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IRSN
INSTITUT DE RADIOPROTECTION
ET DE SÛRETÉ NUCLÉAIRE

2023
ANNUAL REPORT

MEMBER OF
ETSON

The French Institute for radiation protection and nuclear safety (IRSN) is the public expert on nuclear and radiological risks.

As a Public Industrial and Commercial Establishment ("EPIC" - *Établissement public à caractère industriel et commercial*) overseen jointly by the French ministers in charge of the ecological transition, the Armed Forces, energy, research, and health, IRSN is fully in line with the State's modernisation policies, as testified by its risk management approach and by its implementation of a global corporate social responsibility policy.

IRSN's missions serving public authorities and the population are to assess, research, protect, anticipate, and share. The institute's singularity lies in its ability to combine researchers and experts to anticipate future questions on the development and management of nuclear and radiation risks. IRSN teams are keen to publish their work and share their knowledge with society, thereby helping to improve access to information and dialog with stakeholders.

Independence, anticipation, excellence, and sharing are IRSN's essential ambitions in order to contribute to public nuclear safety and security, health, environment, and crisis management policies.

For more information: en.irsn.fr

ANTICIPATING AND MEETING THE CHALLENGES OF THE NEW NUCLEAR LANDSCAPE.

For IRSN, the revival of the French nuclear sector is already a reality

Throughout 2023, the Institute's experts examined many files relating to the extension of the operation of the fleet of nuclear power stations in service beyond 40 years, in particular the study of the behavior of the containment buildings of 1,300 MWe reactors, the consideration of climate change, and beyond 60 years, with the investigation of aging and obsolescence over lengths of time that have not been studied to date. IRSN completed the safety review of the Flamanville EPR and continued monitoring the reactor start-up tests. With a view to the construction of the 6 + 8 EPR2 reactors announced by the French President, IRSN has also published fifteen technical notices on the EPR2, incorporating the lessons learned from the reviews of the reactors in operation and those from the review of the EPR.

In parallel with this work, 2023 saw the intensification of exchanges with project owners of small modular reactors, be it Nuward, whose design is inspired by that of pressurized water reactors operating in France or abroad, or other reactors, based on technological breakthroughs requiring significant appraisal work on the part of the Institute.

This very substantial work program requires prioritization of the files put before IRSN with regard to the issues involved.

In support of its current and future expert appraisal work, the Institute is continuing with research projects such as PASTIS, relating to passive safety systems; CABRI, dedicated to the study of the resistance of fuels in the event of a reactivity accident; and MACUMBA, dedicated to the study of the containment provided by concrete walls.

Advances based on a long-term strategic vision

Since its creation, IRSN has always been of the conviction that progress made in both nuclear safety and radiation protection relies on a long-term strategic vision. This conviction has guided the development, since the end of the 1990s, of the ASTEC code for the simulation of severe accidents, which can be used for all nuclear installations: reactors of all types, power plants, etc. This code, which has become the European reference code, brings together both the most advanced modeling and all experimental knowledge related to severe accidents. It is this conviction that inspired the Institute's multi-year strategy in terms of research and appraisal in radiation protection, for which IRSN plays a key role at both European and international level, within bodies such as ICRP or UNSCEAR, to serve as a benchmark institution with which, for example, the WHO and the IAEA collaborate. This is evidenced by the new agreements signed with the latter two bodies, covering topics such as the medical and health management of a radiological or nuclear accident, or the quality of radiotherapy care and the welfare of cancer patients. Concerning research, this multi-annual strategic approach was notably implemented in the establishment of PIANOFORTE, a European partnership coordinated by the Institute. This brings together a consortium of 58 partners from 22 countries in the European Union as well as the United Kingdom and Norway, and which organizes all radiation protection research in Europe. And it is this self-same conviction that has led IRSN to develop a mode of organization and the means for managing radiological and nuclear emergencies – in particular the LATAC laboratory, inaugurated in 2023 – the widely acknowledged quality of which has led to the Institute being requested by the Government to provide its technical support in the context of global events such as the Rugby World Cup and the Paris Olympic and Paralympic Games.

EDITORIAL

Continuing with and building on the transformation projects underway

Throughout 2023, IRSN has been involved in the reform of nuclear safety and radiation protection inspection and research as desired by the Government, with a priority being to maintain the level of quality of research and expert appraisal expected by our fellow citizens. This quality is based in particular on the close coupling of research and appraisal activities, the strict separation of appraisal and decision-making, the coherence of safety and radiation protection approaches at both European and international level, and maintaining the appeal of the professions exercised within the Institute.

In order to help boost the performance of the appraisal and inspection expertise of tomorrow, IRSN has in 2023 continued with and built upon various transformation projects that have been underway for several years, be it skills development with IRSN Academy and the internal university, forward planning for jobs and skills, developing digital solutions and artificial intelligence to take advantage of new technologies with a view to enhancing assessment and research, or the consideration of societal requirements in terms of scientific integrity, CSR, and ethics.

At the time of writing, the ongoing reform of inspection and research in nuclear safety and security and radiation protection may make this 2023 annual report the last one to be published by IRSN.
The men and women who have worked tirelessly since 2001 to make the Institute what it is today will carry on striving in the future to ensure that the high profile of French research and expertise in nuclear safety and radiation protection continues to be maintained. We would like to commend their commitment to the common good, their investment in their duties, their professionalism, and their openness.

Marie-France Bellin
Chairwoman of the Board

Jean-Christophe Niel
Director General of IRSN

Serving nuclear safety and security

2023 will have been marked by the uncertainty arising from the ongoing process of reform to the nuclear safety and radiation protection inspection system. In this context, the teams of the IRSN Nuclear Defense Appraisal Department (DEND) have succeeded in carrying out the multiple missions entrusted to them in fields as diverse as the safety of nuclear installations and materials, transportation, studies of cybersecurity and of the modeling of the effects of explosions, safety appraisals of defense-related systems and facilities, and nuclear and chemical non-proliferation. In all these areas, they have continued to provide their support to the public authorities on issues as essential as the future nuclear aircraft carrier, the 3rd-generation nuclear ballistic missile submarine, and the *Barracuda* program, for which 2023 saw the commissioning of the 2nd Suffren-class nuclear attack submarine.

Under the Law on the organization of the governance of nuclear safety and radiation protection to meet the challenge of the revival of the nuclear sector, these multiple appraisal and inspection activities will be conducted, from January 1, 2025, within the Ministry of Defense, in support of the public authorities in the fields of nuclear defense safety, nuclear safety of civilian facilities, and non-proliferation, where the public authorities are on the front line.

The teams in charge of these missions today look forward to continuing with these missions on behalf of their usual beneficiaries: DNSD, Senior Defense and Security Officers, Euratom Technical Committee, and many more.

Louis-Michel Guillaume
Deputy Director General in charge of the Defense-related missions

THE INSTITUTE IN FIGURES

Budget

38.7%
of the budget is allocated to research (excluding Feurs project)

€294 million
in revenue

€288 million in expenditure, of which **€18 million of equipment purchases**

Technical support for public authorities and the authorities

51.5%
of the budget allocated to technical support and public interest missions (excluding Feurs, Noria, and Building 625 projects)

47 technical opinions and reports to the HFDS (senior official for defence and security) of the French Ministry of Ecology Transition and Territorial Cohesion

65 technical opinions and reports to the Euratom Technical Committee (CTE) and HFDS of the French Economic and Financial Ministries in charge of non-proliferation

69 technical opinions and reports to the Nuclear Defence Safety Authority

398 technical opinions and reports to the Nuclear Safety Authority

Crisis

War in Ukraine

+6
real set-up of the emergency response center

7
national nuclear crisis exercises excluding Defence-related activities

2
national nuclear crisis exercises concerning Defence facilities

20
meetings on the CODIRPA's post-accident work involving IRSN

Human Resources

Average age of
44.72
for women

Average age of
45.6
for men

78.96%
executives

21.04%
non-executive

Profile

1,783
people
(workforce as at 31/12)

1,616
permanent contracts

167
fixed-term contracts

39 employees loaned

23 secondments

57 PhD doctors or research directors

82 PhD students

27 post-doctoral students

International activity

282
bilateral cooperation agreements in force with research or expert bodies

38
countries concerned by these agreements

58
international projects under the aegis of the NEA/OECD, the European Commission, or the ANR

4
projects coordinated by IRSN

Research activity

238
publications listed in the Journal Citation Reports

361
scientific contributions to congresses

33
PhD theses defended

78%
of IRSN articles posted in open access with full text on HAL-IRSN

Training

1,200
hours of teaching **provided externally** (university, engineering school, INSTN (French Nuclear Sciences and Techniques Institute), etc.)

269
hours of teaching **provided during 7 nuclear safety training sessions**

1,019
hours of teaching **provided during the 23 radiation protection training sessions**

Nuclear Defense safety, nuclear security, non-proliferation

39
inspections on the premises of nuclear material holders

19
inspections during transport

104
national inspections **on the protection and control of nuclear material conducted by IRSN**

42
missions accompanying **inspections relating to the international control of nuclear material**

6
missions accompanying **international inspections on the prohibition of chemical weapons**

46
technical controls **of means approved for the transport of nuclear material**

People and the environment

465
whole body radiometry measurements **taken for worker monitoring, 403 of which were taken using mobile resources**

551
stations

139
measuring points **for the ambient dose rate**

551
sampling points for the monitoring **of radioactivity throughout the country**

5,963
environmental samples **taken for radiation measurements**

PROPOSED REFORM OF THE ORGANIZATION of nuclear safety and radiation protection governance

Announced following the Nuclear Policy Council on February 3, the proposed reform of the organization of nuclear safety and radiation protection governance was the subject of internal work throughout 2023 within the Institute and with the main actors or stakeholders involved in nuclear safety in France. This government proposal led to the investigation of 3 reform projects concerning, firstly, the integration of passive dosimetry services within the CEA, secondly, the integration of Defense and Security appraisal services both within the Ministry of the Armed Forces and the CEA, and, lastly, the implementation of a new structure grouping all other activities of IRSN and ASN.

2023

February 3

Meeting of the Nuclear Policy Council announcing that *"IRSN's technical skills will be brought together with those of ASN, taking care to include the synergies, with the CEA and the Nuclear Safety Officer for Defense-Related Facilities and Activities (DSND)."*

February 8

Mission letter from the Minister of Energy Transition to the Chairman of ASN, the Director General of IRSN and the General Administrator of CEA, for them to propose the initial measures to implement these organizational changes.

February 16

Public hearing of Jean-Christophe Niel, Director General of IRSN, by the French Parliamentary Office for Evaluation of Scientific and Technological Options (OPECST) on the topic "Opportunities and challenges of the new safety organization in France", accompanied by Karine Herviou, IRSN's Deputy Director General in charge of the Nuclear Safety of Installations and Systems Division, and in the presence of Pierre Henriet, Deputy, and Gérard Longuet, Senator, rapporteurs, and representatives from ASN, CEA, EDF, ORANO, CNRS and Anccli.

March 8

Public hearing of the Director General of IRSN by the French Senate's Commission for Economic Affairs.

March 21

Audition of Jean-Christophe Niel by Senator Jean-François Rapin, Chair of the French Senate's Committee for European Affairs, Special Rapporteur on the appropriations of the "Research" mission, as part of a budgetary control on IRSN.

May 9 and 16

Adoption in the National Assembly and then in the Senate of the so-called "nuclear acceleration" law without the provisions relating to the merger of ASN and IRSN.

June 14

Hearing of Jean-Christophe Niel by the rapporteurs of the study conducted by the French Parliamentary Office for Evaluation of Scientific and Technological Options (OPECST), Jean-Luc Fugit, Deputy of Rhône, and Stéphane Piednoir, Senator of Maine-et-Loire, on the consequences of a possible reorganization of ASN and IRSN.

June 22

Vote on French law no. 2023–491 of June 22, 2023 on the acceleration of procedures related to the construction of new nuclear facilities near existing nuclear sites and the operation of existing facilities, taken in joint committee.

June 28

Visit to IRSN by the rapporteurs of the study conducted by the French Parliamentary Office for Evaluation of Scientific and Technological Options (OPECST), Jean-Luc Fugit, Deputy of Rhône, and Stéphane Piednoir, Senator of Maine-et-Loire, further to OPECST's hearing of the Director General of IRSN on June 14.

July 11

OPECST's report on *"the consequences of a possible reorganization of ASN and IRSN in the scientific, technological, nuclear safety and radiation protection areas"*.

July 19

Meeting of the Nuclear Policy Council (NPC), which confirmed the government's desire to move forward in the direction of the creation of *"a major independent authority for safety and radiation protection"*, and instructed the Minister of Energy Transition to initiate consultations with the stakeholders and parliamentarians with a view to preparing a bill by the autumn.

September to December

Establishment of working groups with the stakeholders concerned to propose broad lines of future missions as well as organizational and operating principles with:

- CEA for activities related to passive dosimetry;
- the Ministry of the Armed Forces and the CEA for all activities relating to Defense and Security appraisal;
- the ASN for the future "Nuclear Safety and Radiation Protection Authority".

November

Mandatory and optional consultations of various bodies by the government concerning the *"bill on the organization of nuclear safety and radiation protection governance to address the challenge of the revival of the nuclear sector"*.

November

Opinion of the National Association of Local Information Committees and Commissions (Anccli).

November 14

Opinion of the Higher Energy Council.

November 22

Opinion of the National Council for Higher Education and Research.

November 29

Opinion of the National Council for Ecological Transition (CNTE).

December 3

Opinion of the High Committee for transparency and information on nuclear safety (HCTISN).

December 4

Meeting for discussions between the Minister of Energy Transition and IRSN and ASN staff on the bill to reform the organization of nuclear safety and radiation protection governance in the framework of the revival of the nuclear sector.

December 14

Opinion of the Council of State.

December 20

Presentation of the bill by the Minister for Energy Transition in the Council of Ministers.

December 20

Submission of the bill to the Senate, first reading and appointment of the rapporteur for the bill.

2024

2023 HIGHLIGHTS

JANUARY

Signing of a framework agreement between IRSN and Ineris

MARCH

20th IRSN Thesis Days

APRIL

Deployment of the IRSN employer brand

FEBRUARY

Co-organization by IRSN, CEA, Inserm, and CNRS of a conference dedicated to research on the safe and optimized use of ionizing radiation as part of World Cancer Day

FEBRUARY

Inauguration of the MACUMBA experimental facility in Saclay

APRIL

5th CABRI International Program Trial in Cadarache

First full deployment of the mobile cell during an emergency exercise at the Saint-Laurent-des-Eaux power plant

MAY

MARCH

Partnership with Esprit Sorcier TV: IRSN's participation in the *Science en questions* ("Questions of Science") program

MARCH

Pour la Science magazine (in French only): a partnership renewed since 2020 for promoting the research conducted by IRSN

The *Rencontres Internationales* for High School students on Radiation Protection

MAY

JUNE

IRSN Discovery Day on the occasion of the 60th anniversary of the Cherbourg Radioecology Laboratory

Technical dialog as part of the CIGEO creation authorization request

JUNE

JULY

IRSN - Anccli: 20 years of partnership

JULY

Visit by Sylvie Retailleau, French Minister of Higher Education and Research, to the IRSN stand on the occasion of the 40th anniversary of OPECST

SEPTEMBER

Inauguration of LATAC, an innovative platform for environmental monitoring

Signing of a memorandum of understanding with SSTC NRS, the IRSN counterpart in Ukraine

SEPTEMBER

OCTOBER

Fête de la science ("Science Festival"): open days in Le Vésinet

First PIANOFORTE call for projects: 9 selected projects involving 69 teams from 22 European countries

DECEMBER

1 RESEARCH Building expertise for the future

What were the key events in research?

"2023 was an iconic year for IRSN. First, there was the evaluation report by the High Council for the Evaluation of Research and Higher Education (Hcéres): published in March, it was positive in tone and recognized the quality of the Institute's research, its leadership at the European level in several areas and its proactive commitment to open up to society. Among the strengths, Hcéres noted IRSN's adaptive approach and clear, forward-looking vision to meet the requirements of the authorities, public authorities and society. Finally, it recognized the legitimacy of its goals for 2022–2026 of being a responsible and socially-aware scientific institution.

Even more than the resumption of the CABRI reactor tests, this position as a responsible and socially-aware scientific institution has already been shown in several achievements in 2023:

- the opinion of the Research Steering Committee on climate change, which recommended the implementation of a meta-research program on this matter: the adoption of this recommendation demonstrates IRSN's willingness to equip itself with improved cross-functional management tools;
- the inauguration of the MACUMBA experimental platform on the aging of materials underscores the Institute's capacity to invest to respond to current issues;
- the first call for tenders of the European partnership PIANOFORTE, led by IRSN, which highlights the Institute's proactive approach to structuring European research in radiation protection.

Finally, I would like to mention two major landmarks of radiation protection research in 2023: the change in scale in radioecology, which is now investigating the effects on ecosystems and the services they provide, and the publication of IRSN's work on the linear no-threshold law, which brings reliability to the international radiation protection system."

Patrice Bueso
Strategy Director

IN BRIEF

EVALUATION OF IRSN BY HCÉRES

In March 2023 the High Council for the Evaluation of Research and Higher Education (Hcéres) published its IRSN evaluation report. It stated in the report that *"IRSN carries out to the highest standard its missions in coordination with the State in a strategic sector for France and in a changing geopolitical context"*. Hcéres underlined the strength of the Institute's model, coupling expertise and research, and commended *"the outstanding effort to open up to society"*.

IN BRIEF

THE APPRAISAL – RESEARCH INTERFACE, UNDER THE SCRUTINY OF THE SCIENTIFIC COUNCIL

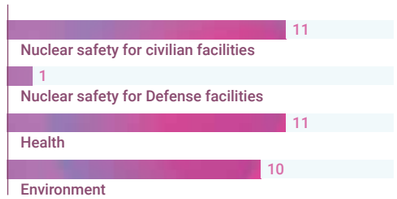
At the end of February, IRSN's Scientific Council published a report on the models of organizations engaged in research and appraisal, highlighting the maturity of the IRSN organization.

It also noted differences between the radiation protection and nuclear safety areas, concerning the interface between the activities of the experts and researchers. Lastly, the report identified levers to strengthen IRSN's capacity to adapt and anticipate.

Participating in the national training effort in and through research in the nuclear field

Like any research organization, IRSN attaches fundamental importance to training in and through research. Its doctoral program is an essential vehicle for transferring knowledge and skills to young people, as well an exceptional framework for investing in new areas and deploying its partnership policy.

The hundred PhD students at IRSN represent nearly one third of the human resources that the Institute devotes to scientific production. 30 new theses were launched in 2023, 26 by PhD students employed by IRSN. This work covers all areas of research. In addition, 33 theses were defended, in the following areas: 12 in safety (including one concerning defense facilities), 11 in health and 10 in the environment.



20th IRSN Thesis Days

A high point in the life of PhD students, this event took place at the end of March. It brought together 220 participants, including 91 PhD students from the Institute, their supervisors, and representatives from IRSN's main scientific partners. The second- and third-year PhD students reported on the progress of their work and welcomed the first-year students. The agenda included the challenges of artificial intelligence and climate change, with a conference on AI and a Climate Fresk workshop, respectively.

IN BRIEF

PUBLICATION OF TWO OPINIONS BY THE COR

The IRSN Research Steering Committee (COR) adopted two opinions in 2023. The first concerned skills in the nuclear sector. The COR emphasized the importance of measuring the effectiveness of skills *in situ* in partnership with the actors and the academic world. In its second opinion on the effects of climate change on nuclear safety and radiation protection, the COR recommended, in particular, structuring IRSN's actions within a specific cross-functional metaprogram.

TRACEABILITY AND SHARING

To meet the traceability needs of research activities, in 2023 IRSN deployed the ElabFTW electronic laboratory notebook. In order to organize its research data management, meet the requirements of the research funders and the relevant regulations, and prepare for the distribution of data in open data mode, the Institute now imposes, for any new research project, the use of a Data Management Plan that implements and reinforces its commitment to the Open Science movement.

NUCLEAR SAFETY

International collaboration under the auspices of OECD

Chaired by the Director General of IRSN, the NEA/OECD's Committee on the Safety of Nuclear Installations (CSNI) is tasked with identifying the research needs in the nuclear safety area so that the international community can therefore undertake cooperative projects.

In 2023, the CSNI began writing a roadmap for the next 15 years, in order to determine the programs to be launched, in the current context of the revival of nuclear power and the actors' willingness to extend the operation of facilities.

One of the major contributions of the NEA and CSNI is to encourage partners to launch joint experimental research projects. IRSN is taking part in 24 ongoing projects and manages three of them - ESTER, CIP and FAIR - and conducts experiments for these in its facilities.

Thus, the first semi-integral test of the ESTER program was successfully carried out at the beginning of 2023 on the CHIP (chemistry of iodine in the primary cooling system) test bench in Cadarache suitable for these new experiments. This program is aimed at better identifying conditions that may contribute to deferred emissions due to fission product deposits on the surfaces of an installation during a major accident.

Improving knowledge of reactivity accidents

Following the CIP1-2B test conducted at the end of 2022, the 5th test of the CABRI international program (CIP) was carried out by the IRSN and CEA teams on April 24, 2023, at the CABRI facility in Cadarache now equipped with a "water loop", representative of the thermo-hydraulic conditions of a pressurized water reactor (PWR). Mostly financed by IRSN, this program studies the behavior of nuclear fuel rods in PWR reactors in an accidental power excursion situation.

Researching fire risks

On June 1st, 2023, the NEA/OECD launched a new five-year program called FAIR. Focusing on fire risks, it brings together some twenty organizations. The experimental campaigns will be conducted by IRSN on its Galaxie experimental platform in Cadarache.

IN BRIEF

RSNR PROJECTS: POSITIVE REPORT

In the closing meetings for the RSNR projects held in 2022–2023, the French National Research Agency congratulated IRSN for the scientific results obtained, the quality of project management and compliance with commitments. These projects, launched under the Investments in the Future Program, were part of the consideration of the factors and consequences of the Fukushima-Daiichi accident and, for the projects managed by the Institute, were aimed at acquiring new knowledge about serious accidents and their radiological consequences.

EPICUR: a unique in the world facility

The only one of its kind, IRSN's EPICUR irradiator at Cadarache can be used to study the behavior of iodine and different types of materials during a major accident in a nuclear reactor. Its specificity is to be coupled to a test loop making it possible to recreate the conditions representative of such an accident. The cobalt-60 sources were replaced in the first quarter of 2023, allowing EPICUR tests to continue.

A new experimental facility

Key elements of research, experimental and software platforms require substantial investments to meet the increasingly specific needs of scientific projects.

Inaugurated on February 3, 2023, the MACUMBA installation of the MISTRAL platform at Saclay will be able to accommodate different types of models of reinforced concrete structures encountered in nuclear facilities (PWR containment structure, walls representative of ventilated areas of laboratories and plants) in order to subject them to controlled mechanical and thermal stresses. COBRA is the first research program conducted at this facility. Its purpose is to estimate the dry air/air-steam leakage rate and the retention of aerosols in the wall of a containment structure of a 1300 MWe pressurized water reactor, based on its state of cracking during a serious accident.

An optimization approach

In order to maximize the use of its experimental and software platforms, the Institute is participating in the OFFERR project to enhance these facilities at the European level. Bringing together 17 partners, OFFERR aims to create a network of experimental research infrastructures, to facilitate access to them for European scientists and students, and to contribute to the development of research projects drawing on these facilities. In April 2023, OFFERR published its first call for research projects using one of the 178 installations listed in its database.

Preparing for appraisals of future nuclear fuels

In order to acquire knowledge on the behavior in accident situations of a new generation of more accident-tolerant fuels (ATF), likely to be deployed in the future in French nuclear power stations, IRSN is already investing in new international research programs.

Following the Fukushima-Daiichi accident, manufacturers launched the development of new types of fuels with the aim of providing greater resilience in accidents. The changes made concern both the claddings containing the fuel pellets – in particular to limit oxidation and deformation phenomena in the event of a loss of coolant – and the pellets, in order to ensure better retention of the fission products and to reduce mechanical stresses on the cladding.

The Institute is thus associated with research programs, conducted under the auspices of the OECD Nuclear Energy Agency, including test campaigns aimed at studying the behavior of ATFs in configurations representative of reactor accident situations. IRSN is also preparing to carry out experiments on ATF claddings made available by Framatome, EDF's supplier. The results of this work will enable IRSN to develop and validate specific models to simulate the behavior of these future fuels.

HEALTH – ENVIRONMENT

Risk prevention: Ineris and IRSN strengthen their collaboration

Signed on January 19, 2023, the framework agreement between IRSN and the National Institute for Industrial Environment and Risks (Ineris) aims to reinforce the actions carried out by the two institutes in the area of risks and for the preservation of biodiversity and health.

Long-standing partners, Ineris and IRSN - key players in chemical and industrial risks for the first, and radiological and nuclear risks for the second - play a complementary role with the public authorities. The decision to strengthen their collaboration responds to the wish to coordinate their resources to address two major challenges:

- the rise in health, environmental and cyber risks, and in risks from geopolitical or terrorist threats;
- the advancement of knowledge and the development of prevention in respect of environmental health.

It targets four areas more specifically:

- modeling the dispersion of chemical and/or radiological substances in an accident situation;
- assessing the health and environmental impacts of these substances;
- managing and using environmental monitoring data;
- the human and social sciences, and the tools and methods to support decision-making.

Concluded for five years, the agreement will enable IRSN and Ineris to share strategic and forward-looking thinking, pool their resources and strengthen the effectiveness of the support provided to public authorities.

Priority programs and equipment for exploratory research (PEPR): IRSN and Ineris partnered with IRiMa

Launched in May 2023 under the France 2030 plan, the IRiMa program aims to develop a science of risks that can contribute to strengthening France's resilience in the context of global changes. Its uniqueness and strength are to bring together all the communities potentially concerned: geosciences and natural risks; technological and nuclear risks; human and social sciences.

IN BRIEF

PARTICIPATORY RESEARCH IN THE DUNKIRK AREA

The regional participatory research project ORRCH-IDEeS was selected as part of the French National Research Agency's 'Sciences with and for society' call for projects.

This multi-partner project on the health impacts linked to multi-environmental exposure in the Dunkirk area aims to guide public policies and make populations co-stakeholders in a research project.

FIGHTING CANCER: TOWARDS BETTER USE OF IONIZING RADIATION

On February 2, 2023, on World Cancer Day, IRSN in collaboration with the CEA, Inserm and CNRS organized a conference on research into the safe and optimized use of ionizing radiation for the screening, diagnosis and treatment of cancer. This event brought together health professionals, scientists and representatives of the European community and international organizations at Maison Irène and Frédéric Joliot-Curie in Brussels.

IN BRIEF

FIRST CALL FOR PIANOFORTE PROJECTS

The European partnership PIANOFORTE for radiation protection research, led by IRSN, launched its first call for projects in March 2023, focusing on three areas: research on the development of cancers induced by ionizing radiation; the evolution of diagnostic and therapeutic procedures towards individualized treatments; the development of risk assessment and management approaches as well as technological capabilities for dealing with situations of armed conflict or natural disasters. Nine projects were selected. They comprise 69 teams from 22 European countries.

Understanding the impacts of radioactivity on ecosystems

The work carried out by IRSN is aimed at better understanding the environmental impact of exposure to ionizing radiation, in order to preserve both biodiversity and the benefits that humans derive from it.

In 2023, IRSN conducted field research as part of its BEERAD and KERO projects, with the aim of assessing the consequences of radioactive discharges from the Fukushima-Daiichi accident. The BEERAD project concerned the effects of ionizing radiation on bees, investigating both their health and their ability to maintain their pollination and honey production functions. As for the KERO project, its aim was studying the consequences of radioactive contamination on wildlife, focusing on a model species: the tree frog *Dryophytes japonicus*.

A comprehensive approach

The work carried out aims to assess the health of ecosystems, using diverse and complementary approaches. Ecosystem services (the benefits humans derive from ecosystems) are one component of this state of health. Their utility as an indicator of the state of biodiversity was highlighted in a recent publication by the Institute. In the same way, IRSN is participating in the DECORHONE project to identify the ecosystem services provided in the Rhone corridor, in order to have an inventory before studying the impact of ionizing radiation.

For a consolidated radiation protection system

IRSN conducts epidemiological studies to study the effects of exposure to low doses of ionizing radiation, in order to improve prevention and verify the soundness of the radiation protection system.

The EPI-CT study published in the *Lancet Oncology* and *Nature Medicine* journals confirmed an excessive risk of malignant brain tumors and hematologic malignancies in children and adolescents after CT scans. These cancer risks increase with the dose administered, but remain very low in view of the diagnostic benefit of CT scans.

Similarly, the INWORKS study published in the *British Medical Journal* confirmed a relationship between the risk of death due to cancer and the repeated exposure to low doses of ionizing radiation among workers in the nuclear industry.

In addition, in the *Journal of Radiological Protection* IRSN published its view on the validity of the Linear No Threshold (LNT) model. Based on a summary of the state of recent knowledge in radiobiology and epidemiology, IRSN concluded that the LNT model is suitable for estimating the risk of cancer associated with exposure to ionizing radiation in support of the radiation protection system.

New research projects

Two research projects were launched in 2023 at IRSN. "Watch your heaRT" is aimed at assessing the risk of cardiac arrhythmias in the five years following radiotherapy for breast cancer. Funded by ANSES, "BECOME" investigates the risk of radiation-induced brain cancer among medical professionals.

[2] NUCLEAR SAFETY
Reinforcing the capacity for facility appraisals and anticipating the future

Using feedback to measure the gain in safety from the Institute's recommendations

"While the approach of integrating research and nuclear safety appraisal is far from being a new reality for IRSN, the progressive maturity of the dialog between these two missions – thanks to a cross-functional coordination that has succeeded in creating a real chain of complementary skills – now makes it possible to ensure its coherence and stability, as stressed by the High Council for the Evaluation of Research and Higher Education (Hcéres). Research programs must therefore meet the needs of the appraisal while maintaining the necessary distance to avoid putting the control system under strain as a result of a too direct transfer of research results into the appraisal. The introduction of cognitive technologies to both research and appraisal is also part of this maturing process.

Providing quality appraisal, in addition to being based on state-of-the-art knowledge, also requires an assessment by the Institute's experts of the implications of their work on operational safety. In order to meet increased safety requirements, particularly following the Fukushima-Daiichi accident, nuclear facilities have seen their rule set, equipment and operating rules become more complex. It is now important for our experts to draw on feedback to ensure that the gain in safety expected from their recommendations is not called into question by the complexity of the installations."

Karine Herviou
Deputy Director General,
in charge of Nuclear Safety

Supporting the commissioning of the EPR

With a view to the start-up and commissioning of the Flamanville (Manche) EPR in 2024, IRSN has completed the appraisal of the major files and continued the analysis of the reactor's assembly tests.

In 2023, IRSN completed the appraisal of the safety report and the general operating rules sent by EDF in support of the EPR commissioning request. Among the various opinions issued by the Institute in this context, three relate more specifically to the design of the pressurizer safety valves, the water filtration system of the internal tank of the reactor building (see inserts), as well as incorporating the feedback from the commissioning of the first EPRs. At the same time, the Institute continued to assess the results of the reactor start-up tests, highlighting the need to perform some of them again – in particular some hot tests – during the assembly qualification phase of the facility.

IRSN will examine the results of the post-start-up tests and the ramp-up of the EPR with a view to industrial commissioning in 2024.

The water filtration system of the internal tank in the reactor building

In the event of a break in the primary circuit, the EPR is equipped with a safety injection system to compensate for the water loss resulting from the break and to keep the reactor core under water. As debris is likely to be carried by the water as a result of the circuit break and disturb the operation of the safety injection circuit, the latter is equipped with filters. They were subjected to qualification tests in EPR configuration in the Viktoria loop (located in Levice, Slovakia), which IRSN made use of in its analysis.

The design of the pressurizer safety valves

The EPR is equipped with a pressurizer to regulate the pressure and prevent an excessive pressure rise in the reactor primary circuit. The tests carried out on the pressurizer valves, actuated by pilots directly connected to it, showed that their behavior was sensitive to the temperature of the pilots, and a risk of leaks on the pilots.

In its appraisal, IRSN recommended carrying out tests to corroborate the justifications provided by EDF in this regard. In the meantime, strengthened operational arrangements are implemented to ensure that the valves operate correctly under load.

Natural hazards: IRSN is studying the resilience of nuclear installations

Snow, storms, marine submersions, floods, earthquakes, etc. - nuclear installations are potentially exposed to natural hazards that must be assessed in order to take the appropriate protective measures. IRSN continued this work in 2023, in particular as part of international collaborations.

A multidisciplinary working group, attached to ASN and led by IRSN, investigated the damage potentially caused by wind or snow to structures and equipment important for the safety of nuclear facilities. In their report, which will provide the knowledge base for a future ASN guide, the experts showed that this damage can result not only from mechanical stresses induced by wind pressure or the weight of snow on structures, but also from indirect effects such as projectile impact, clogging of air intakes or the loss of resources external to the site.

In addition, as part of its safety assessments of nuclear sites located at the sea coast and their protection against the risk of submersion, IRSN conducted research into the estimation of extreme sea levels and developed a fully public database listing more than 800 events that have occurred since the beginning of the seventeenth century.

Lastly, in the seismic field, experts from the Institute took part in observation missions following earthquakes in the regions of Kahramanmaraş (Turkey) and La Laigne (France). The field experience acquired during these missions enhances IRSN's insight into earthquake resistance simulation tools and the work execution plans, and contributes to the increase in skills of its experts, in particular the youngest ones.

The report entitled "State of knowledge, practices and recommendations concerning wind and snow aggression on basic nuclear installations" (in French only).

The Institute's participation in two international seminars on natural hazards

The first was a workshop organized by the OECD Nuclear Energy Agency (NEA) on the consideration of natural hazards at IRSN and the second, organized by the Institute, focused on the magnitude 6.3 earthquake that hit the Petrinja region (Croatia) in 2020.

RP4-1300: The technical dialog with society continues

Launched jointly by IRSN, Anccli and ASN with the participation of EDF, in December 2022, in parallel with the appraisal, the technical dialog conducted as part of the 4th periodic review of the 1,300 MWe reactors (RP4-1300) continued in 2023 with the organization of three meetings (in May, June and October) at which IRSN presented technical elements on ten topics. These sessions made it possible to gather questions and expectations from civil society, which IRSN will take into account in its appraisal.

IN BRIEF

PUBLICATION OF IRSN'S FIRST SAFETY APPRAISALS IN THE FRAMEWORK OF RP4-1300

The four opinions published by the Institute in 2023 respectively concern the change to steam generators, the new rule set for the study of primary coolant loss accidents, the post-Fukushima hard core and the assessment of the core's reactivity following an automatic shutdown of the reactor.

IRSN issues its opinion on the modification of safety barriers to prevent the risks of red oils reactions in the UP3-A plant in La Hague

Under certain conditions, reactions between products present in the spent fuel processing process can lead to the formation of unstable compounds, called red oils, generating a risk of explosion which must be prevented. At ASN's request, IRSN examined the modification of the safety barriers associated with the ORANO Recyclage safety demonstration.

The T2 workshop of the UP3-A plant in La Hague (Manche) separates the fission products, uranium and plutonium. The resulting fission product solutions are concentrated by evaporation and then stored in workshop tanks prior to vitrification. The extraction process implemented uses an organic solvent that can, under certain conditions, form unstable nitrate compounds, called red oils, likely to decompose violently and generate a large amount of explosive gases.

Based on the documents examined at ASN's request, IRSN considered as acceptable the modification of part of the lines of defense involved in preventing the formation of red oils in the evaporators of the new fission product concentration unit of the T2 workshop.

IRSN assesses EDF's detection of new cracks on pipes at Penly and Cattenom

EDF's discovery of thermal fatigue cracks on the Penly (Seine-Maritime) reactor no. 2 and Cattenom (Mosel) reactor no. 3, both with a unit power of 1,300 MWe, led IRSN to examine, at ASN's request, possible changes in the periodic inspection strategy carried out by the operator.

In March 2023, EDF announced the discovery of a deep crack (23 mm with a total thickness of 27 mm) of stress corrosion cracking on a weld of the safety injection circuit connected to the primary circuit of reactor no. 1 of the Penly nuclear power station. Subsequently, when searching for any other defects, the operator detected thermal fatigue cracks on the Penly reactor no. 2 and Cattenom reactor no. 3. Thermal fatigue is a known cause of damage to nuclear reactor circuits resulting from repetitive temperature variations, which can lead to the appearance of cracks. The main method of prevention is the design of the circuits or the precautions taken in operation, in order to prevent the pipes from being subjected to cyclic temperature variations.

The fatigue cracks of the Penly reactor no. 2 and Cattenom reactor no. 3 were not discovered on the welds examined as part of the periodic inspection program, but thanks to the additional checks intended to search for stress corrosion defects. The results of these additional checks will be incorporated in the further appraisal of the kinetics of corrosion crack propagation. In the longer term, the Institute considers that EDF's control programs with regard to these two causes of damage will have to be adapted to new knowledge and has initiated a review in this respect.

Decommissioning of nuclear facilities: growing appraisal activities

IRSN examined the safety files related to the decommissioning of various nuclear facilities such as the two reactors in Fessenheim (Haut-Rhin) and two solid waste management facilities located in Cadarache (Bouches-du-Rhône) and Fontenay-aux-Roses (Hauts-de-Seine). The Institute concluded that the submitted files were technically acceptable and made recommendations.

After analyzing the safety file for the decommissioning of the Fessenheim power plant, IRSN formulated recommendations in two areas – firstly, controlling risks during tank cutting operations, and secondly, the provisions for monitoring contamination outside certain worksite airlocks – and considered satisfactory the commitments made by EDF in terms of organizational and human factors, studying possible accident situations, waste management and impact studies.

With regard to the decommissioning of INB no. 56, located in Cadarache and used by the CEA since the 1960s for storing solid radioactive waste, the Institute recommended the implementation of provisions aimed at limiting the potential consequences of one of the items of waste recovery equipment falling during handling.

Lastly, with regard to INB no. 166, another CEA solid waste storage facility located in Fontenay-aux-Roses, IRSN recommended supplementing the radiological monitoring of groundwater and water courses downstream of the site.

IRSN and EDF file a patent for a new system measuring radioactive aerosols on a decommissioning site

This device, able to correct the variations in the particle size of aerosols that disrupt the measurement of activity by current continuous ambient air monitoring systems, represents a significant advance for the radiation protection of workers in nuclear facilities.

Manufacture of radiopharmaceuticals: IRSN assesses the INB no. 29 periodic review file

Dedicated to the manufacture of radiopharmaceuticals, INB no. 29, located in Saclay (Essonne), is operated by CIS Bio International. Following the appraisal of the periodic safety review file for this facility, IRSN recommended, in particular, improved sealing of the containment enclosures as well as the facility being laid up if the automatic fire extinguishing system is unavailable.

IN BRIEF

IRSN CO-ORGANIZES PATRAM 22, A SYMPOSIUM DEDICATED TO THE PACKAGING AND TRANSPORT OF RADIOACTIVE MATERIALS

This 20th symposium, organized with the support of IRSN, brought together more than 700 players involved in the transport of radioactive materials on June 11 - 15, 2023 in Juan-les-Pins (Alpes-Maritimes). It enabled them to debate a wide range of topics in this respect, such as mechanics, safety, containment, heat transfer, manufacturing, security, maintenance and quality.

Enhanced appraisal: IRSN organizes a seminar with its German and American counterparts

The Integrated Feedback Platform (PIREX) has been deployed within IRSN for two and a half years now. A new version, which went into operation in 2023, incorporates developments coordinated with users. It was a component of the seminar bringing together IRSN, GRS and NRC at the end of the year.

Developed by IRSN in order to capitalize on all significant events reported each year by the operators of nuclear facilities or transports of radioactive substances, the Integrated Feedback Platform (PIREX) uses algorithms implementing artificial intelligence techniques (automatic language processing, machine learning, etc.) in order to extract, faster and more comprehensively than before, lessons learned from the some 47,000 significant events reported by nuclear facilities since their start-up. PIREX thus makes it possible to orient, on the one hand, IRSN's appraisal work (identification of the issues and themes to be examined) and R&D work (identification of new knowledge needs) and, on the other hand, the support to the security authorities (support for inspections, assessments, etc.).

At their joint seminar, IRSN, GRS and NRC discussed, among others, the contribution of innovative technologies for safety appraisals, of which PIREX is a good example.

IRSN is focusing on the safety of small modular reactors

Several countries, especially in the European Union, are interested in new concepts of small modular reactors that make extensive use of passive safety systems. As part of its appraisal and research activities, IRSN participated in various discussions and technical meetings on this subject throughout 2023[1].

Speaking in April at the seminar chaired by Mariya Gabriel, European Commissioner for Research and Innovation, on the EU's strategic autonomy and research conducted within the EURATOM framework, the Director General of IRSN presented the nuclear safety challenges linked to new technologies such as small modular reactors (SMR). The presentation of the IRSN "PASTIS" project, dedicated to passive safety systems for pressurized water reactors, illustrated the associated research needs.

On November 30, 2022, in Washington the President of the French Republic launched a Franco-American nuclear cooperation program. In this respect, the IRSN and the US NRC included in a common roadmap the aspects related to the safety of SMRs and the contribution of passive systems to it. Technical discussions made it possible to compare the safety analyses of the US NUSCALE and French NUWARD reactors. They are continuing with a view to collaborating on the use of the future PASTIS platform, located in Cadarache, which was presented in the follow-up meeting at the Elysée on November 29, 2023.

IRSN commissions version 3.1 of the ASTEC software and develops its adaptation to SMRs

This software system makes it possible to simulate accident scenarios with a reactor core meltdown, from the initiating event to releases into the environment. Originally developed for pressurized water reactors, ASTEC has evolved to apply to other nuclear reactors and facilities such as nuclear fuel storage pools and, soon, some small modular reactors.

[1] See also the main file, "360° vision: At the start of a decade of major challenges for safety appraisals".

3 DEFENSE-RELATED NUCLEAR SAFETY, SECURITY, NON-PROLIFERATION Support for changes in programs, facilities and threats

Support for changes in threats and the means put in place to protect against them

"The IRSN teams in charge of defense-related nuclear appraisal, the security of nuclear facilities and non-proliferation provide support to multiple authorities, with the assistance of civil nuclear experts. These are mainly the Nuclear Safety Officer for Defense-Related Facilities and Activities (DSND), the Senior Defense and Security Official (HFDS) of the Ministry of Energy Transition[2] for the fight against malicious acts, the Euratom Technical Committee (CTE) for the Non-Proliferation of Nuclear Weapons and the HFDS of the Ministry of the Economy, Finance and Industrial and Digital Sovereignty[2] for the implementing in France of the treaty banning chemical weapons.

In this regard, IRSN provides support for the continuous evolution of nuclear programs linked to defense – such as the development of the new generation of ballistic-missile submarines and nuclear aircraft carriers, and the renovation of nuclear deterrence facilities – and examines the associated operational feedback.

For civil nuclear, in the context of a national nuclear security regulation that has just been renewed, the Nuclear Defense Appraisal Department (DEND) plays a role in strengthening the nuclear security of many facilities in the face of threats – including cyber-attacks – by making use of specific research, often carried out in partnership. IRSN and the French-German Research Institute of Saint-Louis have just jointly filed a patent for an innovative visualization system for experiments into explosive attacks.

Lastly, in the field of nuclear and chemical non-proliferation, IRSN is continuing and adjusting its provision of support to the French public authorities based on the new challenges posed by changes in the geopolitical context and changes in international regulations."

[2] Titles in effect as at 12/31/2023.

Laurent Mandard

Director of Nuclear Defense and Security Appraisal

Nathalie Chaptal-Gradoz

Assistant to Director of Nuclear Defense and Security Appraisal

"Law no. 2023–610 of July 18, 2023 giving the Customs Administration the means to deal with new threats introduces, in Article 17, the possibility of exchanging information between its agents, those of the Ministry of the Economy in charge of implementing the CWC and "the staff of entities acting on their behalf". In this regard, IRSN will now be able to receive and use information received from customs relating to chemicals listed in the CWC. In particular, these exchanges will enable the consolidation of import and export declarations from the civil sector and the resolution of discrepancies between States Parties identified by the OPCW. The practical arrangements for exchanges will be governed by an agreement that the parties have planned to finalize before the start of 2024. This new provision helps to strengthen the control measures related to the holding or intention to hold the most sensitive chemicals."

IRSN and the French-German Research Institute of Saint-Louis develop a joint innovation

Improving understanding of the physical mechanisms of blast waves and having tools to predict the consequences of explosions in order to better protect against them: these are the objectives that guided the development of the MOST system, which ISL and IRSN began exploiting in 2023.

As part of its safety studies and research activities, IRSN, together with the French-German Research Institute of Saint-Louis (ISL), launched in 2017 the development of a rapid imaging project called MOST, which combines a camera and a light source, enabling the visualization, in real time, of dynamic phenomena in disturbed environments, in particular following an explosion. Obtaining sharp images not polluted from the light intensity of the fireball makes it possible to track what is happening in the immediate environment of the explosion – in particular the propagation of the shock wave – and ultra-fast digital video coupling to track its phenomenology.

This innovation was the subject of a patent application at the end of 2022, which falls within the scope of the Institute's missions to improve the understanding of the physical mechanisms of blast waves, by having tools to predict the consequences of explosions so as to better protect against them. In 2023, IRSN and ISL applied to the Ministry of the Armed Forces for RAPID financing to support dual innovation, which will enable them to design and develop a complete process, produce a prototype and study its marketability.

IN BRIEF

IRSN CONTRIBUTES TO THE PREPARATION OF THE 5TH CWC REVIEW CONFERENCE

In its technical support to the Ministry of Industry for issues related to the application of the Chemical Weapons Convention (CWC), IRSN contributed to the preparation of the 5th review conference held in May at the headquarters of the Organization for the Prohibition of Chemical Weapons (OPCW) in La Haye (Netherlands). The Institute's representatives put forward proposals aimed at improving the method of selecting the sites to be inspected (which fall under the category of defined organic chemicals).

Nuclear safeguards: IRSN shows its expertise in training

In 2023, IRSN hosted training sessions in Fontenay-aux-Roses (Hauts-de-Seine) in the field of nuclear safeguards, both as part of European financing and the Institute's cooperation with the US DOE.

In June, IRSN welcomed trainees from South Africa, Brazil, Ghana, Iraq, Jordan, Nigeria, Turkey, Poland and Ukraine for training aimed at increasing the trainees' capabilities to meet their countries' international obligations in terms of nuclear safeguards by implementing best practices in this field. In October, the Institute held a similar session in Singapore.

As part of its cooperation agreement with the DOE on nuclear security and safeguards, in October, IRSN also held a training session on the coordination between physical protection and the accounting and control systems for nuclear materials during a nuclear security event. This workshop brought together 16 participants from Algeria, Ivory Coast, Ghana, Morocco, Nigeria, the Democratic Republic of Congo and two regional organizations, the African Commission on Nuclear Energy (AFCONE) and Forum of Nuclear Regulatory Bodies in Africa (FNRBA).

IRSN's participation in the joint INMM-ESARDA conference

At this event in May in Vienna, which brought together more than 700 participants from American and European associations on nuclear safeguards and security, the Institute made presentations on major themes of the conference, such as nuclear material accountancy, metrology, training or the impact of SMRs on international declarations.

IRSN's Transport Operations Center celebrates its 40th anniversary

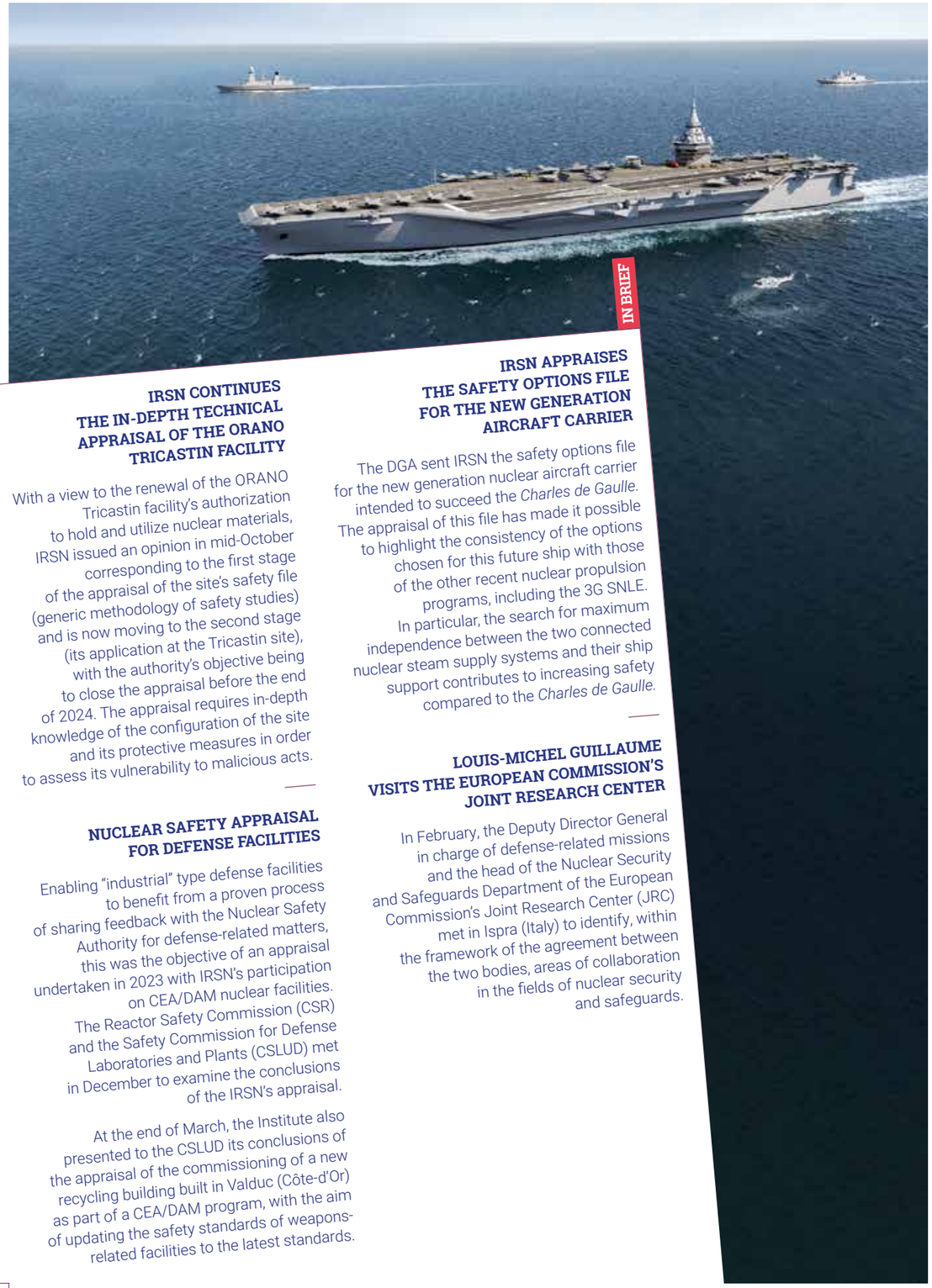
Within the IRSN Nuclear Defense Appraisal Department, the transport operations center (TOC) is responsible, in particular, for an official mission: managing requests for approval for nuclear material transports as well as their monitoring. This body, which celebrated its 40th anniversary in 2023, carries out, among others, the technical inspection of the equipment used to transport these materials.

As part of its mission, a TOC team visited the road terminal of the Melox factory, operated by ORANO Recyclage in Chusclan (Gard), on March 28 – 29, in order to carry out the technical inspection of a road tractor, an MX8 type semi-trailer and two containers belonging to ORANO NPS, a prerequisite for the renewal for one year of their approvals for the transport of category I and II non-irradiated nuclear materials. Every year, on average, 50 pieces of equipment are subject to a check that exclusively concerns the so-called "physical protection" devices and systems implemented to detect and delay an attempted malicious act during transport. The aim is to ensure that they are always present, in good working order and comply with regulations. For example, there are 250 inspection points for a road tractor.

IN BRIEF

IRSN'S ACTIVE PRESENCE AT THE INTERNATIONAL CONFERENCE ON CYBERSECURITY IN THE NUCLEAR WORLD

Emphasizing the international bodies' awareness of the rise in cyber threats and the commitment to tackle them, CYBERCON23, the first international conference dedicated to cybersecurity, was held on June 19 – 23 at the initiative of the IAEA. A member of the conference's organizing committee, IRSN chaired a session and presented its work on the cybersecurity of nuclear material transports and its HYDRA platform, a tool for assessing the control-command architecture of a reactor.



IN BRIEF

IRSN CONTINUES THE IN-DEPTH TECHNICAL APPRAISAL OF THE ORANO TRICASTIN FACILITY

With a view to the renewal of the ORANO Tricastin facility's authorization to hold and utilize nuclear materials, IRSN issued an opinion in mid-October corresponding to the first stage of the appraisal of the site's safety file (generic methodology of safety studies) and is now moving to the second stage (its application at the Tricastin site), with the authority's objective being to close the appraisal before the end of 2024. The appraisal requires in-depth knowledge of the configuration of the site and its protective measures in order to assess its vulnerability to malicious acts.

NUCLEAR SAFETY APPRAISAL FOR DEFENSE FACILITIES

Enabling "industrial" type defense facilities to benefit from a proven process of sharing feedback with the Nuclear Safety Authority for defense-related matters, this was the objective of an appraisal undertaken in 2023 with IRSN's participation on CEA/DAM nuclear facilities. The Reactor Safety Commission (CSR) and the Safety Commission for Defense Laboratories and Plants (CSLUD) met in December to examine the conclusions of the IRSN's appraisal.

At the end of March, the Institute also presented to the CSLUD its conclusions of the appraisal of the commissioning of a new recycling building built in Valduc (Côte-d'Or) as part of a CEA/DAM program, with the aim of updating the safety standards of weapons-related facilities to the latest standards.

IRSN APPRAISES THE SAFETY OPTIONS FILE FOR THE NEW GENERATION AIRCRAFT CARRIER

The DGA sent IRSN the safety options file for the new generation nuclear aircraft carrier intended to succeed the *Charles de Gaulle*. The appraisal of this file has made it possible to highlight the consistency of the options chosen for this future ship with those of the other recent nuclear propulsion programs, including the 3G SNLE. In particular, the search for maximum independence between the two connected nuclear steam supply systems and their ship support contributes to increasing safety compared to the *Charles de Gaulle*.

LOUIS-MICHEL GUILLAUME VISITS THE EUROPEAN COMMISSION'S JOINT RESEARCH CENTER

In February, the Deputy Director General in charge of defense-related missions and the head of the Nuclear Security and Safeguards Department of the European Commission's Joint Research Center (JRC) met in Ispra (Italy) to identify, within the framework of the agreement between the two bodies, areas of collaboration in the fields of nuclear security and safeguards.

[4] RADIATION PROTECTION Protecting the health of people and the environment

How does IRSN envisage its action in the field of radiation protection?

"IRSN is committed to conducting its activities in the field of radiation protection, maintaining a great synergy between research, appraisal and response to emergencies. This synergy is a requirement for a quality response to requests, whether from the public authorities or society. Thus, the Institute is carrying out research to better understand the mechanisms and consequences, for people and for the environment, of exposure to ionizing radiation, with the intention of coordinating the research effort between the different European actors: the launch of the PIANOFORTE project call for tenders is an example of this in 2023. The aim of this research is to serve our appraisal capacity effectively, whether for our recurring activities such as the publications of the diagnostic reference levels (DRL) report, the monitoring of workers or the surveillance of French Polynesia, and for the various opinions given to authorities or public authorities. At the same time, IRSN is continuing its investments to continuously improve its capacity to respond to a radiological or nuclear emergency: this is evidenced by the inauguration in 2023 of the LATAC laboratory, an innovative infrastructure enabling the urgent measurement of contaminated samples in large numbers.

Lastly, the Institute is very attentive to the involvement of the stakeholders and the public, whether through participatory sciences such as *OpenRadiation*, the technical dialogs with the CLIs and Anccli on important matters or the reflections carried out by its ODISCÉ committee on openness to society in the medical field.

Recognition of this requirement is reflected in particular in the renewed appointment of the Institute as a Collaborating Center for the World Health Organization (WHO) and as a Capacity Building Center (CBC) for the International Atomic Energy Agency (IAEA)."

Jean-Christophe Gariel

Deputy Director General,
in charge of Health and Environment

HEALTH OF PEOPLE

Optimizing the monitoring of workers' exposure

Among the IRSN's missions, the monitoring of workers is the subject of an annual report, mainly carried out using the data from the SISERI national register, which IRSN manages.

Read the "Radiation Protection of Workers" report (in French only).

In September 2023, IRSN published its report on the monitoring of workers exposed to ionizing radiation in 2022. The report presents the results of the monitoring of external and internal exposure of workers in the medical, dental, and veterinary fields, nuclear and non-nuclear industry, research and airline flight personnel.

Among the main findings, the drop of nearly 2% in the number of workers monitored in 2022 compared to 2021 is mainly linked to the number of workers monitored in the medical field. In addition, the average individual dose (0.90 mSv), up 6% compared to 2021, concerns almost all areas while remaining lower than in the years preceding the health crisis. It is mainly due to the resumption of air traffic.

Two focuses complement this data: one on the difference in exposure between female and male workers, mainly in the nuclear and non-nuclear industries. The second focus concerns the exposure of operators during the operation of nuclear reactors: external operators are generally more exposed than those of EDF, due to the use, for certain activities, of trades that EDF does not have (scaffolder, insulator, or welder).

A new SISERI portal

Commissioned at the end of June, the new SISERI portal is the result of three years of collaboration between IRSN and the Directorate-General for Labor.

The aim was to simplify the centralization and exploitation of the measurements. The new portal utilizes interoperabilities with the government platforms to verify the information entered. This means that the teams in charge of its operation can spend more time analyzing the data and conducting actions to complete the reference data.

Learn more: https://docs.siseri.irsn.fr (in French only).

Openness to society: as close as possible to the Cli

Since 2003, IRSN has carried out numerous actions with the Cli (Local Information Commissions) to provide support for their increase in skills, on issues related to nuclear safety, radiological monitoring of the environment or the health impacts of ionizing radiation.

Thus, at the invitation of the Ecrin Malvési Cli, the Institute was able to present to the public the radiological study of the ORANO site in Malvési, and in particular its "Lifestyle Survey" section.

During this meeting, the scientific objectives for the participation of local actors and the progress of the various studies were presented. In this regard, the local residents' lifestyle survey was widely addressed with a direct call for volunteers and the dissemination of information on the current establishment of the directory of voluntary households.

Radiation protection for patients: analysis of diagnostic reference levels

In June 2023, IRSN published its 7th report on diagnostic reference levels (DRL), based on data from the 2019–2021 period, compared with the current DRL values in order to examine the need for an update.

Based on data provided by radiology and nuclear medicine institutions when carrying out diagnostic examinations, IRSN periodically analyses these data in order to update the DRL values if necessary. DRLs are "guideline values" to guide practitioners in optimizing exposure induced by radiological or nuclear medicine examinations. In particular, they take into account the technological development of the devices used and the practices of healthcare professionals.

For a review of the values

According to the latest report published by IRSN, the participation of establishments has stabilized at around 50% for conventional radiology, and 90% for computed tomography and nuclear medicine. The analysis of the data collected shows results in adults that are lower than the values of the DRLs in force in all areas.

This report is accompanied by recommendations that include the need to review DRL values in all areas, with priority for computed tomography. It also recommends the creation of values, for example for breast tomosynthesis or cone beam computed tomography (CBCT) in dental radiology, as well as the removal of reference levels for some examinations that have become infrequent, such as renal scintigraphy at DTPA.

This report was presented by experts from the Institut at the Journées Scientifiques de la *Société Française de Physique Médicale* (SFPM) on June 7 – 9, 2023 and at the Journées francophones de radiologie diagnostique et interventionnelle on October 13 –16, 2023 in Paris.

Read the "Analysis of data for updating diagnostic reference levels in radiology and nuclear medicine - 2019-2021 report".

The ODISCÉ Committee publishes its second opinion

In its June 21, 2023 meeting, the ODISCÉ committee adopted its second opinion on the openness to society of IRSN's work in the medical field.

This is an innovative body, created by IRSN in 2022 to help in developing its policy of openness to society. The ODISCÉ (Openness and promotion of dialog with civil society on appraisals) committee is composed of some twenty members with different profiles. Provided for in the Institute's objectives and performance contract, this body is tasked with advising the Institute in order to promote new science-society interactions on the appraisal of nuclear and radiological risks and to increase the audiences involved.

Recommendations

This second opinion proposes that IRSN be a player in a shared understanding of the challenges. It also calls for the strengthening of dialog and participatory work between all stakeholders involved in medical radiation protection. It is structured around four main recommendations aimed at:

- strengthening the dialog with stakeholders in the oncology ecosystem,
- contributing, with the stakeholders in the field, to the development of content and tools for the dialog between patients and healthcare professionals in the context of an informed decision by the patient,
- conducting participatory research on the side effects of therapeutics in order to improve patients' quality of life,
- boosting a participatory dimension in research and study work.

ENVIRONMENTAL HEALTH

An innovative platform for environmental monitoring

LATAC was inaugurated on September 21, 2023 at IRSN's Le Vésinet site. With this new platform for analyzing environmental samples, the Institute is strengthening its role as a reference in environmental monitoring for the public authorities.

A long-established site for the radiological monitoring of the environment carried out in France for over 60 years, Le Vésinet is now home to a new 600 m^2 facility designed to accommodate the successive operations to be carried out, from taking environmental samples through to their analysis. It deploys cutting-edge techniques of preparation, radiochemistry and metrology to characterize the radionuclides it is looking for as precisely as possible. Mass spectrometry analysis coupled with chromatography makes it possible, for example, to very quickly obtain many measurement results for alpha emitters such as uranium and plutonium from just a single sample.

A multi-role platform

Thanks to this new technical platform with over 45 items of high-tech hardware, IRSN is able to analyze up to 150 samples of all kinds in a single day. This high capacity, compared to that of specialized laboratories in this field, gives it greater responsiveness to requests it will receive, even in an emergency situation.

The new platform also hosts international R&D projects, such as a joint thesis with IRSN's Singaporean partner NUS/SNRSI.

Its technical capacities will also make it possible to continue development of new methods for the detection and measurement of radionuclides, in fields as diverse as understanding the transfer of radioactivity in ecosystems, measuring materials in decommissioning plants, and food analysis.

French Polynesia: low exposure of the population

In December 2023, IRSN published the report on its radiological monitoring of the environment in French Polynesia for the years 2021-2022.

The regular radiological monitoring of French Polynesia involves seven islands, five high islands and two atolls, spread over the five archipelagos of the territory. It was supplemented in 2021–2022 by environmental radiological sampling and measurements on three additional high islands, Moorea (the Society Islands archipelago), Rapa and Raivavae (the Austral Islands archipelago), and on six atolls - Pukarua, Reao, Vahitahi, Vairaatea, Nukutavake-Pinaki and Hikueru - located in the Tuamotu archipelago.

What did the report show?

This new measurement campaign confirmed that the radioactivity levels detectable in the Polynesian environment were in line with those of previous years; the levels were very low.

The Polynesian population's exposure to ionizing radiation was almost exclusively of natural origin. Cosmic radiation and radionuclides of natural origin present in soils and foodstuffs thus contributed to over 99% of the population's exposure, excluding medical exposure.

In 2021–2022, the total effective dose, including external exposure and internal exposure by ingestion and inhalation, was in the order of 1.4 mSv for the adults in French Polynesia. Exposure due to artificial radioactivity represents a very small proportion of this, in the region of 0.1%.

What role does citizen participation play?

IRSN participated in the 7th European Participation Meetings, held in Rouen from 26 to June 28, 2023, on the theme of "Participation at the heart of the challenges of the territories".

Among others, the Institute spoke in a podcast on citizen participation in managing risks. It also led a participatory workshop on citizen measurement with a view to the co-assessment of radiological risks, bringing together some thirty people to whom OpenRadiation sensors were loaned so that they could measure ambient radioactivity.

IN BRIEF

PARTICIPATIVE SCIENCE

The OpenRadiation Community met on February 2, 2023: a day of discussions to discover the experiences of other communities interested in different topics related to the environment (air quality, botanicals, etc.) and to deepen certain topics, such as the installation of OpenRadiation sensors or the measurement of radioactivity by the public.

An open source and open data participatory science project for the measurement of radioactivity in the environment, OpenRadiation is a community of citizens who want to participate in the measurements and contribute to characterizing the environment.

Radioactive waste disposal: the Cigeo appraisal begins

The appraisal of this flagship project began in 2023 and will mobilize IRSN for several years: it concerns the disposal in a deep geological clay layer of high-level and long-lived intermediate-level waste.

On January 16, 2023, IRSN received the Cigeo application for authorization to build (DAC), filed by the French National Agency for the Management of Radioactive Waste (ANDRA).

Located on the border of the Meuse and Haute-Marne, Cigeo is the French geological disposal project for high-level (HLW) and intermediate-level long-lived (ILW-LL) waste.

Its "reference" inventory foresees approximately 83,000 m^3 of radioactive waste, already produced and to be produced until the end of operation of the French nuclear facilities having obtained their authorization to build before 2016. In order to study the impact of French energy policy, ANDRA has included adaptability studies into its disposal project for a so-called "reserve" inventory.

Appointed by the French Nuclear Safety Authority, IRSN will mobilize its teams for the appraisal of this application for two and a half years, the overall process of instruction and public consultations being estimated at around five years. The Institute will make use in particular of the research it has conducted for several years. This research, in particular that conducted in its Tournemire underground laboratory, is aimed at preparing for the appraisal of this project's safety issues.

Strengthened technical dialog

In its process of dialog with society, IRSN, with the Anccli and the CLIS of the Bure laboratory, organized several discussion sessions: preparation day (January 27); launch (April 18); plenary meeting (June 23) on the geology, waste inventories and the pilot industrial phase; specific meetings on the disposal footprint (September 15), waste packages (October 13), co-construction of a scenario (October 20); plenary meeting on the risks and aggressions, recoverability of the packets and the pilot industrial phase (November 15). The technical dialog will continue throughout the scientific and technical assessment of the application.

IN BRIEF

MONITORING GEOLOGICAL DISPOSAL

Under the EURAD European joint program (MODATS project), in 2023, IRSN organized two workshops in Nancy and then in Paris to discuss with civil society the complex problem of monitoring the geological disposal of HLW/ILW-LL waste.

The participants, from 11 European countries, were able to discuss three topics: the relative perception of stakeholders on this subject and its decision-making challenges; the added value for the reliability of a pluralistic interpretation of monitoring data; and society's main expectations concerning monitoring.

Assessing remote monitoring

Funded by BPI France, the PALLAS project brings together IRSN, the Savoie Mont-Blanc University, Gustave Eiffel University, SOCOTEC Monitoring, AUGLANS and NAGA Geophysics, and is aimed at developing a multidisciplinary experimental platform for research related to the remote monitoring of radioactive waste packages. Thus, the Tournemire research laboratory will host full-scale experiments in the workshop as well as *in situ* in a tunnel under conditions representative of waste disposal.

360° VISION

AT THE START OF A DECADE OF MAJOR CHALLENGES FOR SAFETY APPRAISALS

The benefit of an overview of civil and defense nuclear facilities

"Whether evaluating the design of facilities in the planning stage or monitoring their construction, the challenges of extending the operational life of those in service, the decommissioning of those in final shutdown or the management of radioactive waste, the nuclear safety expert profession requires a system-wide view, over the long term. The simultaneous examination of next-generation projects and operation extension projects allows the expert, in particular, to acquire knowledge and skills that will enrich the Institute's positioning on the various files.

At the beginning of the 2000s, the studies carried out into the design of the EPR-type reactors in the planning stage at that time fueled the definition of objectives for extending the operation of reactors in the fleet beyond 40 years. Similarly, ongoing appraisal and research on the design of EPR2 reactors or small modular reactors (SMR) will contribute to progress in various forms. Firstly, with respect to controlling the compliance of reactors in the context of their continued operation beyond 50 or 60 years, through the development of innovative non-destructive control means. Then by defining safety improvements, such as replacing equipment or components with more efficient equipment or components. Similarly, the feedback from operating the facilities currently in operation, including the most recent ones such as the Taishan EPRs, fuels the design choices for new projects.

This cross-functionality also applies between civilian and defense installations, with the examination of the safety standards applied to the nuclear propulsion of certain vessels of the French Navy fueling the studies conducted on SMRs. The safety analyses and recommendations of IRSN's experts thus provide the authorities with the benefit of an overview of civil and defense nuclear installations."

Karine Herviou

Deputy Director General,
in charge of Nuclear Safety

PREPARING FOR SAFETY APPRAISALS OF THE "NEW NUCLEAR"

Against a backdrop of climate disruption and a growing demand for electricity – which RTE estimates must increase from 449 TWh to nearly 630 TWh in France by 2050 – the French government's choice is focused on energy sobriety, energy efficiency, renewable energies and nuclear energy.
In February 2022, the President of the Republic announced France's intention to acquire six new EPR2 type nuclear reactors and expressed its interest in developing new concepts such as small modular reactors (SMR).
What strategy is IRSN implementing to prepare for the examination of the safety files that will be submitted to it as part of the construction of the EPR2 and the development of SMRs? How will its action contribute to the harmonization of nuclear safety approaches and practices at the international level? Responses…

EPRs and SMRs respond to quite different logical criteria. The first are high-power reactors (over 1,600 MWe) intended for generating electricity, which are envisaged as relays for the nuclear fleet in operation. The second are planned multi-purpose low-power reactors (less than 300 MWe), able to generate electricity or heat, or even both, in a combined manner, for example, in order to generate hydrogen.

EFFICIENT SAFETY APPRAISAL FOR THE EPR2 PROGRAM

For the renewal of the nuclear fleet, in May 2021, EDF proposed to start building three pairs of EPR2 reactors to the government. An option for four additional pairs is considered. At the end of June 2023, EDF submitted an application for authorization to build a first pair on the Penly site.

Drawing on the appraisal of the design and construction of the Flamanville (Manche) EPR – for which it is about to analyze the last start-up tests and ramp-up in 2024 – IRSN has defined an appraisal strategy aimed at completing, by the end of 2025, the review of the preliminary EPR2 safety report. This strategy is in line with the continuity of the appraisal of safety options, which the Institute presented to the Permanent Group of Experts for Reactors in 2019, and will be based on the ASN/IRSN guide no. 22 for the design of pressurized water reactors. To optimize resources, the Institute will focus on the main developments of the EPR2 compared to the EPR: transition from a double to a single containment enclosure and from four to three safety trains, better diversification of the cold source and the electrical supply... Then, it will assess the successive safety files produced by EDF following the decree establishing it, through to the authorization for commissioning announced by EDF for 2035/2037. For the different EPR2 pairs planned, particular attention will be paid to the effects of climate change as these can be anticipated over the planned operational life of these reactors, taking into account the planned installation sites.

ANTICIPATING SAFETY ISSUES CONCERNING SMRS

Worldwide, nearly 70 SMR concepts have been announced, based on a large variety of sectors: pressurized water, high-temperature gas, fast-neutron (cooled by sodium, molten salts, gas, lead) reactors, etc. In France, the France 2030 "Innovative Nuclear Reactors" scheme provides support for the development of new reactors and has already announced several winners. For IRSN, such diversity required taking into consideration as early as possible the characteristics specific to the main concepts from a safety perspective. Thus, as from 2015, the Institute produced an initial appraisal report relating to the possible sectors in order to maintain a high level of safety requirements for this type of reactor. In 2024, it is preparing to assess the safety options file submitted by NUWARD (consortium comprising EDF, Technicatome, Naval Group, CEA, Framatome and Tractebel). The NUWARD SMR project comprises two compact pressurized water reactors of 170 MWe each, whose modularity is intended to enable part of the assembly operations to be carried out in the factory. At the same time, IRSN is continuing a cycle of discussions with the designers of other advanced models in order to identify with them, according to the characteristics of their concept, the priority topics to be investigated for safety. Security issues, which are very specific for this type of installation, will be the subject of dedicated appraisal in parallel.

HARMONIZING SAFETY REQUIREMENTS AND THE RESEARCH EFFORT INTERNATIONALLY

Some SMR developers are considering installing them close to industrial areas, or even urban areas, and ultimately building many units. These elements justify the definition of ambitious safety objectives in terms of limiting the consequences of accidents, including those adopted for generation III, EPR-type reactors. In addition, the possibility of operating similar SMRs in different countries wishing to acquire such reactors calls for international harmonization of the safety requirements in force. IRSN has been contributing to the work of the IAEA's Small Modular Reactor Regulators' Forum since 2014. It also participates in the SMR Expert Group within the NEA Nuclear Facilities Safety Committee to identify the need for knowledge related to SMRs and, under the impetus of Jean-Christophe Niel, Chairman of this committee, it has published a roadmap entitled *"Research Recommendations to Support the Safe Deployment of Small Modular Reactors"*. Regarding NUWARD SMR, the Institute participated in the first phase of the Joint Evaluation Review of the concept, alongside the French, Finnish and Czech nuclear safety authorities, and will be involved in the second phase of this evaluation extended to a greater number of countries.

UNDERSTANDING THE IMPLICATIONS OF THE DEVELOPMENT OF SMRS ON THE NUCLEAR FUEL CYCLE

While NUWARD SMR is a pressurized water reactor whose fuel is similar to that of the fleet in operation, the implementation of a fast-neutron or gas-cooled SMR would require the development of a fuel cycle suitable for manufacturing fuel elements and managing the waste produced. These aspects raise many specific questions in terms of nuclear safety and security.

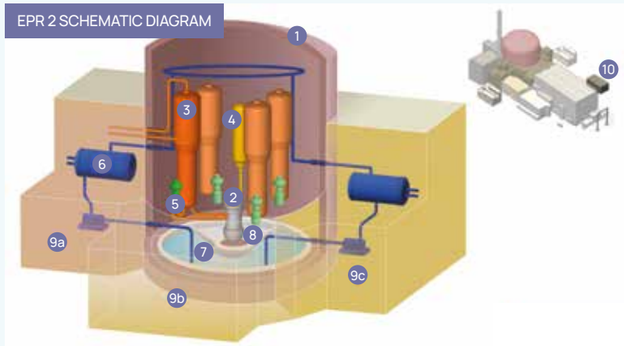
RESEARCH TO UNDERSTAND THE PHENOMENOLOGY OF PASSIVE SAFETY SYSTEMS

Small modular reactors, such as NUWARD SMR, use passive systems to ensure their safety. Research projects with which IRSN is associated aim to verify that the safety functions of these passive systems will be ensured in an accident situation.

- Funded by the ANR[1], the PASTIS project (*PAssive Systems Thermalhydraulic Investigations for Safety*) studies the physical phenomena involved in passive systems dedicated to the removal of residual power from a reactor in an accident situation. The first phase of the project consists in developing an experimental platform in Cadarache (Bouches-du-Rhône), consisting of a loop dedicated to studying the two-phase natural circulation (ALCINA) and a cooled enclosure dedicated to studying convective motions and wall condensation (KoKoMo). During the second phase of the project, the analysis of the experimental results will contribute to the validation of the thermohydraulic models of the CATHARE and ASTEC software.
- Carried out in the framework of EURATOM, the PASTELS (*PAssive systems: Simulating the Thermalhydraulics with Experimental Studies*) project brings together 11 partners from six European Union countries. It includes an experimental component with the performance of tests and the exploitation of existing tests, and a digital component with simulations of these tests with thermohydraulic software.

[1] France 2030 - ANR-22-PAST-0001.

EPR 2 SCHEMATIC DIAGRAM



1. Reinforced concrete shall with steel liner on the inner surface
2. Reactor vessel
3. Steam generator (x4)
4. Pressurizer
5. Pump (x4)
6. Containment heat removal system (x2)
7. Water tank
8. Corium spreading area in the event of core meltdown
9. Independent safeguard buildings (9a, 9b, 9c)
10. Diversified heat sink for the cooling of the safety systems credited in the event of a major accident

INCREASING
THE SAFETY OF THE NUCLEAR POWER STATIONS IN OPERATION

While the appraisal of the "hard core" type provisions, intended to strengthen the robustness of nuclear reactors against extreme hazards following the accident at the Fukushima-Daiichi power plant and those associated with the "Grand Carénage" carried out by EDF, is still ongoing, IRSN is preparing for the new challenges, with regard to safety, of extending the operating time of the French nuclear power plant fleet: a more efficient fleet, operated for longer and more resilient to climate hazards.

RESPONDING TO NEW SAFETY CHALLENGES

The 5th periodic safety review of the 900 MWe reactors (RP5-900), which will be launched shortly after the completion of the 4th review (RP4-900), will address quite different challenges. Inclusion of the feedback from the Fukushima-Daiichi accident, and the safety objectives defined by the ASN for the operation of reactors beyond 40 years, had led to the resumption of a large number of studies, numerous modifications and major changes to the general rules of operation.

With regard to RP5-900, the main challenges are to stabilize the safety rule set of the reactors concerned and to focus on operational safety, seeking simplifications if possible; then to ensure that the facilities comply with this rule set; and finally to take into account climate change and its consequences in the long term on the damage that the facilities may be subjected to.

USING OPERATIONAL FEEDBACK TO ASSESS THE EXPECTED GAINS IN SAFETY FROM THE INSTITUTE'S RECOMMENDATIONS

EDF is preparing major developments that will have an impact on IRSN's future appraisal activities. Thus, EDF wants to deploy multi-annual programs on its sites to verify that equipment complies with their safety rule set, supplementing current operating practices, and field visits, in addition to the investigation programs already planned in the framework of periodic reviews.

In order to increase the availability of its reactor fleet in service, the operator is also considering a new MOX fuel management with increased operating times between shutdowns. The Institute will analyze the safety demonstration studies rerun by EDF to take into account this new fuel management.

In the longer term, EDF is considering a simplification of the general operating rules, by which it intends to facilitate the work of operators and limit the duration of certain shutdowns that it considers to be linked in particular to the complexity of the current safety rule set. In this area, IRSN and ASN have initiated a preliminary dialog with EDF aimed, in the first instance, at identifying the issues raised and defining a strategy.

ANALYZING THE OTHER PERFORMANCE LEVERS OF THE REACTOR FLEET IN SERVICE

EDF is considering other performance levers for the fleet, such as increasing the electrical power of certain reactors, including through an increase in the nuclear power capacity. This would have an impact on the margins of the safety studies, which must be anticipated sufficiently in advance.

In order to restore margins with respect to safety criteria, material changes are envisaged. For example, with the introduction of new more accident-tolerant fuels (ATF), it would be possible to limit the phenomena of oxidation and deformation of the claddings in the event of a cooling loss accident and to ensure better retention of the fission products. The results of future test campaigns and the data from the research programs conducted will enable IRSN to develop and validate specific models for simulating the behavior of these future fuels.

Another lever is a less conservative simulation of physical phenomena occurring during incident or accident situations studied, which requires increased efforts for validating the software used. In this respect, IRSN will examine the results of the experiments carried out, for example, in the framework of the CEA's METERO project (experimental platform allowing the study of complex and varied flows), to simulate these phenomena, compare them with those of the CATHARE software and ensure that all physical phenomena have been taken into account.

ANTICIPATING THE AGING OF THE FLEET IN THE CONTEXT OF THE EXTENSION OF ITS OPERATING TIME

With a view to extending the operating time of the reactors beyond 60 years, IRSN has participated in defining, with ASN and EDF, the outline of a feasibility file that the operator must establish in 2024 and 2025. The Institute will assess this file starting in 2025 in order to present its conclusions to the ASN's Permanent Groups of Security Experts in 2026. The aging of equipment and facilities will be central to this appraisal, with a particular challenge: assessing the ability of the non-replaceable equipment to ensure, for a period much longer provided for in the design, the safety functions assigned to it. This concerns three main types of equipment:

- the reactor vessel, forming part of the second containment barrier, where the mechanical properties of the steel change under the effect of neutron radiation, and it is necessary to ensure that its properties remain sufficient in the event of an accident;
- the reactor enclosure, the last containment barrier, for which IRSN will examine, in particular, the change in the preload state and the aging of the concrete it is made of (the IRSN's ODOBA and MACUMBA research programs will provide knowledge on these issues);
- the electric cables, for which IRSN plans to launch research actions as from 2024, focusing in particular on cables with major safety implications, in order to ensure their functionality beyond 60 years.

TAKING INTO ACCOUNT THE IMPACT OF CLIMATE CHANGE ON THE FLEET

To determine climate hazards, EDF relies on a watch, reviewed every five years, which aims to anticipate the consequences of climate changes on compliance with safety objectives and must lead to in-depth analyses in the event of a "major climate event". This process and its results are assessed by IRSN, which has its own calculation capabilities based on statistics of the extremes.

As part of the appraisal concerning the extension to the service life of existing reactors beyond 60 years, it is planned that EDF will produce a document at the end of 2024 presenting "an inventory of the provisions for adapting to climate change on an international level, and innovative solutions resulting from R&D work". For its part, IRSN has undertaken, together with Météo France and the Pierre-Simon Laplace Institute, research through two doctoral theses to assess long-term changes in weather-related hazards.

CONTINUING
TO IMPROVE FUEL CYCLE SAFETY

The processing of spent fuels, recycling, storage, etc. The fuel cycle is confronted with major industrial policy challenges associated with nuclear safety issues, which will result in an increasing volume of appraisal activities for IRSN in the coming years.

TAKING INTO ACCOUNT THE OPERATING DIFFICULTIES OF THE MELOX PLANT

Operated by ORANO in the municipality of Chusclan (Gard), the Melox plant produces fuel assemblies based on uranium-plutonium mixed oxide (MOX). The manufacturing difficulties experienced by the facility from 2018 onwards have generated increasing volumes of rejects sent to the plants in La Hague (Manche). In 2022 and 2023, IRSN published expert opinions on the safety files transmitted by ORANO for the creation of new storage capacities to accommodate them. In addition, ORANO has undertaken projects to modify this plant for which IRSN will have to carry out appraisals.

DEALING WITH THE STORAGE CHALLENGES IN THE LA HAGUE PLANTS

In addition to these rejects, there is a problem in La Hague with the storage of plutonium from the processing of spent fuels, whose evacuation to the Melox plant is delayed. Another challenge is the storage of spent fuel assemblies in the pools in La Hague. ORANO has submitted an authorization application file, which IRSN will examine in 2024, for the densification of fuel pool storage, pending the commissioning by EDF, after 2030, of a new spent fuel storage pool on the La Hague site. At the same time, ORANO is exploring the dry storage of spent fuels in Eagle TN-type packaging.

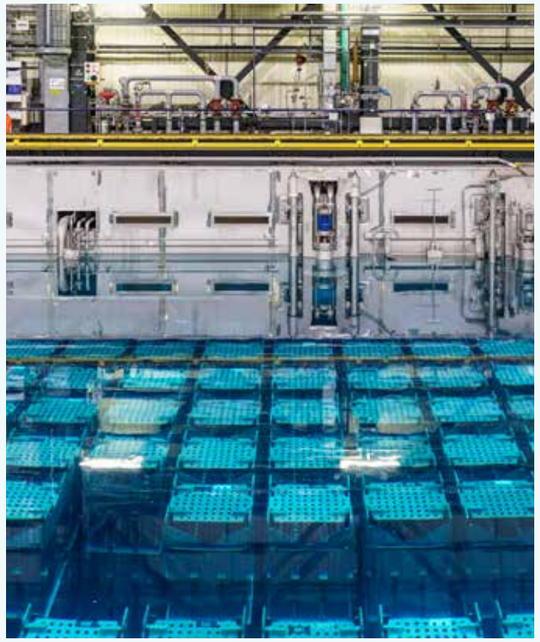
Finally, the storage at La Hague of high-level or long-lived intermediate-level waste, in the form of glass or compacted, pending the entry into service of permanent disposal, has led ORANO to create additional storage capacities on the La Hague site.

CONTROLLING THE AGING OF FACILITIES OF THE CYCLE

IRSN will report its conclusions on the 2nd safety review of the Melox plant in 2024. In addition to production difficulties resulting in particular from a change in uranium supply, IRSN examines the problems of maintaining a facility in service for almost 30 years and the increase in collective dosimetry linked to these operations.

In La Hague, whether UP3 (INB no. 116) or UP2-800 (INB no. 117), the main challenges are those of reassessing the behavior of structures and equipment in service for more than 30 years in the face of natural hazards (earthquakes, snow, wind, tornadoes, etc.) and analyzing aging phenomena that influence the service life of key equipment such as the dissolver in the shearing-dissolution workshop or the evaporators in the fission product concentration workshop.

In addition, the challenge is to anticipate, for the post-2040 period (the current multi-year energy program retaining the choice of spent fuel processing until at least this deadline), an industrial solution – satisfactory from a safety point of view – either for the processing, or ultimately for the final disposal of spent fuel assemblies.



APPRAISAL OF THE NEW TRANSPORT AND STORAGE PACKAGING

New models are being developed for transport packaging, which is essential for the fuel cycle operation. This is the case for the new TNG3 and TN112 packaging, developed by ORANO NPS for spent fuels, or the Eagle TN for their transport and dry storage. Their appraisal by IRSN has highlighted certain safety improvements.

ANTICIPATING
THE DECOMMISSIONING OF NUCLEAR FACILITIES AND THE MANAGEMENT OF RADIOACTIVE WASTE

Spread over decades, the decommissioning of nuclear facilities and the management of the resulting waste pose, par excellence, safety issues linked to the long-term management, among other things in terms of monitoring the facilities concerned and resistance to both aging and hazards, in particular climatic hazards.

ABSORBING A LARGE NUMBER OF DECOMMISSIONING FILES

With a view to examining the safety files that will be submitted to it, IRSN develops its own studies, for example for the characterization of climatic hazards and the analysis of the aging of materials such as elastomers. The Institute has already conducted a reflection on the decommissioning strategies of the major operators (EDF, CEA, ORANO), in particular examining the necessary conditions to successfully complete all decommissioning projects, taking into account their specific features (radiological inventory, location, type of waste that will be generated, etc.). In fact, in the coming years, this will involve assessing files relating to the decommissioning of a variety of reactors (UNGG in Chinon, Saint-Laurent-des-Eaux and Bugey, PWR in Fessenheim, etc.) and nuclear fuel cycle facilities (former fuel processing facilities in La Hague, etc.).

CAPITALIZING ON FEEDBACK

The decommissioning operations underway at Chooz and the preparatory operations for the Fessenheim decommissioning provide, in particular thanks to the standardization of reactors for each power level, feedback that enables a certain degree of confidence in the possibility of decommissioning the nuclear fleet under satisfactory conditions. However, since parameters such as the availability of storage facilities for the waste generated may constrain the progress of decommissioning operations, IRSN is paying particular attention, as part of its appraisal of the CEA, EDF and ORANO strategies, to the chaining of the different decommissioning projects and the associated waste management.

ENSURING SAFE WASTE MANAGEMENT

The decommissioning of nuclear facilities and the evolution of the reactor fleet, in particular the spent fuel reprocessing strategy, will change the nature and volumes of waste to be handled, leading IRSN to prepare for the acquisition of new knowledge in view of the appraisal of future safety dossiers. The development of new reactor sectors such as SMRs has therefore stimulated reflections led by IRSN, for example, as part of the European Joint Program for the Management of Radioactive Waste (EURAD) or the international SITEX Network.

In addition, the decommissioning of nuclear facilities will generate large volumes of long-lived intermediate-level waste, requiring dedicated facilities such as ICEDA pending the entry into service of CIGEO. The same situation applies to very low-level waste, for which the imminent saturation of the current disposal capacity requires the development of new management options. Lastly, the same applies to the graphite waste (long-lived low-level) resulting from the decommissioning of UNGG-type reactors, for which the management sector is currently being defined, or bituminous waste which requires additional research relating to the safety of their management.

PROVIDING SUPPORT FOR THE COMMISSIONING OF CIGEO

The creation of the CIGEO geological disposal facility, if decided, will require safety appraisal support, in particular during its pilot phase with a limited inventory aimed at qualifying some of its components and the methods adapted to its industrial operation, then during the ramp-up of the facility. It should be noted that the evolution of the French nuclear power plant fleet, with the planned commissioning of six new EPRs, raises the issue of the capacities required to accommodate the additional volumes of waste generated, in terms of operational safety and after closure of disposal.

Monitoring the aging of dry packages is also a safety issue for which IRSN has launched, in its Tournemire underground research laboratory, a research program called PALLAS, in addition to those already in progress in this laboratory.

IMPLEMENTING
INNOVATIVE APPROACHES AND TOOLS

Faced with the increasing complexity of appraisal issues and new digital capabilities linked to the evolution of cognitive technologies, IRSN is innovating to meet the future challenges of nuclear safety appraisal.

BETTER TARGETING ITEMS OF CONCERN AND CLARIFYING TECHNICAL POSITIONS

The Institute's initiatives encompass various areas – from expert systems to tools incorporating artificial intelligence – in order to develop a set of information processing or digital modeling methods capable of facilitating the identification of items of concern in terms of safety or radiation protection and providing support for technical positions.

LEVERAGING THE DATA CAPITAL AVAILABLE TO IRSN

In order to coordinate these initiatives, the *Enhanced Appraisal* program has been put in place, with an organizational structure based on agile governance, integration of IRSN's rule sets and giving priority to the design of tools to assist appraisal and to the development of knowledge that can be mobilized thanks to the intersection of the data available to the Institute.

PROSPECTIVE REFLECTIONS TO PREPARE FOR METHODOLOGICAL AND TECHNOLOGICAL DEVELOPMENTS

The functional objectives of the *Enhanced Appraisal* program aim to facilitate the expression of needs, pool resources and strengthen knowledge and skills on these new technologies. In addition, current issues concern the impact of artificial intelligence on nuclear risk management, on the explainability and trust in the models and, more generally, on the sharing of data in the context of appraisals. These prospective reflections are carried out in collaboration with ASN – in particular on a project to develop a nuclear safety data hub – with operators (EDF, CEA, etc.) and, internationally, with German and American partners of the Institute, GRS and the US NRC. The aim is to prepare for methodological and technological developments that may have an impact on safety and, by extension, on its appraisal and on the expert's own profession.

NEW WAYS OF INTERACTING WITH SOCIETY

In an innovation laboratory approach to citizen participation in nuclear safety and radiation protection, IRSN is developing new ways of opening up to society:

- *partnership-based opening,* in the form of future workshops with Anccli and the CLIs;
- *territorial opening,* by being as close as possible to the publics concerned by nuclear and radiological risks, for constructing with them an assessment of these risks in their territory;
- *openness to new dialog tools,* such as serious games, which enable participatory science to be built on topics such as post-accident or waste management;
- *openness to new publics,* such as young people (primary school to young working people), by analyzing their perception of risks and adapting to them so as to arouse their interest and involvement.

With this in mind, IRSN is working on creating a metric to assess the impact of its actions, which it will share in 2024 with its counterparts that are signatories of the openness to society charter. It is also the winner of the ANR's *Science with and for society* call for projects, which will enable it to conduct participatory research actions in the Dunkirk area in partnership with the *Université du Littoral Côte d'Opale.*

[5] CRISIS AND POST-ACCIDENT Mobilizing teams and expanding capacities for action

Main highlights of 2023

"The year was firstly marked by our continued monitoring of the situation in Ukraine, which led us to regularly reassess the risks. Discussions during the year with ASN, CEA and ORANO also made it possible to significantly improve the transmission of technical data to the Crisis Technical Center in the event of an accident, in particular by the operational implementation of the automated transmission of measurements to the chimneys of the facilities in real time, which represents a major advance.

The scaling up of our mobile cell also continued in 2023. The full-scale national exercise carried out in Saint-Laurent-des-Eaux (Loir-et-Cher) allowed us to test the deployment of all of our field measurement equipment, especially aerial equipment.

Also in the area of measurements, the construction of our crisis organization has continued with the definition of the procedures for the involvement of our fixed laboratories in the field of health and, in the area of the environment, by the commissioning of the LATAC (laboratory for the processing and analysis of environmental samples in post-accident situations)."

Philippe Dubiau

Assistant Director
for Emergency Response

IN BRIEF

FIRST TRAINING EXERCISE WITH EDF ON THE FLAMANVILLE EPR

On October 10, 2023, IRSN's ERC took part, with EDF's teams, in a first exercise simulating an accident situation at the new EPR at Flamanville (Manche). The scenario simulated a primary coolant loss accident leading to a reactor core meltdown. In the ERC, this exercise allowed the members of the "Facility Assessment" unit (one of the ERC units) to become familiar with the calculation tools and documentation made available to emergency team members; they were able to properly assess the events in the scenario. The result: a positive report for this stage in IRSN's preparation for the start-up of the EPR.

EXERCISES

First full deployment of the mobile cell in Saint-Laurent-des-Eaux

The crisis exercise carried out on May 23, 2023, around the Saint-Laurent-des-Eaux power plant in Loir-et-Cher was an important milestone for IRSN. For the first time, all the resources of IRSN's mobile cell were deployed.

During this full-scale exercise, a team consisting of some fifty IRSN experts and all their radioactivity measurement equipment deployable in the field (17 mobile beacons; 2 mobile on-board measurement devices, including one in a helicopter and one in a vehicle; 3 mobile laboratories; 1 transmission vehicle; etc.) joined the fifty firefighters already present and the CEA and EDF teams. The scenario imagined an accident at the Saint-Laurent-des-Eaux power plant. At noon, given the development of the situation, the Prefect of Loir-et-Cher triggered the Emergency Response Plan and decided to evacuate the populations within a radius of five kilometers around the power plant.

Detectors on a helicopter

Together with the head of rescue operations, the IRSN teams coordinated the measurements aimed at acquiring detailed knowledge of radioactivity levels in the different environments impacted by the radioactive discharges. The strategy of measurements after release making it possible to confirm IRSN's Emergency Response Center (ERC) assessments was tested in a realistic way: the mapping of soil contamination, using detectors installed on a helicopter and in a vehicle, was carried out under real conditions. These helped to identify in less than one day the contaminated area in which populations could not live permanently.

This exercise, which was very instructive, will enable IRSN to further improve its measurement resources and strategies and their deployment. This will provide the Prefect with information to make the most appropriate decisions for protecting the populations.

ORGANIZATION

Emergency management: participating in the review of the national plan

In 2023, continuing the work carried out in 2022, IRSN contributed to the review of the French National Plan for Response to a Major Nuclear or Radiological Accident, which was created in 2014.

Initiated in 2022 by the General Secretariat for Defense and National Security (SGDSN), the update of this plan progressed significantly during 2023. The general objective, 10 years after its first version, was to incorporate more fully the feedback from the Fukushima-Daiichi accident, and the work carried out at the national level on the doctrines, in particular on the post-accident. IRSN participated in the various working groups (communications, radiological measurements, manufactured goods, waste, transport, radiological zoning, etc.) set up in 2023 and whose objective was to update the plan's action sheets. Based on its scientific and technical knowledge, the Institute contributed to the preparation of around fifteen sheets. This new version of the French National Plan for Response to a Major Nuclear or Radiological Accident will be finalized in early 2024.

IN BRIEF

A REINFORCED ON-CALL SERVICE

For the 2023 Rugby World Cup, which took place in France, IRSN, as an expert in nuclear and radiological risks, reinforced its on-call system with 25 additional posts (ERC health unit, fixed laboratories for health and environment measurements). Thus, throughout this major sporting event, from September 8 to October 28, a total of 300 emergency team members were mobilized to ensure that each week a team of 60 people were ready to intervene. A similar system is planned for the Paris 2024 Olympic and Paralympic Games.

ACTIVE MONITORING

Ukraine: maintaining a continuous watch

IRSN mobilized its emergency organization the day after Russia's invasion of Ukraine, which was on February 24, 2022. Since then, the Institute has continuously monitored the situation.

Since the start of the Russian war of aggression against Ukraine, IRSN has provided scientific advice and operational assistance to the French public authorities and international bodies. As in 2022, it responded to direct questions and requests from ministries concerning the radiological risk, and regularly exchanged information with its Ukrainian counterpart or the IAEA.

Thus, in 2023, IRSN reassessed on several occasions, given the time that had passed since the reactors were shutdown and the potential consequences of a core meltdown accident, which remains possible in the event of a loss of all cooling means.

Furthermore, following the damage to the Kakhovka dam, located downstream from Ukraine's Zaporizhzhya nuclear power plant, on June 6, 2023, IRSN assessed the risks of a loss of the site's water resources and now regularly monitors their evolution.

IRSN teams also regularly monitor radioactivity levels on a daily basis, especially in Ukraine and neighboring countries.

A summary also incorporating information from international bodies and a summary of news in the media is maintained internally every week for the benefit of all emergency teams.

POST-ACCIDENT

OPAL 2.0: a tool in the service of the territories

OPAL, the Post-accident Awareness Tool for local stakeholders, has evolved in 2023 with a new, richer and more ergonomic version, which was tested during a co-construction workshop.

The result of the collaboration between IRSN and Anccli since 2010, OPAL is intended for CLIs and elected representatives. This tool makes it possible to map the consequences of medium-sized accident scenarios in the post-accident phase, in order to anticipate and prepare in advance for the long-term management of an accident.

On July 4, 2023, a participatory workshop was organized by the IRSN Lab, at Fontenay-aux-Roses (Hauts-de-Seine), with members of CLI and Anccli to test the new version of OPAL (updated post-accident zoning, research tools, more fluid ergonomics, etc.) and take note of their requirements. Following this workshop, around twenty new user needs were identified and are being integrated.

On September 14, 2023, an awareness-raising day on post-accident situations took place in Gravelines (North), at the initiative of the Gravelines CLI and Anccli. Some fifty people were present, including many entrepreneurs from Dunkirk. IRSN presented the new version of OPAL, which was used to produce support maps for reflection by the participants. The new version of OPAL, or "OPAL 2.0", will go into production in 2024.

A "post-accident" workshop with students

On May 9, 2023, the SPOS team visited the University of Technology in Compiègne (Oise) to test a participatory workshop dedicated to post-accident with students of all levels. A serious game invited them to discuss the different possible alternatives to deal with a post-accident situation in a territory. This workshop is part of the Demeterres Mousse research project coordinated by the CEA, part of which is aimed at developing a decision-making tool for the post-accident management of a territory.

[6] INTERNATIONAL Diversifying and enriching partnerships to advance nuclear safety and radiation protection

New European and international opportunities for IRSN

"2023 was marked by the increase, worldwide, in the interest expressed by many countries in nuclear power and by particular attention to SMR technology.

IRSN has supported this momentum, ensuring, from a scientific and technical point of view, that the related nuclear safety issues are taken into account. We have therefore been able to strengthen our position as a "European expert in radiological risk". The events organized in 2023 at Maison Irène and Frédéric Joliot-Curie in Brussels strengthened our relations with the European Commission and all our European partners. The appointment, last June, of IRSN's Director General, Jean-Christophe Niel, as Chair of ETSON, the European network of TSOs, underlines France's leadership in nuclear safety.

Furthermore, with our leading involvement in the PIANOFORTE project, we contribute, together with our partners, to the definition of the European research strategy in radiation protection.

Lastly, at the international level, the Institute has continued its cooperation with the IAEA, particularly in the context of the war in Ukraine and the risks it poses to Ukraine's nuclear facilities, and has strengthened it in the field of health and the fight against cancer ("Rays of Hope" program)."

Cyril Pinel
European and International Affairs Director

International agreements

IRSN provides technical support to six nuclear safety organizations.

In the fields of nuclear safety and radiation protection, in 2023, IRSN responded to four tenders for Southeast Asia (ASEAN), Turkey, Bulgaria and Ukraine, and won the last two. The six-month contract with the Bulgarian safety authority concerns safety studies of VVER reactors. As for Ukraine, this is a continuation of the previous ones, financed by the European Commission. Indeed, IRSN has been working with Ukraine for a decade now. Additionally, IRSN was already involved this year in four multi-year contracts to provide appraisal services for the Nuclear Safety Clearinghouse (managed by the European Commission's Joint Research Center), Iraq, Norway and the Netherlands. These appraisal contracts illustrate IRSN's scientific and technical excellence, as well as its commitment and international reach. Furthermore, as in each year, in 2023, IRSN also investigated the sales files of licenses for calculation codes developed by IRSN, in particular the ASTEC code. This code can be used to simulate all phenomena involved in a core meltdown accident of a water-cooled reactor.

10 EMPLOYEES
within the Business Unit for International Business Development.

11 RESPONSES
to international tenders since January 2021, with a success rate of 50%.

Jean-René Jourdain

Assistant Director for International Business Development.

"The Business Unit for International Business Development contributes to IRSN's international reach by exporting the French approach and expertise in respect of nuclear safety and radiation protection. This unit's activities also contribute, through international contracts, to maintaining rare skills within the Institute (for example, knowledge of the VVER reactors widely used worldwide) and to acquiring new skills. They also participate in the training of the Institute's young experts."

IRSN takes part in the IAEA General Conference

In September 25 – 28, 2023, IRSN's Director General, Jean-Christophe Niel, led the Institute's delegation attending the 67th General Conference of the International Atomic Energy Agency (IAEA), in Vienna, Austria.

The risks to nuclear safety caused by the war in Ukraine were key areas of concern, as was the growing interest of many countries in nuclear energy. Jean-Christophe Niel met with IAEA's Director General, Rafael Mariano Grossi, to discuss the Institute's cooperation with the Agency's emergency center (IEC), and the Institute's contribution to the *Rays of Hope* program to fight against cancer. IRSN will also receive IAEA accreditation in 2024 for its training offer in this area.

In addition, Jean-Christophe Niel held face-to-face meetings with the leaders of the Institute's main foreign partners and, as Chair of ETSON, with the European Commission, WENRA and Lydie Evrard, IAEA Deputy Director General in charge of Nuclear Safety and Security. At the INSAG forum organized alongside the Conference, he spoke on the theme of *Resilience to strengthen safety* and IRSN experts participated in other parallel events dedicated, among others, to the crisis or SMRs.

United Arab Emirates: Renewed cooperation

At the IAEA General Conference in September 2023, the Emirates Safety Authority (FANR) and IRSN renewed their framework cooperation agreement. On this occasion, they were able to share the success of the MORAD project, an atmospheric radionuclide dispersion study program. This program, which also involves the Khalifa University, started in 2018 in the framework of the progressive commissioning of the Barakah nuclear power plant. The last workshop of this collaboration took place on October 9 and 10, 2023 in Abu Dhabi, where the prospect of a new collaboration program was discussed.

ETSON Conference

On October 11 – 12, 2023, Jean-Christophe Niel participated in the second ETSON conference[1], organized in Brussels by BEL V, the Belgian counterpart of IRSN. The occasion for the forty participants from the 15 members of the European network to discuss the main issues, in a specific context for stakeholders in the safety area. IRSN presented its actions related to openness to society, corium stability, and the various projects underway in ETSON's technical groups.

[1] Entitled "TSO Challenges in a Rapidly Evolving Environment".

IN BRIEF

STATE-OF-THE-ART TRAINING

The IAEA regularly calls on IRSN experts to provide state-of-the-art training in the area of the medical and health management of radiological and nuclear emergencies. Last example dated May 2023 at the Barakah nuclear power plant, United Arab Emirates. The training, which included doctors, nurses and physicists, focuses among others on examples of radiation accidents and practical exercises on decontamination procedures.

MEMORANDUM OF UNDERSTANDING SIGNED WITH UKRAINE

In September 11 – 14, 2023, IRSN received the visit of Ihor Shevchenko, Director of Ukraine's State Scientific and Technical Center for Nuclear and Radiological Safety (SSTC NRS). The occasion for Jean-Christophe Niel to sign a memorandum of understanding with him, strengthening cooperation in many areas (emergency situations, ASTEC code, etc.), while the aggression facing Ukraine continues to threaten the safety of its nuclear facilities.

IRSN'S EXPERTISE RECOGNIZED AGAIN BY INTERNATIONAL BODIES

2023 was marked by the international recognition of the quality of France's expertise. The appointment of Jean-Christophe Niel as member of the International Nuclear Safety Advisory Group (INSAG) was renewed on March 24 by the IAEA through to 2026. He was also elected Chair of ETSON, the European Technical Safety Organization Network, on June 14. At the same time, on August 24 the appointment of Louis-Michel Guillaume, Deputy Director General, as member of the IAEA Advisory Group on Nuclear Security, AdSec, was renewed for three years.

IRSN CERTIFIED BY THE POLISH NUCLEAR SAFETY AUTHORITY

On July 11, 2023, Strategy Director visited Warsaw for the official signature of the Institute's certification by the Polish Nuclear Safety Authority (PAA). Sign of a strengthened partnership, this referencing offers IRSN the opportunity to be consulted by the PAA as technical and scientific support in order to assess the safety of future nuclear installations in Poland.

IN BRIEF

SPOTLIGHTING IRSN RESEARCH IN BRUSSELS

As a permanent member of Maison Irène and Frédéric Joliot-Curie, a link between French research and European institutions, IRSN organized several events there in 2023: a meeting on September 13 on the safety of SMRs, highlighting the PASTIS facility, and an event on December 8 on the ASTEC project's contribution to the European Commission's goals in the field of nuclear safety[1].

[1] See also "Fighting cancer: towards better use of ionizing radiation", Chapter 1.

Maintaining continued collaboration with Japan

2023 was marked by two major meetings between IRSN and Japan. The safety of fuel cycle facilities and the Fukushima-Daiichi nuclear site were among the major topics that were discussed.

As part of the French-Japanese cooperation, a remote seminar was organized on 24 and January 25, 2023, so that the IRSN Nuclear Safety division could exchange ideas with its Japanese counterpart (NRA) and the Japanese Atomic Energy Agency (JAEA). The main objective was to discuss the safety of fuel cycle facilities. In total, thirty employees shared the latest information on the facilities in each of the two countries, the difficulties encountered, the ongoing appraisal and the progress of their R&D programs in support of the assessment of discharges.

Common issues

A few months later, on June 26 – 27, IRSN received a Japanese delegation composed of members of the NRA and representatives from the Nagaoka University of Technology (NUT). They discussed possible collaborations regarding the analysis of the explosion that occurred in reactor no. 3 of the Fukushima-Daiichi power plant. Among others, the performance of combustion tests in addition to those implemented by the NRA with the NUT was addressed. They may be carried out by the CNRS ICARE laboratory in Orléans. Thus, by their diversity all the discussions between IRSN and its Japanese counterparts illustrate the consistency of their cooperation in all the Institute's fields of expertise.

IN BRIEF

THE RENCONTRES INTERNATIONALES FOR HIGH SCHOOL STUDENTS ON RADIATION PROTECTION

The 2023 Rencontres took place on May 23 – 24 at CEA Marcoule (Gard). 93 high school students and their teachers from France, Japan and Moldova presented their work and scientific workshops on radiation protection. A great opportunity to demonstrate their involvement and share their research, co-constructed, on a voluntary basis, during the year with their teachers and experts, in particular from IRSN, for example, on the effect of irradiation on cells.

WELCOMING A DELEGATION FROM THE EUROPEAN COMMISSION'S JOINT RESEARCH CENTER

Following an invitation extended by IRSN in November 2022, a delegation from the European Commission's Joint Research Center (JRC), led by its Deputy Director General, Bernard Magenhann, and its Safety and Security Director, Ulla Engelmann, visited Cadarache (Bouches-du-Rhône) on October 16, 2023. The program included visiting the security research platforms and a presentation of IRSN's activities and projects in the field, with a particular focus on the ASTEC code and the PASTIS project.

[7] FUNCTIONAL DEPARTMENTS Overseeing performance and being useful to society

IRSN's transformation continues

"Although 2023 was not run of the mill, mainly marked by the proposed merger of IRSN and ASN, and by an increase in staff turnover, the results remain positive. Firstly, in the area of using and sharing knowledge, digital learning has expanded and the School of Management was launched in September. We have also initiated a partnership with the University of Nuclear Professions for 2024. The communities of practice have continued to develop and are truly successful! Next, we built and published our responsible digital roadmap for the next 5 years. And a number of flagship projects of our digital transformation have been completed: data conservation, redesign of the SISERI application, new website, etc. Furthermore, the HR department has been reorganized around three major issues: employment and attractiveness, with the professionalization of the recruitment process in a tight labor market; GPEC (with the implementation of a new job reference framework); and QLWC (with the renegotiation of the teleworking agreement and the implementation of the initiative to prevent psychosocial risks). As for CSR, it represents one of the major subject areas in the transformation of the public institution, thus of IRSN, where it is present at all levels. Lastly, IRSN Lab provided support for and accelerated many projects this year: it is definitively anchored in the Institute's culture."

Michel Enault

Transformation Director

COMMUNICATION, INFORMATION AND EDUCATION

Digital communications: major web-based developments

A complete redesign of the website www.irsn.fr

Launched on March 16, 2023, this new content-enriched version offers a more modern design, more intuitive navigation and responsive compatibility for optimal viewing on computers, tablets and smartphones. The homepage highlights, in texts and videos, recent content and the Institute's "Major Issues". Themed sections provide access by theme (environment, health, safety, etc.) to the extensive available content. A new section, dedicated to research, allows users to find out about the Institute's laboratories, projects and facilities. The site maintains its knowledge base, rich in educational content, infographics, podcasts and videos to foster public understanding.
The English version en.irsn.fr was subsequently published.

Repères, a magazine now 100% digital, available on reperes.irsn.fr

The mission of IRSN's magazine, *Repères*, is to provide professionals and the general public with keys to understanding nuclear safety and security, radiation protection, with an educational approach to risk prevention. The magazine deciphers the news related to these issues and reports on the Institute's actions in these areas.

As reading habits change, *Repères* became a 100% digital medium in November 2023, also developed in responsive design. While offering a new reading experience, the magazine's spirit remains the same, focusing on an educational approach to the issues.

www.irsn.fr
https://reperes.irsn.fr/

IN BRIEF

MEASURING RADIOACTIVITY: A NEW SERIES OF EDUCATIONAL VIDEOS

What is the difference between Gray, Sievert and Becquerel? How does IRSN measure radioactivity in the environment and in humans? Every day, the public asks IRSN questions about the measurement of radioactivity. To answer them, as part of its mission to inform, the Institute has published nine educational videos with researchers and experts talking about their scientific and technical fields.

YouTube @IRSNvideo

Meeting the general public

One of the Institute's missions is to inform and raise awareness in the general public to issues related to nuclear and radiological risks. Focus on the main actions carried out in 2023.

In October 6 – 16, the Institute mobilized again for the Science Festival. Experts from the IRSN Radiation Protection Study and Appraisal Department took part in the L'Esprit Sorcier's program, "Science en direct", on the theme of diagnostic examinations involving radioactivity. In addition, the Institute opened its Le Vésinet (Yvelines) site again this year. About 700 people came to meet IRSN experts and find out about their activities. IRSN took part in numerous events throughout the country: "Dans les bras du Rhône" festival, with a visit to the Arles radiological environmental monitoring station; Science in the classes, workshops in the Science Villages in Nantes (Loire Atlantique), Cherbourg (Manche) and Manosque (Hautes-Alpes).

New this year: on the 60th anniversary of the Cherbourg Radioecology Laboratory, IRSN welcomed the public on June 24 for a discovery day in the center of the city.

DECLICS

IRSN took part for the first time in *Dialogs between researchers and high school students to interest them in building knowledge* (DECLICS). Seven IRSN scientists met with high school students from Clamart (Hauts-de-Seine) on December 14 in a speed meeting.

Gaining impact

In 2023, IRSN continued its partnership with magazine Pour la science and launched a new one with the "Science en questions" program on the L'Esprit Sorcier TV channel. Explanations.

Since 2020, IRSN has collaborated with the general magazine Pour la science, which has a print run of 55,000 in order to reach another type of readership and broaden the Institute's target audience. Four topics were covered in 2023: "How to reduce the risk of marine submersion of nuclear power plants", "Understanding and preventing a reactor core meltdown", "Better estimating exposure to radiation for flight personnel" and "Reducing the risk of a hydrogen explosion during a nuclear accident". Each time, these three-page articles highlighted the Institute's research work. This positive partnership will continue in 2024.

L'Esprit sorcier TV

And for the first time, IRSN was a partner of the "Science en questions" program broadcast at 7 pm on Wednesdays on the L'Esprit Sorcier TV channel. This family channel was officially launched in December 2022. The Institute thus participated in the first three broadcasts of about 50 minutes, with two of its experts in each of them: "Nuclear, how to avoid disaster?", "We bathe in radioactivity" and "The effects of radiotherapy". Also available on YouTube, these shows have between 2,800 and 5,600 views.

Watch the "Science en questions" programs on the L'Esprit Sorcier TV YouTube channel (in French only).

YouTube

IRSN's active participation in OPECST's 40th anniversary

For its 40th anniversary, OPECST organized several events in the National Assembly and Senate to illustrate the link between science and politics. On July 7 – 13, 2023, an exhibition brought together, alongside IRSN, a dozen scientific bodies. This event was an opportunity for the Institute to (re-)present the diversity of its activities, in an educational, interactive way, to parliamentarians and citizens, who could exchange ideas with the thirty employees present on the stand.

IN BRIEF

ALL RESILIENT TO RISK

The national *"Tous résilients face aux risques"* day organized by the Ministry of Ecological Transition took place on October 13, 2023, to make the population aware of major natural and industrial risks and develop collective resilience. On this occasion, the Institute conducted a three-week communications campaign on social networks promoting educational content, among others the "Radioactivity" exhibition on nuclear power and radiation protection.

IN BRIEF

SURVEY ON FRENCH PEOPLE'S PERCEPTION OF RISKS AND SECURITY

For over 30 years, the IRSN barometer has been monitoring French people's perception of risks and security. The 2023 report (2022 survey) was published on June 19. Among the highlights to note: climate risks were seen as being higher (+16 points vs. 2021) and the favorable opinion of the French for nuclear power strengthened. 50% (+6 points) said nuclear power plants must continue to be built.

https://barometre.irsn.fr

IN BRIEF

MEETING YOUNG TALENTS

To promote its professions and continue to build the pool of future employees, IRSN took part in numerous forums and trade fairs in 2023 (Forum Horizon Chimie and Forum Trium[1] in Paris in October, the "Paris pour l'Emploi" job fair in November, etc.). The Institute also met many students from engineering schools (INSA, INSTN, Grenoble - INP Phelma, etc.). Lastly, new in 2023, a recruitment campaign for work-study students was launched in May and relayed on social networks.

[1] The student-business career forum organized by and for students from the École des Mines Paris-PSL, École des Ponts ParisTech, ENSTA and ENSAE.

HUMAN CAPITAL

IRSN unveils its employer brand

In April 2023, following a joint project by the Communication and Transformation departments and employees, IRSN unveiled its employer brand.

With more than 50 professions and nearly 1,800 employees, IRSN has many skills. In a fast-growing nuclear sector, linked to the government's stimulus plan, the labor market is nevertheless especially tight and competitive. The needs are many: in 2023, the Institute planned 170 recruitments. Against this backdrop, where commitment and a sense of purpose are essential for attracting and retaining employees, promoting its professions among the younger generation and providing extensive training have become priorities.

Let your talent shine with us!

To meet the challenges of recruiting, attracting and retaining talent, IRSN launched its employer brand in April 2023. Two communication campaigns have been conducted. The first was based on the definition of the five pillars: the Institute's mission, pride in feeling useful, reciprocity, social responsibility and ambition to shine. The second resulted in video portraits of employees talking about their career and professional experience in IRSN. For full visibility, these communication campaigns were relayed on social networks.

Gueules de l'emploi

To give its employer brand more visibility, IRSN participated in the "Gueules de l'emploi" digital exhibition in November 2023. By associating an object, symbolizing a profession, with each person photographed by artist Christophe Duron, the Institute showed the usefulness of its professions. Its goals are to showcase its human wealth, make its professions known and highlight women and men from all backgrounds, proud of their Institute.

Look at the online exhibition by flashing this QR Code (in French only).

IRSN, a partner of the University of Nuclear Professions

In 2023, a partnership agreement was drawn up between the University of the Nuclear Professions (UMN) and IRSN. In March, the Institute also participated in the all-new National Nuclear Professions Week, co-organized by the UMN and the Job Center. At UMN's request, IRSN also spoke in engineering schools to raise students' awareness of safety and radiation protection. Its job opportunities will soon be posted on the UMN[2] portal and thus gain visibility.

[2] monavenirdanslenucleaire.fr.

IN BRIEF

TRANSFORMATION AND REORGANIZATIONS

On January 16, 2023, a new delegated human resources department was set up. At the core of the Institute's strategic management, it reinforces deployment of its policy to attract and retain talents.

The Health-Environment Division also implemented a new organization of the Environment Department on July 1st 2023. This reorganization aims to bring together teams of experts and researchers, in particular on the issues of environmental health and transfers of radionuclides in environments.

DIGITAL

IRSN continues its digital transformation

The digital transformation program (DTP) brings together flagship projects of the Institute's digital transformation, in the framework of a sustainable budgetary path and governance at the highest level.

Of the 29 projects in the 2022 DTP, eight were completed in 2023, including the redesign of two major tools of the Institute's official missions (SISERI and ICEBERG), finalization of the integrated HR management platform, as well as three core projects for data governance and deployment of the Data strategy.

Deployment of the Data strategy

The roadmap for using the Institute's scientific and technical data at the service of its missions continued in 2023: the Institute's open data policy was defined, and the data governance committee is now operational. Change support has been implemented in particular by setting up a network of local contacts for managing research data, coordinating the DATAVAL community and organizing a data week, October 9 – 17.

Skills development and knowledge sharing

In terms of training, a new School of Management was launched in 2023, with several learning paths added to the internal university's offering.

New training modules on the Institute's operation have therefore been created (CSR, quality, expenditure chain, etc.). In addition, e-learning training courses have been developed (70 available) and are a great success with employees. This year, a review was also started on the fifteen communities of practice that have been formed since 2021 to improve their performance. Lastly, to make access to knowledge even easier, IRSN has redesigned the user interface of its ASK search engine, which provides access to over 700,000 documents. Optimized thanks to user feedback, ASK's new version was released in early December.

IN BRIEF

ADVANCES IN DATASCIENCE

The ability to deploy and master the use of Datascience at the Institute is an issue for the efficiency and confidence in the performance of its missions. Actions carried out in 2023 included providing a "low code/no code" Datascience platform and support for its use to test its contribution to business projects, implementing a Datascience training offer adapted to IRSN's problems, and setting up a network of Datascience contacts.

ETHICS AND PROFESSIONAL CONDUCT

IRSN has a new charter

Published in March 2023, this charter aims to better anchor ethics and professional conduct in the Institute's professions, including in crisis or emergency situations.

Developed with the members of the Ethics and Professional Conduct Commission, it covers the various contemporary ethical dimensions[3], as well as the ethical challenges faced by IRSN in the context of its missions: scientific rigor, independence, integrity, impartiality and conflict of interest. In 2024, a guide to best practice will be developed from the principles set out in this charter.

[3] Social, environmental, research, biomedical, animal experimentation, economic ethics.

Read the "ethics and professional conduct charter" (in French only).

IN BRIEF

WORKING TOGETHER

In 2023, the deployment of IRSN's CSR policy was notably implemented through actions aimed at energy efficiency, sustainable mobility and responsible digital. In order to promote widespread employee awareness of CSR issues, actions were organized in several formats: call for ideas on energy efficiency, CSR e-learning, manager training, challenges, serious game and Climate Fresk. This issue of employee engagement was also reflected in the Institute's new incentive agreement providing for 20% of the workforce to participate in these actions, which was reached in 2023. Lastly, during the European Sustainable Development Week, from September 18 to October 8, employees were able to discuss the actions carried out at the sites with regard to soft mobility, digital sobriety, biodiversity or reducing the environmental impact.

CORPORATE SOCIAL RESPONSIBILITY

Valérie Marchal

CSR Officer

"In 2020, IRSN formalized its CSR policy in a roadmap up to 2023. The results for the last three years show that the ecological transition issues have been disseminated and incorporated at both the functional and operational level. This is shown by the dynamic driven by the CSR community of practices and the increase in units committed to low-carbon approaches. Above all, this transformation is integrated into the IRSN governance with an active contribution from employees, and it is one of the keys to its dynamism!"

Responsible digital: D3NSI wins the Green Infra trophy

Awareness-raising campaigns, minimized amount of equipment, socially responsible reuse of laptops with the adapted company Ecodair, circular economy, best practices, rationalization of data storage spaces, merging applications, etc.: IRSN's Responsible Digital Roadmap addressing the challenges of the digital strategy and CSR was published at the beginning of 2023. A few months later, on June 19, at the TopTech awards ceremony[1] IRSN, through the digital department, won the DSI Green Infra Trophy, thus confirming its exemplary commitment to responsible digital.

[1] Organized in Paris by the magazine L'Informaticien, the TopTech awards recognize the best IT projects of the year (performance, innovation, environmental and social impacts).

ASSETS

The future HEQ building takes shape in Cadarache

Funded by the France Relance program, construction of the future office building in Cadarache made good progress in 2023.

This modern bioclimatic building, certified High Environmental Quality (HEQ), embodies IRSN's strong environmental commitment, with half the impact and very low greenhouse gas emissions. It will bring together over 200 employees from 14 different entities in 5,400 m². Before their move in December 2024, the staff were involved throughout the project in preparing their future installation.

GOVERNANCE

Board as at January 1, 2023

Missions

Through its deliberations, the Board rules on IRSN affairs. In particular, it deliberates on the general conditions of organization and operation, the Institute's strategy and programs, and the annual report. It also approves the budget, the amending budgets, the accounts for each financial year, and the net income appropriation.

Members

One Member of the French Parliament
Natalia Pouzyreff, MP for the Yvelines Department

One senator
Stéphane Piednoir, Maine-et-Loire Senator

Ten State representatives

Christian Dugué, inspector for nuclear security at the DGA (*Direction générale de l'armement* - French Government Defense procurement and technology agency), representing the Minister of the Armed Forces

Benoît Bettinelli, head of the Nuclear Safety and Radiation Protection Mission of the Department of Technology Risks, representing the Minister for the Environment

Joëlle Carmes, deputy Director of Environmental and Food Risk Prevention, at the Directorate-General for Health, representing the Minister of Health

Guillaume Bouyt, deputy Director for the nuclear industry at the DGEC (*Direction générale de l'Énergie et du Climat* - Directorate general for energy and climate), representing the Minister for Energy

Frédéric Ravel, scientific Director for the Energy, Sustainable Development, Chemicals and Processes sector at the Directorate-General for Research and Innovation, representing the Minister for Research

Arnaud Gillet, head of the Risk Assessment and Management Office at the Directorate-General for Civil Security and Crisis Management, representing the Minister for Civil Security

Anne Audic, deputy Director of Working Conditions, Health and Safety at the Directorate-General for Labor, representing the Minister for Labor

Arnaud Wieber, head of the Energy, Investments, Industry and Innovation Office at the DB (*Direction du budget* - Budget Directorate), representing the Minister for the Budget

François Bugaut, representative in charge of nuclear safety and radiation protection for defense-related activities and facilities

Bernard Doroszczuk, chair of the French Nuclear Safety Authority (ASN)

Five advisory members

Marie-France Bellin, chair of the Board, University lecturer and hospital practitioner in the Department of Diagnostic and Interventional Radiology of Bicêtre-Paul-Brousse hospital, nominated by the Minister of Health

Laurent Moché, CEO of Edenkia, nominated by the Minister for Energy

Fanny Farget, scientific Research Director at the CNRS (French National scientific research center), nominated by the Minister for Research

Patrick Dufour, auditor General of the Armed Forces on special assignment, nominated by the Minister for the Armed Forces

Ginette Vastel, doctor in pharmacology, nominated by the Minister for the Environment

Eight employee representatives

Patrick Lejuste, CGT
Léna Lebreton, CGT
Philippe March, CGT
Amokrane Allaoua, CGT
Thierry Fleury, CFDT
Valérie Bruno, CFDT
Vincent Chevalier, CFDT
Sandrine Roch-Lefevre, CFE-CGC

Six ex officio or associate members

Cédric Bourillet, Director General for Risk Prevention and Government Commissioner

Jean-Pascal Codine, Budget Auditor

Jean-Christophe Niel, Director General of IRSN

Louis-Michel Guillaume, IRSN Deputy Director General in charge of defense-related missions

Isabelle Flory, IRSN Accounting Officer

Cédric Gomez, secretary of IRSN's Works committee

Scientific Council as at December 1, 2023

Missions

The Scientific Council gives its opinion on IRSN's programs. It assesses their results and is able to provide recommendations on the direction of the Institute's activities. It may be consulted by the Board's chairperson or by the supervisory ministers on any subject within the Institute's remit. Its opinion may be sought on any issue or project involving IRSN.

The Scientific Council meets twice a year in plenary session and may also meet, at its convenience, with fewer participants, possibly extended to include external experts in order to review a research theme or program more precisely.

Members

Robert Barouki, Lecturer in Biochemistry at Paris University and Head of the Inserm T3S "Toxicology, Therapeutic Targets, Cellular Signaling and Biomarkers" Unit, Head of the Clinical Metabolomics and Proteomics Biochemistry Department at Necker Children's Hospital; Chair of the Scientific Council

Jean-Christophe Amabile, Brigadier General (Medical Doctor), Professor at the Military School of Val-de-Grâce, Director of the French Defense Radiation Protection Service (SPRA)

Christine Argillier, Research Director and Deputy Scientific Director of the AQUA Department at the French National Research Institute for Agriculture, Food and Environment (INRAE)

Bernard Bonin, Scientific Advisor for the Energy Division of the French Alternative Energies and Atomic Energy Commission (CEA)

Alain Kaufmann, Director of the ColLaboratory, a collaborative and participatory action research unit at the University of Lausanne (Switzerland)

Louis Laurent, Scientific Director at the French National Research and Safety Institute for the Prevention of Occupational Accidents and Diseases (INRS)

Elsa Merle, Professor at the PHELMA Engineering School of the Grenoble Institute of Technology

Michèle Sebag, Research Director at the French National Center for Scientific Research (CNRS), Interdisciplinary Laboratory of Digital Sciences of Paris-Saclay University

Pierre Toulhoat, President of the Environment and Climate Change Division at the French National Academy of Technologies

Marc Verwerft, Head of the nuclear fuels group at the *Studiecentrum voor Kernenergie* (Belgian Nuclear Research Center), Public Interest Foundation, SCK CEN (Belgium)

Denis Veynante, Research Director at the French National Center for Scientific Research (CNRS), macroscopic molecular and combustion laboratory, CentraleSupélec, Deputy Director of the open data for Research Department of the CNRS

Nuclear Safety and Radiation Protection Research Steering Committee as at December 1, 2023

Missions

The Committee is an advisory body to the Board, giving opinions on research objectives and priorities in the fields of nuclear safety and radiation protection. It adopts a global approach that takes into consideration the requirements of society and public authorities – complementing the work of IRSN's Scientific Council – and focuses on the quality and relevance of the Institute's research programs and outcomes from a scientific perspective.

Members

Public authorities

Supervisory ministry representatives

Martin Rémondet, Research and Innovation Department, representing the French Ministry of Ecological Transition

Général Nicolas Leverrier, Weapons Inspector for nuclear security, Armaments Inspectorate, representing the French Ministry of the Armed Forces

Xavier Averty, Task Officer at the Policy and Supervisory Office, Directorate General for Energy and Climate (DGEC), Ministry of Ecological Transition

Stéphane Grandjean, Nuclear Energy Task Officer, Directorate-General for Research and Innovation (DGRI), Ministry of Higher Education and Research

Representing the French Directorate-General for Labor

Jean Galvé, Head of the Office for Physical, Chemical, Biological and Occupational Disease Risks, Directorate-General for Labor

Representing the French Nuclear Safety Authority (ASN)

Vincent Cloitre, Director of the Office of the Director General of the ASN

Companies and professional associations

Philippe Laurent, Deputy director of the technical department – Lyon, EDF

Patrick Devin, President of the SFRP (*Société française de radioprotection* – French radiation protection society)

Émilie Lacroix, Safety and Environment Director, ORANO

Jean-Marc Simon, Associate Lecturer, Hospital Practitioner, Radiotherapy-Oncology Department at Pitié-Salpêtrière Hospital

Sébastien Crombez, Director in charge of Safety, the Environment and the Industrial Strategy (DISEF) of Andra

Employees in the nuclear sector

Representatives of the national trade unions

Jean-Paul Cressy, FCE-CFDT
Jacques Delay, CFE-CGC
Patrick Bianchi, CFTC
Olivier Chaumont, FO
Christian Holbé, CGT

Elected representatives

OPECST representatives

Philippe Bolo, MP for the Maine-et-Loire department

Representative of Local Information Commissions (Cli)

Marie-Pierre Mouton, Chair of CLIGEET (local information commission for major power plant equipment suppliers for Tricastin)

Representatives of municipalities hosting a nuclear facility, proposed by the Association of French Mayors

Bertrand Ringot, Mayor of Gravelines
Alain Gallu, Mayor of Pierrelatte

Associations

Jean-Paul Lacote, France Nature Environnement

Guy Kantor, Director of the *Ligue Nationale Contre le Cancer*

Advisory members

Jean-Claude Delalonde, Chair of Anccli (French national association of local information committees and commissions)

Christine Noiville, Chair of the High Committee for transparency and information on nuclear security (HCTISN)

Marie-France Bellin, Chair of the IRSN Board

Léna Lebreton, Director of the IRSN Board

Research organisations

Philippe Stohr, Director of Nuclear Energy, CEA

Cyrille Thieffry, Task Officer for Radiation Protection and Nuclear Affairs, IN2P3, CNRS

Étienne Augé, Deputy Vice-President of Paris-Saclay University, representing *France Universités*

Vincent Laflèche, Director, ParisTech

Foreign members

Christophe Badie, Head of Radiation Effects Department, UK Health Security Agency (UKHSA)

Ted Lazo, Former head of the radiological protection program at the OECD Nuclear Energy Agency (NEA)

Ex officio members

Vincent Berger, Atomic Energy High Commissioner

Cédric Bourillet, Government Commissioner, represented by **Benoît Bettinelli,** task Officer for Nuclear Safety and Radiation Protection, French Ministry of Ecological Transition

Jean-Christophe Niel, Director General of IRSN

Robert Barouki, Chair of the IRSN Scientific Council

Steering Committee for the Nuclear Defense Appraisal Division (CODEND) as at December 1, 2023

Missions

The Steering Committee examines the program of activities prepared by the Nuclear Defense Appraisal Division (DEND) within IRSN's Defense, Safety, and Non-Proliferation Division before it is submitted to the Institute's Board.

It is consulted when the Board is called upon to make decisions relating specifically to the organization or operation of this division and makes recommendations to the Board on matters related to DEND activities.

Members

François Bugaut, Chair of CODEND, in charge of nuclear safety and radiation protection for defense activities and installations

Thierry Burkhard, Army General, Armed Forces Chief of Staff, represented by Rear Admiral **Frédéric Dreher**

Emmanuel Chiva, Armaments General Representative, represented by Armaments General Engineer **Christian Dugue**

Christophe Mauriet, Secretary-General for the Administration of the Ministry of the Armed Forces, represented by **Antony Peltier**

Général Nicolas Leverrier, Inspector of nuclear weapons, represented by Naval Captain **Pierre Suleau**

Mélanie Joder, Budget Director of the French Ministry of the Economy, Finance and Recovery (MEFR), represented by **Arnaud Wieber**

Guillaume Ollagnier, Director of strategic, security and disarmament affairs for the Ministry for Europe and Foreign Affairs

Anne Blondy-Touret, Secretary-General, Senior Defense and Security Official of the Ministries of Economics and Finance, represented by **Samuel Heuze**

Guillaume Leforestier, Senior Defense and Security Officer of the Ministry for Ecological Transition, represented by **Nathalie Domblides**

Ethics and Professional Conduct Commission as at December 1, 2023

Missions

The Ethics and Professional Conduct Commission is an advisory body provided for in IRSN's decree of organization. It is responsible for advising the Board on preparing the ethics policies applicable to the Institute's activities and for monitoring their implementation, particularly as regards the conditions under which separation is ensured between expert appraisals carried out on behalf of government departments and those carried out for public or private operators. It also serves as a mediator when problems of an ethical nature arise.

Members

Françoise Roure, Chair of the Commission, Inspector General, Chair of the "Safety, Security and Risks" Section of the General Council of the Economy, Industry, Energy and Technology, and member of the Inspection Committee, PhD in Economics, specialty "International Economics". Retired

Lionel Bourdon, Senior Medical Officer, Full Professor at the Military School of Val-de-Grâce. Scientific Director of the Institute for Biomedical Research of the Armed Forces (Brétigny-sur-Orge), Director of the research component of the Armed Forces Health Service transformation programme ("SSA 2020"), Senior research professor for the Armed Forces Health Service. Retired

Raja Chatila, Emeritus professor of robotics, artificial intelligence and ethics at the University of Sorbonne in Paris. His research covers several aspects of robotics in robot navigation, motion planning and control, cognitive and control architectures, human-robot interaction, machine learning and ethics. Member of the College of Ethics of the Ministry of Higher Education, Research and Innovation and of the Scientific Council of Orange

Marc Clément, President of the Administrative Tribunal Chamber of Lyon, member of the Environmental Authority of the CGEDD (*Conseil général de l'environnement et du développement durable* - General council of the environment and sustainable development). Member of the Aarhus Convention's Implementation Committee (United Nations)

Alexandra Langlais, CNRS researcher in environmental law, CNRS bronze medalist – Environmental research manager at IODE (Western Institute: Law and Europe) – author of research and appraisal works on the laws on waste, soil, water, etc. Also a member of the GDR NoST (Standards research network - science and technologies)

Mauricette Steinfelder, Inspector General, member of the CGEDD (*Conseil général de l'environnement et du développement durable* – General council of the environment and sustainable development) and the Environmental Authority. Retired

Éric Vindimian, Rural Engineering, Water and Forest General Engineer, specialist in the impact of toxic substances on the environment and on health, and in the assessment of public environmental policies, member of the Environmental Authority of the CGEDD (*Conseil général de l'environnement et du développement durable* – General council of the environment and sustainable development). Retired

ODISCÉ Committee as at December 1, 2023

Missions

The ODISCÉ (*Ouverture et impulsion du Dialogue avec la Société Civile sur l'Expertise* – Outreach to and encouraging dialog with civil society on expert appraisal) Committee is a consultative body advising the IRSN's Director General, made up of experts and participation leads. Its objective is to encourage new scientific-society interactions on the appraisal of nuclear and radiation risks, to encourage regular and in-depth dialog, by broadening the audiences involved.

Members

Michel Badré, Chair of the ODISCÉ Committee, first chair of the Environmental Authority and former EESC Vice-President, Chair of the National Commission for Public Debate (CPDP) on "New reactors and the Penly project"

Évelyne Allain, Director of the French Institute of Instructors in Major Hazards and Environmental Protection (IFFO-RME)

Isabelle Barthe, Investigating commissioner, CNDP representative and member of several CPDPs (PNGMDR, New Reactors and Penly project)

Guillaume Blavette, Representative of France Nature Environnement

Anne Chevrel, University lecturer, engineering consultant and director of Vox Operatio

Paul Christophe, MP for the Nord department and Chair of the CLI of Gravelines

Marc Clément, Member of the Environmental Authority and Vice-Chairman of the Aarhus Convention Implementation Committee

Élise Courcault, Head of Health Democracy & Living Lab at INCa

Sébastien Farin, Director of Dialog and Foresight at Andra

Emmanuelle Jannès-Ober, Deputy Head of the Open Science Department at INRAE

Cécile Laugier, Deputy Environmental Director of the Nuclear Production Division at EDF's Nuclear Production Department

Yves Lheureux, Anccli (French national association of local information committees and commissions)

Clément Mabi, Lecturer at UTC, specialist in relationships between technological innovation and democracy, particularly in its participatory forms

Alima Marie-Malikité, Director of the Office of the General Management of SPF, in charge of outreach and dialog with society

Yves Marignac, Head of the nuclear and fossil energy division of the negaWatt Institute

Maïté Noé, Deputy Mayor of Vinon-Sur-Verdon, Vice-President of the Cli of Cadarache

Christine Noiville, Research Director at CNRS, Chair of HCTISN

Marion Roth, Expert in citizen participation in communities, former director of *Décider Ensemble*

Yannick Rousselet, Independent Nuclear Safety Consultant, representing Greenpeace France in the CLIs of the Manche department

Simon Schraub, PhD in Medicine and Social Sciences, Director and Vice-Chairman of the *Ligue contre le cancer* (Bas-Rhin Committee)

Serge Vidal, Representative of the CGT National Federation of Mines and Energy

ORGANIZATION CHART

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Jean-Christophe Niel

Defense, security and non-proliferation division

Louis-Michel Guillaume
Deputy Director General, in charge of Defense-related missions

Laurent Mandard
Director of Nuclear Defense Appraisal

Health and environment division

Jean-Christophe Gariel
Deputy Director General, in charge of Health and Environment

Jean-Michel Bonnet
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Marc Gleizes
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Nuclear safety division

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Deputy Director General, in charge of Nuclear Safety

Igor Le Bars
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Patrice Giordano
Director of Safety Research

Assets and real estate

Hervé Barbelin
Deputy Director General, in charge of Assets and Real Estate
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Real Estate and Security Director
Director of the Fontenay-aux-Roses site

François Vallette
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Michelle Agarande
Risk and Performance Director

Philippe Dubiau
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Cyril Pinel
European and International Affairs Director

Patrice Bueso
Strategy Director

Michel Enault
Transformation Director

Sandrine Kirchenbaum
General Secretary

Marie Riet-Hucheloup
Communications Director

From left to right: Marie Riet-Hucheloup, Patrice Bueso, Louis-Michel Guillaume, Philippe Dubiau, Sandrine Kirchenbaum, Michel Enault, Jean-Christophe Niel, Karine Herviou, Jean-Christophe Gariel, Cyril Pinel, Isabelle Flory, Hervé Barbelin, Michelle Agarande

ABBREVIATIONS AND ACRONYMS

A

AdSec: Advisory Group on Nuclear Security within the IAEA.

IAEA: International Atomic Energy Agency.

Anccli: *Association nationale des comités et commissions locales d'information* (French National Association of Local Information Committees and Commissions).

ASEAN: Association of Southeast Asian Nations.

ASN: *Autorité de sûreté nucléaire* (French Nuclear Safety Authority).

ASTEC: Accident Source Term Evaluation Code.

B

BEERAD: Assessment of the effects of ionizing radiation on bees.

BU-DCI: Business Unit - International Business Development *(Développement commercial à l'International).*

C

CEA: *Commissariat à l'énergie atomique et aux énergies alternatives* (French Alternative Energies and Atomic Energy Commission).

CEA/DAM: Directorate of Military Applications of the CEA.

CIP: CABRI international program.

Cli: *Commission locale d'information* (Local Information Commission).

Clis: *Comité local d'information et de suivi* (Local information and monitoring committee).

CPDP: *Commission particulière du débat public* (Special National Commission for Public Debate).

CSR: Corporate Social Responsibility.

CWC: Chemical Weapons Convention.

D

D3NSI: *Direction déléguée au développement numérique et aux systèmes d'information de l'IRSN* (IRSN Directorate for Digital Development and Information Systems).

Declics: *Dialogues entre chercheurs et lycéens pour les intéresser à la construction des savoirs* (Dialogs between researchers and high school students to get them interested in building knowledge).

DGA: *Direction générale de l'armement* (French Government Defense procurement and technology agency).

E

EPR: Evolutionary power reactor / European pressurized water reactor.

ERC: IRSN Emergency Response Center.

ESARDA: European Safeguards Research and Development Association.

ETSON: European Technical Support Organizations Network.

EURAD: European Joint Program on Radioactive Waste Management.

G

GPEC: *Gestion prévisionnelle des emplois et des compétences* (Strategic workforce planning).

GRS: *Gesellschaft für Anlagen- und Reaktorsicherheit* / GRS - Company for the safety of nuclear facilities and reactors in Germany.

H

HCTISN: *Haut Comité pour la transparence et l'information sur la sécurité nucléaire* (High Committee for Transparency and Information on Nuclear Safety).

HEQ: High environmental quality.

I

IER: Institute of Environmental Radioactivity (Fukushima University).

INCa: *Institut National du Cancer* (French National Cancer Institute).

INRAE: *Institut national de recherche pour l'agriculture, l'alimentation et l'environnement* (French National Research Institute for Agriculture, Food and Environment).

INMM: Institute for Nuclear Materials Management.

INSA: *Institut national des sciences appliquées* (French National Institute of Applied Sciences).

INSAG: International Nuclear Safety Advisory Group.

INSTN: *Institut national des sciences et techniques nucléaires* (French Nuclear Sciences and Technology Institute).

IRiMa: Integrated Risk Management for making companies more resilient in the age of global change.

J

JAEA: Japanese Atomic Energy Agency.

JRC: Joint Research Center of the European Commission.

M

MACUMBA: *Moyens d'essais Appliqués à l'étude du Confinement assuré par des Murs en Béton Armé* (Test Means Applied to the Study of Containment by Reinforced Concrete Walls).

MODATS: MOnitoring equipment and DAta Treatment for Safe repository operation and staged closure.

MORAD: MOdeling of RAdionuclide Dispersion.

N

NRA: Nuclear Regulation Authority / Japan.

NRC: Nuclear Regulatory Commission / USA.

NUS/SNRSI: Singapore Nuclear Research and Safety Initiative of the National University of Singapore.

NUT: Nagaoka University of Technology.

O

OPCW: Organisation for the Prohibition of Chemical Weapons.

OPECST: *Office parlementaire d'évaluation des choix scientifiques et technologiques* (French Parliamentary Office for the Evaluation of Scientific and Technology Choices).

ORRCH-IDEeS: *Orientation pluraliste de la recherche sur les risques chroniques, initiatives sur le territoire de Dunkerque pour l'environnement et la santé* (Pluralist research focus on chronic risks, initiatives in the Dunkirk area for the environment and health).

P

PAA: Polish National Atomic Energy Agency.

PALLAS: *Plateforme pluridisciplinaire de surveillance dans le cadre d'alternatives au stockage* (Multidisciplinary monitoring platform for disposal alternatives).

PASTIS: Passive Systems Thermalhydraulic Investigations for Safety.

PNGMDR: *Plan national de gestion des matières et déchets radioactifs* (French National Radioactive Materials and Waste Management Plan).

PPI: *Plan particulier d'intervention* (Special intervention plan).

Q

QVCT: *Qualité de vie et des conditions de travail* (Quality of life and working conditions).

R

RSNR: Call for research projects on nuclear safety and radiation protection.

S

SGDSN: *Secrétariat général de la défense et de la sécurité nationale* (French Secretariat-General for National Defense and Security).

SISERI: *Système d'information de la surveillance de l'exposition aux rayonnements ionisants* (Information system for monitoring exposure to ionizing radiation).

SITEX network: Sustainable network for independent technical expertise.

SMR: Small Modular Reactor.

SNLE 3G: 3rd-generation nuclear ballistic missile submarine.

SPF: *Santé Publique France* (Public Health France).

SPOS: *Service des politiques d'ouverture à la société de l'IRSN* (IRSN outreach policies department).

SSTC NRS: State Scientific and Technical Center for Nuclear and Radiation Safety / Ukraine.

T

TSO: Technical Safety Organization.

U

UNGG: Uranium natural graphite gas.

UTC: Compiègne University of Technology.

V

VVER : Russian acronym for pressurized water reactor.

Approved by the IRSN Board on March 7, 2024

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English version of the annual report
ISSN 2679-6791

Design & execution
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IRSN
INSTITUT DE RADIOPROTECTION
ET DE SÛRETÉ NUCLÉAIRE

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

MAILING ADDRESS
BP 17
92262 Fontenay-aux-Roses Cedex

TELEPHONE
+33 (0)1 58 35 88 88
WEBSITE
www.irsn.fr
E-MAIL
contact@irsn.fr

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