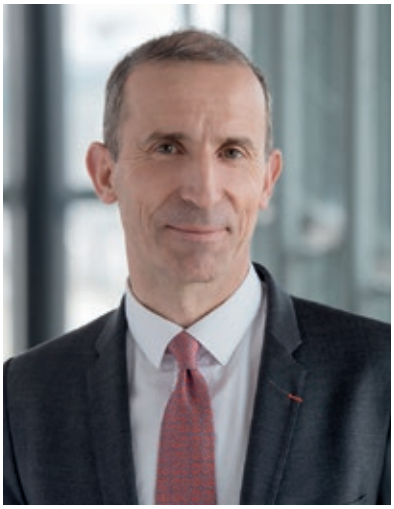
2019 edition

Status of safety in nuclear facilities

General Inspectorate Annual Report

orano

Message from the CEO
Philippe Knoche



The effective management of nuclear safety, the environment, radiation protection and safety at work has continued to be a priority issue each and every day, and has been championed by all employees both on our various sites and at national level.

In terms of nuclear safety for Orano, our 2019 results follow on from those of previous years. Thanks to the involvement of all Group employees, they are satisfactory and have allowed us to meet the targets set: no events ranked levelI 2 on the INES scale, an incident prevention rate below 0.1, and no instances of radiological exposure above the regulatory limits.

As well as these positive results, I would like to take a look at three notable points: the Teil earthquake on November 11, in the Rhône Valley near the TRICASTIN site; the fire at a lubricant manufacturing plant and storage depot near Rouen on September 26; and, lastly, the report published by Mr Folz on the FLAMANVILLE EPR on October 28. Although this first event did not have any impact on our site in terms of safety, and the other two were not directly linked to our Group, there are many lessons to be learned.

What is striking about these events is that they touch on both the design and the operation of plants, as well as on the management of degraded situations, in terms of organization, techniques, skills and communication. The lessons learned from forthcoming or future analyses sum up the key goals for the coming years: organizations in which responsibilities are clearly defined; resources commensurate with the responsibilities held; the maintaining of skills, particularly in sensitive professions; facility design, taking into account changing hazards; and unfailing preparation for the management of emergency situations. These lessons should inform our thinking and our action as an operator of industrial facilities.

Within our Group, we have already taken numerous steps to increase the safety of our activities still further.

The cycle of operating experience feedback is an essential part of our continuous improvement approach. It already works well in terms of event reporting and analysis, but requires improvement regarding the correct calibration of the measures to implement, and the timescale for their application. It should be possible to strengthen this dynamic through a more systematic analysis of weak signals in order to identify cross-cutting causes and areas for improvement. We must also share our experience of existing action plans more widely to make even quicker progress.

The quality of operational documentation is another issue that is often raised. Projects have been launched at all the sites to make it more accessible and effective, and to ensure that it meets the needs of operators. A first standard on the drafting of operating procedures has been issued. We need to keep up our efforts on this challenging subject, share the lessons learned from the first projects completed and expand deployment.

Our four-year Nuclear Safety and Environment Policy comes to an end in 2020. This provides us with a real opportunity to draw on the findings of its implementation and delve even deeper over the next years. Such efforts must be founded on joint work so that everyone involved can take maximum ownership, whether they are operators, maintenance managers, designers or purchasers. The rigorous approach that we must all apply to each basic task on a daily basis should guide our every action.

I encourage all of you to read this report and take away from it the best practices for your own level.

Vision of the Inspector General

Pascal Wilz

Based on a review of key indicators, analysis of reported events, and the lessons learned from inspections and various observations, nuclear safety is satisfactory. Areas for progress have been identified and action plans put in place.

This annual report by the General Inspectorate deals with industrial risk prevention, and assesses management of nuclear safety and radiation protection for the year 2019 within the scope of Orano's activities and facilities.

The document is based on findings made during implementation of the annual inspection program, and incorporates analyses of significant events impacting nuclear safety, radiation protection and the environment. It takes into account the documents made available to the General Inspectorate, and is based on the observations and analyses of the Group's safety, security, radiation protection and environmental specialists. It also draws on the regular discussions held with the nuclear safety authorities, their technical support partner the IRSN[1], as well as stakeholders and French government agencies.

Main results

2019 was the seventh consecutive year with no INES level 2 events. The incident prevention rate, or IPR, remained below 0.1. Personnel exposure levels also remained low, under the regulatory values for exposed personnel. In addition, the radiological impact on the environment of sites was well below regulatory values.

1 Operating experience and event analysis are the main drivers of continuous improvement in nuclear safety.

In 2019, of the **139 significant events** reported by Orano or originating with Orano, **none reached level 2 of the INES scale. Seven were at level 1 and 132 at level 0**.

These results show that no level 2 events have occurred for several years, while there has been a continuous reduction in the number of level 1 events (13 in 2016, 12 in 2017 and 8 in 2018). As for level 0 events, these increased very slightly (105 in 2017, then 121 in 2018).

The overall increase in the number of significant events reported in 2019 is chiefly explained by the noteworthy number of deviations in periodic inspections and tests, and by repeated readings above the prescribed limit at the discharge stack, identified during the first year of operation of the Philippe Coste plant.

1 *A glossary of abbreviations and key main technical terms is provided on page 63 of this report.*

These opposite changes in the number of level 1 and level 0 events led to a drop in the IPR, which remains below the Group's target of 0.1. This is consistent with the results of other nuclear operators[2].

Apart from the events already mentioned, the most significant deviations across all Orano activities were:

- the loss of integrity of a carboy containing uranium materials awaiting processing, following on from an event reported in 2018;
- prescribed material mass limits being exceeded in waste storage drums;
- the presence of an item of contaminated waste in a conventional waste skip;
- a cleaning robot falling into a reactor building pool.

The operating experience feedback process continues to be satisfactory, although the re-occurrence in 2019 of an event that happened in 2018 illustrates insufficient depth in the root cause analysis of this case. This analysis constitutes a key factor in ensuring that events do not happen a second time.

Lastly, safety-related events – i.e. those with less of an impact than significant events – are correctly reported to the French Nuclear Safety Authority (ASN), although the information feedback mechanism varies by site.

2 Dosimetry levels remained stable and low both for the Group's employees and those of our subcontractors. They are in line with the results of previous years.

While the French annual regulatory limit is 20 millisieverts (mSv) for category A personnel, average doses were **0.8 mSv and 0.5 mSv respectively for employees and external workers.**

40 Group employees and 3 external workers received a dose of more than 14 mSv, which is the Group's internal alert threshold.

No annual value in excess of 18 mSv has been recorded since 2008 (for a French annual regulatory limit of 20 mSv for category A personnel).

3 The radiological impacts on the environment from nuclear sites **remain at very low levels**, less than 20 microsieverts (µSv) per year (for a regulatory limit of 1000 microsieverts for members of the public).

4 In 2019, **30 thematic inspections**, assessments or visits and 29 follow-up inspections were conducted. These inspections generated **86 recommendations** and as many action plans to be implemented by the inspected entities. These figures can be compared to **128 recommendations closed out under monitoring**.

In addition to the main observations, which are detailed in the dedicated section of this report, the following key remarks can be made regarding the inspection program.

This program aims to strike a balance between the regular monitoring of nuclear and occupational safety issues, any requests that may be made by sites or BUs, and regulatory requirements, taking into account the capacity to perform these inspections.

Among the issues covered, the annual monitoring of waste recovery and packaging (RCD) projects by the General Inspectorate, provided for in an ASN decision, should be adapted to take into account feedback from inspections performed since 2015 and the improvement of ASN capacities in this area.

The processing of recommendations in a timely manner constitute an area for improvement that was identified in the 2018 report. Collective efforts have been made to address past recommendations, notably the most long-standing. For its part, the General Inspectorate has increased the number of follow-up inspections to ensure the good advancement of action plans. The results at the end of 2019 are encouraging, as is shown by the fact that the number of recommendations outstanding for more than two years has halved. This dynamic must be maintained, and will enable us to envisage catching up on these delays by the end of 2020.

ITER visit by the CEA, Framatome and Orano General Inspectorates (September 2019)

Establishing close ties with the general inspectorates of other operators continues to be a source of mutual benefit. In this respect, the joint seminar with the CEA and Framatome in September 2019 has allowed us to develop our respective practices and identify areas for improvement to boost the performance of each entity. To this end, joint events have also taken place with the participation of inspectors from Framatome and Orano. Lastly, as in previous years, a joint inspection was performed with the General Inspectorate of the CEA of a nuclear facility under shared responsibility.

Care will be taken to ensure that these exchanges and continue.

5 **The deployment of the 2017–2020 Nuclear Safety and Environment Policy** has proven satisfactory. The 2019 plan had 142 actions spread equally between safety in facilities, safety during operations, and

2 *An IPR of around 0.1 was given in the 2019 ASN report on the status of safety and radiation protection.*

the performance of nuclear safety and environmental management. Special care was paid to aligning the deployment plan and the points for attention raised by Senior Management, the operational entities, the HSE division, the General Inspectorate and the ASN. The actions in the deployment plan for the year aimed to secure progress in the following areas:

- the deployment of regulated nuclear facility (INB) regulations and facility compliance;
- the strengthening of operational management and internal expertise regarding waste;
- the improvement of standards and operational documentation;
- the sharing of requirements with suppliers and professional training in the monitoring of activities entrusted to external operators;
- the development of practices for sharing experience and feedback, including extending the base to weaker signals;
- the long-term sustainability of managerial and HSE training efforts;
- the strengthening of the HSE division through the Safety Focus program and risk mapping exercise.

In addition to these actions, with a view to a consistent overall approach, it seemed important to better understand the priorities expressed by the sites and the BUs. The following main areas were identified for 2019:

- **training**, aiming for simplification, the digitalization of modules where possible, development of career paths and the roll-out of a joint safety culture module;
- **workstation documentation**, with operational documentation being updated more quickly and effectively, some support materials being digitalized and the repository of safety requirements applicable to facilities being formalized and kept up-to-date;
- **sharing of experience**, seeking to take better notice of weak signals;
- **subcontracting**, with the strengthening of supplier monitoring;
- **waste management**, through the simplification of processes in place and the strengthening of safety culture.

These points are further developed in this section. Particular attention has been given to structuring our approach by aligning the objectives and actions of the Nuclear Safety and Environment Policy with day-to-day site priorities in terms of operational safety.

2020 will be a pivotal year in terms of safety management. It should allow us to draw on the experience of deploying the 2017–2020 policy and identify areas that require further action in order to prepare a new policy for the years to come.

Safety management is an element that has not been inspected by the General Inspectorate in the past three years. It is likely to be examined at the end of 2021, given the developments mentioned above.

Maintaining skills

Skills remain an important issue within the nuclear safety and environment policy. Two priorities are to develop the technical and managerial skills of the management staff and to deploy the training programs identified following regular evaluations of nuclear safety skills.

The annual skills review process was implemented for the first time in 2018, allowing identification of the roles under strain. This collaborative work, initially performed jointly by the BUs and the contact point for each discipline, with the support of experts, was then consolidated at Group level.

Applied during a second exercise in 2019, this review confirmed that nuclear safety and environment, and radiation protection disciplines remained critical.

In the field of nuclear safety, the main issues were the attractiveness of experienced roles, a lack of prospects and problems with visibility regarding subsequent roles, namely opportunities to transfer between safety and production disciplines. Several measures are envisaged to resolve these issues: work on the scope of roles, support for the rejuvenation of the workforce, increased efforts in safety engineer training and an increase in cultural diversity.

Regarding radiation protection roles, these appear to lack recognition and visibility in the context of strong internal and external competition. Action is being taken on recruitment, training, attractiveness and the establishment of a professional pathway between the BUs.

In addition to this work on skills, for several years the Group has been running two cross-disciplinary HSE leadership programs: Safety Excellence and Safety Focus.

Training for Facility Managers at the Georges-Besse II plant, November 2019

The 2019 actions followed on from those taken in 2018 and, in some cases, were strengthened.

The Safety Excellence training (facility managers, site directors, project managers and safety engineers) has continued at a significant rate. It has been possible to train 146 trainees, a 20% increase in the training efforts. Two self-assessment campaigns have also been carried out: the first for the top 50 Group managers, and the second for facility managers. In addition, the Safety Focus campaign has continued at the LA HAGUE and MELOX sites. This campaign has helped assess training needs in both quantitative and qualitative terms. Its results account for a large part of the training efforts mentioned above.

A 2019–2020 master plan to improve the quality of nuclear safety and environment training and its digitalization has been published to optimize training efforts.

The nuclear safety sector takes a dynamic approach to training and skills. Tools are available and put to use, providing a good level of trust in the mastery of this issue.

Monitoring of subcontractors

The monitoring of subcontractors continues to be a major issue in day-to-day safety management.

In this area, the following areas for improvement were identified for 2019:

- updating the internal repository to ensure compliance with the changes to subcontracting regulations in the nuclear industry;
- the development of actions for external operators to raise awareness regarding risks at Group facilities;
- the deployment of actions on the ground to prevent and detect irregularities;
- the anchoring of operational monitoring provisions within our organizations, with monitoring managers acting as part of a network and field focused monitoring plans;
- the strengthening of the involvement of external operators in the system for reporting observations and deviations, and in the analysis of events in which they are involved.

Annual subcontracting report 2017–2018, published in July 2019

Major efforts have been made to update the internal document repository.

The updating of the **external operator monitoring directive**, which incorporates five years' implementation of the initial version and the regulatory changes, sets out the guiding principles of subcontractor monitoring, specifies the modalities for certain special configurations such as activities involving company consortia or industrial operators, and indicates training methods for monitoring managers.

Glove box training, École des Métiers, LA HAGUE

The support for the application of this directive deserves special recognition. Entering into force on January 1, 2019, its operational implementation was intended to come into effect from December 31 of the same year. In addition, a "transition" document was produced. For each applicable requirement, this document provides a reminder of the regulatory provisions or ASN opinions in that area as well as the possible forms of proof. This major effort – carried out by the Group HSE department, the operating sites and BUs working in collaboration – will help facilitate the implementation of this directive.

The **management system specification for suppliers**, which formalizes the requirements specific to nuclear activities in addition to the requirements of standard ISO 9001:2015, was also updated. This revision incorporates ASN requests, notably regarding unscheduled actions and the duty to alert, the notion of "activity important for product quality", special requirements regarding techniques and skills to manage cleanup and dismantling activities.

Lastly, methodological work led by the HSE department aimed to ensure coherence between the observations and areas for improvement identified by the ASN and the General Inspectorate during their inspections, and the operational provisions taken by sites.

In addition to this work, which sets out the applicable framework, **the observations of the independent safety organization** (the General Inspectorate, first-level controls and internal inspections at LA HAGUE) indicate the strengths and points to improve in operational implementation.

It therefore seems that the procedures used by operators (such as prevention plans or Radiation Work Permits

(RWP), for example) to ensure control of operations are correctly implemented. Nevertheless, greater discipline must be applied, notably when it comes to completing documents. In this respect, the responsibility assumed when signing a document is not always understood by the signatory.

The effective management of this issue is based on the monitoring plans in place. Progress is being made towards effective management, although understanding of the notion of "technical inspection" in the sense of the INB order can be further improved. The deployment of actions associated with the control of irregularities is ongoing.

Safety Culture

For several years now, the Group has been engaged in an initiative to continuously improve the safety culture of its employees.

A key part of this initiative is the self-assessment process, with a view to the entities concerned completing self-assessment during the policy period and implementing improvement actions based on the results.

In addition to this tool, several steps have been taken to develop and maintain a culture of operational safety. Two of these illustrate the work done in 2019.

A shared, Group-wide e-learning module on safety culture was produced following requests from the sites. Developed internally, this educational module is based on the fundamentals of safety culture as formulated by the World Association of Nuclear Operators (WANO). Tested at the end of 2019, deployment has commenced and will be expanded in 2020.

Projects BU internal communication on safety culture

The initiative launched in 2018 by the Projects BU is intentionally more targeted towards engineering disciplines. It was extended in 2019 through a monthly publication illustrating one or two principles of a safety culture using practical examples of events or situations encountered in a nuclear setting (internally or externally to the Group). This second stage should respond to the expectations of the employees who completed the satisfaction survey at the end of the first stage.

The dynamic observed in the deployment of actions to strengthen the safety culture is significant. It is also ambitious in terms of the safety culture self-assessment program, and will require major mobilization to achieve the target set.

Independent nuclear safety organization

Strengthening of the independent nuclear safety organization (FIS) was recommended by WANO in the peer review of Senior Management and its support functions for the LA HAGUE activities conducted at the end of 2017.

The introduction, at the end of 2018, of an inspection unit on the LA HAGUE site that reports directly to the site's Deputy Director constitutes a first response to this request. This unit' s first full year in operation has enabled it to implement a program based on an analysis of the major risks identified, supplementing the monitoring actions already taking place.

The ties between this unit and the General Inspectorate have made it possible to coordinate the inspection programs for 2020, and organize the transfer of reports and the mutual integration of inspectors.

For its part, for more than a year now, the General Inspectorate has systematically received the reports from the first-level controls performed by the LA HAGUE, TRICASTIN and MELOX sites. The analysis of these inspections has substantially supplemented the observations from inspections.

All these actions have given the General Inspectorate a more continuous view of site safety, as well as supplementing inspection preparation and contributing to inspection program design. An initial presentation on this subject is given in this report.

These actions will continue in 2020. Particular attention will be paid to evaluating the efficiency of this mechanism, in collaboration with the sites.

Regulatory watch

In 2018, the regulatory watch process was evaluated as part of the decision to replace the tool used by the Group due to obsolescence. A new tool was selected in 2019. Its deployment, which began at the end of the year, will continue throughout 2020 as part of a revamped process for monitoring and evaluating the compliance of facilities with regulations.

This process is due to be re-evaluated in 2021.

Managing the repository of regulatory documents

The issue of implementing the regulatory texts and decisions of the ASN in relation to nuclear safety was highlighted in the

2018 report. Given the publications released in 2019 and those scheduled for the coming years, this issue remains relevant.

Last year was chiefly marked by the publication of Decree 2019-190 of 14 March 2019 setting out, in the regulatory part of the Environmental Code, the provisions applicable to regulated nuclear facilities, the transportation of radioactive materials and transparency in nuclear matters.

Cover page of ADNE special issue on Decree 2019-190 of March 14, 2019

In addition to codifying several decrees, the text included the following key modifications:

- changes to the elements in authorization files;
- the incorporation of regulatory provisions regarding the facilities or activities required by the regulated nuclear facility that are subject to greenhouse gas quotas, hazardous industrial permission directives or Seveso classification;
- the obligation to maintain an inventory of hazardous substances and mixtures.

This text has also been the subject of analytical work and communications within the Group.

In addition, efforts have continued on the action plans to ensure compliance with the resolutions concerning emergencies and waste conditioning.

In order to take into account the operational application of July 1 of decision 2017-DC-0616 entering fully into force, the internal procedure on the management of modifications was revised, as well as the site procedures and authorization level assessment sheets. The new criteria establishing the levels of authorization required have thereby been implemented.

The ramp-up of the Nuclear Safety Methodological Committee (COMET) over 2019 and the completion of the first deliverables are noteworthy. This work responds to the requirement for the Group to have shared safety methodologies developed with support from the sites and engineering teams.

Operational documentation

For several years, the insufficient quality of operational documentation featured among the observations made in the annual report of the General Inspectorate, notably where this was a cause of significant safety-related events.

The work that had begun in 2018 was stepped up in 2019:

The COMET, or Nuclear Safety Methodology Committee, was created in 2019 in response to the need to harmonize, within the Group's various entities and facilities, the application of regulatory requirements relating to the demonstrations of nuclear safety.

The purpose of this committee is to define new analytical methods to respond to changes in regulatory texts or ASN guidelines, by anticipating needs with the aid of methods used for other French or international facilities. Its activities include sharing experience between sites, participating in working groups with other operators, the ASN or IRSN, supporting operators and engineering in implementing analytical methods and communication and information initiatives.

After defining its organization and mode of operation, COMET met five times during 2019. The main results were the issuance of a guide for analyzing cumulative initiating events, the acquisition by the Group of an accident scenario modeling application to perform probabilistic safety analyses, the further development of EIP qualification principles, the analysis of the impact of climate change on installations, and the Group's positions on various subjects such as the inclusion of malicious acts in the safety demonstration, as well as risks related to lightning.

The topics that were initiated in 2019 and will be completed in 2020 mainly concern the updating of fire risk guides and procedures, the issue of a guide on probabilistic nuclear safety analyses and a further guide on the nuclear safety approach for the design of new facilities.

Seven actions to improve operational documentation were employed on the nuclear platforms.

The first practical results have been achieved and are illustrated in the two sidebars on this topic. The first guide has been released. It gives writers objective guidelines to enable them to prepare fully operational documents that will help operators.

This work will need to continue still further if we wish to see the visible effects at a Group scale.

Periodic review

The activities of the "review advisor cluster" set up in 2017 have continued with the following objectives:

- provide operational assistance to operators and engineers in the application of the 2018 guides;
- coordinate the creation or improvement of sub-processes associated with the overall review development process;
- share the methodological development needs arising from operating feedback, notably through cluster participation in COMET;
- capitalize on operating feedback from the reviews and facilitate the exchange of information between the various sites.

This operational assistance has enabled:

For the LA HAGUE site:

- monitoring of the processing of the periodic review files for INBs no. 117 (UP2-800) and no. 118 (STE3),
- support for operating and engineering teams during preparation of the elements for the files for INB no. 116 (UP3-A).

For the TRICASTIN site:

- support for the operating and engineering teams during preparation of the elements for the files for INBs no. 138 (Socatri), no. 178 and no. 179 (Parcs), with the review file for these last two sent to ASN on December 31,
- support for the operating teams during preparation of the orientation reports (DOR) for INB no. 168 (GBII), sent to ASN on August 30.

For the MELOX site:

- support for the operator in drawing up the strategy and preparing for the review of this facility.

The files submitted in 2019 were prepared with the support of the new methodological guides. Content has been standardized and approaches made coherent for all Group facilities.

Methodological assistance, in line with the action taken by COMET, has focused on starting to improve data collection and archiving processes, and compliance and aging review processes at the sites.

New databases have increased capacities to capitalize on the lessons learned from periodic reviews, making it possible to monitor the commitments made to the ASN, collect review observations to anticipate future requirements in terms of analysis methodology and identify future sensitive issues. This has also made it possible to capitalize on the financial operating experience associated with the preparation of files, and the cost of commitments.

Benchmarking between the various Group entities according to technical and organizational themes has simplified the decision-making surrounding operating experience feedback.

Lastly, the opening up of the cluster to external operators has resulted in concrete discussion (CEA, EDF), notably during the OECD working group on "Developments in Safety Assessment Approaches and Safety Management Practices of Fuel Cycle Facilities" (October 7 to 9, 2019).

The creation of this cluster provided a response to the need to apply consistent approaches and methods, schedule periodic reviews in line with the industrial strategy of facilities, and optimize file costs.

Figure 1: Industrializing the review process

After two years in operation, the cluster is working in a way that perfectly responds to the aim of achieving overall coherence in the performance of periodic reviews. It also provides an overview of the schedules for the various files that form part of the review files. In this respect, the intranet site for sharing information, developed by the cluster, is regularly consulted by the relevant collaborators (more than 115 unique visitors and 4200 pages viewed per month, with 4000 views of cluster communications via the Yammer network). It is a high-performance tool

Two examples of operational documentation improvement workshops

THE DESIGN OF A STANDARD FOR THE DRAFTING OF OPERATING PROCEDURES AT THE MELOX PLANT: THE 3U'S RULE

USEFUL

- The document meets the needs of the future users
- The document contains all the necessary information
- The document contains all the relevant information (no overload)

USABLE

- The document is understandable by its future users
- The document is easy to use in all the conditions for carrying out the tasks for which it was designed
- The document is free of errors of form and content

USED

- The document is actually used by the target
- The document presents an interest for the target
- The document fits the uses required by the target (operating framework and updating)

Figure 2: Implementation of 3U's rule

Standardization of operating procedures is one of the pillars for improving the plant's performance. To this end, a workshop was used to specify the rules and best practices for building this standard, thus making it possible to improve existing documents and to specify the criteria to be met by future drafters of these documents.

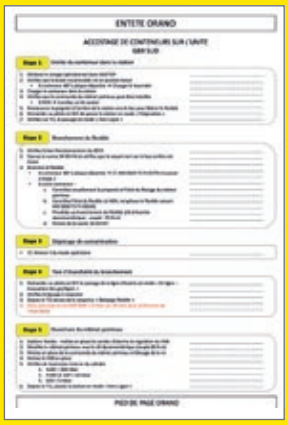
This standard is based on 4 principles:

- organize and group information in a logical way, then constitute sequences of activities presenting a succession of actions to be carried out chronologically,
- accompany the description of the actions with an illustration that contributes to the understanding of the instructions and helps to build the mental representation of the action to be carried out,
- write descriptions in accordance with the rules of ergonomics for the presentation of information, and
- carry out practical tests of the use of new documents before their distribution to ensure that they meet the expectations of future users, both in terms of form and content.

Then, the drafters of the operating procedures were trained to adopt a user-centered approach during the design phase. This approach is governed by the 3U's rule, presented in Figure 2.

DESIGN OF THE MEMO FOR DOCKING AND UNDOCKING OF A CONTAINER ON GB II (TRICASTIN)

Organized at the request of the operator, this workshop comprised two main phases.



Simplified guide or "memo"

The first phase was to assess the existing operating procedure from a HOF standpoint. Following an analysis of the data in the documentation, interviews with the operators and observation of a docking operation with the use of the operating procedure, the following findings emerged:

- document is structured and clear but quite lengthy (around 60 pages),
- document features a flowchart giving a synthetic view of all the operations linked to the task,
- document is regularly updated,
- document features illustrations accompanying the performance of the procedural steps,
- operator performs certain steps not indicated in the document.

This exercise allowed us to identify several areas for improvement:

- the presentation of the outputs of the "Conditions" blocks,
- use of the imperative for all action verbs,
- use of operational "trade" vocabulary,
- identification of the specified requirements in the flowcharts using a clearer visual convention,
- improvement of the principles for inserting photos and diagrams,
- clear highlighting of changes made to the document, and
- creation of a simplified operating guide limited to presenting the different steps, without detailing each individual operation.

The second phase of this workshop therefore consisted of developing a simplified version of this operating procedure, in the form of a "memo" or quick reference guide that incorporates the points for improvement identified previously.

for sharing all the information and data on the subject. Nevertheless, the two other objectives have not yet been attained. We therefore need to continue to capitalize on the data and their analysis. For these reasons, it seems important to maintain this advisor cluster function.

Human and organizational factors

Reinforcing operational discipline by improving use of **human performance tools (HPT)** and ensuring that human and organizational factors (HOFs) are duly taken into account when conducting activities constitute part of the Nuclear Safety and Environment Policy.

In 2019, the internal repository in this area was strengthened. Following identification of the training needs of HOF specialists and engineers in 2018, 2019 was the year in which the process for incorporating HOFs into projects, major modifications and dismantling operations was set out in detail.

On the ground, an initial inspection on the subject of HOFs was performed at LA HAGUE by the General Inspectorate in 2019. Without going into all the observations, which are detailed in the section on inspections, it is clear that HOFs are effectively taken into account both in the document repository and in the deployment of human performance tools.

HOF network meeting, PRISME

6 **Managing fire risks** is one of the safety issues shared most by the sites. In this respect, four inspections were performed on this subject in 2019.

It seemed important to summarize the observations of the Independent Safety Organization in this area for the LA HAGUE and TRICASTIN sites.

At LA HAGUE, site personnel and, to a lesser extent, those working for external companies are aware of the fire risks associated with their activities and know the associated responses. The process for completing and issuing fire

Criteria for involvement of HOF stakeholders

The criteria for calling on HOF stakeholders in the event of a non-significant modification or a significant event have been specified in a guide, according to the principle of making **involvement proportionate** to the contribution to the safety challenge.

For **non-significant modification projects** that are the subject of a modification file, stakeholders are brought into play in accordance with the scope and impact of the modification. Analysis of these impacts is carried out according to the following five areas:

- **characteristics of the tasks**, their perimeter, their distribution between the operator and the machine,
- **work environment** in which an activity involving risk takes place (workstation, workspace and physical surroundings),
- **operational documentation,**
- **work tools and equipment** necessary for carrying out a human task involving risk (the tooling or the control and supervision system, the human-machine interface), and
- **organization and working modes:** modification of interfaces between facilities, companies, services, disciplines and functions.

Once this initial analysis has been carried out, the level of involvement of specialists is adapted according to the number of criteria to address.

The involvement and contribution of HOF stakeholders in the **handling of significant events** is based on the nature and severity of the event. Here it is a question of identifying whether the event has causes of a HOF nature.

Human and organizational factors in projects, modifications or dismantling operations

The requirements for taking HOF into account in projects (design, modification of facilities, or dismantling), for which the Group is the contracting authority or project manager, have been specified in a directive applicable since January 1, 2020.

Built on the basis of requirements, standards and operating feedback at national and international levels, the inclusion of HOF in design projects follows two main principles:

- HOF stakeholders are called upon to develop the approach to be adopted: the project manager calls upon a specialist (may be a representative of the site entity or the contracting authority) to identify the methods for conducting the HOF tasks on the basis of the requirements described in the directive. The specialist will then seek the opinion of the facility's HOF correspondent to determine the approach and the granularity of the analyses to be carried out,
- an iterative process adapted to the specificities of the project (challenges, impacts, complexity, etc.): process is defined by the HOF specialist and the project manager, and shall specify, for each phase of the project, the tasks to be carried out and the documents to be produced.

The analyses cover the following 4 components:

The operator

- The needs, roles and responsibilities of the operators in the operational process, from which stem in particular the choices of automation (Human-Machine breakdown) and the organization of the teams (Human-Human breakdown).
- The level of skill required for operators and the means implemented to acquire it (training, etc.).

Joint working arrangements

- Communication between and coordination of actions and activities.
- Collaborative work between disciplines and between individuals (formal and informal exchanges).

The work environment

- Adaptation of premises, workstations and work tools to the requirements of human activity.
- The characteristics of the supporting documentation (sets of procedures, operating rules, etc.).

General organization

- Supervision and management.
- Corporate culture and processes.
- Management of changes in work situations.

This approach is structured and organized in a HOF integration plan, which is a document designed to be referred to and developed on an ongoing basis during the project, under the responsibility of a person with the necessary expertise.

permits, and the management of fire protection system impairment were found to be satisfactory. Vigilance is nevertheless required to ensure that rounds performed after the end of hot work are correctly recorded.

The design of fire protection and prevention equipment is suitable for the safety issues. Site action plans have been under way (since 2015) to renovate the fire detection system and compartmentation, repair defective fire doors (or, failing that, to identify compensatory measures) and finalize the incorporation of lessons learned from the level 1 event into the annual extinguisher checks.

Management of the fire load is based on the 5S approach, the good organization of facilities and the updating of the IT application used for fire load management. These initiatives need to be expanded so that they are deployed across all facilities.

On the ground, passages, points of access for operating teams and rooms containing equipment important for the protection of interests (EIP) requiring protection against the effects of fire are kept clear.

Lastly, a large number of drills and simulation exercises are held and personnel are familiar with the first response sheets. Secure communication by GLI during drills is an HPT acquired as a standard. Quality of implementation varies and represents a point requiring attention.

For TRICASTIN, the effectiveness of prevention measures can be seen in that fact that outbreaks of fire are infrequent, and have fallen in number over the past three years. However, five cases – which were quickly controlled and were without impact – occurred following hot work. Comparison with the LA HAGUE site over the same period shows that hot work did not lead to any outbreaks of fire there. This point forms part of the exchange of best practices to be set up between the two platforms. The training completed by operating personnel, the checks by the HSE team, the management of fire loads and the specific measures introduced at EURODIF to train operating personnel constitute particular strengths.

The completion of fire permits requires improvement.

Regarding equipment maintenance, the standardization of inspection frequencies for fire doors is a good practice. However, the maintenance plans must be updated in relation to the fire door list and to ensure the completeness of operating procedures for the periodic tests and inspections. Effort must also be made to improve coherence between the operating procedures and reports, and ensure that the checks are exhaustive.

KATCO operating team, Kazakhstan

Contents

LA HAGUE site

2019 Highlights

At national level, within the scope of Orano's activities, the year was primarily marked by work on the National Radioactive Waste and Materials Management Plan. Against this backdrop, Orano continued to modernize its industrial production systems on all sites and to ramp up production at its most recent facilities.

TRICASTIN site

PHILIPPE COSTE PLANT

The Philippe Coste plant continued its ramp-up phase in 2019. Two milestones are of note.

The first took place in September. The first container of natural UF_6 produced at the Philippe Coste plant was used to supply the centrifuges at the Georges Besse II plant.

The second milestone was transition to the "industrial production" phase in October. This milestone formally marks the transfer of the Project to the operating team, with the Project continuing to provide support during the production ramp-up phase.

Georges Besse II plant, TRICASTIN

INB NO. 138 - TRIDENT

At administrative level, Decree No. 2019-113 of February 19, 2019 authorized the introduction of several modifications to INB no. 138. The main change was the authorization to create a new radioactive waste treatment workshop known as TRIDENT. This project is now close to completion, and reached an important milestone in August with the powering up of equipment and electrical rooms.

TRIDENT - First power-up of equipment

LA HAGUE site

EVAPORATOR IN-SERVICE MONITORING

In-service monitoring of the evaporators in the R2 and T2 facilities confirmed they had capacity to continue operating until the arrival of new equipment, with the exception of one T2 evaporator. This was subjected to specific limitations: average use corresponding to 21 days per month until the next inter-campaign in May 2020 and an increase in measurement statistics at the next inter-campaign, in order to preserve its potential.

Orano submitted a request to change the shutdown criterion so as to take the actual availability time of the equipment into account and thus optimize the end of its operating lifecycle by complying with the limit thickness criterion.

PROGRESS ON THE NCPF PROJECT

The replacement of evaporators under the new fission product concentration facilities (NCPF) project continued. The principal items of equipment have been manufactured (evaporators, tanks, condensers, etc.). The evaporators were installed in the buildings in the second half of the year and the distillation column was assembled in NCPF T2.

Active gallery for connection of the NCPF T2 evaporator

The safety investigation also continued: the ASN opinion is expected in March 2020 for NCPF T2 and June 2020 for NCPF R2. The safety reports for active connections were filed in September 2019 for NCPF T2 and January 2020 for NCPF R2. The investigation started with a view to obtaining authorizations for deploying active connections, and acid tests are expected in August 2020 for NCPF T2 and November 2020 for NCPF R2.

Evaporator compartment

REPLACEMENT OF THE R7 EVAPORATOR

Tests on the new evaporator, checking of documentary standards and training of teams continued with a view to commissioning in the first half of 2020. The learning of the teams was facilitated through use of 3D software specifically created for this purpose. In addition to normal operation of the facility, this tool also looks at how to run the evaporator in a substandard situation.

Training module on the R7 evaporator

EXTENSION OF THE CONTAINER STORAGE FACILITY (ECC) IN INB NO. 116

Resolution CODEP-CAE-2019-000624 issued by the ASN President on January 9, 2019 authorized modifications to internal routes used to transport radioactive substances as part of the project to extend the ECC facility.

FIRST FLIGHT OF A FOLDABLE DRONE IN AN ACTIVE CELL

The first video inspection of equipment in an active cell in the T3 facility was performed at the end of the year using a drone equipped with an anti-collision system. Fitted with sonar and infrared sensors and a high-definition camera, the device was used to validate the possibility of carrying out checks in areas inaccessible to operators. The size of the device meant it could be placed in the cell via a sheath designed for endoscopes.

Inserting the drone into the compartment

COMMISSIONING OF THE NEW CRISIS CONTROL CENTER

The new crisis center was inaugurated in April. The facility was set up as an outcome of the supplementary safety assessments. It follows on from that of the storage unit which has been operational since 2016. It will allow for the control of crisis operations over several days and for provision of information to stakeholders with a high degree of safety.

COMMISSIONING OF THE DISSOLVER WHEEL IN FACILITY R1

The operation to replace the dissolver wheel, started in late October 2018, was completed at the end of February, followed by the restarting of the facility on March 1. The first operation of its type in the plant, it was completed in a very short space of time thanks to the mobilization of all engineering and operational teams and the companies involved *(see insert on page 23)*.

Laying the CIME foundation stone

BESSINES-SUR-GARTEMPE site

Prefectural order DL/BPEUP 2019-014 of January 28, 2019 authorized the creation of the **Center for Innovation in Extractive Metallurgy (CIME)**. The foundation stone of the building was laid on September 10.

Prefectural order DL/BPEUP 2019-015 of January 28, 2019 authorized a facility for storage of sludge and processing waste known as the "Lavaugrasse Storage Unit" (USL). The facility is classified under heading 1716 of ICPE nomenclature with a maximum capacity of 35,000 m^3 to hold solid waste from uranium ore processing and sludge from the cleaned pools of water treatment plants on former uranium mining sites.

Prefectural order DL/BPEUP 2019-055 of April 18, 2019, drawn up to modify the amended prefectural order of March 20, 2012, authorized Orano Med to operate a medical-grade radium production facility known as the "Maurice Tubiana Laboratory". It also allows the company to carry out modifications to expand the laboratory's production capacity.

MELOX site

The project to create a new crisis control center continued with the civil engineering and first modifications phase now complete. Like the equivalent installations at LA HAGUE and TRICASTIN, this facility has been designed and built to meet the highest safety requirements in terms of withstanding natural events.

The facility is expected to be operational by the end of 2020. Its commissioning will conclude the overhaul of all emergency management facilities on Orano's nuclear sites.

MELOX crisis control center, pouring the first level slab

ASN resolution 2019-DC-0678 of July 16, 2019, which amends the related 2012 and 2015 resolutions, defines the new regulations applicable to the project.

MALVÉSI site

The civil engineering works for the UO_2 facility project continued to take shape as the first concrete was poured in October. This important stage in the project means it is now possible to start building the structure, which will be based on an innovative process using scrapped structures that are factory pre-assembled, and into which the concrete will be directly poured.

Lagoon rehabilitation continued in INB no. 175 ECRIN, a process started in November 2018. With the two compartments known as PERLE and CERS now built and fitted out, preparations were made to empty the sludge stored in the two settling ponds B5 and B6 using a controlled dredger that arrived on site in October.

A total of 19 months of dredging are planned to transfer 72,000 m^3 of stored sludge. These operations will be carried out under the supervision of the ASN. The dredger was launched and the first sludge transfer operations were carried out in January 2020.

Construction of the UO_2 facility, MALVÉSI

CHÂTILLON site (Headquarters)

Moving Orano's headquarters from LA DÉFENSE to CHÂTILLON in late 2019 resulted in the creation of a new crisis control center.

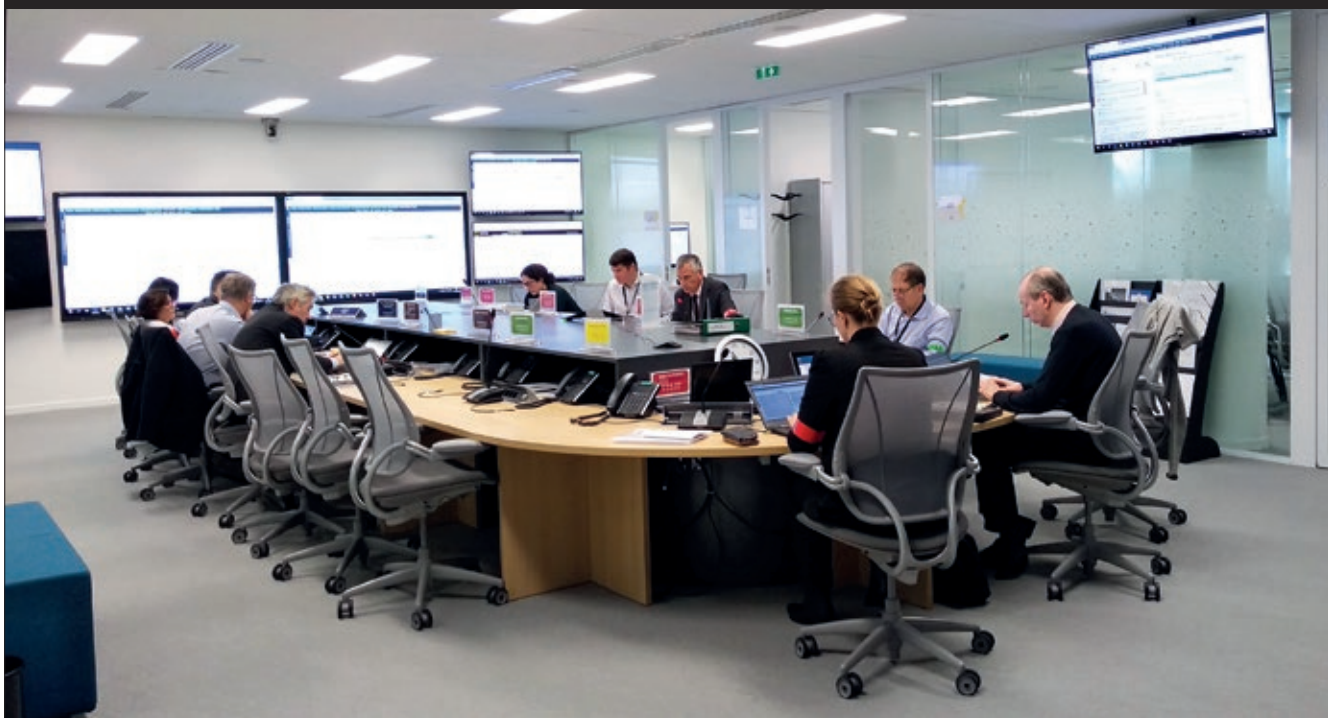
The architecture of the control center incorporates the proven principles of those used at La Défense, while improving information sharing between its different units. The control center was tested during two exercises at the end of the year, including the national transport exercise, and achieved highly satisfactory results.

Packaging

Resolution CODEP-DTS-2019-009033 issued by the ASN President on June 26, 2019 approved packages consisting of TN Lab packaging, whether loaded with radioactive or non-radioactive materials. This package is considered compliant as a B(U) type package design. The package is approved until June 26, 2024.

In order to obtain transport approval for TGC 27 packaging (compacted waste), a first drop test from a height of 9 meters was carried out in October by the German safety authority with a 1:1 scale model. This first test was followed by a broad testing program which will continue over 2020 (falls from different angles, falls on a punch).

National control center (CHÂTILLON) during a crisis management exercise



Giving packaging a new lease of life

Reusing transport packaging for new assignments is an opportunity, and one that materialized through two projects in 2019: use of TN® 13/2 type packaging for internal transport, and refurbishment of 3 TN GEMINI™ packages for new transport assignments.

In response to an international call for tenders, the **reuse of TN® 13/2 packaging** used for transporting spent fuel on public roads in France was chosen as a shuttle solution to transfer spent fuel from the reactor building to the site's central storage pool. In addition to the advantages of immediate availability and lower costs, this solution offers the best level of safety, guaranteed by a new approval agreement.

TN® 13/2 packaging on the LA HAGUE site

Adopting the same approach, **three TN GEMINI™ packages** manufactured in the early 2000s were rendered compliant with the latest applicable regulations in less than 18 months, allowing their reuse to remove drums of waste from an operating site to a storage site.

As the 3 packages had not been used or maintained for 10 years, a variety of work was carried out on them:

- refurbishment operations, mainly the replacement of components and spare parts, maintenance checks, and repair of surfaces,
- changes to the packaging in accordance with the latest versions of the safety file, and
- particularly onerous and innovative repairs on the type B packaging: drying of shock absorbing materials in the packaging, and repair of various threads on the shock absorbing hoods and cover.

TN GEMINI™ packaging before and after refurbishment

Trihom finalizes its development plan

In order to meet the challenges of training in the nuclear industry, and thanks to significant investments made between 2015 and 2019, Trihom, a subsidiary of Orano DS, has now completed its development plan.

Inauguration of training facilities in BEAUMONT-EN-VÉRON, September 2019

Over this period, the company renewed and strengthened its network of offices in France. Each year, around 35,000 trainees from the nuclear industry are taught in one of 17 training centers belonging to Trihom, which boasts a catalog of more than 300 certified training courses and its own engineering department with the capacity to develop tailor-made modules.

Trihom, which celebrates its 30th anniversary in 2020, has increased its workforce by 40% over the last few years to support the growth of its activities, including digitization of all its educational materials. This growth has been facilitated by the confidence customers have shown in Trihom.

The inauguration of its training facilities in BEAUMONT-EN-VERON in September marked the final stage in the development plan.

Find out more: **www.trihom.fr**

Design safety to serve production

In addition to new projects, modifications or adding functionality to facilities, design engineering is also called upon to support the production of existing facilities. It was in this context that the dissolver wheel of the R1 workshop was replaced in early 2019, an operation that had never been carried out before.

Design safety engineers play an important role in this type of operation. They have to quickly learn about the technical environment and, most importantly, the safety standards of the rooms and compartments in which operations take place.

Through daily discussions with the other disciplines involved (process, mechanical engineering and testing functions but also with the teams from the Beaumont Research Hall (HRB) who carry out all the tests necessary for tooling and sensitive operations), as well as with operators and the operational safety teams of the workshop in question, the level of authorization required to conduct operations can be quickly defined along with the type of safety file to be produced.

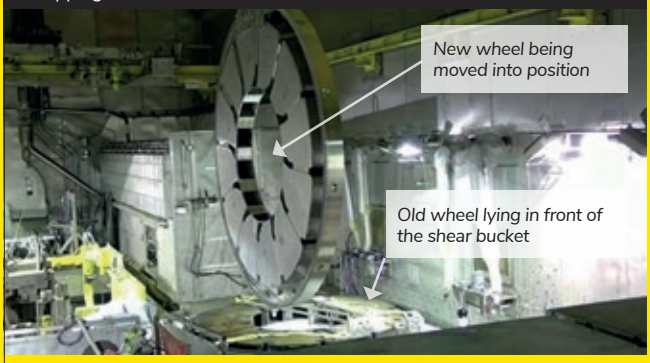
The safety engineers then prepare the safety files in support of the operator and their teams. The aim of these files is to prove that safety management of the modified facility on completion of the operation is compliant with the existing standards of the workshop, but also to prove that safety has been properly managed while the works themselves were being carried out.

In the case of changing the R1B dissolver wheel, a safety analysis was conducted in support of the file initiated by the operator, and included the risks associated with the various handling operations involved.

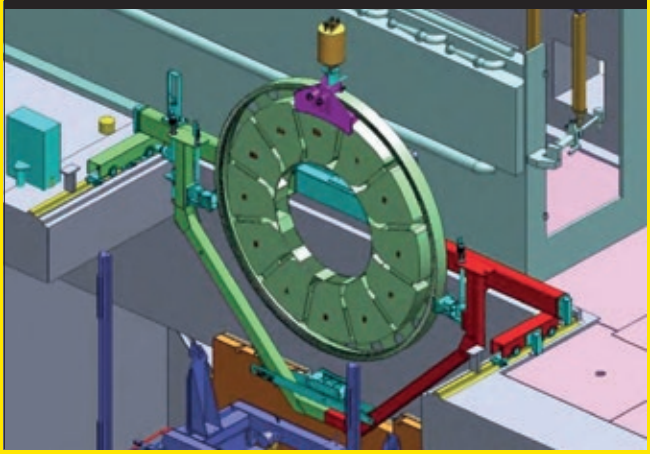
In addition to strong technical skills, the various members of the design teams, including safety engineers, demonstrated their ability to work in large teams and their adaptability, made necessary in particular by the many changes and uncertainties inherent in a very tight design and deployment timetable (this timetable being in many instances constrained by the scheduled maintenance shutdown periods of facilities).

Design safety was therefore an important component in the performance of the wheel replacement, making it possible to meet the ambitious timetable initially planned at the start of the project.

Swapping out the dissolver wheel



Digital simulation of dissolver wheel replacement



Motor cutting operation, *TRIADE*

Lessons learned from the inspections

The General Inspectorate conducted 30 inspections, thematic assessments and visits, together with 29 follow-up inspections, reflecting a particular effort to address the recommendations made during inspections in previous years.

2019 inspections

Aligned with previous years, the inspection programs were structured around four major objectives:

- maintaining a high level of safety and security control as the organizations transformed, or ensuring that existing organizations maintain their capacity to respond to unplanned situations,
- maintaining the control of safety functions (fire, radiation protection, containment of radioactive substances, criticality, removal of residual power),
- managing daily aspects of safety and security through the rigorous application of operating processes and procedures, and
- complying with the requirements of safety authorities for monitoring and supervision of activities.

With regard to results, **30 inspections**, thematic assessments and visits and **29 follow-up inspections** further to recommendations were conducted.

These inspections generated a total of **86 recommendations** and as many action plans by the inspected entities. **128 recommendations were also closed out under monitoring**.

Use of augmented reality for engineering projects

REACTIVE INSPECTION

No reactive inspections were performed in 2019.

ORGANIZATIONAL CHANGES AND MANAGEMENT OF SPECIFIC SITUATIONS

TRICASTIN ORGANIZATIONAL CHANGES

Since 2012, the TRICASTIN plant has been committed to introducing a pooled form of organization. A first step was carried out in 2012-2013. The "TRICASTIN 2017" organizational project is continuing to undertake simplification initiatives with the aim of creating an integrated organization. Two inspections on operating feedback with regard to the reorganization project were scheduled at 9 months and 18 months in response to a commitment made by the site to the ASN.

The 9-month operating feedback exercise sent to the ASN examined the themes set out in the commitments made by the site, which were comprehensively monitored.

The 18-month operating feedback exercise should address the same themes as the 9-month exercise and identify the results of actions undertaken to control the impact of reorganization on protected interests, as well as the results of monitoring programs. The objectives, scope and conclusions should be developed to take account of organizational changes post "TRICASTIN 2017".

JOINT INSPECTION WITH THE CEA OF INB NO. 54

A joint inspection was conducted with the Nuclear General Inspectorate of the CEA on the CADARACHE site. The aim was to assess the conditions for resuming dismantling operations in the cryotreatment unit of INB no. 54, for which the CEA is the nuclear operator and the Dismantling and Services BU (D&S BU) is the contractor.

The facility was commissioned in 1985, has been out of operation since 1989, and undergoing decommissioning since March 2009. Its decommissioning has been suspended since May 2019 due to technical difficulties.

The inspection highlighted the substantial improvements decided upon and implemented in terms of criticality management. In particular, the CEA submitted an authorization request to the ASN to simplify criticality management standards, made possible by the reduction in the quantity of materials now present in the facility. IT tools and operating procedures have been simplified accordingly to facilitate the internal movement of packages and avoid situations likely to result in human error, by reducing the number operator tasks. The CEA and Orano have reviewed their organizations to streamline relations and strengthen local supervision. Finally, the operations resumption program provides for a progressive phase to remobilize teams and train them in the new standards. All of the above factors were deemed positive. However, the success of these improvements depends on effective supervision of the operators on worksites and on the implementation of plans to check and monitor operations to create and prepare waste packages with a view to their disposal.

PROCESSING OF ABNORMAL SITUATIONS IN ENGINEERING DEPARTMENTS

Two inspections were carried out to assess how engineering departments deal with abnormal situations and take operating feedback on board.

For the NP&S BU, the proficiency level was satisfactory. However, discrepancies were noted between actual

practice and the documents applicable. Management of changes in methodological standards and deployment of an IT tool to process quality events must be improved.

For the Projects BU, the proficiency level with regard to handling abnormal situations and consideration of operating feedback differed depending on the responsibilities exercised. It was satisfactory for assignments carried out in the capacity of project manager. Ambiguities in the standards applicable must be removed to guarantee proficiency in the requirements defined for deviation management when services are provided to assist project owners. Finally, the procedure of the Operating Feedback Management Group must be set out in the methodological standards.

Inspection team at MELOX

MAJOR RISKS ASSOCIATED WITH SAFETY FUNCTIONS

RADIATION PROTECTION

Two inspections examining radiation protection of persons were conducted at MARCOULE and at MALVÉSI. These inspections concluded that personnel exposure levels were low compared with regulatory limits and the Group's targets. At MARCOULE, certain radiation protection operations are subcontracted and conducted in an integrated way, in accordance with the principles of the site's radiation protection culture. At MALVÉSI, the consequences of extending the stock of uranium concentrates must be given more consideration from a radiological protection point of view.

CRITICALITY MANAGEMENT

A criticality management inspection at MELOX showed that the procedures for managing hydrogenated materials, introduced in 2015 following a declared deviation, allow precise management of the quantity present in glove boxes and in the so-called “dry” rooms, as a result of the checks put in place and the skills of the personnel concerned. The fact that there is no formal description of their application in the deviation management system suggests that reporting of weak signals could be further improved. From a more general point of view, it would be worthwhile defining an efficiency measure for this process.

FIRE RISK MANAGEMENT

Four inspections on management of fire risk were conducted.

At LA HAGUE, two inspections conducted a few months apart showed that action plans were deployed to upgrade fire extinguisher maintenance and repair or replace defective fire doors. In 2019, fire outbreaks were limited and none were caused by hot work. However, deployment of the “5S” strategy must be completed in order to limit the heat load density in facilities to a strict minimum, rounds to check safety equipment must be stepped up, and stopping of thermography testing should be examined in light of operating feedback. Finally, contractors must be reminded of the procedures to follow in the event of fire.

At TRICASTIN, the effectiveness of prevention measures was reflected in the small number of fires in the plant, a figure which has been decreasing over the last three

Operational resources, McCLEAN LAKE, Canada

years. However, outbreaks are still happening as a result of hot work. Best practices must be discussed with the LA HAGUE site to manage this issue. Finally, completion of fire permits requires further improvement.

At MALVESI, fire risk is considered to be a major issue by the site. Its management depends in part on increasing the availability of human and material resources. Prevention is mainly based on limiting heat load, through appropriate housekeeping, which must continue to be closely monitored by local management. In addition, completion of fire permits must also be improved. Management of chemicals requires increased vigilance: inventories must be carried out and chemicals in regular use should be stored in suitable cabinets.

CONTAINMENT OF RADIOACTIVE MATERIALS

Two inspections on containment of radioactive materials were conducted on the MELOX and TRICASTIN sites.

At MELOX, constructive arrangements, rules for working with glove boxes and associated training initiatives helped to control the risk of dispersal of radioactive substances, and the level of radiological cleanliness in rooms was satisfactory. Reducing the number of containment breaches remains an important issue and is being monitored by the plant with the attention it deserves. However, the recycling of training courses on glove box work must be better monitored.

At TRICASTIN, as part of the periodic review of INB no. 155 (TU5), the first containment barrier will be treated as equipment important for the protection of interests (EIP), leading to improved containment in the long term. For ICPE W, containment control practices must be strengthened by building on what is carried out in TU5.

OPERATIONAL MANAGEMENT OF SAFETY AND SECURITY

SUPERVISION OF CONTRACTORS

Two contractor supervision inspections were conducted at LA HAGUE and MELOX.

The LA HAGUE inspection focused on the procurement process and the multitechnical maintenance contract for the Operational Processing Unit, entrusted to a short-term joint venture (GME) of three companies. The inspection concluded that the processes relating to contractor supervision were detailed and appropriate. Many companies are aware of the importance of this area and related technical and regulatory issues. However, deployment by the GME of technical checks associated with activities important for the protection of interests and their monitoring by the operator must be strengthened. Initiatives to deal with the risk of fraud have been started: training courses have taken place and learnings must now be implemented.

Contractor supervision at MELOX was deemed satisfactory and proportionate to the issues involved. In particular, contractors are monitored in accordance with detailed plans based on a robust methodology. However, operational documentation should be more specific, as should the human performance tools required of contractors when working conditions makes these necessary.

OPERATIONAL SAFETY

A safety inspection was carried out at the TRIADE site. The organization of the site allows industrial activities to be carried out in compliance with safety requirements. The important presence of managers on the ground facilitates dialog and responsiveness. However, control of fire and handling risks, as well as management of periodic equipment checks and tests must be improved. A risk assessment must be completed with regard to chemical risks.

HANDLING

An inspection on management of risk related to handling operations was conducted at TRICASTIN. Significant work has been carried out since 2014 to manage handling operations with self-propelled forklifts, and identical work must be undertaken for lifting equipment. Risk management must be reinforced by clarifying the roles,

responsibilities and skills of the different parties involved in these operations, as well as by strengthening prevention measures based on the challenges of each operation. The practices observed on the ground are varied in nature, and the best practices observed must be extended. Finally, deployment of the Group's safety anchors should be continued.

CHEMICAL MANAGEMENT

A chemical management inspection was conducted at the MELOX site. Use of chemicals is limited and the needs of the plant do not require storage of large quantities. Organizational processes have been completed. Training courses comply with the objectives of preserving employee health and respecting the environment. The delay in integrating regulatory developments related to REACH and CLP is gradually being reduced. However, the rules for managing storage of chemicals must be improved and control of emergency situations must take better account of chemical products.

Hazardous product pictograms

At the McCLEAN site in Canada, a chemical management inspection highlighted clear, detailed and easily accessible operational documentation, trained and supervised shift crews, a robust deviation system, an autonomous and well-equipped crisis team and good levels of tidiness in facilities. However, the industrial safety culture must be improved by integrating the conclusions of various hazard assessments. While all chemicals are stored in suitable cabinets, management of their content must be further strengthened.

INTERVENTIONS AND WORKS

On the MALVÉSI site, the organization deployed allows management of interventions and works in accordance with security requirements. Computerization of the work authorization management system will improve monitoring of stages and the quality of records. As soon as this system is deployed, implementation of internal checks will ensure it is effective and being properly applied.

WASTE MANAGEMENT

At TRICASTIN, the waste management inspection revealed that organizations put in place, the updating of operational documentation, improvement of operating arrangements and the training efforts are delivering compliance with regulatory requirements. Updating of waste studies, standardization of benchmarks and the establishment of a training worksite for preparation of contaminated waste packages were key strengths revealed in the inspection. However, measures to formalize operational responsibilities and implement technical checks on the waste training course design AIP need to be put in place.

MANAGEMENT OF OPERATIONAL SAFETY

Two one-day inspections of the MELOX plant were conducted to ensure good day-to-day safety management practices by checking effective implementation of the operational safety engineer control program, reporting of deviations and appropriate handling of them.

SPECIFIC SUPERVISION AND SURVEILLANCE

This type of inspection makes it possible to monitor the execution of projects or processes. The results of these inspections were audited by safety authorities. They provided proof of compliance with the commitments made by the group in these areas, with a structure independent of the operational organizations in charge of implementing the various projects.

RECOVERY AND PACKAGING PROJECTS

The annual assessment of progress on recovery and packaging projects for legacy waste from the LA HAGUE site showed that silo 130 is now in its operational phase, and the coordinating role played by the D&S BU will allow finalization of training for the future industrial operator's teams. The Industrial Commissioning phase will take place once the first drum of waste has been generated. The sludge recovery and packaging project is experiencing delays with regard to ASN authorizations for the silo roof construction phases, and only the crust clearing phases on silo roofs 10 to 16 have been authorized.

HUMAN AND ORGANIZATIONAL FACTORS

The HOF-themed inspection conducted at LA HAGUE was in response to a commitment made by the facility to the ASN.

The roles and organization of HOF stakeholders are consistent with the internal directive. Good practices were noted in control rooms. The concept of human performance tools (HPT) was understood and applied. There is still work to do on embedding their systematic and consistent use in the operating culture. Requesting

the services of HOF facilitators in the context of change analyses and event analyses continues, however, to be at the initiative of safety engineers and facility managers: this level of request is considered too weak and should be better valued by the site. Facility standards do not identify sensitive activities focused on the risks of each workshop and requiring the implementation of HPTs. The list requiring use of HPTs must be supplemented by a list of sensitive activities specific to each facility.

"EMERGENCY" DECISION-MAKING

ASN "Emergency" decision-making supplements the INB order for the requirements associated with crisis management. The TRICASTIN inspection focused on checking compliance with the requirements applicable in 2019. To make up for the delay in achieving this compliance, management of actions and resources must be strengthened and crisis management integrated into AIP methodology.

Inspections of the other sites affected by this subject will be carried out in 2020.

"CHANGE" DECISION-MAKING

The inspection on compliance with ASN "Change" decision-making at MELOX was the first one to be conducted on this issue following recent regulatory developments. It concluded that these developments have been incorporated into the applicable standards and that the organization and level of independence of the internal control body are clearly defined. Certain applicable documents have yet to be updated, however, and technical checks and assessments of the change process should be strengthened.

Inspections of the other sites affected by this subject will be carried out in 2020.

Assessment mission at COMINAK, Niger

SAFETY ASSESSMENTS

Assessments on the COMINAK and SOMAÏR mining sites in NIGER focused on the deployment of three safety anchors: handling and lifting, lockout and lockout release, and working at height. The aim was to identify hazardous situations that could be improved by implementing immediately applicable and economically acceptable operational measures. On the SOMAÏR site, upskilling of teams, and planning and anticipation of interventions have contributed to improved discipline and a better safety culture. Thirteen operational measures were identified and must be implemented by the site. On the COMINAK site, the reliability of lockouts and the availability of equipment subject to regulatory controls is an important issue. Twenty-six operational measures were identified and have been implemented by the site.

Recommendations for 2019

The inspections conducted in 2019 resulted in 86 recommendations, which can be broken down as follows:

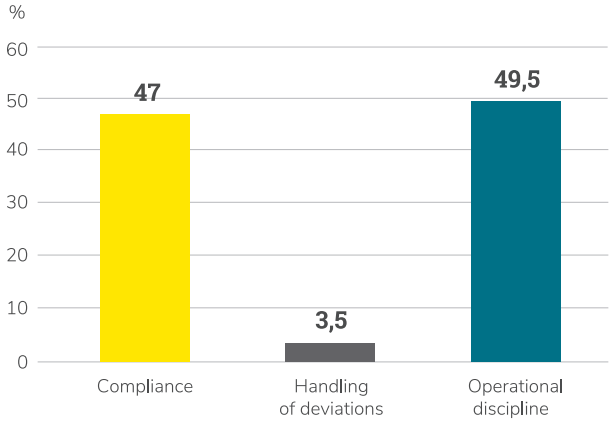


Figure 3: Distribution of General Inspectorate recommendations by area

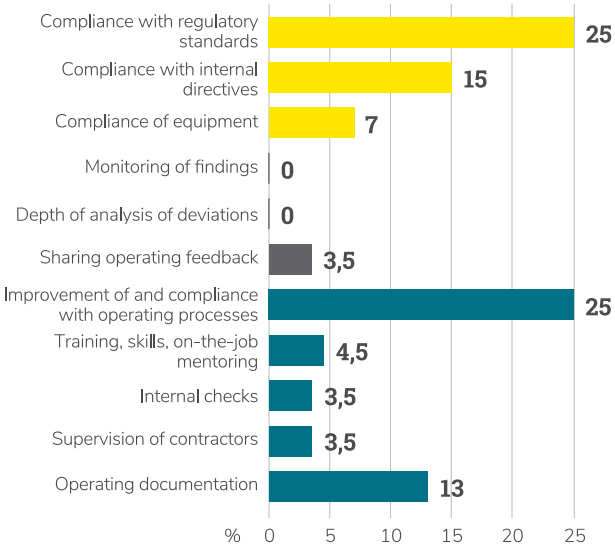


Figure 4: Distribution of General Inspectorate recommendations by sub-area (%)

Cleanup and dismantling operation

Operating feedback from events involving safety and radiation protection

7 events classified at level 1 and 132 at level 0 on the INES scale were declared by Orano or concerned Orano. These figures led to an accident prevention rate of less than 0.1 compliant with the set objective.

No event of level 2 or higher on the INES scale involving the entities of the group, regardless of responsibilities as operator, industrial operator, or service provider, took place in 2019.

139 significant events were declared on the INES scale. None of these events had significant consequences for the personnel, the public, or the environment.

7 level-1 events on the INES scale. These were anomalies with no impact on safety, occurring in situations non-compliant with requirements. They concern:

- four deviations in waste management at MARCOULE and TRICASTIN, three of which concern drums of waste containing radiological materials,
- a delay in the performance of periodic inspections on several facilities of the LA HAGUE site,
- fall of a small robot into the vessel of a shutdown reactor during the cleaning of the pool,
- a malfunction in the procedure for the commissioning of equipment allowing the electrical power supply to be cut off and the startup of the emergency backup generator to be suspended at TRICASTIN.

The number of these events has been continuously on the decrease for 5 years.

132 level-0 events on this same scale. These entailed deviations not impacting safety that are referred to as “weak signals”. They are taken into account in the continuous progress approach and the improvement of risk prevention.

There has been a significant increase in the number of these events over the last 3 years. For 2019, this increase is explained in part by occasional cases of permitted discharge limits being exceeded related to the industrial commissioning of the Philippe Coste plant (TRICASTIN) and by the periods for performing periodic inspections and tests being exceeded on some sites.

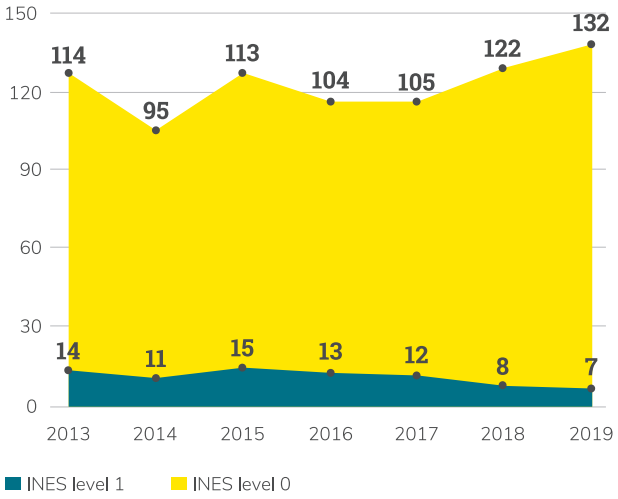


Figure 5: Changes in the number significant events

The proportion of these events declared by Orano subject to a reclassification or a declaration at the request of ASN has decreased at a rate of 13,6% after having increased at a rate of 15,5% in 2018.

The rate of prevention of these events, or IPR*, stood at 0.05 at the end of the year. This result is compliant with the objective set at 0.1.

The breakdown of events by domain and the change in it over the last three years is as follows:

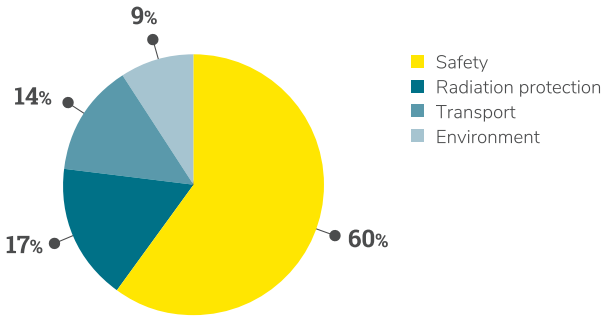


Figure 6: Breakdown by domain of significant events

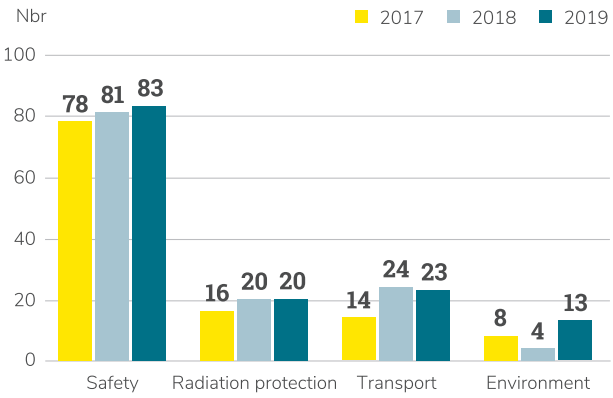


Figure 7: Change between 2017 and 2019 and by domain, in the breakdown of the number of significant events

Of the 139 significant events declared in 2019, 83 were for nuclear safety (60%), 20 for radiation protection (14%), 23 for transportation (17%), and 13 for the environment (9%).

The number of events for the domains of nuclear safety, radiation protection and transportation has remained broadly stable while that for the protection of the environment has increased.

Safety of facilities

The events declared for reasons of the safety of Orano's facilities or facilities for which Orano is the operator occur mainly at facilities in operation during routine operating or maintenance activities.

A more detailed analysis of events concerning safety results in the following breakdown by domain:

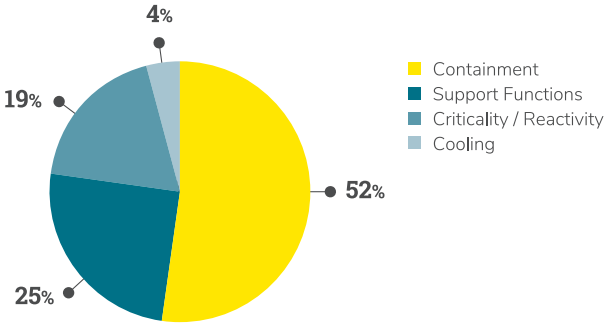


Figure 8: Breakdown by function of events impacting safety

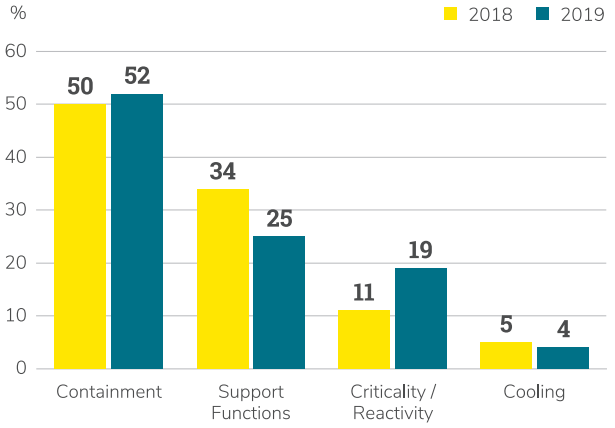


Figure 9: Comparison between 2019 and 2018 of the breakdown by function of events impacting safety

CONTAINMENT FUNCTION

Half of the 40 events related to containment control for radioactive materials concerned a breach of leaktightness in a containment barrier for radioactive or hazardous materials without impacting the environment or persons. These events were mainly due to losses of leaktightness of glove boxes at MELOX, unscheduled shutdowns of building ventilation systems at MARCOULE and losses of leaktightness of waste drums being kept in interim storage under non-compliant conditions at TRICASTIN.

CRITICALITY FUNCTION

The 15 events involving control of reactivity of fissile materials mainly concerned management of waste and effluents. They were due to cases of limits of masses of fissile materials being exceeded related to faults in the characterization of legacy waste at MARCOULE and to insufficient control over compliance with the limits specified by operating standards at TRICASTIN. These cases of limits being exceeded are in part explained by the recounting of legacy drums with more efficient measurement equipment.

SUPPORT FUNCTIONS

These events, which mainly occur during maintenance operations, were due to delays in the performance of periodic inspections and tests of equipment involved in the operation of a support function.

More than half of these events were related to the control of fire risk, 3 of them being outbreaks of fire with no impact on the safety of facilities.

Losses or weakening of equipment performing a support function caused by maintenance interventions are clearly down compared to last year.

Radiation protection

Events impacting safety and radiation protection are broken down evenly between:

- cases of unexpected exposure of persons (internal contaminations and cases of dose rate alarms being triggered), including 2 internal contaminations of more than 1 mSv without exceeding ¼ of the annual dose permitted by the regulations,
- cases of failure to comply with access rules in marked areas (including the wearing of a dosimeter),
- faults in the management of periodic inspections and tests, as well as in that of unsealed radiological sources.

The cases of unexpected exposure of persons, except for these 2 internal contaminations, concerned hot points not identified upstream of services carried out by personnel from Orano DS. The cases of failure to comply with access rules in marked areas were often due to a lack of rigor in the application of these rules on Orano sites, even though the rules are known to the persons involved.

Transportation safety

Of the 23 events declared, 11 involved Orano and 12 other events concerned deviations detected, by sites of the Group, upon acceptance of packages not shipped by Orano.

Environmental protection

In addition to the 13 events declared on the INES scale, 24 were declared for environmental protection (not on the INES scale, not on or on the ARIA scale).

Events declared on the INES scale are up with 7 occasional cases of permitted discharge limits for radiological effluents being exceeded related to the startup of the Philippe Coste conversion plant at TRICASTIN. They were found to be due to the design of equipment such as the crystallizers and the systems for the purification of gaseous effluents.

Of the 24 other events, 9 concerned occasional cases of permitted discharge limits for chemical effluents being exceeded, of which 7 were occasional cases of exceeding of fluorine concentrations, also related to the Philippe Coste conversion plant.

Five releases were related to a pierced fluorine pipe at TRICASTIN and losses of leaktightness of equipment containing refrigerant fluids at LA HAGUE and at TRICASTIN.

Air production and refrigeration equipment, TRICASTIN

ANALYSIS BY SITE

LA HAGUE

The LA HAGUE site declared several events, including 1 INES level one event, related to periodic inspections and tests which were not performed within the time periods required by operating standards. These events in particular show a lack of the appropriation of the role by those responsible for coordinating periodic inspections. These deviations led the site to carry out a cross-functional analysis of the causes of these events to draw up an action plan which will be deployed during the course of 2020. Based on the events already highlighted in 2018, the General Inspectorate has planned to conduct an inspection on this topic on each of the nuclear sites in 2020.

Out of the 8 events related to the weakening or deterioration of containment barriers, 5 concerned faults in "operating actions". This topic is a point which requires attention.

Subsequent to the incidents related to handling observed in 2018, an action plan based on a cross-functional analysis of causes was deployed by the site. The deviations were reversed in 2019.

TRICASTIN

The occasional cases of permitted discharge limits for radiological and chemical gaseous effluents being exceeded due essentially to the ramp-up of the Philippe Coste conversion plant have already been underlined above. They are mainly due to the design of equipment and effluent treatment systems. Works have been launched to rectify this.

The TRICASTIN site also declared several events related to periodic inspections and tests which were not performed within the time periods required by operating standards. These events show there to have been faults in the scheduling of these inspections and tests to be performed upon the commissioning of facilities, as well as in performing updates to planning tools subsequent to changes to the General Operating Rules (Règles Générales d'Exploitation – RGE). These deviations may, in certain cases, be accentuated by insufficient coordination between the departments on site, responsible for performing these inspections and tests, and operators.

Events related to cases of permitted limits related to control of the criticality of fissile materials being exceeded in the management of waste drums and liquid effluents in interim storage are up. This topic is an area of concern to be taken into account by the site.

MARCOULE

The MARCOULE site declared several events related to cases of permitted limits related to control of the criticality of fissile materials contained in waste drums being exceeded during retrieval and reconditioning operations. This situation in particular led the site to put in place measures to allow for the consultation of a measurement expert in the event of any inconsistency in measurements during the characterization of a drum prior to its retrieval, as well as to improve the operational documentation intended to ensure that the permitted limits are complied with. It is necessary to remain vigilant to ensure that these measures are adequate.

The commissioning of the liquid effluent treatment station (Station de Traitement des Effluents Liquides – STEL) cement encapsulation facility also gave rise to several events related to faults in the design which is currently undergoing modification.

MELOX

This site experienced 5 losses of glove box containment, which remains at the same order of magnitude as last year. They were in part due to an insufficient knowledge of equipment or procedures, as well as to inadequacies of the operational documentation. The progress plan deployed by the site, launched in 2019, will continue in 2020.

MALVÉSI

As last year, the events mainly concerned the detection upon acceptance of transport containers of drums of concentrated uranium of the dissemination of uranium-bearing materials within the containers. The site always alerts the shipper so that it can analyze the causes of the event and take measures to avoid it happening again.

Event analysis

The significant events declared on the INES scale are addressed in a detailed report to find all causes and to set up appropriate and sustainable improvement actions to effectively prevent recurrence.

The analysis of these detailed reports reveals that the human factor played a significant role in the causes. As shown in the diagram below, the breakdown of causes shows that nearly 80% of them have a human or organizational component: There is little variation in this breakdown from one year to another.

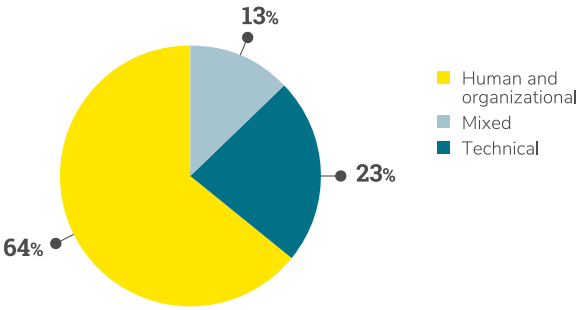


Figure 10: Breakdown of causes of significant events

The breakdown of significant events remains broadly equivalent to 2018 with a few changes:

- an increase in technical causes (from 16 to 23%) explained by the more important share given to corrective maintenance to the detriment of preventive maintenance favoring equipment failures and by the absence of investigation of HOF causes in the event of a technical malfunction,
- a correlated decrease in mixed causes (from 29 to 13%) related to less investigation of the HOF causes of events when the trigger is of a technical nature.

FOCUS ON THE HUMAN AND ORGANIZATIONAL COMPONENT

The analysis of events from a HOF perspective 97 detailed event reports (5 of level 1, 75 of level 0, 12 not on the INES scale and 5 of ARIA level 1). It allows several types of human error to be identified:

- errors of representation, found in 46% of events, and errors in knowledge, found in 30% of events, which are the cause of inappropriate decisions,
- errors of routine. The most frequent errors in human activities (80% of errors) were only present in 15% of events. This rate, which has remained constant from one year to the next, shows that the systems and organizations in place make it possible to mitigate the impact of this type of error (prevention, detection, limiting consequences, etc.).

Gripper box training, École des Métiers, LA HAGUE

- finally, there is a slight increase in intentional human errors or the working around of rules compared to the analysis done in 2018. The main reasons for this are as follows:
  - first and foremost, the wish to carry out the entrusted task or assignment to the detriment of safety objectives,
  - secondly, looking to make a cognitive or physical saving (for example, non-compliance with the procedure for entrance to areas),
  - finally, the existence of a conflict between occupational safety, nuclear safety or radiation protection rules, leading the operator to choose one rule over another.

An increase in collective workarounds was also noted (for example, in one case, resorting to the use of a locking bar instead of the specific key). This is a point which requires attention.

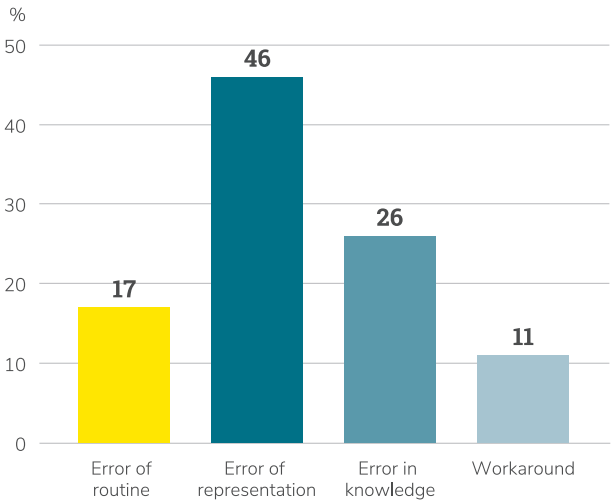


Figure 11: Breakdown of human errors as a % of analyzed events

More in-depth analyses make it possible to identify causal factors for work situations, processes, and general organization.

ANALYSIS OF CAUSES RELATED TO WORK SITUATIONS

In terms of work situations, three factors were found to be preponderant:

- operational documentation: 36% of events remain related to inadequacies of the operational documentation: completeness, lack of documentation at the workstation, lack or improper application of new requirements,
- workstation ergonomics: 24% of events are due to the inadequacy of signage on premises or of the marking of equipment and a workstation environment that is not adapted to the activity,
- skills: 23% of events concern a lack of knowledge of specialist rules or rules relating to the management of facilities and of the working environment, which may be accentuated by an inadequate safety culture.

These three factors remain predominant, year after year. The analysis for 2019 however highlights a significant decrease of nearly 10% in the factors of skills and workstation ergonomics.

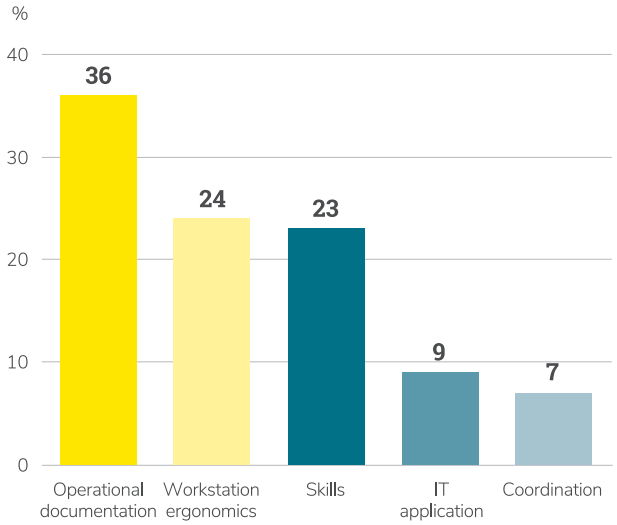


Figure 12: Breakdown of error factors for work situations as a % of analyzed events

ANALYSIS OF CAUSES RELATED TO PROCESSES AND ORGANIZATION

The absence or inadequacy of risk analyses in the design phase and in the intervention preparation phase is the preponderant contributory factor to the occurrence of events (21%). The source of this is to be found in organizational constraints (deadlines, resources), the lack of safety culture or of knowledge and the quality of the operational documentation.

The management of design and changes of work situations (15%) is also a preponderant factor in the cause of events. Thus, technical changes or organizational modifications are not always appropriately expressed in the documentation or in the requirements addressed to service providers. This explains the significant occurrence of organizational factors related to the lack of "definition of roles and responsibilities" and of "coordination between departments/ subcontractors".

The planning process (14%) is a new error factor. During maintenance works (periodic tests and inspections, tests, etc.), faults in coordination and communication between departments are regularly observed to be the cause of events.

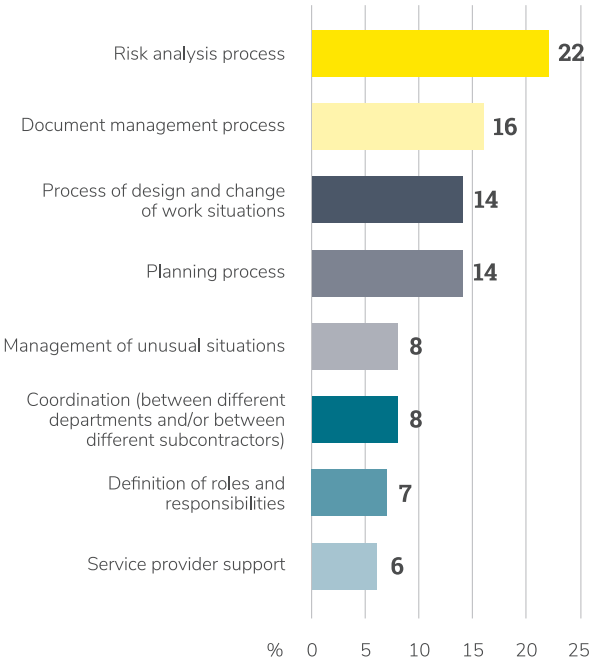


Figure 13: Breakdown of error factors for general organization and processes as a % of analyzed events

The documentation management processes also stands out in the analyses as being an important factor in the cause of events, often related to operational documentation which is inadequate, not up to date or inappropriate.

THE QUALITY OF SIGNIFICANT EVENT REPORTS

The relevance of the analysis depends in part on how in-depth the detailed reports, which are made after each significant event, are. This plays a part in:

- the presentation of all the facts and information making it possible to gain both an understanding of how the event happened and knowledge of the malfunctions which occurred,
- the analysis of the causes of these malfunctions,
- the permanent nature of the measures taken and their consistency with the set of causes identified by the analysis.

This quality is monitored centrally by assigning a level based on the 3 criteria specified above: level A if the 3 criteria are met, level B if only 2 out of the 3 criteria are met, level C if only 1 of the 3 criteria is met and level D if none of the 3 criteria are met.

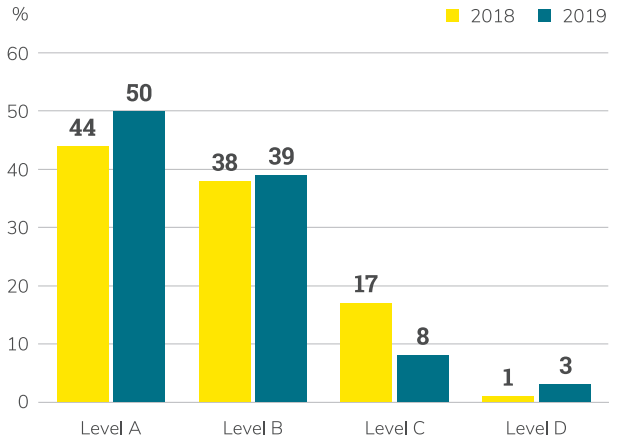


Figure 14: Change between 2019 and 2018 in the quality of reports

The change between 2018 and 2019 shows a noticeable improvement in quality, with a significant increase in level As (6%) and a decrease of the same order of magnitude in level Cs (9%).

The main deficiencies identified in the detailed reports mainly concern the measures taken as a result of events (46%) and the analysis of causes (34%). They also show that sites have difficulty in gaining a complete grasp of organizational factors in the analysis of events. This may be explained by a limited analysis at the level of the facility concerned by the event and not at Site level which would make it possible to consider organizational processes. Attention also has to be paid to the process for providing operating feedback from events at Site level in order to identify causes concerning processes more effectively.

In addition to this, the measures taken as a result of events are categorized according to "the square of possible actions (according to Almaberti)". The analysis of an event allows its repetition to be avoided all the more effectively if the actions taken have a bearing at the same time on design (the change), management (the organization), formalization (the procedure) and training.

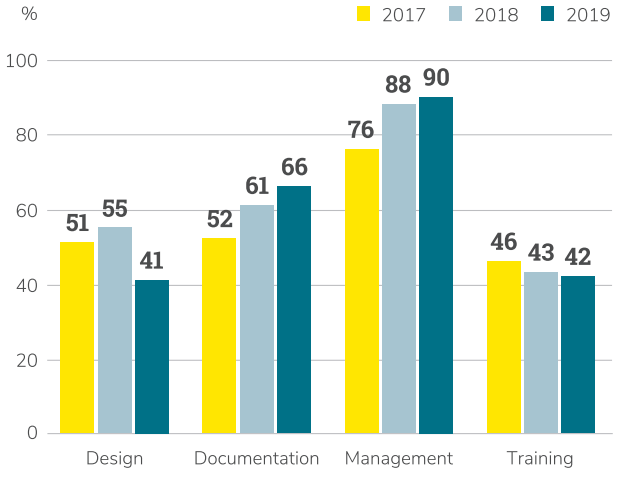


Figure 15: Change in the breakdown of measures taken according to "possible actions" (Almaberti)

In 2019, managerial measures and measures related to documentation were given greater emphasis to the detriment of design and training measures. This trend has been becoming more pronounced since 2017. Particular attention must be paid when conducting the event analysis to the question of the 4 possible domains.

The release of a guide on the processing and the drafting of an event report should make it possible to achieve an improvement in quality. This document aims to provide those responsible for the processing of an event with methodological assistance. Moreover, the monthly communication of this second level analysis according to the two axes of completeness and the balance of measures taken makes it possible to correct the failings observed more quickly. The release of this guide and the feedback to authors on the assessment of the quality of the event reports should make it possible to make progress in terms of operating feedback.

Main areas for improvement

The analysis of the events impacting safety allows the following areas for improvement to be identified:

Concerning the causes of events,

- **the improvement of risk analyses** in the design of and when making changes to work situations and in the intervention preparation phase, continuing training programs on the exhaustiveness of the upstream risk analyses in the safety file, and HPTs (mainly the pre-job briefing, the one-minute wait and the debriefing),
- **the quality of the operational documentatio**n, by paying attention to ensure safety requirements are put into application in operational documents subsequent to changes to general operating rules. In this regard, the update by the TRICASTIN site of the requirement sheet (Fiche d'exigence – FEX) linking each requirement to the operational documents in which it is applied is a best practice which is worth being adopted more widely.
  In addition, the work in progress on the improvement of the taking into account of human and organizational factors in operational documents is to be continued and the operating feedback from this work must be able to be extended to all facilities,

Concerning the operating feedback process,

- **the completeness of analyses**, by endeavoring to gain a grasp of human and organizational factors at site level and by paying attention to ensure that the measures taken are based, as far as possible, on the right balance struck between design, management, formalization and training.

Delay in the performance of technical radiation protection inspections

THE FACTS

The LA HAGUE site has numerous sealed radioactive sources and rooms identified as posing a radiological risk, which undergo checks at periodic intervals in the form of external and internal technical inspections.

Until 2015, external technical inspections were carried out by an internal body approved in this area. The inspections were then performed in campaigns between September and December for radioactive sources and spread throughout the year for atmospheric measurements in rooms.

As of 2016, this mission was entrusted to another approved body. The inspections schedules were spread out across the year for sources and for atmospheric measurements in rooms, they were grouped together geographically. This method of planning has since been renewed and refined year after year.

Subsequent to an inspection, it proved to be the case that:

- some sources had not undergone an external technical inspection at the required periodic interval, due to their location in inaccessible areas (in glove boxes, etc.) or because they were in the process of being retrieved by their manufacturer.
- some rooms had not undergone an inspection at the expected periodic interval as there were in the process of being dismantled, or because they posed technical problems which means it was not possible to access them.

This event, classified as 1 on the INES scale, did not have an impact on personnel or the environment.

ANALYSIS OF HUMAN AND ORGANIZATIONAL FACTORS

The human and organizational factors contributing to this event are as follows:

- **operational documentation:** the technical and administrative specifications accompanying the contract do not explicitly specify the arrangements for its performance such as the schedule, the measures to be taken for the management of sources, the resources to be mobilized or access management,
- **monitoring of subcontracting:** the stakeholders in this contract (site and approved body) do not have a sufficiently precise and shared vision of the periodic intervals at which inspections are to be carried out. An overrun of the anniversary dates (20%) is accepted by each of the parties and is taken into account in the planning, the responsibility for which is left to the contractor. A drift has become built into the performance of these inspections resulting in the deviation in this rate, which has gone from 20% to 29% and in inspections of rooms which will not be carried out.
- **coordination in the performance of inspections:** the approved body encounters difficulties in gaining access to the rooms to be inspected, which are due to permanent or one-off technical causes. Despite the feedback of information from the contractor on this point, no improvement in access to the rooms to be inspected is observed.
- **control over processes specific to the performance of inspections:** SORA, the IT tool for monitoring of sources, does not allow one to distinguish sources which are undergoing procedures of retrieval by their supplier. The approved body's inspection procedures are not adapted to the case of radioactive sources located in zone 4, in glove boxes and at height, due to the difficulty of access.

LESSONS LEARNED

The following measures were taken to avoid recurrence of this event:

- review of the procedure for monitoring and performance of external technical inspections in order to more precisely specify the roles and responsibilities of those involved, the drawing up of schedules, management of deviations, the procedure for management of sources, clarification and accessibility of the arrangements for inspection of sources,
- the reinforcement of coordination and communication between the operator and the approved body: the sharing of the schedule for inspections including the notion of anniversary date, methods of communication and providing information via a regular situation update between the contractor and the site allowing the sharing of specific indicators for the monitoring of the service, and
- the updating of tools with the possibility of having the SORA software updated.

Breach of containment during unloading of a drum of UO_2

THE FACTS

Presentation of the facility

At MELOX, decanting is one of the first steps in the fuel fabrication process. It consists of transferring the uranium oxide contained in a drum in powder form by gravity into a first assembly made up of an airlock and tank, then to transfer it by pressurization via a pipe into two storage and pre-dosing vessels.

Once the transfer is complete, the opening of a valve on the dispatch tank allows the pressure to be evacuated.

This workshop consists of two equivalent lines A and B. There are two points of difference between them: line A features the possibility of injecting nitrogen to facilitate the transfer of the powder and the transfer pipe is equipped with a transparent section allowing the circulation of the powder to be verified.

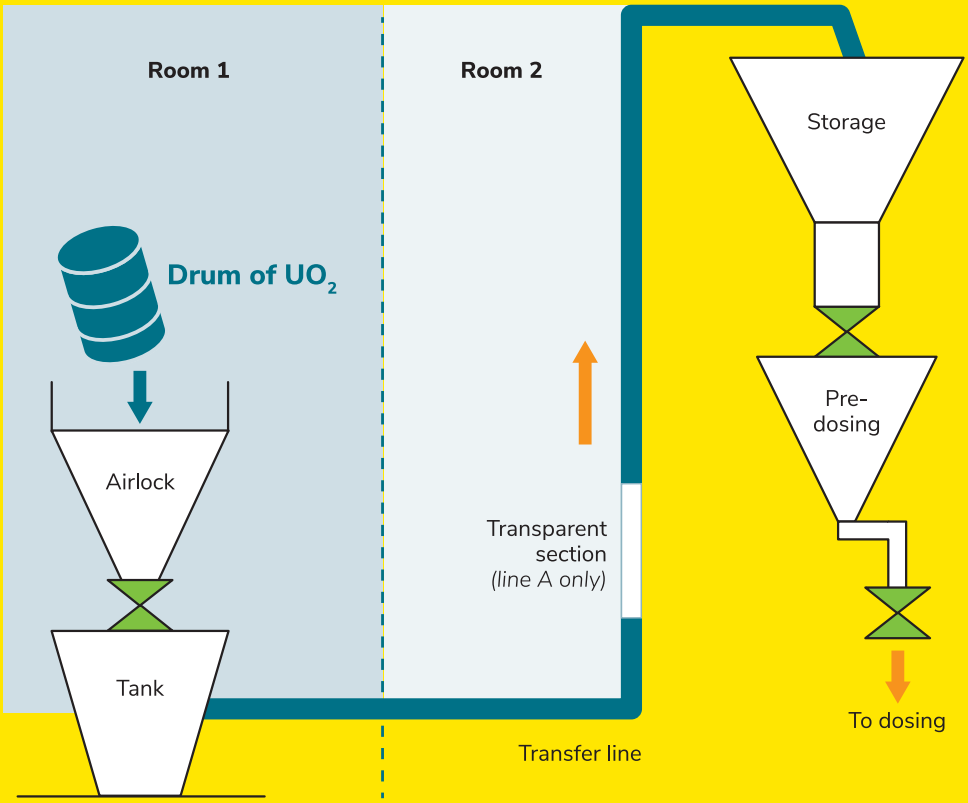
Sequence of events

On Friday August 16, a decanting of drum of UO_2 is scheduled to be performed on line B.

- Before starting the transfer, an operator goes to the room to check the circulation of the powder in the transfer pipe. The operator looks at the visible section of the pneumatic transfer line, in other words line A. He informs his team manager that there is no circulation, then requests him to activate the injection of nitrogen fitted to the supply tank of line A.
- Knowing that the specific visible section of the transfer line concerns specifically the supply of line A, whilst being unaware that the injection of nitrogen concerns only this same workstation, the operator requests and then obtains from his manager confirmation of the injection of nitrogen, which he activates. Still not seeing any powder circulating in the visible section, the nitrogen injection is re-activated a second time. Several moments later, the transfer of the powder is complete.

At the next workstation, a decanting of a drum of UO_2 starts on line A.

- When the nitrogen inerting procedure is launched, a "fire detection" fault is displayed. The fault is



then attributed to the remains of powder already present in the decanting airlock being put into suspension.
- After acknowledgment, the fault is cleared. The automatic inerting cycle, which has been relaunched, requests validation of the opening of the tank filling valve.
- Several moments after validation, a loud noise resonates in the room and an alarm is triggered on an α radioactivity measurement sensor.

The presence of UO_2 is confirmed by the radiation protection department around the filling airlock on the mezzanine and on the floor of the premises.

ANALYSIS OF THE TECHNICAL CAUSES

The breach of containment was caused upon the transfer of the volume of nitrogen under overpressure into the dispatch tank in the filling airlock (under underpressure), when the filling valve was opened. The speed of the transfer of the volume of gas under overpressure was not able to be immediately compensated for by the flow rate of extraction from the filling airlock causing an overpressure to build up in this zone of the sleeve.

In fact, the activation at the 1st workstation of the nitrogen injection gun generated a residual overpressure of 11 mbar in the dispatch tank, whereas the dispatch tank of line A is equipped with an automated locking system that is triggered above 15 mbar.

Moreover, it was not expected to check the pressure of the dispatch tank prior to opening of its filling valve.

ANALYSIS OF HUMAN AND ORGANIZATIONAL FACTORS

The human and organizational factors contributing to this event are as follows:
- **management of skills:** the team coordinator, not having completed his training, did not have a precise vision of how this facility works, the risks involved in the intervention and the type of verification to be performed depending on which line is in use. When he gave his instruction, the operator did not have the courage to call it into question despite the doubt that he had concerning the benefit of this verification, as he knew this line to be opaque,
- **preparation of the intervention:** the operator, who performs the checks, was not involved in the preparation of the intervention. He had to remain in the control room in order to ensure continuity of production at the time when that was being done. It was his colleagues, who took part in the preparation, who passed the information on to him subsequently. The operator was thus not able to fully appropriate the information brought to his knowledge about the intervention and the associated risks, which resulted in incorrect management of the injection of nitrogen. This breakdown in communication between operators also has an impact of course on both the quality and the quantity of the information transmitted,
- **operational documentation:** there is no operating procedure describing the use of the gun and the wording of the nitrogen injection instructions is ambiguous ("powder transfer"),
- **workstation ergonomics:** the principle of "guiding" users was not applied either to the design of the facility or to the operating phase to facilitate the correct performance of the technician's activity: indeed, there is no signage to indicate the tank concerned by the nitrogen injection.

LESSONS LEARNED

The following actions were taken to avoid recurrence of this event:

On a technical level,
- the lowering of the valve opening threshold from 15 to 3 mbar on both transfer lines,
- the addition of a check of the measurement of overpressure of the dispatch tank on both lines concerned,

On a HOF level,
- the reinforcement of raising awareness of the importance of communication on teams,
- the affixing of a label on the nitrogen injection control box on the line concerned.

Radiological inspection of a transport cask prior to processing at TRIADE

Radiation protection

The results of individual and collective dosimetric evaluations have remained stable and indicate that the risk at the general level is properly controlled.

The Group's activities are very diversified offering products, technologies and services in mining, uranium chemistry, enrichment, used fuel recycling, logistics, engineering and dismantling.

This broad diversity of activities generates high variability of radiological risks and potential situations involving personnel exposure to ionizing radiation.

To successfully carry out these activities in the Group's facilities, as well as in those of its customers, in France and abroad, employees of Orano and of subcontractors are protected against ionizing radiation and benefit from dosimetric monitoring suitable for the type of exposure.

Results

The results presented in this evaluation are calculated over 12 consecutive months for the Group's 13,305 employees who underwent individual dosimetric monitoring in 2019, 48% of whom are in France and 52% in mining abroad, and for 10,925 subcontractor employees working on these same sites and with the same distribution. The number of employees in areas marked for reasons of ionizing radiation in 2019 is slightly less than that in 2018, it being 2,200 on sites abroad.

Of Group employees, 69% who underwent individual dosimetric monitoring were classified as category B. This percentage is of the same order of magnitude as that for 2018.

ANNUAL AVERAGE DOSES

In 2019, the level of average doses for personnel monitored (taking into account zero doses or doses under the measurement threshold) remains more than 20 times lower the French regulatory annual limit of 20 mSv, and is identical to that for 2018.

Indeed, the **average dose over 12 consecutive months for the employees of Orano was 0.8 mSv and 0.5 mSv for subcontractor employees**, bearing in mind that these values are calculated based on dosimeters using different techniques (delayed-reading dosimeter for the personnel of Orano and electronic dosimeter for the personnel of subcontractors).

For Orano employees, the disciplines for which highest values were measured are those related to mining activities (2.5 mSv), work in glove boxes (2.2 mSv), as well as activities of nuclear departments carried out as part of maintenance operations on reactors in service, and activities related to clean-up and dismantling (0.8 mSv).

NON-ZERO DOSES[3]

In 2019, 46% of Orano employees and 64% of subcontractor employees received a dose above the measurement threshold. These percentages are comparable to those for 2018 (47% and 63% respectively).

Personnel who underwent dosimetric monitoring and for whom a dose above the threshold was measured, over 12 consecutive months, represent:

- 73% of the Group's employees and 90% of subcontractor employees with a dose below 2 mSv,
- 91% of the Group's employees and 97% of subcontractor employees with a dose below 6 mSv.

These percentages are identical to those for 2018.

The average value of the doses measured, leaving values below the measurement threshold out of the calculation, is 1.9 mSv for personnel of Orano and 0.5 mSv for subcontractors. This value is identical to that for 2018 for personnel of Orano and lower for personnel of subcontractors (0.7 mSv in 2018).

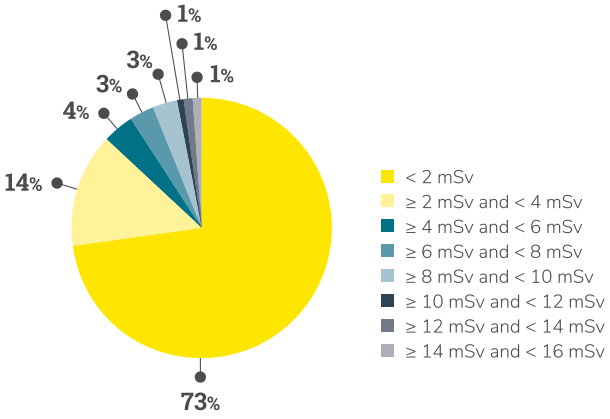


Figure 16: Breakdown of doses received over 12 consecutive months for personnel of Orano

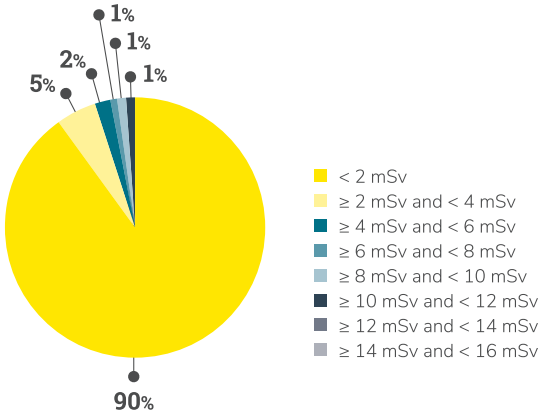


Figure 17: Breakdown of doses received over 12 consecutive months for personnel of subcontractors

COMPARISON WITH THE "PUBLIC DOSE" LIMIT

The dose of 1 mSv/year corresponds to the "public dose", in other words the maximum dose permissible for members of the public, fixed by the French regulations as being permissible resulting from human activities excluding natural radioactivity and doses received via medical treatment.

3 *Dose above the measurement threshold (related to laboratory measurement techniques or dosimeter electronics).*

Over the measurement period:

- 54% of the Group's employees and 36% of subcontractor employees for whom a dose was recorded that was below the measurement threshold,
- 65% of the Group's employees and 83% of subcontractor employees out of the total workforce monitored for ionizing radiation had a zero dose or a dose of less than 1 mSv.

MAXIMUM DOSES

40 employees of the Group and 3 subcontractor employees received a dose above 14 mSv over 12 consecutive months. This value, which is below the regulatory limit (20 mSv over 12 consecutive months), is a performance indicator set up by Orano.

It makes it possible to keep track of the change in the number of persons having received an effective dose for the whole organism of more than 14 mSv/year. A slight decrease in the number of persons with a dosimetry over 12 consecutive months of more than 14 mSv was recorded compared to 2018. The employees concerned all work in underground mines. The decrease observed between the two periods is explained by a reinforcement of preventive measures with regard to emanations of radon and radioactive dust generated at the workstation with a view to controlling ambient radiation.

These results are being monitored and actions which are compatible with the activities of the facilities are being taken in application of the principle of optimization of radiation protection in order to ensure that the dosimetry is at the lowest level possible, given the technical conditions, economic factors and the nature of the operation to be carried out, as required by French regulations (ALARA* approach).

The maximum dose over 12 consecutive months for Orano employees was 15.9 mSv and 15.0 mSv for subcontractor employees. These doses are of the same order of magnitude as for 2018 and below the maximum individual dose of 20 mSv over 12 consecutive months defined by French regulations.

COLLECTIVE DOSES

The collective and individual dosimetric evaluations for a maintenance operation are indispensable in preparing for this operation. The collective dosimetric evaluation is an indicator that varies according to the operation, which reflect the group's diversified activities.

In 2019, the collective dose, for all types of exposure, **was 11,234 H.mSv for Orano employees and 5,483 H.mSv for subcontractor employees.**

The dose due to internal exposure for Orano employees, as well as for subcontractor employees corresponded to around 26% of the effective dose.

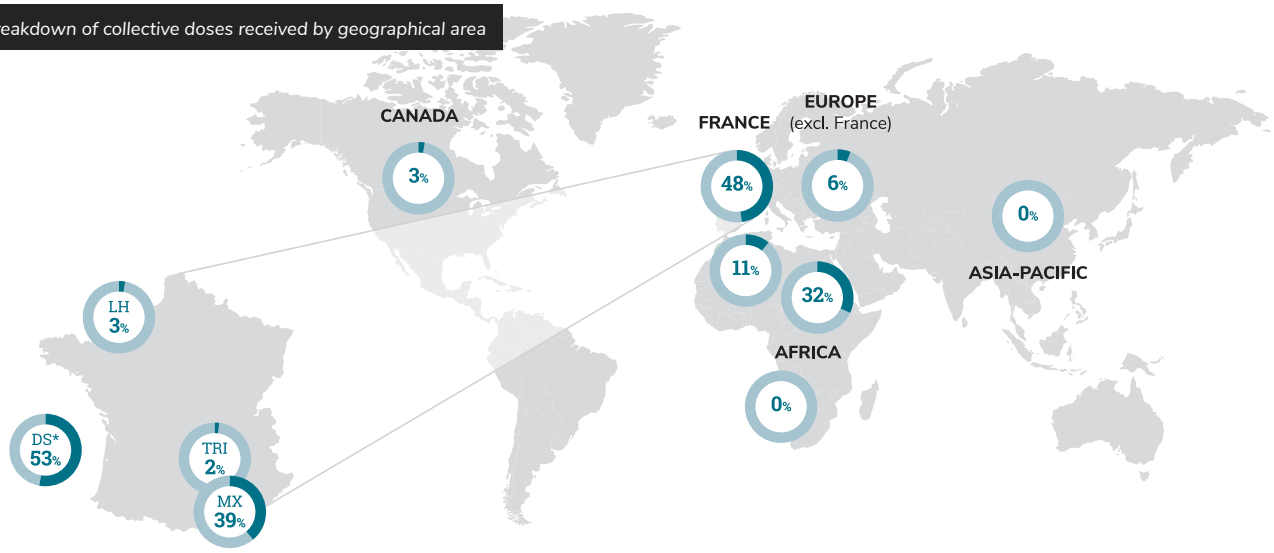
This proportion was around 50% for mining activities: indeed, the internal dose originates from the operations of the COMINAK mine (Niger), and is generated by the radioactivity of decay products of uranium and thorium inhaled in the form of dust and radon.

The geographical distribution by entity of collective doses for personnel of the Group is shown on the map below.

Significant events

During the year, **19 significant events concerning radiation protection**, classified at level 0 on the INES scale, were declared. This number of events is of the same order of magnitude as that for the previous year.

Breakdown of collective doses received by geographical area



(*) *multi-site departments*
Other contributors 3%

These events are broken down equally between incident-related exposures, non-compliance with access rules in marked areas and failures or inspection of radiation protection.

They show the importance of primary radiation protection prevention, which is based on the prior evaluation of risks.

While the results in the area of radiation are still satisfactory, vigilance without banalization of risk is something that we need to remain rigorous about. Operating feedback provides essential data for the improvement and checking of performance in radiation protection. To this end, the approaches already embarked upon are continuing to be pursued, particularly those concerning the definition of personal protective equipment particularly in hot atmospheres, the taking into account of the asbestos risk associated with that related to ionizing radiation, prior evaluations at workstations with estimation of dosimetry and definition of dose constraints, the taking into account with pragmatism of new requirements of the French Labor Code with the aim of simplifying procedures.

Changes in regulations

2019 was particularly rich in changes to regulations, requiring considerable work to be done by specialists from Orano and operators on applying and re-appropriating the changed regulations.

Employee undergoes a radiological inspection

THE "WORKERS" DECREE AND ITS APPLICATION TEXTS

In application of French Decree No. 2018-437 of June 4, 2018 known as the "Workers" Decree, which modifies the general radiation protection measures applicable to workers likely to be exposed to ionizing radiation, two application texts were published in 2019 and one was published at the start of 2020. The provisions of this Decree were supplemented in advance by a joint instruction issued by the ASN and the French Directorate-General of Labor (Direction Générale du Travail – DGT) under reference No. DGT/ASN/2018/229 of October 2, 2018.

The French Order of June 26, 2019, known as the "SISERI Order" ["Arrêté SISERI"], specifies the conditions for conducting individual monitoring of the exposure of workers to ionizing radiation.

Entities of the Group including dosimetry monitoring laboratories are studying the impacts on their dosimetry monitoring processes for personnel. Effectively, whatever the type of exposure (whether internal or external), individual dosimetric monitoring must be entrusted to accredited bodies to guarantee the quality and independence of the measurements and analyses carried out(dosimeter readings or medical analyses). The approval of dosimetry laboratories and of medical biology laboratories granted by the ASN in addition to accreditation has been discontinued.

The French Order of December 18, 2019 specifies the implementation conditions for the radiation protection advisor and the arrangements for training of the radiation protection officer and for certification of radiation protection training bodies and bodies with competence for radiation protection.

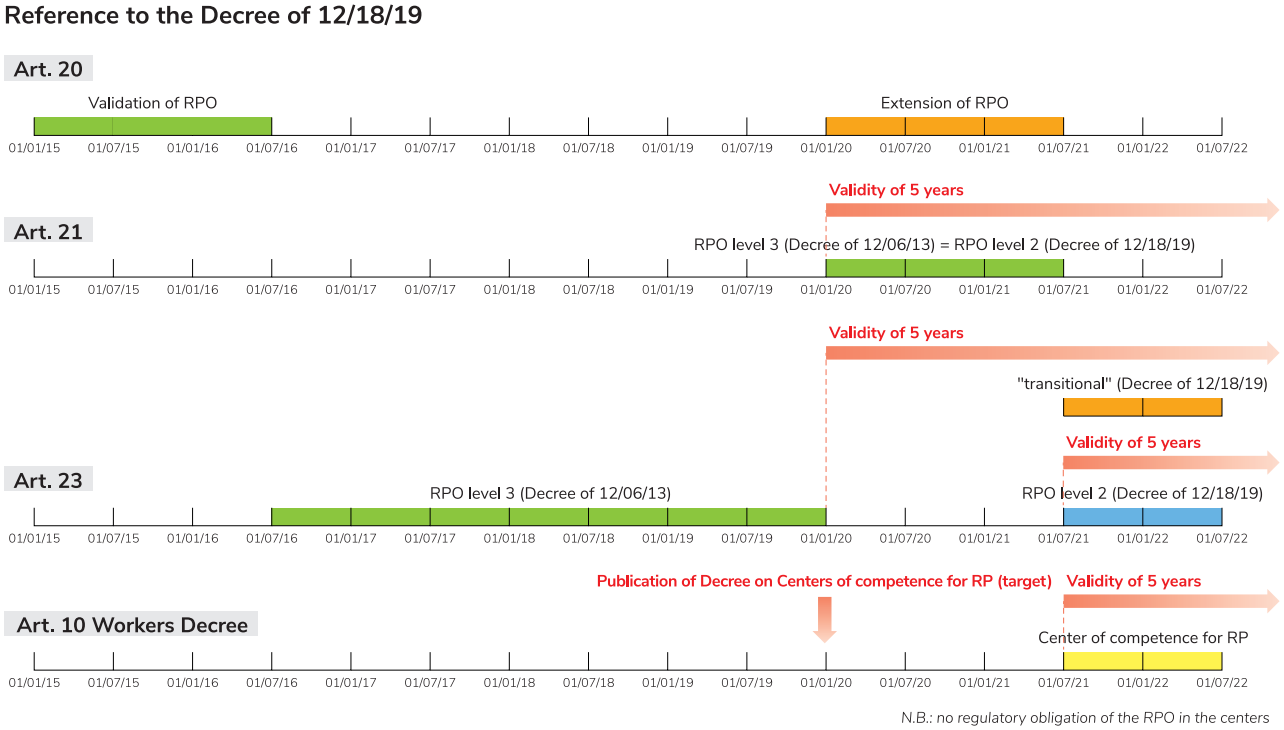
By way of reminder, the employer has to designate at least one radiation protection advisor for the implementation of measures and resources for the prevention of risks of exposure to ionizing radiation. This person is a "prevention specialist" who intervenes as an advisor to the employer on questions relating to radiation protection. In addition to his advisory missions, he participates in the implementation of measures to protect the health and safety of workers.

Transitional measures are defined in the "Workers" Decree and in the Order. They are illustrated in the form of a diagram below.

A restricted work group with radiation protection officers from the different entities of Orano has been implemented in order to validate internal standards of application for the Group.

The French Order of January 28, 2020, also known as the "Zoning Order" ["Arrêté zonage"] modifies the conditions for the delineation and signage of areas

Application of the regulations concerning the training of the advisor and the employer in radiation protection: transitional measures



subject to monitoring and inspection and areas which are specially regulated or prohibited given the exposure to ionizing radiation, as well as rules of health, safety and maintenance. This revision of the text provides a simplification of the radiological zoning, signage adapted for exposure of the lens of the eye and delineation of a "radon area" where necessary.

It would also seem to be important to re-examine the provisions of the "Workers" Decree, which have a potential impact on Orano's activities.

Poster raising awareness of exposure to the crystalline lens of the eye

The exposure value for the crystalline lens of the eye is going to be lowered from 150 mSv/year to 20 mSv/year by 2023. A transitory measure has been in application since 07/01/2018 with a cumulative limit value fixed at 100 mSv over five years, as long as the dose received during the course of a year does not exceed 50 mSv.

On the basis of the internal guide published in 2019, entities of the Group are deploying the methodology defined for the dosimetric estimation of exposure of the crystalline lens of the eye and the recording of the dose for personnel identified as potentially exposed to a dose greater than 15 mSv.

This monitoring is carried out by the employer with the support of the dosimetry body and of the radiation protection advisor based on the crystalline lens dosimeter worn as close as possible to the eye. When working conditions do not allow a crystalline lens dosimeter to be worn, such as for example when doing glove box work at MELOX, the employer defines an alternative method allowing the dose received at the crystalline lens of the eye to be extrapolated from that measured for the whole organism. It then demonstrates that the chosen method provides the same reliability as that based on the measurement of the dose to the crystalline lens. This demonstration is currently being performed at MELOX, along with the implementation of collective measures and individual protective measures (radiation protection glasses), where necessary.

The reference level of the concentration of radon gas in air, which is defined as the level "above which it is judged inappropriate to allow exposures of workers to ionizing radiation", is fixed at 300 Bq/m^3 as an annual average.

The internal guide distributed in 2019, details the applicable methodology for the assessment of risks related to professional activities in the configurations where the exposure to radon is liable to have a harmful effect on workers' health and the measures to be taken when the exposure is liable to exceed an effective dose of 6 mSv/year.

It should be remembered that these elements must be communicated to employees of Orano who intervene on sites and at facilities not owned by Orano.

The arrangements for carrying out **technical verifications of workplaces and work equipment**. Thus, instead and in place of the technical radiation protection inspections until now carried out by bodies approved by the ASN, an initial verification carried out by bodies newly accredited for this purpose is now envisaged.

The modification of arrangements for access to supervised areas and controlled areas. Access to orange and red controlled areas is limited solely to classified workers authorized individually by the employer. A worker can have access, subject to conditions, to a supervised area, yellow controlled area or to a radon area without having to undergo classification in category A or B.

In this respect, an internal procedure describes the rules applicable for the management and access of non-classified personnel to supervised or controlled areas on the Group's sites in France. This procedure, which is going to be deployed at the Group's French entities during the course of 2020, will lead to the classification of employees being revised based on the evaluation of annual doses at their workstation and to a position which is aligned in compliance with regulations being defined (evaluation of the forecast dose, authorization from the employer, traceability of doses).

Certain terms of application of the decree are still to be specified by application decrees (8 decrees are to be issued). An organization into restricted work groups with radiation protection officers from the different entities of Orano remains in place in order to define standards of application for the Group.

AN EXPERIMENTAL WORKSITE

After several months of studies conducted at the initiative of nuclear operators, a French Decree dated April 9, 2019 authorizes the use of an **experiment** consisting of carrying out experimental worksites involving a **combined risk of exposure to asbestos fibers and ionizing radiation**.

This experiment is being conducted by the nuclear operators Orano, CEA and EDF within the framework of an application file for an opinion from the French commission for the assessment of technical innovations in the field of the detection and processing of asbestos in construction (CEVALIA). The aim is to **assess the effectiveness of an alternative decontamination procedure** to the water dousing decontamination procedure. Indeed, on certain worksites where there is dual contamination due to asbestos and radiation, the use of water aggravates the professional risks and is detrimental to the protection of the interests mentioned in Article L. 593-1 of the French Environmental Code.

The alternative proposed by the operators relies on the **use of a colored fixative** which makes it possible to impregnate the asbestos fibers on personal protective equipment (PPE) so as to avoid them being put back into suspension in the air upon doffing of PPE and to check for absence of transfer of contamination.

In addition to this, the operators propose **specific arrangements for the wearing and doffing of PPE** when performing asbestos removal operations.

2020 must be put to use to test an experimental worksite at Orano.

Meeting of radiation protection network

Sampling in the vicinity of McCLEAN LAKE (Canada)

Management of impacts on the environment

To check that our activities do not impact populations, ecosystems, or biodiversity, we conduct permanent monitoring, relying on our recognized human and technical expertise. The data acquired and its interpretation are systematically shared with the stakeholders via public reports and collaborative appraisals.

Results in terms of radiological impact

The annual radiological impacts (or dosimetric impacts) of releases from Orano Cycle's large nuclear sites remain at **very low levels**[4]: 0.08 µSv for the TRICASTIN site, 11.5 µSv for the LA HAGUE site, and less than 0.001 µSv for the MELOX site. These values should be compared with exposure associated with other sources of natural or artificial radiation, and the regulatory limit value for the public of 1000 µSv per year of dose added by nuclear activities.

This very low impact is the result of constant progress over time in terms of treatment at the source and control of releases in the environment. The vigilance of our teams remains a priority in the context of organizational changes underway within the group.

These overall results are published in the informational reports prepared by nuclear sites under Article L. 125-15 of the French Environmental Code (Code de l'Environnement)[5].

Results in terms of chemical impact

With regard to the release of chemical substances, the health impacts around Orano sites are **below reference values**, as assessed with the methods recommended by the French ministry of ecological and interdependent transition, the national institute for industrial environment and risks (INERIS), and the institute for public heath surveillance (InVS).

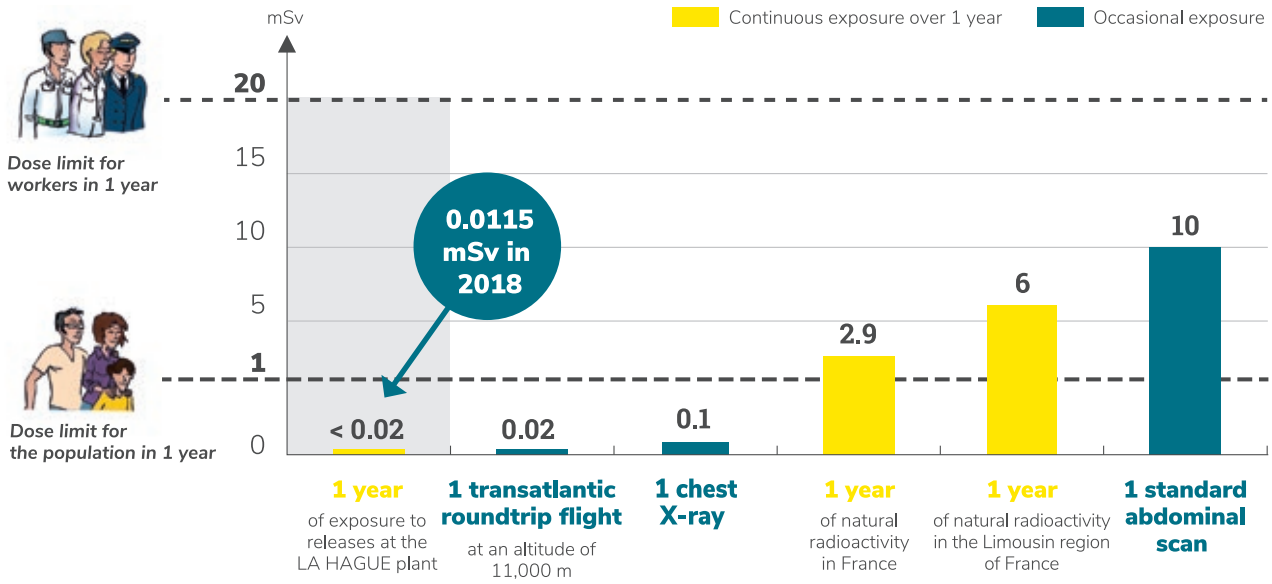
The hazard quotients for threshold effects are less than 1 and the excess individual risks for non-threshold effects are below 1/100,000, whatever the exposure scenarios of local residents and the age categories considered.

Reliability continuously monitored

To guarantee the reliability of the different checks performed, implementation of periodic cross-checking between the various measurement laboratories is required by regulations.

These checks concern part of the measurements conducted by the operator, and are performed by the LA HAGUE and TRICASTIN sites with the IRSN* laboratory in LE VÉSINET. The summary reports on these cross-checks verify the consistency between the various results obtained, and are submitted annually to the ASN.

Conducting cross-checks properly is one of the key points in order that internal laboratories (which ensure release monitoring) obtain ISO 17025 certification, in compliance with the requirements of the ASN* decision No. 2013-DC-0360 of July 16, 2013, as amended.



Comparison of the dosimetric impact of releases from Orano La Hague with different types of exposure

4 *Evaluated based on real releases authorized for 2018.*
5 *These reports are available on the Orano website: https://www.orano.group/docs/default-source/orano-doc/groupe/publications-reference*

Taking climate change into account for our facilities

As an operator of industrial facilities, Orano's primary responsibility is to control and reduce its environmental footprint in order to limit its impact on the environment.

A review of the results recorded over more than 10 years shows that Orano has reduced its environmental footprint very significantly. In particular, the consumptions of water and energy have reduced by 93% and 91% respectively, and direct greenhouse gas emissions (scope 1) fell by 75% between 2004 and 2018 (raw data for the same industrial base).

In terms of the facilities' vulnerability, their design takes into account extreme weather conditions and earthquakes. However, climate change does not simply mean the occurrence of extreme events that might jeopardize the facilities' nuclear safety. Such change is in fact associated with disturbances of various kinds, more or less slow and gradual, which could impair our ability to operate our sites in compliance with the current operating standards.

In order to assess regional trends for the forthcoming decades, the Group has carried out an internal study of expected future rainfall and temperatures, based on the available climate models. Meteorological data from our sites has also been analyzed, in order to assess the observed trend over the last 20 years.

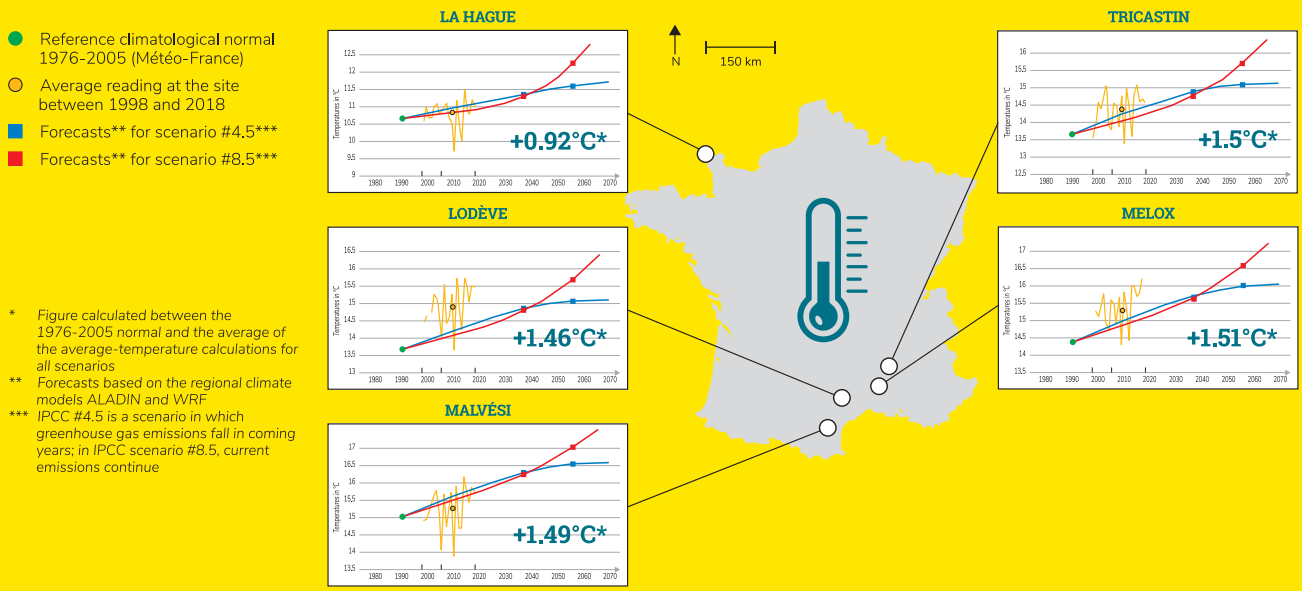
The study of rainfall around our site showed no clear trend for the coming decades, but already shows greater variability, with some particularly wet and other much drier years which may follow in succession. Episodes of drought may become increasingly long, causing reduced flow rate and slower recharge of bodies of both surface and groundwater.

A more detailed analysis of the average and maximum temperatures near our sites shows a slight overall increase (between + 0.2°C and + 1.3°C) over the last 20 years compared with the standard reference temperature (excluding 2019). This increase is more significant for sites in the south of France.

An analysis of the regional climate forecasts for the next few decades shows that irrespective of the scenarios chosen, the trend will continue. The temperature rise may reach between + 0.9°C and + 1.5°C by 2050 (compared with the reference standard). The main risk is an increase in the number and intensity of heat waves. Cold spells, on the other hand, will become less and less frequent and weaker.

Orano will therefore consider how to integrate these changes in terms of the periodic reviews and the reference material used when designing new facilities.

Past and projected temperatures at Orano sites in France



* *Figure calculated between the 1976-2005 normal and the average of the average-temperature calculations for all scenarios*

** *Forecasts based on the regional climate models ALADIN and WRF*

*** *IPCC #4.5 is a scenario in which greenhouse gas emissions fall in coming years; in IPCC scenario #8.5, current emissions continue*

Dismantling operations, LA HAGUE

Dismantling operations

Dismantling activities continued their ramp-up, underway for several years on the LA HAGUE and TRICASTIN sites. These large-scale and complex programs mobilize numerous skills to ensure compliance with the milestones set by the Safety Authorities.

The administrative processes for requesting a dismantling authorization continued on both the LA HAGUE and TRICASTIN sites, with the processes for examining applications for partial dismantling of INBs no. 33, no. 38 and no. 93, the publication of decree for the dismantling of INB no. 105, authorizations for the dismantling or cleanup of the Main Laboratory, Waste Treatment Plant, TU2-TU3 and "Parc P60" individual facilities, and authorizations for the remediation of the north-eastern mounds ("buttes") and of P04 at the PIERRELATTE INBS.

Finally, the administrative process for the decommissioning of INBs no. 65 and no. 90 on the SICN site at VEUREY-VOROIZE concluded with the approval of the two ASN decommissioning decisions by of the Ministry for Ecological and Inclusive Transition.

Facilities nearing the end of dismantling or in reindustrialization

VEUREY-VOROIZE AND ANNECY SICN SITES

For the site at Veurey-Voroize, the administrative process that started in 2014 at the end of dismantling operations for the two INB nos. 65 and 90 reached its term in 2019 when they were decommissioned in the sense of Article L. 593-30 of the French Environmental Code.

In conjunction with the decommissioning process, the plan to establish public-utility easements (Servitudes d'Utilité Publique - SUP) on the land of INBs nos. 65 and 90 was approved by the Local Information Commission and the neighboring communes. The public was then invited to comment during a public inquiry organized by the Prefect of the Isère Departement. The Investigating Commissioner pronounced in favor of establishing the SUPs, so that the plan could be presented to the Departemental Council for the Environment and Health and Technological Risks (CODERST) for the Isère. The Council pronounced in favor of the draft Prefectorial Order, which was published on October 1, 2019, reference DDPP-IC-2019-10-01.

Following its publication, the College of the French Nuclear Safety Authority (ASN) gave an initial favorable opinion on the two draft decommissioning decisions, including the Prefectorial Order referred to above. The ASN gathered observations from the general public on both drafts, and the College of the ASN then gave a second favorable opinion, authorizing the publication of Decisions 2019-DC-0680 and 2019-DC-0681 dated October 29, 2019, relating to the decommissioning of INBs nos. 65 and 90. The two decommissioning decisions were formally approved in Decrees on December 12, 2019.

The decommissioning of the two INBs and the creation of the public-utility easements will enable the total re-industrialization of the site to be completed, in partnership with the industries that already occupy over half the site's area.

The site at Annecy of the company manufacturing nuclear fuel (SICN), which ran nuclear activities under the regime for Installations Classified for the Protection of the Environment (ICPE), has been rehabilitated. Three companies on this site run manufacturing or energy-production activities for local authorities, and one of them plans an extension to increase capacity.

MIRAMAS SITE

The renovation of the Miramas site following the dismantling and decontamination work is continuing with the sale of all the plots for industrial use, in two lots:

- the western area was sold in April 2019 for a solar farm project, with operation planned to start in mid-2020,
- the central area is being decontaminated. At the same time, discussions are underway on the site's sale and industrial re-development.

Facilities undergoing dismantling work

INB NOS. 33, 38, 47, AND 80 - LA HAGUE SITE

Studies and construction for waste recovery and conditioning (RCD) and for dismantling (DEM) continued during 2019 at the 4 INBs undergoing dismantling.

The significant events that occurred during the reporting period were mainly the following:

- the cleanup and dismantling of the overhead crane in a cell of the high oxide activity (HAO)/South facility in preparation for its replacement by two service cranes,
- the carrying out of the worksite to lift the slabs and reduce their volume in the high activity dissolution extraction (HADE) facility,
- the carrying out of the first batch of rinsing of the 1st loop (out of three planned) of the high-radioactivity fission products (HAPF) facility,
- deployment on four worksites in parallel to the dismantling of the cells of the wet process of the medium-radioactivity plutonium (MAPU) and medium-radioactivity uranium (MAU) facilities,
- the recovery of sludges from the bottom of the cells containing the settlers of the STE2 facility,
- the final modifications to the process for recovering and conditioning the waste from silo 130, then

producing the first bundles in order to fill the first drum,
- the completion of the civil-engineering work on the waste-recovery unit for the high-oxide-activity silo. The installation of mechanical process equipment and the work required to recover and condition the hulls and end-pieces is well advanced, and the testing and adjustment of the components is underway. The studies for the recovery operation from the floor of the silo are in progress,
- the preparatory operations for the alterations to the roofs of sludge-containing silos are continuing, in order to install the new equipment required to recover them. Silo 16, which is empty, has been opened to start the alterations to allow sludge-recovery tanks to be installed.

In parallel with this work, the preparatory studies for forthcoming operations have been continued:
- the studies on the processing of fine-grade waste (Déchets de Fines de Granulométries - DFG) have enabled the design of the recovery process to be finalized, while the studies on the civil-engineering work have led to changes in some of the design options, and hence amendments to the construction dossier;
- as regards sludge recovery and conditioning, the research into an alternative process, focusing on recovery in the shortest time while complying with the imposed restraints, is well advanced. This process, which uses a centrifuge to separate the sludge from some of the water and stores it temporarily in cans, has undergone cold testing at the pilot facilities which confirmed the choice of this option; and
- the process for the treatment and conditioning of graphite and magnesium waste from silo 115 has been shifted to a simpler recovery process by machine sorting then interim storage or conditioning for disposal via tried-and-tested channels where possible, confirmed by the feasibility studies carried out. This new approach was presented to the ASN in 2019 and will be the subject of a safety-options report in 2020.

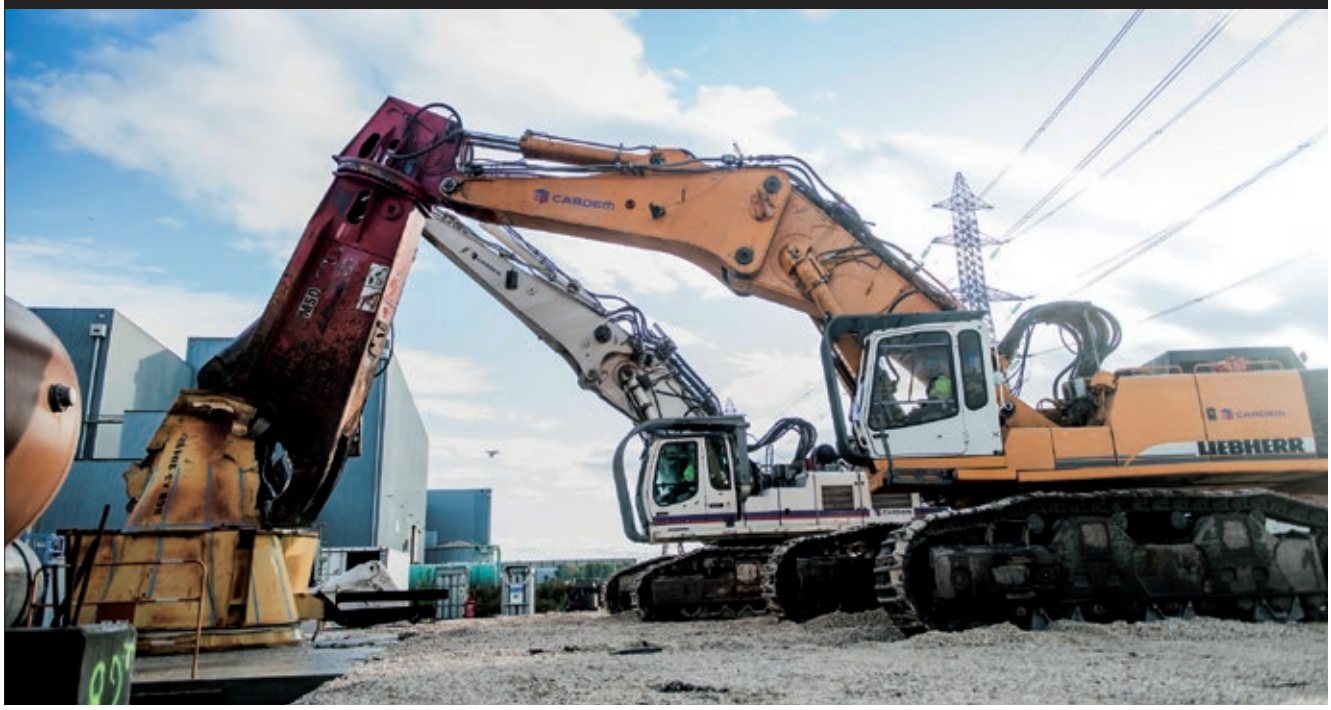
As regards regulation, the notices attached to the files requesting authorization to dismantle part of INBs nos. 33 and 38 were updated during the first half of 2019. The recommendations and the observations in the opinion delivered by the French Environmental Authority on the quality of the impact studies for these requests will be incorporated into the dossier for the public inquiry.

Decision 2019-DC-0673 from the ASN on June 25 2019 defined the provisions that will apply to INBs nos. 33, 38 and 47 in the light of the conclusions from their periodic review.

INB NO. 93 - GEORGE BESSE PLANT - TRICASTIN SITE

The administrative process for authorization to dismantle INB no. 93, which began in 2015, finally resulted in publication of the dismantling decree, on February 5, 2020.

Georges Besse I: a pilot work site for cutting operations



The preliminary-design studies continued in parallel with the authorization process, and included a pilot testing program using new equipment not in use when the plant was operational. The test results were used to qualify the thermal- and mechanical-cutting techniques for the main items of equipment to be dismantled.

INB NO. 105 - CONVERSION FACILITY - TRICASTIN SITE

The administration process to authorize the dismantling of INB no. 105 was completed on December 18, 2019 with the publication of Decree 2019-1368 on December 16, 2019, directing the company Orano Cycle to start the dismantling operations. These operations are divided into four stages:

- the reconditioning of the drums and the removal of the radioactive substances kept in storage areas 61 and 79,
- the dismantling of structures 2000 and 2450,
- the dismantling of the plant chimney and the final cleansing of the buildings and storage areas, and
- the final remediation of soils that might have been contaminated because of the activities carried out at the facility, in order to reach the final target condition.

The dismantling operations must be completed at the latest by December 31, 2034.

UF_6 conversion workshop, TRICASTIN

PIERRELATTE INBS - TRICASTIN SITE

The process and operations to dismantle and cleanse the INBS at Pierrelatte continued in 2019. In particular:

- the authorizations were obtained to dismantle the Principal Laboratory and Waste Treatment Plant individual facilities, and to cleanse the individual facilities TU2-TU3 and P60,
- operations that started in 2017 to demount process equipment in the individual facility Transfer & Sampling (Transfert et Échantillonnage - TE) was finalized,
- operations to remove asbestos from civil-engineering structures in the TU2-TU3 individual facility started, in preparation for the cleansing operations before it is decommissioned,
- the operations to install a reversible impermeable cover on and a connection to the collection and infiltration basin for run-off water were completed for the authorized extension to the scope of the ICPE “Storage of old waste at the Pierrelatte site”,
- operations started to demount equipment in the Principal Laboratory individual facility,
- the administrative process to refurbish installations in the site’s north area continued, as part of the protocol for the transfer of ownership between the CEA and Orano,
- operations to install a reversible impermeable cover on the mound located near the P04 storage area were completed.

ROASTING FACILITY - MALVESI SITE

Operations to remove equipment then demolish the structure of the former roasting facility for waste and metal chips of natural uranium, which commenced in 2018, were completed at the start of 2019, with:

- the recovery of uranium residues from the process systems (furnaces, filters, effluent networks, etc.),
- the removal of the process equipment and utilities, cutting down to size and conditioning in VLL waste packages with a view to disposal at the ANDRA CIRES facility,
- cleanup then removal of cladding and of the metal structure of the building.

Initial operations for the refurbishment of the former magnesiothermic workshop were carried out in 2019: the roofing was waterproofed, opening windows secured, stored waste removed, and the preliminary diagnostics for the work performed.

Transportation of CBF-C1 packages, LA HAGUE

External transportation activities

Industrial performance requires perfect control of transportation flows for radioactive materials, whether their destination is our customers or our sites, and regardless of who produces them. The transportation operations are thus carried out with safety objectives that are identical to those set for the facilities.

Supervision of transportation

Nuclear safety in relation to shipments of radioactive materials requires a defense-in-depth approach based on the principle of three barriers: safety of design, manufacture and maintenance of the casks, reliability of the transportation operations, and the preparation of response in the case of degraded situations.

A RISK MANAGEMENT PROCESS

The management of activities involved in the constitution and shipment of packages, through to delivery to the recipient, is based on an internal process known as the "Managing transportation risk supervision" process, coordinated and implemented by the Nuclear Packaging & Services BU (Emballages Nucléaires & Services - EN&S).

This process completes the application of national and international regulations on the safety of radioactive materials transportation. It takes into account the management of all risks, within a broader scope than that of safety and radiation protection.

The process of supervision is thus broken down into three areas:

- upstream of transportation, by definition, the implementation of a common baseline and permanent deployment of risk analysis,
- in an operational framework, by the monitoring of transportation activities on sites, but also anywhere that activities are carried that impact safety, and
- in the event of an incident or accident, by management of degraded situations.

The review of the process in 2019 assessed its performance and identified one main area for improvement: spot checks at the sites where Orano is the dispatcher, in addition to the spot checks of its transport service providers that the Group already performs.

Common documentary baseline

The definition and implementation of a common documentary baseline provides a shared framework within the group. It mostly comprises texts applicable to the transportation of radioactive and nuclear materials, and two major directives that cover the safety of transportation of radioactive materials and the compliance of packages.

In 2019, the baseline of texts applicable to radioactive and nuclear materials underwent work to update it to take changes to regulations into account:

- the Order of May 29, 2009 relating to the transportation of hazardous goods by terrestrial highways (known in France as the "arrêté TMD"), revised on two occasions,
- the European agreement relating to the relating to the international carriage of dangerous goods by road (ADR) - 2019 version,
- the regulation on the international carriage of dangerous goods by rail (RID) - 2019 version,
- the European agreement relating to the relating to the international carriage of dangerous goods by inland waterway (ADN) - 2019 version,
- technical instructions for the safe transport of dangerous goods by air (ICAO) - 2019 version,
- the regulation on the carriage of dangerous goods (IATA) - 2019 version,
- the international maritime dangerous goods code (IMDG code) - 2018 version applicable in 2020.

A bulletin is addressed to transportation safety advisors in Group entities each time a regulatory text changes, to ensure that such changes are reflected in operational practice.

Risk analysis

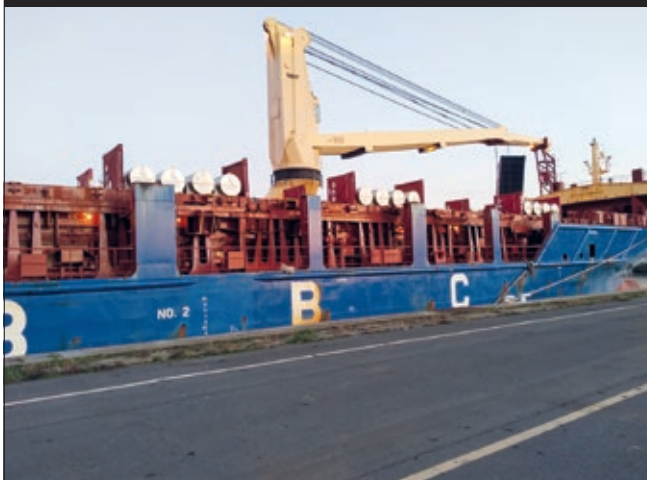
The risk analysis approach first involves identifying and analyzing all of the transportation flows. For 2019, around 800 transportation flows, involving around 4,000 transportation operations, were active. They concerned 15 of the group's sites.

Transportation flows undergo exhaustive data collection to then evaluate their risk level. This risk analysis may include evaluations on the ground, or road surveys.

These studies require diverse types of expertise: organization of transportation, regulatory watch, safety, security, loading and stowage, or informing the public.

They also include the validation of ships that the group's entities may need to load with radioactive waste. In 2019, 30 ships were analyzed.

Loading of a vessel chartered to transport enriched UF_6



Delivery of enriched UF_6 for the IAEA's use

Based on these processes of analysis and validation, the following activities took place in 2019:

- the delivery of two fuel-assembly reloads for foreign operators,
- the delivery of enriched UF_6 on behalf of the IAEA's LEU[6] Bank, and
- the recommencement of transportations of enriched UF_6 to the United States, with 4 dispatches to American fuel manufacturers.

The supervision of transportation

On shipping and destination sites, as well as in the areas of transshipment (such as ports and airports), a qualified team of inspectors is deployed to monitor the preparation and shipment of packages at the group's sites, as well as the activities performed by service providers, in all countries concerned.

The number of inspections assessed as Not Satisfactory (NS), a figure used to evaluate how well transportation is controlled, has reduced, from 5% (of 210 inspections) in 2018 to 3% (of 273 inspections) in 2019. This outcome was achieved through constant focus on the search for low-level trends, measured by the rate of Not Totally Satisfactory or NTS inspections: 28% in 2019 (27% in 2018).

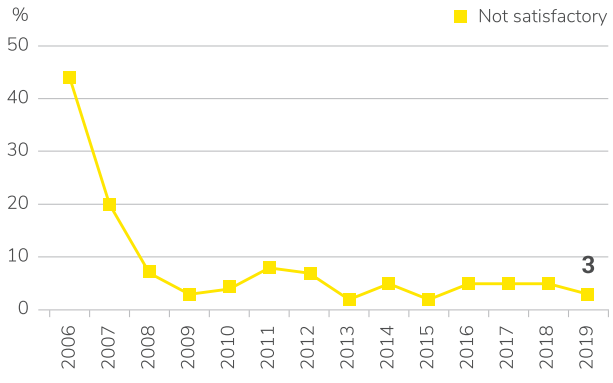


Figure 18: Changes in the level of "not satisfactory" inspections

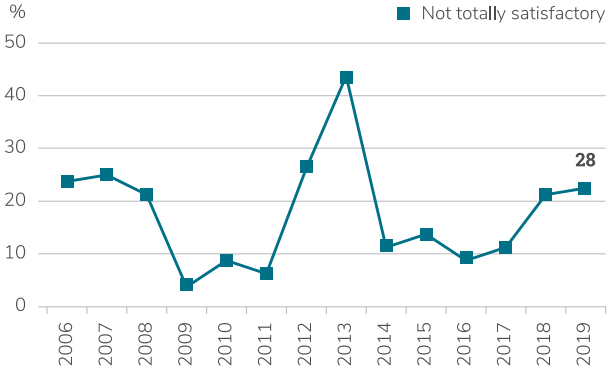


Figure 19: Changes in the level of "not totally satisfactory" inspections

In addition to inspections on the ground, audits of the group's sites and those of suppliers are conducted to evaluate the performance of existing organizations and processes. In 2019, 38 audits were carried out (3 for the sites and 35 for suppliers).

Management of deviations

The level of transportation control is also measured by the number of significant events declared and their level of classification.

In 2019, 23 significant events classed level 0 on the INES scale involved means of transport circulating on the public highway where a Group entity had either dispatched or was to receive the goods (25 in 2018).

Of these events, 18 were reported by a Group entity (21 in 2018) and 11 had causes involving either a Group entity or one of its subcontractors (15 in 2018).

The events involving an Orano entity or one of its subcontractors were essentially errors in preparing the consignment (2) (error in labeling / signing and in the measure of dose rate); in the package (3) (conformance of the bolt securing the crown, insufficient tightening of the packaging sealing (but no loss of seal), and a deviation in some of the volumes of openings useful for calculating leak rates); errors in package delivery (3 consignments from the activity standards laboratory); and point-source contamination identified in the containers (3) (2 consignments from COMINAK and 1 from KATCO).

Management of degraded situations

In case of a degraded situation requiring it, the NP&S BU sets up and coordinates the activation of the transportation emergency and response plan (PUI-T). This plan requires in particular the mobilization of: 1) a command and local decision center (PCD-L) of the BU that interfaces with the command and national decision center (PCD-N) of

the group, and the PCD-L of the site; 2) as shipper or receiver,a technical unit; and a communication unit. This plan also involves sending out specialists to the site of the accident, to the customer, and, if the event occurs in France, to the relevant prefecture.

The plan is tested during internal crisis-response exercises, some of which simulate accidents taking place outside France.

In 2019, the NP&S BU ran or participated in 14 large- and small-scale transportation-crisis exercises, within the Group and externally, centered both on nuclear safety and physical protection. For instance, on November 14, there was a national nuclear-safety exercise called TMR 63 *(see the box on page 61)*, with the Puy-de-Dôme Departement. There was also a national physical-protection exercise, directed by the French Ministry for the Ecological and Inclusive Transition (MTES), the French Institute for Radiological Protection and Nuclear Safety (IRSN) and the French National Institute for the Advanced Study of Security and Justice (INHESJ) in which all those involved in the transportation of used fuel from a nuclear power plant participated.

Training in the area of transportation

Training activities outside the Group continued, as in the previous year.

For the seventh year, the BU contributed to the training delivered by the INHESJ of staff from local authorities responsible for mobilizing the Prefectures' regional operational civil protection centers. The Group's on-call managers took part in the training, to give them a better appreciation of public authorities' expectations of operators involved in transportation. In 2019, the BU helped to organize a crisis scenario in which two on-call managers from Orano participated as trainees in the operation of an operational civil-protection centre.

The Group has also, for the third consecutive year, taken part in the training at the French National School for Fire Service Officers (ENSOSP) for technical advisers to the regional Departments for Fire and Rescue Service (DDSIS) and Prefects. This involvement gives participants a better understanding of the constraints of responders but especially a better understanding of the role of operators in the civil security response organization (ORSEC) and the ways in which they can support responders. In 2019, the BU participated in three training sessions (including two exercises involving the transportation of radioactive materials (TMR)) in which team members from the crisis BU acted as instructors and observers.

Arrival of fuel at the VALOGNES railway terminal

A full-scale crisis exercise

As part of the Group's program of transportation-crisis exercises, we ran a crisis exercise involving teams from the SOMAÏR, the Mines BU and the NP&S BU.

The exercise related to the road transportation of drums of uranium concentrates in a 20-foot ISO container leaving the SOMAÏR's mine for the port of Cotonou, where it was to be loaded on a ship for France for forwarding to the Malvési conversion facility.

Following a simulated road accident causing a loss of containment after drums were ejected from the container, the objective was to test the alert system, the analysis of the accident situation and the scheduling of the decontamination work and the recovery of the packages and the dispersed material, and also the physical intervention of teams from the SOMAÏR and the BU in Niger at the scene of the accident. Five internal Group entities between Niger and France were mobilized (including three crisis centers: PCD-L at SAINT-QUENTIN-EN-YVELINEs, PCD-L at the SOMAÏR and the regional PCD at NIAMEY), and each contributed its decision components, technical assessments and field work. Almost 50 staff were occupied for a period of six-and-a-half hours. The exercise was also intended to test the alerting of the public authorities in Niger, who dispatched staff to the field from the Departemental mining department, the Departemental environment department, the fire & rescue service and the police. This enabled constructive exchanges with the Orano teams present in the field.

Crisis-management exercise in Niger - Situation in the field

An invented scenario with diagrams of the accident scene and a map of the contamination-level measurements was used with resources in the field to reproduce the live situation, including the spread of powder resembling the uranate. The exercise was an opportunity to confront all those taking part with a realistic situation, and thus to take steps to protect the populations and the personnel directly involved, to carry out decontamination operations, to recover the dispersed material, packages and damaged vehicles, and to re-route everything back to the Somaïr mining site to secure it.

Crisis exercise in Niger, return under escort to the SOMAÏR

The exercise proceeded satisfactorily, and was a rich learning experience for the teams from the Mines BU and the NP&S BU in Niger and in France as regards organization, decision-making and technical aspects. The lessons learnt from the exercise will in 2020 form the basis of action plans to improve the crisis-management organization for the transportation of uranium concentrate from mines in Niger.

Use of the RIANA robot during an exercise, TRICASTIN

Management of degraded situations

Orano's commitment to preparing for degraded situation management is determined and continuous, from employees on the ground all the way up to executive management, supported by regularly modernized technical resources.

We have continued our work of the last few years to maintain an operational crisis-management process.

The following areas for improvement in 2019 were identified by the Group's Health, Safety and Environment Department:

- compliance of the repository with regulatory and doctrine changes and with stakeholder expectations,
- changes in training via e-learning or in-depth thematic lectures,
- implementation of a digital strategy focusing more on the conduct of crisis management. In this context, the PCD-N's move from Tour Areva to Châtillon provides an opportunity.

These key areas were used to prioritize all the actions defined as a result of the exercises from previous years.

We began checking the compliance of site organizations with the provisions in the "Emergency Situations" Decision in 2019 with a cycle of inspections by the General Inspectorate. This will continue in 2020. Apart from differences between what is expected and what is in place, we will pay special attention to the implementation of measures that could improve the operational efficiency of the crisis organization.

Work has already started to define both "crisis-management preparation" as an activity important for protection (AIP), and the elements important for protection (EIPs) linked to it.

As regards education and training, a specific session was organized on cybersecurity and malicious acts for people who might be seconded to the PCD-N. In addition, e-learning modules on crisis management and on the National response force (FINA) have been developed and are now in use.

Feedback from exercises during 2019

The Group's central departments participated in seven exercises in 2019, including topics other than nuclear safety. These exercises provided an opportunity to identify areas for improvement and actions to progress them, which have been added to those actions defined in the preceding year that have not already been implemented.

The plurality of the scenarios planned, whether or not related to nuclear safety, is well integrated into the crisis-management organization, in particular at the PCD-N level. This organization was tested in 2019 on aspects related to cybersecurity. Feedback from this exercise will allow us to supplement the internal reference documentation, while ensuring that this aspect is properly addressed in the organization for a nuclear-safety crisis both at the sites and at PCD-N. This area will be tested again in 2020.

The national exercise "Orano Tricastin Specific Response Plan (PPI)" took place on October 15 and 16. It identified areas for improvement, in particular in the coordination between the resources of the public authorities and those of the nuclear operator; in the circulation of photographs to the different control centers in compliance with the confidentiality rules; and in methods of calculating atmospheric discharges.

The national transportation exercise (see box on page 63) was used to test the coordination between the different crisis control centers and the support that the Group can offer in such a situation.

The National Response Force (FINA)

In 2018, the FINA progressed from project mode to a stage where it is maintained in operational condition (MCO). This means that summary sheets for FINA missions are no longer written and that volunteers may be assigned to these missions while they are on standby.

In 2019, we undertook operational missions and created a component for Radiological protection - Occupational Safety. We also gained a good deal from the initial feedback from simulated missions. One example was the fine-tuning of access arrangements appropriate to

Kit for FINA personnel during an exercise

the emergency situation, but still complying with the site access instructions.

We will continue this work in 2020, to ensure that we maintain a consistent operational level across all missions.

Prospects for 2020 and areas for attention

Maintaining the necessary level of staff training to control degraded situations is demanding and requires constant and restrictive investment. The Group's internal dynamic remains high, as regards both team training and the gradual mastery of complex scenarios. The deployment throughout the Group of a new system for maintaining the log book and managing information, to replace the current, now obsolescent, system, is a key issue for 2020. Training courses, sandbox simulations and larger-scale exercises should ensure the system is well understood and used to full capacity.

Apart from actions arising from changes to core principles or regulation, or actions decided as a result of exercises in previous years, we consider that the following points may require attention:

- **the realism of the scenarios.** Setting an objective of simulating significant radiological or chemical consequences outside a site allows us to test the entire crisis-management process. However, achieving that objective may sometimes lead us to develop unrealistic scenarios, and ones that may differ from the scenarios covered in the site's internal emergency plan. Also, for exercises in which the objective is to simulate the post-accident phase, it seems preferable to define a new initial state and sacrifice the scenario's continuity,
- **expertise in conducting the post-accident phase of events.** This phase of an accident is rarely tested during exercises, or only briefly, generally during national exercises. Proficiency requires special expertise and practice. Without waiting for the next update to the principles for post-accident crisis management, we should internally strengthen our skills in this area,
- **the conduct of audio conferences.** Information is shared and decisions are informed by means of a number of audio conferences for the decision, communication or technical circles. These meetings are essential to disseminate information and prepare to take decisions. Nevertheless, from the operator's viewpoint, the last few exercises have shown that the conferences are increasingly taking up more time, which would be better spent on directing action. We therefore need to reflect internally on the scheduling and content of the audio conferences,
- **capacity to simulate all the stakeholders.** The participation of bodies involved in crisis management, even for the lowest intensity exercises, could be more regular, so that the most basic actions become automatic.

Lastly, we should also implement the decisions relating to crisis management that will be agreed following feedback from the fire at the Lubrizol factory.

Training the intervention teams, TRICASTIN

Orano's contribution to the national TMR 63 exercise

The geographical position of the Puy-de-Dôme Departement and the road and rail infrastructures mean that radioactive materials could potentially be routed across the area.

Crisis exercise TMR 63: simulated accident condition - Source IRSN

This exercise corresponded to the approach, initiated by public authorities, to develop the nuclear risk culture in "non-nuclear" departments.

The aim of the TMR 63 exercise was to test the measures (in particular the response from the civil-security organization relating to a TMR) provided both by the public authorities and the operator in the event of an accident during the carriage of radioactive substances in the Departement. It took place over half a day, and used an accident scenario initially unknown to the participants to test:

- the identification of the nuclear and radiological risk by those first on the scene,
- the chain of alert and information for the State services and the transportation stakeholders,
- the mobilization and functioning of the crisis units,
- the decision-making chain, via exchanges between the Group's crisis centre (PCD-N), the dispatcher Orano Cycle TRICASTIN (PCD-L at the TRICASTIN site), the freight forwarder NP&S BU (PCD-L Transport), the IRSN, the ASN and the Puy-de-Dôme Prefecture. These exchanges related in particular to the condition of the damaged packages, changes to that condition, the consequences, arrangements to protect the population and the environment, and the communications made.

The exercise did not involve deployment on the ground, but used a realistic scenario bringing together all of the concerned players. The scenario for the exercise simulated a collision between a road vehicle carrying UF_6 dispatched by the TRICASTIN site and a petrol tanker. The shock of the collision ejected a cylinder of UF6. The fuel in the tank of the tractor towing the tanker then caught fire and the fire spread until it was close to the UF6 packaging.

Beyond these objectives associated with control of the crisis management organization for all of the players (communication and interface between the players, alert system, etc.), the technical teams from the BU were able to verify their capacity to propose a scenario to recover the casks and other items involved in order to meet the requests of the Prefect.

Managing communication with the population and the media was another important objective of this exercise. A specialist firm simulated media pressure so that the communication units of the entities involved received a stream of calls from journalists, articles, and tweets. This pressure was handled efficiently by the various players.

Each of them gained operating feedback from this exercise, which was considered a success overall.

The FINA is in training

The FINA provides transverse support for the facilities at Framatome (ROMANS-SUR-ISERE) and Orano (TRICASTIN). It ran two intervention missions for training purposes during the summer that provided opportunities to put into practice the measures defined for accidental leaks of UF_6 and HF.

Among FINA's missions, R1, Operational Communication, offers an opportunity to use methods of telephone and video communication in the intervention zone, and also to take remote radiological measurements. The data and images obtained can be sent both to the crisis centre for the accident site (PCD-L) and to the Group crisis centre (PCD-N)

Use during a FINA mission at LA HAGUE, September 2019

The FINA, device for pumping aqueous HF

During an exercise at LA HAGUE on September 19, the team responsible for carrying out the R1 mission used a communication network and installed a camera to observe the work of a robot remotely operated by the Intra Group, and installed devices for taking radiological measurements. Personal equipment for team members' telephony, dosimetry and physiological measurements were also used, and the data viewed in real time at the PCD-L.

Glossary

ACRONYMS

AIP: Activities Important for the Protection of interests

ANDRA: French National Agency for Radioactive Waste Management (Agence Nationale pour la gestion des Déchets Radioactifs)

ASN: French nuclear safety authority (Autorité de Sûreté Nucléaire)

BU: Business Unit (in the Orano organization)

CEA: French Atomic Energy and Alternative Energies Commission (Commissariat à l'Énergie atomique et aux énergies Alternatives)

COFRAC: French Accreditation Committee (Comité FRançais d'ACcréditation)

DSND: Delegate for Nuclear Safety and Radiological Protection for Defence-related Activities (Délégué à la Sûreté Nucléaire et à la radioprotection pour les activités et les installations intéressant la Défense)

EIP: Equipment Important for the Protection of interests

EURATOM: European Atomic Energy Community

FINA: Orano's National Response Force

HOF: Human and Organizational Factors

HCTISN: High Committee For Transparency and Information on Nuclear Security (Haut Comité pour la Transparence et l'Information sur la Sécurité Nucléaire)

IAEA: International Atomic Energy Agency

ICPE: Environmentally Regulated Facility (Installation Classée pour la Protection de l'Environnement)

IG: General Inspectorate (Orano)

INB: French Regulated Nuclear Facility (Installation Nucléaire de Base)

INBS: French Defense Nuclear Facility (Installation Nucléaire de Base Secrète)

IPR: Incident Prevention Rate

IRSN: Institute for Radiation Protection and Nuclear Safety (Institut de Radioprotection et de Sûreté Nucléaire)

NCPF: New fission product concentration unit

OEF: Operating Experience Feedback - process designed to organize Operating Experience or Lessons Learned [REX in French]

SSA: Supplementary Safety Assessments

TSN Law: French law no. 2006-686 of June 13, 2006 on transparency and security in nuclear matters, enshrined in the French environmental code

WANO: World Association of Nuclear Operators

B

Becquerel (Bq): International unit of measurement of nuclear activity (1Bq = decay of 1 atomic nucleus per second). The becquerel is a very small unit. Formerly, activity was measured in curies (1 curie = 37,000,000,000 Bq).

C

Cask: Assembly of components needed to safely contain the radioactive material transported. It may include a variety of special materials, such as radiation-absorbing materials or thermal insulation materials, as well as service equipment, impact limiters, and devices for handling and stowage.

Category A or B: Classification categories for workers likely to receive, in normal work conditions, an effective dose of more than 6 mSv per year in the case of a category A worker and of more than one of the dose limits set for the public in the case of a category B worker.

Cleanup: All technical operations to eliminate radioactivity-related risks in a nuclear facility, consisting of decontaminating the structures, equipment, floors and walls of the buildings.

Containment: System of protection which consists of containing radioactive products inside a defined area.

Contamination: Presence of radioactive substances (dust or liquid) on the surface or inside a medium. Contamination in humans may be external (on the skin) or internal (via the skin or by inhalation or ingestion).

Controlled area: Area where access and residence time are regulated for reasons of radiation protection

Conversion: Combination of chemical transformations to convert solid uranium concentrates into uranium hexafluoride so that they may be enriched in fissile uranium (U235) by centrifugation.

Criticality (criticality safety): The study and control of conditions to protect against the occurrence of a criticality accident due to an uncontrolled nuclear fission reaction in normal, incidental and accidental situations.

D

Decommissioning: Administrative procedure consisting of removing a facility from the list of regulated nuclear facilities (INBs). At that point, the facility is no longer subject to the legal and administrative requirements pertaining to INBs.

Decontamination: Physical, chemical or mechanical operation designed to eliminate or reduce the presence of radioactive or chemical materials deposited on a person or equipment, or in a facility or open area.

Defense in depth: A series of lines of defense designed to prevent the appearance, or limit the consequences as necessary, of human or technical failures that could lead to accidental situations.

Dismantling: Combination of technical and administrative procedures carried out following the final shutdown of a facility to achieve defined final conditions enabling it to be decommissioned. Dismantling includes the physical dismantling, the decontamination of all machinery and equipment, and the management of the associated radioactive waste.

Dosimeter: Instrument for measuring radioactive doses received by an individual, or by certain of that individual's organs (passive or operational dosimetry), or by the environment (site dosimetry).

E

Effective dose: The sum of an individual's internal and external exposure to ionizing radiation (energy received and effects related to the type of radiation). It generalizes the effects to the whole body of an individual, taking into account differences in the sensitivity of different organs. It is expressed in millisieverts (mSv), a sub-unit of the sievert (1 Sv = 1,000 mSv).

Enrichment: Process in which the abundance of fissile isotopes is increased in a chemical element. Naturally occurring uranium essentially consists of 0.7% U235 (fissile isotope) and 99.3% U238 (non-fissile isotope), and must be enriched in U235 for it to be usable in a pressurized water reactor. The proportion of U235 is brought to approximately 3 to 5%.

F

Fissile: Describes a nuclide capable of fission; the fission of atoms generates several neutrons.

Fission products: Fragments of heavy nuclei produced during nuclear fission or the subsequent radioactive decay of the nuclides formed. These fission fragments and their decay products are collectively referred to as "fission products".

Fission: Spontaneous or forced splitting of a heavy nucleus, generally after absorption of a neutron, into two or three smaller nuclei (fission products), accompanied by the release of neutrons, radiation and a considerable amount of heat. The substantial energy released is the principle underlying nuclear power generation.

Fuel cycle: The combination of industrial operations involving nuclear fuel. These operations include uranium ore mining and processing, uranium conversion and enrichment, fuel fabrication, used fuel treatment, recycling of recovered fissile materials to fabricate new fuel, and radioactive waste management.

G

Glass: High-level radioactive waste is vitrified and poured into stainless steel canisters.

Glove box: A transparent enclosure in which equipment and radioactive substances can be handled in isolation from the operator. Handling is done with gloves which are sealed to openings in the wall of the enclosure or with mechanical manipulators.

H

Hot work: Any operation or maintenance work requiring the use of an open-flame device, a spark generator or a hot surface.

Hulls: Pieces about 3 centimeters long produced by the shearing of the metal cladding (fuel rods) that had contained nuclear reactor fuel.

I

Incident Prevention Rate (IPR): Internal Group indicator based on the ratio of the number of INES level 1 events to the number of INES level 0 events.

International Nuclear and Radiological Event Scale (INES): International scale designed by the IAEA to facilitate communication about nuclear events. It provides comparative elements that can be used to assess the seriousness of an event. The scale ranges from level 0 (deviation with no safety significance) to level 7 (major accident with considerable health and environmental consequences).

Ionizing radiation: Electromagnetic or corpuscular radiation capable of producing ions directly or indirectly as it passes through matter. This ionizing radiation can be produced by the radioactivity of atoms such as uranium or plutonium.

Irradiation: Exposure of an organism or an organ to ionizing radiation when the radiation source is outside the organism.

M

MOX (Mixed OXide): A mixture of uranium and plutonium oxides used to fabricate certain types of nuclear fuel.

N

Nozzle: Metal component located at the top (top nozzle) or bottom (bottom nozzle) of a fuel assembly. The top nozzle is used to handle the assembly.

Nuclear materials safeguards: Safeguards aimed at preventing any loss or diversion of material, in particular for malicious purposes.

Nuclear safety: Combination of technical and organizational measures related to the design, construction, operation, shutdown and dismantling of regulated nuclear facilities, and to the transport of radioactive substances, which are taken to prevent accidents or limit their effects.

P

Periodic review: The periodic review of a facility assesses the facility's status in terms of the rules applicable to it and updates the assessment of the risks or drawbacks that the facility may present, taking into account in particular the condition of the facility, the operating experience, developments in knowledge and changes to the rules applicable to similar facilities.

Plan National de Gestion des Matières et des Déchets Radioactifs (PNGMDR): The National Radioactive Waste and Materials Management Plan is a document which assesses existing methods of managing radioactive waste and materials, identifies foreseeable storage and disposal facility requirements, indicates the capacities needed for those facilities and the duration of storage, and sets objectives for radioactive waste for which no final management method exists.

Pressurized nuclear equipment: Equipment that is specially designed for nuclear applications and whose failure could give rise to radioactive releases.

R

Radiation protection: Combination of rules, procedures and means for prevention and monitoring aimed at preventing or reducing the exposure of employees and the environment to the harmful effects of ionizing radiation.

Radioactive waste disposal: In France, operation consisting of placing radioactive waste in a specially designed facility for potentially permanent keeping, in compliance with the principles laid down in article L. 542-1 of the French Environmental Code.

Radioactive waste packaging: Operation consisting of packaging waste in a form suited to the containment of radioactive materials, enabling its shipment, storage and final disposal.

Radioactive waste: Radioactive substances for which no further use is foreseen or planned, or which have been requalified as such by the administrative authority pursuant to article L. 542-13-2 of the French environmental code.

Radioactive material: Substance containing natural or artificial radionuclides whose activity level or concentration warrants radiation protection monitoring.

Radioactivity: Phenomenon involving transformation of a nuclide with release of ionizing radiation. Radioactivity may be natural or artificial. The radioactivity of an element decreases over time as the unstable nuclei disappear.

S

Safety analysis report: Report describing the design of regulated nuclear facilities and the measures taken to ensure safety. It inventories the risks presented by the facility and specifies the measures taken to prevent them as well as measures conducive to reducing the probability of accidents and their effects.

Safety standards: Combination of documents called for by the regulations of each country which present measures taken to ensure the safety of a facility. The safety analysis report is one such document.

Sievert (Sv): Unit of measurement of radioactive dose, i.e. the fraction of energy from ionizing radiation received by 1 kilogram of living matter, taking into account the effects on the organ in question, which are a function of the type of radiation. The millisievert (mSv) is used more frequently, which corresponds to one one-thousandth of a sievert, and sometimes the microsievert (µSv), which corresponds to one one-millionth of a sievert.

Storage: Temporary surface or geologic storage of radioactive materials and waste in a facility that is specifically designed for that purpose, pending their removal.

Subcontractor: Natural or legal entity other than the owner-operator and its employees which carries out operations or supplies goods or services within the frame defined by the INB Order of February 7, 2012. In particular, this concerns service providers and subcontractors, experimenters and users.

U

UF_6: Uranium hexafluoride.

UO_2: Uranium dioxide. May be in powder or pellet form. It is the constituent component of nuclear fuel.

Uranium concentrate: Magnesium uranate, sodium, ammonium or uranium peroxide in solid form resulting from the mechanical and chemical treatment of uranium ore. This marketable concentrate contains about 80% uranium.

Used nuclear fuel recycling: After a reactor residence time of three to four years, the used nuclear fuel must be unloaded. At that time, 96% of the fuel materials are reusable (95% uranium and 1% plutonium), while 4% are fission products and minor actinides (final waste). A first step is to separate recoverable radioactive materials from the final radioactive waste contained in the used fuel. The former can be recycled to produce electricity, economizing on natural resources. The waste is packaged safely and sustainably for storage.

Used nuclear fuel: Fuel permanently removed from a reactor core after having been irradiated there.

V

Vitrification: Process used to incorporate concentrated solutions of final radioactive waste (fission products and minor actinides), which have been chemically separated from the used fuel, into a glass structure by mixing it with a glass matrix at high temperature.

W

Waste rock: Earth, sand or rock that contains little or no uranium, but that must be extracted to gain access to the ore itself. Their naturally occurring radioactivity is comparable to that of the surrounding rock.

Orano
Business corporation with a Board of Directors - Capital of 132,076,389 euros
RCS Nanterre 330 956 871
Safety, Health, Security and Environment Department - June 2020

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PRISME - 125 avenue de Paris
92320 Châtillon - France

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