



**IRSN**

INSTITUT  
DE RADIOPROTECTION  
ET DE SÛRETÉ NUCLÉAIRE

*Enhancing nuclear safety*

# ANNUAL REPORT 2017



# ENHANCING NUCLEAR SAFETY IN FRANCE AND INTERNATIONALLY

Further to Act No. 2015-992 of August 17, 2015 on energy transition for green growth, the legislative part of the French Environment Code defines the missions of IRSN, the National Institute for Radiological Protection and Nuclear Safety, the public expert in nuclear and radiological risks, together with those of ASN, the French Nuclear Safety Authority, and of the local information commissions (CLI). Decree No. 2016-283 of March 10, 2016 on IRSN, which implements the Act, places the organization under the joint supervision of the Ministers for Ecology, Research, Energy, Health and Defense.

IRSN is the nation's public service expert in nuclear and radiological risks, and its activities cover all the related scientific and technical issues in France and in the international arena. Its work therefore concerns a wide range of fields, including environmental monitoring, radiological emergency response, radiation protection and human health in normal and accident situations, prevention of major accidents, and safety and security of nuclear reactors, plants, laboratories, transportation, and waste.

It also carries out assessments in the nuclear defense field.

In addition, IRSN contributes to government policy on health, nuclear safety, the environment, and emergency response. Within this context, it interacts with all the organizations concerned including public authorities, in particular the nuclear safety and security authorities, research organizations, and stakeholder associations.

IRSN also contributes to training and providing public information about nuclear and radiological risks.

## HUMAN RESOURCES

# 1,800<sup>1</sup>

employees, including many specialists, such as engineers, doctors, agronomists, veterinarians, technicians, experts and researchers, with 47 doctors or persons qualified to direct research. IRSN is also the place of work of: **81<sup>2</sup> doctorate students** and **6<sup>2</sup> post-doctorate students**.

## BUDGET

# €280M

- 39.8% of budget devoted to research excluding property projects and Feurs;
- 50.7% of budget allocated to technical support and public service missions excluding property projects and Feurs.

<sup>1</sup> This workforce consists of 1,655 persons on permanent contracts and 145 on fixed-term contracts (including 60 persons assigned to other organizations, but excluding 21 temporary assignments).

<sup>2</sup> Expressed in full-time equivalent terms.

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# FOREWORD

Laurent Moché, Acting Chairperson of the IRSN Board of Directors



Since December 2017, when Dominique Le Guludec left the Institute to chair the board of the French National Authority for Health, I have been the Acting Chairperson of the IRSN Board of Directors, a position I have embraced wholeheartedly, fully aware of the responsibilities that come with it.

*“I discovered the incredible diversity of the tasks fulfilled by IRSN, and the complexity of the issues and risks involved in nuclear safety and radiation protection.”*

Before presenting some of the highlights of 2017, I would like to pay tribute to the work accomplished by my predecessor during her four years at the head of the Board of Directors, addressing many major issues to help shape the future of the Institute. I have witnessed her achievements since 2016, when I first became a member of the Board of Directors, with the inauguration of the Finance Committee. It was then that I discovered the incredible diversity of the tasks fulfilled by IRSN, and the complexity of the issues and risks involved in nuclear safety and radiation protection.

The French Act on Energy Transition for Green Growth of August 17, 2015, and the decree of March 10, 2016, have strengthened recognition of IRSN's role in the governance of nuclear and radiological risk. The year 2017 saw full deployment of this role, with regular publication of IRSN's expert opinion reports, and the official introduction of the Research Policy Committee, where stakeholders can voice their expectations of the Institute's research.

Behind the lines, I was impressed by the creation of the Health and Environment Unit, and the appointment of a deputy director for emergency response management.

In 2017, the same quest for efficiency and agility inspired our Director General to initiate in-house reflection on support activities and functional services provided by IRSN.

To propel the Institute forward, he also launched the IRSN 2030 initiative, built around four lines of direction: Excellence, Foresight, Independence, and Sharing.

These incentives have now infused strong ambition into action taken by IRSN. In 2017, noteworthy IRSN contributions touched on the safety options report for the CIGEO project and the anomaly detected on the EPR reactor vessel: two events where IRSN demonstrated its skills in assessment and its dedication to sharing, particularly through discussions with representatives of civil society.

*“Now more than ever before, research guarantees IRSN's excellence and its ability to foresee the issues that will appear as technological choices are made.”*

IRSN's responsiveness was also recognized in action taken following the detection of ruthenium in Europe, a significant event despite having no impact inside French borders.

One last example is the considerable investment spending that was granted to develop the following research platforms: PARISII, on the effects of ingesting and inhaling radioactive substances, AMANDE/MIRCOM, on the effects of ionizing radiation on cells, and MICADO LAB, on the effects of chronic exposure to radiation on ecosystems.

In parallel, IRSN pursued a proactive policy of sharing information with people from all walks of life: citizens living close to nuclear power plants, doctors, members of non-profit organizations, high school students, etc., each with a very different perception of nuclear and radiological risks. IRSN reaches out to each and every one, taking an educational approach to sharing our knowledge.

Scientific excellence, analytical and methodical reasoning backed by the most advanced knowledge in risks, experience feedback, multidisciplinary skills, independence of judgment, and openness are all essential to providing benchmark-setting expert assessments that are operational and commensurate with the issues at stake. In 2018, our assessment expertise will be applied to numerous complex subjects. Noteworthy projects in the field of nuclear safety include the startup of the EPR in France, shutdown of PWRs or extension of their operational lifetime, ageing of research reactors and fuel cycle facilities, new reactor designs, progress on the CIGEO project and, in the medical sector, increasing use of radiation for diagnosis and treatment.

In this context, now more than ever before, research guarantees IRSN's excellence and its ability to foresee the issues that will appear as technological choices are made. It is therefore essential to have sufficient resources to maintain a quality of research that measures up to our ambitions.

The importance of the Institute's action internationally has grown with each passing year: in expert assessments, where IRSN contributes to the development of common safety requirements; in research, where its participation in collaborative programs promotes shared platforms and resources; and in non-proliferation action, where the Institute operates in collaboration with the OPCW.

To meet these challenges, the Board of Directors must keep a watchful eye on the resources required to operate the Institute. In the subjects approached through work with the Research Policy Committee, the Scientific Committee, the Finance Committee and the Ethics Commission, IRSN finds answers that help shed light on major issues it encounters in its activities.

In conjunction with the Research Policy Committee, an advisory body to the IRSN Board of Directors, the research objectives and priorities in the fields of nuclear safety and radiation protection will be addressed using an overall approach that takes into consideration the requirements of society and the public authorities.

This approach complements the activity of the Scientific Committee, which focuses on the quality and relevance of the Institute's research programs and outcomes from a scientific perspective. It also finally complements that of the Ethics Commission, which is responsible for advising the board on preparing ethical charters that will be reinstated in summer 2018.

*“To meet these challenges, the Board of Directors must keep a watchful eye on the resources required to operate the Institute.”*

I will pay careful attention to promoting IRSN's research in ways that demonstrate the Institute's position as a driving force in the governance of risk. This year's Annual Report has evolved to reflect our support of openness and social responsibility.

## Jean-Christophe Niel, Director General



The year 2017 saw a number of changes in France following the presidential and legislative elections in May, with a new momentum affecting the political landscape. Within the scope of its responsibility, IRSN has a key role to play in these changes, as demonstrated by the Multi-Year Energy Program and its impact on the nuclear power sector, as well as France's new healthcare strategy.

In this context, faced with unprecedented challenges, particularly in the field of nuclear safety, and stronger demands for transparency and openness, I initiated discussions to stimulate foresight and set IRSN's targets for the 2030 horizon.

Within the same focus, and in light of these discussions, preparations are under way for the next Performance Target Agreement (2019-2023), an opportunity to consult with our supervisory ministries and institutional counterparts, particularly the nuclear safety and security authorities, regarding the Institute's strategy and key objectives.

Before looking back over some of the key events of 2017, I would first like to pay tribute to the work of Dominique Le Guludec, Chairperson of IRSN's Board of Directors from 2013 until recently, as she has now moved on to chair the board of the French National Authority for Health (HAS).

She encouraged the Institute to open the doors of its research platforms to outside exchanges in order to consolidate its role as a driving force in nuclear safety and radiation protection in France and around the world. I would also like to welcome the arrival of Laurent Moché as Acting Chairperson of the Board of Directors, who is pursuing the same proactive approach.

Among the changes initiated at IRSN in 2017, it is important to highlight action taken in the organization and preparation of emergency response management for nuclear and radiological emergencies. Emergency response management is present in all the activities conducted by the Institute, whether it be nuclear safety and security or protecting people and the environment from the effects of ionizing radiation. It calls on all our areas of expertise in research, assessment and monitoring.

*“In some respects, preventing or managing a radiological or nuclear emergency may be thought of as the ultimate purpose of IRSN.”*

This is also the only area in which IRSN's technical support reaches all public authorities, such as civil and defense safety authorities, the Senior Defense and Security Official (HFDS) of the Ministry of Ecology, the General Secretariat for Defense and National Security (SGDSN), the ministries of the Interior, Armed Forces, Health, Ecology, Labor, Agriculture, Foreign Affairs, and local representatives of State authorities.

In some respects, preventing or managing a radiological or nuclear emergency may be thought of as the ultimate purpose of IRSN. I therefore set out to bring changes to IRSN's governance in this area, particularly by creating the post of Deputy Director for Emergency Response Management, reporting to the Director General.

France is currently one of the few countries that has a national emergency response plan for major nuclear or radiological accidents, developed under the authority of the SGDSN in the wake of the Fukushima accident.

The plan clearly sets out the roles and duties of all the different entities involved in emergency response, including those of IRSN, which plays a leading role in the event of accident situations. The following examples illustrate IRSN's contribution to emergency response management.

In the case of a malicious attack against a nuclear facility, emergency management may come up against constraints; for instance, the operator may be unable to reach different parts of the site in question. This effect on the operator's ability to take action, along with security aspects in general needs to be more specifically addressed in the assessment and forecasting approach implemented by IRSN when providing support to public authorities. Managing situations in which security is a concern is also more complex, given that more actors are involved. The procedures used by the operators, authorities and IRSN to interact and communicate in such situations need to be improved, in close cooperation with safety and security authorities.

In another example involving environment monitoring, reports of ruthenium detected in the air by European networks in late September illustrate this point perfectly. Although no event that might have caused the release of this element had been declared, the news was widely reported in the media in France and around the world. This example demonstrates how important it is for IRSN to have access to all the means required to detect release of radioactive materials, issue alerts, carry out assessments and inform public authorities so that they can decide, if necessary, to implement protective measures.

Last, as demonstrated in feedback from the Fukushima accident, after the emergency phase, managing the post-accident phase has proven to be a major issue that must be addressed through collaborative efforts. At the beginning of 2018, as requested by the ASN, IRSN proposed changes to the 2012 version of post-accident doctrine before the CODIRPA, the steering committee for the management of the post-accident phase of a nuclear or radiological emergency. These changes aim to coordinate emergency and post-accident phases more efficiently, to reduce the complexity induced by overlapping zoning systems (exclusion zone, population protection zone, zone under control of foodstuffs), and to optimize advances in technology applicable to modeling and rapid measurement of contamination.

To develop its expertise in accident and post-accident situations, as in other areas, IRSN carries out research requiring resources that I am determined to maintain, particularly in this period of budgetary uncertainty. My objective is also to work with our partners, especially the Ministry for Research and the ANR, to help consolidate the position France holds in European research dedicated to nuclear safety and radiation protection, by participating in strategic events and submitting attractive responses to requests for proposals.

By focusing on partnerships in France and abroad, we pursue the dynamic process initiated with our counterparts: the ETSO network, research institutes such as CEA, CNRS, university laboratories, and our partners in medical research, including Inserm and the Institut Gustave-Roussy, as well as with industry, in accordance with our code of ethics. IRSN owns several major research facilities, which need to be used more effectively to develop partnerships. Giving the national and international community wider access to such infrastructure also creates opportunities to share maintenance and operating costs.

In November, IRSN was audited by the HCERES (the French High Council for the Evaluation of Research and Higher Education), an essential step for research conducted at IRSN in support of its assessment activities. The Scientific Council played an important part in the process, alongside the Institute. During the audit, IRSN's research strategy was examined by accomplished experts, and we shall begin to integrate their feedback in 2018.

From a more concrete perspective, I would like to mention a few advances in research achieved in 2017.

ROSIRIS, a program designed to learn more about the mechanisms behind the side effects of radiation therapy on healthy tissue, was assessed by a scientific commission according to HCERES procedure. The commission highlighted the scientific advances achieved by this research in risk assessment and the resulting potential for improving assessment of the probability of undesirable outcomes in healthy tissue.

Three major facilities were started up or restarted: MICADO LAB, AMANDE/MIRCOM and PARISII. In 2018, we will begin to collect the initial findings of work conducted in these facilities to study the signature of chronic exposure due to the ingestion of uranium or the effect of chronic external exposure on the cardiovascular system.

At the beginning of 2017, a workshop was held to conclude a European program launched in 2013, coordinated by IRSN, focused on filtering radioactive release in the event of a core melt accident. This work led to improvements in computational models of serious accidents, and also reviewed various existing or innovative iodine filtering systems.

Significant progress was made in 2017 and will be pursued in 2018 on the PERFROI and DENOPI research programs, launched by IRSN in the wake of the Fukushima-Daiichi accident. These research programs study cooling systems in the reactor core and in irradiated fuel storage pools, and are funded by the ANR under the Investment in the Future Program.

Work conducted to renovate the CABRI reactor was completed in 2018, paving the way for the first trial conducted as part of the CABRI International Program.

It should be emphasized that all this research has been conducted in an international context where experimental facilities are being shut down and dismantled, in spite of the significant need for research in these fields. I watch these changes closely and, as chairman of the OECD's Committee on the Safety of Nuclear Installations, I have initiated an inventory of these critical facilities in order to assess the advantages of keeping them in operation, and the risks entailed, for research, in shutting them down definitively.

*“IRSN carries out research requiring resources that I am determined to maintain, particularly in this period of budgetary uncertainty.”*

As a stakeholder in the assessment of health risks, alongside the Directorate General for Risk Prevention (DGPR), the Directorate General for Health (DGS), the Directorate General for Labor (DGT), and the ASN, IRSN actively pursues a leading role in the field of radiation protection.

In 2017, in liaison with the International Commission on Radiological Protection and European research platforms, IRSN organized a week-long international science event on radiation protection, attended by 500 participants, researchers, experts, decision-makers, and risk managers, who addressed all the issues involved in radiation protection today.

IRSN also published a report on 50 years of epidemiological monitoring of 90,000 workers in the French nuclear industry. This study contributes to IRSN's expertise in radiation protection, occupational health and safety, and public health. The results of the study are consistent with the international system for worker protection currently in force.

IRSN has been conducting research on radon for many years. The program entitled “Radon: let's take up the challenge, let's have a change of air”, led by IRSN, came to an end after two years of action taken in fifteen municipalities in Haute-Vienne. This ground-breaking program, implemented in cooperation with local actors, raised awareness of the radon risk among local residents and put them at the center of radon risk management.

Transposition of the directive on basic safety standards, the new regulatory framework for radiation protection in Europe, is a subject that has and will continue to anchor IRSN's work for the DGPR, DGS, DGT and ASN, particularly throughout 2018.

With regard to the environment, in 2017 the Institute published a report entitled Actualisation des connaissances acquises sur le tritium dans l'environnement (Current Knowledge on the Behavior of Tritium in the Environment). This report publishes levels of tritium measured in the environment and describes tritium transfer through the food chain, as well as the principles of tritium metrology.

In metrology, new methods developed to accelerate monitoring of certain alpha- and beta-emitting radionuclides have now reached maturity. Results can now be obtained within only a few hours, as opposed to a few weeks using previous methods. In an emergency situation, this is a major advantage for IRSN, allowing us to provide public authorities with the information they need to make decisions within an appropriate time scale.

As part of the support we provide to the HFDS, ASND and ASN, IRSN assesses civil and defense-related nuclear facilities, within the allocated budget. For this purpose, we have joined efforts with state authorities and industry to reinforce the assessment process by encouraging open and rigorous technical debate, based on science and technology, commensurate with the risks involved.

As in previous years, 2017 was dedicated to major long-term issues and handling unexpected situations.

Some of the long-term issues reviewed by IRSN included the EPR safety analysis, with a particular focus on defects found on the vessel closure head domes; conditions for extending the service life of reactors beyond the fourth ten-year safety review; the CIGEO Safety Options Report; defense-related facilities; naval propulsion reactors; and facilities belonging to the Military Applications Division of CEA.

Regarding security at nuclear facilities and in civil transportation, IRSN issued opinions on important issues for the Senior Defense and Security Official (HFDS), leading to more frequent emergency exercises.

In the area of non-proliferation, alongside recurring actions, IRSN consolidated its role in enforcing the Organization for the Prohibition of Chemical Weapons (OPCW) Convention within the chemical industry at a particularly successful conference opened by the Director General of the OPCW. At the beginning of 2018, IRSN presented its assessment of the EPR-NM Safety Options Report to the ASN Advisory Committee for Reactors. In 2018, IRSN will also finalize its assessment of the Flamanville EPR, a prerequisite to plant commissioning.

Among the unexpected events that occurred in 2017, I would like to mention the intervention of our emergency response unit, called in to support the HFDS and ASN in managing intrusion situations at EDF's Cattenom and Cruas nuclear power plants. In the area of nuclear safety, IRSN analyzed nonconformities involving earthquake resistance in several reactor systems and in the dike built to protect the Tricastin plant, which could lead to flooding at the site.

*“My plan for IRSN is to address this need to continuously adapt to new challenges.”*

IRSN also launched new public information and communication campaigns. In addition to the technical examinations led by IRSN experts in support of the ASN, the issue involving defects found in the steel used to build the steam generator bottom heads in 18 reactors in the EDF nuclear power plant fleet and the EPR reactor vessel closure head domes, as well as technical issues identified while assessing the CIGEO project, led to in-depth technical discussions between IRSN and representatives of civil society in 2017.

IRSN launched Open Radiation, a pioneering collaborative science initiative developed in partnership with IFFO-RME, the FabLab set up at Sorbonne Universities, and Planète Sciences. The initiative allows citizens to download an app to their smartphone and measure radioactivity in the environment, and then share this data on a dedicated website.

Looking to the future, the French Parliament, government, and our supervisory ministries allocated a stable budget to us for 2018, which, in these times of budget restrictions, reflects the importance given to our missions and the trust placed in the Institute. Given that IRSN is continuously called upon to help resolve issues where the stakes are high, especially with regard to nuclear safety, the slight yet consistent annual cuts in our research budget over recent years prevent us from finding satisfaction with the current situation.

*“The approach to IRSN 2030 is collective; this has always been one of the Institute’s strong points.”*

In a constantly changing world, we must continuously adapt to new challenges to ensure that our action is lasting and relevant.

My plan for IRSN, in close cooperation with public authorities, is to address this need to constantly adapt our capabilities so that we can ensure the highest standards of nuclear safety and security, while protecting human health and the environment, in a society that demands to take part in risk management

This is also the goal of the IRSN 2030 initiative mentioned in my introduction. Discussions continue with the kick-off of roughly fifteen workshops organized to get everyone at IRSN involved. The outcome of these discussions will contribute to the new 2019-2023 Performance Target Agreement.

This type of collective approach has always been one of IRSN's strong points. I am confident in our ability to work together to meet the great challenges that lie ahead and achieve the projects that will shape the future of IRSN.

I would like to conclude by naming the four lines of direction identified in the IRSN 2030 initiative.

- + Excellence, which implies that we must constantly strive to achieve the highest standards in the activities we lead to fulfill our responsibilities.
- + Independence, which requires that we remain impartial in our scientific and technical judgments and in our ability to investigate, within our fields of expertise and according to our rules of governance, in areas where the stakes are high.
- + Sharing, which calls on our ability to communicate with all those who have an interest in risk management, while finding ways to involve them in our work.
- + Foresight, which relies on an unwavering determination to look ahead and develop the capability required to innovate in order to meet the expectations of public authorities and civil society.

The challenges are many and reflection has begun, from a number of different perspectives; the aim is to engage IRSN in a new dynamic, in phase with the digital revolution, placing IRSN firmly on track for 2030.

## Georges-Henri Mouton, Deputy Director General in charge of Defense-related missions



Reflecting a more complex geopolitical context, security and defense issues remain at the forefront of concerns in a context marked by the attacks on France and the defense effort.

*“In 2017, IRSN endeavored to make progress in meeting the high expectations of the public authorities in the field of security and defense.”*

In France, it is essential to remain vigilant, attentive and to continue the fundamental work of protecting nuclear facilities and shipments in the face of terrorist threats.

IRSN’s support for the senior defense and security official within the Ministry for Ecological and Inclusive Transition, who is responsible for nuclear security, must be further improved on points for which it provides added value (in such areas as the link between safety and security, pragmatic analysis of resistance capabilities, cyber defense, emergency response management, etc.).

The effort to improve the quality of opinions and expertise must be pursued both in terms of synthesis and the pragmatism of the proposed options.

In its support of the nuclear defense safety officer, IRSN’s Nuclear Defense Expertise Division (DEND) again had a significant workload in 2017. Given the importance of remediation and dismantling issues, the Defense Safety Assessment Department (SESD) will have an additional office in 2018.

*“In France, it is essential to remain vigilant, attentive and to continue the fundamental work of protecting nuclear facilities and shipments in the face of terrorist threats.”*

In the field of the fight against the proliferation of weapons of mass destruction, the director general of the Organisation for the Prohibition of Chemical Weapons (OPCW) inaugurated a symposium, jointly organized by IRSN and the French Chemical Industries Association (UIC), whose aim was to bring together and raise awareness among industry leaders likely to be concerned by OPCW inspections and chemical declarations. The symposium was a success.

DEND also actively participated in the discussion on the consequences of the United Kingdom’s exit from EURATOM for nuclear materials accounting.

In 2017, IRSN endeavored to make progress in meeting the high expectations of the public authorities in the field of security and defense and to develop its organization and methods to this end. The effort will continue in 2018.

# GOVERNING BODY

## + ORGANIZATION CHART AS OF FEBRUARY 1, 2018



## + Functional and support divisions

|  |  |   |   |
|--|--|---|---|
| <b>Strategy, Development and Partnerships</b><br>Patrice DESCHAMPS (i.t.c.*) | <b>International affairs</b><br>Cyril PINEL                      | <b>Communications</b><br>Marie-Pierre BIGOT         | <b>Human resources</b><br>Michel ENAULT |
| <b>Financial, Business and Legal Affairs</b><br>Didier DEMEILLERS            | <b>Security, Assets and Information Systems</b><br>André ROUBAUD | <b>Accounting Office</b><br>Pierre PIQUEMAL-LAGORRE |   |

## + Operational divisions

|  |   |  |  |
|--|---|--|--|
| <b>Defense, Security and Non-proliferation</b><br>Georges-Henri MOUTON | <b>Nuclear safety</b><br>Thierry CHARLES                              | <b>Health and Environment</b><br>Jean-Marc PÉRES |  |
| <b>Nuclear Defense Expertise</b><br>Frédéric MERMAZ                    | <b>Nuclear Safety Expertise</b><br>Frédéric MÉNAGE                    | <b>Health</b><br>Jean-Christophe GARIEL          |  |
|  | <b>Safety Research</b><br>Véronique ROUYER                            | <b>Environment</b><br>François BESNUS            |  |
|  | <b>Systems, New Reactors and Safety Initiatives</b><br>Karine HERVIOU |  | <b>International Business Development</b><br>Jean-Marie MATTÉI |

\*in temporary capacity

A close-up, profile view of a woman with dark hair, wearing a light blue patterned top, looking intently through the eyepiece of a black microscope. The scene is lit with a cool blue light, creating a professional and scientific atmosphere. The background is softly blurred, showing hints of an office or laboratory setting.

**SNAPSHOTS AND  
KEY FIGURES 2017**

# NUCLEAR SAFETY

## Publications

+ “Current State of Research on Pressurized Water Reactor Safety”.  
J. Couturier, M. Schwarz,  
Science and Technology  
Series, May 2017

+ *IRSN’s Position on Safety and Radiation Protection at Nuclear Power Plants in France in 2016*  
(November 2017 Report)

+ “Écoulements turbulents anisothermes et relâchement de produits de fission en situation accidentelle sur un réacteur nucléaire”.  
[Anisothermal Turbulent Flows and Fission Product Releases in an Accident Situation at a Nuclear Reactor].  
Guillaume Brillant,  
HDR Collection, March 2017



### + Steam generator anomalies

As part of the process to examine anomalies detected on some steam generators from EDF’s reactor fleet, IRSN performed an assessment that resulted in ASN taking a position on restarting the reactors in question. Together with ASN and ANCCLI, the Institute also organized a day of discussions with representatives of civil society on February 24, 2017.  
– p. 20

### + Tracking progress at the EPR construction site

In 2017, IRSN contributed to assessing the serviceability of the Flamanville EPR reactor vessel head and bottom head. In partnership with ANCCLI, the Flamanville CLI and ASN, IRSN organized a meeting in July 2017 to present its conclusions and exchange with representatives of civil society upstream of the public consultation on ASN’s draft position.  
– p. 24

### + Experience feedback and facility compliance

As part of its assessment duties, IRSN analyzes incidents reported by operators and managers to identify any warning signs as a precautionary measure. Examining the events that were reported in 2017 led IRSN to question the level of attention that operators pay to compliance with the operational baseline.  
– p. 32

### + CIGEO: IRSN presents its conclusions

On May 18-19, 2017, IRSN presented its assessment of the Safety Options Report for Andra’s CIGEO project to the Advisory Committee for Waste and the Advisory Committee for Laboratories and Plants.  
– p. 26

### + DENOPI: significant advances

In 2017, the DENOPI research program on spent fuel pool uncovering entered the experimental phase. The project, funded by the Investment in the Future Program (PIA) that was implemented by the French National Research Agency (ANR), is based on three lines of research: studying phenomena at pool scale, at assembly scale, and with respect to cladding oxidation in a mixed air-vapor atmosphere.  
– p. 33

### + Assessing the safety of defense-related activities and facilities

2017 was marked by a steady stream of requests and a large volume of reports produced for the DSND. As part of this work, IRSN notably contributed to assessing the report on the second stage of Megajoule Laser Facility operation as well as to the Reactor Safety Commission meeting on authorization to load the RES test reactor.  
– p. 27

## + Strengthening the ETSO network strategy

As one of the initiators of the ETSO network, IRSN plays an active role in its development and action to enhance nuclear security and standardize practices across Europe. In 2017, ETSO welcomed its 16<sup>th</sup> member, the Romanian technical safety organization RATEN ICN.  
– p. 37

## Articles

- Improving the Understanding of Hydriding of Cladding to Anticipate Rupture.

Aktis - Summer 2017

- Criticité : simuler pour prévenir les accidents [Criticality: Simulating to Prevent Accidents].

Repères Magazine - April 2017

## Viva

Contributions à l'analyse de données spatialisées et applications dans les études de risque [Contributions to Analyzing Spatialized Data and Applications in Risk Analysis] – Jean Bacou, dissertation for his research supervision accreditation, defended on October 25, 2017 in Marseille.

# SECURITY AND NON-PROLIFERATION

## Publications

+ “Element of Security and Non-Proliferation, J. Jalouneix, Science and Technology”. Series, August 2017

### + Campaign to raise awareness within industry of the non-proliferation of chemical weapons

As part of its role to provide technical support to public authorities and chemical and textile industry associations in applying international treaties on the non-proliferation of chemical weapons in France, IRSN has contributed to a campaign to raise awareness among French companies of the Chemical Weapons Convention (CWC), launched on the 20<sup>th</sup> anniversary of the creation of the Organization for the Prohibition of Chemical Weapons (OPCW). In October 2017, the Institute jointly organized a conference on this same topic with the OPCW, providing representatives of the pharmaceutical, chemical, cosmetic, agrochemical, textile and paper industries with an opportunity to talk with experts about how the Chemical Weapons Convention is implemented in France and find out more about the CWC and its regulations. – p. 28

### + Nuclear security

IRSN provides support and technical assistance to the departments of the Senior Defense and Security Official (HFDS) of the Ministry for Ecological and Inclusive Transition. In 2017, as part of EDF's application for a license to hold and use nuclear materials in EPR Reactor No. 3 at Flamanville nuclear power plant, IRSN contributed to examining the new detailed technical review procedure introduced by the HFDS for the assessment of this application  
– p. 30



# ENVIRONMENT AND HEALTH

## Publications

- + *Bilan 2016 de l'exposition professionnelle aux rayonnements ionisants en France [Occupational Exposure to Ionizing Radiation in France: 2016]*  
(September 2017 Report)
- + *Actualisation des connaissances acquises sur le tritium dans l'environnement [Current Knowledge on the Behavior of Tritium in the Environment]*  
(October 2017 Report)
- + *Suivi épidémiologique des travailleurs du cycle électronucléaire en France : bilan des études de l'IRSN [Epidemiological Monitoring of Workers in the French Nuclear Power Industry: Results of IRSN Research Studies]*  
(December 2017 Report)

### + New knowledge on tritium

IRSN has published an account of the advances in research in a report entitled "Current Knowledge on the Behavior of Tritium in the Environment".  
– p. 40



### + CERTYF and KRI-TERRES

Two new projects involving IRSN have been selected by ANR as part of its second call for proposals, using funding allocated to Andra by the PIA. The projects aim to study – and hopefully develop – innovative solutions for managing radioactive waste from nuclear facility decommissioning.  
– p. 41

### + Radon: first results from the pilot program in Haute-Vienne

IRSN contributes to radon risk prevention by supporting both national public authorities and local stakeholders.  
– p. 43

### + Radiation protection: IRSN brings together the international scientific community in Paris

IRSN organized and held two major events in Paris for radiation protection professionals, experts and researchers: the 4<sup>th</sup> International Symposium on the System of Radiological Protection with the International Commission on Radiological Protection (ICRP), and the 2<sup>nd</sup> European Radiological Protection Research Week, set up by European research platforms.  
– p. 44

## + Articles

- **Modeling Tritium Transfer in the Environment to Assess its Impact**  
Aktis - Fall 2017
- **Radioactivité dans l'air, évaluer les risques [Assessing the Risks of Radioactivity in the Air]**  
Repères - July 2017
- **Research: Geochemical Investigations Downstream of Former Mines**  
Aktis - January 2017
- **Radioprotection : les solutions s'adaptent aux nouveaux besoins [Radiation Protection: Adapting Solutions to Meet New Needs]**  
Repères - February 2017

## EMERGENCY RESPONSE AND POST-ACCIDENT MANAGEMENT

### Publications

+ *Évaluation dosimétrique de cinq filières de production de biens manufacturés en situation postaccidentelle [Dosimetric Evaluation of Five Manufactured Goods Production Chains in a Post-accident Situation]* (November 2017 Report)

#### + Participation in CODIRPA's work

In 2017, CODIRPA began a major discussion process lasting several years on the changes to be made to post-accident management policy, as part of the lessons to be learned from the Fukushima accident. In this context, in early 2018, IRSN put forward changes to the post-accident management policy published in 2012. – p. 47

#### + First AGORAS conference



As part of research undertaken in the wake of the Fukushima accident, IRSN held the first conference of the AGORAS project on improving the governance of nuclear safety organizations and networks at the Cité Universitaire in Paris on November 21, 2017. – p. 48

## INFORMING

#### + "Radiation Protection In Question" website

As part of its duty to provide training, information and education to the public on nuclear and radiological risks, IRSN has added the final touches to an educational website entirely dedicated to the field of radiation protection. – p. 50

#### + Science Fair



With Science Villages, lab tours, open days and conferences, the 2017 Science Fair saw almost 3,000 different events taking place all over France. IRSN was out and about in Paris, Aix-en-Provence, Vinon-sur-Verdon and Poissy on October 6-8, 2017. – p. 50

#### + Media Events

- A joint ASN and IRSN press conference was held on June 28, 2017, on the EPR reactor vessel and vessel head at Flamanville nuclear power plant.

- IRSN and the Association of Environmental Journalists organized a meeting with the press on Wednesday, September 6, 2017. Jean-Christophe Niel met with over a dozen journalists specialized in environmental subjects to discuss topical issues.

## EFFICIENCY

#### + Better-performing commercial activities

In 2017, IRSN's commercial services grew by 8.5% overall, and more specifically within the dosimetry and international services business units. – p. 52

#### + Preparing an agreement on quality of life in the workplace

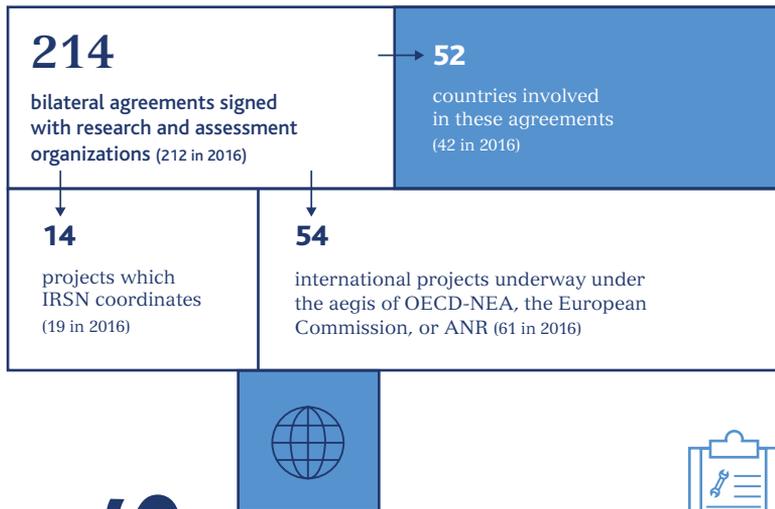
To draw up an agreement on quality of life in the workplace and preventing occupational stress, three working groups representing IRSN staff were formed to discuss the topics of equality, well-being and balance. – p. 54

#### + An exemplary building in Fontenay-aux-Roses

Building 01, which was completed in July 2017, meets strict criteria in terms of energy efficiency, functionality and comfort. – p. 57



## + INTERNATIONAL



# ACTIVITY KEY FIGURES

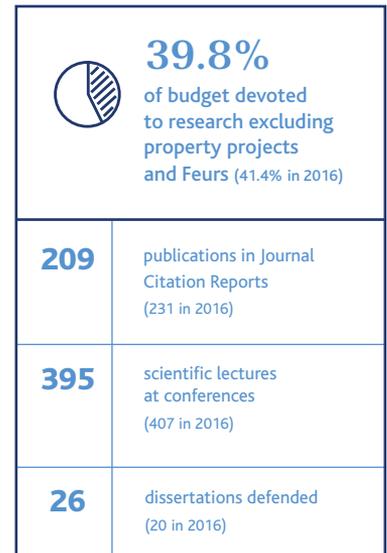
IRSN financial report 2017 is available on the website [www.irsn.fr](http://www.irsn.fr)

## + TECHNICAL SUPPORT FOR PUBLIC AUTHORITIES

**50.7%**  
 of budget devoted to technical support and public service missions excluding property projects and Feurs (49% in 2016)

**536** technical notices and reports to ASN (531 in 2016)

## + RESEARCH



**99** technical notices to ASN (104 in 2016)

**118** technical notices to Authorities in charge of non-proliferation (119 in 2016)

**62** technical notices to the nuclear defense safety Authority (77 in 2016)

## + DISSEMINATION OF KNOWLEDGE

# 2,896,291

visits to the IRSN website  
(2,455,336 in 2016)

# 402

notices and reports published  
on the IRSN website (351 in 2016)

# 153,825

pages consulted in the "Research"  
section of the IRSN website  
(146,189 in 2016)

# 40

requests for IRSN action  
received from local information  
commissions (24 in 2016)

# 3

IRSN publications (1 in 2016)

# 15

IRSN operations at local  
information Commissions  
(16 in 2016)

# 111

students from French and foreign  
schools took part in the radiation  
protection workshops in schools  
initiative (117 in 2016)

## + INTELLECTUAL PROPERTY

# 21

french patents in force  
(including 2 co-owned)  
(25 including 10 co-owned in 2016)

# 59

patents in force abroad  
(42 in 2016)

# 28

software applications and databases placed with  
the software protection Agency (APP)  
(including 7 co-owned)  
(28 including 7 co-owned in 2016)



## + TRAINING

# 126

hours of training given  
at ENSTTI France  
in 5 training sessions  
on nuclear safety  
(154 in 2016)

# 744

hours of teaching given  
at ENSTTI France  
in 28 training sessions  
on radiation protection  
(764 in 2016)

# 1,650

hours of teaching given  
outside the Institute  
(universities, engineering  
schools, INSTN, etc.)  
(1,660 in 2016)

# 43,109

hours of training given to maintain  
the skill levels of engineers  
and experts  
(43,250 in 2016)

# €1.32M

spent on training  
(€1.39M in 2016)

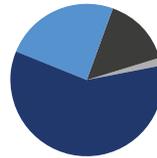


## + BUDGET BREAKDOWN



### Total funding

- 59.4% Budget act 190 grant
- 24.3% Operators' contribution
- 14.9% Other French or foreign funds (aside from budget act)
- 1.4% Budget act 212 grant



### Amount of other funds

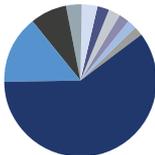
**€33.71M** French funds

**€2.92M** foreign funds



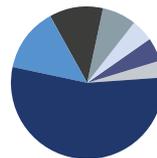
### Foreign funds

- 60.1% Riskaudit
- 14.4% European Union
- 7.8% Others
- 3.4% Nuclear power joint venture co.
- 3.2% Bundesamt fur Strahlenschutz
- 2.6% IOAC
- 2.5% EU Directorate General
- 2.2% NRC
- 1.9% NRA
- 1.8% China Nuclear Power



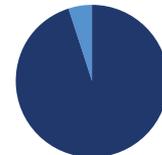
### French funds (aside from budget act)

- 54.5% Others
- 13.6% State
- 11.5% EDF
- 7.1% CEA
- 4.9% ENSTTI
- 4.8% Areva
- 3.6% ANR



### Operating and investment expenditure

- 95% Operating expenses
- 5% Investment



## + SERVICE CONTRACTS

€32.3M

revenue  
(€38.9M in 2016)

24,407

customers  
(24,695 in 2016)

€20.36M

commercial services  
(€20.13M in 2016)

€10.86M  
Dosimetry  
(€10.39M in 2016)

€0.86M  
Biological analyses  
(€0.80M in 2016)

€2.23M  
Riskaudit  
(€1.86M in 2016)

€1.50M  
EDF  
(€2.57M in 2016)

€1M  
Training  
(€0.60M in 2016)

€3.91M  
Others  
(€3.91M in 2016)

## + HUMAN RESOURCES

### + Distribution of employees



94

employees recruited  
on permanent  
contracts  
(44 in 2016)

60

persons assigned to other  
organizations permanent  
contracts  
(64 in 2016)

21

temporary assignments  
(21 in 2016)

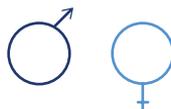
1,800

employees  
(1,770 in 2016)

→ 1,655 permanent contracts  
(1,627 in 2016)

→ 145 on fixed-term contracts  
(143 in 2016)

|   |   |   |
|---|---|---|
| 81<br>doctorate<br>students<br>(73 in 2016) | 6<br>post-doctorate<br>students<br>(19 in 2016) | 47<br>doctors or persons qualified to direct<br>research (48 in 2016) |
|---|---|---|



● 54.5% Men

● 45.5% Women



● 75.9% Executive staff

● 24.1% Non-executive staff



## + Average age

43.7

years for women  
(43.3 in 2016)

44.3

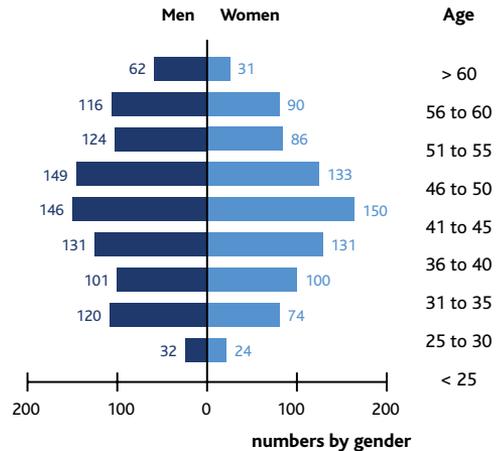
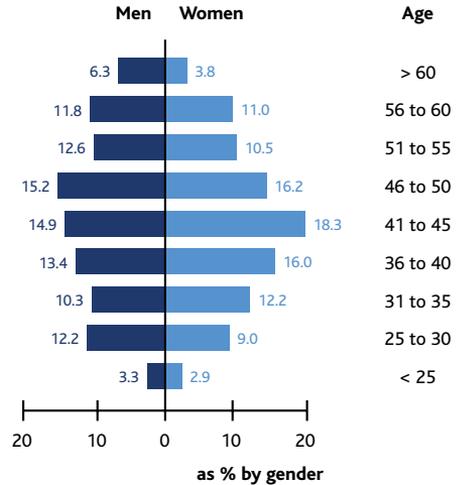
years for men  
(44.6 in 2016)

## + Locations

- 1,343 CDI employees on permanent contracts in the North Region
- 312 employees on permanent contracts in the Southeast Region



## + Distribution of men/women by age group



## SENIOR MANAGEMENT COMMITTEE AS OF FEBRUARY 1, 2018

**Jean-Christophe NIEL**  
Director General

**Georges-Henri MOUTON**  
Deputy Director General,  
in charge of Defense-related missions

**Jean-Bernard CHÉRIÉ**  
Deputy Director General,  
in charge of Administration

**Thierry CHARLES**  
Deputy Director General  
in charge of Nuclear Safety

**Jean-Marc PÉRES**  
Deputy Director General  
in charge of Health and Environment

**Jean-Luc LACHAUME**  
Executive Director for Emergency  
Response

**Giovanni BRUNA**  
Scientific Director

**Martial JOREL**  
Director of Knowledge Management

**Patrice DESCHAMPS**  
Director of Strategy, Development  
and Partnerships\*

**Marie-Pierre BIGOT**  
Director of Communications

**Cyril PINEL**  
Director of International Affairs

**Michel ENAULT**  
Director of Human Resources

**Jérôme JOLY**  
Senior Advisor

**Sylvie SUPERVIL**  
Inspector General and Quality Officer

## EXECUTIVE COMMITTEE AS OF FEBRUARY 1, 2018

The IRSN Executive Committee is chaired by the Director General and made up of 26 members representing the Institute's operational and functional divisions.



François BESNUS (14), Marie-Pierre BIGOT (22), Giovanni BRUNA (15), Thierry CHARLES (18), Jean-Bernard CHÉRIÉ (3), Michel CHOUHA\*\* (8), Didier DEMEILLERS (4), Patrice DESCHAMPS (16), Michel ENAULT (19), Jean-Christophe GARIEL (24), Karine HERVIOU (10), Jérôme JOLY (11), Martial JOREL (23), Jean-Luc LACHAUME (20), Didier LOUVAT\*\*\* (21), Jean-Marie MATTÉI (25), Frédéric MÉNAGE (12), Frédéric MERMAZ, Georges-Henri MOUTON (2), Jean-Christophe NIEL (1), Jean-Marc PÉRES (9), Cyril PINEL (6), Pierre PIQUEMAL-LAGORRE (7), André ROUBAUD (13), Véronique ROUYER (17), Sylvie SUPERVIL (5)



\* Acting Director \*\* Riskaudit \*\*\* ENSTTI.

# STRATEGIC CHALLENGES

## IMPLEMENTING SCIENTIFIC STRATEGY

*IRSN conducts research with the aim of improving knowledge to enhance nuclear safety and radiation protection and to prepare for the assessment activities of tomorrow. It was with this aim in mind that in 2016 IRSN drew up a scientific strategy to be implemented within its safety, health and environmental research units.*

### DEVELOPING THE SCIENTIFIC STRATEGY

While the discussion on scientific strategy has sought to determine the most pressing scientific issues involved in radiation protection, safety and security to be addressed over the next ten years, its implementation requires an approach that defines the relevant subject areas demanding further research, anticipates any scientific or technological obstacles and identifies the solutions to overcome them. This exercise contributes to IRSN's forward planning, particularly for its next Performance Target Agreement and its 2019-2023 Medium-Term Plan.

In parallel, IRSN has turned to its Scientific Council throughout the year to examine these research initiatives. In particular, the Council has highlighted the need for IRSN to reflect on the positioning of software and large platforms, to improve the process of identifying future research areas when it comes to major equipment, and to enrich its approach to research by incorporating the need for probabilistic risk analysis.

The Scientific Council reiterated that access to experimentation was essential and invited IRSN to propose an alternative strategy in case it met scientific obstacles. Finally, it stressed IRSN's unique role in fitting together the building blocks to address the complexities of nuclear safety, security and radiation protection issues.

### RESEARCH ASSESSMENT BY HCERES

All public bodies conducting research have to undergo assessment every five years, and most of IRSN's 2017 assessment was carried out during the year. As required by the High Council for Evaluation of Research and Higher Education (HCERES), there are two parts to the assessment: the assessment of the research units and the assessment of the IRSN as a whole.

Based on subsidiarity, IRSN had proposed an external assessment body for the research units. This was approved by HCERES in March 2017, and IRSN then formalized the procedure into guidelines.

Assessing IRSN as a whole involved a self-assessment submitted to HCERES on June 30 followed by an on-site visit by a panel of experts in November 2017, which focused on the link between IRSN's strategy and governance on the one hand, and the management of its research on the other.

IRSN's research will now be assessed on an ongoing basis over the next five years across 15 themed research groups. These groups were identified during the process of implementing IRSN's scientific strategy through its research approach, which was carried out during the year with the research units.

*As required by HCERES, the assessment can be broken down into two parts: the assessment of the research units and the assessment of IRSN as a whole.*



## TOWARDS EUROPEAN COOPERATION ON WASTE

IRSN is contributing to the European research structuring strategy by helping to draft a proposal for a joint European programming tool, to be used for planning and carrying out research into the management and disposal of radioactive waste. Following on from the work and conclusions of the European JOPRAD program, this project brings together technical safety bodies (TSOs), operators, research bodies and representatives of civil society. It plans to respond to the Euratom call for tender, the deadline for which is September 28, 2018. The purpose of the tool is to integrate R&D, knowledge management, networking and sharing of knowledge with civil society.

### In brief

#### + Efficiency

As part of a drive to make the use of their resources more efficient and streamlined, IRSN and CEA have begun a new reflection process on the potential for pooling or jointly developing simulation tools and experimental infrastructure, in the fields of both safety and radiation and environmental protection. This is an approach that IRSN plans to transpose to other research partnerships, by granting access to its experimental platforms. These prospects of strengthened cooperation will enable the best skills to be mobilized in a context of limited resources.

#### + Development

Having reached a phase of maturity in their application, several projects – namely a hydrogen measuring device and a filtration medium for iodine – undertaken in the wake of the Fukushima accident, as part of the PIA/RSNR program, secured extra funding in 2017, enabling them to take a further step towards industrial use.

#### + Partnership

IRSN contributed to the bid for a call for tender launched by INCA in 2017 to develop a network for pre-clinical research on radiotherapy in France, coordinated by AP-HP. The submitted project aims to collectively and gradually develop a shared strategic research agenda to improve one of the main cancer treatment options.



### FOCUS ON...

#### IRSN 2030 project

The first half of 2017 saw the Director General mobilize IRSN to engage in a collective internal reflection process on IRSN's ambitions of excellence, independence, sharing and forward planning from now to 2030.

The process should allow IRSN to set itself pertinent strategic guidelines and associated operating principles in order to adapt to changes in its environment.

The 2017 management seminar, together with the service proposals and general assembly meetings constituted the first phase of the process of putting ideas into motion, which enabled the first IRSN 2030 summary report to be drawn up. The report was presented to the Board of Directors in October 2017.

A series of workshops open to all staff was launched in November 2017. It will draw to a close in April 2018 with the creation of proposals for achieving IRSN's strategic ambitions.

At the end of the reflection process, the IRSN 2030 project will be implemented operationally through programs and action plans; it will inform the discussions held to prepare the new performance target agreement with the supervisory authorities, due to enter into force in 2019.



As a research organization, IRSN devotes nearly 40% of its budget to research.

## FOCUSING ON THE MAIN NUCLEAR SAFETY, SECURITY AND RADIATION PROTECTION CHALLENGES

*As the public expert in nuclear and radiological risks, IRSN provides support to the public authorities and government departments. With demand for its risk assessment services growing, IRSN has been keen for several years to prioritize requests for technical support through preparatory discussions with the public and supervisory authorities on the referrals it receives, while working to improve its efficiency.*

### ✚ MAKING STRATEGIC CONSISTENCY A PRIORITY

To achieve its objectives with regard to required technical excellence and the conformity of its assessment work with the commitments it has made, IRSN has for some years followed an approach based on dialogue with everyone involved in the process of preparing opinions.

This approach is based on an agreement governing the procedures by which IRSN provides technical support. Particular attention is paid to defining an operating framework that encourages discussion with the public authorities and to prioritizing the requests for technical support it receives. In 2017, the framework agreement between ASN and IRSN came up for renewal for the period 2017-2022.

Although the new agreement contains all the same technical support terms as previous agreements signed between IRSN and ASN, it also includes new provisions introduced by the Act on energy transition for green growth (TECV Act) and Decree No. 2016-283 on IRSN. As a result, ASN and IRSN have defined practical procedures for the publication of IRSN's opinions. They have also set up a reflection and discussion group on research activities, since ASN has responsibility under the TECV Act for making recommendations and proposals on research needs in nuclear safety and radiation protection.

The ambition of strategic consistency with the public authorities is also reflected in increased efforts on the programming and regulation of its assessment activity, taking account of the deadlines for industrial projects such as the commissioning of the EPR reactor and the fourth ten-yearly outage inspections of 900 MWe reactors.

This strategic consistency is also established ahead of any technical investigations, by defining the safety and radiation protection objectives that will constitute the applicable regulatory reference framework. In 2017, IRSN provided support to the public authorities in the context of ongoing work to transpose European Directive 2013/59/Euratom, laying down basic safety standards for protection against radiation.

*The ambition of strategic consistency with the public authorities is a priority for IRSN.*

Under its technical support mission, for monitoring and warning purposes IRSN spends a large amount of time on monitoring facilities and their operating conditions, the radiological state of the environment, and worker exposure. In 2017, IRSN was mobilized in relation to issues such as the detection of ruthenium-106 in the atmosphere in Europe and its impact on the land and, as regards nuclear facility safety, the handling of problems related to the seismic resistance of pipes in the pumping stations

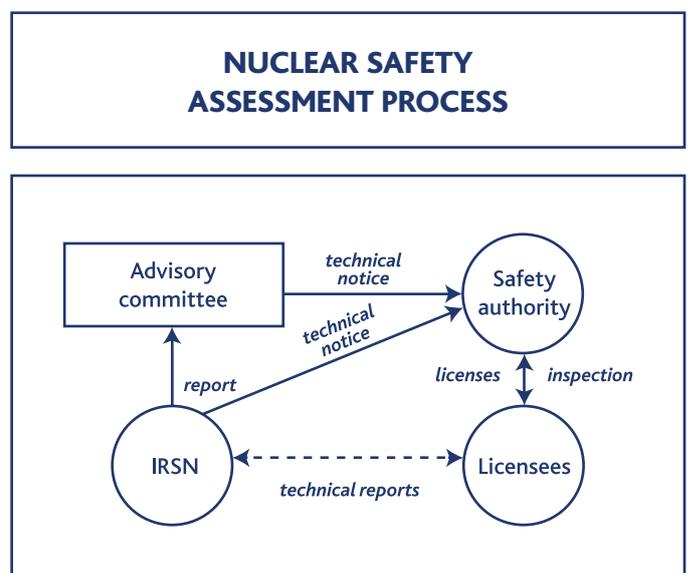
of 29 nuclear reactors in France, as well as the behavior of a canal dike at the Tricastin nuclear power plant in the event of an earthquake.

### TRANSPOSING BASIC STANDARDS FOR RADIATION PROTECTION INTO REGULATIONS

As part of the technical support it provides to the Ministries of Health, Employment and Risk Prevention, IRSN took part in work to transpose European Directive 2013/59/Euratom of December 5, 2013 into French law, which lays down basic safety standards for radiation protection. During this undertaking, IRSN's expertise was put to good use preparing the texts of the decrees, one of which concerns the provisions of the Labor Code, the other concerning the provisions of the Public Health, Environment and Defense Codes, respectively. The work will continue into 2018 with the preparation of the implementing orders.

#### In brief

+ Public policy  
 IRSN contributed to develop the national health strategy for 2018-2022, published by the Ministry of Solidarity and Health at the end of 2017. The Institute highlighted the use of ionizing radiation in the medical field and environmental health problems linked to multiple exposure.



## NEW ORGANIZATION OF RADIATION PROTECTION ACTIVITIES

IRSN developed its organizational structure on July 1, 2017 in order to clarify its activities in radiation protection, the synergies between research and expertise, and its cross-disciplinary approach to emergency response. It set up a Health and Environment Unit, which has two operational divisions, one for health and one for the environment. A Deputy Director of Emergency Response was appointed to work under the Director General.

These changes enable IRSN to adapt to increasingly demanding institutional, technical and societal expectations, both in France and internationally, and to meet the following challenges:

- + being able to provide proportionate and consistent radiological risk assessment services;
- + strengthening IRSN's ability to provide emergency response when a nuclear or radiological accident occurs, regardless of its origin;
- + maintaining IRSN's standing as the authority in radiological characterization;
- + better understanding the effects of exposure to ionizing radiation on healthy tissue, especially in applications in the medical field;
- + acquiring knowledge aimed at achieving a better understanding of the mechanisms related to the effects of chronic exposure to low-dose ionizing radiation, including the specific problems associated with multiple exposure in particular.



In 2017, IRSN submitted more than 800 reports to the public authorities for civil and Defense-related matters.

## FOCUS ON...

### Efficiency and performance

For many years now, IRSN's procurement policy has reflected the government's five performance areas, namely economic performance, access for SMEs to public procurement, integrating innovation, and the inclusion of social and environmental clauses. Every year, IRSN's procurement action plan is submitted to the government's procurement department. At the start of 2016, the target savings rate was 2.1%, but ultimately IRSN achieved a rate of 3.42%, resulting in savings of €3.73 million on the total amount of purchases communicated during the year.

In addition to a constant quest to meet the need for goods and services at the right price, time and quality to ensure that IRSN can fulfill its missions, its procurement policy has fostered the development of a procurement approach that is sustainable in the long term: efforts were made in 2016 to provide legal safeguards for the public procurement contracts signed by IRSN, on account of the current legal situation as regards public procurement; to foster greater competitiveness by launching its consultations on the government's online procurement platform; and to seek opportunities for discussion with companies through work on sourcing prior to the launch of competitive procedures, and negotiations where regulations permit.

These actions led to the awarding of:

- + 2,373 contracts to SMEs and micro businesses, worth a total of €21 million, representing 19.27% of the allocated budget for 2016;
- + 62 contracts in the sheltered employment sector, for social inclusion;
- + 173 contracts containing an environment clause;
- + 30% of the total 2016 spending on innovative purchases.



## IRSN 2030

**Excellence**  
*Prioritize expertise favoring informed decision-making*

## OPENNESS TO SOCIETY: FURTHER INNOVATION

*After eight years of implementing IRSN's Charter on Openness to Society, its employees have taken up the challenge in their practices, which has led to satisfying the environmental principles of the right to information and public involvement. IRSN now plans to develop innovative approaches to better apprehend the benefits of its interactions with society and diversify the ways in which this input is incorporated into its assessment and research activities.*

### **+** STRENGTHENING PARTICIPATION

In 2017, IRSN continued to pursue its policy of openness to society by looking in particular at the development of new methods of participation.

In the context of the CIGEO project to dispose of radioactive waste in a deep geological repository, new methods of holding technical discussions between IRSN's experts and members of civil society were employed. For this project, IRSN took the initiative of involving civil society in the process of assessing the safety options report for the CIGEO Disposal Facility. Discussion with stakeholders on complex issues with major societal implications, like waste management, helps to put the assessment process on a more solid footing.

As part of ongoing cooperation with ANCCLI, technical dialogue initiatives now look at the most complex and high-risk issues and start as early as the phase of examination by IRSN. One example of this is the joint organization by ANCCLI, the Flamanville CLI, ASN and IRSN of technical discussions on the anomaly in the composition of the steel used to make the reactor vessel head and bottom head of the EPR at Flamanville (Manche), which were proposed as early as 2015. The participants in these discussions have been meeting regularly ever since. The fourth meeting took place on July 5, 2017 and was a chance to look back over the whole technical appraisal process and its conclusions. Similarly, in February 2017, a discussion meeting organized in conjunction with ANCCLI and ASN brought together stakeholders to review the report on carbon content anomalies in the steel used in a number of steam generators in French nuclear power plants.

IRSN also set up another new stakeholder involvement initiative by endeavoring to involve patient associations in its responses to calls for tender issued by research funding bodies, such as the ANR, in the healthcare sector. This type of initiative aims to make use of the knowledge held by stakeholders, instead of restricting IRSN's analysis solely to scientific and technical aspects. This approach was used in the case of a research project on bone regeneration strategies in patients having undergone treatment for cancer of the upper aerodigestive tract by a protocol using radiotherapy.

### AN INNOVATIVE MEANS OF INTERACTING WITH SOCIETY

To develop stakeholder involvement, the European SITEX-II project to build a lasting network of independent technical experts in the safety of deep geological radioactive waste disposal has worked in particular on the development of new modes of interaction with civil society on these issues. From 2015 to 2017, IRSN experts involved in the SITEX-II project trialed a means of involving civil society throughout the project by holding themed seminars in which around thirty European organizations and non-institutional experts from civil society took part.

The value of these discussions on waste disposal was apparent to all parties involved, including the safety authorities and their technical experts, researchers and civil society. Reports are being finalized and a network known as SITEX\_Network, led by IRSN, was set up in January 2018 in the form of an association. It is divided into three panels representing the TSOs, the safety authorities and civil society.



#### IRSN 2030

##### Sharing

*Develop partnerships with civil society for the common good*

# 15

IRSN operations at local information commissions

## INCORPORATING RESEARCH POLICY COMMITTEE RECOMMENDATIONS

The Research Policy Committee met twice in 2017, continuing the cycle initiated to establish how well IRSN takes account of the Committee's views in directing its research studies. The Committee measured progress in the field of research into the effects of low doses and high doses, and assessed the extent to which its recommendations had been followed. The meetings provided an opportunity to reflect on topics of interest for future research projects, such as the consideration of multiple exposure in research on low doses, European research into radiation protection on the whole, and IRSN's approach to research on accident prevention in the field of nuclear facility safety. They also gave the Committee a chance to assess the progress of the multi-disciplinary groups working on post-accident recovery and very low level waste (VLLW) management.

## 2017 IRSN BAROMETER ON FRENCH PUBLIC PERCEPTIONS OF RISKS AND SAFETY

IRSN's barometer on French public perceptions of risks and safety has been published every year since 1990 and records changes in public opinion on issues related to social and environmental concerns, scientific and technical expertise, and risk situations, including those arising from civil nuclear applications. For the first time, the 2017 Barometer, which is based on a survey conducted in November 2016, was enhanced by having external scientists give their perspective on the results of IRSN's analysis.

*The Barometer's results demonstrate the importance that the French place on knowledge-sharing, transparency and pluralism, continuing the trend shown in previous editions.*

Among the points of note in 2017, the issues related to the EPR (anomalies in the steel used to make the reactor vessel head and bottom head) and the steam generators were only specifically mentioned by 20% of those questioned, despite the issues receiving a large amount of media coverage. 2017 continues the trend of previous editions, showing the importance that the French place on knowledge-sharing, transparency and pluralism. What emerges is that nuclear power plants uphold an image of reliability, even though the French public continues to express concern about the impact on their health, and that the occurrence of an accident at a nuclear power plant remains the most feared type of industrial disaster. One marked change is that perceptions of the competence and credibility of those involved in nuclear risk management in various capacities have diminished significantly.

In 2017, the Barometer was enriched by having external scientists give their perspective on the results of IRSN's analysis.



### FOCUS ON...

#### CIGEO: as attentive as possible to society's concerns

During its examination of the safety options report for the CIGEO project, submitted by Andra, IRSN consulted members of ANCCLI, the Bure CLI and the citizens' panel from the public debate on CIGEO held in 2013, as well as non-institutional experts from the very start of the assessment process.

IRSN's aim is to establish structured dialogue between public experts and representatives of civil society, and to ascertain their main concerns so that these can be incorporated into the analysis and the conclusions of IRSN's assessment. After gathering comments and questions, IRSN explained to the participants how it had taken account of each point in question in its assessment of the report.



As part of actions to promote openness to society, a technical dialog on waste took place between ANCCLI, the Bure CLIs and IRSN on December 13 and 14, 2017.

# ASSESSING NUCLEAR FACILITIES IN OPERATION

*As the public expert in nuclear and radiological risks, IRSN examines the safety reports submitted by licensees and provides opinions and recommendations to the public authorities. As far as civil facilities in operation are concerned, IRSN provides technical support to the ASN in the form of opinions, which it also publishes on its website as part of its policy of openness to society.*

## +

### STEAM GENERATOR ANOMALIES

As a result of the anomaly detected in 2014 in the reactor vessel head and bottom head of the Flamanville 3 EPR, EDF discovered excessively high carbon levels in the steel used to make the primary heads of 46 steam generators at nuclear power plants in operation. The presence of excess carbon in steel can affect its mechanical properties, reducing its strength. Carbon content measurements were made on the external surface and non-destructive tests were carried out on the primary heads of the affected steam generators.

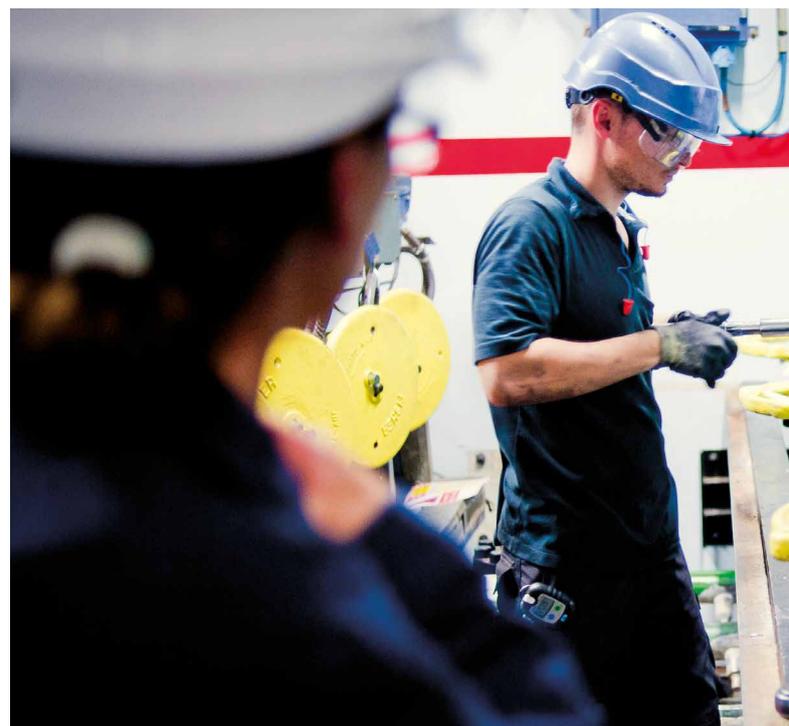
This anomaly meant that EDF had to re-examine the risks of sudden failure of those steam generators insofar as the mechanical properties of the steel have been altered. These studies were supplied by EDF in October and November 2016 and have been assessed by IRSN.

IRSN's assessment consisted in assessing the impact of this anomaly on the risk of sudden failure of the steam generators in question. To this end, IRSN drew on the initial justifications communicated by EDF, as well as its own calculations and the available literature data and research results. IRSN also reaffirmed its position on the mechanical properties of steel containing high carbon levels by drawing on the expertise of the Belgian assessment body, Bel V, a member of the ETSO network, which comprises IRSN and its European counterparts. Lastly, IRSN made a joint visit with ASN to the Japanese manufacturer, JCFC, in particular to understand more about the cause of the excessive carbon levels observed.

*IRSN's assessment consisted in analyzing the impact of this anomaly on the risk of sudden failure of the steam generators in question.*

On the basis of the analyses carried out and the associated recommendations, IRSN's assessment concluded that, in view of the compensatory measures taken by EDF, there was no risk of sudden failure of these 46 primary heads. IRSN's examination of the justifications provided by EDF enabled the ASN to take a position on restarting the six reactors affected.

As part of this process, IRSN, jointly with the ASN and ANCCLI, organized a discussion day on February 24, 2017. The meeting provided an opportunity to discuss the complex issue and to understand the particular concerns of the participants representing civil society, especially relating to safety margins.



## PUMPING STATION FLOOD RISK IN THE EVENT OF AN EARTHQUAKE

Following the detection of advanced corrosion of several water pipes in the pumping station at the Belleville site, EDF reported the results of its investigations on the entire power plant fleet to the ASN. As part of the process, IRSN examined the report on this significant safety event reported by EDF in October 2017, which was at level 2 on the INES scale and affected 29 reactors in nuclear power plants in operation.

The degree of corrosion of the pipes meant that it was no longer possible to guarantee their resistance to an earthquake and could therefore cause a flood in the pumping station. In a situation like this, flooding of the essential service water system pumps would cause partial or total loss of coolant, depending on the site, for the reactors and spent fuel pools.

EDF began work to bring the reactors at power plants in operation into compliance, by carrying out temporary repairs or replacing entire sections of corroded pipe.

For each of the affected reactors, IRSN ensured that the compensatory measures taken by EDF pending repair were adequate. In parallel, IRSN carefully checked the adequacy and appropriateness of the repairs planned by EDF to ensure reactor and spent fuel pool cooling is guaranteed in the event of an earthquake.

# 536

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



## PROTECTING THE TRICASTIN NUCLEAR SITE FROM FLOOD RISKS

The ASN's decision to temporarily shut down the Tricastin nuclear power plant and certain Orano (formerly Areva) facilities on this site was mainly based on IRSN's assessment of the consequences of insufficient strength of a section of dike along the Donzère-Mondragon canal on the safety of site facilities, in the event of a seismic margin earthquake (SME). Since 2007, IRSN had carried out several technical assessments, which had revealed the possible fragility of a section of the Donzère-Mondragon canal dike near the Tricastin site and the need for a geotechnical survey of the materials used in the construction of this section.

*The reinforcements proposed by EDF were assessed by IRSN, which concluded that they were suitable to ensure the dike's stability in the event of an SME.*

The results of the investigations carried out for this purpose in 2016 by the licensee confirmed the risk of loss of integrity of this portion of the dike in the event of an SME of magnitude 5.2. The protection of the reactors at Tricastin and of the other nuclear facilities operated on the site by Orano (formerly Areva NC) from flood risks relies particularly on the dike.

The inability to provide evidence of the stability of a section of dike in the event of an SME, thereby compromising the safety demonstration of the EDF reactors and other facilities on the site, prompted the licensees to report a significant safety event to the ASN in August 2017. Besides the temporary shutdown of the Tricastin nuclear power plant, the ASN asked EDF to supplement its geotechnical investigations in order to characterize in more detail the composition of the section of dike in question and, before restarting the reactors, to carry out the necessary reinforcement work on it.

The reinforcements proposed by EDF were assessed by IRSN, which concluded that they were suitable to ensure the dike's stability in the event of an SME, provided that certain monitoring and maintenance measures were implemented. Completion of the reinforcement work enabled the ASN to lift its temporary shutdown order in early December.

Authorization to restart the Orano (formerly Areva NC) facilities was given before the reinforcement work was carried out, once special protection measures against flood risks had been implemented for these facilities.

IRSN assesses the safety of nuclear reactors and each year publishes "IRSN's Position on Safety and Radiation Protection at Nuclear Power Plants in France".  
(Photo: Blayais power plant)

## FUEL ROD CLADDING STRENGTH CRITERIA

On June 15, 2017, IRSN presented its assessment of the strength criteria for fuel rod cladding to the Advisory Committee for Reactors. The cladding acts as the first containment barrier separating the radioactive material from the environment. The majority of the criteria, taken essentially from the American safety baseline dating from the 1970s, had not been reviewed since EDF's fleet of nuclear power plants was designed, even though the operating conditions of the reactors, the fuel and knowledge had all evolved.

These criteria, such as the thickness of the oxide that forms on the cladding surface due to a reaction with the coolant water or the temperature reached by the cladding, concern values that are characteristic of a physical state that the fuel can reach but that it must not exceed. The limit values are determined through experiments simulating the situations that can occur in a reactor, ranging from normal operation to accident situations. The safety report studies aim to demonstrate compliance with these criteria, taking a conservative approach.

IRSN undertook a complete review of the criteria on the basis of information received from EDF and the current state of knowledge provided by R&D in France and abroad. The integration of operating experience feedback (the presence of rods with integrity defects and lateral deformation of fuel assemblies) in the criteria and the safety demonstration were also examined.

This extensive task for both EDF and IRSN, requiring a combination of assessment and research, confirmed certain limit values, supplemented others and also led to the introduction of new criteria.

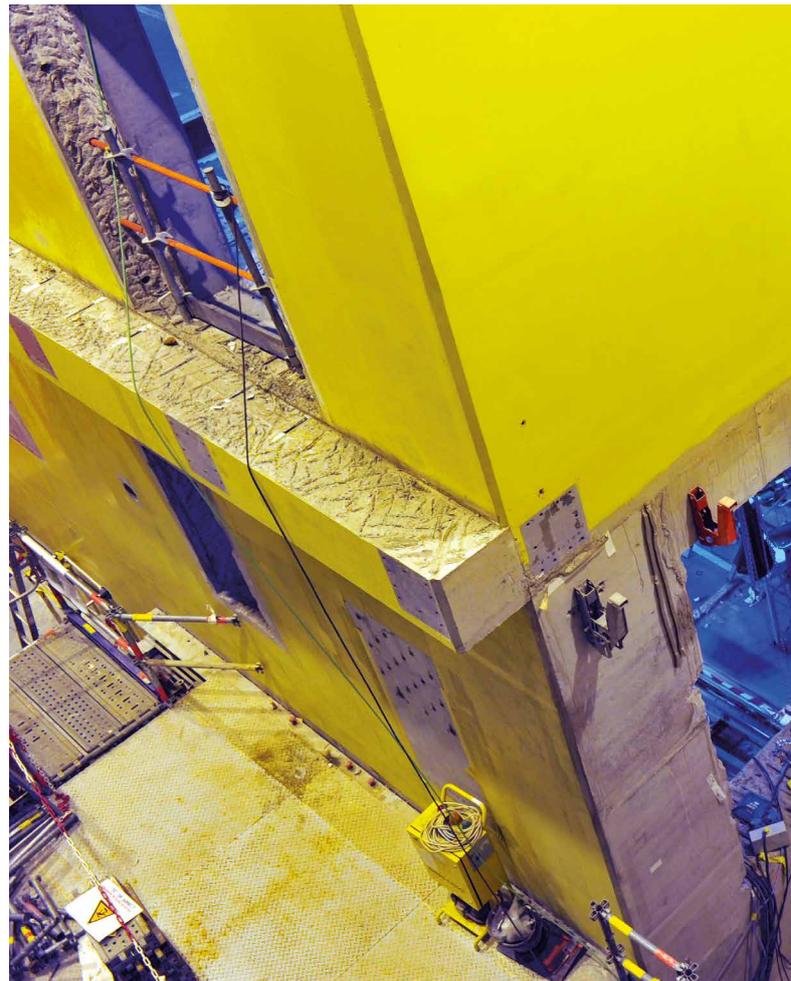
## FUTURE METRO LINE TO PASS CLOSE TO THE CEA PARISSACLAY CENTER

IRSN examined the safety study submitted by CEA on the compatibility of its nuclear facility activities on the Saclay site (Essonne) with the creation of a public transport route nearby, namely the future line 18 of the Paris metro.

IRSN's assessment looks at facilities which, in some cases, are due to change in the short or medium term. The final shutdown of several nuclear facilities on the Saclay site – experimental reactors and the waste treatment plant – followed by their decommissioning is in fact scheduled to take place in the next few years, which could affect their hazard potential.

As regards the consequences of the metro's operation on the safety of the nuclear facilities, including any accident situations likely to affect it, IRSN considered CEA's analyses to be satisfactory, except for those related to fire risks. For these risks, IRSN considers it necessary to verify that a generalized fire in a metro train would not have an impact on the facilities.

Concerning the possible consequences of an accident affecting a nuclear facility on the site for metro passengers and staff, IRSN's examination of the three accident situations presented by CEA led it to conclude that some of the assumptions result in an under-estimation of the potential radiological consequences of these accidents.



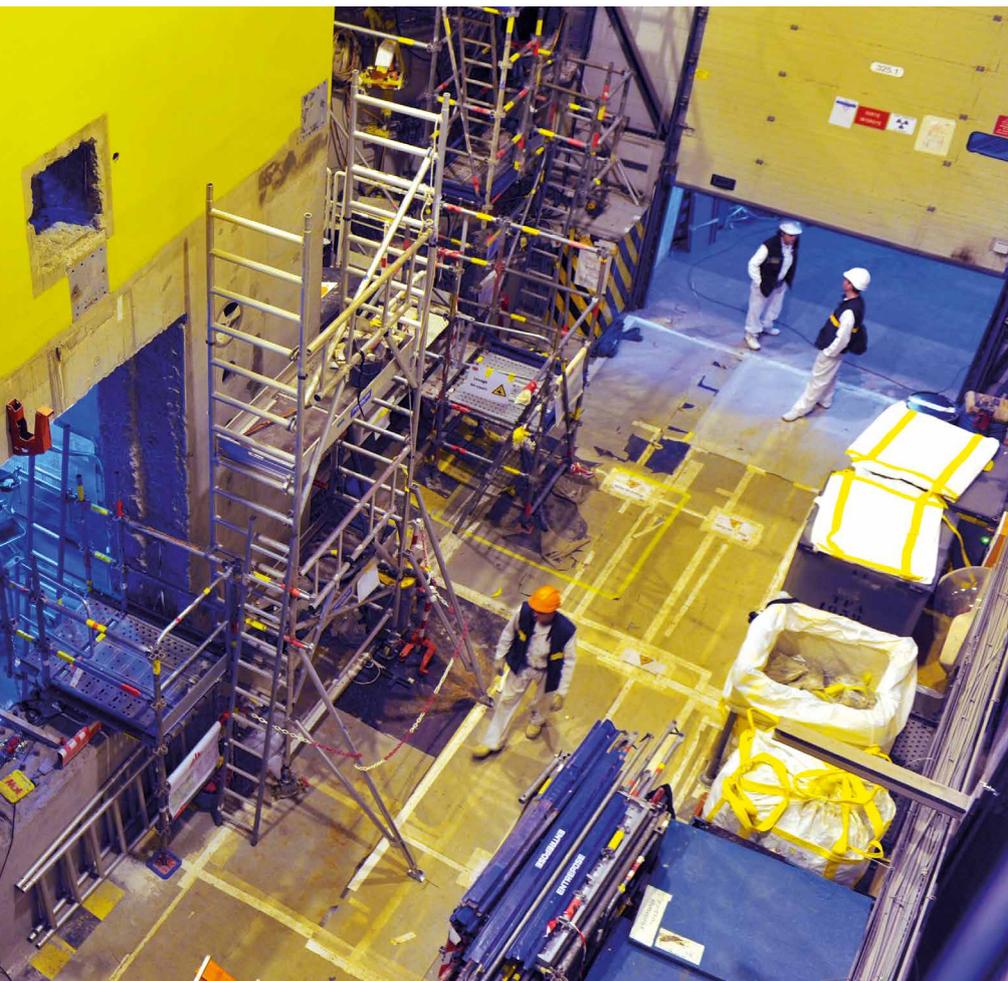
## STUDIES OF EVENTS AND INCIDENTS

The two reports published by IRSN in 2017 on safety at basic civil nuclear installations in France in 2015 and 2016 show that there was a slight drop in the number of significant events reported, all of which were limited to levels 0 and 1 on the INES scale.

IRSN is keen to point out that, in the case of French nuclear power plants, most events are attributable to organizational failures or to errors made during maintenance operations.

Since then, three events reported in 2017 at level 2 on the INES scale have highlighted the importance of, and risks associated with, the quality of maintenance and checks on the compliance of facilities with applicable safety requirements.

For other facilities, IRSN has emphasized the need to improve the technical and organizational measures associated with the radiation protection of operators in areas where there is a contamination risk and to take account of the specific characteristics of certain phases of plant decommissioning.



Decommissioning of old facilities at La Hague: intermediate storage compartment of the HAO silo at the UP2-400 plant.



### IRSN 2030

#### Independence

*Continue to guarantee impartial expert assessments relating to overall risk management*

## FINAL SHUTDOWN AND DECOMMISSIONING OF FORMER FACILITIES AT LA HAGUE

IRSN presented the conclusions of its assessment of the safety reports received from Orano (formerly Areva NC) to the ASN advisory committees, to support its applications for the final shutdown and complete decommissioning of its basic nuclear installations No. 33 (UP2-400 plant) and No. 38 (STE2 liquid waste treatment station and AT1 pilot facility) on the Orano (formerly Areva NC) site at La Hague, including operations to recover legacy waste stored at these installations.

IRSN concluded that the safety measures chosen by Orano (formerly Areva NC) are satisfactory and did not identify elements likely to compromise the projects to recover the legacy waste. Confinement management of “cells” contaminated by significant quantities of radioactive materials still require special analysis.

#### In brief

##### + International cooperation

As part of the European ASAMPSA\_E project coordinated by IRSN, 30 European, Japanese and American partners worked together to draw up guidelines that include new phenomena and the associated methods to be taken into account in probabilistic safety analyses (PSAs). These guides, which are designed for licensees and technical safety organizations, cover different external hazards such as earthquakes, floods, lightning, extreme weather conditions, and plane crashes.

##### + Viktoria Facility, Slovakia

IRSN is studying the design of the filters in the sumps allowing reactor coolant system water to recirculate in the case of an accident. Tests were carried out at the Viktoria Facility in Slovakia in 2017 to characterize the quantity of impurities retained by a standard filter and the risk of chemical reactions occurring that would stop the filter from working properly. These results will be used in particular as part of discussions on the fourth ten-year inspection.

# 11

technical reviews performed to support ASN Advisory Committee meetings regarding safety

# ENHANCING THE SAFETY OF FUTURE NUCLEAR FACILITIES

*To assess the safety of facilities at the design or construction stage, IRSN has set up an organizational structure and acquired resources giving it the necessary knowledge and tools to conduct safety assessments prior to the granting of licenses for construction or operation. It takes a multidisciplinary approach to the analysis of documentation submitted by the licensees.*

## ✚ MONITORING OF THE EPR PROJECT

As IRSN continues to examine the documentation supporting the application for the EPR operating license, on-site startup tests are in progress to check that facility systems function correctly before and after fuel is loaded. In April 2017, an IRSN expert was seconded to the site to monitor these tests.

*IRSN has helped to assess the serviceability of the reactor vessel head and bottom head of the EPR reactor at Flamanville.*

In the summer of 2017, IRSN acted jointly with the ASN's Nuclear Pressure Equipment Department (DEP) to assess the serviceability of the reactor vessel head and bottom head, which were affected by a manufacturing defect causing an excess carbon content. The assessment was performed for the purpose of a presentation to the Advisory Committee for Nuclear Pressure Equipment. It emerged from this joint investigation that Framatome (formerly Areva NP) had demonstrated the serviceability of the vessel head and bottom head of the EPR reactor at Flamanville and that in-service monitoring measures should be implemented to check the equipment periodically while the facility is in operation. At this stage, the feasibility of such checks appears to have been demonstrated for the bottom head. However, this is not the case for the reactor vessel head. If these checks cannot be carried out, the vessel head will have to be replaced in a few years' time.

Continuing the technical dialogue conducted since 2015 on this issue, IRSN arranged a meeting in July 2017, in partnership with the French National Association of Local Information Commissions and Committees (ANCCLI), the Flamanville local information commission (CLI) and the ASN, to present its conclusions and talk to representatives of civil society ahead of the public consultation on the ASN's draft position statement.



## SAFETY OF SMALL MODULAR REACTORS

SMRs are small reactors that can be installed within a single infrastructure, i.e. on a modular basis. With a maximum power of around 300 MWe, they offer a good level of safety compared to more powerful reactors using the same technology. They can be used as power reactors or for other applications such as urban heating systems.

The SMR Regulators' Forum was set up in 2015 to address the main challenges that the licensing of small modular reactors (SMRs) pose for nuclear safety authorities. Since the Forum was created, IRSN has held the vice-presidency. Among its members are the safety authorities of countries such as the USA, Canada, China, Russia, South Korea and the UK.

At the end of a two-year pilot phase, the Forum published a report presenting its initial conclusions. It appears that most national regulatory frameworks are adequate for examining construction license applications for SMRs. They allow a graded approach to be taken, which means that safety requirements can be imposed in proportion to the risks.

# 300

MWe (approximately 1,000 MWth)  
maximum power of SMRs

Given that these small reactors still pose a significant hazard potential, the Forum was keen to stress that their design must be based on the defense-in-depth principle.

The reactors have specific features that must be taken into account, and the Forum is continuing its work by exploring this further.

The Forum also plans to examine the specific requirements that should apply to the design and construction of SMRs, taking an integrated approach that includes human and organizational factors. The Forum also aims to examine the possibility of a licensing procedure common to several safety authorities, since the different SMR models are likely to be operated in more than one country. In this regard, the Forum is planning a discussion with SMR designers so that it can base its exploration of the issue on real examples.

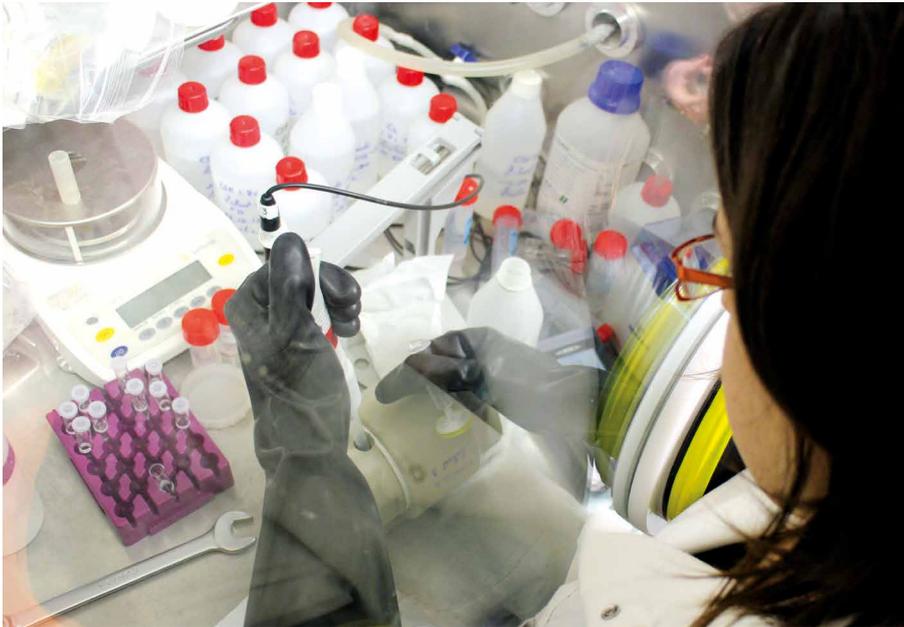


# 1,722

mechanical tests carried out  
by Framatome (formerly  
Areva NP) to support  
the demonstration of  
serviceability of the vessel  
head and bottom head  
of the EPR reactor at Flamanville

 Flamanville EPR: monitoring of startup tests by IRSN's experts.

## ✚ CIGEO: IRSN PRESENTS ITS CONCLUSIONS



Analyses are carried out at the LUTECE laboratory, in particular to determine the radionuclide confinement properties of a deep geological repository.

On May 18 and 19, 2017, IRSN presented its examination of the safety options report for Andra's CIGEO project to the Advisory Committees for Waste and for Laboratories and Plants, respectively.

The report examination took place as part of IRSN's technical support to the ASN, its main aim being to assess the degree of maturity of the project and the suitability of the options chosen from the point of view of safety and radiation protection, and to identify whether any major changes to the design are needed. IRSN took the initiative of gathering questions from representatives of civil society during its examination of the report.

Its analysis found that Andra had made progress towards demonstrating the safety of the CIGEO project at the safety options report stage, particularly as regards controlling risks while the facility is in operation. However, IRSN identified four points likely to lead to modifications in the facility design. The first concerns the disposal repository architecture, with a view to preventing the underground infrastructure from becoming a significant pathway for the transfer of radionuclides to the surface. Some accident situations, such as a waste package becoming stuck in a cell, need to be studied in further detail, as do the strategy and resources for monitoring the repository structures.

Finally, the risks related to fire in cells used for the disposal of bituminized waste packages undoubtedly constitute the most significant issue. In IRSN's view, the concept chosen by Andra for this type of waste does not manage these risks sufficiently. Consequently, it recommends either studying the possibility of pretreatment to neutralize the thermal reactivity of the bituminized waste, or revising the disposal facility concept to eliminate the possibility of fire spreading in the cell. According to IRSN, these points need to be addressed before the construction license application for the facility is submitted.

### In brief

#### + Multi-risk Study

At the request of the Aude prefecture, IRSN studied the potential health impact associated with the operating license application submitted by Orano (formerly Areva NC) for a treatment plant for waste containing nitrates. IRSN has submitted its conclusions, which state that the radiological impact does not require further measures in addition to those already planned by Orano (formerly Areva NC); the same applies to the chemical impact, with the exception of releases of nickel, arsenic and benzene, for which IRSN recommended a reduction in the discharge limits applied for.

# SAFETY ASSESSMENTS OF DEFENSE-RELATED ACTIVITIES AND FACILITIES

*IRSN provides technical support to the Representative in charge of Nuclear Safety and Radiation Protection for Defense-related Activities and Facilities (DSND).*

*In the context of this work, IRSN assesses the safety and radiation protection of nuclear facilities and transport within the DSND's scope of activity.*

*2017 was marked by a steady stream of support requests and a large volume of reports produced for the DSND on a wide variety of subjects, such as the future nuclear-powered attack submarine, the Suffren, and nuclear-powered vessels already in service.*

*The two following subjects had a particular impact in 2017.*

## ASSESSMENT OF THE SAFETY REPORT ON THE SECOND STAGE OF MEGAJOULE LASER (LMJ) FACILITY OPERATION

The LMJ, which is located at CESTA (a science and technology research center in Aquitaine), was set up to contribute to the simulation program being run by CEA's Military Applications Division, by carrying out experiments on the interaction between lasers and materials, using high-power lasers.

In 2017, IRSN examined the safety report on the license to continue operating the facility, which should lead to the LMJ laser lines and PETAL\* line being used at their nominal power. It looked particularly carefully at the assessment and management of risks involving radiation produced by the interaction between the laser and the material and by the activation of the materials.

## REACTOR SAFETY COMMISSION MEETING ON AUTHORIZATION TO LOAD THE RES TEST REACTOR

The RES test reactor at the regulated nuclear defense facility (INBS) in Cadarache is a special simulation tool for designing and keeping the on-board reactors and their nuclear cores in working order.

2017 was marked by the presentation to the Reactor Safety Commission of a report by IRSN on the license application for operation of the reactor part submitted by the licensee. The report was written to help the DSND to decide whether to authorize the loading of the first core, giving particular consideration to the safety of the loading operations and of storing the fuel elements in the vessel during the period between loading and criticality by confirming the production quality of the core and ensuring that it behaves correctly in the event of an earthquake.

# 62

technical notices  
submitted to the  
Nuclear Defense  
Safety Authority

Aerial view of the RES  
individual facility.



\*PETAL: laser line that can deliver a very high-power laser for experimental purposes in a number of research areas, particularly civil research.

# CONTRIBUTING TO SECURITY AND NON-PROLIFERATION

*In accordance with the missions assigned to it, IRSN provides support and assistance to the public authorities responsible for checking compliance with regulations on the protection and control of nuclear materials, nuclear facilities and nuclear material transport, and to the public authorities responsible for ensuring compliance with the international commitments made by France in the field of non-proliferation of nuclear and chemical weapons.*

## ▣ CAMPAIGN TO RAISE AWARENESS WITHIN INDUSTRY OF THE NON-PROLIFERATION OF CHEMICAL WEAPONS

IRSN provides technical support to the public authorities and to chemical and textile industry associations on the application of international treaties on the non-proliferation of chemical weapons in France. In this context, IRSN has contributed to a campaign to raise awareness among French companies of the Chemical Weapons Convention (CWC), launched on the 20<sup>th</sup> anniversary of the founding of the Organization for the Prohibition of Chemical Weapons (OPCW).

The CWC, which was ratified by 192 countries and has been in force since April 29, 1997, requires that all States Parties provide an inventory of any chemicals and chemical facilities above certain thresholds that could potentially be misappropriated from their habitual use for unlawful purposes. The 2017 awareness campaign was designed to make companies located in France aware of the existence and regulatory obligations of the Convention.

# 12

missions to escort international inspections involving the chemical weapons ban



*"Preventing the misuse of chemicals and chemical plants" booklet published for the 20th anniversary of the OPCW.*



Colloquium on “Preventing the diversion of chemicals and chemical facilities” held at the Maison de la Chimie in Paris on October 17, 2017.  
 Left to right: M. Mouton (IRSN), M. Dufour (Office of the Senior Defense and Security Officer of the French Ministry for the Economy and Finance), M. Üzümcü (Organisation for the Prohibition of Chemical Weapons), M. Lalliot (Ministry of Europe and Foreign Affairs) and M. Juéry (UIC, the French Chemical Industries Association).

## SELF-DIAGNOSIS SUPPORT BOOKLET AND CONFERENCE

As part of the campaign, IRSN contributed to the production of the booklet entitled *Prévenir le détournement de produits ou d'installations chimiques* [Preventing the Diversion of Chemicals and Chemical Facilities], which enables companies to carry out a quick self-diagnosis to determine if they are vulnerable.

IRSN also jointly organized a conference on the same topic, which provided representatives of companies in the pharmaceutical, chemical, cosmetic, agrochemical, textile and paper industries with an opportunity to talk to experts about how the Chemical Weapons Convention is implemented in France and find out more about the CWC and regulations.

## FOLLOW-UP WITH AN INTERNATIONAL EVENT

To present its cooperation with associations representing the chemical and textile industries as well as the English version of the booklet to an international audience, on November 29, 2017, the Permanent Representation in The Hague and IRSN held an side event to the 22<sup>nd</sup> Conference of the States Parties (CSP) in partnership with the French Ministry for European and Foreign Affairs, the Secretariat of the Senior Defense and Security Official and the French Chemical Industries Union.

A number of diplomats, OPCW inspectors and personnel from the OPCW's Technical Secretariat attended the event and the French initiative was highlighted by Marco Mensink, Director General of the European Chemical Industry Council and Secretary of the International Council of Chemical Associations, in his speech to all the States Parties attending the CSP.

# 118

technical notices sent  
to the non-proliferation  
authorities

# 45

missions  
to escort inspections  
involving international  
nuclear material control

## **+** NUCLEAR SECURITY

IRSN provides support and technical assistance to the Senior Defense and Security Official (HFDS) of the Ministry for Ecological and Inclusive Transition, which is responsible for inspecting the protection of nuclear materials, facilities and transportation. The two subjects described below illustrate its activities in 2017.

### **DETAILED TECHNICAL REVIEW**

As part of the application for a license to hold and use nuclear materials in EPR Reactor No. 3 at Flamanville nuclear power plant, EDF submitted a study evaluating the effectiveness of the organizational structure and resources implemented to prevent any acts aimed at altering, damaging or dispersing radioactive materials. A new detailed technical review procedure was introduced by the HFDS for the assessment of this application. The HFDS held working meetings starting in 2015, which were attended by IRSN, to explain to the licensee the assumptions to be used in the study. At the request of the HFDS, IRSN's analysis looked at how well EDF takes account of threats, identifies targets, assesses vulnerability and manages emergency response and IT systems security. IRSN delivered the results of its assessment of the issues raised. The HFDS commended the high quality of the assessment report.

This new review procedure is carried out over the course of several months. It requires clearly setting out the different stages in the assessment request, such as the meetings in which the HFDS presents the objectives, expectations and schedule to all parties, intermediate meetings and the meetings for defining the technical framework.

### **MONITORING NUCLEAR MATERIALS TRANSPORT**

Following IRSN Transport Operations' introduction of the retrofitted Mazarine tool for the management and monitoring of nuclear materials transport, and at the request of the HFDS of the Ministry of Energy, IRSN has launched a new project which should allow information on transportation activities to be sent in real time to the public authorities concerned, upon request. The specifications for the project take account of the needs expressed by ASN.

**169**

national inspections related to protection and control of nuclear materials

**57**

technical checks on approved equipment for transport of nuclear materials

**99**

technical notices sent to ASN

**41**

transport inspections



 A license application for the Flamanville NPP EPR Reactor 3 to hold and use nuclear materials was submitted by EDF to the Senior Defense and Security Official (HFDS).

# IDENTIFYING AND ASSESSING INCIDENTS

*As part of its assessment activities, IRSN analyses incidents reported by licensees and operators to identify any weak signals for prevention purposes. IRSN also carries out investigations, using its modeling tools in particular, to identify the origin of artificial radioactive elements detected in the environment by its monitoring systems.*

## EXPERIENCE FEEDBACK AND COMPLIANCE OF FACILITIES

Ongoing research to improve safety and manage the state of reactors: the safety approach in France attaches great importance to the changes to be made by the operator of a basic nuclear installation at the time of each safety review, to improve safety. However, these improvements cannot be fully effective unless the technical foundation of the facilities is well known and maintained, i.e. unless the facilities are compliant with their operating baseline. An examination of all the events reported in 2017 prompted IRSN to reflect on the amount of attention paid by licensees to compliance.

Managing the compliance of EDF's facilities in order to improve safety relies on a wide range of activities (maintenance, inspection, testing, etc.), some of which were carried out regularly since the plant was built, while others were introduced during operation. It was in this context that EDF highlighted several deviations that led to three significant safety events (SSEs) at level 2 on the INES scale being reported in 2017.

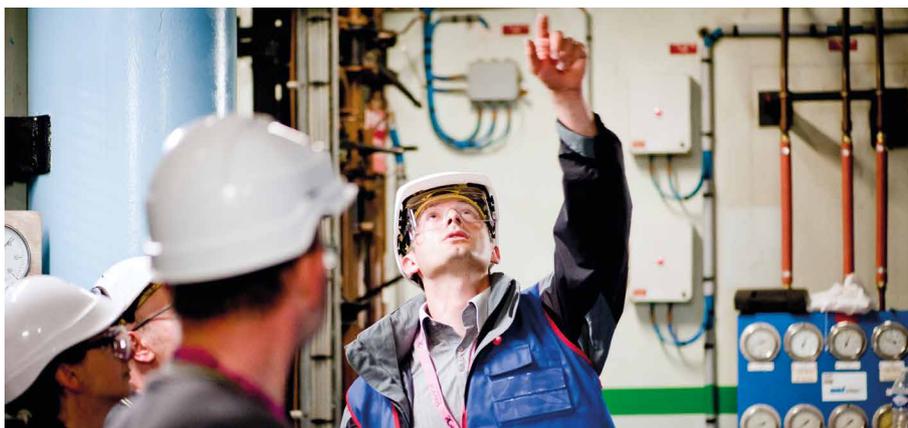
In late 2016, IRSN stated in its report on the use of experience feedback that EDF should look again at the adequacy and appropriateness of the very large number of inspections carried out at its facilities, especially in the context of preventive maintenance.

An event involving the corrosion of pipes at the pumping stations of 29 reactors illustrates this problem: the maintenance program implemented at each reactor failed to detect the deterioration of the pipes and therefore to anticipate the need to replace them.

*An examination of all the events reported in 2017 prompted IRSN to reflect on the amount of attention that the licensee pays to compliance.*

Similarly, maintenance programs cannot detect all deviations, especially those resulting from incorrect installation when the reactors were built, or equipment that is difficult to access or inspect. This was one of the lessons learned from significant safety events involving the anchoring systems securing the emergency generator sets of 1,300 MWe reactors.

In IRSN's view, this experience feedback raises questions both about the scope of the inspections carried out as part of compliance checks of the units performed during the ten-yearly outages, and about the way in which these inspections are performed. IRSN had already highlighted this point at the end of its examination of experience feedback, particularly in view of the upcoming fourth ten-yearly outages of the 900 MWe reactors.



*In 2017 IRSN published a report presenting its overall assessment of the significant events reported by EDF to ASN in 2016 and its analysis of the significant events that had occurred in 2015 and 2016 at the 85 basic nuclear installations other than nuclear power plants in operation.*

# 6

actions taken  
by the emergency  
response center



The dikes of the Donzère-Mondragon canal were reported by EDF and Orano (formerly Areva NC) due to a noncompliance with the safety baseline for the Tricastin site facilities.

Finally, in August 2017 EDF and Orano (formerly Areva NC) reported a noncompliance with the safety baseline for the nuclear facilities on the Tricastin site, linked to the robustness of the Donzère-Mondragon canal dikes in the event of an earthquake. This significant event is a reminder that the compliance of nuclear facilities relies on the necessary field checks of the assumptions used for the safety demonstration being carried out with an urgency that is appropriate and proportionate to the safety risks, so that the compliance of nuclear facilities relies on the timely performance of the necessary field checks of the assumptions used for the safety demonstration, commensurate with the safety risks involved in order to enable a rapid response to bring the facility back into compliance.

## DETECTION OF RUTHENIUM-106 IN FRANCE AND ELSEWHERE IN EUROPE

IRSN carried out investigations to locate the source and assess the scale of ruthenium-106 detected between September 27 and October 13, 2017 by a number of European atmospheric radioactivity monitoring networks. IRSN mobilized all of its atmospheric radiation monitoring resources. It also ran simulations, the results of which indicated that the most plausible location of the release was between the Volga and the Ural regions and that the release probably occurred in the final week of September. The simulations estimated that the amount of ruthenium-106 released was between 100 and 300 terabecquerels, which would have caused countermeasures to be taken to protect the local population if the event had occurred in France.

The atmospheric concentrations of ruthenium-106 measured in France had no impact on human health or on the environment. IRSN's analysis of exposure scenarios suggested that systematic checks for contamination of imported foodstuffs were not necessary.

An international committee of experts, including IRSN, BFs (Germany), Stuk (Finland), SSM (Sweden), NRPA (Norway) and ONR (United Kingdom), was set up by the Russian authorities, and chaired by the Nuclear Safety Institute of the Russian Academy of Sciences (IBRAE). Its objective is to determine the source of the ruthenium release. Its first meeting was planned for the end of January 2018.

## DETECTION OF RADIOACTIVE IODINE IN EUROPE

As part of its atmospheric monitoring mission in France, IRSN sought to determine the origin of tiny traces of iodine 131, a radioactive element of artificial origin, detected in the atmosphere in Europe in January and February 2017.

IRSN's investigations established that the traces of iodine 131 measured in several European countries during that period could not have originated from the radioactive releases that occurred in Norway from October to November 2016, as a result of an accident at the Halden reactor. Because the iodine 131 levels measured were so low, the location of the source of emission has not yet been precisely identified, but it is plausible that it was in Eastern Europe.

### In brief

+ Measurements near La Hague

Following the publication by the Association for Radioactivity Monitoring in Western France of the results of measurements showing contamination to the north-west of the Orano (formerly Areva NC) site at La Hague (Manche), IRSN conducted some specific measurements in October 2016 and January 2017. The presence of abnormal levels of artificial radionuclides is probably due to the storage of waste produced in the 1970s, which has now been removed. The dosimetric impact of this contamination is very low.



## IRSN 2030

**Independence**  
*Maintain the early warning role of IRSN*

# DEVELOPING RESEARCH AND SHARING KNOWLEDGE

*IRSN's research aims to further knowledge in all of its fields of activity and contributes to the Institute's performance at all levels of nuclear and radiological risk governance, namely prevention, diagnosis and remediation, emergency response and post-accident management. IRSN ensures its activity is driven by scientific excellence and innovation, thereby contributing to the development and sharing of knowledge.*

## ✚ DENOPI PROGRAM: SIGNIFICANT ADVANCES

Significant advances were made in 2017 in three areas of the DENOPI research program, launched by IRSN following the Fukushima-Daiichi accident. This research program was set up to study spent fuel pool uncovering and is funded by the future investment program run by the ANR. In the wake of the 2011 nuclear accident in Japan, the ANR set aside a significant budget to finance research aimed at improving the prevention and understanding of severe accidents at reactors.

Area 1 of the program focuses on studying phenomena in the pool itself. In 2017, design studies were carried out for the MIDI experimental facility, representing a spent fuel pool on a scale of 1:6.

*In 2017, the DENOPI program to study spent fuel uncovering entered its experimental phase.*

Area 2 of the program is dedicated to studying phenomena within a fuel assembly. It focuses on accident mitigation through the spraying of water and uses two facilities: MEDEA and ASPIC. The MEDEA facility represents the upper part of a fuel assembly at full scale. It is used to study the penetration and distribution of sprayed water within the assembly. The first test campaign was run in 2017 with an air-water configuration. The design studies of the ASPIC facility representing an electrically heated fuel assembly at full scale were completed in 2017.

Area 3 will study cladding oxidation phenomena in a mixed air-water atmosphere. The tests carried out in 2017 have led to a clearer understanding of the role of the oxide layer formed when the reactor is in operation, and the key role played by nitrogen and defects in the oxide layer. These experimental results will be used to improve the models.



*As part of DENOPI, IRSN has set up an experimental facility known as MEDEA, which is used to study two-phase flows that can occur within fuel assemblies stored in pools, in a boiling accident.*

## 39.8%

of budget devoted to research,  
excluding property projects and Feurs

## COMPLETION OF THE EUROPEAN PASSAM PROJECT

On February 28 and March 1, 2017, the final workshop of the PASSAM project took place, coordinated by IRSN with eight European partners. Launched in 2013 as part of the European Commission's 7<sup>th</sup> Research and Development Framework Program (FP7), the PASSAM project studied the retention of radioactive releases, which can occur in the environment following a core melt accident at a nuclear reactor.

The project focused on improving the filtration systems in nuclear reactors and studying innovative systems for trapping iodine compounds which, in the short term, pose the greatest health risk.

Over a four-year period, the PASSAM project assembled a database of the performance of each filtration system studied. A number of existing systems were reviewed, including sparging filters, sand bed filters and metal pre-filters, as well as some innovative systems, such as high-pressure sprays, electrostatic precipitators, improved zeolites, acoustic agglomerators and combined wet and dry filtration systems.

The results of the experiments enabled new calculation models to be developed and existing ones to be improved. These models are mainly used by severe accident simulation software, in particular IRSN's ASTEC software, which is used in the European Union, but also software specific to sparging filtration systems. The results of the PASSAM project were published in a final report available on the project website.

## CABRI INTERNATIONAL PROGRAM: A PIVOTAL YEAR

2017 saw the final commissioning tests successfully finalize the requalification of the CABRI experimental reactor after a lengthy renovation period. The campaign of operating tests on the reactor during a power transient, which took place from January to March 2017, enabled the entire operating domain of the facility to be characterized; analysis of these tests was also required in order to obtain the ASN's authorization to carry out the Cabri International Program (CIP). The hodoscope alignment tests, enabling the movement of the fuel in the test section to be monitored live, were conducted in June 2017.

2017 also saw the start of preparations for the first CIPQ test of the Cabri International Program, which aims to study reactivity accidents, with the loading of a test rod into the hot cell apparatus of the Active Fuel Examination Laboratory (LECA) at Cadarache.



The CABRI International Program (CIP) is dedicated to studying reactivity accidents in pressurized water reactors.

**395**

scientific papers presented at conferences (MINERVE database)

**21**

French patents in force (including 2 co-owned)

**26**

young researchers defended their theses in the fields of the environment (11 theses), nuclear safety (10 theses) and health (5 theses) in 2017

**32**

new theses hosted this year for IRSN's programs

## SARNET, THE SEVERE ACCIDENT RESEARCH NETWORK OF EXCELLENCE

Still very active 12 years after its creation, the IRSN-coordinated European Research Network of Excellence, SARNET, has joined the NUGENIA\* association dedicated to research on Generation II and III reactors. Its activities include conferences, technical seminars, training courses and the development of new R&D projects.

The 8<sup>th</sup> ERMSAR conference in Warsaw in May 2017 brought together 170 participants from 25 countries, including 30 from Asia. Around 60 young researchers attended the 7<sup>th</sup> course on severe accident phenomenology that took place in Slovenia in October. Several new R&D projects have recently been launched: CORE-SOAR on core degradation, which will come to a close in 2018 with the publication of a report on the international state of the art; IPRESCA on the retention of fission products by sparging in water; and SAMHYCO-NET on the risk of hydrogen explosion in the containment during the late phase of an accident and mitigation systems such as recombiners. For the last two of these projects, modeling and experimentation began in 2017.

The launch of these different projects demonstrates the importance of research in the field of severe accidents and the role played by SARNET as a driving force in mobilizing research partners to engage with projects of common interest, such as the 22 organizations from 14 different countries involved in the SAMHYCO-NET project, for example.

## SAFETY OF CORIUM RECOVERY AT FUKUSHIMA

Assessing the production and dispersion of contaminated aerosols during the laser cutting of corium at the damaged Fukushima-Daiichi reactors is IRSN's contribution to a research project being jointly run by Onet Technologies and CEA, on behalf of *Mitsubishi Research Institute* and the Japanese Ministry of the Economy.

IRSN is providing its specialist knowledge and expertise in physics and aerosol metrology to determine the quantity and characteristics of the aerosols emitted during cutting and using its numerical simulation capabilities to predict their dispersion. The tests are performed in a laboratory on the Altea laser cutting platform at CEA Paris-Saclay, where non-radioactive corium simulants are used.

## CRITICALITY: A FRANCO-JAPANESE COLLABORATION

Following the Fukushima-Daiichi accident, JAEA (Japan) is going to renovate one of its criticality experimentation facilities, STACY, to study the criticality of fuel debris beds. Given that the last experiment at STACY took place 10 years ago, JAEA has asked for support from IRSN, which has organized many international programs held at a similar facility at CEA Valduc.

Since 2014, IRSN has been working with JAEA, through a Japanese engineer seconded to IRSN, on the design of reference experiments on fuel debris beds, with the aim of studying the criticality risks when they are recovered from damaged reactors. This collaboration is part of the PRINCESS project, which aims in particular to maintain access for IRSN to criticality experimentation facilities once the facilities in question at CEA Valduc have been shut down.

## MICADO LAB

The MICADO LAB facility is used to study the impact of ionizing radiation on living organisms within the ecosystems that are the final recipients of many pollutants, including radionuclides. IRSN is working on a thesis that aims to assess the effects of chronic exposure to ionizing radiation on epigenetic and genetic mechanisms and their consequences for the development of the central nervous system at early developmental stages in the zebrafish (*Danio rerio*).

This organism, commonly used in toxicology, offers many advantages such as transparent, abundant and easily accessible embryos, and a fully sequenced genome. The work focuses on the development of the central nervous system, a key organ that plays a crucial biological role in the organism and is known to be particularly sensitive to stressors, especially at the early stages of development.

In 2017, zebrafish embryos were exposed to ionizing radiation at the MICADO LAB facility at different larval stages. The impact of ionizing radiation on embryo development at the morphological, physiological and molecular levels will be characterized during chronic exposure at a range of dose rates of several orders of magnitude, from 0.1  $\mu\text{Gy/h}$  to 100  $\text{mGy/h}$ . The exposure experiments will also make it possible to compare DNA methylation with gene expression.

The data acquired will be analyzed using an integrative systems biology approach. Epigenetic modifications can dictate the fate of a cell by regulating its gene expression without affecting the DNA sequence.



## IRSN 2030

Excellence  
Steer and conduct research  
on nuclear and radiological risks  
in an international setting

\*NUclear GENeration II & III Association.

## ASSESSMENT OF THE ROSIRIS RESEARCH PROGRAM

In 2017, IRSN's ROSIRIS research program was assessed by a scientific committee, using the methods proposed by HCERES for assessing IRSN's research units.

Launched in 2009, ROSIRIS aims to find out more about the mechanisms behind the side effects of radiation therapy on healthy tissues. The goal is to establish a causal link between the action of ionizing radiation at molecular level, its early effects at cellular level and any delayed consequences at tissue level.

The assessment highlighted the scientific advances made by a highly original and ambitious interdisciplinary program on fundamental concepts such as dose and relative biological effectiveness (RBE). For example, the concept of RBE is revisited using an integrative approach to express the response of living organisms at different scales, which is essential for risk assessment. On the basis of the self-assessment report, which was commended by the committee, the committee questioned IRSN about the strategic development necessary to process biological data in one of the project areas, and recommended that long-term partnerships should be set up on a formal footing with external teams as a matter of priority. To date, various teams have been approached, such as the Gustave-Roussy Institute and CEA's Fundamental Research Division.

It also confirmed the potential positive impact of the research on assessing the probability of complications or side effects in healthy tissue and on helping to identify new approaches to limit those effects.

### In brief

#### + Research

The PARIS II experimental platform, designed for research on the incorporation of radioactive substances by ingestion and inhalation in rodents, went into operation on July 3, 2017 on the Fontenay-aux-Roses site.

#### + Doctoral student meetup

On December 11 and 12, 2017 IRSN co-organized the first "energy doctorate" days with TOTAL and EDF. Doctoral students have many opportunities to present their research, but here the aim was to go beyond just scientific discussion. The initiative aimed to highlight the value of the doctoral students' work, which is central to the research, and to organize discussion sessions between the students in order to bring different points of view to bear on similar or related problems. Over the two-day period, 45 doctoral students worked together in creativity workshops, to review the future challenges of energy resources and means of energy production, the associated risks and responsibilities, research networks and new research practices. The documents produced by the students on these different themes will feed into the national energy research strategy.

#### + Doctorate prizes and recognition

In 2017, Elif Oral was awarded a European prize by the JCR group (a public-sector and international reinsurer) for her thesis on the multidimensional modeling of seismic wave propagation in linear and non-linear media. Salima Kaissoun won a prize for her paper presented at the International Conference on Nuclear Engineering, held in China. Her work aims to characterize, through an opening in the containment of a nuclear facility, the quantity of radioactive pollutant likely to be transferred to the outside during maintenance and decommissioning. Alexia Lapière was awarded a prize by the event organizers for her talk at the Microbiota and Health Conference. Her thesis research, conducted in collaboration with INRA, aims to evaluate the efficacy of a probiotic in reducing damage to a healthy colon when administered prior to starting pelvic radiation therapy.



### FOCUS ON...

#### Knowledge management: forming a network

A key event in 2017 as part of work on knowledge management was the creation of a network of coordinators to organize and run knowledge management within their units.

A review of the strategic analysis of knowledge was carried out for the field of pressurized water reactor safety. As a result of the review, a knowledge management action plan was produced. Further analyses have been undertaken in the fields of health and safety during radioactive material transport and of facilities other than pressurized water reactors.

Analyses of reference waste package knowledge sets in the fields of the environment and health have also begun, based on experience gained from work in the field of reactors.

The drive to capitalize on the knowledge of "knowledge-holders" has led to the production of more "knowledge books", in particular the one on the *Main risks associated with the chemistry of the PUREX process for processing spent fuel*.

In parallel, the findings of safety assessments carried out between 1974 and 1982 and the reports on safety research issued since 2000 have been added to the intranet knowledge portal.



The aim of IRSN's ROSIRIS program is to learn more about the mechanisms behind the side effects of radiation therapy on healthy tissue.

# ENHANCING INTERNATIONAL COOPERATION

*IRSN plays a driving role in advancing nuclear safety and radiation protection in an international context. As a Technical and Scientific Support Organization (TSO), IRSN sets up its own multinational scientific partnerships or conducts its activity within the framework of EU (ETSON network of TSOs), IAEA or OECD/NEA programs and projects.*

*These international activities help to develop IRSN's knowledge and to maintain a high level of expertise through exposure to different technologies and safety practices. They also enable the development of shared knowledge among partners and foster a uniform approach to risk management in Europe and throughout the world.*

## ETSON: STRATEGY REINFORCEMENT

As one of the founding members of the ETSON network, IRSN plays an active role in its development and actions, which aim to advance nuclear safety and to harmonize practices across Europe. In 2017, ETSON accepted its sixteenth member, the Romanian technical safety organization RATEN ICN. At the meeting of its general assembly in June, ETSON approved the renewal of its strategy. Its aim is to become the leading association of experts in Europe in the field of nuclear safety and security.

*As one of the founding members of the ETSON network, IRSN plays an active role in its development and actions, which aim to advance nuclear safety and harmonize practices across Europe.*

In this context, ETSON enhanced its international standing by signing an agreement with the IAEA and getting involved in the IAEA's next TSO Forum. Within the European Commission, ETSON is also in contact with the Joint Research Centre and is working with DG ENER on analysis of the technical adaptation of the Nuclear Safety Directive within the Member States.



Pierre-Tanguy building, IRSN's headquarters.

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**countries involved in cooperation agreements with research and assessment organizations**

In 2017, work on the technical guides on safety assessment led to the approval of a guide on the comparison of regulations for the assessment of pressurized water reactor vessels.

As regards research policy, the ETSON Research Group, in liaison with the Technical Board on Reactor Safety, has set eight general priorities for safety research. They will be presented as part of preparations for the next EURATOM call for proposals:

- + improvement of thermohydraulic studies for existing facilities;
- + the impact of one or more external events;
- + methods for beyond-design-basis safety assessments;
- + development and validation of integral computer codes for severe accidents;
- + scenarios for accidents involving spent fuel in pools;
- + thermophysical and thermodynamic properties of corium;
- + study of ageing, degradation mechanisms, modeling and the material properties of metal components;
- + small modular reactors.

## RESULTS OF THE HORIZON 2020 EURATOM 2016-2017 CALL FOR PROPOSALS

IRSN participates in eight of the 25 projects chosen by the European Commission in the H2020 Euratom 2016-2017 call for proposals. Six of them are in the safety category, while the other two concern medical radiation protection and the “tritium” problem. Experts from IRSN are also involved in advisory committees for three other projects.

IRSN’s share of the total funding granted by the European Commission remains stable compared to the previous call for proposals. The evaluation criteria were set by the European Commission. In the proposals selected that involve IRSN, the Commission emphasizes the “clarity of the objectives consistent with expectations”, the “innovative character of the project”, and other aspects relating to its “technological impact” and “economic impact”.

## RADIATION PROTECTION: IRSN EMBARKS UPON A JOINT ENDEAVOUR WITH QST, ITS JAPANESE COUNTERPART

IRSN has signed a scientific cooperation agreement with the Japanese National Institute for Quantum and Radiological Science and Technology (QST). This five-year agreement extends the existing collaboration between IRSN and the Japanese National Institute of Radiological Sciences (NIRS), the activities of which have been merged into the QST. The endeavor concerns five areas of radiation protection, namely the effects of chronic exposure to low doses of ionizing radiation on health, diagnosing and treating persons accidentally over-exposed, the epidemiology of carcinogenic and non-carcinogenic effects of ionizing radiation, internal and external dosimetry in normal and accident situations, and, lastly, biological dosimetry.

The collaboration reflects a desire to strengthen Franco-Japanese cooperation in nuclear safety and radiation protection.

## CONTRIBUTION TO JAPANESE POST-FUKUSHIMA PROJECTS

To prepare for the decommissioning of the Fukushima-Daiichi reactors, Japanese authorities and industrial companies have been driving research efforts and, to do this, have sought help from the international community through the OECD. Hence, in 2017, IRSN took part in the BSAF project to diagnose the extent of the damage to the reactors. The innovative approach used by the project consisted in comparing radioactive releases from all the reactors (calculated by severe accident software) and in carrying out reverse calculations of the releases from the readings taken by detection equipment in the environment.

IRSN has thus contributed to the acquisition of knowledge to support decision-making on the technology to be used for decommissioning the reactors, and will continue to do so under the TCOFF and Pre-ADES projects that began in 2017. IRSN can help to promote the use of analyses in improving the overall understanding of severe accidents and will draw on its expertise on the behavior of materials and thermodynamic databases.

### In brief

#### + Cooperation with ENEA (Italy)

In 2017, Jean-Christophe Niel, Director General of IRSN, and Federico Testa, President of the Italian National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA), signed a renewal of the cooperation agreement on nuclear safety and radiation protection between the two organizations for a further five years. The areas of cooperation include R&D on nuclear fusion, the development of Monte-Carlo codes, emergency response management, and passive safety.

#### + Study for FANR (United Arab Emirates)

Under the agreement signed at the end of 2016 between IRSN and the United Arab Emirates safety authority (FANR), the first project (modeling the dispersion of radionuclides in the atmosphere and in the marine environment) entered the technical task definition phase. The aim is to develop tools adapted to environmental conditions in the Persian Gulf.

#### + International EUROS SAFE Conference

The EUROS SAFE Forum was held in Paris on November 6 and 7, 2017, and was attended by nearly 240 experts of 25 different nationalities. This international conference on nuclear safety and security, radioactive waste management and radiation protection brings together mainly representatives of nuclear safety authorities and technical safety organizations (TSOs). In addition to a strong European presence, there were also representatives from South Korea, Japan, the USA, Turkey and Vietnam.

#### + International research on fire

The third phase of the OECD’s PRISME research project run by IRSN began in 2017. This international partnership includes 13 organizations from seven countries. The work focuses on realistic fire scenarios encountered at nuclear facilities and includes the study of fire sources such as electrical cabinets and cableways.

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



IRSN was involved in diagnosing the extent of the damage to the Fukushima-Daiichi nuclear reactors as part of the BSAF project run under the aegis of the OECD-NEA.

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bilateral cooperation  
agreements in force with  
research and assessment  
organizations



FOCUS ON...

**Regional ENSTTI partner  
platforms to foster international  
expansion and training in  
nuclear safety and radiation  
protection**

The European Nuclear Safety Training and Tutoring Institute (ENSTTI) continued its expansion in 2017. Originally set up to provide vocational training courses throughout Europe in nuclear safety and security as well as radiation protection, while developing a common reference basis for skills, ENSTTI now operates throughout the world from a network of regional partner platforms. ENSTTI deploys its international catalogue in Kiev (Ukraine), Singapore, Rabat (Morocco), Pretoria (South Africa) and Rio (Brazil), now offering more than 50 training courses. These regional platforms have been developed in particular to run the training and tutoring program under the European Union's Instrument for Nuclear Safety Cooperation, with the collaboration of the IAEA's regional nuclear safety networks. In 2017, a third of ENSTTI's international training program (11 courses) was run from these regional platforms. These regional training courses trained 165 people from 39 non-European countries with the support of 43 expert instructors from IRSN and other members of the ETSON network.

## INTERNATIONAL SERVICES

2017 was a good year for the EEIG RISKAUDIT IRSN/GRS International in terms of tenders awarded in the European Union through its INSC instrument. As a result, over the next three years, IRSN will be involved new projects to support the safety authorities in Ukraine, Belarus, Turkey and Morocco within the framework consortia led by Riskaudit. In parallel, IRSN has also been awarded an important tender by China's TSO, the CNPE, which will run for five years and cover 19 subject areas.

In 2017, also in the context of its Riskaudit partnership, IRSN has worked on contracts with the safety authorities of China, Vietnam, Brazil, Indonesia, Egypt, Mongolia, Belarus and Armenia and has played an active part in the activity of Clearinghouse, which processes operating experience feedback from nuclear power plants.

The activities it has undertaken, which cover a wide range of topics related to the fuel cycle, different types of nuclear facility and the distribution of codes, include most notably:

- + the provision of a service with significant implications under the INSC contract for China on its development of research on nuclear safety and radiation protection. This service should in the medium term open up prospects for joint research between the Chinese entity and IRSN;
- + the examination of the report released by the safety authority of Belarus (GAN) concerning the results of the stress tests defined by the European Nuclear Safety Regulators Group (ENSREG), conducted on the two Russian-designed Generation III reactors under construction. The report examination, carried out at the European Commission's request by various European experts, including experts from IRSN, led to recommendations concerning the comprehensiveness and relevance of the tests. These recommendations are to be incorporated by GAN in its final report, which will be peer-reviewed in 2018.

These activities consolidate IRSN's reputation on the international stage and demonstrate its ability to lead from the front in a highly competitive context.

## INSC: EUROPEAN INITIATIVE TO BOOST NUCLEAR SAFETY

Since its creation in 2007, and prior under the 1991-2006 TACIS program, the Instrument for Nuclear Safety Cooperation (INSC) program has enabled the European Union to contribute to improving nuclear safety in Eastern European countries, the EU's neighboring countries and beyond.

The Commission's objective, through the Technical Aid to the Commonwealth of Independent States (TACIS) and the INSC programs, has been to harmonize safety practices by helping the safety authorities and technical safety organizations in the EU's neighboring countries to develop both their legislative frameworks and training. These activities now extend to all "newcomer" countries wishing to develop nuclear activities or to improve their inspection and control systems. Either directly or through Riskaudit, IRSN has won many tenders within consortia and therefore regularly works on projects proposed by the INSC.



### IRSN 2030

**Sharing**  
*Strengthen European  
cooperation in the field  
of research, expertise  
and experience feedback*

# ACTING TO PROTECT THE ENVIRONMENT

*Knowing and understanding what becomes of radioactive materials in the environment, regardless of their origin, is one of IRSN's fields of research. This research, combined with environmental radiation monitoring activities essential for detecting abnormalities, is vital for guaranteeing the excellence of IRSN's expertise in the field of radiation protection for humans and ecosystems.*

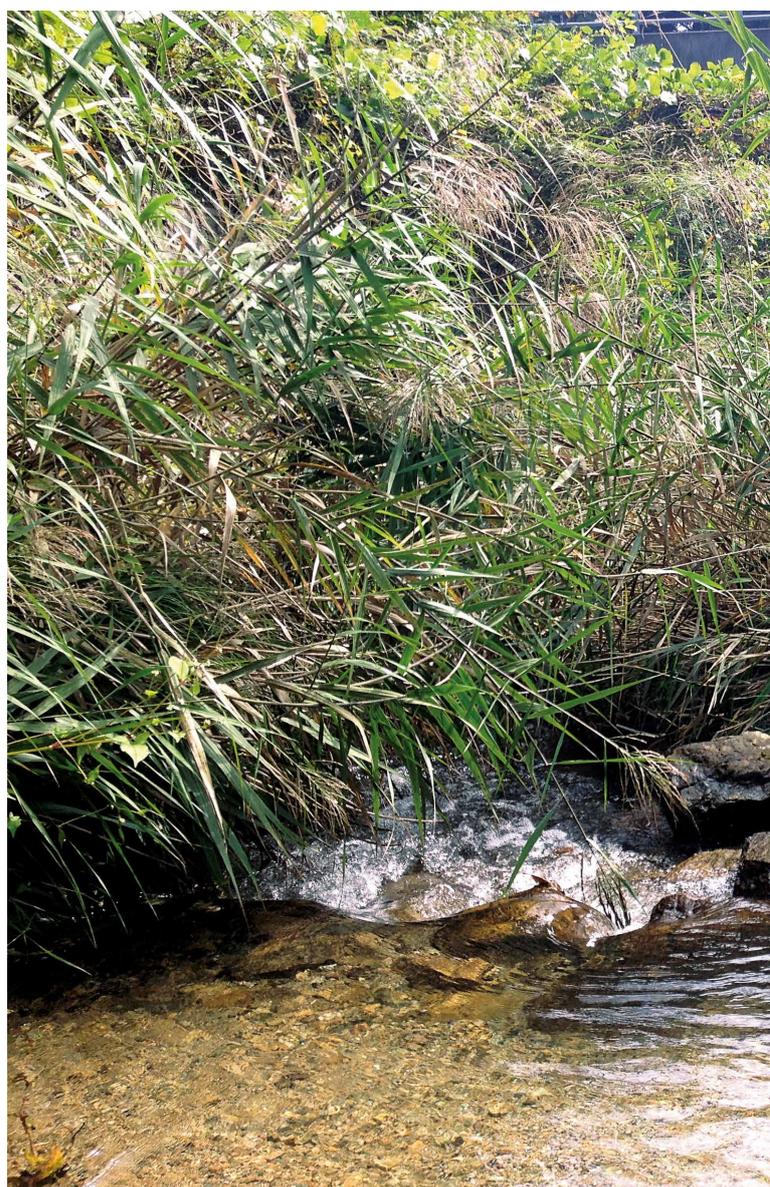
## NEW KNOWLEDGE ABOUT TRITIUM

Tritium is produced naturally in the upper layers of the atmosphere, but is also emitted into the environment by the nuclear industry. This radionuclide, with its low radiotoxicity and relatively short radioactive half-life (12.3 years), is present in the biosphere mostly in the form of tritiated water. The main exposure pathway for the public is ingestion. In light of questions about the behaviour of tritium in the environment, its potential bioaccumulation by living organisms and the methods of assessing the biological effects of tritium in humans, the ASN published a White Paper on tritium in 2010, making recommendations for the research areas to be developed. Seven years later, IRSN has published a survey of the progress made in research, in a report entitled *Actualisation des connaissances acquises sur le tritium dans l'environnement* ("Updating the knowledge on tritium in the environment").

The report is based on IRSN's recent and on-going work on a review of the latest international publications. It discusses issues related to the measurement of tritium, from sampling to the effectiveness of different analysis methods, it presents the levels measured in different environmental compartments (air, water, soil, sediment) and explains how to interpret them according to origin/source. It also presents a review of knowledge about the physicochemical forms of tritium, what happens to these forms in the environment and how long they remain there, and their transfer to the food chain.

*In 2017, IRSN published a report entitled "Updating the knowledge on tritium in the environment".*

For example, the persistence of tritium in the environment – in its form bound to naturally occurring organic material or in its synthetic form – is observed in all compartments of the biosphere. Although tritium persists in its organically bound form within terrestrial plants (prairie grasses) or in the sea (seaweed) for a few weeks to a few months, it can remain for much longer in woody plants and in sediments containing detrital organic matter from the soil (several years to several decades).



## AMORAD: LOOKING TO VALIDATE DEVELOPED MODELS

Since 2013, IRSN has been running the ANR AMORAD project, which aims to improve the models used to predict the dispersion and transfer of radionuclides in the continental-marine environment. A key challenge is to reduce the uncertainty associated with the assessment of radiation exposure in order to improve the management of the radiological impact of a nuclear accident on humans and the environment.

Alongside its 12 research partners, IRSN has pursued its programme of activities by gradually entering into a phase of validating the transfer models developed and of multidimensional (scientific, socio-economic) appraisal, both of which are necessary for decision-making. Two years before the project comes to an end, the 4<sup>th</sup> Scientific and Technical Committee meeting has ensured that the programme will deliver the tools and recommendations for an integrated approach to assessing the radiological consequences of a nuclear accident, as a support for decision-making.

By 2017, AMORAD had already produced 18 scientific papers in international journals and 55 communications at conferences.



## + CERTYF AND KRI-TERRES

Two new projects in which IRSN is participating have been selected as part of ANR's second call for research projects to win funding allocated to Andra by the PIA for the exploration or development of innovative solutions for managing radioactive waste produced by the dismantling of nuclear facilities.

The CERTYF project will broaden understanding of the influence of environmental constraints (temperature, radiation, hydrogen, rock) on the resistance and ageing of several families of optical fibres used increasingly in nuclear facilities. Andra must set up systems to monitor the components of its geological disposal facility throughout its long operating life (around 100 years) and after its closure, and on this basis is exploring various avenues of research.

KRI-TERRES will develop an innovative approach to planning ahead, in the event of nuclear facility decommissioning, for the management of soil that may have been contaminated by radioactive liquid discharged by the facility during its lifetime.

## INVENTORY OF FORMER URANIUM MINING SITES: UPDATE OF MIMAUSA

IRSN has published the second version of the MIMAUSA database (*Mémoire et Impact des Mines d'urAniUm : Synthèse et Archives*) that it has run since 2003 at the request of the Ministry for Ecology's Directorate General for the Prevention of Risks. MIMAUSA, which is available on IRSN's website, allows anyone to find out the location and history of mining operations, rehabilitation works and the current administrative situation of former uranium mining sites that were operating in France between 1950 and 2001. It thus meets the challenges of both conserving and sharing knowledge of the status of these sites.

Subsequent updates have enriched the inventory, which now contains 250 sites following the addition in 2017 of 17 mining sites in Brittany. New features have been added to MIMAUSA, which means it is now possible to access environmental reports by Orano (formerly Areva NC), IRSN reports, administrative documents, plans and maps interactively and for all sites.

The database can be accessed at <https://mimausabdd.irsn.fr>

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sites in Brittany added to the former uranium mines radiation monitoring list

AMORAD project: environmental sampling campaigns in Japan are improving the models used to predict radionuclide dispersion and transfer in the marine and terrestrial environments.



Under the Openradiation scheme, any member of the public with a sensor and a smartphone can take measurements of radioactivity in the environment.

## OPENRADIATION

IRSN has launched a collaborative science initiative that is helping to promote direct dialogue between civil society and researchers and experts. As part of its Openradiation project, in partnership with the French Institute for Training in Major Risks and Environmental Protection, the “FabLab” at the Sorbonne Universities and Planète Sciences, IRSN is offering all members of the public the opportunity to take measurements of environmental radioactivity using a smartphone app, and to upload the data onto a website specially set up for that purpose. Various sensor technologies can be connected to the smartphone. Meanwhile, the project has developed a proposal for sensor technology that is also available in kit form for educational use.

The project has two aims. Under normal circumstances, it enables members of the public to get involved in measuring radioactivity in a collaborative, educational or informative context. In an emergency, it gives members of the public the opportunity to contribute to the supply of data that can be used to assess a radiological situation, by taking real-time measurements on the ground.

All of the data on the website, which was opened to the public during the 2017 Science Fair, is available to view and download.

### In brief

+ 4<sup>th</sup> ICRER conference

IRSN and the NRPA jointly organized the 4th International Conference on Radioecology and Environmental Radioactivity (ICRER 2017) in Berlin, with the support of the European radiation protection research platforms, the International Atomic Energy Agency and the International Union of Radioecology. Nearly 300 scientists, industry representatives, regulators and experts came together for a week to discuss nine topics designed to stimulate development of the knowledge, methods and tools necessary to achieve advances in human and environmental radiation protection.

+ Cooperation with Singapore

Under their cooperation agreement signed in 2015, IRSN and the Singapore Nuclear Research and Safety Initiative jointly organized in Singapore, through ENSTTI, a high-level training conference on the multidisciplinary theme of monitoring radioactivity in the environment, for 20 regional engineers and researchers. The Initiative aims to become the Asian center of excellence for nuclear safety and radiation protection training and assessment.

# 434

monitors (including 393 stationary Teleray monitors, 30 mobile monitors and 7 river monitors, making up the national remote monitoring network)

# 474

sampling points for radioactivity monitoring throughout France

# 130

ambient dose rate measurement points

# 4,315

environmental samples taken for radiological measurements



## IRSN 2030

### Independence

Continue to guarantee impartial expert assessments relating to overall risk management

# PLAYING AN ACTIVE ROLE IN PUBLIC HEALTH

As part of its radiation protection duties, IRSN divides its action to protect the public, workers and patients into three areas: monitoring, assessment and research. It thus plays a role in public health through its work on radiological risks, for which it takes a multidisciplinary approach and which is the subject of national, European and international collaboration.

## ■ RADON: FIRST REPORT ON THE HAUTE-VIENNE PILOT PROGRAM

Radon is a radioactive gas. Preventing the risks associated with its presence in homes is a public health issue which IRSN is helping to resolve, both by supporting national government as part of the 2016-2019 National Radon Action Plan and alongside local players. This is reflected in the innovative pilot program, "Radon, let's take up the challenge, let's have a change of air", run by IRSN over a two-year period with 15 local councils in Haute-Vienne.

- + Phase 1 of the program (from December 2015 to June 2016) saw 729 local volunteers measuring radon levels in their homes using a kit provided by IRSN. In more than 70% of homes, the reference level of 300 Bq/m<sup>3</sup> – above which action is recommended according to EU Directive 2013/59 – was exceeded.
- + During phase 2 (June 2016 - March 2017), the Felletin construction industry vocational college and partners in the program offered to help residents who were interested in taking remedial action. 300 residents attended one of the four information meetings, and around a hundred took part in one of the 11 workshops held to look at the solutions that could be implemented.

- + Phase 3 (July - December 2017) consisted in checking the work done in 104 homes to ensure its effectiveness and, where appropriate, specifying additional work that could reduce radon levels further still.

*IRSN contributes to radon risk prevention both in support of the national authorities and alongside local players.*

This program adds to the experience gained by IRSN through other local actions to raise public awareness and to improve understanding of the problem of radon in buildings and manage the risks associated with it.

It illustrates two inseparable and vitally important issues for the implementation of a policy on radon at a local level:

- + the role of measurements taken by volunteers in identifying risk levels and raising public awareness;
- + the ability of members of the public to take action on the basis of the results, through information-sharing and dialogue at every stage up to remediation.



*In risk prevention, IRSN ran an innovative pilot program, "Radon: let's take up the challenge, let's have a change of air", over a two-year period with 15 communities in Haute-Vienne.*

## RADIATION PROTECTION: IRSN BRINGS THE INTERNATIONAL SCIENTIFIC COMMUNITY TOGETHER IN PARIS

IRSN organized and hosted two major events in Paris for all radiation protection professionals, experts and researchers: the International Commission on Radiation Protection (ICRP)'s 4<sup>th</sup> International Symposium on the System of Radiological Protection, and the 2<sup>nd</sup> European Radiation Protection Research Week, initiated by the European research platforms.

For nearly 90 years, the ICRP has been developing and improving radiation protection recommendations and practices, which help to protect patients, workers, the public and the environment.

Meanwhile, European research platforms conduct research and address the technical and organizational aspects of radiation protection: MELODI (low doses), EURADOS (dosimetry), NERIS (emergencies and prevention), ALLIANCE (radioecology) and EURAMED (radiation protection in medicine).

This international event opened by OPECST (the French parliamentary office for the evaluation of scientific and technological choices) was attended by more than 540 participants and consisted in seven sessions on: the effects, risks and detriment at low dose and low dose rates; advances in dose coefficients; innovative radiotherapy techniques; post-accident recovery; integrated protection of people and the environment; recent scientific progress in radiobiology and radiopathology, epidemiology, dosimetry, radioecology, medical applications of ionizing radiation, preparation for emergency situations and emergency response; strategic research agendas (SRAs) and the associated European roadmaps.

This unique opportunity to share their points of view on the current challenges in different areas of radiation protection, as well as on avenues for new research, the updating of policies and better interaction between stakeholders was greatly appreciated by all.

## REPORT ON 50 YEARS OF EPIDEMIOLOGICAL MONITORING OF NUCLEAR WORKERS

The carcinogenic effect of ionizing radiation is now well established in the case of moderate to high doses, i.e. doses above 100 millisieverts (mSv). An increase in the number of cancers in populations exposed to these dose rates has been observed in many epidemiological studies, in particular on the survivors of the atomic bombings in Hiroshima and Nagasaki, on radiotherapy patients and on radiologists.

In the 1980s, IRSN set up cohorts of workers covering all stages in the French nuclear power production cycle. The aim of these epidemiological studies was primarily to analyse the potential risks associated with chronic radiation exposure, through external irradiation or internal contamination, in a context of multiple exposure that was common among workers (radiological exposure as well as chemical and physical exposure with stressors, such as noise and heat, and working conditions, such as shift work). In addition to the scientific objective of increasing understanding, these epidemiological studies aimed to provide support for radiation protection assessment in both occupational health and public health contexts by performing health checks on the populations and companies being monitored.

The results of IRSN's research and the contribution they have made to international studies are presented in a report available on IRSN's website. These results are of direct importance in confirming the hypotheses underpinning the current radiation protection system.

As part of this, IRSN is monitoring five main cohorts which, along with the workers currently being added, represent 90,000 workers in industry and research and all stages of nuclear power production.

- + A national cohort of nuclear workers formed by the merger of two cohorts is being monitored for external exposure (CEA/AREVA\*/EDF cohort). The study focuses on workers monitored for external exposure. This cohort consists of workers in the CEA/AREVA NC\* group and workers at EDF's nuclear power plants.
- + Three other cohort studies focus on populations of workers potentially exposed to internal contamination: uranium miners, workers at uranium ore processing and concentration plants (F-Millers cohort) and workers in the uranium cycle (TRACY cohort).



# 727

whole-body radiation counts  
performed for worker monitoring,  
including 474 using mobile equipment

IRSN organized and simultaneously hosted two major events in Paris for radiation protection professionals, experts and researchers: the Fourth International Symposium on the System of Radiological Protection of the International Commission on Radiological Protection (ICRP) and the Second European Radiological Protection Research Week set up by the European research platforms.

With the CEA/AREVA\*/EDF cohort, IRSN has also participated in the international INWORKS study (*International Nuclear WORKers Study*), coordinated over the last few years by the International Agency for Research on Cancer (IARC). This study uses the most informative cohorts of the 15-country study carried out in the 2000s: the French, American and British cohorts of nuclear workers amounting to a total population of 308,000 workers with an average monitoring period of over 27 years.



FOCUS ON...

**Transposition of council directive 2013/59/Euratom**

Over three years, IRSN made an active contribution to the regulatory work in transposing the European directive of 5 December 2013 laying down basic safety standards for radiation protection into French law. Transposition should take place in early 2018.

In 2017, IRSN provided support to the DGT (the French Directorate General for Labour) in preparing the decree amending the French Labour Code. Most notably, it was consulted on the procedures for monitoring workers in a radiological emergency. The final version of the draft decree was submitted to the French Council of State for examination on 7 November, so that it could be published jointly with the decree amending France's Public Health Code, to which IRSN also contributed.

The three main thrusts of the draft decree, as far as "workers" are concerned, take account of feedback related to current regulations. They aim to:

- + improve the effectiveness of risk prevention measures for workers;
- + ensure an integrated approach to all occupational risks;
- + step up the requirements taking account of the type and scale of the risk, and allow greater flexibility for medium-sized, small and very small companies.

IRSN will also participate in the preparation of the orders applying the decree.



**IRSN 2030**

**Excellence**  
*Manage knowledge and use data within a digital environment*

**+ REPORT ON OCCUPATIONAL EXPOSURE TO IONIZING RADIATION**

The results confirm the steady increase in the number of workers monitored and the stability of average individual exposure in the last five years:

**393,293**

workers monitored in 2016



**0.17**

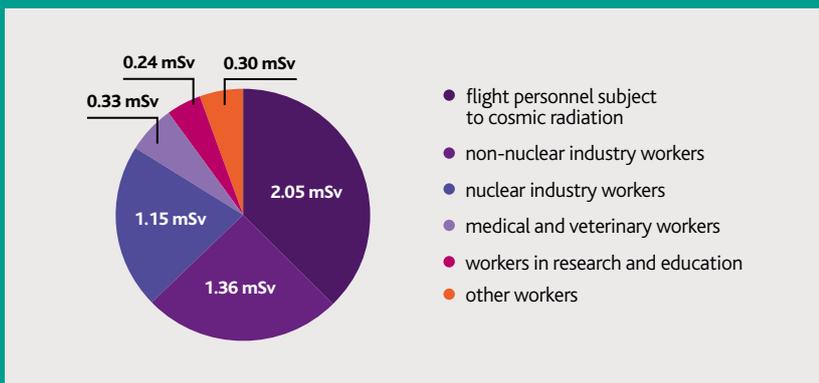
millisieverts on average in individual external exposure

**1**

recorded case where the regulatory limit of 20 mSv was exceeded

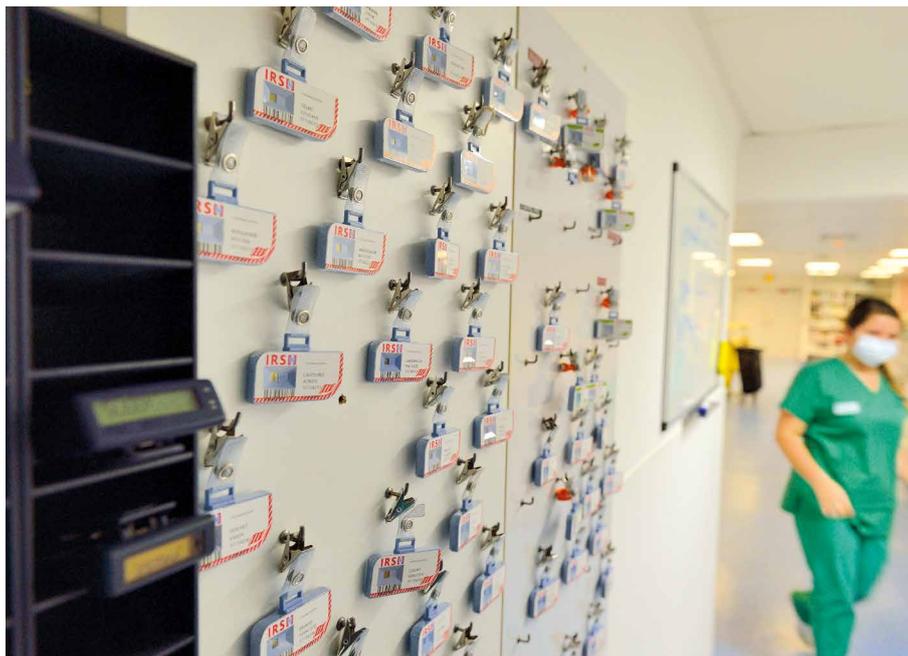
**+ EXPOSURE BY SECTOR**

The size of the workforce in the various sectors remains stable or has increased slightly overall:



IRSN monitors occupational exposure to ionizing radiation as part of its activities of continuous radiation protection monitoring and support for the public authorities. The 2016 report covers all sectors of activity subject to the licensing or declaration regime, as well as workers exposed to technologically enhanced naturally occurring radioactivity.

\*known as Orano from February 2018.



 IRSN's dosimetry laboratory monitored around 169,000 workers in France in 2017.

## CHARACTERIZING OLD RADIOACTIVE SOURCES AT A UNIVERSITY

The disposal of old radioactive sources is a problem faced by many parts of civil society (universities, industry, etc.). IRSN's expertise in working in contaminated and irradiated environments means that it can respond safely to the need to characterize these sources before they are collected by a third party.

In 2017, IRSN implemented a protocol for identifying and characterizing 42 sources on a university campus in western France. A multidisciplinary team ensured both their own safety and that of the publicly accessible site, took radiation measurements, and conditioned the sources as required. When they had finished, the university was able to start recovering its sources.

# 1,250,000

analyses of French workers' dosimeters carried out by IRSN in 2017

## DOSIMETRY SERVICES

In 2017 IRSN's dosimetry laboratory performed dosimetry monitoring on around 169,000 workers in metropolitan France and its overseas territories, for 24,000 companies in various sectors. This represents a total of more than 1.25 million analyses of passive dosimeters.

Committed to its clients, the laboratory maintains a direct dialogue with both the radiation protection specialists at the clients' sites, who advise employers on radiation protection for workers, and the occupational physicians responsible for monitoring the workers' health.

In 2017, there was an increase in the use of the laboratory's customer portal, which has been continually developed since 2015. More than 7,000 users now use the portal for secure online access to dosimetry results, in compliance with current regulations. The portal's many functions facilitate the logistical management of dosimetry and statistical analysis of the results. It also allows communication to take place largely by electronic means.

During the year, IRSN also organized nearly 17 visitor days for professionals and students, at its laboratories, including the dosimetry laboratory and the radiotoxicological medical analysis laboratory, which have relocated to a new building on the Vésinet site (Yvelines). The site is the only technical platform of its kind in Europe. These visitor days provided an opportunity for valuable discussions, with IRSN constantly looking to increase the effectiveness of the support it provides to its clients.

# PREPARING FOR EMERGENCIES AND POST-ACCIDENT MANAGEMENT

*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. IRSN's teams prepare for this mainly through participating in national and international exercises.*

## ✚ PARTICIPATION IN CODIRPA'S WORK

IRSN is a member of several working groups of CODIRPA, the Steering Committee for the management of the post-accident phase of a nuclear accident or radiological emergency, which is run by the ASN. The work being done by these groups ties in with the roadmap set out in the national emergency response plan for major nuclear or radiological accidents.

*In 2017, CODIRPA began a major discussion process lasting several years on the changes to be made to post-accident management policy.*

In 2017, IRSN submitted a number of contributions, including:

- + a report on waste management during the post-accident phase. This contribution is part of the preparation of policies and strategies governing action to reduce contamination in the affected areas and to reduce the amount of waste generated;
- + responses to questions arising from the "Stakeholder involvement" group for health professionals responsible for working with the population affected by a nuclear accident;
- + advice on the management of "non-food commodities", such as timber, construction materials and linen.

Finally, in 2017, CODIRPA began a major, multi-year discussion process on the changes to be made to post-accident management policy, as part of the lessons to be learned from the Fukushima accident. In early 2018, IRSN proposed changes to the post-accident management policy published in 2012.

These changes take into account the lessons learned from the Fukushima accident, particularly as a result of international research and simulations run during exercises.

Experience shows that these post-accident measures can have a major human, economic and financial impact. It also shows that they need to be defined and implemented in advance.

The proposed changes aim to:

- + coordinate emergency and post-accident phases more effectively;
- + reduce the complexity induced by overlapping zoning systems, namely exclusion zones, population protection zones, and zones under control of foodstuffs;
- + make the most of advances in technology applicable to modeling, simulation and rapid measurement of contamination.



## 8

meetings involving IRSN as part of CODIRPA's work on post-accident management

*IRSN takes part each year in national and international emergency response exercises, and the teams from its mobile unit can be mobilized for these exercises, e.g. for the exercise on the Framatome site in Romans-sur-Isère in October 2017.*

## ✚ FIRST AGORAS CONFERENCE

As part of research undertaken in the wake of the Fukushima accident, IRSN held the first conference of the AGORAS project on improving the governance of nuclear safety organizations and networks in Paris. This event, which was opened by IRSN's Director General, brought together academics, industry representatives and institutions to discuss the question: How is an institutional balance established and how does it develop between the various organizations involved in preventing nuclear accidents and in managing it, should one occur?

*In particular, the conference looked at how realistic emergency response exercises are and how effective they are in preparing for unexpected situations.*

The conference encouraged debate on the knowledge developed and how well this is taken onboard by the different communities and stakeholders concerned, such as those involved in operations or researchers. In particular, the conference looked at how realistic emergency response exercises are, and how effective they are in preparing for unexpected situations; and at the role of the tools used to regulate nuclear risks, especially the importance given to two-way dialogue with the public. Its conclusions underlined the value of understanding the mechanisms of cooperation between organizations for improving accident prevention and better preparing for emergency response and post-accident situation management.

### SHAMISEN: 28 RECOMMENDATIONS FOR BETTER PROTECTING THE PUBLIC

IRSN was a member of the European SHAMISEN project (*Nuclear Emergency Situations, Improvement of Medical and Health Surveillance*, OPERRA 2015-2017, FP7 - grant agreement 604984), a project in which its experts made contributions in the fields of dosimetry, epidemiology and openness to society. The program drew up 28 recommendations based on lessons learned from the Chernobyl and Fukushima accidents. In a post-accident situation, this roadmap aims to improve the living conditions and medical and health monitoring of populations affected by a nuclear accident by taking into account the social, economic and psychological effects of such an accident. It underlines the importance of taking account of the wellbeing of affected populations, their involvement in managing a radiological accident and respect for their independence and dignity.

### LAUNCH OF THE EUROPEAN "TERRITORIES" AND "CONFIDENCE" PROJECTS

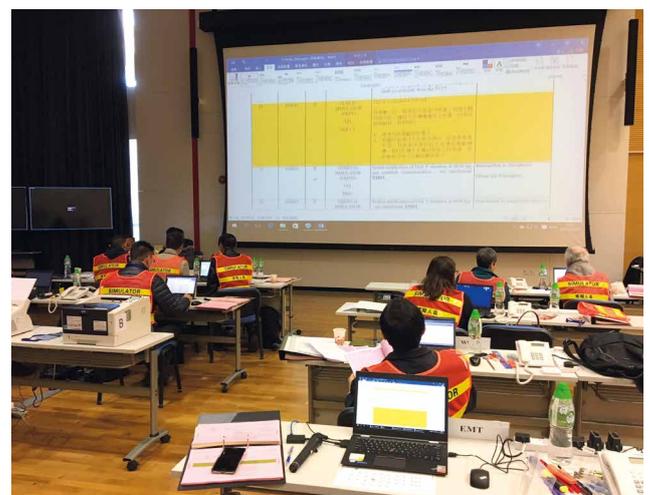
IRSN is involved in two of the three projects selected under the first call for projects for CONCERT, the joint European program for the integration of radiation protection research. IRSN is the lead for the TERRITORIES project involving 11 partners over three years. It aims to build an integrated and graded method for managing the risks related to long-term exposure in contaminated areas, after a nuclear accident or in a context of enhanced natural radioactivity.

The approach aims in particular to reduce uncertainties related to dose assessment in humans and wildlife, and to involve all stakeholders in decision-making processes. IRSN is also a contributor to the CONFIDENCE project involving 31 partner organizations, which aims to improve the decision support systems used in managing nuclear emergencies in order to protect the populations of the affected areas and cause as little disruption as possible to their living conditions.

#### In brief

+ Emergency response exercise in Hong Kong  
IRSN assisted the Hong Kong government with preparing and running the "Checkerboard II" exercise simulating a severe accident at the Daya Bay nuclear power plant. This type of exercise is held every 5 years. A variety of people were involved in this major exercise, including experts, figures from industry, and members of Hong Kong's government, making a total of nearly 1,000 participants. It took place in Hong Kong on December 20 - 21. As part of a government contract, IRSN designed the technical scenario for the exercise, and experts from IRSN ran the exercise *in situ* over the two-day period. The exercise was rounded off with a symposium on nuclear energy held on December 22 at the University of Hong Kong, in which IRSN was involved.

|  |  |
|--|--|
| <p><b>2</b></p> <p>national nuclear emergency exercises involving defense-related facilities</p> | <p><b>6</b></p> <p>national nuclear emergency exercises excluding defense-related activities</p> |
|--|--|



IRSN took part in the preparation and running by the Hong Kong government of an exercise simulating a severe accident at the Daya Bay nuclear power plant.

## FIRST PROJECT DELIVERABLES

IRSN has been coordinating the European FAST Nuclear Emergency Tools, or FASTNET, project since the end of 2015, for a four-year term. The project involves 20 partners from 18 countries, with the IAEA acting as a third party.

The aim of the project is to more reliably predict the progression of a severe accident and to anticipate the source term of a nuclear accident. It uses the partners' work as the basis for extending the capabilities of methods and tools of atmospheric release prediction in accidents to all types of power reactor in Europe as well as to a generic spent fuel pool concept.

Three of the four main project deliverables are currently being developed: a database of accident scenarios, a standard set of reference tools qualified for diagnosis and prognosis, and improved innovative probabilistic tools. The final deliverable involves developing methodological guidance applicable to the "Severe accident management guidelines".

## INTER-LABORATORY COMPARISON EXERCISES

In 2017, IRSN took part in several radioactivity measurement comparison exercises with two objectives: to validate the metrological quality of its own atmospheric radiation measurement system and to work on system interoperability to improve cooperation between different countries in the event of a radiological emergency.

- + Feedback from the atmospheric measurement comparison exercise conducted in February with the US Department of Energy (DOE) at the Nevada Test Site validated the metrological qualities of IRSN's airborne measuring system ULYSSE, which complements its ground-based systems, namely Marcassin and Téléray.
- + Under the PRINCESS project, IRSN is preparing to run an international inter-laboratory comparison exercise with the DOE in 2018 on criticality accident dosimetry, to develop special "criticality" dosimeters.
- + To produce dosimetry benchmarks for the exercise, in May IRSN took part in characterizing the radiation field emitted by the FLAT-TOP reactor at the Nevada Test Site. The international atmospheric radiation measuring exercise, ARM-17, organized in June by the Swiss Federal Office for Civil Protection (FOCP) over an area of 3,000 km<sup>2</sup>, enabled the team from IRSN to successfully implement recent developments and improvements to the ULYSSE system, in particular the rapid production of maps and the real-time transmission of data to IRSN's back-office.
- + IRSN produced the scenario for an international exercise to measure accidental contamination of the environment, held in Japan by the IAEA, in the context of its Response and Assistance Network (RANET). Teams from Australia, China, France (IRSN), Germany, Japan, Ukraine and the USA took part in the exercise. It was designed to test the involvement and coordination of international measurement teams providing assistance to a country affected by a nuclear accident.



### FOCUS ON...

#### International conferences

In 2017, IRSN experts spoke at a number of international conferences on emergency response management:

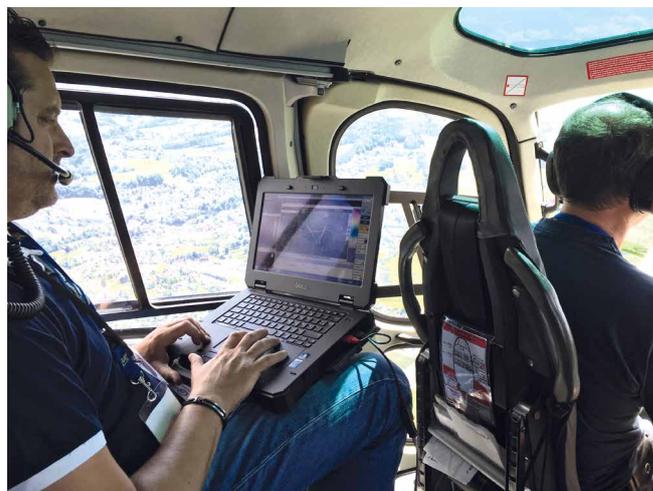
- + the annual workshop of the NERIS platform, dedicated to post-accident research coordination, held in Lisbon in May;
- + the Radiation Protection Week, held jointly with the ICRP symposium in Marne-La-Vallée in October;
- + the IAEA workshop held in Vienna in October. IRSN chaired this conference, which was organized to prepare a guide to "emergency preparedness and response" for the transportation of radioactive materials.



### IRSN 2030

#### Expectations

*Broaden its capacity to cover all kinds of emergencies*



Airborne radiological measurement inter-comparison exercise organized by the Swiss Federal Office for Civil Protection (FOCP) in June 2017.

# INFORMING SOCIETY OF THE RISKS

*In accordance with its decree, IRSN is pursuing its voluntary commitment to transparency and stepping up its communication effort both by providing educational materials and by diversifying the methods it uses to convey information to the general public.*

## ■ "RADIATION PROTECTION IN QUESTION" WEBSITE

As part of its duty to provide training, information and education to the public on nuclear and radiological risks, IRSN has added the final touches to an educational website entirely dedicated to the subject of radiation protection. This "Wikipedia" of radiation protection will be launched in early 2018. Although primarily aimed at students, health professionals and industries concerned with radiation protection, it is also there to answer questions from the general public. It provides key information on all topics of interest to these audiences in a simple and concise way. The information is split into themes: the basics of radiation protection, history and organizations, regulation, radiation protection of patients, workers and the public, the physics of radiation, radiobiology and radiopathology. Internet users will also find information on the website about the key concepts of radiation, regulatory standards, scientific and technical concepts, recommendations on best practices and the results of the latest research, as well as links to factsheets, bibliographies and documents providing further information on particular topics. They can be kept up to date on the latest news through a special blog accompanied by audio podcasts of discussions between radiation protection professionals and experts.

## TENTH INTERNATIONAL RADIATION PROTECTION WORKSHOP IN SCHOOLS

150 high school pupils and their teachers from Belarus, Colombia, France, Germany, Japan, Moldova and Ukraine met at INSTN in Paris to share the work they had done during the year at workshops run by their teachers with the support of radiation protection experts. This 10<sup>th</sup> edition of the event, organized by IRSN, the ASN, CEA-INSTN, CEPN, the Pavillon des Sciences de Franche-Comté and SFRP gave them the opportunity to visit facilities including IRSN's SOFIA simulator, which specializes in reactor operation in normal and accident situations.

## SCIENCE FAIR AND TOURING EXHIBITIONS

IRSN chose the 2017 Science Fair to present a preview of its collaborative science initiative, Open Radiation, at the Cité des Sciences de la Villette in Paris. Openradiation is an initiative enabling members of the public to share their own radioactivity measurements online (see the Openradiation article on page 42).

IRSN was also out and about in different regions, running workshops at the Science Villages in Aix-en-Provence (Bouches-du-Rhône), Vinon-sur-Verdun (Var) and Noirmoutier (Vendée) and offering schools and the general public the chance to see experiments on various topics such as fire risks in industrial environments, the simulation of an accident at a nuclear reactor, radioactive releases in the event of a nuclear accident and risks to the environment. In Poissy (Yvelines), IRSN presented an exhibition on radioactivity and multimedia games, including a simulation of the dose received during medical imaging examinations.



IRSN took part in the Poissy Science Fair, presenting its exhibition on radioactivity and some multimedia games.

## SUCCESS OF THE ASN/IRSN TOURING EXHIBITION

The purpose of the joint ASN/IRSN exhibition, “Radioactivity: Hundreds of Questions, One Exhibition”, is to raise public awareness of the risks associated with natural and artificial radioactivity. It is reaching a growing number of school pupils throughout France and has prompted various educational initiatives. This year it visited around thirty secondary schools. It was also set up in the hall of the education authority headquarters in Dijon, and IRSN presented it in partnership with Morvan Nature Park in Saint-Brisson (Nièvre) during a local clubs and associations fair. Two secondary schools used the exhibition as the basis for a project for their pupils, as part of a supervised independent study (TPE) initiative, to set up measuring equipment to take radioactivity measurements for sharing on a citizens’ map. Five other secondary schools used it to find out more about radon prior to a participative science initiative: with equipment loaned by IRSN, the pupils took measurements in their homes and presented the results to the public.

### In brief

+ Mayors’ Fair

IRSN had a joint stand with the ASN at the Salon des Maires Mayors’ Fair, held in November at the Paris Exhibition Centre, to inform elected representatives and the general public about safety and radiation protection monitoring and assessment in France.



## PRESS TRIP ON DECOMMISSIONING

Several nuclear reactors are currently being decommissioned in Europe, namely in France, Germany, Italy, Lithuania and the UK. In France, decommissioning activity could increase if nuclear reactors are scheduled for final shutdown in the coming decades. This raises nuclear safety and radiation protection issues, and presents technical challenges related to the dismantling process and society’s involvement in it. IRSN organized a “European tour of PWR reactor decommissioning” to inform the media about the issue and share its expertise on safety in this field. Around a dozen journalists – from press agencies, regional and national newspapers, radio stations and specialist magazines – took part in the trip, which took them from Italy’s Garigliano power plant to the Chooz power plant in the Ardennes region, via Greifswald, in former East Germany. During the visits, they were able to meet the facility operators, SOGIN, EDF and EWN, as well as representatives from the Italian safety authority (ISPRA) and the German scientific and technical research and assessment organization (GRS).

# 70

articles were published as a result of the press trip on the decommissioning of PWR reactors in Europe



FOCUS ON...

### The top ten most viewed items on IRSN's website in 2017

1. Environment Factfile on “Radon”
2. “The Chernobyl accident (Ukraine 1986)” Safety Factfile
3. “Understanding the basics of radioactivity” Nuclear and Society Factfile
4. “Detection of traces of radioactive iodine in Europe in January 2017” News article
5. “Radioactivity and its effects on humans” Health Factfile
6. “Seismic risk and nuclear facilities” Safety Factfile
7. “The Fukushima-Daiichi accident (Japan 2011)” Safety Factfile
8. “Detection of Ruthenium-106 in France and Europe: results of IRSN’s investigations” News article
9. “Radiotherapy” Health Factfile
10. “Radiation protection for workers” Health Factfile

# MODERNIZING AND IMPROVING EFFICIENCY

## ECONOMIC PERFORMANCE: A POLICY OF CONTINUOUS IMPROVEMENT

*IRSN is keen to boost its economic performance by improving the performance of its commercial activities, but also by controlling its spending and optimizing its real estate costs.*

### **+** BETTER-PERFORMING COMMERCIAL ACTIVITIES

In 2017, IRSN's commercial services grew by 8.5% overall, and more specifically within the dosimetry and international services business units (see the section on international cooperation). This growth was accompanied by a restructuring of IRSN's radiation protection activities, grouping together dosimetry and radio-toxicological analysis services and the related administrative activities.

The improved performance of its commercial activities is also due to the implementation of computerized invoicing within the public sector and the use of direct debit, which is currently being deployed.

### **JOINT PROCUREMENT**

In the area of procurement, action is taken to control growth in expenditure, particularly by developing the number of joint procurement agreements with other public bodies. This means that, in addition to joint contracts with CEA, IRSN has also started to cooperate with CNRS, UGAP, and public organizations in general. An agreement was signed in October 2017 with the central purchasing unit at CNRS, for scientific instrumentation and IT equipment to begin with.

At the end of the first year in which IRSN has been subject to the French public procurement code, 161 consultation procedures have been launched, 281 orders have been created – 23 of which have been put before the contract advisory committee – and 26.8% of orders have been placed on the basis of framework agreements.



## OPTIMIZING REAL ESTATE COSTS

As part of the process of updating its long-term property strategy for the 2017-2022 period, in accordance with the government's real estate policy objectives, IRSN has begun an analysis of its property portfolio and of the human and financial resources dedicated to property, as well as two studies, one looking at the future of Buildings 02 and 44-23 on the Fontenay-aux-Roses site, and the other looking at optimizing its facilities on the Cadarache site. The aim of this work is to develop a strategy for the maintenance and renovation of IRSN's buildings in order to modernize them, reduce their running costs and make more efficient use of their facilities.

### In brief

#### + Computerized invoicing

Since January 1, 2017, IRSN's suppliers have been able to submit their invoices electronically via Chorus Pro, a shared, secure and free IT tool developed by the French government as part of its modernization of the public sector, in order to speed up invoice processing times. The use of Chorus Pro will become mandatory in 2020 for all invoices submitted to public bodies.

#### + Direct debit

To improve the efficiency of its revenue collection processes, IRSN has set up a direct debit system, particularly for its dosimetry billing. The first test was approved in late 2017.



### FOCUS ON...

#### Launch of the digital archiving project

In 2017 IRSN launched its electronic archiving project known as ARCHE. The aim is to manage digitally the documents produced by all processes used in the context of IRSN's activities. An electronic archive would store and allow retrieval of these documents while guaranteeing their authenticity, integrity and preservation throughout the storage period.

The project began with the development of the first prototype for managing electronic invoices issued and received via the national Chorus Pro portal. This first stage will be used test whether the probative value of these invoices is well enough protected to meet accountancy-related legal obligations.



## IRSN 2030

Sharing  
Develop synergies  
within the Institute

IRSN began a review of its property as part of the updating of its 2017-2022 Multiyear Property Master Plan and some studies looking at the future of two buildings at Fontenay-aux-Roses.

## SOCIAL LIFE: AN INITIATIVE FOR THE COLLECTIVE BENEFIT OF PERSONNEL

Because organization and working conditions play a central role in IRSN's overall performance, it works to maintain an atmosphere conducive to dialogue with employees and good employee relations.

### PREPARING AN AGREEMENT ON QUALITY OF LIFE IN THE WORKPLACE

The 2014 agreement on quality of life in the workplace and preventing occupational stress is about to expire, so discussions were held on IRSN's policy on quality of life in the workplace, taking a participative approach that included staff representatives. To do this, three working groups representing IRSN staff were formed to discuss the topics of equality, wellbeing and balance. The groups came together a number of times between September and December and made suggestions on equality in the workplace, the work-life balance, stress prevention and workplace organization. These suggestions will be incorporated into the draft agreement, due to be negotiated in the first half of 2018.

### COLLECTIVE BARGAINING

In 2017, six agreements were negotiated and signed: an agreement on the 2017-2019 cross-generation contract; an agreement on the timetable for informing and consulting staff representative bodies and on monitoring the restructuring of the Radiation Protection, Environment, Waste and Emergency Management Unit; a memorandum of understanding on the mandatory annual pay bargaining for 2017, the first since 2010; a pre-election memorandum of understanding on the 2017-2020 works committee and staff delegate elections; an agreement on the staff representative bodies; and a 2017-2019 profit-sharing agreement.

Other negotiations were undertaken in parallel, on updating provisions related to the careers of staff representatives and how negotiations are organized (amendment to the union rights agreement), and on the inclusion and safeguarding of jobs for people with disabilities (a new agreement for 2018-2020).

### UPGRADING SUPPORT AND FUNCTIONAL SERVICES AT IRSN

Discussions were initiated in late 2017 with the aim of making IRSN operation more streamlined and efficient and adapting the structures and organizations within it to contribute to an improvement in its overall performance. They review the support and functional services at IRSN and their interfaces, including with the Institute's internal governance. This work, composed of three stages and involving over 250 employees, is being carried out in a spirit of openness and will continue into 2018.



#### FOCUS ON...

#### Preparing a new agreement on the employment of people with disabilities

In line with its voluntary policy of welcoming employees with disabilities, IRSN has taken advantage of the renewal of its agreement on the subject to propose initiatives to develop the resources of its disabilities mission.

It has suggested to the unions that a network of local representatives should be called upon to promote and implement its policy more effectively across all sites. It aims to increase efforts to recruit people with disabilities on permanent and fixed-term contracts by increasing direct employment rates and, in the case of temporary employment, by agreeing to negotiate higher management costs with temporary employment agencies, enabling them to conduct more targeted searches in view of our practices. Lastly, it has proposed measures to support employees with disabilities and their teams in order to help them to integrate more successfully and support them throughout their career. The most recent negotiation meetings should enable a draft to be submitted in early 2018.

**72.48%**

participation rate in the staff representative elections held in 2017, producing the following results:

**41.15%**  
CGT

**35.14%**  
CFDT

**23.70%**  
CGC

## IN-HOUSE UNIVERSITY

The in-house university (Ui) supports employees' skill and career development.

*The Ui serves the aim of promoting, sharing and transferring IRSN's knowledge and expertise and developing individual and collective skills.*

The in-house university is open to all employees and offers tailored, internal training courses, including on job-specific skills and on the specific culture and working methods of IRSN. It serves the aim of promoting, sharing and transferring IRSN's knowledge and expertise and developing individual and collective skills. Its operating and development depend primarily on a body of teaching staff who are IRSN employees and a collective approach in which everyone contributes, combined with innovative teaching methods. The Ui thus helps to share internally the understanding developed by IRSN, in order to meet current and future scientific and technical challenges more effectively. It also plays a part in driving efficiency by valorizing in-house knowledge and redeploying it internally.

The assessment module offers training courses for IRSN assessment activities. Its modular structure – composed of five levels of training courses – enables training programs to be developed for those responsible for carrying out IRSN's assessments of nuclear and radiological risk management.



*In 2017, 24 training sessions were held for 195 participants, and two new courses were taught, namely on containment and human and organizational aspects.*

# 57

**emergency response management training sessions were held in 2017**

The emergency response module designs and runs training courses to train all IRSN employees in emergency response management, as well as courses for developing and maintaining the skills of emergency response team members. 57 training sessions were held in 2017, for 393 participants.

IRSN's strategy and management module aims to publicize and share IRSN's strategy, to strengthen its management culture and to meet the challenges of communication and openness to society. New training courses were designed in 2017 so that a more comprehensive range could be offered from 2018, including strategy & governance and the challenges of communication at IRSN, in addition to the awareness days organized on openness to society.

The newly renamed operational support module aims to integrate the operating and support units into IRSN's activities more effectively in order to make IRSN more efficient, more reliable and easier to run. Emphasis is placed on designing training courses on the "tools" available to managers, the expenditure chain at IRSN and the legal issues associated with IRSN's activities. Existing courses were revised in 2017 to make them more interactive and practical, to ensure a more thorough learning process and skills that are easier to apply in work situations. The employer-delivered courses on radiation protection and quality management were just two of these revisited programs.

Investing in the Ui today also means training more employees in core job skills by optimizing the resources assigned to continuing professional training. In-house training has grown steadily and in 2017 represented 34% of the total training hours and 43% of total attendance.



FOCUS ON...

### Strategic refocusing of training

Training, which is part of IRSN's role, is an important method of conveying safety and radiation protection culture. Externally, this is reflected in its contribution to initial and continual training courses. In the interests of efficiency and optimizing requests for IRSN experts to contribute to training courses, and to support the growth of its in-house university, the Institute is pursuing a targeted policy concerning the choice of the external teaching programs in which its experts are involved.

In the case of continuing training, it prioritizes courses run by ENSTTI under the IRSN name and those run in the context of its partnership with INSTN. In 2017, continuing training courses in radiation protection for professionals – both outside and inside IRSN – were adapted to the new regulatory frameworks.

## AN INNOVATIVE WORK CONTEXT

By modernizing its buildings and IT equipment, and improving their security, IRSN is developing the technical environment it requires to face future challenges.

## REVISION OF THE IT SYSTEMS SECURITY POLICY

To take account of changes to regulations on IT security, the need to exchange data with IRSN's external partners and the global context in terms of cybercrime, in 2017 IRSN revised its IT systems security policy, which covers all of its computer resources (software, hardware, networks, messaging services, servers, workstations, backup equipment, IT security features, etc.) and the data they contain.

IRSN drew up an exhaustive chart of its IT systems and laid the foundations of an IT continuity plan, which should be rolled out in 2018.

## SITE SECURITY UPGRADES

Like IRSN's IT systems, the systems used to monitor and protect the sites accommodating its personnel and equipment were upgraded in 2017 to keep them operational and reinforce their protection against risks. Design and organizational changes were also applied in response to changes in regulations in this field.



*At Fontenay-aux-Roses, building 01 delivered in 2017 meets strict criteria for energy efficiency, functionality and comfort. It has "NF Tertiary Building" certification.*

## AN EXEMPLARY BUILDING AT FONTENAY-AUX-ROSES

Building 01, which was delivered in July 2017, meets strict criteria in terms of energy efficiency, functionality and comfort. It is certified to “NF commercial building” standards, with a 30% cut in energy consumption, in line with French building regulations from 2012. The building houses a 250-seat auditorium, IRSN’s emergency response center, which has been modernized and reorganized to accommodate all the units necessary to run operations in an emergency, and IRSN’s new DATA Center. The data center is classed as Tier III, and its operational security is unparalleled among the facilities.

The eco-design of the building is based on three concepts:

- + anticipating the needs of future users and how they will change over time;
- + selecting innovative and efficient heating and ventilation systems;
- + and opting for low-impact technical solutions for water management.

At all key stages of the project, the building’s future users were involved in defining requirements and choosing the solutions to meet them.

### -39%

fewer reams of paper per staff member bought since 2009

### -57%

cut in the CO<sub>2</sub> emissions of vehicles bought or leased between 2009 and 2016

### -10%

cut in the amount of electricity consumed per employee between 2009 and 2015



FOCUS ON...

### Corporate social and environmental responsibility

In 2008, IRSN launched a sustainable development initiative which, since 2010, has led to the development and implementation of a sustainable development policy, focusing on 4 main areas:

- + protecting the environment and controlling risks;
- + maintaining a high level of social commitment;
- + developing responsible procurement and sales;
- + strengthening links with stakeholders.

In 2017, a review of this policy was carried out with the involvement of IRSN’s network of sustainable development representatives. A series of proposals was drawn up, which will be examined in 2018, with the aim of preparing an action plan to include measures that can be implemented in the short term. The discussions informing this review will contribute to the definition of a corporate social and environmental responsibility policy, on the basis of the future planning undertaken with the IRSN 2030 project.

Lastly, in 2017, IRSN continued to pursue its environmentally responsible approach through partnerships with industry and local councils, such as the council of Fontenay-aux-Roses and its city bike share scheme, Vélib, with a station set to open in 2018 in the immediate vicinity of the IRSN site.

# GOVERNING BODIES

## + BOARD OF DIRECTORS

AS OF FEBRUARY 1, 2018

### Missions

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

### — A member of parliament

**Perrine GOULET**, Deputy from the Nièvre department.

### — A senator

Nomination pending.

### — Ten government representatives

**Jacques COUSQUER**, Nuclear Safety Inspector for DGA, the French defense procurement agency, representing the Minister of Defense.

**Laurent TAPADINHAS**, Deputy Director to the Commissioner General for Sustainable Development, 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 of Health.

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

**Faouzia FEKIRI**, Head of the Risk Resilience Assessment Office of the Directorate General for Civil Protection and Emergency Response, representing the Minister of Civil Protection.

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

Representing the Minister of the Budget (nomination pending).

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

**Pierre-Franck CHEVET**, Head of the Nuclear Safety and Radiation Protection Mission.

### — Five advisory members

**Jean-Claude DELALONDE**, Chairman of the National Association of Local Information Commissions and Committees, nominated by the Minister of the Environment.

**Bruno DUVERT**, Air Force Brigadier General, nominated by the Minister of Defense.

Representing the Minister of Health (nomination pending).

**Laurent MOCHÉ**, Acting Chairperson of the IRSN Board of Directors in temporary capacity. CEO of Edenkia, nominated by the Minister of Energy.

**Agnès SMITH**, Professor at the Ecole nationale des céramiques industrielles de Limoges, nominated by the Minister of Research.

### — Eight staff representatives

**Léna LEBRETON**, CGT.

**Nicolas BRISSON**, CGT.

**François DUCAMP**, CGT.

**Laurence ESTELLER**, CFE-CGC.

**Thierry FLEURY**, CFDT.

**François JEFFROY**, CFDT.

**Olivier KAYSER**, CFE-CGC.

**Christophe SERRES**, CFDT.

### — Ex officio or associate members

**Jean-Pascal CODINE**, Budget Comptroller.

**Philippe BOURACHOT**, Works Committee Secretary.

**Marc MORTUREUX**, Director General of Risk Prevention and Government Commissioner.

**Georges-Henri MOUTON**, Deputy Director General, in charge of Defense-related missions.

**Jean-Christophe NIEL**, Director General.

**Pierre PIQUEMAL-LAGORRE**, Accounting Officer.

## + STEERING COMMITTEE FOR THE NUCLEAR DEFENSE EXPERTISE DIVISION – CODEND

AS OF FEBRUARY 1, 2018

### Missions

The committee examines the activity program prepared by the nuclear defense. Expertise division before it is submitted to the institute's Board of directors. It is consulted when the Board of directors is called upon to make decisions relating specifically to the organization or running of this division and advises the Board of directors on matters related to division activities.

**Alain GUILLETTE**, CODEND Chairman, representative in charge of Nuclear Safety and Radiation Protection for Defense related Activities and Facilities.

**François LECOINTRE**, General, representative of the Armed Forces Chief of Staff.

**Éric SCHERER**, Nuclear Weapons Inspector.

**Norbert FARGÈRE**, Engineer General for Armaments, representing the DGA, the French defense procurement agency.

**Frank BARRERA**, Colonel, representing the administrative Secretary General of the Ministry of Defense.

**Adrien BICHET**, Representing the Budget Director.

**Clément ARMINJON**, Representing the Director of Strategic Affairs, Security and Disarmament at the Ministry of Foreign and European Affairs.

**Christian DUFOUR**, Deputy Head of the Economic and Nuclear Infrastructure Security Department, representing the High Civil Servant for Defense and Security of the Ministry of the Economy and Finance.

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

**Serge POULARD**, Advisory member, appointed by the Minister of Industry.

**Jacques COUSQUER**, representing the general delegate for armaments.

## + SCIENTIFIC COUNCIL

AS OF FEBRUARY 1, 2018

### Missions

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 of the French Geological Survey (BRGM), IRSN Scientific Council Chairman.

**Jean-Christophe AMABILE**, Chief Medical Officer, radiation protection specialist at the Armed Forces Radiation Protection Department (SPRA).

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

**Patsy-Ann THOMPSON**, Director of Environmental and Radiation Protection and Assessments at the Canadian Nuclear Safety Commission, nominated by the Minister of the Environment.

**Frank HARDEMAN**, Director in charge of Radiation Protection-Environment-Health at the Belgian Nuclear Research Center (SCK-CEN).

**Jean-Paul MOATTI**, University professor.

**Guy FRIJA**, University professor.

**Denis VEYNANTE**, Research Director 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 CEA Nuclear Energy Division, nominated by the Minister of Research.

**Denis GAMBINI**, Medical practitioner, researcher at the Occupational Health Department at the Hôtel-Dieu hospital in Paris, nominated by the Minister of Labor.

## + ETHICS COMMISSION COMPOSITION

AS OF FEBRUARY 1, 2018

### Missions

The Ethics Commission is provided for under the IRSN organizational regulations and reports to the Board of Directors. It is responsible for advising the Board on preparing ethical charters that are applicable to the Institute's activities and for monitoring their application, including conditions within the Institute for separating 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.

**Jean-Pierre DUPUY**, Chairman of the Commission, Corps des Mines Engineer General, philosopher, professor at the École Polytechnique and Stanford University, California, and member of the French Academy of Technology.

**Marc CLÉMENT**, Public reporter to the Administrative Appeal Court in Lyon, member of the Environmental Authority of the General Council for the Environment and Sustainable Development.

**Éric VINDIMIAN**, Engineer General in rural engineering, water and forests, Regional Director of the Irstea (French research institute for environmental and agricultural science and technology), specialist in the impact of toxic substances on the environment and health and in 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.

**Frédéric WORMS**, Professor of Philosophy at the Ecole Normale Supérieure, Director of the Centre international d'étude de la Philosophie française contemporaine (part of the République des savoirs, USR 3608 ENS/Collège de France/CNRS), Member of the French National Ethics Advisory Committee (CCNE).

## + NUCLEAR SAFETY AND RADIATION PROTECTION RESEARCH POLICY COMMITTEE – COR

AS OF FEBRUARY 1, 2018

### Missions

The nuclear safety and radiation Protection Research Policy committee, or COR, is an advisory body to the IRSN Board of directors, giving opinions on research objectives and priorities in the fields of nuclear safety and radiation protection. It adopts a global approach that takes into consideration the requirements of society and 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, representative of the Ministry of Health.

**Lionel MOULIN**, Head of the Environmental Risks and Health Mission, Research Department, Directorate for Research and Innovation, representing the Ministry for Ecological and Inclusive Transition.

**Jean-François CAU**, Nuclear Safety Inspector, DGA (French Defense Procurement Agency), representing the Ministry of Defense.

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

#### + Representing the Ministry of Labor:

**Thierry LAHAYE**, in charge of matters relating to the protection of workers against physical hazards, Directorate General for Labor.

#### + Representative of French Nuclear Safety Authority:

Nomination pending.

### — Companies and professional associations

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

**Bernard LE GUEN**, EDF representing SFRP.

**Bertrand de l'ÉPINOIS**, Safety Standards Director, representing Orano (formerly Areva).

**Jean-Jacques MAZERON**, Head of the Radiotherapy-Oncology Department, Pitié-Salpêtrière Hospital, SFRP representative.

**Soraya THABET**, Director of Risk Control, Andra.

### — Employees in the nuclear sector

#### + Representatives of national labor unions:

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

**Martine DOZOL**, FO.

**Claire ÉTINEAU**, CFTC.

**Jacques DELAY**, CFE-CGC.

**Christian HOLBÉ**, CGT.

### — Elected representatives

#### + OPECST representatives:

Nomination pending.

#### + Representative of the Local Information Commissions (CLI):

**Monique SENÉ**, Vice-President of ANCCLI.

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

Nomination pending.

**Bertrand RINGOT**, Mayor of Gravelines.

### — Associations

**David BOILLEY**, President of Acro.

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

**Simon SCHRAUB**, Director of the Ligue Nationale Contre le Cancer.

### — Advisory members

**Jean-Claude DELALONDE**, President of ANCCLI.

**Marie-Pierre COMETS**, President of the High Committee for Transparency and Information on Nuclear Safety.

### — Research organizations

**Daniel FAGRET**, Deputy Director General for Strategy – Inserm.

Paristech representative (nomination pending), representative of the French Conference of University Presidents (CPU).

**François GAUCHÉ**, Director of Nuclear Energy, CEA.

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

### — Foreign members

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

**Ted LAZO**, NEA, OECD.

**George YADIGAROGLU**, Professor of Nuclear Engineering at the Swiss Federal Institute of Technology.

### — Ex officio members

**Yves BRÉCHET**, Atomic Energy High Commissioner.

**Marc MORTUREUX**, Government Commissioner, represented by **Benoît BETTINELLI**, Head of the Nuclear Safety and Radiation Protection Mission, Ministry for Ecological and Inclusive Transition.

**Pierre TOULHOAT**, IRSN Scientific Council Chairman and CEO of the French Geological Survey (BRGM).

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

## GLOSSARY

- A**
- 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.
- ASTEC** Accident Source Term Evaluation Code, a system of computer codes developed collaboratively by IRSN and GRS to evaluate the physical phenomena occurring during a core melt accident in a pressurized water reactor.
- B**
- Bel V** Subsidiary of the Belgian Federal Agency for Nuclear Control.
- BSAF** Benchmark Study of the Accident at the Fukushima-Daiichi Nuclear Power Plant, a project run by the NEA/OECD.
- C**
- CABRI** CEA test reactor used by IRSN to study nuclear fuel safety.
- CEPN** French Nuclear Protection Assessment Center.
- CIGEO** Project for a repository in Meuse/Haute-Marne for the reversible geological disposal of radioactive waste.
- CLI** Local Information Commission.
- CLIS** Local Information and Oversight Committee, now known as CSS, Site Oversight Committee.
- CONCERT** European Concerted Program on Radiation Protection Research.
- COR** Nuclear Safety and Radiation Protection Research Policy Committee.
- CRITICALITY (RISKS)** Risks associated with uncontrolled chain reactions in fissile materials.
- CSA** Complementary Safety Assessment. The term generally used outside France is “stress test”.
- D**
- DoE** US Department of Energy.
- DOSIMETRY** Assessment or measurement of the dose of radiation (radioactivity) absorbed by a substance or an individual.
- DRL** Diagnostic Reference Levels.
- DSND** Representative in charge of Nuclear Safety and Radiation Protection for Defense-related Activities and Facilities.
- E**
- ECS** Complementary safety assessments.
- EEIG** European Economic Interest Grouping.
- EFFECTIVE DOSE** A physical variable used in the field of radiation protection, where it serves to assess the impact of exposure to ionizing radiation on biological tissue. It takes into account the sensitivity of the affected tissues and the type of radiation. The sievert (Sv) is the unit of effective dose.
- ENSTTI** European Nuclear Safety Training and Tutoring Institute.
- EPR** European Pressurized-water Reactor.
- ERMSAR** European Review Meeting on Severe Accident Research.
- ETSON** European Technical Safety Organizations Network.
- EURATOM** European Atomic Energy Community.
- H**
- HCERES** High Council for Evaluation of Research and Higher Education.
- HDR** Accreditation to supervise research.
- HFDS** Ministry of Energy Senior Defense and Security Official, the authority in charge of nuclear material protection and control in France.
- I**
- IAEA** International Atomic Energy Agency.
- ICRP** International Commission on Radiological Protection.
- INB** Regulated nuclear facility.
- INBS** Regulated nuclear defense facility.
- INCA** French National Cancer Institute.
- INES** International Nuclear Event Scale, graded from 0 to 7.
- INSC** Instrument for Nuclear Safety Cooperation, cooperation contracts financed by the European Commission.
- INSTN** French National Institute for Nuclear Science and Technology.
- J**
- JAEA** Japanese Atomic Energy Agency.
- JOPRAD** Coordination action for European research on radioactive waste disposal in deep geological repositories.
- M**
- MWe** Megawatt electric, unit of electric power produced. In a pressurized water reactor, the thermal power released is about three times greater.
- N**
- NEA OECD** Nuclear Energy Agency.
- NUGENIA** Nuclear Generation II & III Association, a European association for research on Generation II and III reactors.
- O**
- OECD** Organization for Economic Cooperation and Development.
- OPCW** Organisation for the prohibition of chemical weapons
- OPERRA** Open Project for the European Radiation Research Area.
- P**
- PETAL** Laser line that can deliver a very high-power laser for experimental purposes in a number of research areas, particularly civil research.
- PIA/RSNR** French program of investment for the future/Research into nuclear safety and radiation protection.
- PRINCESS** Project for IRSN Neutron Physics and Criticality Experimental Data Supporting Safety.
- PSA** Probabilistic Safety Assessments.
- R**
- RADIONUCLIDE** Radioactive isotope of an element.
- S**
- SFRP** French Society for Radiation Protection.
- SMR** Small Modular Reactor.
- SNETP** Sustainable Nuclear Energy Technology Platform, a European platform devoted to nuclear technology.
- SSE** Significant safety event.
- T**
- TACIS** Technical Assistance to the Commonwealth of Independent States, a European program of assistance for restructuring the economies of new independent states.
- TECV** French Act on energy transition for green growth.
- TSN** French Act of June 13, 2006 on transparency and security in the nuclear field.
- TSO** Technical safety organization.
- U**
- UGAP** French Union of Public Procurement Groupings, a public procurement organization.
- US-NRC** United States Nuclear Regulatory Commission.

# LEGAL INFORMATION

## IRSN SITE DETAILS

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## PHOTO CREDITS

### Cover



Interior of the Alkaline Smelting Furnace at IRSN's Environmental Radioactivity Measurement Laboratory. Using molten salts between 800 and 1,000°C, the furnace makes it possible to quickly mineralize solid samples taken from the environment to measure their radionuclide concentrations.  
Credits : Francesco Acerbis/IRSN media library

### Inside

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### Snapshots

Nicolas Lartigue/Pellicam/IRSN media library

## EDITORIAL COORDINATION AND PRODUCTION

### Steering Committee

Senior Management Committee

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Valérie Marchal, Directory of Strategy,  
Development and Partnerships

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Strategy: Matthieu Schuler\*  
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\* Director of Strategy, Development and Partnerships until January 31, 2018.



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