



**RÉPUBLIQUE  
FRANÇAISE**

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**IRSN**

INSTITUT DE RADIOPROTECTION  
ET DE SÛRETÉ NUCLÉAIRE

# Annual report 2019



MEMBER OF

**ETSON**



# Enhancing nuclear safety in France and abroad

Assess, research, protect, anticipate and share: these are the missions of IRSN in the service of public authorities and the public. IRSN's uniqueness lies in its ability to bring together researchers and experts to anticipate questions regarding the evolution and control of nuclear and radiological risks. The women and men of IRSN are committed to publicizing their work and sharing their knowledge with society. They thus contribute to improving access to information and creating the conditions for dialogue with stakeholders.

IRSN participates in formulating government policies on nuclear safety and security, health, the environment and emergency response management. A French industrial and commercial public undertaking (EPIC) under the joint responsibility of the Minister for the Environment, the Minister of Defense, and the Ministers for Energy, Research and Health, IRSN fully follows governmental modernization policies as evidenced by its approach to risk management and the implementation of a comprehensive policy on social responsibility.

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# Foreword

**MARIE-FRANCE BELLIN**

CHAIRPERSON OF THE BOARD  
OF DIRECTORS

&

**JEAN-CHRISTOPHE NIEL**

DIRECTOR  
GENERAL

As we write these lines, the health emergency resulting from the Covid-19 pandemic is seriously disrupting the daily lives of our fellow citizens, limiting the movements of most and weighing heavily on economic activity. In these unprecedented circumstances, we want to pay tribute to those – first and foremost health professionals – who mobilize day and night to sustain life in our country. We also wish to affirm here the full commitment of IRSN's teams, who are prepared in all circumstances to pursue the mission entrusted to them: provide excellent and independent technical assessment in the service of nuclear safety and security and radiation protection.

For IRSN, remaining fully operational during the health emergency is an ongoing requirement. The Institute has mobilized and continues to do so to this end.

IRSN is therefore pursuing its assessments and research in order to participate in major meetings in the fields of nuclear safety and security and radiation protection in the years to come. Commissioning of the Flamanville EPR, extending the operating life of the reactors beyond 40 years, dismantling facilities such as the Fessenheim nuclear power plant, developing new diagnostic and therapeutic tools using ionizing radiation, increased attention in France to health and environment issues, the effects of chronic exposure to low doses of ionizing radiation, possibly combined with other stressors, radon risk management ... the priorities are numerous.

To best meet the needs of public authorities, its partners, society and its employees, in both normal and exceptional situations, such as the one we're currently experiencing, IRSN is adapting in order to perform its missions and use its resources more efficiently.



“

IRSN does not work alone, but interacts with many stakeholders in nuclear safety and radiation protection, including its supervisory ministries, government administrations, the authorities for whom it prepares assessments, its French and foreign partners, industry and society more broadly through its efforts to increase awareness of its work.

JEAN-CHRISTOPHE NIEL

“

First of all, we would like to pay tribute to those who, like health care professionals, are mobilizing day and night to ensure life continues in our country.

MARIE-FRANCE BELLIN

What does this mean for the Institute? First, it is about improving assessments to better support decision-making, improving research to better anticipate and innovate, and developing staff to ensure their full involvement. It is also about improving interactions with our stakeholders to better take into account their needs, and a better use of our resources to optimize our functioning. Finally, it is about improving fulfillment of our social, environmental, ethical and professional conduct in order to better accommodate societal changes.

To realize our ongoing goal of improving how we perform our missions, we have developed a long-term vision for our Institute: IRSN 2030. This strategy for the next few years is driven by our 2019-2023 Performance Target Agreement and a new organization implemented in recent months. It is the result of extensive discussion, numerous interactions with our supervisory ministries and other interlocutors – including the safety authorities – and a significant mobilization of IRSN's women and men as part of a quality social dialogue.

Structured around five goals – preparing for the future, transforming, putting our facilities to the best use, operating effectively on a daily basis, and controlling risk – this new organization will strengthen our capacity for assessment and innovation by strengthening our governance, improving our overall performance, and simplifying our operating practices.

It will ensure better use of our experimental platforms and data repository. It is accompanied by the nomination of site managers to strengthen on-site supervision and a manager for our corporate social responsibility policy. It pools skills, resources and funds for procurement and risk management. The new organization highlights another crucial issue that has been identified, innovation, with the creation of IRSN Lab, which brings together innovative initiatives related to the Institute's disciplines and operations.

IRSN funds and operates fine experimental platforms, some of which are found nowhere else, including the MIRCOM microbeam, research equipment on the interaction between ionizing radiation and cell cores, the ODOBA facility for studying concrete aging, the PARISII platform for the study of in vivo contamination and the DENOPI facility for researching the thermohydraulics of spent fuel pool uncovering.

These platforms are the foundation for implementing our scientific strategy in support of our expertise, and for organizing our collaborations. To enhance their value, both scientific and technical as well as budgetary, a unit has been created to promote them.

“ To realize our ongoing goal of improvement, we have a long-term vision for our Institute, IRSN 2030, a strategy for the coming years, expressed in our Performance Target Agreement and a new organization implemented several months ago.

JEAN-CHRISTOPHE NIEL



Let's go back to the data, which come from all of IRSN's disciplines: environmental and worker monitoring, experiment programs, assessments, etc. In light of the new methods and tools for dealing with data, they represent a significant potential for progress for IRSN. For this reason, a unit is now responsible for determining the potential of this data in order to ultimately increase the scientific and technical gain from our assessments and research. In 2019, IRSN was awarded two calls for projects from the French Fund for Government Modernization through Artificial Intelligence. The objective of the first, PIREX, is to assist in the analysis of approximately 1,200 events which are declared each year by the operators of nuclear facilities, including reactors, plants and laboratories. The second aims to improve the data of the SISERI database for enhanced dosimetric monitoring of workers exposed to ionizing radiation as part of their professional activity. By honoring these two projects, the government also demonstrates its recognition of IRSN's modernization efforts.

If nuclear safety is the responsibility of governments, the European stakeholders – safety authorities, technical safety organizations (TSOs) such as IRSN, operators – have organized networks to foster convergence in their respective policies, making Europe a true driver for nuclear safety worldwide.

For the European TSO Network (ETSON), of which IRSN is a founding member, nuclear safety thus means harmonizing practices based on sharing technical approaches and procedures for assessments as well as on the importance of research as a means for acquiring knowledge.

“ Strengthening the effectiveness of the Institute includes enhancing the value of its experimental platforms and the data collection from its research, monitoring and assessment activities.

JEAN-CHRISTOPHE NIEL



IRSN Lab was created in 2019 to bring together innovative initiatives related to the Institute's disciplines and operation.

MARIE-FRANCE BELLIN

In this spirit and in compliance with still uncertain conditions, IRSN plans to organize the EUROSAFE Forum, ETSON's major annual meeting of TSOs, in November 2020. The Institute will likewise continue to invest in European partnership research, a method of organizing research that has proved its effectiveness, as evidenced by the 14 projects selected by the European Commission out of the 21 presented by IRSN, in consortium with other European TSO as part of the Euratom Horizon 2020 call for proposals for 2019-2020.

In terms of strategy, IRSN will continue to serve ETSON's two main objectives in 2020: strengthening its ties with the European Commission as well as its interactions with safety authorities and the industry network.

A discussion of IRSN's future must address human resources, which are central to maintaining excellence in both the assessments and research carried out by our teams. By implementing a policy intended to strengthen its attractiveness in a competitive environment, the Institute aims, in areas where skills are scarce, to recruit, train and retain experts. Here again, the IRSN 2030 transformation process is key to maintaining IRSN's leading role.

The visits to IRSN's facilities in 2019 and the meetings with its experts and researchers by outside figures – parliamentarians, representatives of the State, its supervisory ministries and authorities, French and foreign scientific and technical officials, the media, civil society representatives – demonstrate the nation's interest in its operations and facilities.



For IRSN and other ETSON members, nuclear safety requires harmonization of technical assessment practices and research projects, a tool for knowledge acquisition.

JEAN-CHRISTOPHE NIEL

“ IRSN will continue to work towards two of ETSON's strategic objectives: strengthening its links with the European Commission and its interactions with safety authorities and industry.

JEAN-CHRISTOPHE NIEL

“ Human resources are at the heart of maintaining excellence in both the assessments and research conducted at IRSN.

MARIE-FRANCE BELLIN

We would like to conclude on society's high expectations with regard to health and environmental issues, as borne out by media coverage.

With much modesty given the complexity of these subjects, but with a strong conviction, the IRSN model sought by the state in 2001 with:

- risk assessment distinct from risk management, i.e. an assessment body separate from the decision-making body;
- an assessment of all facets of nuclear and radiological risk: safety, security, protection of persons and the environment from ionizing radiation, and long-term assessment;
- an assessment based on expertise and research, the latter taking into account needs required for expertise and in turn reinforcing expertise based on knowledge;
- an assessment based on interaction with society: it is not a co-assessment (the responsibilities of the stakeholders must be clearly defined for these subjects), but this is about the ability to explain and accept the interrogations that ultimately support the assessment; this includes data that increase confidence in risk management. •



# Interview

## LOUIS-MICHEL GUILLAUME

DEPUTY DIRECTOR GENERAL FOR DEFENSE MISSIONS AND IN CHARGE  
OF THE DEFENSE, SECURITY AND NONPROLIFERATION DIVISION



IRSN expects 2020 to have a significant workload for its teams working on defense and security missions.

LOUIS-MICHEL GUILLAUME

In 2019, the high volume of activity continued for IRSN's defense and security missions, including defense nuclear safety assessment, the security of nuclear facilities and transport, and nuclear and chemical nonproliferation. IRSN's teams assigned to these missions are ready and preparing to meet two challenges.

“ Our teams are preparing for two major challenges: in the defense field, to simultaneously accompany renewal, regeneration and maintenance operations as well as the dismantling of equipment and facilities. In the security field, they must continue to adapt to changing circumstances.

LOUIS-MICHEL GUILLAUME

As part of its missions in the defense sector, IRSN supports not only operations over the life cycle of defense equipment and facilities – renewal, regeneration, maintenance and dismantling – but also the management of associated waste. For its security missions, it must continue to accompany a change characterized by the shift from the risk of nonproliferation of nuclear materials to the growing threat of malicious acts of any kind.

Within this framework, the Institute works to support public authorities in the fields of defense and security. Such support involves addressing multiple issues: for example, for research this means using high performance equipment to simulate systems used in the nuclear industry to assess their ability to resist cyberattacks and to pursue testing the effects of weapons and explosives on structures. IRSN continues to modernize protected or classified Institute information system networks, particularly for nuclear material accountancy and electronic declarations. In addition to introducing these new tools, there is a constant human resources challenge for the Institute to recruit and retain the experts it needs in a competitive marketplace.

The workload for 2020 is not expected to decrease. IRSN's security assessment of defense systems will continue on the Suffren-class nuclear attack submarines and third-generation nuclear-powered ballistic missile submarines, in addition to mobilizing significant resources for the associated support and nuclear fuel cycle facilities.

The same is true of security and nonproliferation, with the continuation of the program of the Ministry for Ecological and Inclusive Transition to strengthen the security of civilian nuclear facilities and transport, inspection and control missions in various fields, and mentoring in foreign countries in the framework of the Convention for the Prohibition of Chemical Weapons. In 2020, IRSN will also continue to accompany the government's discussions on updating the regulations taking into account operating experience feedback. At the same time, through training in missions of the International Physical Protection Advisory Service (IPPAS) and its participation in IAEA meetings, IRSN plans to solidify its international position as an expert on topics such as nuclear security, safeguards or nonproliferation.

While there's no shortage of challenges, public authorities can count on the commitment of IRSN's teams to meet them. •

“ IRSN continues to work to support public authorities in the area of defense, security and nonproliferation.

LOUIS-MICHEL GUILLAUME

# KEY EVENTS IN 2019

## 01 / 19

### Collaboration agreement

with the University of Nagasaki on the study of the effects of ionizing radiation on living organisms.

### Publication

of the second report on children's exposure in medical imaging.

### Publication

of the Report on the Radiological State of the Environment in France.



## 04 / 19

### Renewal

of the framework partnership agreement between Météo-France and IRSN for six years.

### Visit

to IRSN's research facilities by G7 nuclear experts.

### Opinion

of IRSN on break preclusion requirements and defects that were not detected in the end-of-manufacture controls of the main steam lines of the Flamanville EPR.



## 05 / 19

### Participation

by IRSN in the 23 public meetings organized by the Special Commission for Public Debate within the framework of the future French National Radioactive Materials and Waste Management Plan (PNGMDR).

### Publication

of the report on the issues involved in the dismantling of pressurized water reactors.

### Contribution

of IRSN to irradiated patient care, under the aegis of the IAEA.



## 03 / 19

### IRSN and the United States Nuclear Regulatory Commission (U.S. NRC)

signed a cooperation agreement in the areas of emergency preparedness and response.



## 06 / 19

### IRSN

participated in 8 of the 13 research projects selected under the Euratom 2020 Call for Projects.

### First edition of Shared Knowledge Days

event co-sponsored by IRSN and Ancli to provide local information commissions with IRSN's knowledge and operating experience feedback on nuclear safety topics they identified together. This event reflected the Institute's willingness to share its technical expertise, following the commitment made in its Charter on Openness to Society.

### Investigations

into the cause of a high level of tritium measured in the Loire River.



## 07 / 19

### IRSN

participated in six projects selected by the French National Research Agency (ANR), French National Cancer Institute (INCa) and Inserm.

## 09 / 19

### Conclusion of the FASTNET project

whose objective, following the Fukushima accident, was to develop tools and a method for rapid, organized and reliable prediction of accident outcomes and anticipation of atmospheric releases.

### Publication

of the 2018 report on Occupational Exposure to Ionizing Radiation in France.

## 10 / 19

### Report

on the consultation on safety improvements to 900 MWe reactors.



## 11 / 19

### As part of the state visit

of the French President to China, the Memorandum of Understanding on Fuel Safety was signed by Jean-Christophe Niel, Director General of IRSN and Dr. Ren, Director General of the Nuclear and Radiation Safety Center, the Institute's counterpart, under the patronage of the French and Chinese ministers of ecology.



## 2019

Periodic review  
of 900 MWe reactors.



## I. MAKING TRANSFORMATION PART OF THE STRATEGY

In 2019, IRSN began a profound transformation outlined in its 2019-2023 Performance Target Agreement with the French government, which states the Institute's goals and strategic directions. In addition creating a division for transforming and reorganizing the operation and support functions, the digital roadmap is a way for a major transformation program of IRSN in the coming years.

### — Digital transformation actions in 2019

Defined in 2018, IRSN's Digital Roadmap aims to provide all Institute staff with a digital and mobile working environment. The priority of the digital transformation program is agility, as it places user needs and demands at the heart of a collaborative approach. In 2019, efforts focused on making progress on data, which has enabled, among other things, to develop a culture of data visualization, define a catalog of data acquired by IRSN in the field of radiation protection and implement a technical platform for collating databases for this field.

It is also developing knowledge-sharing tools. The scope of the Institute's internal search engine has been expanded, as has the scope of digital communication tools. The digital workplace project was launched, and IRSN staff experimented with various collaborative tools such as using the Teams platform to prepare an assessment. These developments aim to facilitate teamwork, including when working on the go and from home. In 2020, new collaborative tools will be rolled out for all employees, development will continue on the use of the Institute's scientific and technical data, and implementation of electronic signatures will be expanded to favor digital processes and their simplification.

### — Toward a new management model

The analysis completed in 2018 as part of reorganizing the operation and support functions demonstrated the need for change in the culture and practice of managers as keys to transforming the Institute.

The management meetings of 2019 marked the launch of the management transformation program. The objective is to build a new model using collective intelligence to better take into account societal expectations and the challenges before the Institute, particularly in terms of employee retention and scientific and technical performance.



### — IRSN encourages even more collaboration

The quality level of the work carried out by IRSN is largely based on the use of the best available knowledge and the skills of its staff. In a highly competitive labor market, maintaining the skill level of its staff requires IRSN to remain an attractive choice in order to retain employees and bring new talent on board. To accomplish this objective, the Director General has encouraged input from staff, including during the "2030 Workshops" held in the summer of 2018. A major component in transforming the Institute, the evolution of managerial policy – and more particularly of modes of collaboration – has therefore seen the launch of several actions that will continue in 2020. →

→ These actions will create spaces for the Institute's teams to work in collaboration, to create communities of practices that foster collaboration and sharing experiences, including through training in design thinking... Efforts are also being made to maintain effective collaboration while working remotely, based on introducing the best practices.

#### — An ambitious CSR dynamic that engages employees

As part of its strategic transformation, IRSN has also stimulated a dynamic of social and societal responsibility which aims to go beyond the objectives of the sustainable development charter established by the Institute in 2011. This new corporate social responsibility (CSR) policy is based on an ISO 26000 process leading to reaffirming IRSN's sense of action and responsibilities.

In 2019, it resulted in the creation of the position of CSR delegate attached to the Transformation Division and the definition of governance based on a CSR Council composed of employees and Directors Circle. Through the efforts they lead, they will ensure the new CSR dynamic, which will drive transformation on several levels:

- institutional, including the Institute in the dynamics of public institutions responding to the government's CSR recommendations;
  - regulatory, through the implementation of laws relating to integrity, professional conduct, transparency (including the Sapin II and Pacte Laws), as well as measurement and performance indicators;
  - innovation, with challenges to transform the Institute's CSR practices and culture through short- and medium-term actions.
- The Institute's CSR Roadmap has four themes: protection of people and employees, actions in favor of the environment, achieving excellence and taking responsibility, and active involvement in the evolution of society. It will be reflected in an action plan in 2020.

#### — A laboratory for innovation

As a follow-up to the IRSN 2030 process, the Institute has just created an innovation laboratory called IRSN Lab. Beginning in 2020, this small unit is a transformation tool that enables employees to experiment with new methods of finding solutions in the field covering different societal, organizational, scientific and technical problems.



It will use the creativity and shared understanding of the problems encountered on a project based on observation of the user's practices and experience. Ultimately, IRSN Lab will help create informal networks that will be spaces for exchange. It is a physical, open and modular place that is characterized by a framework and working methods that promote the emergence of innovative products, services and organizational methods. It is about putting the user experience at the heart of the design and improvement of IRSN products and services, whether internal or external use. In 2019, the head of IRSN Lab was given the initial tasks of defining its services and operation, setting up its site, and launching operation in the first quarter of 2020.

#### — Rolling out the knowledge management policy

Established in 2012, IRSN's knowledge management initiative has identified, through analyses in all scientific and technical fields, key knowledge to be maintained or developed over the short to medium term. IRSN has put in place action plans covering all topics and has structured tools for sharing and transmitting knowledge such as the in-house university and the ASK search engine. The challenge in the coming years will be to ensure that this approach is sustainable in the Institute's functioning, to promote knowledge sharing by all collaborators, and to strengthen its synergy with other Institute policies, including that concerning skills management. •

## II. RESEARCH TO IMPROVE ASSESSMENTS FOR THE FUTURE

The contributions of research, together with those of operating experience feedback, constitute the foundation of an assessment for which quality is constantly upgraded. As public expert, IRSN has no shortage of challenges, whether they concern safety with the aging and decommissioning of operating facilities, the development of new generation reactors or the processing and storage of waste, radiation protection with the goal of limiting and managing the adverse effects of radiation therapy treatments, better protecting populations in the event of a radiological or nuclear emergency, or better understanding the effects of radionuclides on terrestrial and marine ecosystems... In all these areas, the Institute must implement an ambitious knowledge acquisition strategy.

#### — Strong involvement in European and national projects

In line with its commitment in the 2019-2023 Performance Target Agreement, IRSN continued to work for high-level research partnerships in order to meet the challenges of assessment, as evidenced with the Institute's success in European and national calls to tender. Thus, at the European level, IRSN is participating in eight of the 13 research projects selected under the Euratom Horizon 2020 call for projects for 2018-2019 in the fields of safety, waste management and radiation protection. Among them, the Institute is coordinating the RC2A project on the radiological consequences of accidents likely to result in the transfer of contamination from the reactor coolant system to the environment. It is also participating in a project to improve the prediction capabilities of severe accident computer codes and in three other projects, respectively on the safety of modular reactors, the safety of molten salt reactors and the use of nuclear data in modeling tools. IRSN will contribute to the development of a roadmap for research into the cleanup of facilities undergoing dismantling. It is involved in Andra's EURAD program on geological waste disposal. Finally, IRSN will be part of the consortium for the HARMONIC project researching the health effects of fluoroscopy and new approaches in pediatric cardiac radiotherapy.

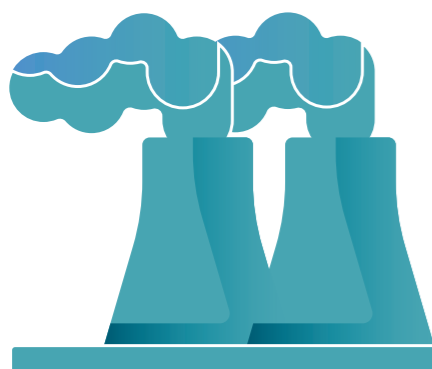
In France, nine projects involving IRSN were selected for funding by the French National Research Agency, the French National Cancer Institute, the French Institute of Health and Medical Research and the French Agency for Food, Environmental and Occupational Health and Safety. The projects in the health field involve research to limit the side effects of radiotherapy; optimize the use of ionizing radiation and evaluate the associated risks; improve the health care of persons accidentally exposed to ionizing radiation; and treat radiation-induced gastrointestinal syndrome. Two projects concerning the environment were selected.

The first seeks to establish, based on mathematical analyses using neural networks, the causal links between the concentrations of contaminants of different families (radionuclides, microplastics and derivatives) and the anthropogenic pressures exerted on large watersheds in France. The concentrations of contaminants will be reconstructed from sedimentary archives collected downstream of large rivers (Loire, Rhône, Seine, Garonne, Meuse, Moselle, Rhine), and which will cover at minimum the last hundred years. The project will use scenarios to predict trajectories of contaminants for upcoming decades. The second project, DARE, will perform site effect studies in the vicinity of Tricastin. These results confirm the role of IRSN as a major player in safety, radiation protection and environmental research.

#### IN BRIEF

##### Risk management

The colloquium marking the end of the AGORAS project to improve governance of nuclear safety organizations and networks was held in October 2019. Funded under the call for projects in nuclear safety and radiation protection research by France's Investments for the Future Program, AGORAS brought together nuclear operators, ASN, IRSN and the public to delve into the organizational issues and characteristics of the decision-making system in the nuclear field, and the procedural framework for emergency response management.





### — Work on criticality

The 11<sup>th</sup> International Conference on Nuclear Criticality Safety was held in Paris in September 2019. Organized by IRSN under the aegis of the OECD, the gathering brought together more than 300 experts from 17 countries. Every four years, this nuclear criticality safety event is the occasion to learn about current research through technical presentations, poster sessions, workshops and technical visits. Major themes in 2019 included improved simulation equipment performance, criticality accidents, the use of recent techniques such as artificial intelligence for simulation and virtual reality for training. The conference also highlighted the need for experiment programs and the challenges raised by the recovery of corium from the damaged Fukushima Daiichi reactors. Likewise, in the same approach based on exchange and collaboration for improved assessment of risk situations, IRSN has provided members of the Nuclear Energy Agency (NEA) the MORET computer code for calculating criticality safety in facilities and during the transport of nuclear materials. Developed over more than thirty years, the code very ergonomically performs complex simulations and has a broad validation base that covers a large number of configurations that may be encountered in the nuclear fuel cycle. Implementation of the MORET computer code by scientists from NEA member countries will contribute to improving safety and enrich operating experience feedback in the use of the code.

### 📌 Civil engineering

The focus of the Structural Performance Modeling and Analysis Laboratory (LMAPS), established in 2019, is civil engineering. It will conduct research and modeling to better understand and quantify the performance of structures and equipment in nuclear facilities, including aging and concrete pathologies. LMAPS has an extensive network with a national and international profile (ENS Paris Saclay, the Materials and Sustainability of Construction Laboratory (LMDC), French Alternative Energies and Atomic Energy Commission (CEA), Centrale Nantes (ECN), Université de Sherbrooke in Canada, Canadian Nuclear Safety Commission (CNSC) and U.S. Nuclear Regulatory Commission (NRC).

[www.irsn.fr/LMAPS](http://www.irsn.fr/LMAPS)

### 📌 Partnerships

In 2019, IRSN concluded some 50 collaboration agreements in the area of R&D. Some are part of the multi-year collaboration agreement in force with CNRS, while others are part of projects selected by various research funding agencies at the national and European level. The multi-year framework agreement with the Reactions and Process Engineering Laboratory, a joint unit of CNRS and Université de Lorraine, was renewed. As a result, IRSN will be able to consolidate development of models predicting the change in behavior over time of very high-efficiency filters designed to limit releases from nuclear facilities to the environment.

### — Advances in serious accidents

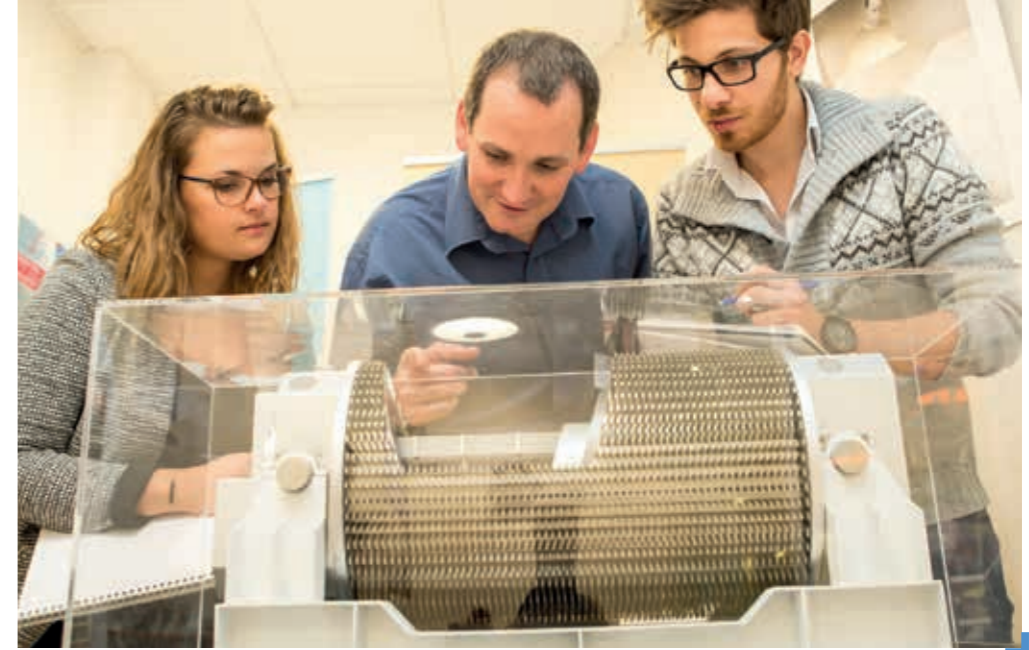
In April 2019, IRSN hosted the closing seminar of the first phase of the MITHYGENE project. Funded via the call for projects in nuclear safety and radiation protection research by France's Investments for the Future Program, the project aims to further knowledge and modeling of hydrogen explosions in a reactor core melt accident and develop simulation tools and in situ risk assessment. Launched in 2013 for five years, MITHYGENE has two phases. The main results of the first phase concern hydrogen dispersion within the containment, and the conditions favoring acceleration of hydrogen flame propagation.



Mathias Roger, a doctoral student at IRSN's Human and Social Sciences Laboratory (LSHS), won the "Three-minute thesis" competition. His work focuses on the process of creating and revising a risk assessment methodology.

### 📌 Theses Days 2019

Over four days in early April, second- and third-year doctoral students presented their work to researchers of the Institute and its various research partners (universities, industry, etc.), for a total of 220 participants at the event held in La Grande Motte in southern France. It was an opportunity for all participants to recognize progress made in all research work carried out within the Institute, break down barriers between disciplines, find time for discussions between the different laboratories, and consider the life of research in IRSN, France and abroad. It also demonstrates the role the Institute assigns to research-based training and its commitment to forging links with the academic world.



The experimental data is used to validate the simulation software. The objective of the second phase is to improve the radiation resistance of the gas measurement instrumentation and to calculate the number of sensors to place in the reactor containment to produce the most accurate and reliable diagnostics. In parallel, the MIRE project, led by IRSN and whose goal is to limit the release of gaseous fission products in the event of a reactor core melt accident, has been extended by 30 months in order to improve on initial results.

Funded under the call for projects in nuclear safety and radiation protection research by France's Investments for the Future Program, MIRE consists of different research lines aiming to establish recommendations on the effectiveness of filters for trapping elements such as volatile iodine species or ruthenium tetroxide. The results provide a better evaluation of releases during the venting phase, knowledge of the performance and limits of existing vent filters with regard to these gases as well as their capacity for trapping certain porous materials. The second phase of the project will explore the capacities of these materials further downstream, in particular by carrying out tests in conditions as close as possible to those of a pressurized water reactor accident. Finally, the OECD STEM2 experiment program was completed in late 2019. For four years, it studied the behavior of fission products (iodine and ruthenium) under severe accident conditions. The experiments, mainly carried out on the CHROMIA platform, improved knowledge of the effect of pre-aged paints on the production of organic iodides, the chemical stability of metal iodide and iodine oxide-type aerosol deposits as well as the behavior of ruthenium in the reactor coolant system. IRSN worked with its STEM2 partners in preparing a new OECD program, ESTER, on delayed releases.

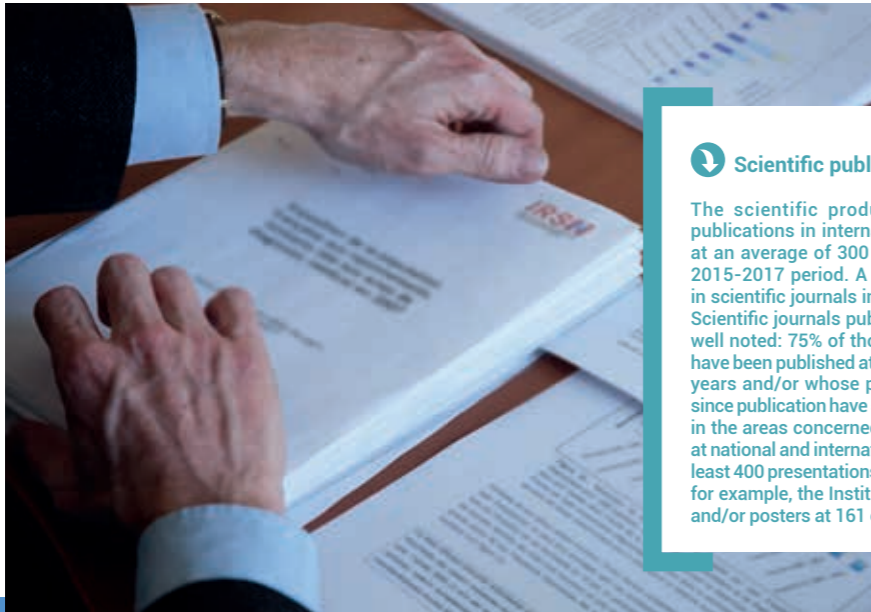
### 📌 IRSN committed to sharing scientific knowledge.

In 2019, the Institute became part of Open Access – a means of sharing research articles in a digital format that is free of charge and compliant with rights and archiving authorizations – by launching a new tool for managing the publication of its scientific publications on the national HAL portal. By providing all with access to its research papers, and in keeping with commitments made with scientific publishers, IRSN is thus fostering knowledge sharing in the nuclear and radiation protection fields through an approach that ensures openness, fair access, transparency, responsible stewardship, and flexible reuse of data.

<https://hal-irsn.archives-ouvertes.fr/>

### 📌 Renewal of the framework partnership agreement between Météo-France and IRSN for six years.

The new agreement signed on April 19, 2019 focuses on expanding the exchange of meteorological and radiological data, and implementing bilateral advisory and awareness-raising actions to promote a better flow of know-how and data between the two organizations. This will help meet nuclear safety requirements and improve support to the public authorities.

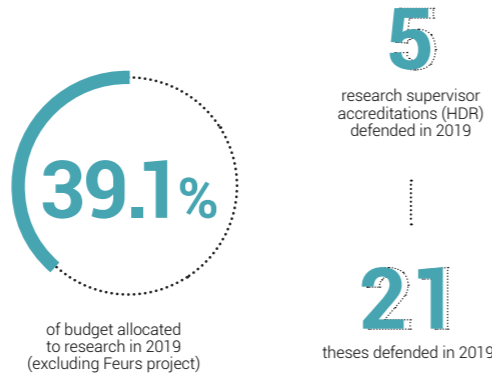


**Scientific publications**

The scientific production of IRSN teams for publications in international databases stabilized at an average of 300 documents per year for the 2015-2017 period. A large majority (80%) appear in scientific journals in the Journal Citation Report. Scientific journals publishing the work of IRSN are well noted: 75% of those in which articles of IRSN have been published at least three times within three years and/or whose publications have been cited since publication have 50% of the best impact factors in the areas concerned. The Institute is also active at national and international conferences, offering at least 400 presentations per year on average. In 2017, for example, the Institute staff made presentations and/or posters at 161 conferences and symposia.

**Fire research**

IRSN's teams are researching fire, a major risk in a nuclear facility, with a focus on propagation conditions. For example, the FIGARO program studies glove box fire scenarios and the suspension of radionuclides involved in these fires. Researchers finalized the verification campaign for the medium-scale experimental SIMBAG device and associated metrology in 2019 and conducted an initial experiment campaign. At the same time, a collaboration began with Japan's Nuclear Regulation Authority (NRA), which will co-fund the program until early 2024. In 2019 a second test campaign of the PRISME 3 program was conducted under the auspices of the OECD in IRSN's SATURNE and DIVA facilities. The campaign studied the spread of an electrical cabinet fire to another electrical cabinet in various fire scenarios. The tests will improve and validate the SYLVIA and ISIS simulation tools developed by the Institute. One of the tests carried out in confined/ventilated environments also exposed fire detectors to ambient conditions approximating those of an actual accident.



**Second component of the AMORAD project**

Implemented from 2013 to 2019, the objective of the AMORAD program was to optimize models for predicting radionuclide dispersal in the environment and evaluating their impact on the marine environment and terrestrial ecosystems. Funded under the call for projects in nuclear safety and radiation protection research by France's Investments for the Future Program, AMORAD II is being extended until 2022 to gain further knowledge of radionuclide transfer processes in continental environments (soil-forest) and watersheds through soil erosion. An economic section has been added to the program to complete development of IRSN's ARPAGON software, which is used to assess the direct costs of contamination in a region after a severe accident. The aim is to take into account the economic impacts associated with loss of forest and water resources and with requirements to prohibit the supply of water for drinking and irrigation.

**IRSN's ongoing assessment**

In 2019, IRSN published two reports evaluating its research on criticality and core melt.

**Launch of the IXBONE project**

Launched in June 2019 for four years, the IXBONE project is developing a new cellular therapy strategy to limit the side effects induced on bones by radiotherapies in the treatment of cancers of the upper respiratory and digestive tracts. IXBONE receives funding from the French National Research Agency under the 2018 call for Collaborative Research Projects - Enterprise. It seeks to develop a cell therapy protocol using mesenchymal stromal cells for the regeneration of injured bone tissue. This is a joint project of the Regenerative Medicine and Skeleton Laboratory (Inserm-Université de Nantes-Oniris RMES 1229), IRSN and OTR3.

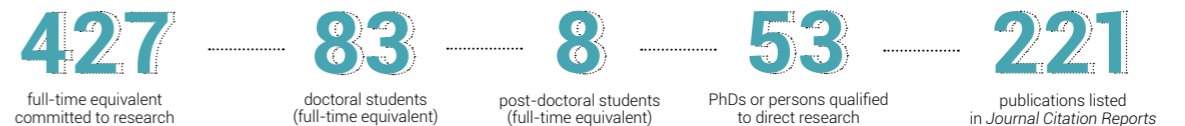


**IRSN, signatory to the San Francisco Declaration on Research Assessment**

Today, the scientific output of a researcher, team, organization or country is still measured using quantitative bibliometric indicators, which are not suitable for assessing the intrinsic quality of published results. A growing number of research organizations therefore advocate qualitative peer assessment. They initiated the San Francisco Declaration on Research Assessment in 2012 and the Leiden Manifesto in 2015. In 2019, IRSN signed the San Francisco Declaration to join this international movement to improve practices for evaluating research activities. The declaration's principles coincide with the basis of the evaluative practices and the publication process recommended by the High Council for Evaluation of Research and Higher Education (HCERES).

**Extension of the PRIODAC project**

Since 2014, IRSN has coordinated the PRIODAC project, whose main objectives are to determine the modalities (dosage and frequency) for administering stable iodine to persons in an area of repeated or prolonged radioactive accidental releases and to assess the potential side effects of this iodine intake for different categories of the population (infants, children, adults, pregnant women and the elderly, etc.). PRIODAC is funded under the call for projects in nuclear safety and radiation protection research by France's Investments for the Future Program. An extension of the project until 2022 was accepted to consider further details of administering iodine to pregnant women.





### III. ANTICIPATING AN EMERGENCY

In case of an incident or accident, IRSN is responsible for putting forward proposals to the safety authorities on technical, health and medical measures to protect the public and the environment in the area concerned and for supporting the public authorities. Through its teams participating in national and international exercises, the Institute plays a role in the national nuclear and radiological emergency system and contributes to updating France's post-accident policy. In this framework, it studies feedback from the post-accident management of the Fukushima Daiichi accident.

#### — Preparing for malicious acts

Emergency response now appears in the 2019-2023 Performance Target Agreement as a strategic area for progress, along with assessment, research and openness to society. This change reflects IRSN's commitment to further strengthening its skills – especially assessment – and its mobilization and response capabilities, particularly in situations involving malicious acts. The Institute strengthened its emergency response organization in July 2019 by creating two new "security functions" within its facility assessment unit:

- a specialist in security involving malicious acts whose role is to question the potentially malicious origin of a security event and, where appropriate, assess its impact on the diagnosis and prognosis of the security of the facility, transport or package concerned;
- a "security liaison officer" whose role is to collect information from the operator about the ongoing security event.

Setting up these two new functions, to be filled by security experts from IRSN's Defense and Security Division, will be accompanied by the development of methods, tools and protocols for exchanges with operators in addition to those already in place. In late 2019, as part of the preparation for handling a situation involving a malicious act and in keeping with the commitment made under the 2019-2023 Performance Target Agreement to devote one exercise per year to protecting facilities from such acts, IRSN designed and carried out its first internal exercise in which the scenario was based on a malicious act on public roads. It mobilized the Institute's emergency teams to handle a very different situation from those used in national emergency exercises on the safety of nuclear facilities, especially with the predominance of a health problem. Feedback from the exercise will identify needs for development in terms of organization, methods, tools and training to handle these situations. In addition to its activities to prepare for situations involving malicious acts, IRSN participates, both in France and abroad, in various exercises and projects aimed at strengthening its emergency response capabilities.

#### ↳ Anticipating atmospheric releases for a rapid response in accident situations: FASTNET project conclusions

Launched in October 2015 under IRSN's leadership, the Horizon 2020 FASTNET project involved a consortium of 20 partners from 18 countries (including the United States, Canada and Russia), as well as the IAEA. In the aftermath of the Fukushima Daiichi accident, its aim was to develop the tools and a method for rapid, reliable and organized prediction of how an accident will develop and any releases into the atmosphere. Completed in September 2019, the project created a reference database of accident scenarios, improved the tools required to rapidly assess atmospheric releases and developed a common assessment methodology. This will enable emergency response centers to react quickly in emergency situations in most nuclear power plants in order to better protect the surrounding population.



#### — A strategy of post-accident measures in the event of a nuclear accident

Following the accident at the Fukushima Daiichi nuclear power plant, IRSN developed a strategy for the radiological characterization of a region contaminated by radioactive releases. It relies on mobile measurement equipment which complement modeling tools for a rapid assessment of the situation. High-frequency gamma spectrometry on board light aircraft can provide rapid assessment of the affected area, followed by helicopters (metrology device on board aircraft), in order to refine the assessment with more precise measurements, and finally in vehicles, at the edge of the perimeter and in populated areas, for a very precise definition of the zone. Through international exercises, the Institute compares its performance and interoperability with those of organizations abroad. This latter aspect is particularly important in that the contamination resulting from an accident is likely to cover several countries. In Orange, in southern France, the Institute participated in a one-week exercise, AGC 2019, which brought together teams from the CEA and IRSN, as well as from German, Italian and Czech organizations, in the presence of American and Swiss observers. ↻

#### ↳ Involving stakeholders living in contaminated regions: TERRITORIES project

In November 2019, the final seminar of the TERRITORIES project was held in Aix-en-Provence in southern France. The project was launched in 2017 to better take into account uncertainties and involve stakeholders in risk assessment procedures and management actions for regions affected by long-term radioactive contamination. The project made it possible to identify and illustrate good practices in characterizing radioactivity in the environment and dosimetric calculations as well as to collect the expectations and concerns of stakeholders for greater consideration of the uncertainties in the management of a contaminated region.

#### ↳ First anniversary of IRSN's Emergency Response Center

The new Emergency Response Center, commissioned in October 2018, is the nerve center of IRSN's emergency organization, and includes, compared to its predecessor, many improvements that have been defined with the emergency response team: new general organization of units, integration of new units (for health and international relations), centralized emergency documentation, modernization of spaces and tools available to each unit and image walls. After a year of use, the feedback is generally positive: there is currently an effort to gather opinions from the IRSN emergency response team and potential needs for further improvements. During the course of a year, IRSN's emergency response team was mobilized and the center was activated as part of participation in ten national emergency exercises, seven local emergency exercises, one internal exercise and numerous trainings and simulations. In 2019, the Emergency Response Center was activated once during the Le Teil earthquake on November 11.

#### ↳ Protecting people contaminated by a radiological accident: IRSN participates in a triage exercise

In November 2019 at the Satory military camp near Paris, IRSN participated in a triage exercise with a group of people believed to be contaminated with iodine-131 as a result of a nuclear reactor accident. More than 130 people and 45 specialized vehicles were mobilized for this exercise involving personnel and resources from IRSN, the Civil Defense Training and Response Unit and the Army Radiological Protection Service. For civilian and military authorities, this inter-ministerial exercise provided numerous lessons on many aspects such as interoperability of resources, logistics for care, measurement equipment and measurement thresholds to apply for the triage of contaminated persons.

↻ In 2020, the results of the exercise will be presented at a workshop on airborne gamma spectrometry in the United States at the initiative of the U.S. Department of Energy.

In addition to portable measurement equipment, there may also be analysis of environmental samples to determine the nature of contamination in areas affected by releases of a radiological or nuclear accident. •

## IV. CONTRIBUTING TO TRANSPARENCY AND DIALOGUE

Each day, an attentive citizen watchfulness contributes a little more to the safety of nuclear facilities, as demonstrated by the close cooperation of local information commissions and their national association, Anccli, with IRSN. This cooperation was expanded in 2019 to cover various research and assessment topics involving issues that call for dialogue between representatives of society and experts on nuclear and radiological risk.

### — Consultation on safety improvements for 900 MWe reactors

IRSN accompanied the French High Committee on Transparency and Information on Nuclear Safety in the consultation process for improving the safety of 900 MWe reactors as part of the fourth periodic review of the plant series. In 2019, the Institute was deeply involved, alongside ASN and Anccli, in a public consultation on proposed improvements to assure the safety of the nuclear facilities concerned. It contributed to 13 public meetings and three workshops on specific topics, such as plant aging and protection against aggression, chosen by certain local information commissions.

18

actions by IRSN for local information commissions and Anccli

78

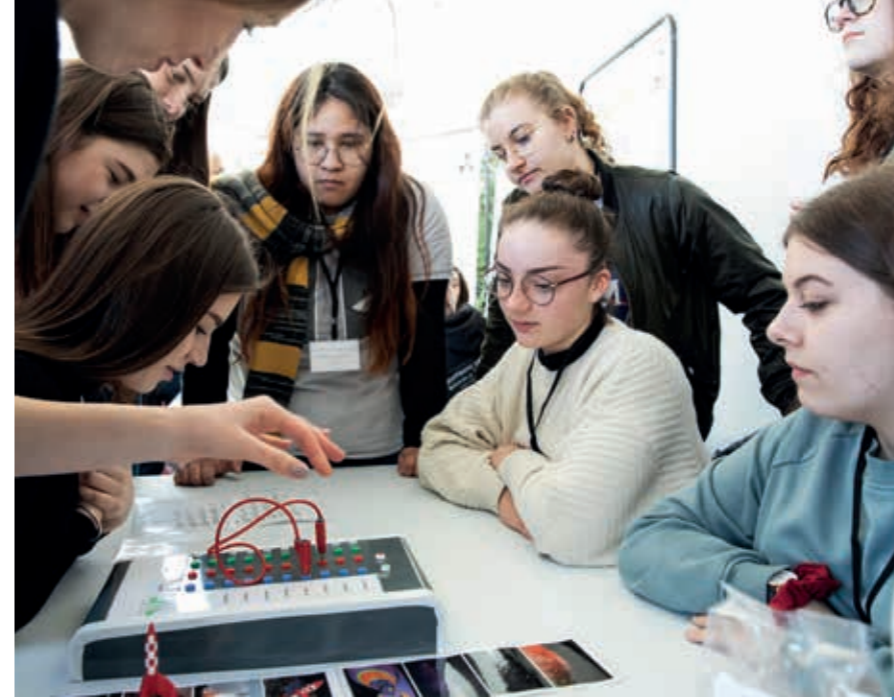
requests were made by local information commissions to IRSN

The Institute has also created a dedicated website which includes a collection of documents and frequently asked questions. The most discussed topics concern facility compliance, improvements in corium recovery, protection of fuel storage pools, informing the public early on in emergency situations and organizational and human factors. Because of this technical dialogue, IRSN now refers to the main questions posed by the public in its opinions.



### ↳ IRSN and Anccli join forces to share knowledge

The two partners launched Shared Knowledge Days in 2019. The initiative is intended to provide local information commissions with IRSN's knowledge and feedback on nuclear safety topics identified together to strengthen the technical competence of their members. Custom designed using topics identified by one or more commissions, the Shared Knowledge Days event provides an opportunity to deepen the discussion with a combination of theory and concrete examples. The event, held in June, was the occasion to present the fundamental principles of nuclear safety and the bases of the safety demonstration, as well as to discuss the sequences that led to the Three Mile Island, Chernobyl, and Fukushima accidents. This approach reflects the Institute's willingness to share its technical expertise, in compliance with its commitment to openness to society found in its charter.



110

students from French and foreign schools took part in the radiation protection workshops

### — Public debate on the management of radioactive materials and waste

In 2019, IRSN participated in 23 public meetings organized by the Special Commission for Public Debate (CPDP) in the framework of the future French National Radioactive Materials and Waste Management Plan (PNGMDR). The plan represents a major issue for the Institute in that the technical and societal questions raised were related to the management of all radioactive materials and wastes from numerous perspectives, including health, the environment, and the economy. Furthermore, the diverse subjects involve various scientific fields covered by many experts at the Institute. IRSN's contribution to the debate relied on feedback from the initial meetings, and the formats used – video, podcasts, serious games, workshops, etc. – were adapted to the topics and audiences. The accompaniment of public meetings provided numerous lessons for IRSN's experts, in particular on how they address issues related to the management of radioactive materials and waste. They thus noted the importance of discussing not only the technical solutions and projects that are being investigated, but also the abandoned alternatives.

### — Increasing awareness of high school students to radioecology

In March 2019, in Cherbourg-en-Cotentin, IRSN participated in the presentation by 150 high school students and their teachers from three high schools in the Manche department of the results of their scientific work on the risks related to radioactivity, as part of an international program of high school workshops on radiation protection. For the twelfth year in a row, these meetings enabled high school groups from France (Agneaux, Audincourt, Bastia, Boulogne-Billancourt, Cherbourg-en-Cotentin, Coutances, Dunkirk, Marly-le-Roi, Nantes, and Poitiers) and other countries (Belarus, Japan, Moldova) to share their research work, done under the supervision of their teachers, with experts and researchers. A total of 16 high schools contributed in 2019. •

### ↳ Contribution of IRSN to an NEA workshop on stakeholder participation

In September 2019, the 2nd NEA Workshop on Stakeholder Involvement: Risk Communication, Dialogue toward a shared understanding of radiological risks was held in Paris. IRSN's Director General, in his capacity as Chairman of the NEA Nuclear Safety Committee, moderated the session «Engaging in dialogues with civil society and the next generation». Discussions focused on the conditions for dialogue with the public, how to share understanding of risks, and why experts and researchers must engage in dialogue with society.





Producing assessments that meet the evolving safety challenges of nuclear facilities and enhancing their safety is at the heart of the work carried out by IRSN. This covers the operational organization

of its teams, the development of new analytical tools and research programs, and the use of operating experience feedback and the best available knowledge. In 2019, against the background of the possibility of French nuclear reactors continuing to operate beyond the forty years planned for their design, the Institute evaluated the major subjects of the periodic review of the 900 MWe reactors for their fourth 10-yearly outage inspection (VD4-900). At the same time, it continued the review of the Flamanville EPR with a view to its commissioning, including weld anomalies in the main secondary system, and performed the assessment of the periodic review of the UP2-800 plant in La Hague and that of the safety files associated with the dismantling of nuclear facilities. This preparatory work will lead to the submission, in the first quarter of 2020, of its findings on the safety review associated with fourth 10-yearly outage inspection. The Institute will also continue preparation of the corresponding review of 1300 MWe reactors (VD4-1300). Finally, development of the PIREX artificial intelligence tool will enhance analysis of operating experience feedback from nuclear facilities by using the power of algorithms to process a very large amount of data. Actions strengthening the coordinated articulation of assessment and safety research activities will continue in parallel to anticipate the knowledge necessary for risk assessment.

—  
**THIERRY CHARLES,**  
 Deputy Director General in charge of the Nuclear Safety Division

### — Analyzing deviations in welding on the main steam lines of the Flamanville EPR

In April 2019, IRSN presented to the Advisory Committee on Nuclear Pressure Equipment its findings concerning the analysis of the approach proposed by EDF to justify the “break preclusion” of the main steam lines of the main secondary circuit of the Flamanville EPR reactor in northwest France. EDF has chosen to subject the main steam lines of the main secondary systems of the Flamanville EPR reactor to enhanced requirements to prevent a line break with a high level of confidence, so as not to retain the complete break of these lines in the nuclear safety demonstration studies of the facility. However, nonconformities were found on the welds of the reactor’s main steam lines, including eight factory welds located on the containment penetrations. The treatment presented by EDF to ASN in July 2018 favored, for certain welds, a backfitting that would justify “break preclusion” of the lines. For others, EDF planned to justify making no changes, in particular to the welds located on the containment penetrations.

11

technical reviews performed to support ASN Advisory Committee meetings regarding safety

468

technical notices and reports submitted to ASN (excluding defense-related activities)

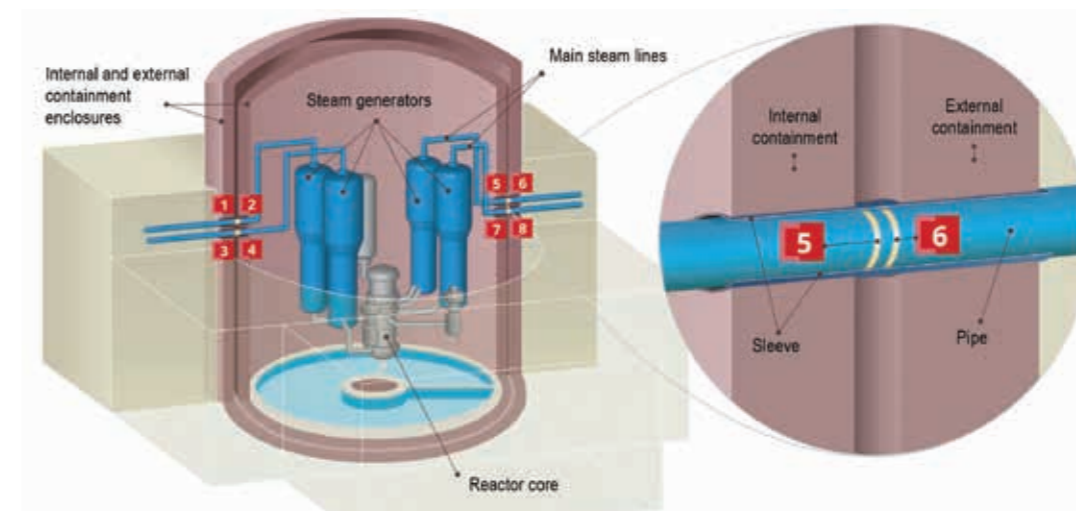
IRSN’s analysis focused on two aspects:

- characterization of the toughness properties of the welds on the main steam lines at the containment penetrations;
- characterization of the phenomenon of “aging under deformation” of the welding materials of main steam lines.

In concluding its assessment, IRSN recalled that the break preclusion process is based on work of excellent quality and on the high level of confidence justified by this quality of work.

### Flamanville EPR: welding anomalies

The welding problem concerns the main lines for removing steam from the secondary system of the EPR. They pass through the double-wall containment enclosure. Eight containment penetration welds are located on lines between the two walls.



#### ■ Containment penetration welds 1 to 8

The main steam lines with break preclusion include 66 welds, eight of which are at the double containment of the reactor. These welds show deviations in their fabrication.

**— Operating experience feedback from EDF's nuclear power plant fleet**

IRSN analyzed the 2015-2017 operating results of EDF's fleet, including operating experience feedback from events reported during this period. In its opinion, the Institute highlights two types of events reported by EDF: maintenance non-qualities and precursor events. For the former, IRSN's study of a sample of 584 events shows that the non-quality problems originate in the work planning and preparation phases. The organizational and technical context in which these interventions take place also contributes to errors made by field personnel. The Institute recommended not limiting analysis of causes to the operator's actions, but to consider more broadly the planning of operations, preparation and feedback from similar activities. The Institute notes that half of precursor events are rooted in maintenance non-qualities, in particular in deficiencies in preparing operations, further supporting the previous recommendation.

**— Putting analyses of events declared by operators to good use**

In late 2019, in order to further improve the conditions for assessing feedback, IRSN launched the PIREX project, winner of the 2019 call for projects from the Fund for Government Modernization. The fund's mission is to increase the effectiveness of public action order to make better use of funds that have been made available. The project will create a digital platform for handling significant events declared by French nuclear operators. This platform should facilitate decompartmentalizing the handling of feedback, drawing lessons to guide IRSN's assessment work, and offer, with the aid of artificial intelligence, analysis useful for all stakeholders involved in the continuous improvement of nuclear safety. By proposing an action with "enhanced assessment", PIREX is part of the objectives to which IRSN has agreed in its 2019-2023 Performance Target Agreement.



**IN BRIEF**

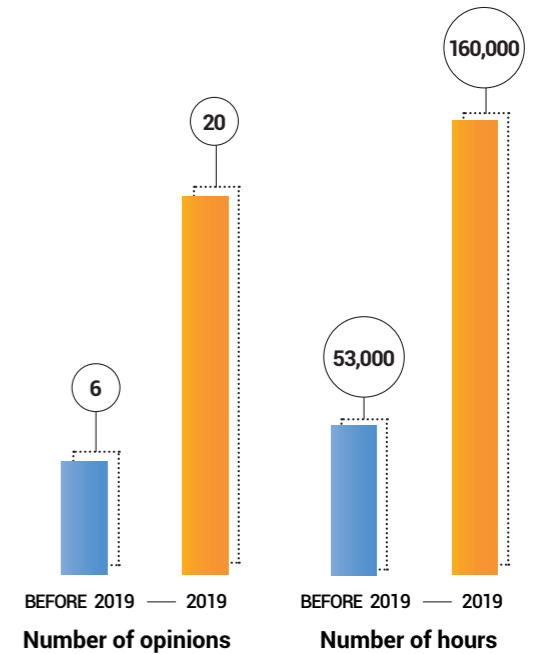
**Safety review**

IRSN completed the assessment of the ten-year safety review of Orano plant UP2-800 for processing spent nuclear fuel in La Hague. The review included evaluation of the facility's compliance with its safety basis and its safety review in light of current best practices.

**Dismantling**

IRSN published a report on nuclear safety, radiation protection and environmental protection issues resulting from the dismantling of pressurized water reactors. It addresses the specific risks associated with the dismantling and cleanup of equipment, structures and soil. It also covers issues related to operators' exposure to radiation, concurrent operations and staggering them over time, as well as organizational and human issues, including subcontracting operations, and the transportation and storage of waste and effluents.

**NUMBER OF OPINIONS GIVEN BY IRSN FOR PREPARING FOURTH 10-YEARLY OUTAGE INSPECTIONS AND RELATED TIME SPENT BY IRSN**



**— Preparation of RP4-900**

In 2019, IRSN continued its analysis of the provisions adopted by EDF in the framework of the fourth periodic review of the 900 MWe reactors (RP4-900). It also undertook to prepare its summary opinion on the review, which is scheduled for publication at the end of the first quarter of 2020. The aim of the 10-yearly safety review of nuclear facilities is to verify compliance with the applicable safety basis and improve their level of safety by integrating operating experience feedback and the latest knowledge. The planned improvements will also make it possible to complete the final phase of changes resulting from the operating experience feedback from the Fukushima Daiichi accident. The fourth 10-yearly visits of the 900 MWe reactors highlighted two particularly important safety topics: the risk of corium melting through the foundation raft in the event of a serious accident and the recirculation of cooling water accumulated at the bottom of the reactor containment in the event of a loss of coolant accident in the reactor coolant system.

For the latter, IRSN conducted tests at the Viktoria facility in 2018 and 2019 in support of its assessment. The facility, inaugurated in 2011 by IRSN and Vuez, its partner in Slovakia, is used to conduct experiments under conditions similar to those likely to be encountered in different types of nuclear reactors during a loss of coolant accident. Finally, in the framework of this fourth review, the Institute played a large part in the consultation with civil society on safety improvements for 900 MWe reactors. Thus, since 2014, in coordination with Anccli, it has sustained a technical dialogue with civil society. It also participated in the public consultation organized by the High Committee on Transparency and Information on Nuclear Safety from September 2018 to late March 2019 and in the proposed public meetings and workshops. It has prepared a list of frequently asked questions available on the consultation website. Through this technical dialogue, IRSN now refers in its opinions to the main questions posed by the public in the framework of the technical dialogue and provides answers to the extent that is possible.





#### — Assessment of the periodic review of the ATALANTE facility at the CEA Marcoule site

At the request of the French Nuclear Safety Authority (ASN), IRSN performed an assessment of the second periodic review of the ATALANTE facility (alpha workshops and laboratories for transuranic analysis and reprocessing studies – INB 148), operated by the CEA. The facility houses research equipment for the processing of irradiated fuels and packaging of high activity nuclear waste. It consists of laboratories, cells and shielded process lines spread over five buildings at the Marcoule site. IRSN found the examination of the facility's compliance carried out by the CEA to be suitable. Operating experience feedback did not reveal any significant points, but particular attention should however be paid to integrating safety requirements into operating documents and ensuring crews apply the safety basis. The safety review of the facility, although requiring some additions, was generally satisfactory, with the operator to continue actions to evaluate how the site would be affected in the event of an earthquake.

#### Review inspection

In October 2019, IRSN provided support to ASN during the review inspection of EDF's Golfech nuclear power plant, which mobilized 11 Institute experts and 13 ASN inspectors for five days.

Finally, no comments were necessary on the accident situations studied as well as the conclusions of the post-Fukushima complementary safety assessments. On the basis of this information, IRSN concluded that, in view of the operator's action plan and the commitments made during the course of the assessment, the measures taken for continued operation of INB 148 are satisfactory. On June 19, 2019, the conclusions of IRSN's assessment were presented to the Advisory Committee for Laboratories and Plants (GPU).

#### — Nonconformities affecting the reactors in operation at the Flamanville nuclear power plant

IRSN analyzed the nonconformities identified for two safety-related systems in Flamanville reactors 1 and 2: emergency generators and cooling water pumping stations (Opinion 2019-00281 of December 12, 2019). EDF highlighted corrosion damage to the pipes and the air cooler supports of the four emergency diesel generators at the Flamanville nuclear power plant during additional checks requested by the ASN following an inspection, in which IRSN participated, on August 30, 2019. On December 2, 2019, during ASN's inspection, in which the Institute also participated, numerous deviations were also highlighted on the equipment of the two pumping stations at the site. After analysis, IRSN considered it essential that these deviations be resolved before restarting the two reactors to ensure the functioning of the systems in all situations for which they were qualified, particularly in the event of an earthquake.

More generally, IRSN expressed its concern about the situation encountered at the Flamanville site and observed that ASN's enhanced surveillance and EDF's action plan were likely to improve the situation. For IRSN, the top priority of the operator of Flamanville must be to make its facilities compliant, starting with all equipment in the safety demonstration, in order to calmly envisage the restart of the two reactors, with extensive analyses of the state of the facilities and site organization. •







### Olivier Dubois, Assistant to the Director of Safety Assessment at IRSN

#### Contributing to the safety of EDF's nuclear power plant fleet during periods of extreme heat

During the heat waves that affected France in the summer of 2019, IRSN and ASN closely monitored the impact of high temperatures and reduced water flows from heat sinks (rivers and canals) on the operation of nuclear power plants. In particular, they requested that EDF measure temperatures in premises with safety-critical equipment. During the 2003 and 2006 heat waves, outdoor air temperatures measured at the sites were higher than those retained in the design basis for the reactors. EDF then established a "heat wave" baseline for each type of reactor to verify the correct operation of safety-critical equipment at higher air temperatures. Since then, some equipment has been replaced with new models that are more resistant at high temperatures. Among the most important safety-critical equipment for a nuclear reactor, emergency diesel generators provide electrical power for backup equipment in the event of an accident. Equipment operation may be affected by high outside temperatures. EDF thus conducted tests during the summer of 2019 on a dozen generators. IRSN is currently analyzing the results and the conclusions will be made in the first half of 2020, with particular attention paid to the changes planned by EDF to ensure reliable operation of generators during periods of extreme heat. ASN also asked IRSN to draw the initial lessons from these heat waves and determine the need for additional measures and monitoring of facilities required during extremely hot periods. ”

## Word from the expert

### Earthquake

Following the earthquake on November 11, 2019 in Le Teil in the Ardèche department in southern France, the reactors in the Cruas nuclear power plant near the epicenter were shut down. IRSN assessed the in-depth diagnosis of facilities carried out by EDF before the reactors were restarted, with a focus on civil engineering structures and the condition of safety-critical equipment. Beyond this initial analysis, the question arises of reassessing the seismic risk at the Cruas and Tricastin power plants. To this end, EDF will submit to ASN the conclusions of its analysis, which IRSN will assess late in the first quarter of 2020.



# 03

## Assessing the safety of defense-related facilities and activities – Contributing to security and nonproliferation



IRSN provides technical support to the competent authorities in the fields of defense nuclear safety, nuclear security, and nuclear and chemical nonproliferation.

In this framework, the Institute upholds its commitment to examining the reports for new defense facilities, reviewing the safety of existing facilities and analyzing reports related to facilities undergoing dismantling. In 2019, it also examined the security reports of new and existing nuclear facilities outside of the defense sector. As part of the technical support it provides to the Ministry for Ecological and Inclusive Transition, IRSN participated in inspections, monitored nuclear material transport operations on French soil and controlled the nuclear material accounting records held by operators. In the field of nuclear and chemical nonproliferation, it continued its review of the reports relating to the Chemical Weapons Convention, of which France is a signatory, and provided support to the Euratom Technical Committee for international declarations. Throughout the year, IRSN made progress in its digital transformation with the ongoing reworking of its protected networks and the digitization of nuclear material accountancy declarations, which has significantly reduced the volume of print-outs and streamlined processes, as well as with the development of software for the computer-based monitoring of nuclear material shipments. Finally, in the field of research, last year IRSN developed its skills in cybersecurity and in research into weapons and explosives through partnerships with the French-German Research Institute of Saint-Louis.

—  
LAURENT MANDARD,  
Director of Nuclear Defense Expertise and Security



## I. DEFENSE NUCLEAR SAFETY

### — Technical support to defense-related facilities and activities

As part of the technical support it provides to the Representative in charge of Nuclear Safety and Radiation Protection for Defense-related Activities and Facilities (DSND), in 2019 IRSN continued its review of the safety measures associated with the core embarkation and criticality of the Suffren, the first nuclear-powered attack submarine in the Barracuda program launched this year. This program consists of the construction of six Suffren-class nuclear attack submarines (SSNs) to replace the six Rubis-class SSNs. IRSN analyzed both the safety reports specific to the submarines and those related to their support infrastructure in Cherbourg, Brest and Toulon. More broadly, the Institute began assessing the studies conducted in the framework of the renovation and adaptation of land-based naval propulsion support facilities. At the same time, IRSN carried out an analysis of the safety files for the naval nuclear propulsion onboard the third-generation nuclear-powered ballistic missile submarine (SSBN). Finally, it supported the withdrawal from service of Sapphire, the first Rubis-class SSN decommissioned by France. •



© Marine Nationale



**David RACIMOR,**  
Head of the Defense Nuclear  
Facilities Undergoing  
Dismantling Assessment Unit

### Creation of the Defense Nuclear Facilities Undergoing Dismantling Assessment Unit

The Defense Nuclear Facilities Undergoing Dismantling Assessment Unit (Bureau d'évaluation des installations nucléaires de la défense en démantèlement, BEIND) was created within IRSN's Defense and Security Division in readiness for the heightened safety assessment activity related to the CEA Marcoule regulated nuclear defense facility, located in the Gard department, now mainly in the dismantling phase. After opening in 2018, BEIND, which I was tasked with leading, examined several reports in 2019 on some of the most important issues for the Marcoule site: the recovery of legacy waste from decladding facilities and magnesium structural waste, the safety review of the plutonium extraction plant, the safety review preparation file for certain Generation-I reactors, as well as the one for part of the site's liquid effluent treatment plant. ”

Word from  
the expert

55

technical notices and reports  
submitted to the ASND

111

technical notices issued to the MTES  
Senior Defense and Security Official

## II. NUCLEAR SECURITY

### PHYSICAL PROTECTION OF NUCLEAR MATERIALS

#### — Numerous security inspections, assessments and instructions

The regulations on the protection and control of nuclear materials, in facilities and during transport (PCMNIT), laid down in Article R. 1333-1 of Decree No. 2009-1120 of September 17, 2009, govern the possession, use and transport of nuclear materials (deuterium, lithium-6, plutonium, thorium, tritium and uranium). The application of this regulation is monitored based on a program of inspections conducted in nuclear facilities in operation, defined by the departments of the Senior Defense and Security Official of the Ministry for Ecological and Inclusive Transition. In 2019, as part of its duties, IRSN contributed to around 100 inspections conducted in facilities according to two methods: firstly, technical assistance for which IRSN staff act as inspectors on the authority of the Ministry, and, secondly, technical support in which they prepare inspections and escort the inspectors in the field. As inspectors, they also carried out more than 30 inspections on shipments of nuclear materials. Another area in which IRSN is involved at the service of public authorities is the assessment of security studies for facilities holding nuclear materials. These security studies are split into two sections: first of all, threat characterization, which consists in presenting the assumptions adopted by the operator to model the capacity for action for the design-basis threats of theft or sabotage, as defined by the national security directive applicable to nuclear facilities; followed by the sensitivity study, which consists in the operator identifying potential targets at their facility in relation to the various threats considered; and, finally, the facility vulnerability study, which must demonstrate the ability of the security measures implemented by the operator to protect the targets identified against these various threats.

53

technical checks of approved  
equipment for the transport  
of nuclear materials

35

shipment inspections

#### Participation in the International Cybersecurity Forum

IRSN took advantage of its participation in conferences at the International Cybersecurity Forum in Lille in January to drive progress in a project to create a virtualization platform for research into information systems. At the head of a delegation of cybersecurity specialists, its Deputy Director General in charge of defense-related and national security missions consulted with partners and industrial stakeholders in the field.

#### Coordinating security exercises

On behalf of the MTES Senior Defense and Security Official, IRSN organized, led and evaluated two security protection and assessment exercises (EPEES), involving several hundred workers. One took place on Framatome's site in Romans-sur-Isère, the other at the CEA Marcoule center. These exercises tested the protection measures put in place by operators, as well as how they are coordinated alongside State resources, to deal with an act of terrorism.

In 2019, IRSN issued its opinion on the threat characterization and sensitivity studies for several fuel cycle facilities. In 2019, IRSN also submitted opinions on the incorporation of security requirements from the design stage of projects for future nuclear facilities. It therefore issued opinions on the review of the security options report for EDF's future centralized spent-fuel storage pool and on the preliminary information submitted on the security of the Cigeo project for a deep geological radioactive waste repository. The Institute provided the information to the Senior Defense and Security Official prior to the start-up of Orano's Philippe Coste plant in late 2018, in readiness for it reaching its nominal capacity in 2021. Finally, experts from the Institute issued two opinions on the vulnerability study for new facilities on the Framatome site in Romans, as well as on the project for a new response center located on the CEA Cadarache site. It should be noted that the various analyses conducted in this way by IRSN were done through interaction between the Institute's safety experts and security experts. In the field of nuclear material transport security, IRSN Transport Operations examined over a thousand requests for authorization to transport these materials submitted by licensed carriers and then performed its role of operational monitoring and alerting for shipments in progress. For this purpose, it has an information system that is undergoing an ambitious modernization program, as part of the digital transformation objective set out in the 2019-2023 Performance Target Agreement between the French State and IRSN. •

### III. NONPROLIFERATION



#### ↳ IRSN at the 60<sup>th</sup> INMM Annual Meeting

At the 60<sup>th</sup> Annual Meeting of the Institute of Nuclear Materials Management (INMM), held in California, IRSN presented its work, conducted for the CTE, on the collection and evaluation of open-source data for the application of the Additional Protocol to the safeguards agreement between France, Euratom and the IAEA. INMM is one of the leading associations in the field of security and safeguards for nuclear nonproliferation.

#### NUCLEAR

##### — Contribution to IAEA activities

IRSN continued to play an active role with the IAEA in the field of safeguards agreements signed between IAEA and the signatory States to the Treaty on the Non-Proliferation of Nuclear Weapons (NPT).

- The Treaty of Tlatelolco established the first nuclear-weapon-free zone in Latin America and the Caribbean. It was ratified by all 33 countries concerned. One of its protocols requires the States to sign a comprehensive safeguards agreement with the IAEA. In March 2019, a draft French declaration – prepared by IRSN on behalf of the Euratom Technical Committee (CTE) – was sent to the IAEA for the first time on small quantities of nuclear material held in the French Antilles, a region covered by the Treaty of Tlatelolco.

- In the context of discussions on IAEA safeguards, IRSN contributed to the public authorities' considerations by providing the French authorities, in particular the CTE, with technical information on potential changes to current measures.

##### — Preparing for Brexit

Britain's exit from the EU will change, at least temporarily, the regulatory framework governing the imports and exports of nuclear materials between France and the UK. IRSN analyzed the consequences that this will have for the French authorities, in particular in relation to prior notification and the associated timeframes. It also assessed the impact that future changes will have on its own tools developed for managing notifications.

# 51

missions to escort inspections involving international nuclear material control

# 11

missions to escort international inspections relating to the prohibition of chemical weapons



#### ↳ Visit by Isabelle Braun-Lemaire

In January 2019, Isabelle Braun-Lemaire, General Secretary and Senior Defense and Security Official of the Ministry for the Economy and Finance, met with the IRSN team which, on her behalf, is in charge of implementing the Chemical Weapons Convention (CWC) in the industrial sector. Her visit gave rise to in-depth discussions on the activities carried out by the Institute for the benefit of the State and industry.

#### CHEMICAL

##### — Support to the OPCW

IRSN provides technical support to the Ministry of Europe and Foreign Affairs and the Ministry for the Economy and Finance for implementing the Chemical Weapons Convention (CWC) in the civil sector throughout France. In 2019, for the first time, France provided support to the Organisation for the Prohibition of Chemical Weapons (OPCW) through IRSN: as part of the OPCW's mentoring program, France hosted four representatives from the Côte d'Ivoire in charge of implementing the Convention in their country. This task entrusted to France reflects the OPCW's recognition of the Institute's expertise and know-how in ensuring that the Convention is properly implemented. Another IRSN publication was presented on this occasion: the booklet on preventing the diversion of chemicals and chemical facilities, developed in partnership with different federations and labor unions in the chemical and textile industries. The aim of the publication is to raise awareness among the various stakeholders about the dual-use products that they use.



#### Guillaume Daniel, Head of the Nuclear Section

2019, a year filled with international relations in the field of nonproliferation

For IRSN, 2019 will have been marked by international relations in the field of nonproliferation. First of all in March 2019, when the Euratom Technical Committee, the Ministry for Ecological and Inclusive Transition and IRSN hosted their British counterparts from the Office for Nuclear Regulation (ONR) in Paris. We discussed our respective practices in terms of nuclear materials monitoring and control, which enabled everyone to develop their vision of these activities in different national regulatory frameworks. On this occasion, the French party presented the resources put in place by France – in particular, the tools and Internet portals set up by IRSN – to meet its international obligations in this field. In May, the Institute joined a meeting with the Ministry of Europe and Foreign Affairs, the Euratom Technical Committee and the Australian Safeguards and Non-proliferation Office (ASNO), which, on behalf of the Australian Parliament, is responsible for ensuring that France meets the commitments made under a bilateral agreement signed with Australia strictly limiting the use of radioactive materials imported to the civilian sector. We provide ASNO with information for them to compare with their own data and with those provided by third parties that use nuclear materials subject to this agreement. With a view to efficiency, the discussions provided the French participants with a better understanding of the type of information that is useful to ASNO for carrying out its duty.”

Word from  
the expert



## PHYSICAL MONITORING OF NUCLEAR MATERIALS

### — Assessment of radiation detection instruments for detecting the trafficking of radioactive materials

The fight against the illicit trafficking of radioactive and nuclear materials is one of the ways in which IRSN contributes to nuclear security. Preventing this trafficking is based on the installation of radiation detection instruments, for which it is difficult to assess the performance: there are several possible scenarios and configurations, the environment in which the detector is installed has a significant impact on the results, and there are numerous sources of uncertainty. From 2016 to 2019, as part of a consortium led by France Expertise, IRSN participated in the Illicit Trafficking Radiological Assessment Program (ITRAP+10) initiated by the European Union and the United States to evaluate the performance of commercial radiation detection equipment available on the market. The program consisted of two studies: one on the modeling of detection instruments and another on their configuration according to the settings chosen and the nature of the sources to be detected. Within this framework, IRSN developed static and dynamic equipment test benches and conducted some 2,500 tests on different detection instruments. It extrapolated the results of the tests carried out to validate the models of the detection instruments and to simulate situations with sources passing by, in order to assess the probability of detection of each detector depending on the sensitivity of the configuration. The Institute shared the results of its assessments in June 2019 in Portorož, Slovenia, at the 2019 ANIMMA International Conference on Advancements in Nuclear Instrumentation Measurement Methods and their Applications. These results show a good correlation between the detection instrument models and the experimental data obtained. They make it possible to select the operating characteristics of a given detector to establish an optimal ratio between the false alarm rate and the detection probability for radioactive and nuclear materials.



## NUCLEAR MATERIAL ACCOUNTING

### — Contributing to regulatory developments

2019 marks the tenth anniversary of the implementation of Decree No. 2009-1120 on the protection and control of nuclear materials, in facilities and during transport (PCMNIT). At the request of the Ministry for Ecological and Inclusive Transition and in liaison with the Euratom Technical Committee, IRSN provided an assessment on the prospects of future changes to regulations. The Institute has in particular studied the consequences of potential developments on the implementation of the centralized nuclear material accountancy system entrusted to it. Its analysis focused on the effectiveness of monitoring and control, on the use of information required to comply with international laws on the control of materials, such as the safeguards agreement between France, Euratom and the IAEA, and on certain bilateral commitments.

### Training for IPPAS missions

Three IRSN employees were trained to fulfill missions of the International Physical Protection Advisory Service (IPPAS), a service undertaken by the IAEA at the request of a Member State to assess its level of compliance with international good practices in nuclear security. This training provided by the IAEA will enable IRSN to contribute to such missions.

### — Digitalization

As the first step in a comprehensive approach to digitalization, in February IRSN set up PATIO, a telematics access portal for operators. This digital platform intended for exchanges between the centralized accountancy system and nuclear material holders simplifies and speeds up contact management.

In addition, 2019 saw a significant decline in the volume of paper mail sent related to the monthly inventory check between the centralized accountancy system and operators' local accountancy records. This comprehensive digitalization approach has been incorporated into the renewed contract for the maintenance and updating of the centralized nuclear material accountancy software program (LCCMN), the basis of centralized accountancy. ●



### Contribution to IAEA training

IRSN participated in an IAEA working group to develop an online training course on accountancy and the control of nuclear materials. As a trainer in the field of nuclear material accountancy, it also contributed to a training program organized by the IAEA in South Korea.



## OLIVIER FICHOT, Head of the Cybersecurity and Protection Systems Research Unit

### Cybersecurity management for industrial control systems: IRSN employees honored

IRSN's Cybersecurity Unit is tasked with assessing the security of the information systems used by nuclear operators, starting with EDF, Orano and CEA. To do so, it conducts studies, tests and inspections on both their physical protection systems and on their I&C systems. These are rapidly changing fields with regard to technology, which implies a continuous effort on the part of the Institute to maintain its expertise. This is provided through training seminars and ethical hacking competitions consisting in entering a system (computer or robot) in order to identify any vulnerabilities and correct them. In 2019, one of our employees was honored in a competition between pen testers to hack industrial connected objects, while another employee was awarded an American certification in cybersecurity management for industrial control systems. Through training and competitions, IRSN is able to verify the effectiveness of the measures put in place by operators and to make them aware of good practices for information system security. At the end of 2019, the Institute developed a platform for virtualizing computer systems and will connect modules to it in 2020 to partially simulate industrial I&C systems, access control systems, etc., helping to strengthen its autonomy in this area. ”

Word from  
the expert



Given the increasing frequency with which IRSN is solicited by different stakeholders in society – MPs, local information commission members, citizens, etc. – its experts must be able to provide substantiated answers to the questions asked. In recent years, IRSN has been increasingly called upon by health authorities to help them to understand the origins of clusters of diseases such as cancers or malformations. In these circumstances, where it is very difficult to establish a link between the effects observed and the causes, the Institute provides scientific insights alongside other health agencies. Moreover, to best address these questions about the link between environment and health, IRSN, which collects large amounts of data in both of these fields, is developing tools that can cross-reference all of this data thanks to artificial intelligence, which should make it easier to establish potential links between environmental causes and the consequences or impacts on health and to learn from them for the management of radiological risk. Another trend is the growing call for diagnostic techniques or therapy treatments that use ionizing radiation. For IRSN, the rapid development of these techniques creates a closer link to the hospital world in the form of collaborations, enabling it to closely monitor the changes to these techniques in order to guarantee patients a high level of radiation protection. Finally, in regard to research, the projects in which IRSN became involved in 2019 reflect a step toward a heightened partnership approach in France, Europe and around the world.

— **JEAN-CHRISTOPHE GARIEL,**  
Deputy Director General in charge of the Health and Environment Division

## I. PROTECTING THE ENVIRONMENT

### — PNGMDR: two IRSN reports issued to inform the public debate on radioactive waste management

IRSN conducts research and assessments of all aspects related to the treatment and management of radioactive waste. In order to provide technical and scientific insights into the preparation of the public debate on the fifth National Radioactive Materials and Waste Management Plan (2019-2021 PNGMDR), Chantal Jouanno, President of the French National Public Debate Commission (CNDP), solicited IRSN for two assessments. The first of the two reports submitted by IRSN to the CNDP in May focuses on the analysis of the dry storage options for radioactive fuels. The assessment considered the potential suitability of dry storage for some spent MOX and ERU fuels currently stored underwater. It also reviewed possible changes to current dry storage and transport concepts that would make them suitable for spent fuels with residual heat levels that are significantly higher than the current reference values. This technical assessment supplements the one conducted by IRSN in 2018 for the Parliamentary Committee of Inquiry into the Safety and Security of Nuclear Facilities in France. The second report, *International Panorama of Research on Alternatives to Geological Disposal of High- and Intermediate-Level Long-Lived Waste (HLW/ILW-LL)*, is a bibliographical review. Using information published by national and international agencies (IAEA, OECD/NEA) and in scientific journals, it identifies the main alternatives to geological disposal explored around the world. It provides historical and scientific evidence to appreciate the context in which these options came about, were explored and, in some cases, rejected. It also identifies any relevant technical and societal issues.



This work has provided citizens with food for thought on the key issues discussed in the various forums for public debate in which IRSN experts and researchers actively participated. By the same token, they informed the public decision.

### — Radon: new tools, new measurement campaigns

For several years, IRSN has been committed to supporting public authorities and local stakeholders in protecting against the dangers related to the presence of radon in buildings, which constitutes a public health issue. This naturally occurring radioactive gas is the second leading cause of lung cancer in France after smoking. With a view to accompanying the implementation of regulatory changes to radon risk management in 2018 resulting from the transposition of European Directive 2013/59/Euratom, IRSN carried out two actions in support of public authorities. At the request of the Directorate-General for Health, IRSN developed a protocol for measuring radon concentrations in a sample of facilities open to the public in French Guiana, Wallis and Futuna and Saint Pierre and Miquelon. The objective was to update or obtain data prior to the implementation of radon monitoring and risk management measures in overseas regions. Measurement campaigns conducted in French Guiana and Wallis and Futuna in collaboration with local health authorities showed annual average radon concentrations below the reference level of 300 Bq/m<sup>3</sup>. A campaign in Mayotte is also planned for 2020. At the request of the Directorate-General for Labor, the Institute developed a guide containing instruction sheets for employers so that, in accordance with new regulatory requirements, they are able to measure the radon concentration themselves in workplaces where it is likely to reach or exceed 300 Bq/m<sup>3</sup>. →

### IN BRIEF

#### PETAL, a portal for ordering radioactive sources

IRSN has developed a collaborative tool through which, in just a few clicks, its laboratories can order the radioactive standard sources essential for the development of their activities: calibration of measuring instruments, marking of samples, requirements related to COFRAC accreditation. While reducing the processing time of orders, the portal makes it easy to track the unsealed sources provided.





### Michel BAUDRY, Deputy Director of the Environment

#### Investigations into the cause of a high level of tritium measured in the Loire

During the year, IRSN conducted various investigations to understand the origin of an unusually high level of tritium measured in the Loire River. On June 18, the Association for Radioactivity Monitoring in Western France (ACRO), an approved laboratory for the measurement of radioactivity in the environment, drew the attention of the public and the authorities to the high level of one of the tritium measurements carried out in the Loire riverbed, in Saumur, during a citizen measurement campaign in the river's drainage basin. Two days later, IRSN published a notice confirming the exceeded value, without any health issue, revealed by ACRO and specifying its strategy for identifying the causes of the anomaly. "As part of its responsibility regarding the radiological monitoring of the environment, the Institute is taking urgent action to eliminate any doubt about a suspected abnormal situation that could affect the integrity of the ecosystems", explains Michel Baudry. IRSN then investigated three avenues: a discharge of tritium from one or more of the operator's facilities; hydrological conditions prevailing at the time of the sampling; and a discharge from a source other than EDF. Following its checks, calculations, modeling of tritium transfer and surveys, IRSN published its findings in October: the anomaly was in all likelihood related to the hydrological characteristics of the Loire River at the time of sampling, since the sample measured was probably taken in an area where the water had not mixed properly. However, considering the unusually high tritium concentration observed (310 Bq/L), IRSN decided to further investigate by organizing a new sampling and measurement campaign with ACRO in 2020. "

## Word from the expert



→ This year, IRSN contributed to the development of the Franco-Swiss platform jurad-bat.net, which was launched in June 2019. This knowledge-sharing tool on indoor air pollution and radon will promote the pooling of skills and experience and contribute to training professionals in the region in radon risk management. A measurement campaign initiated by IRSN in Baume-les-Dames, in collaboration with the Doubs Center for Balanced Urban and Rural Development, showed that 25% of the results exceed 300 Bq/m<sup>3</sup>. IRSN supported the private individuals involved in studying solutions to reduce radon concentrations, in partnership with experts in the construction industry. •

#### Report on the Radiological State of the Environment in France

IRSN presented and commented on its analysis of the results of measurements carried out between 2015 and 2017 in the environment surrounding nuclear sites in France by the various member organizations of the National Environmental Radioactivity Measurement Network (RNM). This report shows that the radioactivity levels measured are highly stable. It includes assessments of the doses likely to be received by populations living near the sites. For the first time, it presents a section on former mining sites.

# 502

monitors make up France's remote monitoring network,

including

# 438

Téléray stations

## II. PLAYING AN ACTIVE ROLE IN PUBLIC HEALTH

### 2<sup>nd</sup> report on children's exposure through diagnostic medical imaging

Medical imaging is undeniably beneficial to patient care. It is, however, the main factor contributing to the population's exposure to artificial ionizing radiation, to which children are especially sensitive. As part of its duty to monitor the radiobiological exposure of the French population, which it has been carrying out since 2003, the Institute dedicates a specific report to the monitoring of children under 16 years of age. To do so, it implements the national ExPRI system (exposure of the population to ionizing radiation) through which it provides authorities and health professionals with up-to-date data on the monitoring of the various medical procedures: conventional, dental and interventional diagnostic radiology, computed tomography and nuclear medicine.

Its second report highlights a marked decrease in the radiological exposure of children in France for the 2010-2015 period, even though the average frequency of medical imaging procedures remained relatively stable, both in number and in breakdown by imaging method.

In 2015, 604 diagnostic procedures were carried out per 1,000 children, an increase of 1.5% compared with 2010. The annual effective dose for exposed and non-exposed children fell by 25%. The effective dose for exposed children dropped by 34%.

This observed decrease in exposure is therefore exclusively due to the overall decrease in average dose per medical imaging procedure.

It is explained by improvements in technology and the optimization of practices in radiology departments and clinics, both of which are the result of intensified awareness campaigns conducted by the authorities and learned societies. •

#### Treatment of an irradiated patient

Under the auspices of the IAEA, IRSN contributed to the care of a Georgian patient at Percy Military Hospital who was accidentally exposed to radiation twenty years ago. Suffering from severe complications, the patient received treatment involving a combination of reconstructive surgery and cell therapy. This new medical protocol is the fruit of the continuous improvement of knowledge on the treatment of radiation-induced lesions in which IRSN participates.



#### Report on occupational exposure

IRSN presented its annual report on the exposure to ionizing radiation of approximately 400,000 workers monitored in the health, nuclear, industrial, research and air transport sectors. Revealing a small change in indicators, the report confirms the need to maintain specific monitoring in the fields of dismantling, subcontracting and interventional radiology.

# 599

whole-body counts for the individual monitoring of workers, including

# 421

using mobile facilities



### Collaboration agreement with Nagasaki University

During several scientific seminars in which IRSN participated in Japan, the Institute signed a collaboration agreement with Nagasaki University to study the effects of ionizing radiation on living organisms through experimental and epidemiological research. This approach is part of IRSN's commitment to strengthening its links with the various Japanese organizations specializing in radiobiology.



### Pascale SCANFF, Head of Data Use and Application Development (SVDDA)

#### AI in the service of exposed workers

IRSN is one of the 15 winners of the State's call for expressions of interest to experiment with artificial intelligence in the public service. As such, it will develop a prototype automatic alert system to assist in the monitoring of workers exposed to ionizing radiation.

The efforts of a team of experts in radiation protection and data use at IRSN were key to the success of this project. IRSN will explore the use of algorithms to develop a tool capable of automatically detecting abnormal dose values among a set of measurement results. This will grow with the data on the context of the worker's exposure available on the SISERI platform managed by the Institute: sector of activity, occupation and dose kinetics over time. The national SISERI register centralizes, verifies and stores data from the dosimetric monitoring of the 400,000 workers exposed to ionizing radiation in France. The individual dose values recorded are currently compared to the limits set by regulations in accordance with the principle of exposure limitation.

By providing indications with regard to the work context, the future alert system will facilitate the application of the principle of radiation protection optimization ALARA: keeping the dose received "As Low As Reasonably Achievable".

This project provides IRSN with the opportunity to make the most of its skills in data science. It confirms its desire to experiment with AI techniques in order to improve the effectiveness of its monitoring work in the field of radiation protection. The method of automatically detecting anomalies in data sets will have many uses on the large volume of data obtained by the Institute through monitoring. ”

Word from  
the expert

# 05 Developing international cooperation



Whether in the field of research or assessment, international partnerships are an increasingly strategic lever of development for IRSN. Seeking greater proximity and interactivity, the teams in the

International Affairs Division and in IRSN's functional and operational divisions are working together more closely. This closeness makes it possible to better identify the research or assessment subjects in which IRSN and its counterparts around the world have skills and technical resources that can be pooled, particularly through cooperation agreements, in order to improve efficiency. For example, in research most of the large experimental facilities under the leadership of IRSN are already being operated with the support of its traditional partners and seeing new players, such as China, join forces. This is the case for GALAXIE, for instance, a facility for research into the control of fire risk in nuclear facilities, or the ODOBA platform for the study of concrete pathologies and their consequences for nuclear building structures, etc. In the field of assessments, IRSN and some strategic partners such as its Belgian counterpart, Bel V, or its German one, GRS, share their skills and good practices as part of their cross-examination of major safety reports. Finally, in fields such as emergency response management – a strategic objective in the Performance Target Agreement between the French State and IRSN – the memorandum of understanding signed with the United States will contribute to strengthening the Institute's level of emergency preparedness.

—  
CYRIL PINEL,  
Director of International Affairs





— **IRSN participates in the work of the G7**  
Under France's G7 Presidency in 2019, IRSN hosted experts from the Nuclear Safety and Security Group (NSSG) at the Cadarache site in southeastern France in April 2019. At the initiative of the French G7 Presidency, NSSG members studied the question of the "availability and sustainability of scientific assessment to support nuclear safety decisions". On this occasion, research facilities were presented to the NSSG delegation: the CABRI experimental reactor, which aims to study the behavior of fuel rods during reactivity injection accidents; the GALAXIE platform, used to study fire risk in nuclear facilities; and the ODE platform, used to simulate the accelerated aging of the concrete used to construct them. During discussions with experts from the Institute, the delegation addressed, among other things, the challenges of maintaining a high-level research tool to support assessment work, as existing research facilities age or are closed, in particular to ensure that knowledge and experience are passed on to the younger generation of experts.

### Cooperation

On the occasion of the visit by the Director of NSC, IRSN's counterpart TSO in China, accompanied by a representative of the National People's Congress of the People's Republic of China, IRSN and NSC renewed the bilateral cooperation agreement on safety and radiation protection for ten years. NSC highlighted its interest in the technical subjects of dismantling, reprocessing and research on severe accidents. This interest was confirmed during the French President's state visit to China, during which a memorandum of understanding on fuel safety was signed between IRSN and the NSC. During the visit, cooperation was also suggested on the question of concrete aging, thereby opening up the prospect of broadened and long-term cooperation between IRSN and the NSC.

### IN BRIEF

#### EUROSAFE

The annual EUROSAFE Forum was held on November 4 and 5 in Cologne, Germany, bringing together the teams of European technical safety organizations (TSOs) to discuss nuclear safety and radiation protection issues. EUROSAFE was also an opportunity to exchange with TSO partners: a total of 16 institutions were present, including the International Atomic Energy Agency (IAEA). The next Eurosafe Forum will be held in Paris from November 2-3, 2020.

#### — Participation in the IAEA General Conference

IRSN actively participated in the 63<sup>rd</sup> IAEA General Conference, held in Vienna on September 16-20, 2019, with a scientific forum on health and the use of ionizing radiation, a source of innovation for treating cancer. The General Conference provides Member States with an opportunity to share details about their nation's nuclear program and various current issues, particularly in the scientific field. High-level contributors included several experts from the Institute, with a speech by Marie-France Bellin, Professor of Medicine and Chair of the IRSN Board of Directors on technological advances in nuclear and radiological medicine. Outside the conference, IRSN participated in several side events on the aging of nuclear facilities or the lessons to be learned from the treatment of a Georgian patient suffering from radiological burns at Percy Hospital, with the support of the Institute. Lastly, the final seminar of the European FASTNET project took place during the Conference. The project involves 20 partners from 18 countries, along with the IAEA, and aims to provide faster, more structured responses to emergency situations at most nuclear power plants in order to better protect the surrounding population. Bilaterally speaking, IRSN has been solicited on numerous occasions and, through the signing of agreements, has consolidated its relations with its principal partners (Belgium and Finland), while opening up prospects for new partnerships with other countries, such as Canada, Spain and Singapore.



### Karine Herviou, Director of Systems, New Reactors and Safety Initiatives

#### IRSN safety assessments for the development of Small Modular Reactors (SMR)

IRSN is actively involved in discussions on the safety approaches for Small Modular Reactors (SMR). These small, modular, low-power reactors are designed to be manufactured and assembled in series, in the factory, to facilitate their installation on site. The power of these reactors is less than 300 MWe, giving them intrinsic safety properties that are generally better than higher-power reactors that use the same technology. Their specific characteristics (compactness, more extensive use of "passive" systems, construction method, etc.), however, raise new issues. For several years, the IAEA SMR Regulators' Forum has sought to better understand and anticipate the developments necessary both in terms of regulations and safety assessment practices for this type of reactor. It brings together the safety authorities of the United States, Canada, the United Kingdom, the Russian Federation and China, and makes recommendations to design engineers and potential operators. In this way, IRSN shares its experience in the safety assessment of standardized reactors, as well as in recent projects, such as the Flamanville EPR. As Vice Chair of the Forum, I speak regularly, for instance to express the position of the SMR Regulators' Forum to the NEA Committee on Nuclear Regulatory Activities in June, and more recently during a side event of the IAEA General Conference relating to the Regulatory Cooperation Forum. ”

Word from  
the expert

#### — Cooperation with the National University of Singapore

As part of the partnership on nuclear safety training signed in 2015 with the National University of Singapore (NUS), in February 2019 IRSN hosted representatives from the National Research Foundation (NRS) and the Singapore Nuclear Research and Safety Initiative (SNRSI). The aim of the visit was to review cooperation between the two entities and to discuss the content of a new agreement to strengthen the collaboration. The fields covered by current cooperation include safety assessments with severe accident modeling, emergency response and the training of Singaporean experts through the European Nuclear Safety Training and Tutoring

Institute (ENSTTI). In this context, ENSTTI and SNRSI signed a cooperation agreement for training and tutoring in the field of nuclear safety and radiation protection. Thus, several national and regional training courses have been carried out by IRSN, ENSTTI and SNRSI in Singapore. Similarly, several Singaporean interns came to IRSN for training courses or tutoring lasting one to six months. For the renewed agreement, the Singaporean representatives would like to extend the areas of cooperation, in particular to include environmental fields, such as radiochemistry, and the effects of radiation (radiobiology). Additionally, IRSN and the SNRSI are interested in developing research exchange programs between laboratories.

### Emergency response

A workshop was held in January 2019 between IRSN and the Japanese agency JAEA on the topic of emergency preparedness and response. The seminar provided an opportunity to discuss the measurement strategy for establishing post-accident zoning and to introduce the emergency response organizations from the two entities.

241

bilateral cooperation agreements in force with research and assessment organizations

47

international projects in progress under the aegis of OECD NEA, the European Commission or the ANR

49

countries involved in these agreements

### — Partnership renewed with Bel V

In 2019, IRSN renewed the framework agreement with Bel V, a long-standing partner of the Institute, for five years. This agreement facilitates cooperation and technical discussions in the field of radiation protection and nuclear safety. In this framework, cross-assessments were carried out, confirming the respective positions of the two institutes on certain sensitive subjects, such as the structural damage to a bunkered building at Doel nuclear power plant. In addition, several joint research projects are being conducted with Bel V, including the European FASTNET project completed in 2019. The FASTNET project led to the two partners discussing the '3D/3P' assessment method used at IRSN in emergency response situations to diagnose the situation and make a prognosis as to its development, as well as the utility of having effective tools to assess the releases. Finally, IRSN participated in the drafting of bids for calls to tender within the framework of the Instrument for Nuclear Safety Cooperation (INSC), in consortia involving Bel V and other Belgian partners.

### ↴ Dismantling

IRSN is now a member of the new committee on the dismantling of nuclear facilities and the management of legacy sites created within the NEA to help its members to manage a wide range of issues related to dismantling. The Institute will contribute to the harmonization of nuclear safety practices and approaches for the dismantling and management of legacy sites.

### ↴ Tools for emergency response

In March 2019, IRSN signed a memorandum of cooperation with the NRC's Office of Nuclear Security and Incident Response (NSIR) to strengthen cooperation between the two entities. This partnership provides for cross-participation with observers during exercises in France and the United States in order to compare the various analysis and diagnosis/prognosis methods, as well as the computer codes used in emergencies.

### ↴ Assistance

IRSN is involved in 12 of the 13 tasks in the INSC contract to provide assistance to the Chinese safety regulator (NNSA/NSC). In particular, the Institute is involved in developing the nuclear safety R&D program. Through this work, 43 themes were identified for which the NSC participated in international bodies along with 14 research programs involving Chinese and European organizations.

### ↴ Security

IRSN met with its U.S. counterparts as part of the 12th IRSN-DOE/NNSA Permanent Coordinating Group in early September. Thanks to constructive discussions, the two partners plan to create new projects in the fields of cybersecurity, the effects of weapons and explosives, and measurement methods for nuclear and radiological materials safeguards and security.



### — Participation in ETSO work

IRSN is particularly active in ETSO, the European Technical Safety Organisations Network. In 2019, ETSO members were dedicated to responding to and winning the European Commission's call to tender for the technical implementation of safety directive 2013/59/Euratom. The work is still in progress and the results will be presented at the Commission in 2020. Discussions are also ongoing to establish a closer relationship between ETSO and the Western European Nuclear Regulators' Association (WENRA) through technical collaboration. This would strengthen the European safety architecture, built around the European Commission, national regulators and technical safety organizations. In addition, ETSO continues to develop with the creation of a group tasked with communicating and promoting the role of TSOs. ETSO has also just published an update to its Safety Guide, the umbrella document for its Technical Safety Assessment Guides.

# Informing the public

# 06



One of the tasks in the general interest entrusted to IRSN is the contribution to informing the public on nuclear and radiological risks. It is an activity that requires a clear, educational approach in order to enable a wide audience – school audiences, the general public, the press, etc. – to better understand and apprehend the challenges of nuclear risk control. To achieve this aim, the Institute has developed its communication strategy to extend the reach of its actions. IRSN is now developing a wide range of material: publications, digital content (websites, social networks, etc.), data visualization, podcasts, videos, exhibitions, conferences...

—  
MARIE RIET-HUCHELOUP,  
Director of Communications



### — More educational communication that is adapted to new modes of communication

Throughout 2019, IRSN has enhanced its communication by adapting it to new formats and taking a more educational approach. Social media is now an integral part of our daily lives. For several years, IRSN has taken advantage of this new opportunity to inform and interact with its audiences by adapting its communication to these new formats. It is now present on Twitter, Facebook, LinkedIn and YouTube. In 2019, in order to broaden the scope of its knowledge while applying a clear and educational approach to sometimes very technical notices and reports, IRSN developed communication materials for educational purposes. Thus, through the Institute's involvement in the fifth National Radioactive Materials and Waste Management Plan (PNGMDR), it has made six podcasts available to a vast audience via social media (LinkedIn, Twitter, website), not only to explain the challenges of the Plan and IRSN's involvement but also to make the technical aspects of the debate more accessible (difference in and feasibility of different waste storage options, for example). On Twitter, campaigns to inform and decode science have raised our profile. For example, the campaign carried out on Twitter and LinkedIn about the IRSN 2019 Barometer on risk perception and safety (48 messages on the main lessons learned from the Barometer between October 2 and November 6, 2019) contributed to an increase of more than 15% in our Twitter following and of more than 60% on LinkedIn. At the end of the year, the earthquake in Le Teil called on the action of IRSN experts. Explaining this earthquake and the risks associated was one of the communication challenges for IRSN: a video was produced, led by an IRSN expert who provided the educational material to understand the significance of this event. Broadcast on our digital platforms and our YouTube channel, its success confirmed the value of adapting our communication to new uses.

#### GROWING AUDIENCES

##### Informing the public

16,030

followers on Twitter

18,806

followers on LinkedIn

3,022

followers on Facebook

4,165,880

pages viewed on the IRSN website

151,742

pages viewed in the section on research

261

notices and reports published on the IRSN website

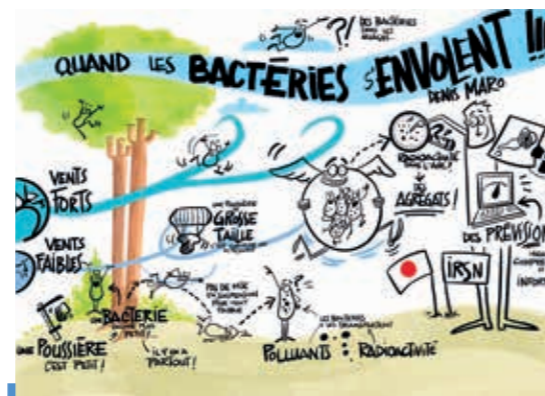
#### IN BRIEF

##### Education

In October, IRSN participated in the Science Day in mainland France, overseas regions and abroad with the theme "Talk Science, Imagine the Future", including: a Science Live event at Forum des Halles (Paris), a "Video makers Celebrate Science!" evening, an open day for schools, and a science workshop in Cadarache.

##### Environment

As part of IRSN's educational activities for high school students, radioactivity measurements were carried out alongside teams from the Cherbourg-Octeville Radioecology Laboratory. After focusing on radioactivity in water in 2018, 2019 was concentrated on monitoring the radioactivity in the air.

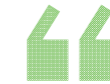


### — Understanding radioactivity

To develop citizen's knowledge of nuclear and radiation protection, IRSN and the ASN created an educational exhibition, made available to mayors, teachers, local information commissions, representatives of associations, and health professionals. Consisting of around 80 exhibit panels broken down into 10 themed sequences, the exhibition "Radioactivity: Hundreds of Questions, One Exhibition" provides clear and objective information on radioactivity, its uses, risks, and its effects on health and the environment. In 2019, it was presented 49 times, mostly in schools and hospitals.

### — Making expertise accessible, understanding research.

During the public debate on the French National Radioactive Materials and Waste Management Plan (PNGMDR), IRSN organized a press trip in July 2019. The purpose of this trip was for journalists to discuss the various technical and scientific approaches to radioactive waste management, notably dry storage. Seven print journalists from national and regional press agencies and media outlets visited two storage sites in Switzerland: Gösgen and Zwiilag. Alongside IRSN experts, the journalists were also able to discuss the topic with members of the Swiss Federal Nuclear Safety Inspectorate (IFSN) and the Swiss Federal Office of Energy, an agency at the Federal Department of the Environment and Energy. The press trip was rounded off with a visit to the Tournemire experimental station where IRSN experts presented the Institute's research programs in the field of deep geological disposal. IRSN also organized a press visit in November 2019 to its Le Vésinet site, in order to present to journalists the resources it uses to perform its regulatory duty of radiological monitoring of the environment.



We presented an exhibition on radioactivity at Besançon University Hospital during Patient Safety Week last November. The exhibit panels were installed in the main hall, where they would not be missed by the public and professionals passing through, with the nuclear medicine health executive and radiation protection officer present for one hour each day. This gave us the chance to talk with visitors about three topics: background irradiation, radon and the use of radiation in hospitals. The exhibition prompted questions and discussions with both visitors and patients. The former were particularly interested in radiation at altitude (through air travel) and radon exposure; the latter were more concerned with the various levels of radiation they may have received through diagnostic imaging procedures.»

—  
Éric Daguet, Health Executive at Besançon University Hospital – Radiation Protection Officer.

The Institute contributes to continuous monitoring in the field of radiation protection and in particular to the radiological monitoring of the environment. It is also responsible for managing and processing dosimetric data on workers exposed to ionizing radiation, as well as the inventory of radioactive sources. During the visit, the journalists observed samples of soil and plants being taken, followed by the analysis of the environmental samples. This information campaign enabled journalists to understand all of the means used by IRSN to carry out its duties: air monitoring networks (Téléray, OPERA-Air); water monitoring (Hydrotéléray), analysis of rainwater near nuclear sites; sampling for all environments (terrestrial, continental and marine aquatic, groundwater, atmospheric); provision of radioactivity monitoring data for the environment in France through the National Measurement Network (RNM) and the website [www.mesure-radioactivite.fr/en](http://www.mesure-radioactivite.fr/en).

## I. MANAGING RISK

### — Creation of a Risk and Performance Division

In 2019, as part of its efforts to modernize and transform its public efforts, IRSN established a Risk and Performance Division. It unites the key functions that contribute to the development of an integrated risk management system, including data protection and information system security. Implementation of the system must be based on the tools that provide structure for the Institute, i.e., the quality management system and audits, while strengthening an approach founded on ethics and professional conduct and developing a compliance policy, essential to the institution's credibility.

### — Renewal of ISO 9001 certification

Certified since 2007, the Institute obtained a three-year renewal of ISO 9001 certification for all its activities and sites in 2019. Among the strengths identified by the certification body are the Institute's relationships with its many stakeholders, including civil society, and the coherence of the strategic alignment of all divisions with the Performance Target Agreement. The auditors however encouraged IRSN to expand its efforts to identify the expectations of its stakeholders and to simplify its validation levels for certain deliverables. Progress on these subjects will be reviewed during the next monitoring audit, scheduled for 2020. •



### IN BRIEF

#### Ethics and professional conduct

Renewed at the end of 2018, the Ethics Commission presented its progress report to the IRSN Board of Directors. Specifically, the document reviews application of IRSN's Code of Ethics and Professional Conduct. The Commission recommends a greater effort to accompany employees in the process. It also recalls the Commission's goal of providing IRSN with outside insight into questions of ethics and professional conduct related to all its missions.



## II. HUMAN RESOURCES

### — Guidance through change

As part of reorganizing operation and support functions, the Institute accompanied employees from the initial discussions through implementation of the new organization on July 1, 2019 through:

- a unanimous agreement providing for staff representatives at IRSN's major sites for a monthly meeting to address the concerns of employees affected by the reorganization;
- an assistance unit whose role is to listen to employees about their career change wishes and their feelings;
- an occupational psychologist available for counseling;
- a monitoring committee chaired by the Director General, with the participation of the secretary of the Central Committee for Health, Safety and Working Conditions, to handle feedback.

This very comprehensive mechanism has enabled employees to express themselves, resolve complex situations and make the necessary adjustments for a better functioning of the organization.

### — Tailored teleworking program

After four years of experience, IRSN sought to relax and expand the use of teleworking so that this option can fully constitute a tool for improving performance while creating a better balance between work and personal life.

### Equality

Since January 2019, the Gender Equality Index has been used to evaluate occupational equality between women and men in enterprises with more than 50 employees. In 2018 IRSN received the overall score of 88/100 and can thus be considered an enterprise that carefully oversees professional equality between women and men.

### Agreements

In February 2019, IRSN signed a method agreement on the management of jobs and career paths. It provides for the separate negotiation of strategic workforce planning issues, measures to assist occupational mobility and vocational training. The negotiations resulted in agreement on strategic workforce planning and progress on measures to accompany mobility.

The negotiations culminated in a unanimous agreement on November 8, 2019 which takes into account the regulatory developments of 2017 and the need for flexibility in organizing work sought by managers and employees. Thus, three options of annual packages of teleworking days are offered with significant flexibility in planning fixed days. In addition, employees for whom regular teleworking is not possible now have access on an occasional basis. These new conditions also reflect IRSN's willingness to respond to issues of societal responsibility and institutional transformation.

## III. CORPORATE SOCIAL RESPONSIBILITY (CSR)

### — A new CSR dynamic

Committed since 2010 to sustainable development, IRSN sought to stimulate a new dynamic encompassing the entire field of corporate social responsibility in 2019. The decision builds on a commitment reaffirmed in the 2019-2023 Performance Target Agreement and on discussions carried out as part of IRSN 2030.

As a result, the Institute should now be able to undertake the ISO 26000 process, which defines how organizations can and should contribute to sustainable development. With the creation of a CSR mission within the Transformation Division and the appointment of a delegate in July 2019, the Institute is committed to a comprehensive policy integrated at all levels: strategic decisions, processes and day-to-day practices.

An initial inventory of the Institute's actions under its CSR policy was launched in 2019. It will continue in 2020 by identifying actions carried out within the framework of the new CSR effort. Performance indicators will also be discussed to evaluate new efforts.

### Agreement on the Social and Economic Committee

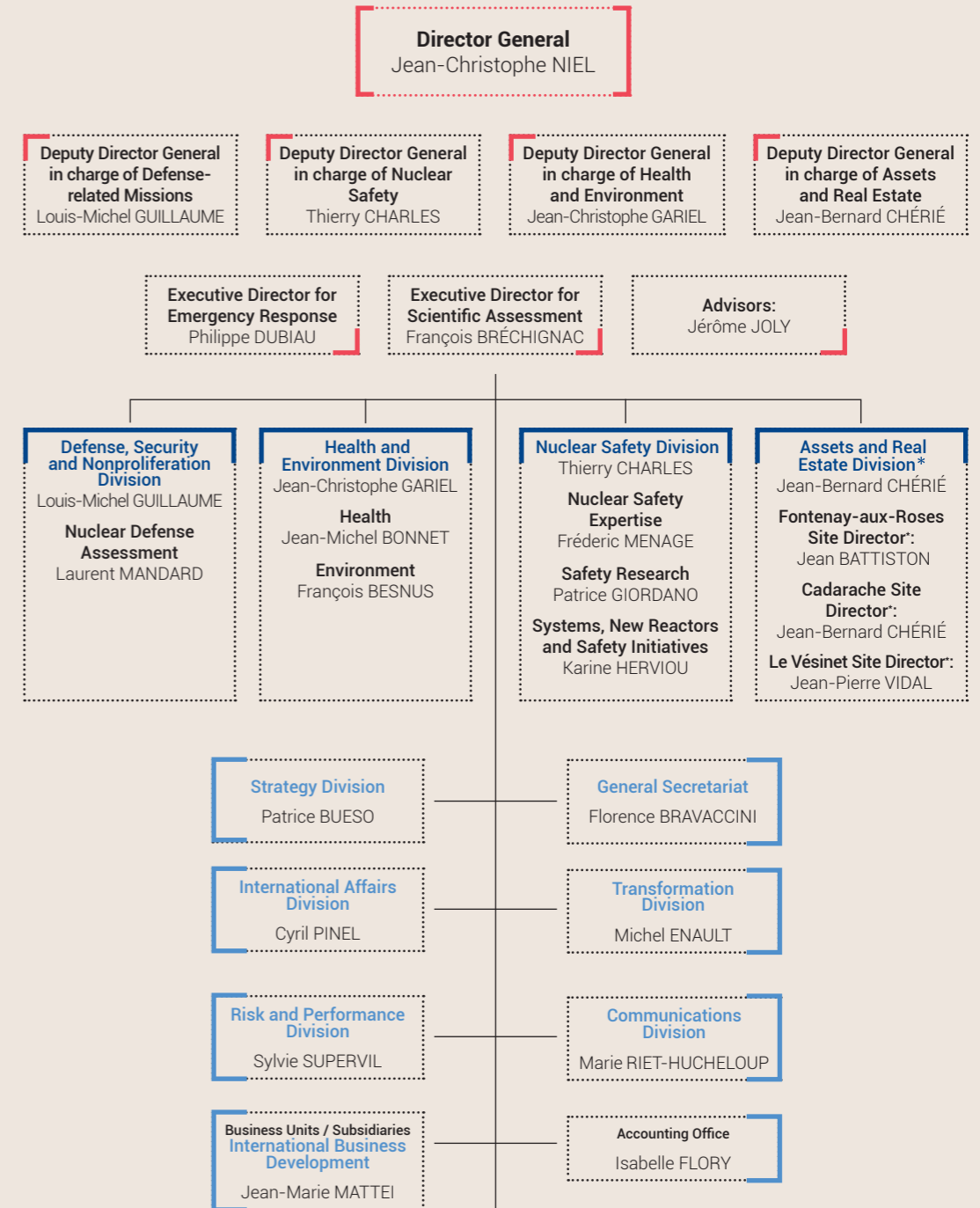
On June 3, 2019, IRSN's management and two of the three representative trade union organizations signed an agreement on the functioning of the Social and Economic Committee and the right to organize. The agreement is concluded pursuant to the Order of September 22, 2017 on the new organization of social dialogue providing for the replacement, no later than January 1, 2020, of all the current bodies – Works Council, Staff Delegates and Health Committee, Safety and Working Conditions (CHSCT) – by a single body, the Social and Economic Committee (CSE). This single body is composed of different commissions and delegations. The main objective of the agreement reached within IRSN is to continue to foster high quality social dialogue.

## IV. ORGANIZATION CHART AS OF FEBRUARY 1, 2020

GENERAL MANAGEMENT

OPERATIONAL DIVISIONS

FUNCTIONAL DIVISIONS



\* Created as part of IRSN's new operational framework and put in place on July 1, 2019, the function of site director is a significant contribution to the proper governance of the Institute. Representing the director general in work with local institutional stakeholders to strengthen IRSN's position in the region, the site director also serves as the director general's delegate in the field of health, safety and environmental protection,

and manager of internal emergency situations. The site director oversees proper implementation of policies and strengthening team cohesion at sites.

Independent of the business hierarchy, the site director ensures the sites are anchored in the general governance of the Institute and promotes the development of close ties between employees and site units as well as general management.

## V. MEMBERS OF THE SENIOR MANAGEMENT COMMITTEE



**[1] Jean-Christophe NIEL,**  
Director General

**[2] Louis-Michel GUILLAUME,**  
Deputy Director General  
for Defense Missions, in charge  
of the Defense, Security  
and Nonproliferation Division

**[3] Jean-Bernard CHÉRIÉ,**  
Deputy Director General in charge  
of the Assets and Real Estate  
Division

**[4] Thierry CHARLES,**  
Deputy Director General in charge  
of the Nuclear Safety Division

**[5] Jean-Christophe GARIEL,**  
Deputy Director General in charge  
of the Health and Environment  
Division

**[6] Jérôme JOLY,**  
Advisor to the Director General

**[7] Sylvie SUPERVIL,**  
Director for Risks  
and Performance

**[8] François BRÉCHIGNAC,**  
Executive Director for Scientific  
Assessment

**[9] Michel ENAULT,**  
Director for Transformation

**[10] Patrice BUESO,**  
Director for Strategy

**[11] Cyril PINEL,**  
Director for International Affairs

**[12] Marie RIET-HUCHELOUP,**  
Director of Communications

**[13] Florence BRAVACCINI,**  
General Secretary

**[14] Philippe DUBIAU,**  
Executive Director  
for Emergency Response  
reporting to the Director General

## VI. GOVERNING BODIES

### — BOARD OF DIRECTORS AS OF FEBRUARY 1, 2020

#### Responsibilities

The Board of Directors, through its deliberations, rules on matters of IRSN's governance. This includes the general conditions governing the Institute's organization and operation, its strategy and program, and its annual report. It also approves the budget, amending budgets, year-end financial statements and income appropriation.

#### • A member of Parliament

**Perrine GOULET,**  
Parliamentarian, Nièvre department

#### • A senator

**Stéphane PIEDNOIR,**  
Senator, Maine-et-Loire department

#### • Ten government representatives

**A representative of the Minister  
for Defense,**  
pending nomination

**Élisabeth BLATON,**  
Deputy Head of Nuclear Safety  
and Radiation Protection  
in the Technological Risks  
Department, representing  
the Minister for the Environment

**Joëlle CARMES,**  
Deputy Director of Environmental  
and Food Risk Prevention at the  
French Directorate General for Health,  
representing the Minister for Health

**Aurélien LOUIS,**  
Deputy Director for the Nuclear  
Industry, Directorate General  
for Energy and Climate, representing  
the Minister for Energy

**Frédéric RAVEL,**  
Scientific Director of the Energy,  
Sustainable Development, Chemistry  
and Process Department of the  
Directorate General for Research  
and Innovation, representing  
the Minister for Research

**Martin CHASLUS,**  
Head of the Risk Resilience  
Assessment Office of the Directorate  
General for Civil Protection and  
Emergency Response, representing  
the Minister for Civil Protection

**Frédéric TÉZÉ,**  
Deputy Director for Working  
Conditions, Health and Safety,  
Directorate General for Labor,  
representing the Minister for Labor

**Diane GEHIN,**  
Deputy Head of the Energy,  
Profit-sharing, Industry and  
Innovation Office at the Budget  
Directorate, representing  
the Minister for the Budget

**Alain GUILLEMETTE,**  
Representative in charge  
of Nuclear Safety and Radiation  
Protection for Defense-related  
Activities and Facilities

**Bernard DOROSZCZUK,**  
Chairman of the French Nuclear  
Safety Authority (ASN)

#### • Five advisory members

**Michel FRITSCH,**  
Air Force Brigadier General,  
nominated by the Minister  
for Defense

**Ginette VASTEL,**  
State Doctor of Pharmacology,  
nominated by the Minister  
for the Environment

**Marie-France BELLIN,**  
Chair of IRSN Board of Directors,  
Professor of Medicine in Diagnostic  
and Interventional Radiology  
at Bicêtre and Pierre-Brousse Hospitals,  
nominated by the Minister for Health

**Laurent MOCHÉ,**  
CEO of Edenkia, nominated  
by the Minister for Energy

**Fanny FARGET,**  
Director of Scientific Research at the  
French National Center for Scientific  
Research (CNRS), nominated  
by the Minister for Research

#### • Eight staff representatives

**Nicolas BRISSON,**  
CGT

**Laurence FRANÇOIS,**  
CGT

**Léna LEBRETON,**  
CGT

**Patrick LEJUSTE,**  
CGT

**Annie CONSTANT,**  
CFDT

**Thierry FLEURY,**  
CFDT

**Olivier KAYSER,**  
CFE-CGC

**Sandrine ROCH-LEFÈVRE,**  
CFE-CGC

#### • Ex officio or associate members

**Cédric BOURILLET,**  
Director General of Risk Prevention  
and Government Commissioner

**Jean-Pascal CODINE,**  
Budget Comptroller

**Jean-Christophe NIEL,**  
Director General

**Louis-Michel GUILLAUME,**  
Deputy Director General in charge  
of Defense-related Missions

**Isabelle FLORY,**  
Accounting Officer

**Philippe BOURACHOT,**  
Secretary, Social and  
Economic Committee



## \_\_\_ STEERING COMMITTEE FOR THE NUCLEAR DEFENSE EXPERTISE DIVISION (CODEND) AS OF FEBRUARY 1, 2020

### Responsibilities

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

**Alain GUILLEMETTE**,  
CODEND Chairman, Representative in charge of Nuclear Safety and Radiation Protection for Defense-related Activities and Facilities

**Marc VÉRAN**,  
Rear Admiral, representing the Armed Forces Chief of Staff

**Bruno DUVERT**,  
General, Nuclear Weapons Inspector

**Frank MOLLARD**,  
Colonel, Chief of Staff of the Secretary General for Administration, representing the Secretary General for Administration of the Ministry of Defense

**Adrien BICHET**,  
representing the budget director

**Jacques RAHARINAIVO**,  
representing the Director of Strategic Affairs, Security and Disarmament at the Ministry of Foreign and European Affairs

**Christian DUFOUR**,  
Head of the Economic and Nuclear Infrastructure Security Department, representing the Senior Defense and Security Official of the Ministry of the Economy and Finance

**Mario PAIN**,  
Deputy Senior Defense Official, Head of the Department of Defense, Security and Economic Intelligence, representing the Senior Defense and Security Official at the Ministry of Ecological and Inclusive Transition

**Serge POULARD**,  
advisory member, appointed by the Minister for Industry

## \_\_\_ SCIENTIFIC COUNCIL AS OF DECEMBER 1, 2019

### Responsibilities

The Scientific Council examines and gives its opinion on IRSN activity programs and ensures that its research programs are scientifically relevant and of the highest quality. It examines program results in order to prepare recommendations on Institute strategy. It may be consulted by the Board's chairperson or by the supervisory ministers on any subject that comes under the Institute's authority.

**Pierre TOULHOAT**,  
Deputy CEO and Scientific Director of the French Geological Survey (BRGM) and Chair of IRSN Scientific Council

**Jean-Christophe AMABILE**,  
Chief Medical Officer, associate professor at Val-de-Grâce, Deputy Head of the Defense Health Expertise and Strategy Division of the Central Directorate for Defense Medical Services

**Robert BAROUKI**,  
Physician, Biochemist and Toxicologist, Professor of Biochemistry at Université Paris-Descartes, Director of Inserm Unit 1124, Head of Biochemistry, Metabolomics and Proteomics at the Necker-Enfants Malades Hospital

**Hugues DELORME**,  
Professor specialized in neutron physics at the School of Military Applications of Atomic Energy (EAMEA)

**Frank HARDEMAN**,  
Director General of the Belgian Federal Nuclear Control Agency (FANC)

**Guy FRIJA**,  
Physician, Emeritus Professor of Radiology at Université Paris Descartes, Vice-Chair of the Imaging Committee of Medicen

**Denis VEYNANTE**,  
Director of Research at the French National Center for Scientific Research (CNRS)

**Éric ANDRIEU**,  
Professor at the Toulouse National Polytechnic Institute (INP)

**Bernard BONIN**,  
Deputy Scientific Director of the Nuclear Energy Directorate of the French Alternative Energies and Atomic Energy Commission (CEA)

**Louis LAURENT**,  
Director of Studies and Research at INRS

## \_\_\_ ETHICS COMMISSION AS OF FEBRUARY 1, 2020

### Responsibilities

Mentioned in the decree organizing the IRSN, the Ethics Commission reports to the Board of Directors and is responsible for advising it on preparing ethical charters that are applicable to the Institute's activities and for monitoring their application, including conditions at the Institute for distinguishing between assessment missions performed on behalf of government departments and those performed for public or private operators. It also serves as a mediator when problems of an ethical nature arise.

**Françoise ROURE**,  
Inspector General and Chair of the Security, Safety and Risk Section of the General Council on Economy, Industry, Energy and Technology

**Lionel BOURDON**,  
Senior Chief Medical Officer and Associate Professor at Val-de-Grâce. Retired. Most recent position: Scientific Director of the French Armed Forces Biomedical Research Institute (IRBA)

**Marc CLÉMENT**,  
President of Chamber at the Administrative Court in Lyon, member of the Environmental Authority of the General Council for the Environment and Sustainable Development. Member of the Implementation Committee of the Aarhus Convention (United Nations)

**Alexandra LANGLAIS**,  
CNRS Research Officer in environmental law, CNRS bronze medalist. Head of the Environment Section of the Western Institute of Law and Europe (IODE). Author of works of research and investigation on laws concerning waste, soil, water law, etc.

**Mauricette STEINFELDER**,  
Inspector General, member of the General Council for the Environment and Sustainable Development and the Environmental Authority, retired. Member of the Scientific Council of the Environmental Data and Statistical Studies Department

**Éric VINDIMIAN**,  
Engineer General in rural engineering, water and forests, specialist in the impact of toxic substances on the environment and health and assessment of public environmental policies, member of the Environmental Authority and Coordinator of the Research and Technology Commission of the General Council for the Environment and Sustainable Development

## \_\_\_ NUCLEAR SAFETY AND RADIATION PROTECTION RESEARCH POLICY COMMITTEE (COR) AS OF FEBRUARY 1, 2020

### Responsibilities

An advisory body to IRSN Board of Directors, the Research Policy Committee provides opinions on research objectives and priorities in nuclear safety and radiation protection. It adopts a global approach that takes into consideration the requirements of society and the public authorities, complementing the activity of IRSN's Scientific Council, which focuses on the quality and relevance of the Institute's research programs and outcomes from a scientific perspective.

### • Public authorities Supervisory ministry representatives:

**Bruno GILLET**,  
Task Officer, Directorate General for Research and Innovation, representing the Ministry of Research Representative of the Directorate General for Health, representing the Ministry of Health, nomination pending

**Sylvain ROTILLON**,  
Head of the Environmental Sciences and Society Governance Mission, Research Department, Directorate for Research and Innovation, representing the Ministry for Ecological and Inclusive Transition

**François-Xavier GOMBEAUD**,  
Nuclear Safety Inspector for the DGA, the French defense procurement agency, representing the Ministry of Defense

**Fabrice LEGENDRE**,  
Task Officer at the Policy and Supervisory Office, Directorate General for Energy and Climate, representing the Ministry for Ecological and Inclusive Transition

### Representative of the Labor Directorate:

**Hervé Visseaux**,  
Head of the Physical Risk Prevention Unit, Directorate General for Labor

### Representative of the French Nuclear Safety Authority:

**Bastien Poubeau**,  
Chief of Staff to the Director General of ASN

### • Companies and professional associations

**Noël CAMARCAT**,  
Nuclear Research and Development Officer, Generation and Engineering Branch, EDF

**Bernard LE GUEN**,  
Chair of the French Society for Radiation Protection (SFRP)

**Bertrand MOREL**,  
Research and Development Director, representing Orano

**Jean-Marc SIMON**,  
Associate Professor, practitioner in the Radiation Oncology Department at the Pitié-Salpêtrière Hospital

**Soraya THABET**,  
Director of Strategy for Risk Control and Safety, Andra

### • Employees in the nuclear sector Representatives of national labor unions:

**Jean-Paul CRESSY**,  
FCE-CFDT

**Martine DOZOL**,  
FO

**Patrick BIANCHI**,  
CFTC

**Jacques DELAY**,  
CFE-CGC

**Christian HOLBÉ**,  
CGT

### • Elected representatives

**OPECST representatives:**  
**Philippe BOLO**,  
Deputy of Maine-et-Loire  
+ one nomination pending

### Local information commissions (CLI) representative:

Nomination pending

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

**Bertrand RINGOT**,  
Mayor of Gravelines

### • Associations

**David BOILLEY**,  
President of the Association for the inspection of radioactivity in western France (Acro).

**Jean-Paul LACOTE**,  
representing France Nature Environnement

**Simon SCHRAUB**,  
Administrator of the Ligue nationale contre le cancer

**Lionel LARQUE**,  
Head of the Alliance for Science and Society (Alliss)

### • Advisory members

**Jean-Claude DELALONDE**,  
Chair of the French Association of Local Information Committees and Commissions (Anccli)

**Christine NOUVILLE**,  
Chair of the High Committee for Transparency and Information on Nuclear Safety (HCTISN)

**Marie-France BELLIN**,  
Chair of IRSN Board of Directors, Professor of Medicine and Medical Practitioner in Diagnostic and Interventional Radiology at Bicêtre-Pierre-Brousse Hospitals

### • Research organizations

**Philippe STOHR**,  
Director of Nuclear Energy, representing CEA

**Cyrille THIEFFRY**,  
Task Officer for Radiation Protection and Nuclear Affairs, IN2P3, representing CNRS

**Charles PERSOZ**,  
Deputy Director of ITMO Public Health, representing INSERM

**Étienne AUGE**,  
Professor of Physics, Vice-President of Paris-Sud, representing the French Conference of University Presidents (CPU)

**Vincent LAFLECHE**,  
Director of ParisTech, representing ParisTech

• **Foreign members**

**Christophe BADIE**,  
Environmental Assessments Department, *Public Health England*, United Kingdom

**Ted LAZO**,  
Nuclear Energy Agency (NEA), OECD

• **Ex officio members**

**Patrick LANDAIS**,  
High Commissioner for Atomic Energy

**Cédric BOURILLET**,  
Government Commissioner, represented by

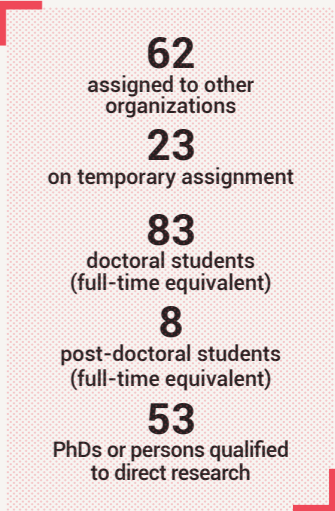
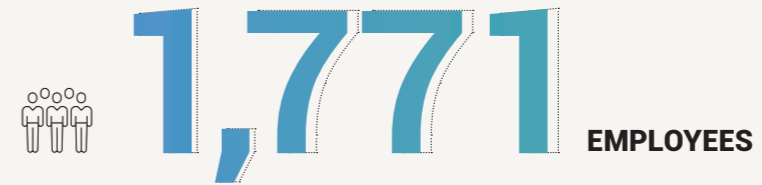
**Benoît BETTINELLI**,  
Head of the Nuclear Safety and Radiation Protection Mission, Ministry for Ecological and Inclusive Transition

**Pierre TOULHOAT**,  
Deputy CEO and Scientific Director of the French Geological Survey (BRGM)

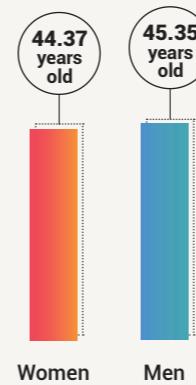
**Jean-Christophe NIEL**,  
Director General of IRSN

## MAIN KEY FIGURES

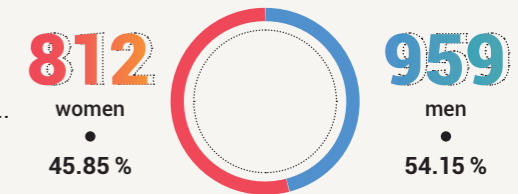
### Human Resources



#### AVERAGE AGE



#### PROPORTION OF WOMEN TO MEN



**88** new hires on indefinite-term contracts



**43,543** hours of training provided to maintain skills

### Intellectual property



active patents in France (including 4 co-owned)



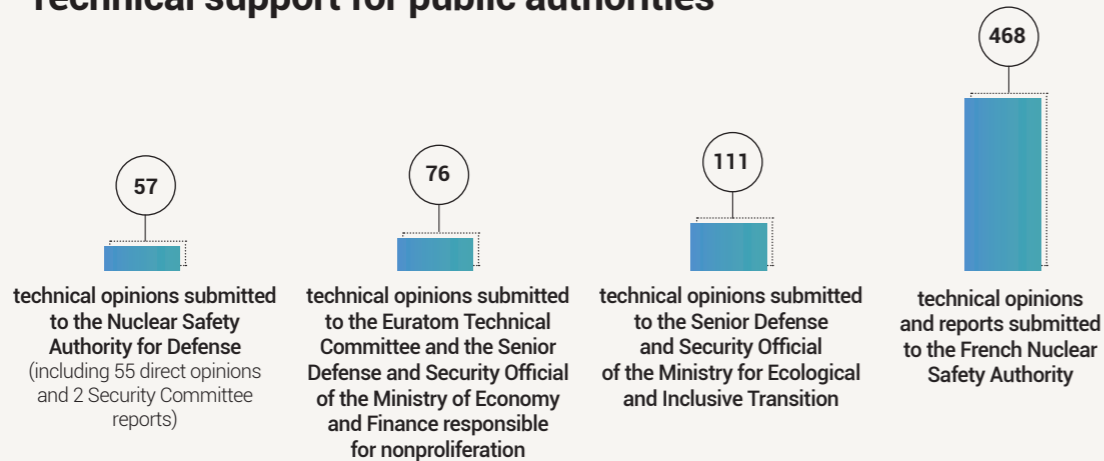
software programs and databases registered with APP, the Agency for the Protection of Programs (including 7 co-owned)



active patents abroad



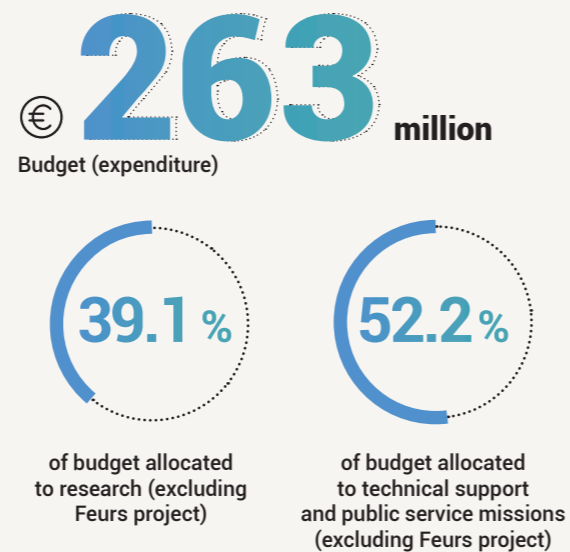
## Technical support for public authorities



## Institute activities



## Budget



## Service contracts



## GLOSSAIRE

### A

**NEA** Nuclear Energy Agency of the Organisation for Economic Co-operation and Development (OECD).  
**IAEA** International Atomic Energy Agency.  
**ANCCLI** French National Association of Local Information Commissions and Committees.  
**ANDRA** French National Radioactive Waste Management Agency.  
**ANR** French National Research Agency.  
**ASN** French Nuclear Safety Authority.  
**ASND** French Nuclear Safety Authority for Defense-Related Facilities and Activities.

### B

**Bel V** Subsidiary of the Belgian Federal Agency for Nuclear Control.  
**BRGM** French Geological Survey.

### C

**CABRI** CEA test reactor used by IRSN in experiments to study nuclear fuel safety.  
**CEPN** Nuclear Protection Assessment Center.  
**CWC** Chemical Weapons Convention.  
**CIGEO** Project for a repository in Meuse and Haute-Marne for the reversible geological disposal of radioactive waste.  
**ICRP** International Commission on Radiological Protection.  
**CLI** Local Information Commission.  
**CLIS** Local Information and Oversight Committee, now known as CSS, Site Oversight Committee.  
**CNDP** French National Public Debate Commission.  
**CODIRPA** French Post-accident Management Steering Committee.  
**COR** Nuclear Safety and Radiation Protection Research Policy Committee.  
**CPDP** Special Committee for Public Debates.  
**CRITICALITY (RISKS)** Risks associated with uncontrolled fission phenomena in fissile materials.  
**CTE** Euratom Technical Committee.

### D

**DoE** US Department of Energy.  
**DOSIMETRY** Assessment or measurement of the dose of radiation (radioactivity) absorbed by a substance or an individual.  
**DSND** Representative in charge of nuclear safety and radiation protection for defense-related activities and facilities.

### E

**ENSTTI** European Nuclear Safety Training and Tutoring Institute.  
**EPIC** French industrial and commercial public undertaking  
**EPR** Evolutionary Power Reactor (European pressurized water reactor).  
**ETSON** European Technical Safety Organisations Network.  
**EURATOM** European Atomic Energy Community.

### G

**GPEC** Strategic workforce planning.

### H

**HCÉRES** High Council for Evaluation of Research and Higher Education.  
**HCTISN** High Committee for Transparency and Information on Nuclear Safety.  
**HFDS** Senior Defense and Security Official.

### I

**INB** Regulated nuclear facility.  
**INSC** Instrument for Nuclear Safety Cooperation – cooperation contract financed by the European Commission.

### M

**MTEs** Ministry for Ecological and Inclusive Transition.  
**MIRCOM** Ion microbeam used in the radiobiology of intra- and inter-cellular communications.  
**MOX** Mixture of plutonium oxide and uranium oxide – nuclear fuel.  
**MWe** Megawatt electric, unit of electric power produced.

### N

**NRA** Nuclear Regulation Authority (Japan).

### O

**OECD** Organisation for Economic Cooperation and Development.  
**OPCW** Organisation for the Prohibition of Chemical Weapons.  
**ODOBA** Observatory for the durability of reinforced concrete structures. The program studies concrete pathologies and their consequences for nuclear structures.

### P

**PARISII** Experimental platform for research into the intake of radioactive substances through ingestion or inhalation.  
**PNGMDR** French National Radioactive Materials and Waste Management Program.  
**PRISM** International program of experiments to research the propagation of smoke and heat from a fire in a basic nuclear facility.  
**PIA/RSNR** French program of investment for the future/ Research into nuclear safety and radiation protection

### R

**RADIONUCLIDE** Radioactive isotope of an element.

### S

**SFRP** French Society for Radiation Protection.  
**SISERI** Information system for monitoring exposure to ionizing radiation.  
**STEM** Source Term Evaluation and Mitigation - Program to learn more about the behavior of radioactive materials that could be released to the environment in the event of a fuel melt accident in a nuclear facility.

### T

**TSO** Technical Safety Organization

### U

**UGAP** French Union of Public Procurement Groupings, a public procurement organization.  
**UNSCEAR** United Nations Scientific Committee on the Effects of Atomic Radiation.  
**U.S. NRC** United States Nuclear Regulatory Commission.

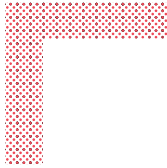
APPROVED BY THE IRSN BOARD OF DIRECTORS ON MARCH 5, 2020.

COVER ILLUSTRATION: Chemical reactor in which gaseous iodine is produced by interaction of dimethyl sulfate with sodium iodide solution (PERSÉE facility) ©Francesco Acerbis/IRSN | IRSN's PERSÉE facility is a test bench for the study of gaseous effluent treatment equipment in nuclear facilities as well as laboratories, plants and hospitals that are sources of radioactive iodine.

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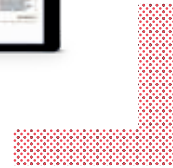




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