclear plants

IRSN conducted an in-depth review of radiation protection in the currently operated EDF nuclear plants. The purpose was to identify the problems met by the operator with regard to radiation protection, and to assess the provisions taken to improve the situation.

This review included two parts: first, a review of the policy defined by EDF at national level and second, assessing its application in some nuclear plants. IRSN reviewed the following topics: statement of inspections, incidents and dosimetric results registered between 1999 and 2002, the organisation of the radiation protection implemented by EDF central services, the management of radiological areas, the management of operations and work sites (with some assessment on actual cases of on-site work management) and finally, the management of sealed and unsealed sources.

Results

The technical investigation allowed assessing the actions taken by EDF central services, such as the implementation of specific exchange and decision-making places, and the creation of a radiation protection guideline. This guideline is essential for on-site implementation of provisions appropriate to the various topics relating to radiation protection (radiological cleanliness, dose optimisation, metrology, control of regulatory aspects). The analysis of dosimetric results demonstrated an overall improvement since 1996, both in terms of individual doses and collective doses. IRSN nevertheless emphasised discrepancies: efforts should be continued, especially for certain professional skills (heat insulators, sheet-metal workers, welders and logistic support activities such as the installation of scaffolding...).

In general, IRSN reported the implementation of a progress dynamics (hiring, training of agents in charge of radiation protection, management of sources, etc.), which nevertheless remains variable from one plant to the other. The requirement for better consistent practices was recorded for various topics (management of radiological areas, management of work sites, management of sources), in particular for service providers who have to integrate the specific features of the various plants in which they have to work.

Possible improvements

They more specially cover:

- the distribution of tasks between contract managers and radiation protection service agents;
- the control of radiological situation developments in the areas (for example, changes in the facility status that may result in a sudden increase of the risk in certain premises), the clarification and streamlining of the definition of radiological areas as well as the related signs and finally, the incorporation of the premises contamination risk requiring, in particular, a strengthening in defence and control lines, in the vicinity of contamination sources;
- the management of operations and work sites, in particular within the scope of the optimisation principle application;
- the management and holding conditions for sealed sources, in the specific case of industrial gamma measurement operations (firing conditions in particular).

This assessment was presented on December 18, 2003, to the Standing Advisory Group for Nuclear Reactors, which transmitted its conclusions to the Nuclear Safety and Radiation Protection General Director.

Defence nuclear expertise

Search

The decree setting up IRSN and providing for the identification of activity in the field of defence nuclear expertise led to the merging of most of those actions in a single special department. The main fields concerned are as follows:

- the prevention of malicious actions against nuclear installations and the transportation of radioactive materials;
- the protection and control of nuclear and sensitive materials in order to prevent their theft or diversion for the purpose of proliferation of weapons of mass destruction;
- technical support for public authorities for the implementation of international agreements on the non-proliferation of nuclear and sensitive materials;
- the safety and radiation protection of installations and nuclear activities concerning defence.

Paluel nuclear electricity power plant (Seine-Maritime).

Civeaux Plant (Vienne).

MISSION

see cover flap

Physical protection of nuclear installations and transportation

The physical protection of equipment, a nuclear installation or a nuclear material transport unit requires a set of measures, which may be material or organisational, aimed at preventing either a malicious action which could lead to the discharge of radioactive substances into the environment, or the theft or diversion of nuclear materials.

These measures are designed to ensure adequate defence in-depth. They include delaying components (fences, barriers, reinforced doors, etc.), detector components (radars, infrared systems, closed circuit cameras, etc.), access control systems and response forces. They also include administrative or organisational measures such as confidentiality rules and procedures (two-agents rule, management of keys, etc.).

In this context, it will be noted that physical protection is an essential common point as regards the implementation of the law of July 25, 1980 (protection and control of nuclear materials) and the implementation of the order of December 29, 1958 (protection against malicious action). The approach adopted is the same in both cases and the measures implemented to protect sites have the same level of efficiency whether the target is a sensitive nuclear material or safety-related equipment. The assumptions adopted to define a physical protection system are based on reference threats which specify the characteristics and the means attributed to attackers. Two categories of threats are envisaged, one regarding the theft of nuclear materials and the other regarding malicious action. Threats of internal origin and threats of external origin are taken into account for each of those two categories.

Operator's responsibility

The operator has prime responsibility for the physical protection of its installations and of the nuclear materials it possesses. Public authorities define the required objectives as regards protection and verify that the measures implemented by each operator ensure compliance with those objectives. IRSN places its technical expertise at the disposal of public authorities to assess the efficiency of physical protection measures adopted by operators and carriers. In conducting its surveys, IRSN examines:

- the resistance capabilities of installations or transport equipment with regard to the means implemented to prevent theft or diversion;
- procedures for access to nuclear materials, the removal of those materials from their containments and from the plant or transport cask;
- the capability of the systems set up to detect the loss or theft of nuclear materials, in terms of quantity and time;
- the capability of the systems set up for transportation from their point of departure to their point of arrival.

Transportation of liquid radioactive waste. Tanker LR56 with road tractor. Oak Ridge (United States).

Blayais Plant (Gironde).

Protection of installations

IRSN examines the protection of installations with respect to malicious actions and their findings are submitted to expert groups mandated jointly by HFD and DGSNR. The examination of protection against the theft of nuclear materials is essentially achieved by security studies. IRSN agents are also mandated by HFD to carry out inspections in order to conduct on-site assessment of the efficiency of the measures adopted by the operators. Every year, the Institute's relevant agents conduct about a hundred analyses and carry out about fifty inspection missions, some of them unexpected, on installations. In addition to this continuous activity, IRSN carries out more specific work. This included, in particular, in 2003:

- proposing several statutory provisions aimed at providing better legal foundations for physical protection and taking into account the lessons drawn from the events of September 11, 2001;
- organising a large-scale exercise, on HFD's request, in order to test the decision-making system and co-ordination for the intervention of the various operator and State entities concerned in order to deal with an attack coming within the framework of the reference threats;
- conducting a reactive inspection following the intrusion of demonstrators claiming they were from Greenpeace into the Penly site (Seine-Maritime), and proposing corrective measures to avoid any repetition of this type of event.

Protection of transportation

The physical protection devices installed on nuclear material transport facilities, such as trucks, are examined by IRSN, for HFD, during that equipment's design, manufacturing and operating phases.

Inspections are conducted on carriers' premises by IRSN agents mandated by HFD to check the satisfactory operation and compliance of that equipment.

Furthermore, the most sensitive nuclear material transport operations are monitored in real time by a dedicated IRSN unit: the operational transport section (EOT). In this context, IRSN keeps a continuous watch on the development of telecommunications equipment and information systems so as to improve EOT's monitoring and communication capabilities. In 2003, the studies conducted included, in particular, satellite based locating systems by means of IMMARSAT beacons and on geographic locating by mobile telephony which would allow less sensitive transport units to be monitored at lower cost.

New armour-plating systems are being assessed by IRSN with regard to their vulnerability to armour-piercing ammunition, by ballistic tests in particular.

La Hague (Manche): containers in the solid waste storage facility (EDS).

MISSION

see cover flap

Accounting of nuclear materials

IRSN centralises and controls the accounting data concerning nuclear materials in France. This technical co-operation mission is undertaken for HFD.

Centralisation of accounting data

The statutory system introduced by the law of July 25, 1980, on the "protection and control of nuclear materials" requires the holders of such materials to implement technical measures designed to prevent theft, diversion or accidental loss. These measures include having precise knowledge of the quantity, the nature and the location of the materials held or traded, strict accounting and an exhaustive annual inventory. Two statutory instruments have been defined, as follows:

- the holding of large quantities of nuclear materials requires authorisation and the daily transmission of accounting data. This system is mainly applicable to major players in the nuclear industry;
- the holding of smaller quantities requires only an annual accounting declaration. Installations in this category are often outside the nuclear industry.

The national accounting ensured by IRSN, which must not be confused with the accounting of radioactive sources, provides the public authorities with a quasi real-time view of the nuclear materials held in France by supplying consistent, relevant and reliable data which may be checked by conducting inspections.

A source of information and a control for public authorities

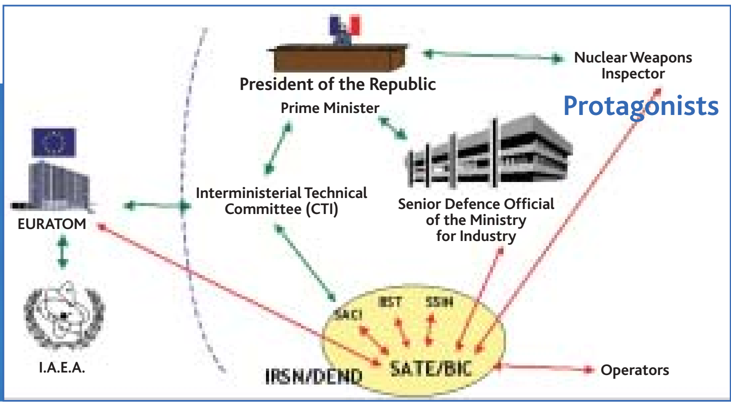
The database managed by IRSN for the national accounting of nuclear materials contains the location of all nuclear material stocks held within the country and their history. It is fed with declarations received from 250 authorised installations and 300 installations which are required to make annual declarations. As regards authorised installations, IRSN received and processed 83,000 lines of accounting entries reported in 35,000 nuclear material operation declaration forms (BDOMN) in 2003. These are encrypted documents containing declarations of stock changes and reporting on operations which have affected materials. BDOMN forms are transmitted in digital format or on paper and are submitted to 350 computer checks

Definition of nuclear materials

The term "nuclear materials" refers to elements which may be used, directly or indirectly, to manufacture a nuclear weapon. In the terms of the law of July 25, 1980, nuclear materials, whose preparation, possession, utilisation, transport, import and export are subject to an authorisation or declaration process, are, with the exception of ores, materials containing the following elements or their compound: plutonium, uranium, thorium, deuterium, tritium and lithium 6. Authorisation or a declaration is required depending on the quantities of material and their state.

A new computerised accounting system in 2003

A new information system for national nuclear material account management, baptised Cicéron, was commissioned in June 2003 without interfering with the daily processing of data. Compared with the previous system, Cicéron includes enhanced functions for account management, consultation and automatic or spot data checks. IRSN is also closely following the development of computer systems provided by French companies in order to achieve their statutory objectives.



IRSN is at the heart of the French nuclear materials control and accounting system.

Technological waste, hull and end-fitting compacting and volume reduction facility at the Cogema spent fuel processing plant in La Hague (Manche).

Search

to verify their consistency and compliance with statutory requirements before they are accepted. The declarations are recorded and the stocks in the national accounting system are updated immediately.
For small-scale holders of nuclear materials, IRSN established 650 annual declaration requests in 2003 and, after checking, these resulted in the listing of 300 installations whose declarations were recorded in the national accounting system. These declarations mainly concern small quantities of deuterium or uranium held in laboratories and, also mechanical parts or radiobiological barriers containing depleted uranium which are used in some radiotherapy equipment and in gammagraphy equipment used for non-destructive testing. The national accounting system is a secure copy of the local accounting systems of nuclear material holders, except for the offset corresponding to the declaration transmission time. Statutory monthly checks are carried out by authorised holders with reference to accounting reports transmitted by IRSN in order to detect and correct any deviations between local accounting data and the data recorded by IRSN. The available data are used for the purpose of analyses and surveys conducted by IRSN or for inspections conducted with its co-operation.

The main tasks carried out to ensure compatibility are:
- daily management and updating of the database;
- checking on compliance with declaration rules;
- development of analysis and inspection tools;
- performance of inspections on the Authority's request for the purpose of assessing the accounting system (nine inspections in 2003);
- transmission of accounting reports to public authorities, nuclear material holders and official international bodies;
- assistance for companies in drawing up their declarations.

Changes in national regulations and new EURATOM regulations

IRSN is also responsible for updating the rules on accounting declarations according to the requirements of industrial firms and the authorities, so that the former can comply with their statutory obligations and the latter can fulfil their role as controllers.
A large portion of France's nuclear installations must also comply with the obligations imposed by the EURATOM treaty. A specific feature in France is the strong link between the accounting required by the law of July 1980 and that required by European regulations. As a technical support centre for the public authorities, IRSN centralises French declarations every month and ensures they are transmitted to the European Commission.
The current revision to EURATOM regulations, which will bring in new accounting reports and a modification to the waste declaration process, will have an impact on national accounting.
Following negotiations in 2003, the main points of the regulations, scheduled for publication in 2004, have stabilised. The changes necessary to national accounting and associated information systems will form the subject of co-operation between IRSN and all the parties concerned.
The new EURATOM regulations will be applicable in part within a limit of 120 days after its publication, and the time limit for accounting changes will be three years.

Work on the laser integration line's experiment chamber, prototype of the future Laser Megajoule, Le Barp (Gironde).

The installation's control room.

MISSIONS

see cover flap

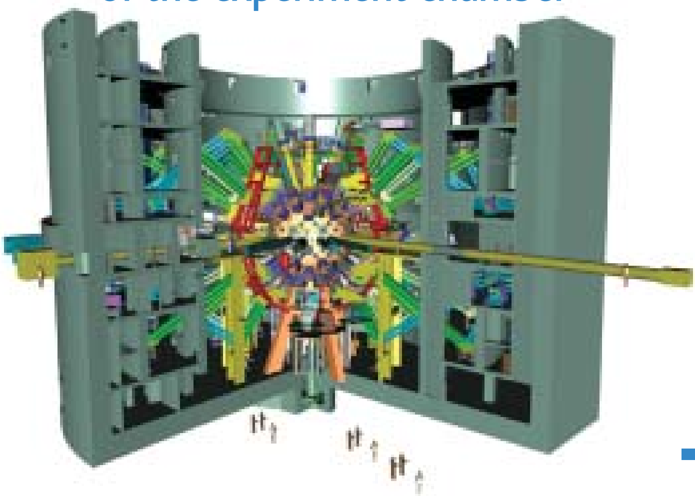
Assessment of the safety of the Laser Megajoule installation

IRSN assessed the preliminary safety report on Laser Megajoule, INBS scheduled for commissioning in 2009/2010.

Sited at the CEA centre of scientific and technical studies of Aquitaine (CESTA), the Laser Megajoule (LMJ) will provide a laboratory facility for the scaled-down simulation of the operation of French thermonuclear weapons. Civilian applications are also envisaged in the fields of laser-matter interaction, fusion by inertial confinement and astrophysics.

The main experiments planned concern the fusion reaction between the nuclei of two hydrogen isotopes, deuterium and tritium, contained in a "target" with a diameter of approximately 2 mm.

Laser Megajoule, diagram of the experiment chamber



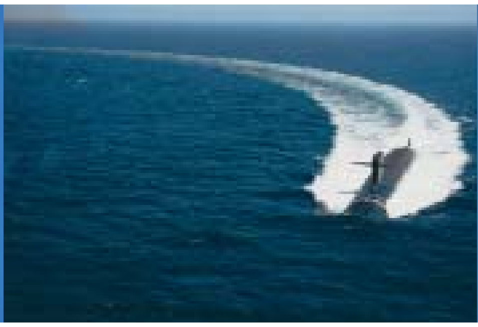
The 240 laser beams will be directed onto the walls of the cavity containing the target in order to heat them to high temperature and generate a large enough stream of X-rays to compress the deuterium-tritium (D-T) mixture in about 10 nanoseconds until reaching the temperature and pressure conditions required to trigger fusion reactions. Each reaction leads to the production of a helium nucleus (or alpha particle) with an energy of 3.5 MeV and a neutron with an energy of 14 MeV. The fusion of the D-T mixture contained in a target produces an energy of 17.5 MJ, which is 10 times greater than that provided by laser beams (1.8 MJ).

Preliminary safety report

On March 18, 2003, IRSN appeared before the Laboratories and Factories Safety Commission (CSLU), as requested by DSND to present its opinion on the safety of the Laser Megajoule on the basis of the preliminary safety report submitted by the operator. This opinion which takes into account the additional information obtained during many discussions with the operator should allow the competent authorities to reach a decision on whether to authorise the installation's construction.

The main risk represented by the Laser Megajoule installation is a risk of external exposure, firstly, to high-energy neutrons during the short periods of firing and, secondly, to ionising radiations emitted by the equipment and structures activated in the course of the numerous operations and tasks required (preparation of experiments, data recovery, "cleaning", maintenance).

The IRSN's main recommendations concern the personnel access management systems and the layout of the experiment hall: the equipment installed in this hall will, indeed, constitute a major source of ambient irradiation after activation. In addition, during construction of the LMJ, IRSN will give its advice on the measures implemented with regard to earthquakes and floods.



Le Vigilant, nuclear-powered ballistic missile submarine (SNLE).

Le Vigilant during construction.

MISSIONS

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Assessment of the SNLE *Le Vigilant*

Third in a series of four nuclear-powered ballistic missile submarines, SNLE, *Le Vigilant* underwent a test campaign in 2003 prior to its commissioning. In this context, IRSN examined the compliance of the vessel's nuclear reactor with the SNLE safety standard.

Some of the pre-commissioning tests, especially those conducted at sea, can only be carried out with the boiler room in operation. For this reason, the operator – the French Ministry of Defence – must first substantiate the compliance of the boiler room with the SNLE safety standard. DSND asked IRSN to examine the documents submitted by the operator for that purpose.
Consequently, in the first half of 2003, IRSN examined the reports certifying the quality of manufacture and fitting of equipment contributing to the reactor's safety.

After this examination, two analysis reports drawn up by IRSN were presented to the panel of experts appointed by the Reactor Safety Commission (CSR). On the basis of these reports and opinions given by the commission, DSND authorised the reactor core to be loaded and to go critical for the purpose of conducting tests at the seaside and at sea (on the surface).

The IRSN analysis showed, however, that the operator's processing of deviations that occurred during manufacture and fitting should be studied further before conducting dive tests. Furthermore, as the results of the first nuclear tests had to be examined by IRSN, the weapons procurement agency, Délégation Générale à l'Armement (DGA), submitted the corresponding additional data and the IRSN analysis was presented to CSR in December.

The commission's decision allowed DSND to authorise the operator to conduct dive tests. The results of these tests will be examined by IRSN in 2004 in order to reach a final decision on the compliance of the nuclear boiler room with the applicable safety standard.

Safety standard

In the same way as for any other nuclear installation, the designers of the SNLE submarine boiler rooms must substantiate the level of safety of their reactors. These substantiations are provided in the form of documents, including the safety report and operating regulations, which constitute the installation's safety standard. This standard, applicable to SNLE submarines, was examined by IRSN and approved for the launching of the first vessel of this type: *Le Triomphant* (commissioned in 1997). It remains to be verified that its successors, *Le Téméraire* and *Le Vigilant,* comply with that standard.

Reactor Safety Commission (CSR)

The decree of July 5, 2001, regarding the safety and radiation protection of nuclear installations and activities concerning defence assigns DSND the role of safety authority for those installations and activities. Article 3 of that decree prescribes that DSND should base its work on technical safety commissions. The Reactor Safety Commission is one of those commissions. Its task is to provide DSND with support in the field of on-board nuclear boiler rooms, a task which is similar to that of DGSNR which advises the Standing Advisory Group for Nuclear Reactors on EDF power generating reactors.

International relations

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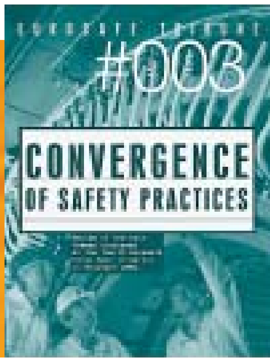
Promoting the Institute's development in a European and international context calls for:

- investment in the construction of Europe as the home of research and participation in European harmonisation in the field of nuclear safety and the definition of radiation protection standards;
- involvement in scientific networks and partnerships on the European level and world-wide;
- contribution to the work by international bodies on the drawing up of technical standards.



EUROSAFE Tribune.

The 5th EUROSAFE European Forum, held at Palais Brongniart, in Paris, on November 25 and 26, 2003.

MISSION
see cover flap

IRSN's role in European construction

In both nuclear safety and radiation protection, IRSN's activities are conducted in an international context. This international contact is essential to the development of the Institute's competencies and expertise in carrying out the missions entrusted to it to achieve a high level of control over nuclear risks.

Now that the European Union has welcomed 10 new members, that the single electric power market is being created and a united European approach to research and expertise is gradually taking shape, IRSN is increasing its focus on European construction and the implementation of EU policies on nuclear safety and radiation protection.

Contributing to the establishment of the European Research Area

Although it is essential that countries operating nuclear installations should have suitable expertise and pursue quality research in the field of nuclear safety and radiation protection, it is now paramount to step up international co-ordination so as to ensure that suitable research capabilities and instruments exist and to achieve consensus on scientific and technical questions.

The ambition, expressed in March 2000 at the European Council in Lisbon (Portugal), to create a European research area took an important step forward in 2003, moving on from the 5th Framework Programme for research and technological development to the implementation of the 8th Framework Programme aimed at reinforcing integrated research in Europe.

In the context of the European Union's 5th Framework Programme for research and technological development, IRSN took part in nearly 40 projects in 2003 concerning:

- the management and extension of the service life of nuclear power plants (SPI project) and the management of severe accidents with, in particular, the modelling and validation of design codes, such as the integrated Franco-German ASTEC code (COLOSS, PHEBEN2 and EVITA projects);
- fuel cycle safety with, in particular, the BENIPA project for the assessment of performances provided by engineered clay barriers which could be used in some projects for radioactive waste storage in deep geological repositories;
- radiation protection and work concerning, among other things, risk assessment as regards;
  – exposures at low levels and low dose rate ("UMINERS - ANIMAL DATA" and RADON EPIDEMIOLOGY projects);
  – professional exposure (EVIDOS and IDEA projects);
  – exposure of members of the public and workers, with the BIODOS internal dosimetry project which aims to supply models that can be used to calculate more realistically the doses received by workers and populations, taking into account all the specific physiological features of individuals;
- the management of a crisis outside the installation concerned (ASTRID project on the development of a method and computer tool to estimate discharges in the event of an accident affecting a PWR).

The year 2003 was also noteworthy for IRSN's special effort in the field of studies on transfers of radioactive materials in the environment, featuring the following projects in particular:

Seminar on the start-up tests for a research reactor in Rabat (Morocco) between April 14 and 17, 2003.

IRSN collaborates with safety and radiation protection organisations from 29 countries:

Germany, Argentina, Belgium, Belarus, Brazil, Bulgaria, Canada, China, South Korea, Croatia, Cuba, Egypt, Spain, United States, Finland, Hungary, India, Italy, Japan, Morocco, Portugal, Czech Republic, Slovak Republic, United Kingdom, Russia, Slovenia, Sweden, Switzerland and Ukraine.

Search

- BORIS which aims to improve the understanding of the mechanisms of radionuclide transfer from soil to plants;
- FASSET which aims to develop a framework to assess the effects of ionising radiation on organisms and the ecosystem, and to prepare reference models for internal exposure, external exposure and dosimetry.

Furthermore, the setting up of the SARNET network of excellence to cover severe accidents, as part of the 6th Framework Programme, demonstrates the will of some 50 European organisations to permanently channel their action in accordance with the integration policy decided upon by the European Union. SARNET is destined to play a major role in identifying the most relevant research topics and in defining the conditions for work carried out in Europe, whether for experimental or technical projects. In this way, it will contribute to maintaining adequate research competencies and capabilities in Europe. It will also contribute to promoting the development and utilisation of the ASTEC design code on severe accident sequences (see the chapter on “Safety of plants, transportation and waste”, page 18).

Towards the convergence of technical safety practices in Europe

Apart from technical consensus on safety issues, there is the question of harmonisation of the practices implemented in European countries. This harmonisation comes up against existing rules and corresponding practices. Nevertheless, the challenges that must now be met by nuclear safety and radiation protection make it indispensable to strive for such harmonisation.

International co-operation

Highlights of 2003 included the strengthening of co-operation with BINE, Chinese expertise organisation, on safety analysis, with the Chinese nuclear safety authority (ANSN) on the re-examination of safety and physical protection, and with America’s NRC in the fields of fire testing and modelling. New projects were also started with India’s BARC research centre, on the modelling of severe accidents and with the Moroccan nuclear expertise organisation, CNESTEN, in the field of the assessment of the installations at the Maamora centre.
2003 also saw the stepping up of co-operation with AVN, the Belgian expertise organisation, in the field of crisis management with the signing of a bilateral agreement in February 2003. IRSN also entered negotiations with the UK’s NRPB and Germany’s BFS for the setting up of a biological dosimetry system that could be mobilised in the event of a radiological incident. It also continued its co-operation with the Russian research organisations, IBRAE, and the Kourchatov Institute, in the field of severe accidents.
Furthermore, a co-operation agreement on nuclear safety and radiation protection was signed with the Japanese research institute, JAERI, in December 2003. The first actions started as a result concern the release of fission products and criticality safety.

RISKAUDIT

RISKAUDIT is a European group of economic interest founded in 1992 by IPSN and GRS to co-ordinate joint international projects. Since its founding, RISKAUDIT has managed about one hundred projects involving its two parent establishments and other European and American technical safety organisations in the context of programmes to provide assistance to Eastern European countries in nuclear safety, financed by the European Commission and EBRD. RISKAUDIT has its headquarters in Fontenay-aux-Roses (Hauts-de-Seine) and two permanent offices in Moscow (Russia) and Kiev (Ukraine).

IRSN, GRS and RISKAUDIT delegation visiting the Chernobyl plant in September 2003.

Franco-Chinese seminar on fire protection, in Beijing, China, in February 2003.

In this respect, essential work is being carried out in the context of international groups of experts, in which IRSN is a part, by the IAEA, NEA and the European commission, in the context of bilateral collaborations such as the one which led to the development of a Franco-German safety approach for the EPR and another established at the end of 2003 with the Finnish safety authority (STUK) for the construction of a reactor of that type in Finland.

EUROSAFE

Tackling the question of the convergence of safety technical practices in Europe from another direction, the EUROSAFE approach is beginning to bear fruit. This scheme is backed by seven European safety and radiation protection organisations: AVN (Belgium), CSN (Spain), GRS (Germany), HSE (United Kingdom), IRSN (France), SKI (Sweden) and VTT (Finland).

The first step was to promote debate by allowing all the parties concerned by nuclear safety and radiation protection, including public authorities, manufacturers, operators, research and expertise institutes, and representatives of civilian society, to identify and discuss important safety issues on which there are differing approaches and views in Europe.

This scheme is supported by three actions which, in 2003, led to the creation of:

- the EUROSAFE Forum which drew nearly 500 persons to its 5th meeting in Paris to discuss the topic of "Expertise and nuclear safety in the face of the challenges of European enlargement";
- the EUROSAFE Tribune, issues 3 and 4 of which covered the convergence of safety practices and the dismantling of power reactors, respectively;
- a website providing an interactive medium dedicated to the EUROSAFE approach (www.eurosafe-forum.org).

While continuing these actions, EUROSAFE is now aiming to make research into operational recommendations a priority matter. The first step in this direction, taken in 2003, concerns the management of scientific and technical knowledge held by European research and expertise organisations. This will form the subject of an international workshop organised in Cologne in 2004.

With regard to more precise matters of safety, EUROSAFE's development is based on comparative safety studies on topics of joint interest (thermal fatigue, database comparisons, etc.) which have been conducted by IRSN and GRS for several years with the aim of finding points of convergence and then identifying and explaining the differences that exist in safety approaches. The aim of this co-operation which is aimed at furthering nuclear safety in Europe was extended to include AVN (Belgium). In this context, the three organisations conducted, in 2003, a comparative analysis of the safety assessment methods they use and the main aspects to be taken

International organisations

International organisations play a major role in the preparation of international scientific and technical consensus, the furthering of knowledge in the fields of radiation protection, nuclear safety and security, and in the development of international regulations. IRSN contributes to the work of these organisations, especially IAEA and NEA, UNSCEAR and CIPR. In this respect, IRSN participated in particular, in 2003, in the strengthening of measures designed to prevent the radiological terrorist acts defined at the G8 summit in Evian and in programmes conducted by IAEA.

IRSN representatives visit the China Experimental Fast Reactor (CEFR) near Beijing, China, in October 2003.

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into consideration for the analysis of safety problems encountered so as to promote the sharing of experience, the performance of joint or complementary work, and the sharing of the results obtained.

For an improvement in nuclear safety in Eastern Europe

Since the beginning of the 1990s, the international community has developed extensive co-operation with East European countries to improve the safety level of their installations. From the outset, the European Union has played a major part in defining and implementing that co-operation.

The French-German Initiative for Chernobyl (FGI)

The FGI programme aims to collect the technical data available on the consequences of the Chernobyl accident for Ukraine, Belarus and Russia to build databases with three main themes: the safety of the sarcophagus, radionuclide transfers in the environment and the health of populations. This programme, supervised by IRSN, GRS and the Ukrainian Chernobyl Centre, mobilises some 30 organisations in the three countries concerned. The databases on sarcophagus safety and radioecology (REDAC: Radioecological Database of Chernobyl) have been completed. In 2003, work was continued on the subject of health and especially on the development of pathologies or health indicators in exposed populations, eating habits and their consequences, and the psychological effects on "liquidators", and the input of the corresponding data into the HEDAC database (Health Database After Chernobyl). In addition, a website (www.fgi.icc.gov.ua) was set up in 2003 to allow the public to consult the general results obtained in the three fields studied.

In the field of the competency of safety organisations, this entails, in particular, the conducting of assessments, the introduction or development of statutory frameworks, the transfer of design codes and training in their utilisation.

In partnership with GRS, IRSN is playing an active part in the implementation of the European Commission's PHARE and TACIS programmes and the European Bank for Reconstruction and Development (EBRD).

In the context of contracts managed by RISKAUDIT, a subsidiary of IRSN and GRS, IRSN collaborated with other European technical safety organisations in 2003 in participating in the following projects:

- the continuation of the in-depth review of the safety report on reactor No. 1 of Russia's Kursk power plant (RBMK type reactor);
- the conducting of studies in connection with the decommissioning of the Chernobyl power plant (Ukraine), reactors 1 and 2 of the Kozloduy power plant (Bulgaria), the Ignalina 1 reactor (Lithuania) and the Aktau power plant (Kazakhstan);
- the survey conducted for the reduction of risks associated with the Chernobyl sarcophagus;
- work carried out for the modernisation of Ukrainian nuclear power plants, the completion of the construction of reactors Khmelnitski 2 and Rovno 4 in Ukraine, and the processing of waste from the Ignalina 2 reactor and the Smolensk power plant (Russia).

IRSN has also provided assistance for the Bulgarian, Slovakian, Slovenian and Czech safety authorities. Furthermore, in 2003, the Institute continued to provide support for CENS which brings together the safety organisations of Central and Eastern Europe with the aim of promoting expertise capabilities in that geographical area.

Contributing to public information and training

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Among the missions laid down in the decree implementing the IRSN is public information and training in radiation protection. Through this objective, the Institute reinforces the action previously undertaken in communications and training. Educational information campaigns should disseminate the knowledge the IRSN has acquired in nuclear and radiation protection. As far as training is concerned, it is a matter of formalising, promoting and teaching the Institute's knowledge. This is done via internal and external training sessions, teaching in outside organisations, supervising thesis and internships.

IRSN's travelling exhibition.

MISSION

see cover flap

Information and communication

The IRSN's missions include developing a culture of risks and nuclear risk prevention within society through communication and information. They also involve developing the Institute's reputation as an organisation devoted to expertise and research in nuclear safety and radiation protection.

An Institute in full working order

2003 was the year of the institutional creation of the IRSN and the implementation of a new organisation. This project mobilised the communications department on several counts:

- internal support during the main stages of the implementation process as soon as the Director General arrived. The organisation of meetings with the Chairman and the department heads, then all the personnel. The new organisation was presented to the managerial staff on September 25 then to all the personnel when it was implemented on October 15. The next day, the personnel discovered a new Intranet in keeping with the organisation. Moreover, the signing of the company-wide agreement in May gave rise to information work. Finally, in 2003 the future in-house newspaper was prepared (editorial line, sections, etc.);
- in November 2003, the missions and the organisation of the IRSN were presented to all those involved in nuclear safety and radiation protection in France;
- a new visual identity and logo were designed to reinforce the new Institute's image.

A new organisation for communication

As part of IRSN's new organisation, the Communications Department, set up in 2002, adapted its action to better fulfil the Institute's missions and contribute to its notoriety.

After careful consideration, the Department drew up three basic missions:

- public information: educational initiatives to help develop a culture of risk;
- relations with high-priority audiences: via communication campaigns directed at professionals working in the environment, health, nuclear safety, the media, etc.;
- in-house communications: to help federate and inform the teams.

Scientific events

As well the information and communication initiatives, the Communications Department took part in the organisation of scientific events:

- the CABRI and TAG (Technical Advisory Group) seminars (April 2 then April 3-4, Aix-en-Provence) which brought together 50 of the CABRI programme partners, to take stock of the progress of the programme and the test table;
- the 5th International Phébus FP seminar (June 24-27, Aix-en-Provence) which brought together nearly 170 scientists to share the results of the programme;
- a Charter drawn up with the ASN (French Nuclear Safety Authority) aimed at improving the efficiency of relations and practices for evaluations related to the safety of basic nuclear installations was circulated among IRSN employees;
- an American committee in charge of improving the waste management of low-level radioactive waste was hosted and European and Asian practices were presented (September).

Inaugurating the Les Angles branch

One of the events in 2003 was the inauguration of the Les Angles regional IRSN branch in May in Villeneuve-lès-Avignon (Gard). It will group together on the same site the teams previously working at the Marcoule nuclear centre and in Avignon.

The radioactivity of Camargue sand

In June 2003, when a report on the radioactivity of Camargue sand was shown on *Envoyé spécial*, a TV programme, the IRSN sent an information note to the local government and the local representatives concerned, describing the action and the research carried out by the IRSN on this phenomenon and the results obtained.

Poster of IRSN's travelling exhibition.


Presenting the new internal organisation on September 25 at the IRSN.

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2003 initiatives

As in previous years, the communication campaigns outside of the Institute concerned the general public, the media and professionals working in the environment, health and nuclear safety.

Professionals

By taking part, as in previous years, in the POLLUTEC Forum (December), the IRSN established contact with professionals working in environmental fields. It presented IRSN expertise and described the services it can provide industrialists and local authorities. In collaboration with the BRGM, it also took part in the Risks Forum organised by INERIS on the theme of environmental safety. In addition, nearly 500 professionals working in nuclear safety were brought together at the initiative of the IRSN, the GRS (Germany) and the European Programmes Committee as part of the EUROSAFE Forum (November). The aim of this meeting was to promote the convergence of technical practices in relation to safety with a view to creating a European centre of expertise.

Finally, in 2003 there was an increase in initiatives directed at professionals working in the health sector. Indeed, the IRSN was present at the MEDEC Forum (March) with a stand devoted to the follow-up of workers and patients, the support given to medical teams, Chernobyl, etc. and a roundtable on "patients and health workers exposed to ionising radiation".

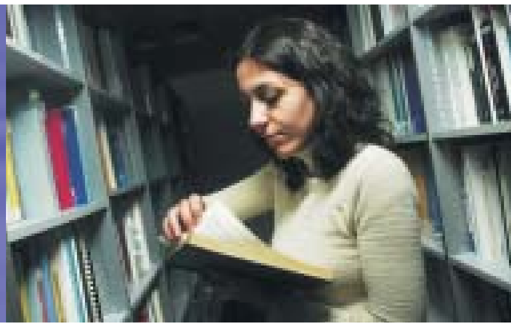
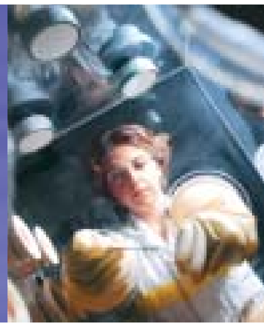
In addition, during a roundtable held at the Entretiens de Bichat (September), the IRSN presented the consensus that had recently been reached, under the auspices of the IRSN, on the strategy to adopt in the event of acute irradiation of a large number of victims.

The general public

As part of its public information mission, the IRSN has presented a travelling exhibition for more than 15 years called "Keeping a Close Watch on Nuclear Energy". Produced by the IRSN and the DGSNR, this exhibition aims to inform the general public, especially school children, about nuclear risks and to explain the means implemented to reduce the risks. In 2003, the exhibition was shown in Givet (Ardennes), Arles (Bouches-du-Rhône) and Uchaud (Gard). It attracted more than 4,300 visitors, 1,300 of whom were school children. To complement the exhibitions, a series of conferences were organised on subjects of general or local interest: in Arles for example, the radioactivity of Camargue sand was discussed. Among other means of information, IRSN's Internet site continues to present in-depth features on radiation protection, the safety of facilities confronted with earthquakes, nuclear accidents, plutonium management, etc. In 2003, people logged onto the Institute's Internet site, which is now in French and English, nearly 400,000 times. Finally, the IRSN provides the public with a collection of booklets on radon, transportation of radioactive material, radioactive waste, etc.

The media

The IRSN is regularly contacted by the media and it tries to reply to journalists requests as quickly as possible. With a view to ensuring transparency and an educational approach, the IRSN keeps the media informed of its activities and provides them with in-depth files to help them understand events. In 2003, these files dealt with the safety of nuclear facilities confronted with earthquakes, the Chernobyl accident and its consequences and how people can be protected from ionising radiation.

PhD students training at the IRSN.

MISSION

see cover flap

Training

Among IRSN missions, training contributes to the development of skills. Whether it is teaching, training through research or further professional training in the field of radiation protection, the Institute aims to disseminate the acquired knowledge within its teams.

It is essential for a research organisation like the IRSN to collaborate with university research laboratories. Although the Institute is orientated towards acquiring knowledge related to its expertise, outside experts should be able to check this research, analyse it, evaluate it and enrich it with new ideas. Given the very wide scope of its missions, the Institute should call upon outside skills to complement its own skills. Therefore, forming relationships with universities is a good way of developing and improving the skills that are useful and essential to the IRSN. Finally, through these relationships, IRSN experts can take part in the training given at these universities and Grandes Ecoles and in this way enable the Institute to acquire notoriety, attract young people and fulfil its training mission.

Teaching

IRSN employees take part in numerous further training and initial training courses related to their field of skills. Thus, the IRSN supports a certain number of training courses including: the Nuclear module (technologies, safety and the environment) at the Ecole des Mines in Nantes (Loire-Atlantique), the Nuclear Energy module in the Industrial Risk Control course at the ENSI in Bourges (Cher), the Radiation Protection module of the Health and Drug Engineering Masters at the Joseph-Fourier University (Grenoble, Isère), the post graduate degree 'Aerosol Science and Air Contamination Engineering' at Paris XII University and the Atomic Engineering course at the INSTN (Saclay, Essonne). In addition, IRSN staff make a predominant contribution to some further training sessions offered by the INSTN concerning the ventilation of facilities, and the filtering of gaseous waste, the evaluation of contaminant transfer, radioecology, the probabilistic safety assessment of PWR, criticality safety and nuclear material management.

Training through research

Every year, the IRSN receives about twenty doctorands (18 in 2003) and fifteen post-doctorand trainees who come to its laboratories to learn about research. They, in return, bring their youthfulness, dynamism and thirst for knowledge and naturally create special relationships with the world of research. Therefore, most of the advisors for the theses undertaken at the IRSN are researchers from outside the Institute.

Agreements with Universities and Grandes Ecoles

When studies are carried out jointly with Universities or Grandes Ecoles, cooperation agreements concerning the joint research and the hosting of trainees are signed. In 2003, cooperation agreements were signed with the Université Libre de Bruxelles (Belgium), the Paris XIII University, ParisTech (all the Paris Grandes Ecoles: Ecole des Mines, Ecole Nationale des Ponts et Chaussées - ENPC, Ecole de Chimie, etc.), the Bourges ENSI, the Nantes and Saint-Etienne Ecoles des Mines, the INSTN. The subjects of these agreements are very varied. As examples, we can cite the modelling of

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radionuclide atmospheric dispersion, a research project undertaken in collaboration with the CEREA (Research and Teaching Centre in Atmospheric Environment) an ENPC research centre, or else the behaviour of structural elements representing a nuclear facility subjected to a violent explosion undertaken in collaboration with the Bourges ENSI.

Further training in radiation protection

Helping provide certain exposed professionals with training in radiation protection is one of the Institute's missions: to fulfil this mission the IRSN organisation implemented in October 2003, identifies this function within the Department for Scientific and Technical Evaluation and Quality (DESTQ).
This positioning clearly shows the relationship between training and expertise/research, of which it is a natural extension and line of development. Training is a means of spreading the principles, rules and methods of radiation protection to the various groups of people who should most benefit from them, especially nuclear energy professionals and those involved in the medical application of radiation.

During the last quarter of 2003, the IRSN defined the main strategic directions of the radiation protection training that it will give in 2004:
- further professional training is considered a priority;
- complementary to "training through research" and the initial training given by IRSN researchers and engineers, it aims to promote the techniques and tools capable of guaranteeing safety, minimising exposure and optimising the dose received by patients and the people around them in medical environments;
- the professional training offered by the IRSN should aim to reconcile theory and practice, so that it can be more easily put to use by those in charge of promoting radiation protection in companies and health facilities;
- drawing on the Institute's activities, the professional training given by the IRSN should integrate new standards and regulations and take recent scientific and technical knowledge into account.

Cooperation agreements with the CNRS

In 2003, the IRSN signed a national cooperation agreement with the CNRS. It has already led to two more specific agreements being signed with CNRS laboratories in 2003 and several other agreements are being defined. These two agreements concern:
- a study of the phenomenon whereby cobalt sulphide inhibits the production of radiolytic gas during the irradiation of model organic molecules (to simulate the irradiation of bitumen which is used to coat some radioactive waste) with the IRC;
- the thermo-mechanical behaviour of underground cavities subjected to an internal temperature rise (this application concerns exothermic radioactive waste stored deep in clay) with the Ecole Nationale des Travaux Publics de l'Etat (ENTPE).

Quality at IRSN

Contribute to the efficacy of the company's management and operations and demonstrate its technical and organisational abilities to ensure the quality of its activities. These are the objectives of the quality management system begun by IRSN. The Institute's goal is to obtain ISO 9001 certification between now and 2006.

The introduction of a quality management system at IRSN

In 2003, IRSN launched a new project that consisted of establishing and introducing a quality management system consistent with its objectives and its organisation, and in accordance with ISO 9001 version 2000. The goal is to obtain the corresponding certification for the Institute's activities between now and 2006.

A quality management system uses quality to support the company's management and operations. At its core, it is based on the identification of the processes that structure the company's activities and on the creation of mechanisms to control and ensure the efficacy of these processes. It is then based on a series of overall measurable objectives that are consistent with the company's strategic goals, as well as on mechanisms to measure how these goals are achieved. It is necessary to associate appropriate indicators with these objectives for measurement purposes.

IRSN overall approach is structured in three major phases:

- establishment of the system bases: characterisation of the processes and definition of the overall measurable objectives (end 2003-beginning 2004);
- deployment of the system: definition of goals and indicators in the units, preparation of performance indicators, and introduction of improvement solutions (2004-2005);
- functioning of the system and probation period before filing the certification application (2004-2006).

The year 2003 was devoted to the overall definition of the Institute's approach and identification of its macro processes. Based on IRSN missions as they are described in its Articles of Association, IRSN identified 7 operational macro processes, 5 management macro processes and 6 support macro processes.

Audits

In 2003, 20 audits were carried out at IRSN. These audits were a continuation of the work that had been carried out in previous years. We would also like to point out that the introduction of the new quality management system is expected to have two main consequences on future audits:

- a gradual acceleration of the audit schedule, which, in particular in 2006, is expected to include a "blank" overall audit of the new system, prior to the filing of the system' application for certification;
- changes in audit methods: we will switch from the conformity audit (the main purpose of which is to detect discrepancies) to an efficacy audit (the purpose of which will also be to assess the extent to which the identified objectives have been achieved).

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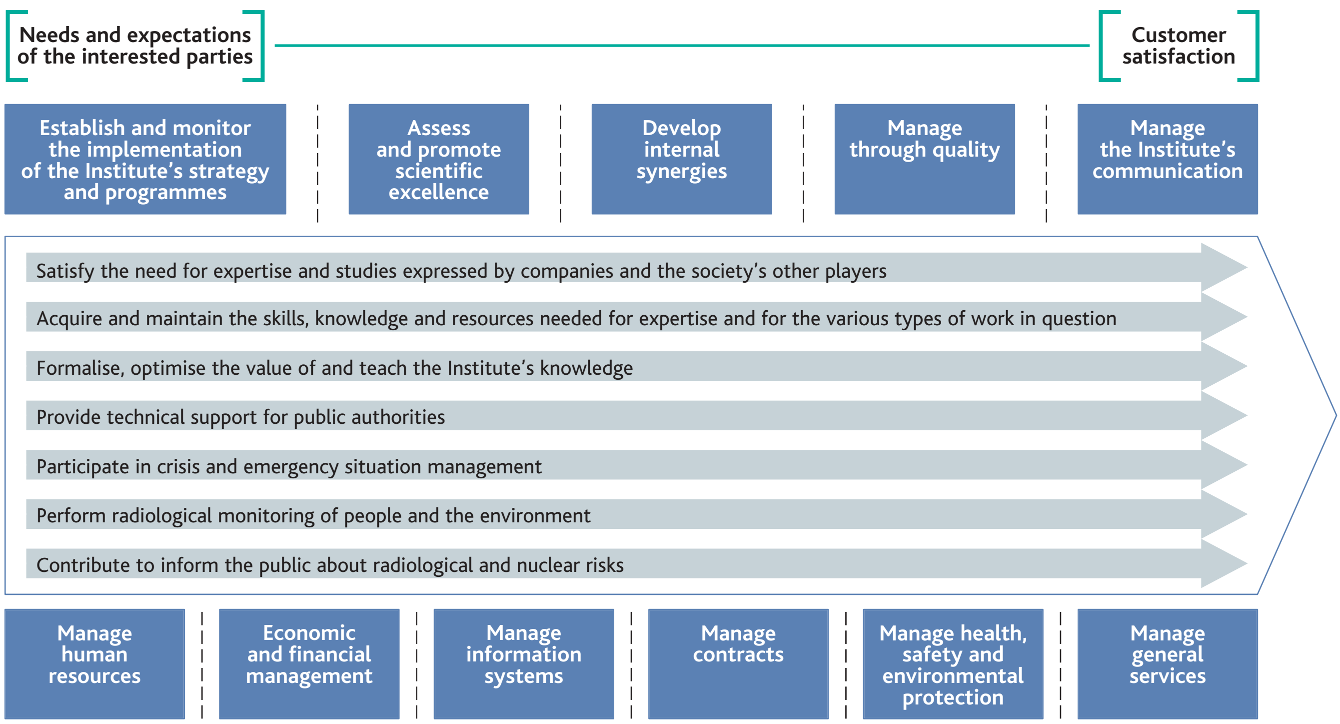
Accreditations and certifications

IRSN currently has 6 accredited units (ISO 17025) and 2 certified units (ISO 9001 version 2000).

In 2003, the following units are certified:

- the CTHIR (Technical Approval, Instrumentation and Radioprotection Centre) tracking audit did not identify any nonconformities;
- the SIAR (Radioprotection Intervention and Assistance Service) obtained the renewal of the certification, version 2000 of ISO 9001 (instead of ISO 9001 version 1994, which it held previously), plus an extension of the scope of the certified activities (this now also includes the measurement of samples by gamma spectrometry).

Cartographic representation of the Institute's macro management, operational and support processes



Glossary

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A

ADEME Agence De l'Environnement et de la Maîtrise de l'Energie (*Agency for the Environment and Energy Control*).

AEP Drinking water supply.

Aerosol Dispersion, in very fine particles (about one micron), of a liquid or solid in a gas (air or oxygen).

AFNOR French standardization institute.

AFSSA Agence Française de Sécurité Sanitaire des Aliments (*French Food Safety Agency*).

AFSSAPS Agence Française de Sécurité Sanitaire des Produits de Santé (*French Agency for the Safety of Health Products*).

AFSSE Agence Française de Sécurité Sanitaire Environnementale (*French Agency for Environmental Safety*).

Alpha (α symbol) radiation composed of helium 4 nuclei, highly ionising but not very penetrating. A sheet of paper is sufficient to stop alpha radiation.

AMANDE Accelerator for metrology and neutronics applications for external dosimetry.

ANCLI Association Nationale des Commissions Locales d'Information (*French Association of Local Information Commissions*).

ANDRA Agence Nationale pour la gestion des Déchets RAdioactifs (*National Agency for Radioactifs Waste Management*).

ANS American Nuclear Society.

ANSN Asian Nuclear Safety Network.

ASTEC (Accident Source Term Evaluation Code) System of computer codes developed in collaboration by IRSN and GRS to assess physical phenomena occurring during an accident of core meltdown of a pressurised water reactor.

AVN Association Vinçotte Nucléaire (*Vinçotte Nuclear Association*) (Belgium).

B

BARC Bhabba Atomic Research Centre (India).

BDOMN Bordereaux de Déclaration d'Opération sur Matières Nucléaires (*Accounting document notifying any operation on nuclear materials*).

Becquerel (Bq) Official international unit for radioactivity measurement. The becquerel (Bq) is equal to one disintegration per second.

BENIPA BENtonite barriers in Integrated Performance Assessment.

Beta (ß symbol) Radiation composed of electrons of negative or positive charge. A few-millimetre air screen or a simple sheet of aluminium can stop this type of radiation.

BfS Bundesamt für Strahlenschutz.

BINE Chinese expertise organisation.

BIODOS European program of researches in internal dosimetry.

BIPM International bureau of weights and measures.

BLEVE Boiling Liquid Expanding Vapour Explosion.

BNEN Standardization bureau for nuclear equipment.

BNI Basic Nuclear Installation.

BNM Bureau National de Métrologie (*National Metrology Bureau*).

BORIS Bioavailability Of Radionuclides In Soil.

BRGM Bureau de Recherche Géologique et Minière (*Office for Geological and Mining Research*).

Burnup fraction Thermal energy produced by nuclear fissions in a fuel mass unit. It is measured in megawatts-day per ton (MWj/t).

C

CABRI Test reactor concerning fuel safety used by IRSN.

CABRI CIP CABRI international program.

CABRI REP-Na Water reactor with sodium loop.

CARMELA IRSN research program on fires in nuclear facilities aimed at gaining further insight into electrical cabinet fires.

CARMELO Combustion Armoires Electriques essais glObaux (*Global Test Electric Cabinet Combustion*).

CAROL Camargue-Rhône-Languedoc, project for studying the distribution of artificial radionuclides in the Lower-Rhône region.

CATHARE Advanced thermal-hydraulic code applied to pressurised water reactors.

CEA Commissariat à l'Energie Atomique (*Atomic Energy Commission*).

CENS Centre d'Etudes Nucléaires de Saclay (*Nuclear Research Establishment of Saclay*).

Cesium (Cs, atomic number 55) Noble, toxic metal whose characteristics are comparable to those of potassium.

CHSCT Comité d'Hygiène de Sécurité et des Conditions de Travail (*Health, Safety and Working Conditions Committee*)

CHU Centre Hospitalo-Universitaire (*French University Hospital*).

Cicéron Centralised computerised accounting related to operations on nuclear materials.

CIREA Commission Interministérielle des RadioEléments Artificiels (*Interministerial Commission for Artificial Radioelements*).

CLAIRE Design of a logic for the analysis and interpretation of results.

CLI Local information commission.

CNESTEN Centre National de l'Energie des sciences et des TEchniques Nucléaires (*French National Centre for Nuclear Energy, Sciences and Techniques*).

CNRS Centre National de la Recherche Scientifique (*French National Centre for Scientific Research*).

COFRAC French accreditation committee.

COGEMA COmpagnie GEnérale des MAtières Nucléaires (*French General Company for Nuclear Materials*).

COLOSS European project devoted to the study of core damage during a severe accident.

Containment building or reactor building Leaktight concrete building housing the reactor pressure vessel, primary system, steam generators and main auxiliaries ensuring reactor safety.

Core Area of the nuclear reactor where nuclear reactions occur.

CRISTAL New French criticality code package developed as part of a joint project between IRSN, CEA and COGEMA. It aims at assessing the criticality risk in all nuclear facilities and transport packages where fissile materials are used.

Criticality Risk of uncontrolled fission phenomena in fissile materials.

Criticality accident Uncontrolled chain fission reaction triggered in an environment containing fissile materials such as uranium-235 or plutonium-239.

CSM Centre de Stockage de la Manche (*La Manche Storage Centre*).

CSN Consejo de Seguridad Nuclear (Spain).

CSNI Committee on the Safety of Nuclear Installations.

CSR Commission de Sûreté des Réacteurs (*Reactor Safety Commission*).

CTC IRSN technical crisis centre.

CTHIR Technical Centre for Radiological protection instrumentation approval.

D

DECOVALEX DEveloppement of COupled models and their VAlidation against EXperiments.

DEND Department for nuclear defence expertise (IRSN).

DESTQ Department for scientific and technical evaluation and quality (IRSN).

DIAPLU PLUtonium behaviour in the DIAgenesis of marine sediments.

DGA Délégation Générale pour l'Armement (*French General Delegation for Armament*).

DGAC Direction Générale de l'Aviation Civile (*French Civil Aviation Authority*).

DGEMP General department for energy and raw materials.

DGSNR General department for nuclear safety and radiation protection.

DISPRO Near-field dispersion.

Diva Device for fire, ventilation and airborne contamination.

Dosimetry Detection, by assessment or measurement, of the dose of radiation (radioactivity) absorbed by a substance or a person.

DPPR Department for the prevention of pollution and major hazards.

DRIRE Regional department for industry, research and the environment.

DRT Department for staff relations.

DSDRE Department for strategy, development and external relations (IRSN).

DSND Delegate for nuclear safety and radiation protection for activities and installations concerned by defence (IRSN).

DSV Department for veterinary services.

D-T Deuterium-Tritium.

E

EAS Containment spray system.

EBRD European Bank for Reconstruction and Development.

ECC European Community Commission.

EDF Electricité de France (*French National Electric Utility*).

ELISA Name given to an experimental loop.

ENPC Ecole Nationale des Ponts et Chaussées (*French National School of Bridges and Roads*).

ENSI Ecole Nationale Supérieure d'Ingénieurs (*French National Higher School of Engineers*).

ENTHALPY European corium thermodynamic database.

ENTPE Ecole Nationale des Travaux Publics de l'Etat (*French National School for State Public Building Works*).

ENVIRHOM IRSN health and environment research program to study the effects of chronic exposures to low-dose radionuclides.

EOT Operational transport section (IRSN).

EPIC Public establishment of an industrial and commercial nature.

EPR European Pressurised Reactor.

EPRI Electric Power and Research Institute.

ERICA Environmental Risk from Ionising Contaminants: Assessment and management.

EURADOS European Radiation Dosimetry Group.

EURATOM EURopean ATOMic energy community.

EURODIF European uranium enrichment by gaseous diffusion plant.

EURSAFE European network for Reduction of uncertainties in severe accident safety issues.

EVIDOS (Evaluation of Individual Dosimetry in mixed neutron-proton fields) Research program funded by the European Community.

EVITA European validation of the integral code ASTEC.

F

FASSET Framework for ASSessment of Environmental ImpacT.

FGI French-German Initiative.

FLAMMES Computer codes describing the evolution of carbonated product fires developed by IRSN.

FLIP Liquid fuel fire interacting with a wall.

FP Research and development Framework Program (European Community).

Framatome Manufacturer of nuclear steam supply systems.

Fuel assembly Cluster of fuel rods, connected with a metallic structure, used in nuclear reactors.

G

Gamma (γ symbol) Highly penetrating but not very ionizing electromagnetic radiation, emitted by the disintegration of radioactive elements. This type of radiation is stopped by concrete or lead screens.

GATeL Automatic generation of tests from a lustre description.

G-CSF Molecule involved in the production of blood cells.

GEA Atomic study group.

GPR Standing advisory group for nuclear reactors.

GPU Standing advisory group of experts for plants.

GRNC Nord-Cotentin radioecology group.

GRS Gesellschaft für Anlagen- und Reaktorsicherheit (Germany).

GSIEN Groupement de Scientifiques pour l'Information sur l'Energie Nucléaire (*French Group of Scientists for Information on Nuclear Energy*).

H

HAT Human Alimentary Tract model.

HFD High civil servant for Defence.

HSE Health and Safety Executive (United Kingdom).

I

IAEA International Atomic Energy Agency.

IARC International Agency for Research on Cancer.

IBRAE Nuclear safety institute of the Russian Academy of Sciences.

Glossary (continued)

ICARE Interpretation of damaged cores for water-cooled reactors: computer code simulating the degradation of a PWR core during a severe accident.

ICHEMM European iodine chemistry project.

ICPE Listed environmental protection facility.

ICRP International Commission on Radiological Protection.

IEC International Electrotechnical Commission.

IFREMER Institut Français de Recherche pour l'Exploitation de la MER (*French Research Institute for Exploitation of the Sea*).

IGR Institut Gustave-Roussy (*Gustave-Roussy Institute*) (France).

IGS Institute of Geological Sciences.

ILL Institut Laue-langevin (*Laue-Langeving Institute*) (France).

INBS Secret basic nuclear installation.

INDOS INternal DOSimetry.

INERIS Institut National de l'Environnement industriel et des RISques (*French National Institute of the Industrial Environment and Hazards*).

INSERM Institut National de la Santé et de la Recherche Médicale (*French National Health and Medical Research Institute*).

INSTN Institut National des Sciences et Techniques Nucléaires (*National Institute for Nuclear Science and Technology*).

INSU Institut National des Sciences de l'Univers (*National Institute for Sciences of the Universe*).

InVs Institut de Veille sanitaire (*French health watch institute*).

IPSN Institut de Protection et de Sûreté Nucléaire (*French Institute for Protection and Nuclear Safety*).

IRC Institut de Recherche sur la Catalyse (*French Research Institute on Catalysis*).

IRSN Institut de Radioprotection et de Sûreté Nucléaire (*French Institute for Radiological Protection and Nuclear Safety*).

IRSN-CHU Saint-Antoine (UPRES EA 1638) IRSN common laboratory – French university hospital belonging to the research department for higher education 1638.

ISO International Organization for Standardization.

ISO 9001 European standard for quality management systems.

Isotopes Elements whose atoms have the same number of electrons and protons, but a different number of neutrons. They have the same name and the same chemical properties Around 325 natural isotopes and 1,200 artificially created isotopes are currently listed.

ITER International Thermonuclear Experimental Reactor.

IVANA Name given to an experimental loop.

J

JAERI Japan Atomic Energy Research Institute.

JCT Joint Central Team.

JNC Japan Nuclear Corporation.

L

LMJ Laser MegaJoule.

LOCA Loss Of Coolant Accident.

LOLF Organic law relating to finance acts.

LTCRA Cellular therapy and accidental radiation protection laboratory.

M

MANON Name given to an experimental loop

MCCI Molten-Core Concrete interaction.

MEDD Ministry for ecology and sustainable development.

MEDEC French trade fair for professionals in the health sector.

MINEFI Ministry of Economy, Finance and Industry.

MIRA Inverse modelling of an atmospheric release.

MOX Fuels of mixed uranium and plutonium oxides.

MWe MegaWatt electric.

N

NEA OECD Nuclear Energy Agency.

NOD-SCID Line of immunodeficient mice.

NRPB Nuclear Radiation Protection Board.

Nuclear fuel Fissile material (capable of undergoing a fission reaction) used in a reactor to develop a nuclear chain reaction. After being used in a nuclear reactor, this is referred to as irradiated fuel.

Nuclear materials Materials which could be used to manufacture a nuclear explosive device They are defined from their fissile (for a fission device), fusible (for a thermonuclear bomb), or fertile (capacity to produce fissile or fusible materials) characteristics. French legislation retains six nuclear materials: plutonium, uranium, thorium, tritium, deuterium and lithium 6 (deuterium and lithium 6 are not radioactive).

Nuclear safety Set of measures taken at all levels of design, construction, operation and decommissioning of the nuclear installations to prevent accidents and limit their effects.

O

OAR Radiation protection assistance office (IRSN).

OECD Organisation for Economic Cooperation and Development.

OPCW Organisation for the Prohibition of Chemical Weapons.

OPERA Permanent environmental radioactivity observatory.

OPRI Office de Protection contre les Rayonnements Ionisants (*French Office for Protection against Ionising Radiation*).

P

PHARE (Poland-Hungary Assistance for Reconstruction of the Economy) European assistance program for reconstruction of Polish and Hungarian economies.

PHEBEN2 European project: Validating severe accident codes against PHEBus FP for plant applications.

PHEBUS Experimental reactor.

PHEBUS-FP Research program devoted to the study of fission product (FP) behavior.

Phénix 250 MWe fast neutron reactor.

PIC Common interest program.

PICSEL Propagation of solid fuel fire in a laboratory and plant environment.

Plant unit Power production unit including a boiler and a turbo-generator set. A nuclear plant unit is mainly defined by its type of reactor and the power of its turbo-generator.

Search

Plutonium (Pu, atomic number 94). Transuranic chemical element. The isotope 239 has a half life of 24,110 years.

POLLUTEC International trade fair for environment-related equipment, technologies and services for industry.

Primary system Reactor coolant system operating in a closed loop, comprising a series of components ensuring the coolant fluid circulation used to extract the heat given off by the reactor core.

PSA Probabilistic Safety Analysis.

PUI In-house emergency plan.

PWR Pressurised Water Reactor.

R

R & D Research and Development.

Radiation protection Set of measures intended to ensure health protection of the population and workers using ionising radiation sources.

Radioactivity Property of certain chemical elements whose nuclei spontaneously disintegrate into other elements emitting ionising radiation.

Radioelement Natural or artificial radioactive element.

Radionuclide Radioactive isotope of an element.

RAFT (Reactivity Accident Fuel Test) IRSN research program developed in collaboration with EDF and JNC (Japan) concerning the safety of fast neutron reactors.

RBMK Graphite reactors from the ex-Soviet Union.

RCC-E Design and construction rules for electrical equipment.

REDAC RadioEcological Database After Chernobyl.

REMORA Radionuclide remobilization in the Rhône prodelta.

REMOTRANS Remobilisation, long distance transport and bioavailability of radionuclides in marine Sediments.

RIS Safety injection system.

S

SARA Automated monitoring of aerosol radioactivity.

SARNET Severe Accident Research NETwork.

SCANAIR Computer system for the analysis of IRSN injection reactivity accidents.

SEQUOIA Progressive quality system – IRSN's goal for the future.

SESAME Accident situation progression plan and assessment methods - computer system developed by IRSN.

SIAR Radiation protection response and assistance service (IRSN).

SID Decision-making Information System (IRSN).

SIEVERT Information and assessment system of the exposure to cosmic radiation during flights.

SIGIS Source inventory information and management system.

SILENE IRSN experimental reactor used for criticality experiments.

SIMEVENT Ventilation simulation software developed as part of a joint project between IRSN, SGN and COGEMA.

SIP Shelter Implementation Plan.

SISERI Ionising radiation exposure monitoring information system.

SKI Statens Kärnkraftinspektion (Sweden).

SNLE Nuclear-powered ballistic missile submarine.

SPA Spent fuel disposal performance assessment.

SSTC State Scientific and Technical Centre (Ukraine).

STARMANIA Station for the study of airborne contamination transfer and mechanical strength under incident and accident conditions.

STUK Finnish safety authority.

SYMBIOSE SYstemic approach for Modelling the fate of chemicals in BIOSphere and Ecosystems.

T

TACIS (Technical Assistance for Commonwealth of Independent States) European assistance program for the reconstruction of economies in the new independent States.

Technicatome Engineering company specialised in safety systems and control of severe environments.

THE Very high efficiency.

THM Thermo-hydromechanics.

TRANSAT Atmosphere water transfer.

U

UEM Unit of expertise in medical radiation protection.

UES Source expertise unit.

UIAR Ukrainian Institute of Agricultural Radiology.

UMINERS-ANIMAL DATA Animal data related to uranium miners.

UNSCEAR United Nations Scientific Committee on the Effect of Ionising Radiation.

UO2 Uranium dioxide.

US-NRC American Nuclear Safety Commission.

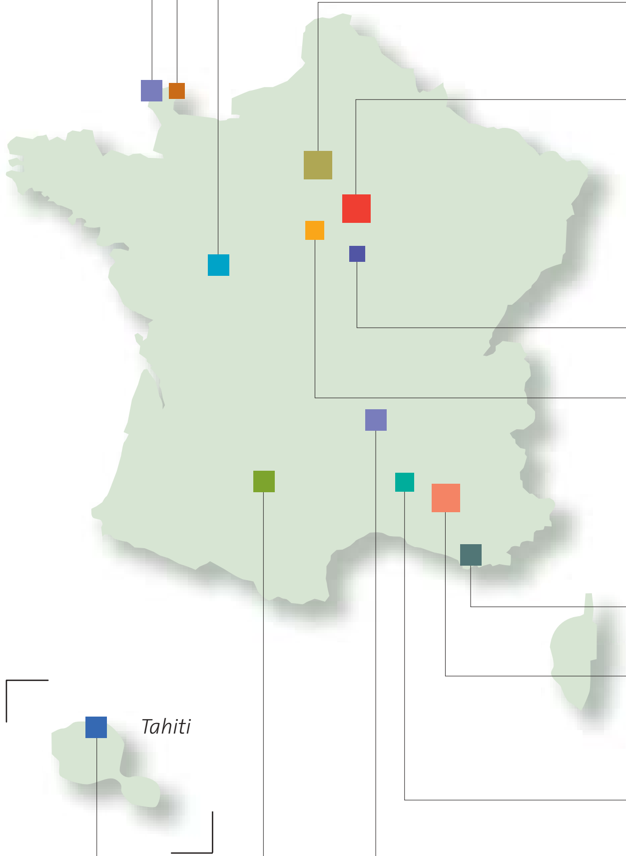
V

VITRA Name given to an experimental loop.

VLLW Very-Low Level radioactive Waste.

VTT Finnish organisation for safety studies.

IRSN sites: workforces, activities



Beaumont – La Hague
■ Environment

Octeville – Cherbourg
Workforce: 15 employees ■ Environment

Angers
Workforce: 1 employee ■ Environment

Le Vésinet
Workforce: 156 employees ■ Environment and response
■ Human radiation protection

Clamart (IRSN head office)
Workforce: 191 employees – **Staff departments**

Fontenay-aux-Roses
Workforce: 698 employees – **Operational activities**
■ Defence nuclear expertise ■ Environment and response
■ Prevention of major accidents ■ Human radiation protection
■ Reactor safety ■ Safety of plants, laboratories, transportation and waste

Orsay
Workforce: 15 employees ■ Environment

Saclay
Workforce: 42 employees ■ Safety of plants, laboratories, transportation and waste ■ Prevention of major accidents

La Seyne-sur-Mer
Workforce: 4 employees ■ Environment

Cadarache
Workforce: 287 employees ■ Environment
■ Prevention of major accidents
■ Human radiation protection ■ Defence nuclear expertise

Les Angles – Avignon
Workforce: 24 employees ■ Environment and response
■ Safety of plants, laboratories, transportation and waste.

Pierrelatte
Workforce: 23 employees ■ Response
■ Human radiation protection

Agen
Workforce: 4 employees ■ Environment and response

Mahina (Tahiti)
Workforce: 2 employees ■ Environment

See the details of IRSN sites on the flap hereof.

Search

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