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This chapter is devoted to pressurised water reactors (PWRs). These reactors, used to produce electricity, lie at the heart of the nuclear industry in France. Many other NPPs described in the other chapters of this report produce the fuel intended for these plants or reprocess it, are used for disposal of the waste produced by them or are used to study the physical phenomena related to reactor operation and safety. These reactors are today operated by Electricité de France (EDF). One particularity in France is the standardisation of plants, with a large number of technically similar reactors, justifying a generic presentation in this chapter.

1 GENERAL INFORMATION ABOUT EDF'S NPPS

The nineteen French nuclear power plants (NPPs) currently in operation are appreciably the same. They each comprise from two to six PWRs, which in total amounts to 58 reactors. For each of them, the nuclear part was designed and built by Framatome, with EDF acting as industrial architect.

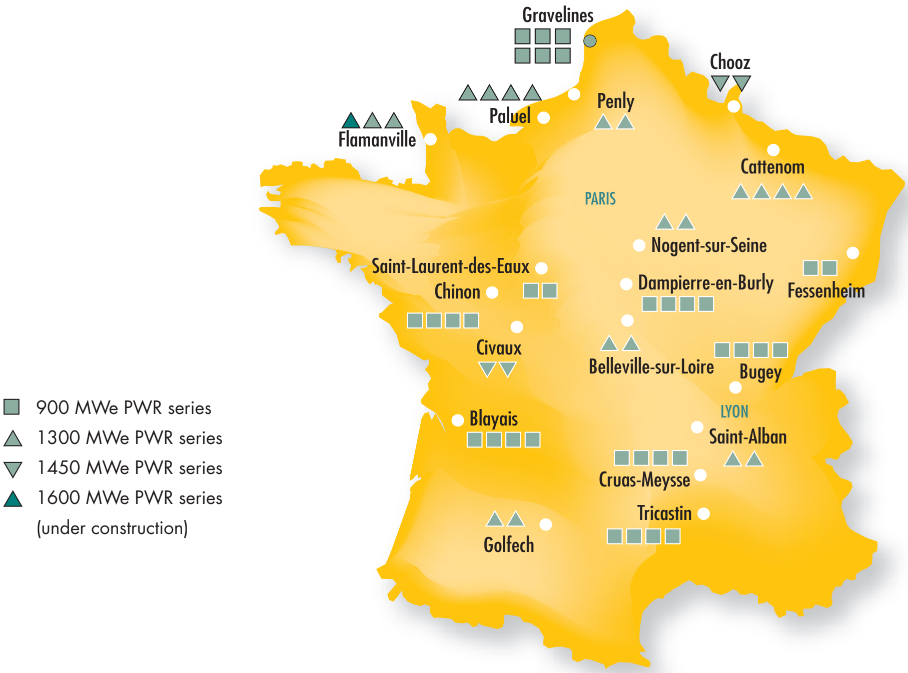
The thirty-four 900 MWe reactors can be split into:
- the CP0 series, consisting of the four reactors at Bugey (reactors 2 to 5) and two reactors at Fessenheim;
- the CPY reactors, consisting of another twenty-eight 900 MWe reactors, that can also be subdivided into CP1 (eighteen reactors at Le Blayais, Dampierre-en-Burly, Gravelines and Tricastin) and CP2 (ten reactors at Chinon, Cruas-Meysse and Saint-Laurent-des-Eaux).

The twenty 1300 MWe reactors comprise:
- the P4 reactors, consisting of the eight reactors at Flamanville, Paluel and Saint-Alban;
- the P'4 reactors, consisting of the twelve reactors at Belleville-sur-Loire, Cattenom, Golfech, Nogent-sur-Seine and Penly.

Finally, the N4 reactors comprise four 1450 MWe reactors, two on the Chooz NPP and two on the Civaux NPP.

Despite the overall standardisation of the French nuclear power reactors, certain technological innovations were introduced as design and construction of the plants proceeded.

The CPY reactors differ from the Bugey and Fessenheim reactors (CPO) in building design and the addition of an intermediate cooling system between that used for



Power reactor locations in France

containment spraying in the event of an accident and that containing heat sink water, along with more flexible operation.

The design of the 1300 MWe reactor systems, core protection devices and plant buildings differs considerably from the CPY reactors. The power increase means a primary system with four steam generators (SG), so that the cooling capacity is greater than for the 900 MWe reactors equipped with three steam generators. Moreover, the reactor containment consists of a double concrete-walled structure, instead of the single wall with steel liner design as with the 900 MWe reactors.

The P'4 reactors differ slightly from the P4 reactors, notably with regard to the fuel building and primary and secondary systems.

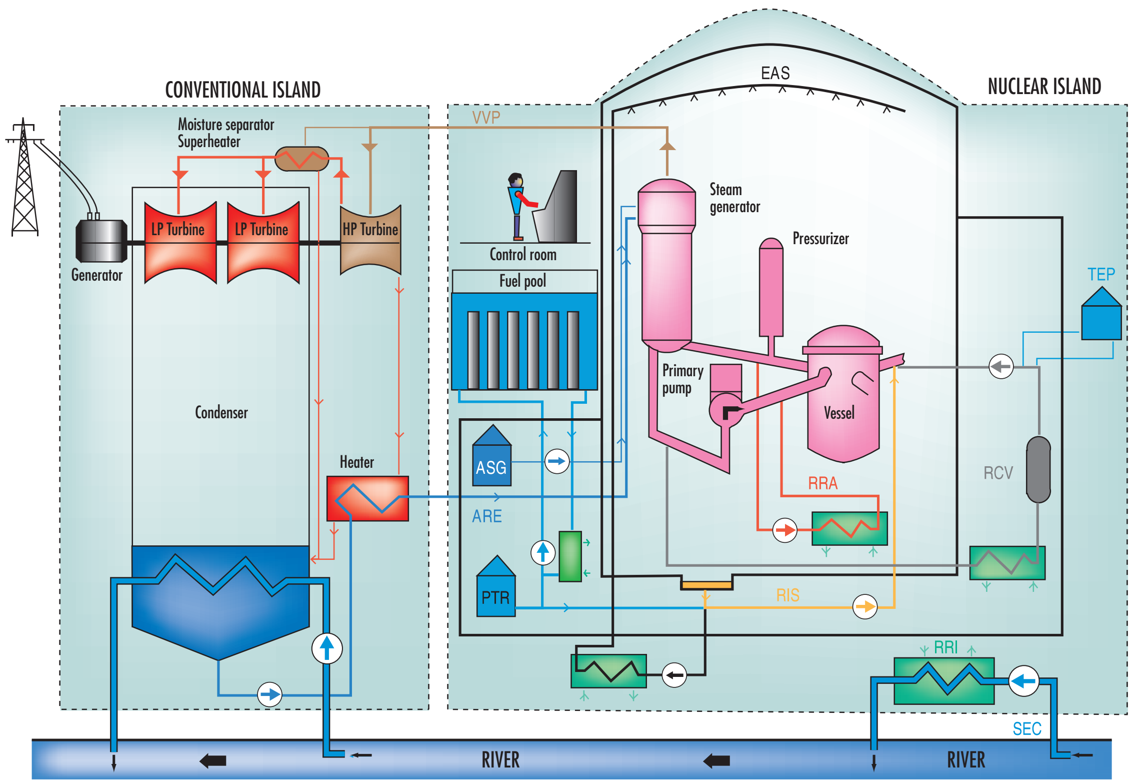
Finally, the N4 reactors differ from the previous reactors in the design of the more compact steam generators and of the primary pumps and in the computerisation of the control systems.

1 | 1 Description of an NPP

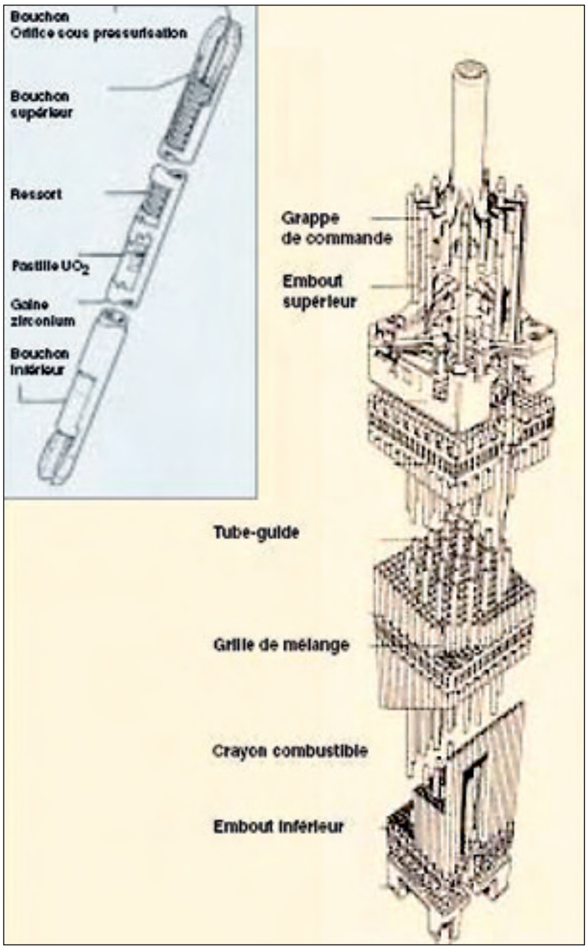
1 | 1 | 1 General description of a pressurised water reactor

In passing heat from a hot source to a heat sink, all thermal electric power plants produce mechanical energy, that they then transform into electricity. Conventional plants use the heat given off by the combustion of fossil fuels (fuel oil, coal, gas). Nuclear plants use that resulting from the fission of uranium or plutonium atoms. This heat produces steam which is then expanded in a turbine to drive a generator to produce 3-phase electric current at 400,000 Volts. After expansion, the steam passes through a condenser where it is cooled on contact with tubes circulating cold water taken from the sea, a river or an atmospheric cooling system.

Each reactor comprises a nuclear island, a conventional island, water intake and discharge infrastructures and possibly a cooling tower.



Block diagram of a pressurised water reactor



Fuel rod for a pressurised water reactor – Fuel assembly and rod cluster control assembly

The nuclear island mainly consists of the nuclear steam supply system comprising the primary system and the systems designed for reactor operation and safety: the chemical and volume control, residual heat removal, safety injection, containment spraying, steam generators feedwater, electrical, I&C and reactor protection systems. Various support function systems are also associated with the nuclear steam supply system: primary waste treatment, boron recovery, feedwater, ventilation and air-conditioning, backup electrical power (diesel generating sets). The nuclear island also comprises the systems removing steam to the conventional island as well as the building housing the fuel storage pit.

The conventional island equipment includes the turbine, the AC generator and the condenser. Some of this equipment contributes to reactor safety. The secondary systems belong partly to the nuclear island and partly to the conventional island.

The safety of pressurised water reactors is guaranteed by a series of strong, independent, leaktight barriers, for which the safety analysis must demonstrate their effectiveness in normal and accident operating situations. There are generally three of these barriers, consisting of the fuel cladding (see point 1|1|2) for the first barrier, the main primary and secondary systems (see point 1|1|3) for the second barrier and the reactor building containment (see point 1|1|4) for the third barrier.

1|1|2 Core, fuel and fuel management

The reactor core consists of rods containing uranium oxide pellets or mixed uranium and plutonium oxides (fuel referred to as MOX), located in fuel assemblies. As a result of fission, the uranium or plutonium nuclei emit neutrons which, in turn, produce further fissions: this is known as the chain reaction. These nuclear fissions release a large amount of energy in the form of heat. The primary system water enters the core from below at a temperature of about 285 °C, flows up along the fuel rods and exits through the top at a temperature of about 320 °C.

At the beginning of the operating cycle, the core has a considerable energy reserve. This gradually falls during the cycle, as the fissile nuclei disappear.

The chain reaction, and hence the reactor power, is controlled by:
– inserting control rod assembly clusters, containing elements that absorb neutrons, to varying depths in the core. These enable the reactor to be started and stopped and its power level to be adjusted to the electrical power to be produced. Falling of the clusters under the effects of gravity triggers automatic reactor trip;
– varying the boron content of the primary system water. The chain reaction is moderated by the boron – in the form of boric acid dissolved in the primary system water – owing to boron's ability to absorb neutrons. Its concentration in the water is adjusted during the cycle according to the gradual depletion of the fissile material in the fuel.

The operating cycle ends when the boron concentration reaches zero. An extension is however possible, if the temperature and possibly the power level are brought below their nominal values. At the end of the cycle, the reactor core is unloaded for renewal of part of the fuel.

EDF uses two types of fuels in its pressurised water reactors:
– uranium oxide based fuels (UO_2) with uranium 235 enrichment to a maximum of 4.5%. These fuels are fabricated in several plants in France and abroad, which belong to the fuel suppliers AREVA and WESTINGHOUSE;
– fuels consisting of a mixture of depleted uranium oxides and plutonium (MOX). MOX fuel is produced by the

MELOX plant that belongs to the Areva group and is located at Marcoule (Gard *département*[1]). The initial plutonium content is limited to 8.65% (average per fuel assembly) and provides an energy equivalence with UO_2 fuel initially enriched to 3.7% Uranium 235. This fuel can be used in the CP1 and CP2 reactors for which the authorisation decrees (DAC) make provision for MOX fuelling. Twenty-two of the twenty-eight reactors are concerned.

Fuel management is specific to each reactor series. It is characterised in particular by:
– the nature of the fuel used and its initial fissile content;
– the maximum degree of fuel depletion at removal from the reactor, characterising the quantity of energy extracted per ton of material (expressed in GWd/t);
– the length of an operating cycle (generally expressed in months);
– the number of new fuel assemblies loaded at each reactor refuelling outage (generally 1/3 or 1/4 of the total number of assemblies);
– the reactor operating mode, with or without major power variation, characterising the stresses to which the fuel is subjected.

1 | 1 | 3 Primary system and secondary systems

The primary system and the secondary systems are used to transport the energy given off by the core in the form of heat to the turbine generator set which produces electricity, without the water in contact with the core ever leaving the containment.

The primary system comprises cooling loops (three loops for a 900 MWe reactor, four loops for a 1,300 MWe, 1,450 MWe, or EPR reactor), the role of which is to extract the heat released in the core by circulating pressurised water, known as the primary water. Each loop, connected to the reactor vessel containing the core, comprises a circulating, or primary pump, and a steam generator (SG). The primary water, heated to more than 300 °C, is kept at a pressure of 155 bar by the pressuriser, to prevent it boiling. The entire primary system is located inside the containment.

The primary system water transfers the heat to the water in the secondary systems, via the steam generators. The steam generators are heat exchangers which contain thousands of tubes through which the primary water circulates. These tubes are immersed in the water of the secondary system and boil it, without ever coming into contact with the primary water.

Each secondary system primarily consists of a closed loop through which water runs in liquid form in one part and as steam in another part. The steam produced in the steam generators is partly expanded in a high-pressure turbine and then passes through superheater separators before final expansion in the low-pressure turbines, from which it is then routed to the condenser. The condensed water is then heated and sent back to the steam generators by the extraction pumps relayed by feed pumps through reheaters.

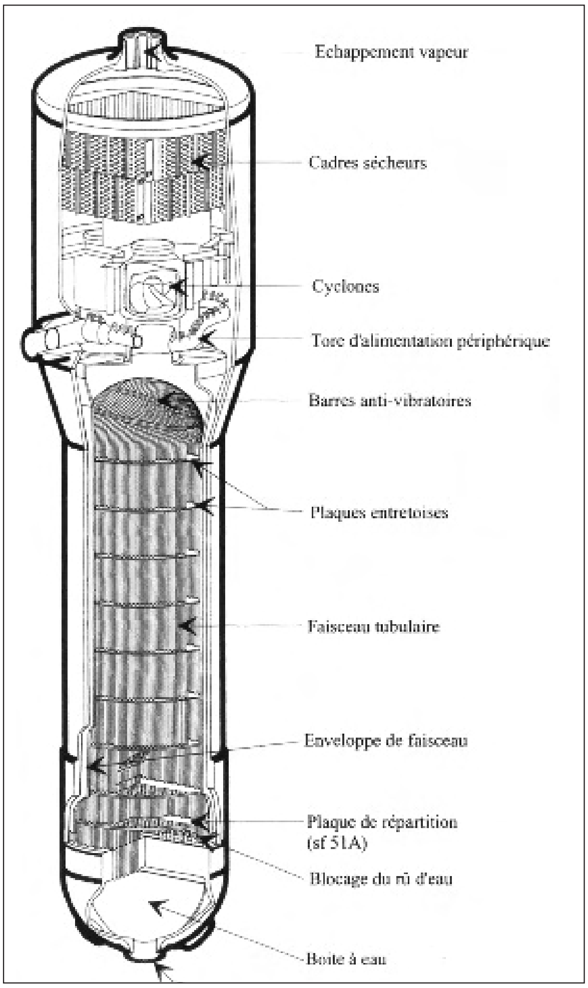
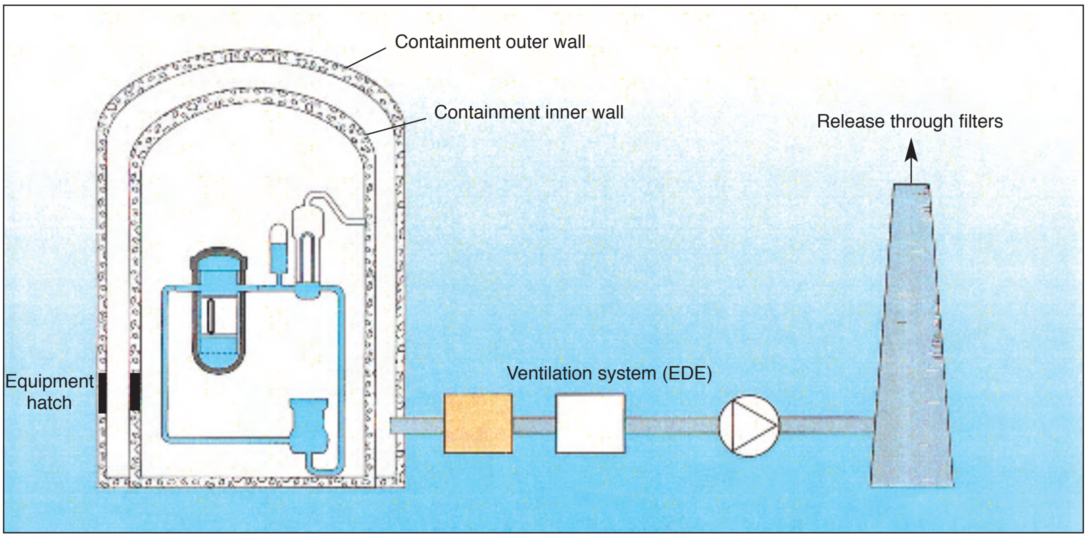


Diagram of a steam generator

1 | 1 | 4 Reactor containment building

The PWR containment building has two functions:
– protection of the reactor against external hazards;
– containment, thereby protecting the public and the environment against radioactive products likely to be dispersed outside the primary system in the event of an accident. The containments are therefore designed to withstand the pressures and temperatures that could be reached in an accident situation, and offer sufficient leaktightness in such conditions.

1. Administrative region headed by a *Préfet*.



Containment of a 1300 MWe reactor

The containments are of two types:
- the 900 MWe reactor containments, consisting of a single wall of pre-stressed concrete (concrete containing steel cables tensioned to ensure compression of the structure). This wall provides mechanical resistance to the most severe design accident pressure and structural integrity against external hazards. Leaktightness is assured by a thin metal liner on the inside of the concrete wall;
- the 1,300 MWe and 1,450 MWe reactor containments, comprising two walls, an inner wall made of pre-stressed concrete and an outer wall made of reinforced concrete. Leaktightness is provided by the inner wall and the ventilation system (EDE) which, in the annular space between the walls, channels any radioactive fluids and fission products that could come from inside the containment as a result of an accident. Resistance to external hazards is mainly provided by the outer wall.

1 | 1 | 5 The main auxiliary and safeguard systems

In normal operation or during normal shutdown of the reactor, the role of the auxiliary systems is to provide the basic safety functions (control of neutron reactivity, removal of heat from the primary system and fuel residual heat, containment of radioactive materials). This chiefly involves the Chemical and Volume Control system (RCV) and the Residual Heat Removal system (RRA).

During operation, the RCV system can be used to control neutron reactivity by regulating the boron concentration of the primary coolant water. It is also used to adjust the mass of water in the primary system according to temperature variations. The RCV system also enables the quality of the primary system water to be maintained, reducing the amount of corrosion and fission products it contains by injecting chemicals (corrosion inhibitors for instance). Finally, this system permanently injects water into the primary pump seals to guarantee their tightness.

The RRA system functions during normal reactor outages to remove the heat from the primary system and the residual heat from the fuel and then to keep the primary system water at a low temperature as long as there is fuel in the core. After the chain reaction stops, the reactor core continues to produce heat, which must be removed to avoid damaging the fuel. The RRA system is also used to transfer reactor pool water after fuel reloading.

The purpose of the safeguard systems is to control incidents and accidents and mitigate their consequences. This primarily concerns the safety injection system (RIS), the reactor building containment spray system (EAS) and the steam generator auxiliary feedwater system (ASG).

The RIS system injects borated water into the reactor core in the event of an accident in order to moderate the nuclear reaction and remove the residual heat. It comprises passive pressurised accumulators and various pumps with appropriate discharge flow rates and pressures for different types of accident situations. In the event of a loss of coolant or steam line rupture accident, these pumps initially draw from the reactor cavity and spent fuel pit cooling and treatment system tank (PTR). Then, when the tank is empty, these pumps are connected to the reactor building sumps, where the EAS spray water is collected, together with any water that has escaped from the primary system in the event of a leak on this system.

In the event of an accident leading to a rise in the pressure and temperature in the reactor building, the EAS system sprays water containing soda. This helps restore acceptable ambient conditions, protect the integrity of the containment and damp down any radioactive aerosols dispersed inside the containment.

The ASG system is used to maintain the water level in the secondary part of the steam generators and thereby cool the primary system water if their normal feedwater flow control system (ARE) becomes unavailable. It is also used in normal operation and during reactor shutdown and restart phases.

1 | 1 | 6 Other systems

The other systems necessary for reactor operation and important to its safety also include:
- the component cooling system (RRI), which cools a number of nuclear equipment items; this system operates in a closed loop between the auxiliary and safeguard systems on the one hand, and the systems carrying water pumped from the river or the sea (heat sink) on the other;
- the essential service water system (SEC), which uses the heat sink to cool the RRI system;
- the reactor cavity and spent fuel pit cooling and treatment system (PTR), used notably to remove residual heat from irradiated fuel elements stored in the spent fuel pit;
- the ventilation systems, which play a vital role in containing radioactive materials by depressurising the premises and filtering all discharges;
- the fire-fighting water systems;
- the I&C system, the electrical systems, etc.

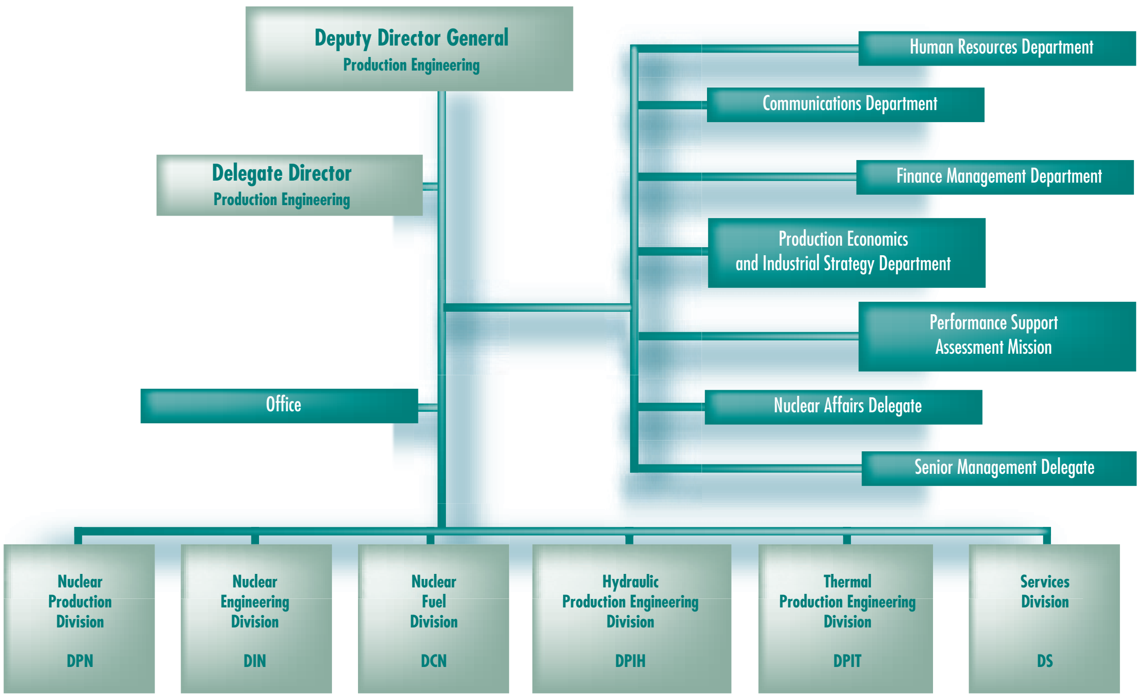
1 | 2 Operation of a nuclear power plant

1 | 2 | 1 EDF organisational structures

Within the EDF Production and Engineering Directorate (DPI), a distinction is made between the functions of operator and designer. The designer is responsible for developing and extracting long-term value from EDF's assets, along with dismantling at the end of operation. The operator is responsible for the short and medium-term performance of its production sites, as well as for safety, radiation protection, security, environmental, availability and daily operating costs issues.

The Nuclear Operation Division (DPN)

The responsibility of operator is assumed by the Nuclear Operation Division (DPN). The Director of the DPN has authority over the NPP directors and also has at his



Organisation of the EDF Production Engineering Department disposal Head Office departments, comprising expert assessment and technical support services responsible for defining DPN policy and participating in the improvement of plant operations.

The role of the Operation Engineering Unit (UNIE) is to support NPPs and DPN management. It is responsible for policy and requirements concerning safety, radiation protection and environmental protection. UNIE therefore drafts the safety requirements applicable to the NPPs and ensures that they are implemented. It helps NPPs achieve their safety and performance objectives. It helps the DPN management in the performance of its duty to manage and control implementation of national decisions concerning all NPPs. The UNIE also helps support the DPN management and the NPPs in implementing changes and integrating technical aspects and human, social, organisational and economic factors.

For all power plants, the Central Technical Department (UTO) is responsible for implementation of operations (modifications and maintenance). It is in charge of generic maintenance, subcontracting policy, oversight of reactor outages and purchasing policy.

Finally, the IN (Nuclear Inspection) teams, on behalf of the DPN authorities, carry out verification assignments on the entire division.

Within the NPPs, the Director's responsibilities are those of the nuclear licensee of the NPPs. The departments are organised according to discipline, comprising safety, radiation protection, production and maintenance. Cross-functional project teams are set up for specific activities such as unit outages. The production and maintenance activities can also call on an engineering department.

The Nuclear Engineering Division (DIN)

The role of designer is assigned to the Nuclear Engineering Division (DIN). In this respect, the DIN is responsible for the NPPs' design requirements. It performs engineering activities concerning future issues, in other words, studies, draft projects and long-term upgrade projects for the NPPs which go beyond the natural scope of the licensee's work. Finally, it oversees projects designed to maintain the assets, primarily design aspects and in particular the periodic safety reviews. It is responsible for new NPP projects in France (EPR Flamanville 3) and those taking place abroad in which EDF is involved. It is responsible for dismantling work.

Among the DIN's engineering centres, the Design Department for Thermal and Nuclear Projects (SEPTEN) is responsible for upstream studies and draft projects.

The National Centre for Nuclear Equipment (CNEN) is more particularly in charge of equipment design and modification on the nuclear island of the N4 reactors and the new NPP projects in France (EPR FA3) and abroad.

Activities concerning the N4 reactors are currently being transferred from the CNEN to the Nuclear Engineering Equipment Department (CIPN) which is currently in charge of the nuclear islands of the 900 MWe and 1300 MWe reactors. In early 2011, CIPN will take over in full CNEN's current responsibilities for the N4 reactors.

The National Electricity Generating Equipment Centre (CNEPE) deals with the conventional islands of all the plants.

The dismantling and waste management activities are handled by the Nuclear Environmental and Decommissioning Engineering Centre (CIDEN).

Finally, the Construction and Operation Expert Appraisal and Inspection Centre (CEIDRE) is responsible for in-service inspection of equipment and for conducting appraisals.

ASN contacts

As part of its national regulatory role, ASN maintains relations mainly with the DPN concerning the power plants in operation and the DIN for new projects. ASN's contacts are the DPN head office departments with regard to handling of generic matters, that is those concerning several if not all of the reactors in service. ASN deals directly with the management of each power plant for issues specifically concerning the safety of the reactors in it. As regards equipment design and study documents, they are discussed in the first place with the DIN. Those concerning fuel and fuel management are also discussed with a third division which has more specific responsibility for these questions, the Nuclear Fuels Division (DCN).

1 | 2 | 2 Close examination of operating documents

NPPs are operated on a day-to-day basis in accordance with a set of documents. All those concerning safety are given particularly close attention by ASN.

These first of all comprise the general operating rules (GORs) applicable to reactors in service. They supplement the safety analysis report, which mainly deals with the measures taken at the design phase of the reactor, and translate the initial scenarios and findings of the various studies into operating rules.

The GORs comprise several chapters, among which those having particular safety implications are carefully reviewed by ASN.

• Chapter III describes the Technical Operating Specifications (STEs), which specify the reactor's normal operating range and in particular the allowable range for the operating parameters (pressure, temperature, neutron flux, chemical and radiochemical parameters, etc.). The STEs also specify the required reaction if these limits are exceeded. In addition, the STEs define the equipment needed according to the condition of the reactor and state what action is to be taken in the event of a malfunction or unavailability of this equipment.

• Chapter VI comprises operating procedures applicable in an incident or accident situation. It stipulates the steps required in these situations in order to maintain or restore the basic safety functions (reactivity control, core cooling, containment of radioactive products) and return the reactor to a safe condition.

• Chapter IX defines the programmes of checks and periodic tests run on the equipment and systems that are important for safety, in order to ensure their availability. If the results are unsatisfactory, then the required response is specified in the STEs. This type of situation may sometimes require the licensee to shut down the reactor in order to repair the faulty equipment.

• Chapter X finally defines the physical test programme for reactor core loads. It contains the rules defining the core verification programmes during reactor restart and for in-service core monitoring.

Secondly, there are documents describing the in-service monitoring and maintenance actions required on the equipment. On the basis of the manufacturer recommendations, EDF defined periodic inspection programmes for the components, or preventive maintenance programmes (see point 3|2|1), based on the knowledge of the potential failures of the equipment.

In certain cases, particularly for pressure equipment, this may entail non-destructive testing methods (radiography, ultrasounds, eddy current, dye penetrant, etc.) which are entrusted to specially qualified staff.

1 | 2 | 3 Oversight of reactor outages

Reactors need to be shut down periodically in order to renew the fuel, which becomes gradually depleted during the operating cycle. At each outage, one third or one quarter of the fuel is renewed. The length of the operating cycles depends on the fuel management adopted.

These outages mean that it is possible to access parts of the NPP which would not normally be accessible during operation. The outages are therefore an opportunity to verify the condition of the NPP by running checks and performing maintenance work, as well as to implement the modifications scheduled for the NPP.

There are two types of outage:
– simple refuelling outage (ASR) and partial inspection (VP) outage: these outages last a few weeks and are devoted to renewing part of the fuel and conducting a programme of verification and maintenance;
– ten-yearly outage (VD): this outage entails a wide-ranging verification and maintenance programme. This type of outage, which occurs every 10 years, is also an opportunity for the licensee to carry out major operations such as a complete inspection and hydrotest on the primary system, a reactor building containment test or incorporation of design changes decided on in the periodic safety reviews (see point 2|2|3).

These outages are scheduled and prepared for by the licensee several months in advance. ASN checks the steps taken to guarantee safety and radiation protection during the outage, and the safety of operation during the coming cycle(s).

The checks carried out by ASN mainly concern the following aspects:
– during the outage preparation phase, conformity with the applicable reactor outage safety requirements. ASN adopts a stance on this aspect;
– at the regular information meetings and inspections during the outage, how the various problems encountered are dealt with;
– at the end of the outage – when the licensee presents the reactor outage summary – the condition of the reactor and its suitability for restart. After this check, ASN authorises reactor restart;
– after criticality, the results of all tests carried out during the outage and after restart.

Hydro-testing of reactor number 3 at Chinon – June 2009

2 THE MAJOR NUCLEAR SAFETY AND RADIATION PROTECTION ISSUES

2|1 People, organisations, safety and competitiveness

The contribution of man and organisations to managing BNI safety is a determining factor in the NPPs in operation, but also in their design, construction and decommissioning. Ensuring that this contribution works constantly to improve safety is all the more important given that safety is always faced with other considerations, such as competitiveness.

2|1|1 Regulating human and organisational factors

For ASN, everything in the working situation and the organisation which has an influence on the actual activity of the individuals working in an installation such as a nuclear power plant, constitutes what are called human and organisational factors (HOF). These elements in particular concern everything to do with the organisation of work, the parties concerned (workforce, skills, motivation, etc.), the technical arrangements and the working environment.

Whatever the level at which the activities to be carried out are stipulated or specified, the situations actually encountered by these individuals in the field constantly change (equipment which does not react as expected, night-work, an inexperienced colleague, varying levels of urgency, labour disputes, etc.), obliging them to adapt how they work (procedures) in order to attain the expected objective at an acceptable cost (fatigue, stress, health, and so on).

It is up to the licensee to ensure that the staff have necessary and sufficient means to adapt their procedures to the variability encountered in the working situations. The staff must be able to carry out their duties correctly (safety, security, efficiency, quality) at an acceptable health cost, while deriving adequate benefit from it (feeling of a job well done, recognition of their peers and their hierarchy, development of new skills, and so on).

Inappropriate resources can lead to risks, for example, inadequate tooling, cramped or poorly lit working environment, insufficient training or practice, poor design of the man-machine interfaces, shortage of spare parts, groups such as operating and maintenance teams destabilised by constant organisational change, insufficient manning levels or time allocated to the tasks. Therefore an operating situation in which performance is satisfactory, but which was obtained at very high human cost to the operators, is a source of risks: a slight variation in the context or a change in operators can be enough to prevent the required performance level from being reached.

ASN regulation

ASN expects the licensee to define an explicit policy to take account of and develop HOF, to acquire the appropriate means and resources for effective action and take steps according to appropriate approaches and methodologies, that are managed and followed-up with a view to continuous improvement.

ASN regulation of HOF is based in particular on the inspections performed in the NPPs. These inspections are an opportunity to review the licensee's HOF policy and organisation, the means and resources committed, particularly in terms of specific skills, the steps taken to improve how HOF are incorporated into operations and to assess actual implementation and results in the field. ASN also relies on the assessments carried out at its request by IRSN and the Advisory Committee for nuclear reactors (GPR).

Incorporating HOF into engineering activities

ASN considers that the licensee must systematically take steps to incorporate human and organisational factors into engineering activities involved in the design of a new facility or the modification of an existing one.

In 2009, with the support of IRSN, ASN continued with its review of EDF's implementation of this approach in the design of the EPR reactor at Flamanville.
– the organisational principles proposed by EDF for the operation team for the new reactor were considered by ASN to be acceptable;
– the programme of ergonomic assessment of the EPR operating systems planned by EDF during the simulator tests to be run until 2010 is considered to be satisfactory. However, ASN recalled that the tests scheduled and necessary for validation of the organisational, human and technical operating resources must be carried out, the lessons learned and design modifications made before the installation is commissioned. The tests must in particular enable ASN and its technical support organisation to reach a decision on the essential aspects of the safety case;
– ASN considers as satisfactory EDF's approach to incorporating human factors into the design process for premises and equipment which, during operation, will entail in-situ interventions.

Finally, ASN asked the GPR for its opinion by the end of 2010 on the organisational principles and human and technical resources EDF intends to deploy for operation of the FA3 reactor, so that it could rule on the acceptability of these resources in terms of human and organisational factors.

With regard to modifications of existing installations, at the beginning of 2009, EDF presented ASN with a report detailing its progress in deployment of the socio-organisational and human analysis (SOH) approach nationwide. During an inspection at CIPN in 2009, ASN checked the actual application of this approach in a number of modification files. The organisation set up at CIPN is satisfactory, but training of the staff in charge of the modification files concerned by HOF factors needs to be improved.

ASN asked IRSN for its opinion on the pertinence of EDF's SOH approach and the effectiveness of its deployment in the various engineering units and in the NPPs.

Incorporating HOF into the plants in operation

The national requirements are not implemented in the same way in all the NPPs. During its NPP inspections, ASN once again observed organisation memos and action plans which were not up to date, human factors (HF) consultants with no engagement letter, plants still without a local network of HF correspondents in the various disciplines, and networks for which the skills required to be an HF correspondent are not formally defined. In some plants, the consultants occupied in deploying national projects and analysing operating experience feedback do not have enough time to address the specific needs of the site itself.

ASN observed that the personnel are generally aware of the tools designed to improve the reliability of interventions as part of the national "human performance" project but that use of these tools varies widely and is sometimes completely lacking in conviction. Some personnel do not feel themselves to be concerned, particularly the more senior members of staff. The tool that is used most often and most widely accepted is the pre-job briefing. The efforts made by the sites to ensure practical implementation of these tools during training sessions (simulators, training worksites) must be intensified. Practical implementation of these tools by the subcontractors also needs to be continued.

The managers are increasing their presence in the field, but attaining targets sometimes appears to take priority over the qualitative aspect of the possible observations and findings. Moreover, the managers sometimes tend to give preference to field visits with clearly defined objectives (inspection, skills assessment) rather than keeping a close watch on the situation through more open observation of the working situations. ASN also noted the trend towards carrying out out field visits while the work was in progress rather than while it was being prepared or during the debriefing.

ASN noted that the field agents and the contractors are not yet associated with issuing and characterising the "grass-roots" observations from the field, which for the time being is reserved for the managers alone.

Analysis of HOF causes in operating experience feedback from reactors in operation

In the NPPs, HF consultants are on the whole well-integrated into the operating experience feedback analysis process. They sometimes support the various disciplines, usually at their request, to help them analyse the human factors aspects of a particular event. The HF correspondents, when appointed, are also involved in the disciplines.

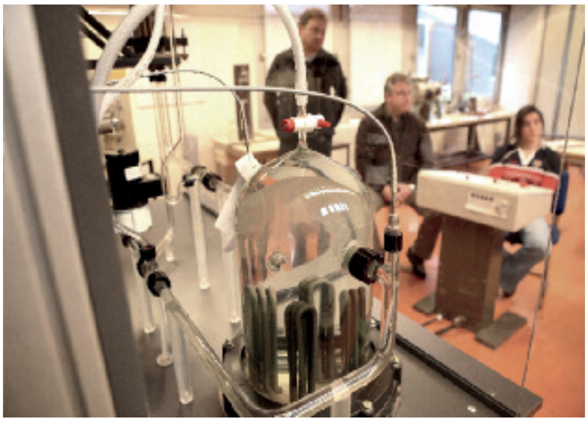
At a national level, the quality of the analysis of HOF causes in the significant event analysis reports is monitored. In 2009, ASN carried out an inspection in the head office departments in charge of this monitoring and considers that the organisation in place needs to be clarified and given a more official format. ASN also observed that this monitoring only concerns events identified as having national implications and that the traceability of this monitoring process needs to be improved.

Finally, the upwards trend in faults linked to ergonomics, already mentioned in 2008, was confirmed in 2009. In the significant event analysis reports notified by the NPPs, ASN observed inadequacies in the identification of causes related to the ergonomics of the workplace. When ergonomic aspects (labelling error, insufficient display of information, lack of working space, etc.) are identified by the plant, the lessons are not always learned and corrective action not always taken. Generally speaking, ASN considers that EDF needs to take particular measures to improve the ergonomics of the workplace and to improve how these aspects are dealt with during the operating experience feedback phase.

2 | 1 | 2 Regulating the management of employment, skills, training and qualifications within EDF

Control of BNI safety rests on the ability of the licensee's management system to ensure that appropriate skills and adequate resources are available at all times during the life of the installation. Article 7 of the order of 10 August 1984 in particular requires that "only individuals with the required skills may be assigned to an activity affecting quality".

The qualification issued by the licensee proves an individual's ability to perform given activities. ASN considers that qualification must be based on justification of the skills acquired through training and professional experience and the skills demonstrated in performance of the professional discipline concerned.



Training session in the training site laboratory in the Paluel NPP (Seine-Maritime *département*)

ASN regulation

Pursuant to the above-mentioned Article 7 of the order of 10 August 1984, ASN monitors the quality of the employment, skills, training and qualifications management system and its deployment in the EDF NPPs. This monitoring relies in particular on the inspections carried out in the plants. They are an opportunity to analyse the results obtained and the quality and the adequacy of the organisational and human arrangements actually made with regard to these issues. ASN also uses the assessments made at its request by IRSN and the GPR.

As in 2008, ASN's monitoring highlights a situation that is on the whole satisfactory. ASN on the whole sees the creation of the professional discipline academies as a particularly positive point, as is the use of the training worksites available in the NPPs.

Qualifications management is on the whole satisfactory. A few problems were noted, such as the insufficient updating of the individual professional progress logs, the absence of any equivalence justification, the absence of any indication that the progress specified in the course evaluation sheets has been achieved, or the absence of any data sheets concerning tutor-based actions. Additional efforts are also required in implementing the working situation observations process for skills evaluation, with these observations contributing to the qualifications renewal decision. Furthermore, the criteria on the basis of which qualification can be temporarily suspended need to be better explained.

2 | 1 | 3 Incorporating safety management into the general management system

In its INSAG 13 document "Management of Operational Safety in Nuclear Power Plants" published in 1999, IAEA gives the following definition: "The safety management system comprises those arrangements made by the organization for the management of safety in order to promote a strong safety culture and achieve good safety performance".

Safety management concerns the steps a licensee must take to establish its safety policy, define and implement a system allowing the safety of its NPP to be maintained and constantly improved. It is based on a process of continual safety improvement, incorporating:
– definition of requirements, of an organisation, or roles and responsibilities, of means and resources, particularly with regard to skills;
– preparation and implementation of arrangements for guaranteeing or enhancing safety;
– monitoring and evaluation of the implementation of these arrangements;
– improvement of the system on the basis of the lessons learned from the inspections and assessments carried out.

For ASN, the safety management system must provide a framework and support for the decisions and actions which either directly or indirectly concern safety issues. The safety management steps taken by the licensee must lead to decisions and actions that promote safety. They must also convey a message that enables the stakeholders to give safety the importance it deserves in their daily activities. Finally, it must be possible to compare them with the results achieved, to allow continual improvement and to ensure that safety progresses.

ASN regulation

The order of 10 August 1984 (see point 3|2|1 of chapter 3) contains the requirements to be followed by the licensee to define, obtain and maintain the quality of its installation and the conditions for its operation. These requirements in particular concern the organisation that the licensee, as the party responsible for its NPP, must put into place in order to control the activities affected by quality, in other words to obtain and guarantee safety.

ASN considers that safety management must be a part of the general management system, to ensure that safety is given consideration in the same way as the other interests protected by the TSN Act, such as radiation protection, environmental protection, but also the security of the electricity grid, the guaranteed supply of electricity to the country, as well as the cost control, NPP availability or corporate competitiveness objectives.

Use of a self-checks during a training session on a training worksite

Improving safety must be a permanent goal for the sites management system. During its inspections, ASN was able to assess the progress monitoring initiated by the sites, which is on the whole satisfactory. Improvements are needed in the traceability of this progress monitoring. It is also important for these measures to be clearly formulated and carried out at clearly defined intervals.

ASN observed that the significant events notified by EDF for operating experience feedback sometimes revealed shortcomings in the steps taken to control the quality of safety-related activities: lack of a questioning attitude, unwillingness to share personal doubts with a colleague or a hierarchical superior, incorrect decision-making without consulting the safety engineer, checks either not carried out or performed only superficially, taking of initiatives without appropriate risk analysis, lack of independence of an individual on the independent safety line. Specific context aspects are sometimes factors contributing to the event, such as the postponement or rescheduling of activities, or deadline pressure

2 | 1 | 4 Monitoring the quality of subcontracted operations

Maintenance of the reactors in the French NPPs is to a large extent subcontracted by EDF to outside companies. This activity involves about 20,000 contractors and subcontractors.

Implementing an industrial policy such as this is left to the initiative of the licensee. Pursuant to the order of 10 August 1984 (see point 3|2|1 of chapter 3) ASN's role is to ensure that EDF assumes its responsibility for the safety of its NPPs, by implementing a quality approach, and in particular by monitoring the conditions in which this subcontracting takes place. This approach is officially laid out in the "Progress and sustainable development charter" signed by EDF and its main subcontractors.

Selection and monitoring of the activities performed by the contractors

EDF has set up a contractor qualification system based on an assessment of their technical know-how and their organisation. In addition, EDF is required to monitor its contractors' activities, or have them monitored, and use operating experience feedback for a continuous assessment of their qualification.

ASN carries out inspections on the implementation of and compliance with EDF contractor monitoring requirements in the NPPs. As part of its oversight of the construction of the FA3 reactor, ASN also carries out inspections on this aspect within the various engineering departments in charge of the design studies (see point 2|4|2).

Radiation protection and occupational safety

This point is dealt with in point 3|8.

2 | 1 | 5 Submitting certain operations to a system of internal authorisations

ASN asked that for certain operations it considered to be sensitive from the nuclear safety and radiation protection standpoint, EDF submit them to a system of stricter internal checks as required by ASN decision 2008-DC-0106 of 11 July 2008 concerning implementation of the internal authorisations system in BNIs. Internal authorisations systems were approved by ASN for the following operations:

– lowering the primary system water level to the "low operating range" of the RRA system with core loaded (transient commonly called "mid-loop operation");
– reactor restart after outages without significant maintenance.

Authorisations in these two areas can only be issued by EDF management or the management of the NPP concerned, following a review by an independent internal body comprising the safety and quality managers. EDF also checks the working of these processes and reports on them to ASN.

2 | 2 Continuous nuclear safety improvements

2 | 2 | 1 Oversight of anomaly correction

Anomalies are detected in NPPs through the proactive measures taken by the licensee and the systematic checks required by ASN. EDF is cultivating a questioning attitude whereby it takes the initiative to look for anomalies.

These anomalies can have a variety of origins: design problems, construction defects, nonconformities introduced during maintenance operations, deterioration caused by ageing, and so on.

ASN considers that periodic reviews and a continuous search for anomalies by the licensee help guarantee that an acceptable level of safety is maintained.

Systematic verification: conformity checks

EDF carries out periodic safety reviews on the nuclear reactors every ten years (see point 2|2|3). EDF thus

Unannounced ASN inspection of 19 June 2009 at the Dampierre-en-Burly NPP following inadequate monitoring of a contractor

On 29 May 2009, during the maintenance and refuelling outage of the Dampierre-en-Burly 1 reactor, ASN was informed that a maintenance operation had not been carried out on the 1 RCV 003 PO pump by the subcontractor of the contractor responsible, even though the documents concerning this maintenance had been filled out and claimed that it had.

Further to this event, ASN carried out an unannounced inspection on 19 June 2009. This inspection identified the origin of this event as being a sequence of quality shortcomings in the preparation of the work and a breakdown in communication and quality assurance of the file by EDF and by the contractor. The inspectors felt that site monitoring was inadequate, even though the contractor was the subject of reinforced surveillance by EDF owing to the numerous anomalies detected in its work in EDF NPPs in 2007 and 2008.

The numerous anomalies detected by the inspectors are indicative of inappropriate monitoring on the part of EDF during the course of this maintenance:

- *lack of any organisation chart and activity monitoring programme;*
- *lack of manpower assigned to monitoring;*
- *failure to perform the analysis prior to the work, which should have identified the monitoring actions required;*
- *lack of a monitoring manager at the kick-off meeting;*
- *no coordination by the monitoring manager of the meeting to lift the prerequisites;*
- *no meeting at opening of the construction site, with joint visit and official report;*
- *no hold points on the maintenance quality plan, except for the first and last phases, corresponding to lifting of prerequisites and to the check on filling out of the quality plan at the end of maintenance respectively, even though the contractor was under reinforced surveillance by EDF;*
- *no real reinforced surveillance of this maintenance work;*
- *failure to suspend the construction site immediately, despite the problems observed by EDF.*

Furthermore, the monitoring carried out by EDF failed to detect the fact that the contractor had not filled out the maintenance quality plan in real time. The monitoring sheets were filled out by the monitoring manager after the work had been done and were neither dated nor countersigned by the contractor or its subcontractor, who were therefore unable to discuss the anomalies in question and propose remedial measures.

compares the actual condition of the NPPs with their applicable safety requirements and identifies any anomalies.

These verifications can be supplemented by a programme of additional investigations designed to check parts of the installation which are not covered by a specific preventive maintenance programme.

"Real time" verification

The performance of periodic test and preventive maintenance programmes on the equipment and systems also helps identify anomalies. For example, routine field visits are an effective means of discovering faults.

Informing ASN and the public

The public is informed of the most significant conformity anomalies (INES scale level 1 and higher) by means of ASN's website. An upstream system was created to ensure that ASN is specifically informed of any conformity anomalies discovered by EDF. When there is any doubt concerning the conformity of an equipment item, EDF notifies ASN accordingly. At the same time, the licensee attempts to characterise the problem encountered. The purpose of this characterisation is to determine whether there is really any nonconformity with regard to the safety requirements defined during the design process. If so, EDF specifies which equipment is affected and evaluates the safety consequences of the nonconformity. ASN is notified of the results of this characterisation. As applicable, EDF sends it notification of a significant safety event.

This procedure guarantees transparency with regard to both ASN and the public.

ASN's remediation requirements

ASN requires that anomalies with an impact on safety be corrected within a time-frame commensurate with their severity. Any conformity anomaly which significantly impairs safety must be corrected rapidly, even if the remedial measures entail a large volume of work. This is why ASN reviews the remediation methods and time-frame proposed by EDF. To carry out this review, ASN takes into consideration the actual and potential safety consequences of the anomaly. ASN cannot authorise restart of the reactor or decide to shut down the NPP until the repair has been completed. This is the case if the risk involved in operation while the anomaly is present is considered to be unacceptable and if there is no appropriate remedial measure. Conversely, the lead-time allowed for correction of a less severe anomaly may be increased when so justified by particular constraints. These constraints may be the result of the time needed to prepare for remediation in conditions of complete safety. They may also arise from national and European electricity grid security objectives.

For example, for earthquake resistance anomalies, one factor in assessing the urgency of the repair is the seismic level for which the equipment in question is designed. In cases in which there is only a need to restore a safety margin for an equipment item which can already withstand a large-scale earthquake, longer repair lead-times may be granted.

2 | 2 | 2 Examination of events and operating experience feedback

The general process for incorporating operating experience feedback

Operating experience feedback is a major source of improvement in terms of safety, radiation protection and the environment. This is why ASN requires that EDF notify it of significant events occurring in the NPPs. Criteria for notification of the authorities were defined for this purpose in a document entitled "guide to notification procedures and the codification of criteria concerning significant events in terms of safety, radiation protection or the environment, applicable to BNIs and radioactive material transport". Each significant event is therefore rated by ASN on the International Nuclear Events Scale (INES), which comprises eight levels from 0 to 7.

Both locally and nationally, ASN reviews all significant events notified. For certain significant events felt to be most important, because of their noteworthy or recurring nature, ASN has a more in-depth analysis carried out by IRSN.

ASN oversees how EDF utilises operating experience feedback from significant events and uses it to improve safety, radiation protection and environmental protection. During inspections in the NPPs, ASN also reviews the organisation of NPPs and the steps taken to deal with significant events and take account of operating experience feedback.

ASN also ensures that EDF learns lessons from significant events that have occurred abroad.

Finally, at the request of ASN, the GPR periodically reviews operating experience feedback from the operation of pressurised water reactors. The GPR met in December 2007 to review the significant events of the 2003-2005 period, in particular concerning events that were significant in terms of radiation protection, the operation of equipment classified as important for the safety of 1300 MWe reactor I&C systems, the operation of ventilation systems and analysis of operating stringency in certain situations and for certain maintenance work.

ASN asked the GPR to analyse the events of the 2006-2008 period at a meeting scheduled for late 2010.

Significant events in 2009

In accordance with the rules for notification of significant nuclear safety, radiation protection and environmental events, EDF in 2009 notified 795 significant events rated on the INES scale, including 699 concerning safety and 96 concerning radiation protection.

In addition, a total of 100 significant environmental protection events were notified, concerning neither nuclear safety nor radiation protection, as no radioactive materials were involved.

Graph 1 shows the trends in the number of significant events notified by EDF and rated on the INES scale since 2005.

Graph 2 shows the trends since 2005 in the number of significant events per area concerned by the notification: significant safety events (ESS), significant radiation protection events (ESR), significant environmental events (ESE).

The number of ESS grew by about 8%

The main cause of this increase is the rise in "generic" significant events. These events are those which concern several nuclear reactors. 28 significant safety events notified in 2009 were generic, as opposed to 11 in 2008. This rise can be primarily attributed to the particular attention paid by ASN to licensee identification of conformity anomalies in the plants. It led to an ASN inspection in early 2009. The gradual implementation by EDF of an operating practices harmonisation plan led to procedural errors in the early stages of its deployment. This rise is also linked to the VD3 900 conformity check which is nearing completion. Finally, ASN also noted that the number of events concerning the third barrier had increased.

The number of ESR fell by about 10% in 2009

On the other hand, the number of ESE again rose sharply in 2009.

The proportion of the number of ESS rated level 1 on the INES scale as compared with the total number of significant events rated in the year is about 10%, an increase over 2008, with 95 significant safety events rated and none for radiation protection. The rise in the number of ESS rated level 1 can be mainly attributed to the search for conformity anomalies. The discovery of certain recurrent anomalies leads to a highest INES scale rating, adding one point to it.

The anomalies currently being dealt with

Mixtures of unqualified greases

On 15 July 2009, EDF informed ASN of a generic incident concerning mixtures of greases in certain electrical servomotors. A servomotor is a motorised system enabling a mechanical element, such as a valve, to reach predetermined positions and then stay there. Opening or closure of valves actuated by an electric motor depends on the correct operation of the servomotor. When they play a role in reactor safety, these servomotors are said to be "qualified", in other words their ability to function in accident conditions has been checked. Maintaining this qualification depends in particular on the use of specific greases, which are themselves also qualified. During maintenance operations, EDF noted that a mixture of greases was used on qualified electric servomotors, which could compromise this qualification. Even though each of the greases was individually qualified, there is no confirmation that qualification of mixtures of these greases could be maintained in accident conditions. This incident was rated level 1 on the 7-level INES scale.

EDF drafted a monitoring and remediation programme concerning all the reactors in operation in France. At the same time, EDF modified its servomotors in order to make it impossible to inject grease erroneously. Finally, long-term steps were defined to make the servomotor lubrication activities more reliable.

Metal floor of an operations building of a CPY plant series reactor

Seismic resistance of metal gratings in the operations buildings

Investigations carried out by EDF revealed the existence of erection faults and non-conforming anchors on the metal gratings in the operations buildings of the Le Blayais, Chinon, Dampierre, Gravelines, Saint-Laurent, Tricastin and Cruas NPPs. In the event of an earthquake, the resistance of these gratings could be compromised.

EDF undertook to carry out remediation work on all the metal gratings no later than December 2009. This incident, which was notified to ASN on 30 March 2009, was rated level 1 on the INES scale.

One ESS was rated level 2 on the INES scale. This concerned the loss of the heat sink of Cruas-Meysse reactor 4 during the night of 1 December 2009.

The average number of events rated levels 0 and 1 per year and per type of reactor, varies according to the plant series, as shown in graph 3.

This is slightly up on 2008 for the 900 MWe and N4 reactors and down for the 1300 MWe reactors. The most significant rise, concerning the N4 reactors, is mainly due to the larger number of reactor outages in 2009 than in 2008. The increased amount of maintenance and activity during the outage periods generally contributes to a rise in the number of events. The small number of N4 reactors means that there might be no outage in one year and then three or four the next year, hence a greater fluctuation in the number of ESS from one year to another on these reactors.

2 | 2 | 3 Periodic safety reviews

Article 29 of the TSN Act requires that the licensees periodically conduct a safety review of their NPPs. This review is carried out every ten years.

The periodic safety review is an opportunity for an in-depth examination of the condition of the NPPs, to check that they comply with all the safety requirements and the applicable safety provisions. Its objective is also to improve the level of safety of the installations, particularly by comparing the applicable requirements with those applied to more recent NPPs. The periodic safety review ends with transmission of the report required in III of article 29 of the TSN Act. After analysis of this report, ASN may impose further technical demands. It notifies the ministers responsible for nuclear safety of its analysis of the report.

The periodic safety reviews therefore constitute one of the cornerstones of safety in France, by obliging the licensee not only to maintain the level of safety of its NPP but also to improve it.

The review process

The periodic safety review comprises a number of successive steps.

1. Comparison of the installation status with the safety requirements and applicable regulations, in particular comprising its authorisation decree and all ASN requirements: this is the conformity check. This conformity check aims to ensure that changes to the installation and its operation, as a result of modifications or ageing, continue to comply with all applicable regulations and do not compromise its safety requirements. This ten-year conformity check does not relieve the licensee of its permanent obligation to guarantee the conformity of its installations.

2. The safety reassessment

The purpose of the safety reassessment is to assess the safety of the installation and improve it in the light of:
– French regulations, and the most recent safety objectives and practices, in France and abroad;
– operating experience feedback from the installation;
– operating experience feedback from other nuclear installations in France and abroad;
– lessons learned from other installations or equipment involving a risk.

Possibly after consulting the GPR, ASN may rule on the study topics envisaged by the licensee before the launch of the safety reassessment studies, during the phase known as the periodic safety review orientation phase.

3. Following these two steps, the licensee sends ASN the periodic safety review report.

This report, required by Article 24 of decree 2007-1557 of 2 November 2007 as amended, comprises the following:
– the installation's operating context for the coming ten years;
– a ranking of the subjects covered by the safety review, along with an analysis to justify this choice;
– a summary of the conformity check presenting its results, identifying any anomalies and the steps taken to remedy them, with justification;
– a summary of the safety reassessment, presenting the methods used and the results plus, when necessary, any improvements envisaged with a justification of the expected benefits (possible modifications and corresponding implementation schedule);
– justification of the installation's ability to operate until the next periodic safety review in satisfactory safety conditions.

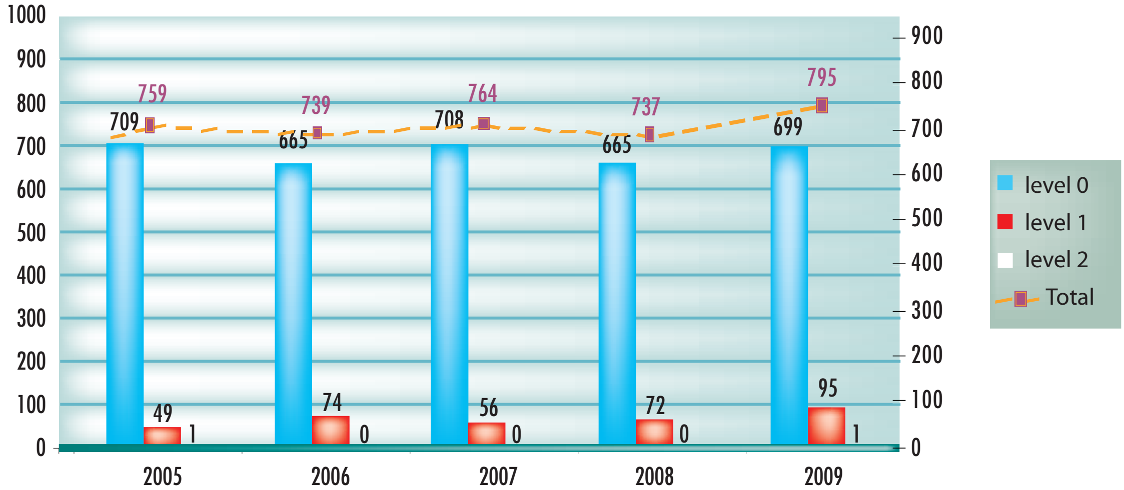
In the installation's periodic safety review report, the licensee adopts a stance on the regulatory conformity of its installation, and on the benefits of whether or not to implement the envisaged modifications designed to improve the installation's safety.

The periodic safety review concerning the third ten-yearly outages for the 900 MWe reactors

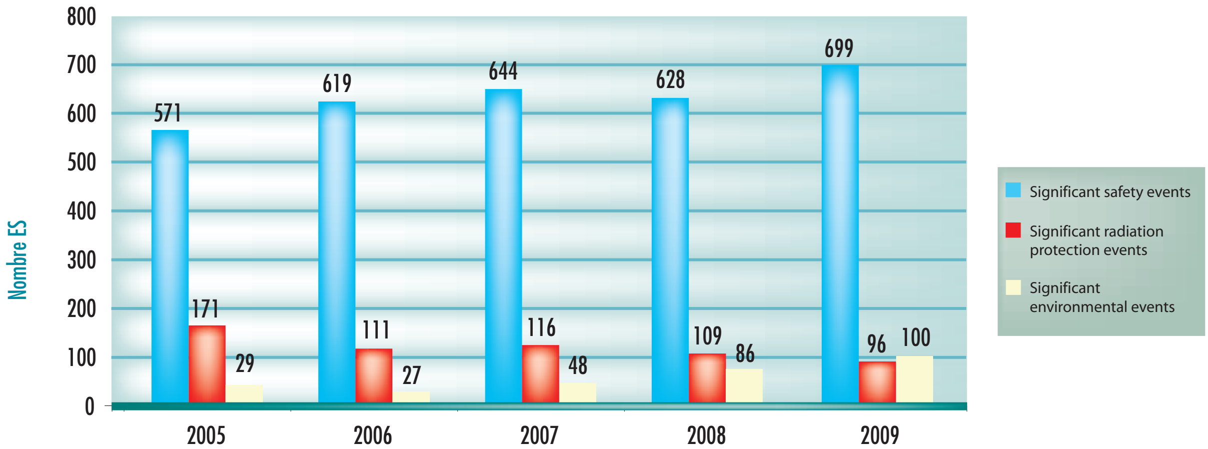
The ten-yearly outage is an ideal opportunity to make the modifications identified in the periodic safety review. To determine the ten-yearly outages calendar, EDF must take account of the hydrotesting schedule set by the nuclear pressure equipment regulations and the frequency of the periodic safety reviews as stipulated by the TSN Act.

The third ten-yearly outages began in 2009 for the first Tricastin and Fessenheim reactors and will end in about 2020 with the Chinon NPP.

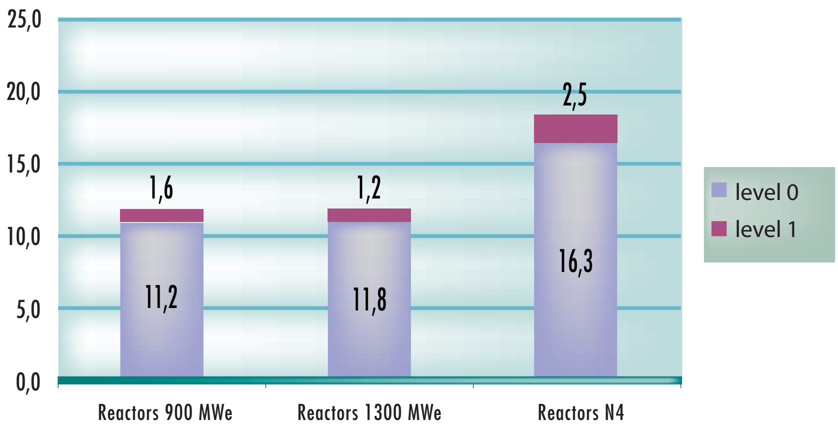
Graph 1: changes in the number of significant events rated on the INES scale in EDF nuclear power plants from 2005 to 2009



Graph 2: changes in the number of significant events per domain in EDF nuclear power plants from 2005 to 2009



Graph 3: average number of INES level 0 and 1 significant events in the EDF NPPs, per type of reactor, for 2009



Significant safety event on the Cruas-Meysse 4 reactor on 1 December 2009

On 1 December 2009, at about 7 p.m., following the massive arrival of plant debris carried by the Rhone river, the screens and strainers on the Cruas 4 reactor cooling water intake became blocked. The normal cooling of the reactor auxiliary systems was lost. EDF triggered the plant's emergency plan at about 11.50 p.m. EDF then implemented its emergency response plan.

EDF applied the operating procedures for management of this type of incident: reactor 4 was shut down and its cooling was provided by the systems designed to deal with these situations. EDF also unclogged the screens and strainers. The cooling systems for the other plant reactors remained operational.

Normal cooling of reactor 4 was returned to service on 2 December at 5.50 a.m. EDF and ASN lifted the emergency procedures at about 6.30 a.m.

ASN rated this incident level 2 on the 7-level INES scale, because simultaneous loss of the two redundant cooling system trains, which are important for safety, is a major failure of the safety arrangements, even if defence in depth remained at a level sufficient to deal with any further failures.

ASN carried out a follow-up inspection of the plant on 16 December 2009 to look at the equipment affected by the incident, reactor operations during the incident and management of the EDF on-site emergency plan. ASN noted that the design of the Cruas-Meysse NPP heat sink was unable to detect or prevent the large-scale arrival of plant debris. Furthermore, the operating procedure associated with this situation did not allow rapid triggering of the on-site emergency plan (PUI). It is however worth noting that the site was able to mobilise the material and human resources needed to deal with this situation.

The safety reassessment of the reviews associated with these ten-yearly outages concerned the following topics in particular:
– internal flooding;
– explosions originating on the sites;
– fire;
– earthquakes;
– climatic hazards;
– drifting oil slicks;
– external hazards liable to lead to simultaneous loss of the heat sink and the electrical power supply.

In July 2009, ASN issued a position statement on the generic aspects of continued operation of the 900 MWe reactors until 40 years after first criticality. ASN identified nothing to call into question EDF's ability to control the safety of the 900 MWe reactors until 40 years after first criticality. ASN also considers that the new safety requirements presented in the generic safety analysis report for the 900 MWe reactors and the installation modifications envisaged by EDF are such as to maintain and improve the overall safety level of these reactors.

However, this generic assessment does not take account of any specific features of individual reactors. ASN will therefore rule at a later date on the individual ability of each reactor to continue to operate, notably on the basis of the results of the verifications carried out during the reactor conformity check as part of the third ten-yearly outage and on the evaluation made in the reactor's safety review report.

The periodic safety review concerning the second ten-yearly outages for the 1300 MWe reactors

In 2006, subsequent to the safety review, ASN declared itself to be in favour of continued operation of the 1300 MWe reactors up to their third ten-yearly outage. The changes arising from this safety review will be implemented by 2014.

In 2009, the Belleville 2 and Nogent 1 reactors incorporated the changes following their second ten-yearly outage safety review.

The periodic safety review concerning the third ten-yearly outages for the 1300 MWe reactors

In 2009, ASN and IRSN began to look at the future orientations of the periodic safety review associated with the third ten-yearly outages of the 1300 MWe reactors. ASN will in particular ensure that this periodic safety review, the first to have been prepared after the TSN Act, complies with the requirements of the Act. The third ten-yearly outages for the 1300 MWe reactors should begin in about 2015.

The periodic safety review concerning the first ten-yearly outage for the 1450 MWe reactors

In 2008, ASN ruled on the orientation of the first periodic safety review for the 1450 MW reactors, which in particular concerns the level 1 probabilistic safety studies and the hazards studies. In 2009, the modifications resulting from the safety review concerning its first ten-yearly outage were implemented on the Chooz B2 reactor.

2 | 2 | 4 Approving modifications to equipment and operating rules

In accordance with the principle of continuous improvement of the safety of its reactors, but also to improve the industrial performance of its production tool, EDF periodically makes changes to equipment and operating rules. These changes can for example be the result of correction of nonconformities, periodic safety reviews, or to take account of operating experience feedback. Decree 2007-1557 of 2 November 2007 clarified the requirements concerning implementation of changes by EDF and their review by ASN.

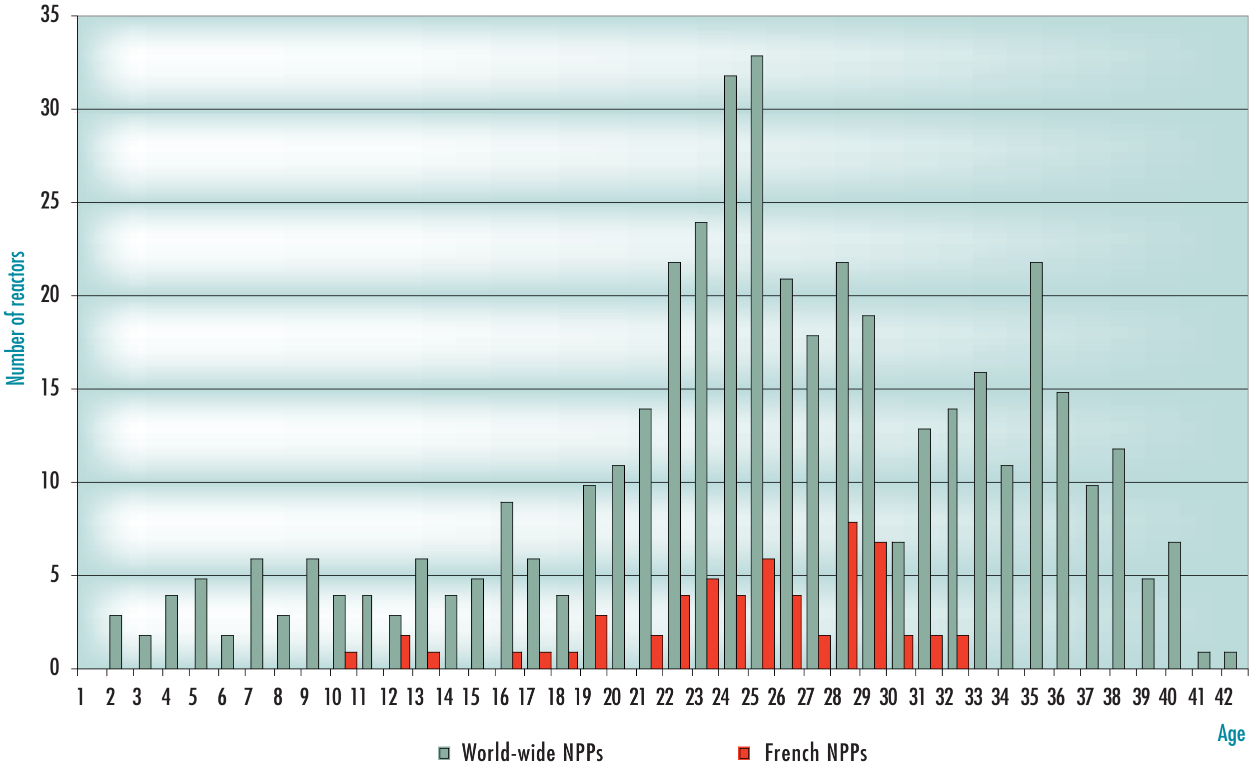
In 2009, the equipment change notifications received by ASN were primarily aimed at improving reactor safety and correcting conformity anomalies. Numerous changes reviewed in 2009 were related to the third ten-yearly outages of the 900 MWe reactors. After analysis of the various files by IRSN, ASN approved implementation of the changes for which the safety impact was considered to be acceptable.

Documentary changes are subject to prior notification to ASN under Article 26 of the above-mentioned decree when they concern chapters III, VI, IX or X of the general operating rules, presented in point 1|2|2. The main documentary changes dealt with in 2009 are presented in points 3|1|1, 3|1|2 and 3|2|4. In 2010, ASN will be expecting EDF to focus on generic modification requests, given the increasing numbers of specific change requests transmitted by each site.

2 | 3 Taking account of nuclear power plant (NPP) ageing

NPPs, like all industrial installations, are subject to ageing. ASN's role in this area is to ensure that, in line with its general operating and maintenance strategy, EDF takes account of ageing-related phenomena in order to maintain a satisfactory level of safety throughout the life of the NPPs.

Graph 4: age breakdown of the reactors in service worldwide (Sources: IAEA, March 2009 and CEA, Elecnuc edition 2008)



2 | 3 | 1 The age of the French NPPs in operation

The NPPs currently in operation in France were built over a relatively short period of time: forty-five reactors, representing 50,000 MWe, or three quarters of all the NPPs in service, were commissioned between 1979 and 1990 and thirteen reactors, representing a further 10,000 MWe, between 1990 and 2000.

In December 2009, the average age of the reactors, calculated from the date of initial reactor criticality, was as follows:
– 28 years for the thirty-four 900 MWe reactors;
– 22 years for the twenty 1300 MWe reactors;
– 12 years for the four 1450 MWe reactors.

2 | 3 | 2 Main factors in ageing

To understand the ageing of a NPP, other than simply the time that has elapsed since it was commissioned, a number of factors must be looked at.

The lifetime of non-replaceable items

The design of a certain number of reactor elements was based on a pre-determined service life, not only because of the cost of replacement, but also and indeed more so because of radiation protection of the workers who would be required to carry out the work. These components require close surveillance ensuring that their ageing rate is indeed as expected. This is in particular the case of the vessel, designed for a service life of at least 40 years (or the equivalent of 32 years of continuous operation at full power). The main mode of vessel ageing is irradiation, which modifies the mechanical properties of the steel of which it is made. The licensee must therefore take steps to predict changes to the vessel's properties and demonstrate that despite these changes, the equipment is able to withstand all normal or degraded operating situations it is likely to encounter, taking account of the safety margins set by the regulations. The reactor vessel is thus checked by monitoring "control samples" of metal and appraising them at regular intervals (see point 3|4|3).

Deterioration of replaceable items

Equipment ageing is the result of phenomena such as the wearing of mechanical parts, hardening and cracking of polymers, corrosion of metals and so on. The equipment must be given particular attention during design and manufacture (in particular the choice of materials) and be the subject of a surveillance and preventive maintenance programme, with repair or replacement as necessary. It must also be possible to demonstrate the feasibility of possible replacement.

Equipment or component obsolescence

Equipment that is important for safety is "qualified" for installation in NPPs. The availability of spares for this equipment is heavily dependent on industrial production by the suppliers. Should the manufacturer cease to make certain components, or simply go out of business, this could create original part procurement problems for certain systems. The safety level of any new spares must then be demonstrated prior to installation. This is to ensure that the equipment remains "qualified" with the new spare part. Given the length of this procedure, the licensees must adopt a vigorous forward-looking policy.

The ability of the NPP to follow changes in safety requirements

Greater knowledge and technological improvements, as well as changes in the acceptability of risk in our societies, are also factors which can lead to the decision that an industrial facility requires extensive renovation work or – if this cannot be done at an acceptable cost – closure at some time in the relatively near future.

2 | 3 | 3 How EDF manages equipment ageing

This "defence in depth" type strategy is based on three lines of defence.

Designing-in the ageing process

During the design and manufacture of components, the choice of materials and the installation arrangements must be tailored to the intended operating conditions and take account of the known or presumed deterioration processes.

Monitoring and anticipating ageing phenomena

During operation, deterioration phenomena other than those designed-in can be revealed. The periodic surveillance and preventive maintenance programmes, the conformity checks (see point 2|2|1) or the operating experience feedback review (see point 2|2|2) aim to detect these phenomena.

Repairing, modifying or replacing equipment likely to be affected

This type of action has to be planned in advance, given the procurement lead-times for new components, the maintenance preparation time, the risk of obsolescence of certain components and the risk of gradual loss of staff technical skills.

2 | 3 | 4 ASN's policy

From a strictly regulatory standpoint, in France there is no limit on the time that an NPP is authorised to operate.

The authorisation decrees (DAC) issued by the French Government do not specify any limit on the operating life. However, these documents refer to the safety analysis report which specifies a hypothetical operating life of 40 years for certain components. In 2009, EDF informed ASN that its goal was to extend the operating life of the nuclear power plants beyond 40 years, under an industrial programme enabling this objective to be achieved in terms of nuclear safety.

In the run-up to the 900 MWe reactors third ten-yearly outages, ASN therefore in 2001 asked EDF to present a precise account of the ageing status of each reactor concerned and demonstrate the possibility of continuing with operation beyond 30 years in satisfactory safety conditions. In response to this request, EDF drew up a programme of work concerning management of the ageing of its 900 MWe reactors.

Implementation of this ageing management programme, the forthcoming periodic safety reviews (VD4), and the demonstration of the strength of certain items such as the vessel or the containment beyond 40 years of operation will all be examined by ASN when it reaches a decision on the ability of the reactors to continue to operate for more than 40 years.

ASN also considers that the new safety requirements presented in the generic safety analysis report for the 900 MWe reactors and the installation modifications envisaged by EDF are liable to maintain and improve the overall safety level of these reactors. The Tricastin 1 and Fessenheim 1 reactors were shut down in 2009 for their third ten-yearly outage. During the course of these outages, which last several months, the reactor is shut down and in-depth, extensive checks are carried out. Based on the results of these checks and on the changes made following the safety review, ASN will issue a position statement, reactor by reactor, on their ability to continue to operate beyond the third ten-yearly outage and for a period of up to forty years. As necessary, it could request intermediate checks before the forty year deadline.

2|4 The Flamanville 3 EPR reactor

After a period of about ten years during which no nuclear reactors were built in France, EDF in May 2006 submitted an application to the ministers responsible for nuclear safety and radiation protection for the creation of a 1600 MWe EPR type reactor on the Flamanville NPP, which already houses two 1300 MWe reactors.

The EPR reactor, which has been under development by AREVA since 1989, is a pressurised water reactor based on an “evolutionary” design, by comparison with the reactors currently in service in France, enabling it to comply with stricter safety objectives.

Overview of the EPR construction site at Flamanville – August 2009

The Government authorised its creation by decree 2007-534 of 10 April 2007, following ASN’s favourable opinion after the technical review conducted with the assistance of its technical support organisations.

After issue of the authorisation decree (DAC) and the building permit, construction work began on the FA3 reactor in September 2007 and is scheduled to last about 5 years. Pouring of concrete for the buildings on the nuclear island began in December 2007. Since then, rebar installation and concreting work has continued. In parallel with the construction work on the Flamanville site, manufacture of the pressure equipment, in particular that of the primary system (vessel, pressuriser, pumps, valves, pipes, etc.) and secondary system (steam generators, valves, pipes, etc.) is in progress in the manufacturers' plants.

2|4|1 The steps up to commissioning

Pursuant to decree 2007-1557 of 2 November 2007 (see point 3|1|3 of chapter 3), introducing nuclear fuel into the perimeter of the NPP and the subsequent start-up, require authorisation by ASN. According to Article 20 of this same decree, the licensee must, one year before the intended commissioning date, send ASN a file comprising the safety analysis report, the general operating rules, a study of NPP waste management, the on-site emergency plan and the NPP decommissioning plan.

Without waiting for transmission of the complete commissioning application file, ASN and IRSN together initiated an advance review of certain topics that required lengthy investigation. At the same time as this advance technical review, to prepare for the commissioning

EPR construction site at Flamanville – September 2009: construction of the reactor building outer containment wall

EPR construction site at Flamanville – installation of the nuclear island basemat – September 2009

authorisation, ASN also checks the construction of the NPP in order to rule on its quality and its ability to comply with the defined requirements.

Advance review of required documents

The advance review conducted by ASN and IRSN mainly concerns the content of the safety analysis report and the general operating rules which have changed with respect to current reactors, especially concerning:
– the methodologies and computer software used by EDF to model incident and accident transients that could occur within the reactor;
– the principles and methods for drafting general operating rules within the framework defined by the regulations;
– the organisational principles and the human and technical resources planned by EDF for operation of the FA3 reactor, for which ASN will request the opinion of the GPR in December 2010 (see point 2|1|1).

Construction oversight

For ASN there are many construction oversight issues involved for the FA3 reactor. They concern:
– applying the rules laid out in the TSN Act to inspection of the construction process;
– controlling the quality of performance of the NPP construction activities in a manner proportionate to the safety, radiation protection and environmental protection issues;
– building on the experience acquired by each party concerned during the construction of this new reactor.

To do this, ASN carries out its regulation and inspection duties and, for the DAC application, produced requirements for the design and construction of FA3 and for the operation of the two Flamanville 1 and 2 reactors located close to the construction site.

The principles and procedures for oversight of the EPR reactor construction cover the following steps:
– detailed design, during which the engineering studies define the data necessary for construction;
– the construction activities, which include site preparation after issue of the authorisation decree, manufacture, construction, qualification and erection of structures, systems and components, either on the NPP or on the manufacturers' premises.

This oversight also covers control of the risks the construction activities present for neighbouring BNIs (Flamanville 1 and 2 reactors) and for the environment. As we are dealing with a nuclear power reactor, ASN is responsible for occupational health and safety inspection duties on the construction site.

Finally, in addition to ensuring oversight of the reactor buildings construction site, ASN also checks the manufacture of the nuclear pressure equipment to be installed in the primary and secondary systems of the nuclear steam supply system. ASN action in this field in 2009 is described in point 2|4|2.

2|4|2 Construction oversight in 2009

Detailed design review

The detailed design review is carried out by ASN with the technical support of IRSN on the basis of a documentary review. In 2009, ASN asked the GPR for its opinion on the design of the digital I&C system and the hardware platforms designed to host its software. The architecture of the digital I&C system comprises two platforms, one of them – for backup operation – was developed specifically for the nuclear industry, while the other – for normal operation – is an off-the-shelf industrial component.

For the latter it is proving harder to demonstrate compliance with nuclear safety requirements than for the components for which these requirements are designed-in. ASN notified EDF of its requests. The ASN conclusions concerning the I&C architecture analysis are shared by the British (HSE) and Finnish (STUK) regulators. Through the international cooperation arrangements (see point 2|4|3) this position led to a joint position statement.

In addition to the detailed design technical review carried out with the support of IRSN, ASN in 2009 conducted nine inspections in the engineering departments in charge of carrying them out and of monitoring manufacturing at the suppliers. ASN thus checked implementation of the requirements of the order of 10 August 1984 in the project management system, in particular the requirements concerning management and oversight of the contractors, identification and management of quality-related activities, management of anomalies, management of operating experience feedback and the consideration given to human and organisational factors on the construction site. Implementation of these requirements was checked both in the engineering departments and on the FA3 construction site.

During these inspections, ASN noted that the organisation put into place in the various EDF departments in charge of monitoring was on the whole satisfactory. Problems with the traceability of the surveillance work carried out by EDF were however detected. Moreover, ASN considers that EDF needs to improve its system for monitoring the documents used in the manufacture of systems, structures and components, to ensure that the right version is used. It also became clear that, with the assistance of specialists in this field, EDF needed to adopt a more systematic analysis and improvement approach to sensitive activities carried out on the construction site, from the human and organisational factors standpoint.

Oversight of construction activities on the FA3 NPP

In 2009, ASN carried out 24 inspections on the construction site, with the assistance of IRSN. These in particular concerned the following technical topics:
– civil engineering, including installation of the steel liner on the reactor building inner containment wall;
– initial electromechanical equipment erection activities;
– electrical systems;
– non-destructive testing and radiation protection;
– organisation and management of safety on the construction site;
– the impact of the construction site on the safety of the Flamanville 1 and 2 reactors.

Following the inspections carried out in 2009 and the review of the anomalies, ASN considers that the Bouygues company, which holds the civil engineering contract, had improved the quality of its documentation and its internal technical supervision. In the civil engineering field, ASN noted the considerable number of requests for waivers to the construction safety requirements and considers that the rigour applied to identifying and justifying these waivers needs to be intensified. ASN noted that the first erection work on the electromechanical systems was not yet benefiting in full from the operating experience feedback from the civil engineering activities, as required by the order of 10 August 1984, in particular prior identification of the activities likely to affect the safety of the future reactor.

Together with IRSN, ASN also initiated a detailed review of the causes and handling of the deviations most significant for safety in 2009.
– At the end of 2008, ASN noted high repair levels following welding of the elements making up the steel liner on the reactor building inner containment wall. On 4 February 2009, ASN asked EDF to take measures to significantly improve the quality of these welds and, in the meantime, to extend radiographic inspection to 100% of the welds. At the end of July 2009, EDF reduced this inspection rate in the light of the significant improvement in the quality of the welds made on the steel liner over a period of several weeks.
– During the course of several inspections, ASN and IRSN observed on the one hand that the construction joints were of insufficient quality and, on the other, that the treatment methods used for these construction joints were not specified in the applicable construction requirements. ASN asked EDF to justify the use of methods other than those specified in the construction requirements. While waiting for these justifications, EDF is limiting the use of these methods to those operations for which the methods specified in the construction requirements are inappropriate and is carrying out stricter checks on their application.
– During the 28 May 2009 inspection on the basemat of the reactor building containment internals, the inspectors alerted EDF to the large number of tasks to be carried out before the planned concreting phase. Following this concreting phase, a review of the anomalies observed by EDF and the contractor in particular showed that an insufficient volume of concrete had been poured in some places and that the formwork had been modified during the concreting operations. These anomalies do not compromise the safety of the structure but do highlight the considerable pressure exerted by the construction schedule. ASN asked EDF to take appropriate measures to prevent a recurrence of this type of situation which generates anomalies.

Occupational health and safety inspection on the FA3 reactor construction site

The occupational health and safety inspections have been carried out by the ASN Caen division since signing of the DAC. The action taken in 2009 consisted in:
– participation in meetings of the joint companies commission for safety, health and working conditions (CIESSCT) and the operational committee for the prevention of illegal labour (COLTI);

– performance of safety inspections on the NPP;
– performance of investigation of accidents occurring on the NPP;
– response to direct requests from the employees;
– response to requests concerning risk prevention plans on construction sites with a large number of contractors.

In 2009, ASN's occupational health and safety inspectors in particular verified that the contractors working on the site complied with the requirements of the Labour Code concerning the declaration of foreign workers, working hours, the risks involved in simultaneous work and the incorporation of operating experience feedback from the others reactors in operation into the design of this reactor.

Regulation of nuclear pressure equipment manufacture

Nuclear pressure equipment (ESPN) comprises the components of a nuclear installation subjected to pressure, which can give rise to radioactive emissions if they fail (vessel, piping, steam generators, etc.). Manufacture of these items is regulated by the order of 12 December 2005 which adds extra safety, quality and radiation protection requirements to the regulatory requirements applicable to the manufacture of conventional pressure equipment (decree of 13 December 1999). ASN considers that the quality of nuclear pressure equipment has to be exemplary, because it determines the safety of nuclear installations. ASN thus assesses conformity with the regulatory

EPR construction site at Flamanville – September 2008: construction of the turbine hall

EPR construction site at Flamanville – September 2009: construction of the pumping station

EPR construction site at Flamanville – June 2009: construction of the operation buildings

ASN stance on EPR reactor I&C

ASN's status and independence and its policy of transparency require that it systematically make public its stance on important subjects. Its position on EPR reactor I&C is based on the assessments so far carried out:
- *in March 2007, ASN released its opinion on the draft authorisation decree, in which it considered a digital EPR I&C system to be acceptable in principle.*

In February 2008, ASN sent EDF a warning letter concerning the planned I&C detailed design, in which EDF would be taking an "industrial risk" by opting for a solution which might not in the end be validated;
- *in June 2009, the GPR issued its opinion on the basis of an analysis by IRSN;*
- *in October 2009, ASN sent EDF a letter mentioning the complexity of the design proposed and underlining that there was nothing to guarantee its feasibility. ASN in particular asked for modifications to the design of this system and additional safety justifications. Similar stances by the Finnish and British nuclear regulators were also sent to AREVA.*

The EPR safety check follows an iterative process, with industry proposing solutions and ASN adopting a stance on them. The ASN stances may naturally lead to design changes. This type of in-depth technical dialogue enables ASN to strengthen the safety choices made. The I&C letter of October 2009 is only one step in this iterative process.

The ASN stance on the EPR I&C system, which is consistent with that of its foreign counterparts, stems from the difficulty that EDF and AREVA have been having so far in producing data to demonstrate its safety. On 2 November 2009, the British (HSE), Finnish (STUK) and French (ASN) nuclear regulators published a joint position statement on the design of the EPR reactor's I&C system. The fact of having made this position public is fully in line with the goals of the 2006 Act on transparency and security in the nuclear field.

requirements of each of the most important ESPN, except for small-diameter pipes. The conformity of the other ESPN is also checked by approved inspection organisations. ASN oversight takes place at the various stages of ESPN design and manufacture. It entails documentary reviews and inspections at the manufacturers, their suppliers and their subcontractors. Furthermore, when a manufactured component entails risks of characteristics heterogeneity owing to the materials production process or the complexity of the manufacturing operations, ASN also asks the manufacture to prove that it is capable of managing these risks. The manufacturer must identify all the possible causes of heterogeneity in the components it produces (risk analysis based on the production process) and demonstrate that the manufactured components will be of the required quality.

In 2009, ASN reviewed a large number of files concerning the design and manufacture of the equipment on the primary and secondary systems of the EPR reactor (vessel, reactor coolant pumps, pressuriser, steam generators, pipes and valves). ASN also itself carried out or asked approved inspection organisations to carry out more than 1600 inspections on this equipment at the manufacturer AREVA NP, its suppliers and their subcontractors. During these inspections ASN noted deviations which are often the result of manufacture of equipment items before their detail design was finalised.

From 14 to 18 September 2009, ASN carried out an in-depth safety management inspection of AREVA NP's manufacture of nuclear pressure equipment (reactor vessel, primary system piping, etc.). This type of large-scale inspection enables ASN to conduct a detailed examination of a site or a range of activities, in order to obtain a more complete picture of the work done and the results achieved by a manufacturer or licensee in a specific area.

The inspection team, consisting of seven ASN agents, reviewed the steps taken by AREVA NP to ensure the quality of the equipment manufactured and which determines the safety of the NPPs built. This inspection took place in the AREVA NP premises in Paris La Défense and in the Chalon-sur-Saône plant. The following topics in particular were examined: quality organisation, decision making procedures, updating of regulation documentation, approval and monitoring of suppliers.

This inspection, which took place in a constructive atmosphere, identified several good practices and strong points in the organisation, particularly in various key processes designed to guarantee high-quality production: audits, internal inspections, processing of anomalies. The ASN inspectors also underlined the high level of qualification of the internal auditors and inspectors and the quality of their reports.

However, ASN considers that the goal must be the highest possible level of nuclear installation safety. Under the supervision of the licensee, a nuclear pressure equipment manufacturer must therefore aim for the highest possible level of quality. In this context, ASN detects possible areas for improvement at the manufacturer AREVA NP.

ASN observed that the roles and duties of the persons in charge of quality at AREVA NP needed to be clarified. It considers that the decision-making process within the company requires a more formal framework. ASN asked AREVA NP to improve certain points in the supplier approval and monitoring processes and to improve how lessons are learned following discovery of an anomaly. ASN also asked AREVA NP to make progress in the field of compliance with documentation requirements.

For ASN, 2009 was significant in that it detected two major anomalies during the manufacture of certain ESPN intended for the FA3 EPR reactor.

AREVA NP detected a manufacturing anomaly on a steam generator component at the end of 2008. This involved an error in the positioning of a hole for a steam generator nozzle. AREVA NP sent ASN a proposal for replacing this component by another, which was already manufactured but whose characteristics were not identical. During the course of 2009, ASN reviewed this proposal. The justifications provided by AREVA NP, and the tests and inspections carried out on the alternative component proposed, enabled the conformity check on the steam generator in question to be continued.

At the end of 2008, during a pressuriser manufacturing inspection, ASN also detected an anomaly in compliance with the mechanical castings production procedures at an Italian supplier of AREVA NP. This anomaly, which involved the use of equipment that did not conform to the standards for performance of mechanical tests to verify the quality of the manufactured parts, resulted from incorrect use of the applicable documentation. This anomaly led ASN in 2009 to reject some of the pressuriser components and request the performance of additional mechanical tests on the components which were not scrapped, in order to demonstrate their conformity. Finally, enhanced monitoring of this supplier was put into place at the request of ASN. This led to inspection by an approved organisation of all the stages in manufacturing important for quality.

2 | 4 | 3 Cooperation with foreign nuclear regulators

At a time when nuclear programmes are enjoying renewed interest worldwide and in order to share experience with other regulators, ASN is increasing its technical exchanges with its foreign counterparts on the design and construction of new reactors.

Bilateral relations

ASN enjoys close relations with foreign nuclear regulators in order to share previous and current experience of authorisation procedures and regulation of the construction of new reactors. In 2009, ASN and IRSN took part in bilateral meetings with the Finnish and British nuclear regulators.

Owing to the EPR reactor construction projects at Olkiluoto in Finland and Flamanville in France, ASN and IRSN in 2004 set up enhanced cooperation with the Finnish nuclear regulator (STUK). In 2009, this enhanced cooperation took the form of two technical meetings and two cross-inspections on the topic of civil engineering, on the FA3 and Olkiluoto 3 construction sites.

Regular discussions between STUK and ASN also take place in order to share experience of nuclear pressure equipment manufacturing.

Enhanced bilateral cooperation with the United Kingdom involves the secondment for several years of a British inspector to ASN and of an ASN inspector to the British regulator as well as technical discussion meetings, in particular concerning I&C.

ASN also observed an inspection carried out by the British nuclear regulator (HSE NII) on the assessment of the EPR design.

Similarly, enhanced bilateral relations with the American nuclear regulator (NRC) led in 2009 to the secondment of an NRC inspector to ASN and of an ASN inspector to NRC, along with a visit by several NRC commissioners and the head of the department in charge of regulating new reactors. In-depth discussions on respective inspection methods also took place during an inspection on the FA3 construction site, in which two NRC inspectors took part.

Towards multinational cooperation

In 2007, the US Nuclear Regulatory Commission (NRC) received an application for certification of an EPR reactor from an industrial group. Cooperation between France and Finland was therefore extended to the United States, for drafting of a multinational cooperative programme for new reactors, called MDEP (Multinational Design Evaluation Program). Canada and the United Kingdom are now also participants in the MDEP group dedicated to the EPR reactor.

Four specific EPR meetings were held in March, May, September and December 2009, one of which especially concerned the topic of instrumentation and control (I&C). Multinational cooperation within the MDEP group took the form of publication of a joint declaration by HSE, STUK and

ASN on the level of requirements relating to the I&C design and safety case.

Other international structures, such as NEA, also offer opportunities to discuss practices and lessons learned from regulating construction of reactors other than the EPR. For ASN, these international exchanges are one of the driving forces behind the harmonisation of safety requirements and regulatory practices.

2 | 5 The reactors of the future: initiating discussions on generation IV safety

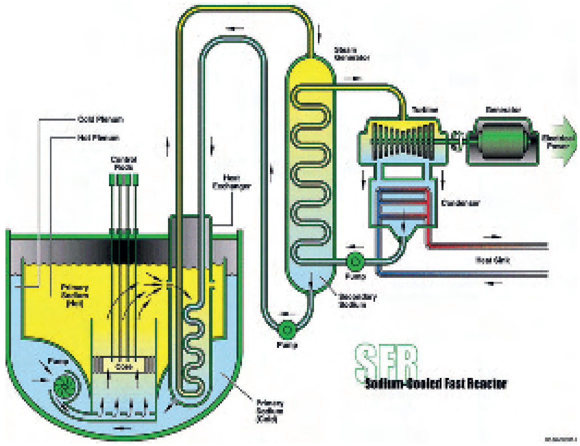
The research organisations and industrial firms of twelve leading nuclear countries, along with the European Union through EURATOM, are preparing for the fourth generation of reactors within the "Generation IV International Forum" (GIF) launched in 2000. Within the GIF, these various partners are pooling their research and development (R&D) efforts in order to assess the potential of different possible reactor technologies.

As part of this international cooperation, the French industrial firms (CEA, AREVA, EDF) are more particularly committed to R&D programmes on sodium-cooled fast neutron reactors (RNR-Na) – a technology for which France already has considerable expertise with Phénix and SUPERPHÉNIX – but also on gas-cooled fast neutron reactors – which is a more long-term prospect requiring further technological innovation.

In the planning Act of June 2006, France set itself the goal of commissioning a first industrial prototype of a fourth-generation reactor by 2020, to pave the way for possible industrial deployment in about 2040-2050.

With this medium to long-term project in mind, ASN plans to initiate monitoring of the development by the industrial partners of the fourth generation of reactors and the corresponding safety prospects. The industrial players in the project therefore formalised a part of their research programme concerning RNR-Na safety in a document sent to ASN and to IRSN at the end of 2009.

For its part, ASN informed the French stakeholders of what it expected in terms of the discussion framework required for the project safety review, on the one hand, and the first documents required in order to initiate the technical discussions, on the other. The first documents expected in late 2009 and early 2010 concern:
– national and international operating experience feedback on the RNR-Na reactors;
– the orientations concerning safety options and R&D actions;
– justification of the choice of RNR-Na reactors.



Schematic of a sodium-cooled fast reactor

ASN considers that the generation IV reactors will have to offer greater safety than the EPR type reactors. Although the initial review work primarily concerns the safety prospects of the RNR-Na reactors, ASN hopes that the safety potential of other types of reactors will also be examined, so that the debate is kept open at this point with regard to the safety objectives of the next generation of reactors.

2 | 6 Reliance on nuclear safety and radiation protection research

Fundamental and applied research is one of the keys to progress in the field of nuclear safety and radiation protection, for several reasons:
– development and validation of innovative technical solutions allow the emergence of new products or processes for operation and maintenance; these solutions replace techniques or intervention methods which offer a lesser degree of protection;
– certain research work aims to improve knowledge of the risks, especially concerning severe accidents, in order to better target protective measures or even spotlight risks that had hitherto been poorly assessed: this is for example the case with experiments concerning the phenomenon of sump clogging, or studies into individual and group behaviour in stressful situations, leading to an improved evaluation of the role of human and organisational factors;
– research is useful in developing high level skills in the field of nuclear safety and radiation protection, thus helping to ensure that there is a ready supply of specialists.

Research into nuclear safety and radiation protection frequently requires the modelling of complex systems (NPPs, the physical-chemical phenomena involved, etc.): the development of increasingly sophisticated computer codes using constantly growing and changing IT resources must be mastered, from expression of requirements to validation of the tool. ASN is attentive to this validation phase, so that the demonstrations by the licensee or the appraisals by the technical support organisations are based on scientifically proven methods or results.

Knowledge of the latest research findings and those questions which still remain unanswered enable the regulatory authorities to measure how realistic their demands really are. ASN therefore keeps abreast of ongoing research work to increase the pertinence of its demands. The ability of the regulatory authorities, or their advisory expert organisations, to control the direction in which research is going, enables them to look again at safety issues that were assumed to be resolved: for example, interpretation of the experiments conducted by IRSN led to a review of the sump clogging risk.

Furthermore, if this knowledge of the latest research findings is important during international discussions between safety regulators, when comparing their nuclear safety and radiation protection actions, then it is essential to the ASN and IRSN contribution to the drafting of recommendations for the IAEA guides.

It is also important for the licensees to make a significant contribution to the nuclear safety and radiation protection research effort, using the results to make their NPPs even safer. There are a number of driving forces behind research into nuclear safety and radiation protection, whether technological aspects or human and organisational factors:

– new reactor projects: the research work launched for the EPR reactor and that associated with the design of the fourth generation reactors, led to the development of new solutions, some of which could be implemented on the existing reactors;
– the desire of industry to improve the performance of its tools: for example, EDF's intention to increase nuclear fuel performance in particular generated work on uranium oxide ceramics, fuel assembly cladding materials and the design codes. This work is also a means of advancing the store of available knowledge and, in certain cases, enhancing safety, for example by improving accident study methods;
– the reactor lifetime issue: EDF's wish to continue with operation of the existing plants initiated research into materials ageing and the evolution of structures and components, particularly the performance of the concrete containments and the properties of steel under the effects of irradiation;
– taking account of event experience feedback: for example the research into the risk of flooding or modelling of oil slick drift.

ASN is aware of the high stakes involved in being familiar with the latest research findings and has set up an organisation to more precisely identify its requirements. ASN thus identified the main subjects of interest, which would require greater investment.

3 NPP SAFETY

3 | 1 Operation and control

3 | 1 | 1 Operation in normal conditions: authorise documentary changes and ensure that they are followed

Technical operating specifications (STEs)

Chapter III of the GOR presents the reactor STE, the role of which is:
– to define the normal operating limits of the NPP if it is to remain in conformity with the reactor design basis scenarios;
– depending on the condition of the reactor in question, to define the safety functions necessary for the monitoring, protection and safeguard of barriers as well as implementation of incident and accident operating procedures;
– to specify the course of action to be followed if a normal operating limit is exceeded or if a required safety function is unavailable.

Permanent modifications to the STEs

EDF may be required to modify the STEs to take account of its operating experience feedback, improve the safety of its NPPs, improve economic performance or even incorporate the consequences of equipment modifications.

In 2009, ASN reviewed a number of documents modifying the STEs permanently, which were either approved or were the subject of requests for additional justifications. One of these files concerns the incorporation of the changes to be made for "Galice" fuel management of the 1300 MWe reactors.

Temporary STE modifications

When, in exceptional circumstances, EDF needs to deviate from the normal operation required by the STEs during an operating or maintenance phase, it must notify ASN of a temporary modification of the STEs. ASN reviews this modification and may approve it, possibly subject to implementation of remedial measures if it considers that those proposed by the licensee are insufficient.

ASN ensures that the temporary modifications are justified and conducts an in-depth yearly review on the basis of a summary produced by EDF. EDF is thus required:

– periodically to re-examine the reasons for the temporary modifications in order to identify those which would justify a request for permanent modification of the STEs;
– to identify generic modifications, in particular those linked to implementation of national equipment modifications and periodic tests.

Field inspection of normal operation

During NPP reviews, ASN checks:

– compliance with the STEs and, as necessary, with the remedial measures associated with the temporary modifications;
– the quality of the normal operating documents, such as the operating instructions and alarm sheets, and their consistency with the STEs;
– staff training in reactor operations.

3 | 1 | 2 Examination of incident or accident operating rules

The condition-based approach (APE)

In the event of an incident or accident on the reactor, the personnel have operating documents at their disposal, designed to enable them to return the reactor to and maintain it in a stable condition.

The steps to be taken in the event of an incident or accident use the condition-based approach (APE). The APE consists in defining operating strategies according to the identified physical condition of the nuclear steam supply system, regardless of the events that led to this condition. Should the condition deteriorate, a permanent diagnosis enables the procedure or sequence in progress to be aborted and a more appropriate procedure or sequence to be applied.

View of an NPP control room

These operating documents are drafted on the basis of incident and accident operating rules, as presented in chapter VI of the GOR. Implementation or modification of these documents must be notified to ASN. During the course of 2009, ASN continued to review changes proposed by EDF for the operating rules of the nuclear reactors in operation and it in particular approved implementation of the files concerning the ten-yearly outages (VD) for each nuclear reactor series. Some modifications to the APE procedures are the result of hardware modifications to be incorporated during the VDs, while others are the result of operating experience feedback or a response to ASN requests for improved safety.

Following on from the “incident or accident response procedure” (CIA) project, ASN in 2009 reviewed the work concerning the information used in the CIA and the coverage of events by the operating procedures contained in chapter VI of the GOR.

In order to prepare for the review of the Flamanville EPR reactor commissioning authorisation application, certain topics covered by the required documents listed in Article 20 of decree 2007-1557 of 2 November 2007 concerning BNIs and supplied by the licensee in its commissioning application, are reviewed in advance. These topics include the principles of incident or accident operations, which will be incorporated in the general operating rules for operation in the event of a safety-related incident or accident. In 2009, ASN and its technical support organisation reviewed the CIA principles for the closed and not closed states of the reactor main primary system, the principles for managing CIA hazards, the interface between CIA and severe accident management and the principles of operation at the various human-machine interfaces.

Regular inspections are organised on the subject of incident and accident operation. These inspections in particular review the management of the operating documents in chapter VI of the GOR (transcription of national reference documents into local documents, reproduction, distribution, etc.), management of specific equipment used in accident operation conditions, and training of operation staff. On the basis of the inspections conducted in 2009, ASN feels that adoption by NPPs of the incident or accident operations rules is on the whole satisfactory.

Reactor operation in severe accident situations

If the reactor cannot be brought to a stable condition after an incident or accident and the scenario resulting from a series of failures leads to core deterioration, the reactor is said to be entering a severe accident situation.

For this type of very hypothetical situation various steps are taken to enable the operators, supported by the emergency teams, to manage reactor operation and ensure containment of radioactive materials in order to minimise the consequences of the accident. The emergency teams may in particular use the severe accident management guide (GIAG). The GIAG and its upgrades are currently being reviewed by ASN and its technical support organisation.

In 2009, ASN approved the changes made by EDF to its approach to severe accident risks, following the GPR review in 2008. ASN nonetheless asked EDF to improve its safety requirements by taking greater account of the long-term management of this type of accident, to strengthen the requirements applicable to the equipment necessary for managing such a situation and to continue to optimise its strategy for management of the water in the reactor pit used to control the evolution of the accident.

On 25 June 2009, the GPR also reviewed the possible countermeasures against the dissemination of radioactive products by the water route, in other words potential contamination of the groundwater by liquid radioactive releases.

3 | 2 Maintenance and testing

3 | 2 | 1 Regulating maintenance practices

ASN considers that maintenance policy is an essential line of defence in preventing the occurrence of anomalies and maintaining the conformity of an NPP with its safety requirements.

Since the mid-1990s, EDF has been implementing a policy to reduce the volume of maintenance. Its aim is to enhance the competitiveness of the nuclear reactors in service, while maintaining the level of safety. This chiefly involves focusing the maintenance effort on equipment which, if it were to fail, would entail the highest safety, radiation protection or operational risks. This policy has led EDF to made changes to its organisation and adopt new maintenance methods.

As is already the case in the aeronautical and military industries, EDF has developed the “reliability-centred maintenance” method. Based on a functional analysis of a given system, this method enables the type of maintenance required to be defined according to the contribution of its potential failure modes to the safety, radiation protection or operational stakes.

Furthermore, taking advantage of nuclear reactor standardisation, EDF is deploying the “pilot equipment” maintenance concept. This maintenance is based on the definition of uniform technical families of similar equipment, operated in the same way in all the NPPs in operation. EDF considers that the selection and close monitoring of a limited number of these equipment items – which then act as pilot items within these families – could, if no failure is detected, spare systematic monitoring of all the equipment in the family.

In this context of widely changing methods and in the light of nuclear reactor ageing, ASN asked the GPR for its opinion on EDF’s maintenance policy and its implementation in NPPs. The GPR held a meeting on this subject on 27 March 2008.

On the basis of this review, ASN considers that the methods used by EDF to optimise the maintenance programmes for the equipment important for safety are acceptable. These methods, which give priority to equipment monitoring, help to reduce the risks involved in equipment maintenance and limit the dose received by the staff involved. ASN did however remind EDF that these methods could lead to failure to detect a new fault or one that was not initially envisaged and asked EDF, as part of the defence in depth principle, to back up the deployment of these methods by maintaining systematic periodic checks for certain equipment.

ASN also reminded EDF that the use of these maintenance methods for pressure equipment on the main primary and secondary systems of nuclear reactors must comply with the requirements of the order of 10 November 1999 concerning the supervision of the operation of these systems (see point 3|6 of chapter 3) and thus only concern areas in which no known deterioration is likely. ASN also strictly defined the conditions for the use of such an approach, stressing the fact that this monitoring would need to be extended if a defect were to be discovered.

ASN also considers that the process set up by EDF for building on operating experience feedback is a means of ensuring satisfactory development of the maintenance programmes. ASN will ensure that EDF takes account of operating experience feedback about the behaviour of the equipment concerned by these changes, in particular with regard to the content and frequency of the inspections.

3|2|2 Examining the qualification of scientific applications

The scientific applications contributing to the safety cases are subject to the requirements of the order of 10 August 1984 mentioned in point 3|2|1 of chapter 3. One of the key requirements is qualification, which consists in ensuring that the application can be used in complete confidence within a specific field.

In 2009, with the support of IRSN, ASN continued to review applications which will be used for EPR reactor studies.

Furthermore, ASN is continuing its work aimed at defining the principles and methods to be used for the qualification review of the computer codes used in the safety case demonstrations.

3|2|3 Guaranteeing the use of efficient control methods

Article 8 of the order of 10 November 1999 specifies that the non-destructive test processes used for in-service monitoring of nuclear reactor main primary and secondary system equipment must, before it is used, undergo qualification by an entity of proven competence and independence.

Ultrasonic inspection of a weld joint

This entity, known as the qualification commission, received renewal of its accreditation (from COFRAC) in 2006.

The role of this commission is to assess the representativeness both of the mock-ups used for the demonstration and the faults introduced into them. On the basis of the qualification results, it confirms that the performance of the examination method is as expected. As applicable, the aim is either to demonstrate that the inspection technique used allows detection of deterioration as described in the specifications, or to explain the performance of the method.

At an international level, the qualification requirements differ appreciably from one country to another, with regard to both the procedures and the tests. The licensees are granted transitional periods of varying lengths for implementation of their respective programmes.

To date, 91 applications have been qualified by the in-service inspection programmes. At present, new processes are being developed and qualified in order to meet new requirements. This mainly concerns the FA3 reactor, for which 41 applications will have to be qualified for the pre-service inspection scheduled to begin in the summer of 2010. In order to reduce dosimetry, ultrasound applications are preferred over radiography.

3|2|4 Authorising periodic test programmes

In order to check the correct operation of equipment important for safety and the availability of the back-up systems that would be called on in the event of an accident, tests are periodically conducted in accordance with the programmes of chapter IX of the GOR.

In 2009, ASN approved the following periodic test programmes:
– changes to the periodic test rules for the 1300 MWe reactor systems utilising Galice fuel management;
– the periodic test programmes linked to the hardware modifications to be incorporated during the third ten-yearly outages of the CP0 reactors;
– the periodic test programmes linked to the hardware modifications to be incorporated during the third ten-yearly outages of the 900 MWe reactors;
– the periodic test programmes linked to the hardware modifications to be incorporated during the first ten-yearly outage for the first-off N4 reactor.

ASN is also continuing to review the design strategy for the EPR periodic tests.

At the same time, ASN is regularly called on to give its opinion on periodic test programme modification notifications.

3 | 3 Fuel

3 | 3 | 1 Controlling in-pile fuel management changes

In order to enhance the availability and performance of reactors in operation, EDF, together with the nuclear fuel industry, is looking for and developing improvements to fuels and their use in the reactor, known as "fuel management".

Since 1996, extending cycle lengths has been a major factor in optimising reactor fuel and operations. This extension is combined with increased fuel enrichment, but the quantity of energy released nonetheless remains limited to an average of 52 GWd/t per fuel assembly, which is the maximum authorised value. ASN ensures that each new fuel management model is the subject of a specific safety case for the reactors concerned, based on the specific characteristics of the new fuel management. When a change in the fuel or its management model leads to EDF revising an accident study method, this requires prior review and cannot be implemented without ASN approval. Since 2007, the adoption of new fuel management requires a decision from ASN containing implementation requirements.

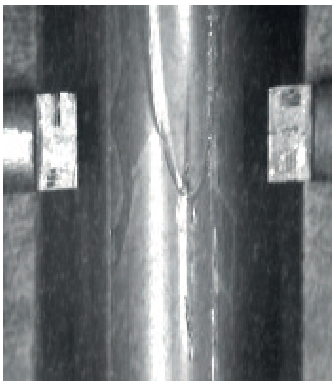
MOX-parity

MOX-parity fuel management concerns the twenty-two 900 MWe reactors authorised to recycle plutonium. The differences with respect to the previous type of fuel management (MOX Garance) are:
– increased burn-up fraction of the MOX fuel assemblies as a result of the greater number of operating cycles (four cycles in the reactor instead of three);
– changes to the initial plutonium content (average of 8.65% instead of 7.1%).

This management is a means of keeping the quantities of plutonium generated by the French NPPs under control. As at 31 December 2008, seventeen reactors had implemented MOX-parity management.

GALICE

EDF has decided to implement a new type of fuel management known as "Galice" (French acronym for limited increase in burn-up for fuel in operation) on some of its 1300 MWe reactors. The uranium 235 enrichment of the fuel assemblies is increased from 4% to 4.5%. The maximum fuel burn-up fraction is then 62 GWd/t and refuelling is hybrid, with some assemblies undergoing three cycles and others four. The average duration of a fuel cycle is 18 months. In 2009, ASN completed its technical review of this fuel management following the GPR meeting of 12 June 2008. ASN approved Galice fuel management on 23 July 2009. For implementation of this new fuel management, ASN specified its requirements in decision 2009-DC-167 of 8 December 2009, pursuant to Articles 3 and 29 of the 13 June 2006 Act on Transparency and Security in the Nuclear Field. The first implementation of Galice fuel management is scheduled for 2010 on the Nogent 2 reactor.



Defect created by "angel hair" on an M5 alloy fuel rod

3 | 3 | 2 Fuel assembly modifications

EDF is continuing several experimental programmes aimed at improving both fuel safety and performance. The avenues for improvement explored are numerous and concern both the component material and shape of the metal parts of the fuel assembly (cladding, skeleton assembly, end-pieces, etc.) and the fuel pellet material.

M5 alloy fuel assemblies

Since 2005, ASN has authorised the irradiation of AFA3GlrAA fuel assemblies (M5 alloy cladding and structure) for a period of three operating cycles in three 1300 MWe reactors (Cattenom 3, Golfech 2 and Nogent 2) and for a period of four cycles in the four N4 reactors (Chooz B1, Chooz B2, Civaux 1 and Civaux 2).

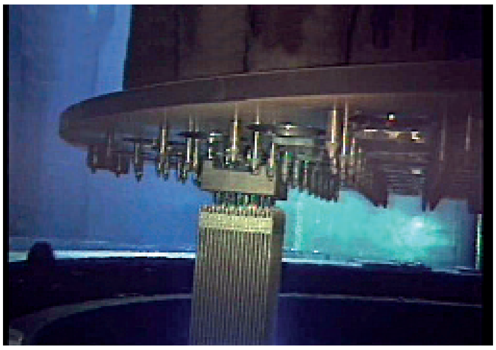
Acquisition of operating experience feedback and characterisation of tightness defects that appeared on some of these assemblies, led EDF to take steps to improve the welding process for the fuel rods making up the assemblies loaded as of 2007, in order to reduce the incidence of cladding tightness defects. The fuel assemblies loaded since 2008 showed no signs of tightness defects at the welds concerned by these improvements. However, further leaks were detected in 2008 on the M5 alloy rods. This was attributed to the presence of small chips of M5, referred to as "angel's hair", which were created abnormally under the fuel assembly spacer grid springs when the rods

Marking out of a foreign body exclusion zone around the spent fuel assembly storage pool in Paluel

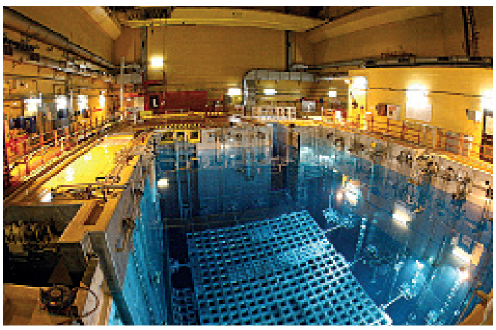
were inserted into the skeleton assembly for fabrication. These chips undergo vibration during reactor operation, leading to wearing of the cladding which can even go as far as perforation.

Corrective measures were taken with fabrication of the fuel assemblies in order to eliminate this cause of tightness defects for the new assemblies loaded in 2009. Tightness defects were again detected in some reactors containing M5 fuel assemblies.

ASN asked EDF to limit the introduction of new M5 fuel loads and to send it the results of the investigations being carried out to identify the causes of the faults observed.



Jammed fuel assembly at the EDF Tricastin NPP (August 2009)



Spent fuel pool

3 | 3 | 3 Improving the safety of fuel handling operations

Fuel handling operations, during which end-of-life fuel assemblies are replaced by new assemblies, take place with the reactor shut down and vessel open. Core refuelling requires underwater handling of fuel assemblies between the fuel building pond and that in the reactor building, so that they can be positioned in the reactor vessel in accordance with a predetermined plan and pre-defined reloading sequences. The efforts made by EDF in recent years to reduce the risk of fuel assembly damage during handling, was continued in 2009 in particular with the gradual introduction of assemblies with improved grids.

Handling of upper internal equipment

In 2009, EDF presented its analysis and the corrective measures it had taken to prevent a repetition of the 2008 incident in which two fuel assemblies became blocked on the upper internals structures (see box below) on the Tricastin 2 reactor.

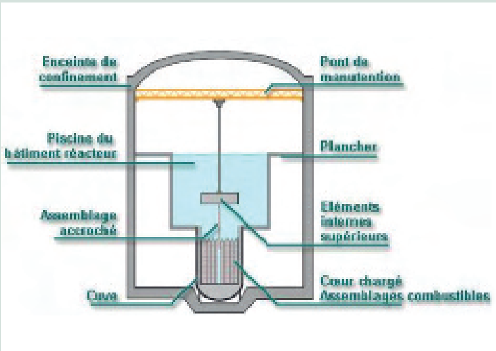
Following discussions with the licensee concerning this incident, ASN decided that the data transmitted did not completely clarify the event and asked EDF to extend and intensify its analysis of the lessons learned from this event and specify the corrective measures identified. ASN in particular asked EDF to examine:
- the impact of the incident on the design and maintenance of the equipment so that it is not a potential generator of foreign bodies;
- the feasibility of strengthening the lines of defence by incorporating additional measures on the fuel assemblies, by carrying out TV inspection of the correct spacing between assemblies and by new measures to compare the assembly positions with the alignment pins on the internal structures;
- whether EDF in-house directives concerning the prevention of foreign bodies in the systems are adequate.

On 9 August 2009, a MOX fuel assembly was blocked by the upper internal structures during unloading of the Gravelines 1 reactor. ASN conducted a reactive inspection on 10 August 2009 on the site in order to examine EDF's management of the event and the steps taken to minimise any consequences. Operations were carried out on 2 September 2009 to safeguard the assembly, separate and then extract the upper internal structures. This enabled the fuel assembly and the rest of the core to be unloaded satisfactorily. On 6 November 2009, a similar incident occurred on Tricastin reactor 2. A reactive inspection was carried out on 7 November 2009. A safeguard tool similar to that developed for Gravelines was used at Tricastin.

These two events entailed no releases either inside or outside the reactor building containment and the assemblies

Incident involving blockage of fuel assemblies in the upper internals

To allow access to the fuel assemblies, for unloading of the reactor core at the end of each operating cycle, the reactor vessel is opened and the upper internal structures are then removed. Their main role is to correctly position the fuel assemblies in the core and support them during reactor operation.



However, one or more fuel assemblies can become snagged on the upper internals alignment pins. The risk of the assembly falling into the vessel or onto the assemblies positioned around can lead to a loss of containment of certain fuel rods with the possibility of radioactive releases into the reactor building.

In the event of an incident, the technical solution defined by the licensee for securing and recovering the snagged assemblies is being analysed by ASN and its technical support organisation, along with possible qualification on a full-scale mock-up, before ASN approves implementation of the changes needed for carrying out the operations to secure one or more assemblies.

remained cooled at all times. The events were rated level 1 on the INES scale at Gravelines and at Tricastin.

3|4 In-depth oversight of primary and secondary systems

The reactor main primary and secondary systems (CPP and CSP), collectively referred to as the nuclear steam supply system (NSSS) and presented in point 1|1|3, are fundamental components of a reactor. They operate at high temperature and high pressure and as they contribute to all fundamental safety functions – confinement, cooling, and reactivity control – they are the subject of extensive surveillance and maintenance by EDF and in-depth monitoring by ASN. Supervision of the operation of these systems is regulated by the order of 10 November 1999, mentioned in chapter 3, point 3|6.

Piping verification by the ASN inspector during hydro-testing of the reactor coolant system (Cattenom in Moselle *département*) – June 2008

On the whole, ASN feels that the condition of the CPP and CSP in the French nuclear power reactors give no cause for concern in the short term but that the known ageing and deterioration phenomena need to be considered and appropriate measures taken, primarily in preparation for and performance of the third ten-yearly outages of the 900 MWe reactors.

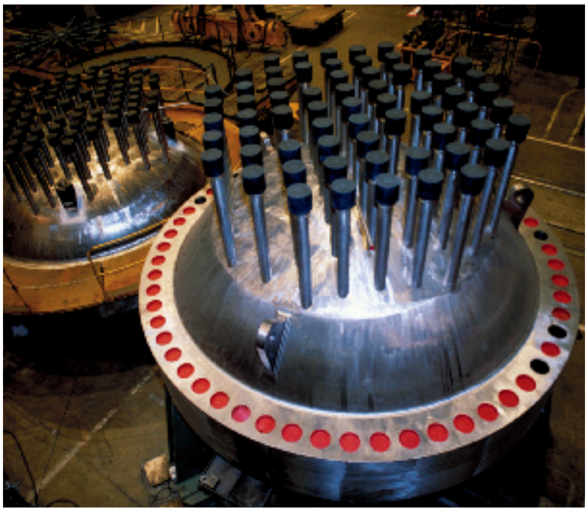
The further damage and anomalies that have appeared since 2006 on the steam generators are dealt with in point 3|4|4.

3|4|1 Monitoring and inspection of systems

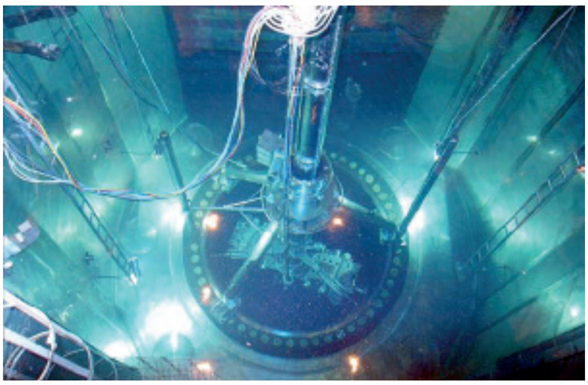
ASN makes sure that the licensee carries out appropriate monitoring and maintenance of the main primary and secondary systems. To do this, the licensee draws up monitoring programmes which are submitted to ASN. After reviewing these documents, ASN can submit requests. The licensee is required to take account of these requests. In addition to these documentary reviews, ASN carries out thematic inspections on equipment maintenance, primarily during the reactor outages. ASN also examines the inspection results transmitted at the end of each outage.

In addition to the monitoring carried out on its systems by the licensee during each outage, ASN checks the good condition of this equipment every ten years, on the occasion of periodic post-maintenance testing. Periodic post-maintenance testing comprises three distinct phases: inspection of the equipment, involving a large number of non-destructive tests, pressurised hydrotesting and verification of the good condition and good operation of the over-pressure protection accessories. Post-maintenance testing of the primary system takes place during the ten-yearly outages, which last several months and are an opportunity to conduct a large amount of maintenance and numerous checks in order to verify the good condition of the equipment.

In 2009, six main primary systems underwent periodic post-maintenance testing. This concerned the Belleville 2, Chinon B3, Nogent 1, Tricastin 1, Fessenheim 1 and Chooz B2 reactors.



Vessel closure head during manufacture (AREVA)



Vessel in-service inspection machine during an inspection

3|4|2 Monitoring of nickel-based alloy zones

Several parts of a pressurised water reactor are made from nickel-based alloys: tubes, partition plate, primary side coating of the steam generators tubesheet, vessel closure head adapters, vessel bottom head penetrations, vessel internals lower guide support welds and repaired vessel nozzle areas.

The use of this type of alloy is justified by its resistance to generalised or pitting corrosion. However, in reactor operating conditions, one of the alloys adopted, Inconel 600, proved to be susceptible to stress corrosion. This particular phenomenon occurs when there are high levels of mechanical stress. It can lead to the appearance of cracking, sometimes rapidly as seen on the steam generator tubes in the early 1980s, or on the 1,300 MWe reactor pressuriser instrumentation taps at the end of the 1980s.

ASN asked EDF to adopt an overall monitoring and maintenance approach for the zones concerned. Several main primary system zones made of Inconel 600 alloy are thus subject to special monitoring. For each one, the in-service monitoring programme, defined and updated annually by the licensee, has to meet requirements concerning the inspection objectives and frequencies. The steam generators and vessel head closures are also covered by a major replacement programme (see point 3|4|4).

In 2004, cracks attributed to stress corrosion were observed on a steam generator partition plate separating the hot leg from the cold leg, for reactor coolant circulation at the bottom of the steam generator. International operating experience feedback and the discovery of cracks on this part of the SG, which EDF had in principle considered to be immune to this type of damage, led ASN to ask EDF to adapt its overall maintenance strategy for the Inconel 600 areas, in order to take account of this damage. All the steam generators equipped with an Inconel 600 alloy partition plate will therefore be checked before the reactors' third ten-yearly outages.

Checks carried out in 2007 showed indications of cracking on two steam generators. Follow-up checks were carried out in 2008 and revealed no significant variation. The checks conducted in 2009 on nine steam generator partition plates showed no further signs of stress corrosion cracking. The follow-up checks will continue in 2010. As at 31 December 2009, 92 steam generators had been checked.

3|4|3 Checking reactor vessel strength

The vessel is one of the essential components of a PWR. This component, 14 m high and 4 m in diameter, with a thickness of 20 cm, contains the reactor core and its instrumentation. The 300 t vessel is entirely filled with water in normal operation and can withstand a pressure of 155 bar at a temperature of 300 °C.

Regular and precise monitoring of the state of the reactor vessel is essential for the following two reasons:

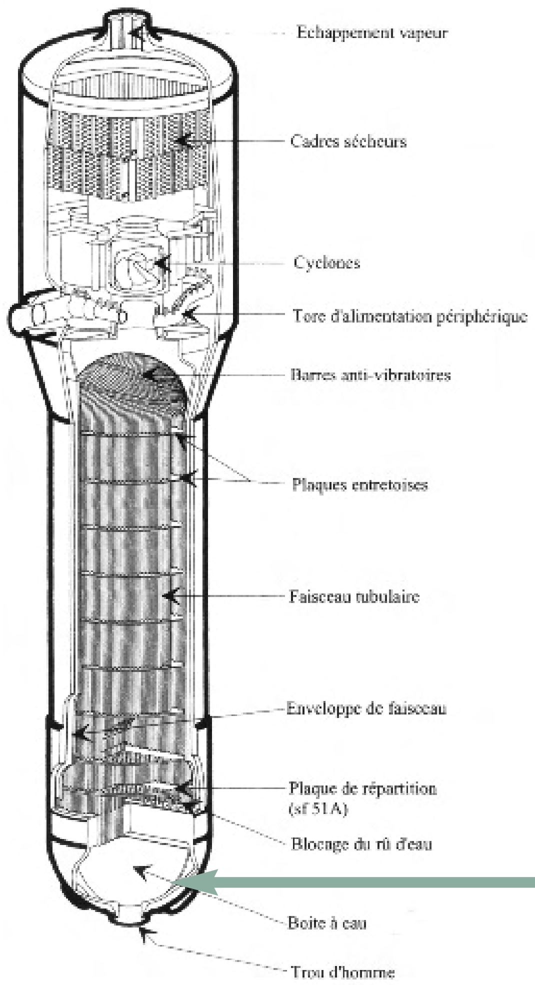
– vessel replacement is not envisaged, for reasons of technical feasibility and economics;
– rupture of the vessel is an excluded accident, so its consequences are not included in the reactor safety evaluation. Validating this assumption however means that appropriate design, manufacturing and operating measures must be taken.

In normal operation, the vessel deteriorates slowly, under the effect of the neutrons resulting from the core fission reaction, which embrittles the metal. This embrittlement makes the vessel particularly sensitive to pressurised thermal shocks or to sudden pressure surges when cold. This susceptibility is also aggravated when defects are present, which is the case of some of the 900 MWe reactor vessels, which comprise non-developing manufacturing defects under their stainless steel liner.

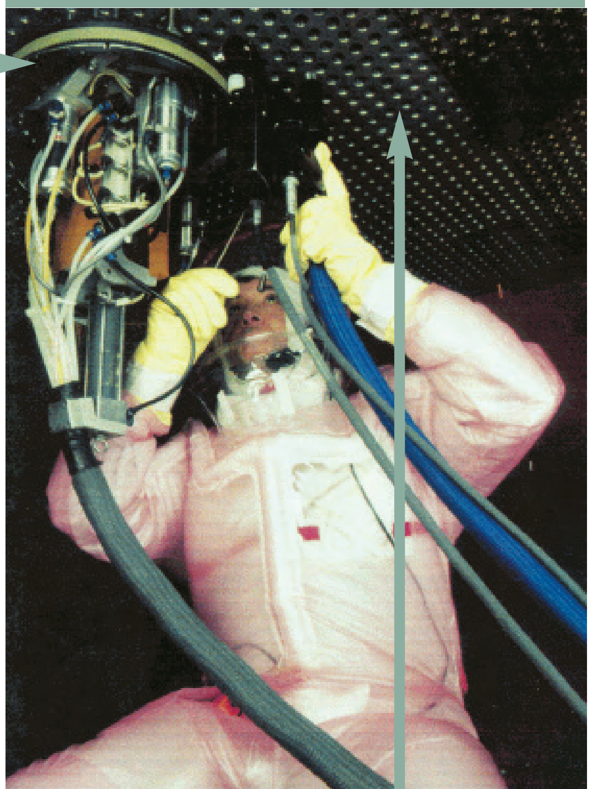
To protect against all risk of rupture, the following measures were taken as of commissioning of the first EDF reactors:

– a program to monitor the effects of irradiation: capsules containing test specimens made of the same metal as the reactor vessel were placed inside the reactor, near the core. Some of these capsules are regularly removed for mechanical testing. The results give a good picture of the ageing of the vessel metal and can even be used to anticipate it, inasmuch as the capsules located near the core receive more neutrons than the metal of the reactor vessel;
– periodic checks, in particular ultrasonic checks to verify that there are no defects or, in the case of vessels containing manufacturing defects, to check that they are not getting worse.

ASN reviewed the files concerning the in-service strength of the reactor vessels forwarded by EDF in preparation for the third ten-yearly outages of the 900 MWe reactors. These files were presented to the experts of the nuclear standing section (SPN) of the Central Committee for Pressure Equipment in 1999 and then in 2005. ASN is today reviewing the answers provided by EDF to the questions raised



Boîte à eau :
la pose de bouchons est réalisée dans la boîte à eau, aux entrées et sorties des tubes des générateurs de vapeur.



Entrée d'un tube : en fonctionnement, l'eau sous pression circule dans ces tubes.

Diagram of a steam generator and installation of plugs in the channel head at this later session. Subsequent to this review and in the light of the results of the inspections made during the third ten-yearly outages on the reactors, ASN will adopt a stance on the conditions for vessel operation beyond thirty years.

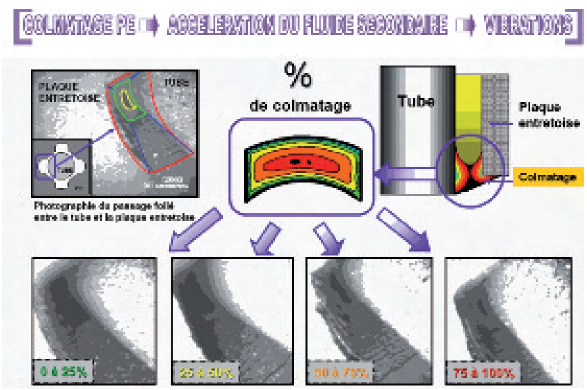
3 | 4 | 4 Checking steam generator tube integrity

The steam generators are exchangers of heat between the water of the primary system and that of the secondary system. The exchange surface consists of a tube bundle comprising from 3500 to 5600 tubes, depending on the model. These tubes contain the primary system water and exchange heat while preventing any contact between the primary and secondary fluids.

The integrity of the steam generator tube bundle is a major factor in safety, as any deterioration of the tube bundle could lead to a leak from the primary system to the secondary. Furthermore, a break in one of the bundle tubes would thus bypass the reactor containment, which is the third confinement barrier. The steam generator tubes are however subject to various forms of deterioration, such as corrosion and wear, and therefore require particularly close attention.

The steam generators are covered by a specific in-service monitoring programme, established by EDF and periodically revised. The current version of this programme was reviewed and accepted by ASN in 2003. A new version was submitted to ASN, which asked EDF to complete it prior to implementation. This programme defines the checks carried out to determine which tubes with significant damage need to be plugged and thus removed from service.

Since the early 1990s, EDF has been conducting a replacement programme for steam generators with the most heavily damaged tube bundles. This programme will continue at the rate of one reactor a year. At the end of 2009, eight of the thirty-four 900 MWe reactors will still be equipped with steam generators containing tube bundles made of non-heat treated Inconel 600 type nickel-based alloy (600 MA), which are the principal victims of the stress corrosion phenomenon (see point 3|4|2).



Tube support plate clogging

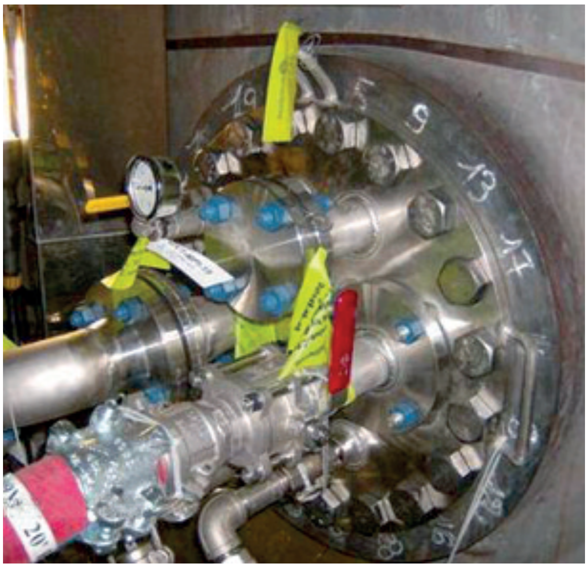
Steam generator clogging

In 2004, a new type of damage occurred and affected several steam generators in the NPPs in operation. This involved rapidly developing fatigue cracking which could lead to leakage between the primary and secondary systems, resulting in unscheduled shutdown of the reactor. After investigations to determine the origin, these fatigue cracks were attributed to changes in the secondary fluid flow caused by clogging of the tube support plates. This clogging phenomenon involves gradual blockage by oxide deposits of the passages between the tubes and the support plates, designed to allow circulation of the water. This clogging has a number of consequences for safety:

– it is a determining factor in the appearance of excessive tube vibration in certain steam generator zones. These vibrations can lead to the rapid development of cracks. EDF thus preventively blocked off a zone of fifty-eight tubes in the steam generators potentially concerned by the phenomenon;
– it can induce considerable mechanical stresses on the steam generator internal structures, particularly in certain incident or accident situations;
– it reduces the water circulation in the steam generators and therefore, for the same measured water level, leads to a reduction in the quantity of water available inside the steam generator. Water level oscillations can also occur in the steam generators in certain operating situations if the clogging levels are high.

The steam generator clogging phenomenon was brought to light following a significant event rated at level 1 on the INES scale, which occurred in February 2006 on Cruas-Meysse reactor 4. A crack developed on a steam generator tube in just a few months, leading to a leak. Since that event and at the request of ASN, which considered that this phenomenon was liable to concern other reactors, EDF has developed and implemented checks on a number of 900 MWe reactor steam generators during the maintenance and refuelling outages. High clogging levels were observed on a number of reactors, a fact that had not been anticipated by EDF. On the upper tube support plates of some of them, up to 80% of the surface area of the water circulation passages is affected.

As this phenomenon is liable to affect the 1300 MWe reactors, ASN also asked EDF to extend the checks to the steam generators concerned. Although EDF gave initial clogging rate estimates based on the evolution of a number of operating parameters, it has since 2008 had access to additional investigative resources allowing a more precise evaluation of its steam generator clogging



Mechanical plug installed in steam generator tube bundle

rates. The steam generators of all the reactors potentially affected by this phenomenon are therefore inspected during the refuelling outages. If the condition of a reactor does not enable it to be operated in complete safety, EDF must repair it.

In response to the ASN requests, EDF extended its studies concerning the impact of clogging on the safety of the 900 MWe and 1300 MWe reactors. ASN together with IRSN assessed the justifications provided by EDF concerning its understanding of the clogging phenomenon and the long-term operating safety of all the reactors. At the same time, EDF is drawing up a strategy for the long-term resolution of this problem. ASN also asked EDF to propose solutions to limit the appearance and development of oxide deposits.

A treatment process: chemical cleaning of the steam generators

To eliminate the metal oxide deposits contributing to clogging of the steam generators, EDF chose a chemical cleaning process to remedy the problem on fifteen reactors identified as being the most heavily clogged.

An initial process, which involved injecting a high temperature (160 °C) chemical solution into the secondary part of the steam generator, was used for the first time in 2007 on Cruas-Meysse 4. This process proved to be effective as it reduced the clogging level to about 15% although it did lead to greater than expected corrosion of certain steam generator component materials, but without compromising the integrity of the equipment. Overall coordination of this process proved to be delicate and was improved with each subsequent implementation.

Owing to the problems encountered in using this process, EDF turned towards a second method working at lower temperature (below 100 °C) which was used in 2008 on two 900 MWe reactors (Cruas 2 and 3) and a 1300 MWe reactor (Belleville 1). This process, employed when the reactor core is unloaded, is easier to coordinate and leads to carbon steel corrosion levels six to eight times lower, while minimising discharges of the gaseous effluents produced, especially ammonia.

EDF therefore continued its remedial cleaning programme with this process on three reactors in 2009 (Cattenom 1, Cattenom 3 and Chinon B3). A further three reactors will be treated in 2010 and 2011 (Cattenom 4, Belleville 2 and Cattenom 2).

As of 2010, EDF also intends gradually to move away from a strategy of remedial maintenance to one of preventive maintenance, using less aggressive and more gentle cleaning processes. Two processes are currently undergoing qualification.

However, despite their effectiveness in bringing down the clogging levels in the steam generators treated, ASN considers that these cleaning processes have an undeniable impact, whether on the steam generator internal structures, particularly with high-temperature washing, or on the tube bundle. Stray signals of undetermined origin can appear randomly during the eddy current testing of the tube bundle, whether after cleaning or after an operating cycle.

Ensuring the absence of risk for tubes with support anomaly

On 18 February 2008, a leak from the primary to the secondary system was detected on the Fessenheim 2 reactor. The origin of this leak was the cracking of a tube with “support anomaly”. This incident was rated 0 on the INES scale.

During reactor operation, the steam generator tube bundles are subject to vibration. This vibration can create rapidly developing circumferential fatigue cracking. In order to minimise the amplitude of this vibration and prevent this type of damage, some tubes are held at the top by anti-vibration bars. During steam generator manufacture, some of these bars were incorrectly positioned, leading to inadequate tube support. These tubes are said to be “tubes with support anomaly”.

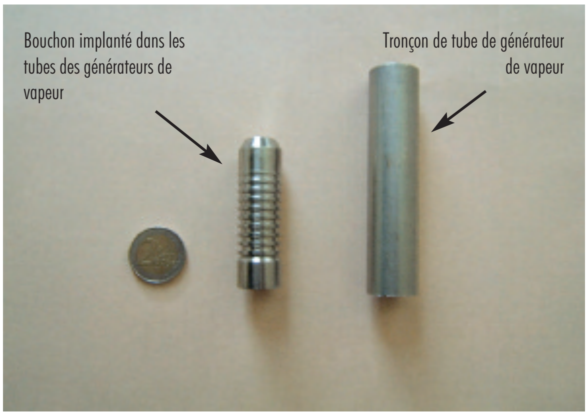
Two steam generator tube breaks, originating in vibration fatigue cracking of “tubes with support anomaly” occurred in North Anna (USA) in 1987 and Mihama (Japan) in 1991. Following these two events, ASN asked EDF in the early 1990s to define a vibration susceptibility criterion for the tubes with support anomaly and, based on this criterion, to plug the most susceptible tubes. Since then, on the steam generators of the thirty-four 900 MWe reactors, about 1500 tubes have been plugged on the basis of this criterion. This approach was also adopted internationally by other nuclear reactor licensees.

After a leak was discovered at Fessenheim in 2008, ASN asked EDF to plug all the tubes with support anomaly throughout the NPPs in operation and to resume vibration fatigue studies in order to explain the failure of the predictive models.

EDF thus plugged all the tubes concerned on the 900 MWe reactors, or nearly 2,500 tubes. At the same time, resumption of thermohydraulic and vibration studies showed that certain parameters had not been sufficiently refined. For example, the influence of steam generator clogging and fouling had been underestimated and the modelling of the Fessenheim 2 steam generators did not completely correspond to their actual geometry.

With regard to the 1300 MWe reactors, the corrected studies show no significant rise in the coefficients characterising sensitivity to vibration fatigue. ASN asked EDF to plug the most sensitive tubes on these reactors, considering that some of them comprised enough margin to rule out any short-term risk. However, additional justification will be required to enable these tubes to be kept in longer-term service on the 1300 MWe reactors. This will be based not only on studies, the completed versions of which should be transmitted to ASN at the end of 2010, but also on inspections.

For N4 reactors, the secondary fluid circulation conditions enable the steam generators to be kept clean, offering short-term guarantees of the absence of aggravating factors such as clogging or head restraint. For these reactors, as for the 1300 MWe reactors, ASN is waiting for the conclusions of the completed studies before ruling on EDF's long-term strategy to deal with the tube vibration fatigue phenomenon.



Installation of equipment during chemical cleaning of a steam generator

Ensuring plug strength

As part of the maintenance performed on the nuclear reactor steam generators, EDF is plugging some defective steam generator tubes.

The plugging operations consist in blocking off the tube inlets and outlets. This is done by means of plugs fixed to the tube walls by a system of splines. This routine maintenance, for which there is satisfactory operating experience feedback in France with regard to effectiveness and plug strength over time, has however since May 2008 been affected by anomalies compromising the success of the operation.

In May 2008, EDF noted that four plugs had been poorly installed on Saint-Alban 2 (one plug had shifted). In February 2009, on Paluel 3, EDF again detected that a plug was not in place. This plug was subsequently found to be at the other end of the tube. It had therefore migrated the entire length of the tube under the effect of the primary pressure.

These anomalies had no consequences for reactor safety. However, plug ejection could lead to rupture of the tube concerned, as happened in 1989 on the North Anna 1 reactor (United States).

At the request of ASN, between July 2008 and the end of 2009, EDF undertook a programme to check that the plugs were in place on all the steam generators in the NPPs in service. This verification programme also brought to light significant damage to one of the welded plugs on the Flamanville 1 reactor. Detection of this event led to the reactor outage being extended by several weeks, to allow for the necessary investigations and repairs.

The verification programme put into place by EDF can check that the plugs are present in the tubes but cannot guarantee that they are correctly attached and cannot therefore completely rule out the risk of possible subsequent shifting.

To be able to rule on the potential risk of shifting of a plug, ASN asked EDF to carry out the investigations necessary for understanding the origins of the phenomenon and for assessing the risk of the plugs shifting and to draw up monitoring criteria for plug installation in addition to the checks carried out to ensure that the plugs are in place. The results of these investigations are expected in 2010.

Henceforth, after each tube plugging operation, EDF will carry out stricter, systematic checks to guarantee that the plugs are correctly installed.

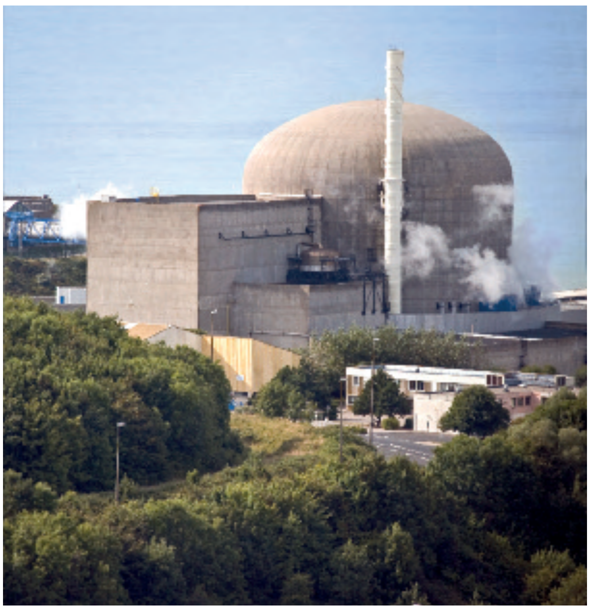
Corrosion on the tube support plates

During the 2009 outage of the Bugey 3 reactor, a type of crack never yet observed in the French NPPs was detected on a steam generator tube during inspections as part of the monitoring programmes applicable to this equipment. The additional operations performed to ensure the integrity of the steam generator tube bundles in the reactor in question, but also of the other reactors potentially affected, revealed two types of damage which were new and poorly characterised by the inspection resources available on the NPPs in operation. This damage was located on the tubes at the circular section support plates and only concerned Inconel 600 MA alloy tubes.

Of the reactors potentially affected, Fessenheim 2 and Bugey 3 showed signs of the greatest damage and underwent additional inspections and appraisals to understand the phenomenon and characterise the condition of the steam generator tube bundle. The other sites concerned, Le Blayais 2|3|4, Gravelines 3, Chinon B2 and Bugey 2 were found to be less affected by corrosion.

ASN asked EDF to carry out preventive plugging on Fessenheim 2, in order to offer sufficient guarantees concerning the serviceability of the steam generators of this reactor for the forthcoming cycle.

In addition to the detailed checks using new methods, a number of tubes were extracted from Bugey 3 for appraisal. The steam generators concerned by these phenomena will be replaced between 2010 and 2014, in accordance with EDF's schedule.



Aerial view of one of the four production units of the Paluel NPP (Seine-Maritime *département*)

3|5 Checking containment conformity

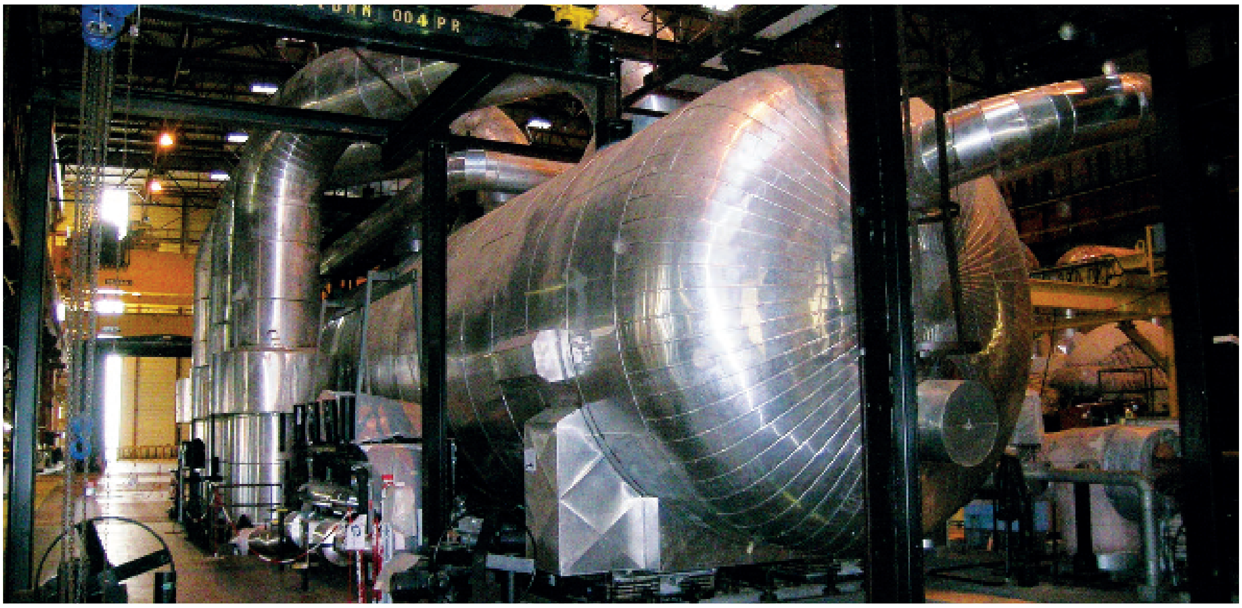
The containments undergo inspections and tests to check their conformity with the safety requirements. Their mechanical performance in particular must guarantee a good degree of reactor building tightness, in the event of its internal pressure exceeding atmospheric pressure, which can happen in some types of accident. This is why these tests, at the end of construction and then during the ten-yearly outages, include a pressure rise up to the inner containment design pressure.

The results of the ten-yearly outage tests for the 900 MWe reactor containments have so far shown leak rates that comply with the regulations. Their ageing was reviewed in 2005 as part of the 30-year periodic safety review, to assess their leaktightness and mechanical strength for a further 10 years. This review brought to light no particular problem liable to compromise the length of the service life. As part of this review process, EDF carried out studies to check the correct operation of the reactor building equipment access hatch in an accident situation. The studies and the modifications identified by EDF were examined during the GPR meeting of 20 November 2008 to close the thirty-year safety review of the 900 MWe reactors.

The results of the ten-yearly outage tests on the 1300 MWe and 1450 MWe reactor containments showed that the leak rate from the inner wall of some of these containments was rising. This was primarily the result of the combined effect of concrete deformation and the loss of pre-stressing of certain cables. Although account was taken of these phenomena at the design stage, they were sometimes underestimated. Consequently, in the event of an accident, certain wall areas would be liable to crack, leading to leaks. To combat this phenomenon, EDF has implemented a preventive repair programme aimed at restoring the tightness of the most heavily affected areas. On the basis of a recommendation from the GPR convened on this subject in early 2002, ASN gave EDF its approval of the strategy. This work is done at each ten-yearly outage. At the end of 2008, fifteen of the twenty four reactors have been completely treated. All the reactors concerned will have undergone the necessary maintenance work by 2012.

3|6 Application of pressure equipment rules and regulations

Owing to the energy that they could release in the event of failure, regardless of the possibly hazardous nature of the fluid (liquid, vapour or gas) that would then be released, pressure equipment entails risks that must be kept under control.


Moisture separator – reheater in the Nogent NPP (2009)

This equipment (containers, exchangers, piping, etc.) is not specific to the nuclear industry and is installed in many industrial sectors such as chemistry, oil refining, paper-making and refrigeration. It is therefore subject to regulation set by the minister for Industry, who imposes the requirements with a view to guaranteeing its safe manufacture and operation.

The equipment in this category liable to emit radioactive releases in the event of a failure is called nuclear pressure equipment and is regulated by the order of 12 December 2005. In addition to the requirements applicable to conventional pressure equipment and the existing texts covering reactor primary and secondary systems, this order imposes additional safety requirements on nuclear pressure equipment, which will enter into force on 22 January 2011. Pursuant to this order and in order to be able to meet this deadline, the licensees were required in 2009 to produce a list of the nuclear pressure equipment used in their facilities. This year, ASN has already started to review the production of these lists.

ASN is also contributing to monitoring the enforcement of the regulations concerning the operation of the non-nuclear pressure equipment in NPPs. This monitoring consists, especially through on-site checks, in ensuring that EDF is implementing the measures required of it. ASN actions in 2008 include audits and surveillance visits of the NPP inspection departments. These departments, under the responsibility of the licensees, are responsible for carrying out inspections to ensure the safety of pressure equipment. However, these departments currently only deal with non-nuclear pressure equipment. Their competence could be extended to nuclear pressure equipment, once the requirements associated with this it, especially those corresponding to its safety roles, have been correctly defined. In 2009, ASN carried out five certification renewal audits for these inspection departments and an initial certification audit for the Flamanville inspection department.

The events of 2009 concerning pressure equipment other than the main primary and secondary systems, dealt with in point 3|4, include damage linked to corrosion and erosion detected on the moisture separator-reheaters (GSS) in some of the 1300 MWe reactors. This equipment, which is designed to dry and superheat the steam from the steam generators, is pressure equipment that entails significant staff safety risks: it consists of a container more than four metres in diameter, twenty metres long and designed for a pressure of seventeen bar and a temperature of 300 °C. The damage brought to light had reached almost half the initial thickness. The licensee has begun a programme of repair, inspection and justification of the zones affected by this damage.

The scale of the damage detected in 2008 and 2009 on several secondary system zones indicates shortcomings for this type of damage mechanism, in the surveillance methods and programmes defined by EDF. ASN is currently monitoring the steps taken following the discovery of the initial damage, particularly by reviewing the measures envisaged by EDF, in order to ensure that the inspection and repair programmes are appropriate to the dynamics of the damage identified.

3|7 Protection against external hazards

3|7|1 Prevention of seismic risks

Buildings and equipment of importance for the safety of NPPs are designed to withstand earthquakes of an intensity greater than the most severe earthquakes that have ever occurred in the region of the NPP. The rules for dealing with the seismic risk are regularly updated in order to take account of new data with retroactive application on a case by case basis during the periodic safety reviews.

Although there is no particularly strong seismic risk in France, this topic is the subject of considerable efforts on the part of EDF and sustained attention by ASN.

Design rules

Basic safety rule (RFS) 2001-01 of 31 May 2001 defines the methodology for determining the seismic risk to surface BNIs (except for radioactive waste long-term repositories).

RFS V.2.g concerning seismic calculations of civil works was revised and published in 2006, in the form of a guide for including the seismic risk in the design of surface BNI civil works. It is the result of several years of work by French experts in the anti-seismic engineering field.

For surface BNIs and based on NPP data, this text defines the anti-seismic design requirements for civil works and the acceptable methods for:

– determining the seismic response of these works, by considering their interaction with the equipment they contain and assessing the associated loads to be used in the design;
– determining the seismic movements to be considered for the design of the equipment.

The anti-seismic design provisions for civil works and the associated methods are defined for the new surface BNIs in ASN guide 2/01 of 26 May 2006 concerning the inclusion of the seismic risk in civil works for BNIs, other than radioactive waste long-term repositories.

Seismic design reviews

Within the framework of the current periodic safety reviews (see point 2|2|3), the seismic design review in particular consists in updating the level of the earthquake to be taken into account, under application of RFS 2001-01.

For the safety reviews associated with the third ten-yearly outages of the 900 MWe reactors, ASN asked EDF to examine the seismic design of the electrical buildings of CPY reactors and analyse the risk the turbine hall represents for the electrical buildings. For CP0 reactors, ASN asked EDF to study the seismic design of the nuclear island buildings and the turbine hall. The studies led to the definition of reinforcement changes for equipment and structures, with work beginning in 2009 during the ten-yearly outages of the Tricastin 1 and Fessenheim 1 reactors. The conclusions of these studies and the modifications identified by EDF were reviewed at the GPR meeting of 20 November 2008 dedicated to closure of the third ten-yearly outages of the 900 MWe reactors.

With regard to the safety review associated with the second ten-yearly outages of the 1300 MWe reactors, EDF studied the earthquake stability of the reactor turbine hall and the strength of the civil works of the electrical building and backup auxiliaries. These studies brought to light the fact that the original design guaranteed the resistance of these reactors to the earthquakes reassessed according to RFS 2001-01, provided that additional justification data was provided concerning protection of the electrical building civil engineering structures and safeguard auxiliaries of P'4 reactors from the risk presented by the turbine hall.

In preparation for the forthcoming seismic reviews (forty-year review for the 900 MWe reactors and thirty-year review for the 1300 MWe reactors), ASN set up a working group comprising EDF, IRSN and ASN. The aim of this working group is to determine the reference earthquakes to be considered for these forthcoming reviews. The discussions concerning the 1300 MWe reactors ended in June 2009. EDF therefore sent ASN a technical report proposing updated seismic levels to be taken into account during the safety review associated with the third ten-yearly outages of the 1300 MWe reactors. ASN sets the safety objectives applicable to NPPs and intends to issue a position statement on these proposals in 2010.

ASN is also taking part in a working group comprising the General Directorate for the Prevention of Risks (DGPR) as well as IRSN and the French Geological and Mining Research Office (BRGM). The aim of this working group is to compare the contingencies taken into account and the construction design of both installations classified on environmental protection grounds (ICPEs) and BNIs.

Jointly with the Swiss nuclear regulator (IFSN) and IRSN, ASN organised a seminar in Strasbourg on 17 June 2009. This international scientific seminar inventoried and reviewed probabilistic and deterministic methods and identified the extent to which recent scientific progress in the field of seismic risk, along with improved data on historical earthquakes, could lead to a reassessment and a further improvement in the level of safety in NPPs. ASN also played an active part in the Provence 2009 conference from 6 to 8 July 2009 to commemorate the centenary

17 June 2009 international scientific seminar on the seismic risk

The presentations and debates concerned how the seismic risk is taken into account in nuclear facilities. This enabled ASN to identify areas in which the seismic risk regulations could be modernised. The seminar brought together more than 100 participants: researchers, experts, foreign nuclear regulators, environmental defence associations, journalists, and so on).

French, Swiss, German and American experts presented the most recent research on evaluation of the seismic risk, the incorporation of uncertainties and site effects, and the engineering methods able to assess the consequences of an earthquake on a nuclear facility.

Numerous debates with those in attendance brought to light the problem of processing uncertainties and incorporating them into the technical approach and the regulatory texts. A large number of experts pointed out the benefits of using a combined deterministic and probabilistic approach to estimating the seismic risk, based on data that are as accurate as possible.

Over and above the widely shared belief that the para-seismic constructions used offer margins guaranteeing resistance to earthquakes larger than those taken into account in the design, new methods currently being developed will lead to improved quantification of these margins in order to strengthen the safety case.

Introduction to the 17 June 2009 seminar by Dr Ulrich Schmocker and Olivier Gupta

of the Lambesc (Bouches-du-Rhône département) earthquake.

3 | 7 | 2 Drafting flood prevention rules

Following the flooding of the Le Blayais NPP in December 1999, EDF began to reassess the off-site flooding risk and the protection of all of its NPPs against this risk. This reassessment mainly concerns a revision of the maximum design flood level (CMS: maximum water level considered when designing the plant's protection structures). The revised CMS takes account of the additional causes of flooding, such as particularly heavy rain, dam failure and rising groundwater. The measures to be taken for the reactors in the event of a rise in the water level were also reassessed. A file was produced for each NPP and works to improve the protection of the sites have been defined. In October 2007, EDF completed the work made necessary by the flood risk reassessment, with regard to the risks of water ingress.

In order to finalise the overall approach to the off-site flooding risk for EDF reactors, but also for other NPPs, ASN asked the Advisory Committee for nuclear reactors (GPR) and the Advisory Committee for laboratories and plants (GPU) for their opinions.

ASN followed the recommendations of the GPR and GPU and issued six particular demands concerning the risk of dam, system or equipment failure, the flooding risk, protection against rainfall and protection of the Tricastin NPP.

A problem was raised on this occasion: the safety of certain installations with regard to off-site flooding depends to a large extent on the behaviour of the off-site structures not belonging to EDF, in particular with regard to the Cruas-Meysse and Tricastin nuclear power plants. Evaluating the robustness and the surveillance and upkeep of these structures entails a decision-making process between the concession-holders, the authorities and EDF that is in principle highly complex. Given this situation, ASN reminded EDF of its responsibilities as licensee and asked it to continue its exchanges with the concession-holders for the structures concerned and to keep it informed of progress.

ASN considers that the progress of studies and work is as expected. For the particular case of the Tricastin NPP, EDF carried out additional studies into the risk of dam failure, a subject on which ASN asked IRSN for its opinion.

At the same time, the working group for revision of RFS I.2.e to deal with the flooding risk, continued its activities in 2009. This group consists of experts from IRSN, licensee representatives and ASN. The new BNI flooding risk protection guide will cover the choice of unexpected events likely to lead to flooding of the NPP, and the methods used to characterise such events. It will concern all the BNIs. This working group held its final meetings in 2009. Consultations will be held in 2010 on the draft guide resulting from its work. The GPR and GPU will meet in 2011. ASN should publish this new guide in 2012.

ASN is also taking part in updating the IAEA guide concerning the off-site flooding risk for nuclear sites. There are a number of objectives:
– to incorporate operating experience feedback;
– to include climate change studies;
– to obtain a single guide (replacing the various IAEA guides on the subject);
– to take account of new phenomena;
– to take account of all NPPs.

2009 was also marked by triggering of the on-site emergency plan (PUI) on two occasions at Le Blayais NPP in anticipation of the violent winds of 24 January and 9 February. The ASN emergency centre was activated both times. The PUI were lifted in both cases a few hours later as the situation improved with regard both to the water level in the Gironde river and the wind speeds. The Le Blayais site was not flooded on either 24 January or 9 February.

3 | 7 | 3 Preventing heatwave and drought risks

The exceptionally hot weather conditions observed since the summer of 2003 have resulted in a significant reduction in the flow and a considerable rise in the temperature of the watercourses constituting the heat sink for certain NPPs. They also led to high air temperatures, in turn raising the temperature inside NPP premises.

During these episodes of heat wave and drought, it became clear that some of the physical limits used in the design of NPPs or stipulated in their GOR, had been reached.

For the 900 MWe, EDF therefore proposed "heatwave" reference documents in order to reassess the operation of the facilities in harsher conditions than initially considered in the design. ASN issued a position statement on these documents in 2009. At the same time as it was drafting them, EDF conducted an in-house heatwave review in order to anticipate any climate changes that could compromise the scenarios used in the "heatwave" reference documents. In 2010, ASN will rule on the adequacy of the organisation put into place by EDF, to justify compliance with the scenarios used in the documents, or if not, to make changes to them to take account of climate change. This reference documentation was also produced for N4 reactors and is currently being drafted for the 1300 MWe reactors. These reference documents have already led to certain equipment modifications being made in order to improve reactor cooling.

ASN is taking part in the national heatwave watch. With regard to this issue, ASN has defined its role and set up a decision-making process in the event of a heatwave occurring.

3 | 7 | 4 Taking account of the fire risk

The fire risk in EDF NPPs is handled using the principle of defence in depth, based on three levels: NPP design, prevention and fire-fighting.

The NPP design rules should prevent the spread of any fire and limit its consequences. This is primarily built around:
– the principle of dividing the NPP into sectors in order to keep the fire within a given perimeter, each sector being bounded by sectoring elements such as doors, fire-walls, fire-dampers, etc., offering a fire resistance rating specified in the design;
– protection of redundant equipment performing a fundamental safety function.

Prevention primarily consists in:
– ensuring that the nature and quantity of combustible material present in the premises remains below that of the scenarios used in the design of the sectoring elements;
– identifying and analysing the fire risks. In particular, for all work liable to cause a fire, a fire permit must be issued and protective measures must be taken.

Fire-fighting should enable a fire to be tackled, brought under control and extinguished within a time compatible with the fire resistance rating of the sectoring elements.

Design

With regard to design, EDF is completing deployment of the fire-fighting action plan (PAI), to ensure the conformity of and improve fire protection for the 900 MWe and 1300 MWe reactors. In 2006, ASN noted that the work to renovate the technical and electrical cable ducting was behind schedule. In 2009, during inspections and six-monthly meetings with EDF, ASN verified the completion of the work that was to have been done before the end of 2008.

During the reviews carried out in 2006, ASN also identified problems with management of loss of sectoring, whether scheduled (for example, when implementing the PAI) or inadvertent. At the request of ASN, EDF proposed a sectoring management reference system which is currently being implemented on NPPs. This reference system is being assessed by ASN and IRSN. ASN will issue a position statement on this reference system in 2010, based on the inspections it carried out in the NPPs.

Finally, for CPY reactors, ASN in 2007 asked EDF to continue with studies into modification of the smoke control system in the electrical buildings. The aim is to restore sectoring of the premises through which the circuits of this system pass and ensure smoke evacuation in the event of a fire, in order to facilitate personnel evacuation and fire-fighting. In 2008, EDF submitted a modification file defining a temporary solution. In 2009, ASN approved implementation of this temporary solution pending the definition of longer-term alternative taking account of its additional demands. EDF's response in 2009 concerning the long-term modification is currently being assessed by IRSN and ASN.

Prévention

Preventing fire breaking out and spreading is primarily based on correct management of combustible materials, whether present permanently in the premises, or only temporarily, in particular during reactor outages.

Preventing fire breaking out and spreading is also based on the quality of the fire permits, in particular the risk assessments and the effective implementation of protective measures in the field.

In the light of the inspections conducted in 2008 and 2009, ASN considers that EDF needs to further improve how the protective measures are implemented as well as the training of those responsible for drafting the fire permits.

Fire-fighting

In 2009, ASN focused on checking NPP conformity with the order of 31 December 1999 (see point 3|2|1 of chapter 3) concerning justification of the adequacy of the fire-fighting organisation set up. EDF therefore presented ASN with an approach justifying compliance with these requirements, on the basis of its internal reference documentation. Subsequent to this presentation, ASN asked EDF to define a programme to implement and check the adequacy of the provisions of its reference documentation on each NPP. EDF presented its validation programme which is in particular based on the internal checks conducted in 2009 and specified that an additional assessment is necessary for some sites. ASN is still waiting for the final EDF assessments.

In addition, during the inspections carried out in 2009, ASN observed that the response teams were deployed as soon as the alarm was triggered, rather than following confirmation of the fire and that the fire-fighting response times had improved. ASN also considers that EDF needs to continue with its fire-fighting efforts, in particular with regard to the actions of

Managing the risk of fire or explosion

the response teams and improving interfacing with the off-site emergency services.

A meeting was held on 16 December 2008 between EDF, the Directorate for Civil Security (DSC) and ASN. This meeting dealt with the interface between the organisations, assessment of the risks and definition of the response scenarios and means or resources to be deployed in the event of a fire. The progress made regarding the secondment of a professional fire-fighter to each NPP was reviewed.

In 2009, ASN monitored the progress of these various steps and more particularly those concerning the secondment of a professional fire-fighter to each plant and the definition of fire scenarios. In mid-2009, EDF had identified fire scenarios for all its plants.

3 | 7 | 5 The explosion risk

Of the accidents liable to occur in an NPP, explosion is a potential major risk. An explosion can damage elements that are essential for maintaining safety or may lead to failure of the containment with the dispersal of radioactive materials into the NPP or into the environment. Steps must therefore be taken by the licensees to protect the sensitive parts of the BNI against the risk of explosion.

In 2005, ASN asked EDF to take greater account of the risk of internal explosion. As part of the safety review associated with the third ten-yearly outages of the 900 MWe reactors, ASN therefore asked EDF to review the existing means of protection against the effects of an internal explosion. ASN also asked EDF to initiate a similar approach for the other reactor series. This approach is in progress for the 1450 MWe reactors. In 2008, ASN asked EDF to clarify how it was initiating this approach for the 1300 MWe reactors. This topic was included in the programme of work for the safety review associated with the third ten-yearly outages of the 1300 MWe reactors.

The reference system for dealing with the risks of internal explosion inside NPPs was transmitted in 2006 by EDF. The safety case presented in this reference system is based on the implementation of prevention and surveillance measures. EDF supplemented its studies by including gases other than hydrogen and by extending its analyses to buildings other than those housing the reactors. This reference system was evaluated by ASN and IRSN, and their conclusions were reviewed by the GPR at the meeting of 20 November 2008 dealing with the closure of the safety review associated with the third ten-yearly outages of the 900 MWe reactors. The modifications resulting from application of this reference system were implemented on the Tricastin 1 reactor and the Fessenheim 1 reactor.

During the explosion risk inspections carried out in 2008, ASN detected non-compliance with the requirements of Article 16 of the order of 31 December 1999 concerning piping transporting explosive fluids, especially in the Le Blayais, Civaux, Golfech and Cruas-Meysse NPPs.

Pursuant to the TSN Act, ASN issued requirements for controlling the explosion risk in its decision 2008-DC-0118 of 13 November 2008. These requirements, defining the steps to be taken by EDF within three months to deal with control of the explosion risk in all NPPs, concern:
– the creation of an organisation and oversight system such as to guarantee compliance with the regulations concerning the explosion risk;
– review of the conformity of all the explosive fluid piping with the requirements of Article 16 of the order of 31 December 1999;
– an in-depth review of the extent to which account is taken of the explosion risks.

In 2009, ASN carried out inspections to check that these steps had been taken. ASN considers that the steps taken on the whole offer a satisfactory response to the articles of the decision, subject to the justification of additional measures by the end of 2009.

At the same time, following the inspections on 25, 26 September and 24 October 2008 at the Cruas-Meysse NPP, ASN detected anomalies with regard to the absence of marking of hydrogen piping and of drawings identifying the routing of explosive fluids, as well as problems with the periodic examination and maintenance of the hydrogen piping. In 2008, ASN served EDF with formal notice to ensure that within three months, the Cruas-Meysse NPP was brought into conformity with requirements concerning management of the explosion risk as stipulated by the regulations. During the inspection of 20 February 2009, ASN observed that EDF had complied with the terms of this formal notice.

3 | 8 Occupational health and safety inspection

Pursuant to Article 57 of the TSN Act and the Labour Code (Article R 8111-11), ASN is responsible for monitoring safety and for occupational health and safety inspection duties in the NPPs. The health, safety, working conditions and quality of employment of the employees of EDF, its contractors and their subcontractors, along with the safety of the NPPs, are now regulated on a coordinated basis by ASN. This regulation takes place at the various stages in the life of the NPPs: construction, operation and decommissioning.

The main duties of the ASN officers in charge of occupational health and safety inspections are:

– to ensure compliance with the labour regulations, by checking that they are effectively and correctly applied, by all means at its disposal, but also by helping EDF to assimilate and implement the requirements of these regulations;
– to investigate work accidents and ensure that the licensee is taking the necessary steps to guarantee worker safety;
– to take decisions concerning the organisation of work (working or rest time waivers) and professional relations;
– to identify and whenever possible monitor labour disputes as part of its conciliation duties;
– to inform and advise the employees and their representatives and the employers, and to take part in the meetings of the health, safety and working conditions committees (CHSCT);
– to identify any shortcomings and abuses not covered by labour legislation as well as in the situation of the establishments checked.

For the 19 NPPs in operation and for the reactor under construction at Flamanville 3, about 20,000 EDF staff and as many contractor personnel are the subject of ASN occupational health and safety inspections.

As at 31 December 2009, ASN had at its disposal 15 inspectors and a central works director coordinating the network of inspectors, for the occupational health and safety inspectorate duties. The coordination duties are strengthened, the methods harmonised and the documentary resources and the results of documentary watch distributed. Finally, the links with the other NPP regulating activities are being consolidated in order to contribute to achieving the integrated vision of regulation that is being sought by ASN.

Coordination with the General Directorate for Labour at the ministry responsible for Labour has been strengthened and should in 2010 lead to the joint signing of a coordination protocol and a circular letter concerning organisation for the departments.

Occupational health and safety work in 2009

ASN's main occupational health and safety inspectorate function in 2009 was to check implementation of the regulations concerning health and safety in the workplace. NPPs represent risks for the workers related to the nuclear nature of the activity, but there are also "conventional" risks. They for example concern electrical installations, pressurised gas or steam equipment, the chemical products used, the explosion risk of hydrogen circuits, the asphyxia risk from nitrogen circuits, work at height, or handling of heavy loads.

In 2009, ASN's regulatory activities covered the following fields:

– with regard to its occupational health and safety inspectorate duties on the Flamanville construction site:
  - participation in the meetings of the inter-companies health, safety and working conditions commission (CISSCT);
  - performance of safety inspections on the NPP;
  - performance of investigation of accidents occurring on the NPP;
  - response to direct queries from the employees;
– the risk of falling from a height on the construction sites, conformity of scaffolding but also of lifting equipment. The subcontractors are in particular monitored on the construction sites during reactor outage maintenance operations. The ASN inspectors repeatedly detected deviations from the regulations, mainly during investigations carried out following industrial accidents. The licensee was then served formal notice to have its installations checked and ensure that the necessary remedial work was carried out;
– systematic investigations following fatal or serious industrial accidents;
– compliance with the requirements of the Labour Code by the companies working on the construction sites, in particular with regard to the simultaneous work by more than one contractor required for operation or maintenance of the NPPs. ASN in particular ensured that exposure to ionising radiations was checked with the same level of quality, regardless of whether the work was done by contractors or by EDF employees.

Verification of implementation of the Labour Code in NPPs: verification of worker aptitude

Verification of implementation of the Labour Code in NPPs: Labour Code and asbestos

However, the ASN inspectors regularly note the purely formal rather than the operational nature of the prevention plans, documents required by the regulations for analysis and prevention of the risks involved in simultaneous work;
– compliance with the rules concerning work in a contaminated environment and the radiological cleanness levels of the premises;
– activities involving the use of carcinogenic, mutagenic or reprotoxic chemical products. The ASN inspectors observed breaches of the regulations, in particular during investigations carried out subsequent to industrial accidents. The licensees were urged to take measures compliant with the precautionary principles: actually eliminate the risk at source or limit worker exposure to these products and find less dangerous alternatives. Steps were therefore taken with regard to formaldehyde emanations from the heat insulation;
– the conditions for work in the vicinity of the reactor when operating at full power, in terms of both exposure to ionising radiations and heat;
– medical monitoring of the workers, which in certain cases could be improved. The ASN inspectors on several occasions noted that the risk assessment documents and the prevention plans were purely formal documents, often incomplete and insufficiently operational.

Through their regular attendance at CHSCT meetings, the ASN inspectors can follow CHSCT activities and obtain regular information about the subjects dealt with, in particular concerning industrial accidents and psycho-social risks.

The ASN inspectors carried out checks on compliance with the regulations regarding working hours, specifically during reactor maintenance outages. As in 2008, they detected anomalies concerning the maximum daily and weekly working hours and rest periods. Reminders concerning the regulations were sent out on this point and waiver requests were examined and, in certain cases, rejected.

The ASN inspectors were required to issue a decision on a number of experiments modifying the organisation of work during reactor outages. These modifications, which aim to optimise how the work is organised and reduce outage durations while improving safety, have significant effects on working rates, conditions and relations, which also have to be taken into account by the licensees.
Finally, ASN is closely following the negotiations under way at EDF concerning management working hours.

The ASN inspectors had to examine subjects raised by the personnel representative bodies (labour disputes, arbitration concerning the CHSCT, quality of services provided and notion of contractor independence) and individual queries. They also take part in the joint work of the operational committees for the prevention of illegal labour (COLTI) chaired by the Public Prosecutor's Office. On the Flamanville construction site ASN, together with URSAFF, the border police and the labour inspectorate, thus carried out a joint inspection on implementation of the regulations concerning foreign workers present on the site for the purposes of international or other services.

Finally, 2009 saw heavy demand from the EDF staff representatives during the labour dispute in the first half of the year, as well as during arbitration of the serious and imminent hazard alert procedures implemented by the CHSCT.

Penal procedures

The ASN occupational health and safety inspectorate sent eight violation notifications concerning 5 sites to the various jurisdictions concerned. These notifications concern violations leading to industrial accidents (5 cases) or concerning working hours (3 cases).

Coordination with the Directorate General for Labour at the ministry responsible for Labour, which was intensified in 2009, will result in early 2010 in the joint signing of a coordination protocol and an organisation circular letter to the departments. ASN will boost occupational health and safety inspector training by improving and lengthening the initial training curriculum. It will strengthen the network of occupational health and safety inspectors by introducing methodology, additional resources (inspection tools) and legal support. Finally, ASN will encourage and support coherent, coordinated and programmed interventions in the NPPs and in particular checks on the subcontractors. The formalised intervention and inspection action plan for the ASN occupational health and safety inspectorate for the period 2010-2012 will focus on:
– targeting its activities consistently with the priorities of the labour policy of the ministry for Labour, by proposing 2 scheduled inspection days per year and per site or pair of reactors;
– contributing to preventing and reducing occupational risks by concentrating on reactor outage sites (work at height, psycho-social risks, chemical/CMR risks);
– guaranteeing that the law is actually applied, in particular with regard to working hours;
– encouraging negotiations and improving the conditions for social dialogue (CHSCT and professional elections);
– the fight against illegal labour (COLTI, monitoring of international contractor services (PSI).

4 RADIATION PROTECTION AND ENVIRONMENTAL PROTECTION

4|1 Oversight of occupational radiation protection

In a NPP, exposure to ionising radiations stems primarily from the fuel (especially when spent) and from the activation products and fission products present in the primary system.

All types of radiations are present (neutrons, alpha α, beta β and gamma γ) and the risk of exposure can be either external or internal.

In practice, 90% of the doses come from external exposure to β and γ radiations due to the activation products formed by the following phenomena:
– corrosion of the materials of the primary system in contact with water, followed by the release of particles and their deposition on the surface of the materials;
– activation of the upper layers of the materials subjected to the neutron flux.

These mechanisms explain the presence of radionuclides in the primary system, including cobalt 58 and cobalt 60, which on their own account for 80% of the doses received through external exposure.

Finally, 80% of the doses received by the workers are the result of maintenance operations performed during reactor outages. In 2009, these doses were spread among a workforce of about 43,000, comprising EDF staff, contractors and subcontractors, as illustrated in graph 5.

EDF policy

At the end of the 1990s, EDF strengthened its radiation protection policy in order to establish a level of stringency equivalent to that of nuclear safety. To do this, EDF took measures specifically designed to reinforce its radiation protection organisation from the highest management level to the departments with competence for radiation protection in each NPP.

ASN considers that this policy has led to significant results over the past ten years. It does however believe that the momentum apparent so far is beginning to fade, as illustrated in graph 6 by an increase of the average collective dose per reactor for two years in succession, which cannot only be explained by the nature of the outages.

EDF has also implemented a series of projects concerning the technical, organisational and human aspects. These projects aim on the one hand to reduce worker doses in the NPPs to a level that is as low as reasonably achievable and to obtain the best possible level of radiological cleanness in the NPPs. For deployment of these projects, EDF has set up a computerised dosimetry management system and action plans on the NPPs, concerning:
– control of radiological cleanness of the primary system;
– entry into controlled areas in work overalls;
– increased presence in the field of personnel from the department with competence for radiation protection;
– reduction of the dose received by the most exposed disciplines;
– definition of the role of the various radiation protection stakeholders.

ASN believes that these projects will improve radiation protection and radiological cleanness, as illustrated by graph 7. However, ASN considers that efforts must be continued in order to improve the way in which the radiation protection culture is shared among the departments, to make the radiation protection organisation more robust and to reinforce the skills and checks in the field.

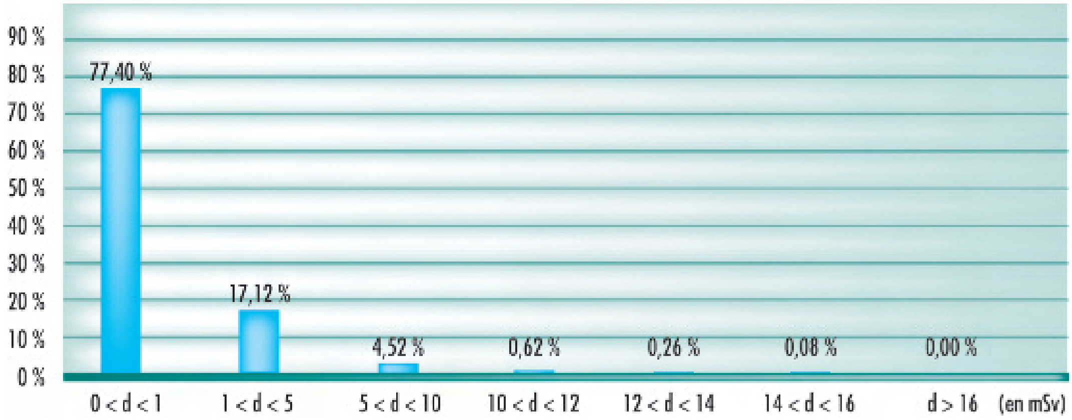
Action taken and the ASN assessment

In 2009, ASN examined the subject of worker exposure monitoring systems in the NPPs, in particular in the reactor building. ASN considers that the general mobile monitoring resources installed to supplement the fixed systems help improve the detection of any deterioration in the radiological conditions. However, ASN sent additional requests to EDF concerning the reliability of the mobile equipment.

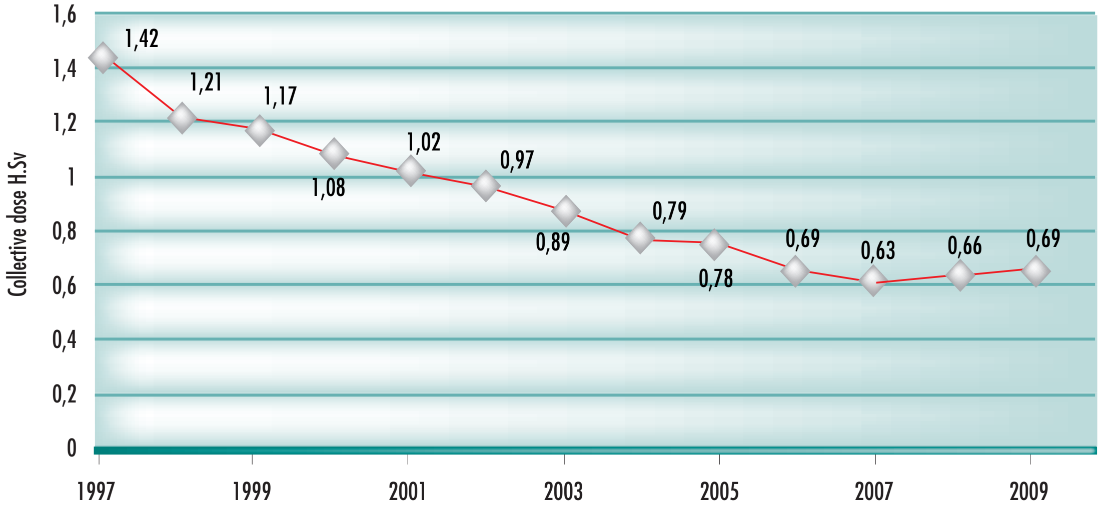
ASN is also continuing to examine the situation prior to commissioning of the EPR, in particular concerning activities with high radiological stakes and the "two rooms" concept, which is a new area in the reactor building enabling certain maintenance operations to be carried out while the reactor is operating. The general review of the EPR dossier is presented in point 2|4 of this chapter.

ASN also examined the way in which radiation protection is taken into account in the programming and performance of maintenance work or of modifications coordinated at national level. In 2009, ASN thus examined the modification file for the fuel assembly transfer and loading systems in the vessel, which is part of the third ten-yearly outages of the 900 MWe reactors. ASN also approved installation of the physical means proposed by EDF to prevent access to the reactor pit room. This room, characterized by very high dose rates, was the scene of overexposure accidents at Tricastin in 1999 and Cruas in 2001. In 2009, ASN also gave a level 2 rating on the international nuclear events scale (INES) to the accidental irradiation on 29 September 2009 of a worker from the ABC company (Horus EIG) during a gamma radiography weld inspection on the EDF Flamanville construction site

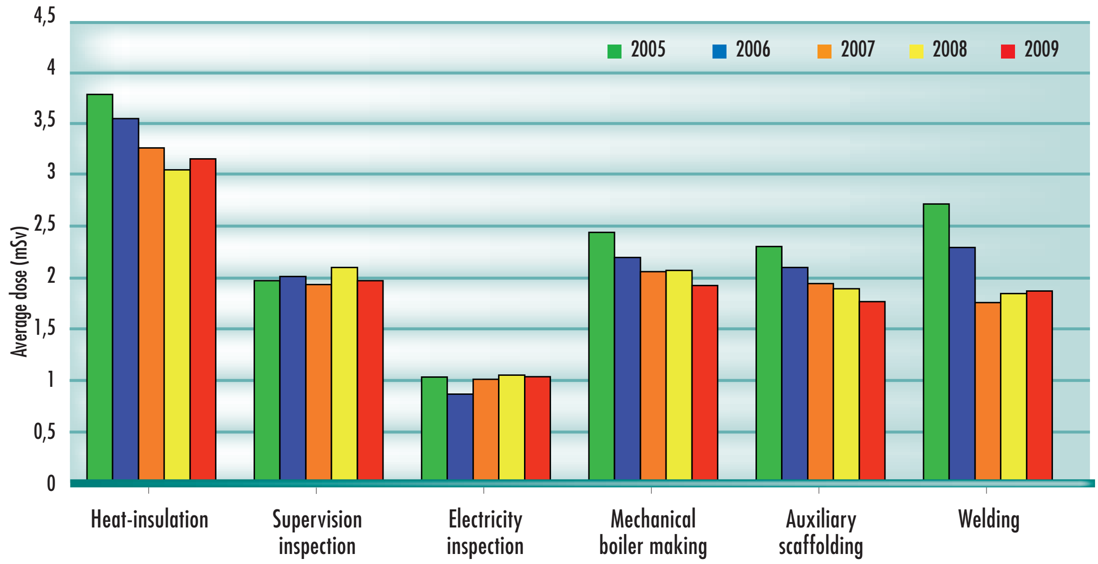
Graph 5: breakdown of the population per dose range for the year 2009 (EDF data)



Graph 6: mean collective dose per reactor (EDF data)



Graph 7: changes in mean individual dose according to categories of workers involved in reactor maintenance (EDF data)



(reactor 1, Manche *département* – see box in point 4|3 of chapter 10).

Finally, with its technical support organisation IRSN, ASN organised meetings to discuss maintaining the radiological cleanness of the primary system and the EDF computerized dosimetry management system. On the first subject, ASN considers that the research efforts made, but also the technical and organisational resources deployed, mean that there is good reason to believe that the doses received by the workers during reactor outages will be reduced. On the second point however, ASN considers that the understanding and use of the tool could be further improved and that this tool can in any case never take the place of meticulous preparation and monitoring of the work site. This preparation and monitoring are a key component of the duties of the persons with competence for radiation protection at EDF and the contractors.

In 2010, ASN will remain vigilant to the setting of dose targets and the organisational and technical measures taken to achieve them, especially during reactor outages. It will pay particularly close attention to the contamination control.

4|2 Managing NPP discharges

4|2|1 Revision of discharge licenses

In 2009, ASN continued to review the effluent discharge and water intake licence renewals for NPPs, initially issued in accordance with the provisions of decree 95-540 of 4 May 1995 concerning the discharge of liquid and gaseous effluents and water intake by BNIs. These licences, issued by the préfets under the previous regulations in this respect, comprise a stipulated validity limit and some are nearing expiry.

ASN's aim is for the majority of the existing licences to be reviewed in order to ensure greater harmonisation among the various NPPs. Since the publication of decree 2007-1557 of 2 November 2007 (see chapter 3, point 3|1|3), the new requirements now take the form of ASN decisions, subject to approval by the ministers responsible for nuclear safety and radiation protection, when the provisions concern environmental discharge limits.

These requirements concerning water intake and all BNI discharges mainly set the quantities, concentrations and surveillance methods with regard to the pollutants liable to be contained in the discharges and in the environment, in accordance with the order of 26 November 1999. On the occasion of these licence renewals, ASN applies the following principles:

– with regard to radioactive discharges, the real discharges from NPPs are constantly falling and are well below the limit values hitherto in force, so ASN is reducing these limit values. It is setting new limits based on operating experience feedback about actual discharges, while taking account of the unexpected situations arising during the course of routine reactor operations. The discharge limits have thus been cut by a factor of between 1 and nearly 40, depending on the radionuclides involved, for the current fuel management procedures. They have however been raised by a factor of 1|25 for liquid tritium discharges, assuming future "high burn-up fraction" fuel management;
– with regard to non-radioactive substances, ASN has decided to set discharge requirements for substances that were not regulated in the past, with virtually all discharges now being regulated.

At the end of 2009, after renewing the Chooz and Civaux licences, 16 NPPs now have revised discharge and water intake licences. Submission of the licence renewal files for the other plants is being staggered until 2011.

4|2|2 Procedures carried out in 2009

Complete revision of the effluent discharge and water intake licences

In 2009, ASN completed its review of the effluent discharge and water intake files for the Civaux and Chooz NPPs.

Effluent discharges and water intake on the Civaux site are now regulated by two ASN decisions of 2 June 2009, 2009-DC-0138 and 2009-DC-0139, published in the ASN Official Bulletin on its website. Decision 2009-DC-0139 setting the environmental discharge limits was approved by an order of 23 June 2009 from the ministers responsible for nuclear safety and radiation protection.

The effluent discharges and water intake on the Chooz site are regulated by ASN decisions 2009-DC-0164 and 2009-DC-0165 of 17 November 2009 and published in the ASN Official Bulletin on its website. Decision 2009-DC-0165 setting the environmental discharge limits was approved by an order of 30 November 2009 from the ministers responsible for nuclear safety and radiation protection.

ASN also continued with its review of the effluent discharge and water intake files for the Dampierre-en-Burly NPP and for the two reactors in operation, as well as for the EPR type reactor under construction on the Flamanville site.

Partial revisions

In 2009, ASN continued to review the applications for changes to the effluent discharge and water intake licences for:

– the Belleville-sur-Loire and Cruas-Meysse NPPs (regulated by the orders of 8 November 2000 and 7 November 2003 respectively): the applications mainly concern a revision of the limit values for tritium discharges and for certain chemical parameters such as metals (copper and zinc), changes to the method of conditioning the secondary systems and the use of biocidal and descaling treatment of the condenser cooling systems;
– the Chinon NPP (regulated by the order of 17 August 2005 amending the order of 20 May 2003): the application concerns measurement of the cooling system purge flow rate;
– the Paluel NPP (regulated by the order of 11 May 200): the application mainly concerns a revision of the limit values for tritium discharges and changes to the chemical parameters for the method of conditioning the secondary systems;
– the Saint-Alban NPP (regulated by the order of 29 December 2000): the application concerns a revision of the limit values for nitrogenated discharges, suspended solids and pH;
– the Saint-Laurent-des-Eaux NPP (regulated by the order of 2 February 1999 amended by the order of 21 February 2006): EDF officially withdrew the initial file and submitted a new file in May 2009 primarily concerning the use of biocidal treatments linked to condenser modifications.

Finally, pursuant to Article 26 of decree 2007-1557 of 2 November 2007, a number of NPPs submitted notifications concerning the dredging of their water intake or discharge structures (Fessenheim, Flamanville) or the increased surveillance of the groundwater, through the creation of new observation wells (Belleville, Chinon, Chooz, Cruas, Dampierre, Fessenheim, Golfech, Saint-Laurent). These operations were expressly approved by ASN without modification to the requirements of the effluent discharge and water intake licences for these NPPs. ASN also issued express approval for dredging on the Dampierre site, for which a notification of works was submitted in 2008.

Particular operations

Clogging of the steam generator support plates was brought to light on several of the French nuclear power reactors (see point 3|4|4). In order to remedy this clogging phenomenon, EDF decided to use two forms of chemical washing on the reactors concerned, one called HTCC and the other called EPRI/SGOG. The work began in 2007 and continued in 2008 and 2009 on reactors 2 and 3 at the Chinon B NPP and reactors 1 and 3 at the Cattenom NPP.

Pursuant to Article 26 of decree 2007-1557 of 2 November 2007, EDF notified ASN of the NPP modifications resulting from use of the chemical washing processes, particularly with regard to the discharge of liquid and gaseous effluents and the use of the equipment necessary for these operations. Based on the data presented in the EDF files (including the demonstration that there were no impacts around the NPP boundary, the discharge surveillance measures taken and the steps taken to inform the neighbours and local residents), the operations were expressly approved by ASN without modification of the requirements of the discharge licence concerning these NPPs.

Examination of management of radioactive and non-radioactive effluents

In 2006, ASN decided to consult the GPR about the management of radioactive effluents and certain non-radioactive effluents from the French NPPs in service and the various means of improving it. This examination concerns the liquid and gaseous radioactive effluents and the associated chemical substances involved in normal operating situations.

The technical review carried out by IRSN continued until May 2009, when the GPR meeting took place. After this meeting, the GPR issued its opinion and EDF undertook to carry out a number of measures on the various topics examined during the technical review.

ASN considers that the approach adopted by EDF should lead to a significant improvement in effluent management and to a further reduction in discharge levels of radionuclides and associated chemical substances in the NPPs. ASN also sent a number of additional requests to the licensee, in particular concerning the production of "material balances", the use of hydrazine degradation processes in the tanks, substances liable to be discharged via the rainwater drainage network during relatively infrequent operations and the qualitative and quantitative evaluation of the operations which make a significant contribution to the production of effluents.

4 | 2 | 3 Identifying radioactive release values

The licensee sends ASN its discharge results every month. These data are regularly cross-checked against reactor operation during the period considered. Anomalies detected give rise to requests for additional information from the licensee.

The 2009 results concerning radioactive effluent discharges are presented in graphs 8 and 9. Graph 8, "Liquid radioactive discharges", presents the 2009 discharges of liquid tritium and liquid non-tritium (carbon 14, iodine 131, nickel 63 and other beta and gamma emitting radionuclides) per pair of reactors. Graph 9, “Gaseous radioactive discharges”, presents the 2009 discharges of gases (carbon 14, tritium and noble gases) and halogens and aerosols (iodine and other beta and gamma emitting radionuclides) per pair of reactors.

Radiological impact of discharges
The calculated radiological impact of the maximum discharges given in the EDF licence applications for the most exposed population group, is well below the dosimetric limit acceptable for the public. The annual effective dose received by the population reference group given in the EDF effluent discharge and water intake licence applications is therefore estimated at between a few microsieverts and a few tens of microsieverts per year.

For example, the annual effective dose corresponding to the limit values requested by EDF for renewal of the Civaux NPP licence, was evaluated at 22 µSv per year. As the actual discharges in 2009 from the Civaux power plant were lower than the stipulated discharge limits, the real annual effective dose for 2009 is lower than this value.

4 | 3 Regulating the management of technological waste

Waste management operations
Most of the operations associated with management of the waste resulting from the operation and maintenance of nuclear reactors take place in nuclear auxiliary buildings (BAN), waste auxiliary buildings (BAC) and liquid waste discharge system buildings (BTE). Following inspections which brought to light unsatisfactory waste management in terms of radioactive materials containment, fire protection and radiation protection, ASN asked EDF to improve waste management on NPPs and to define operating requirements concerning waste management in the BAN, BAC and BTE buildings. EDF inventoried the buildings, compared current practices with those defined in the design documents, and gradually reduced the quantities of waste stored in these buildings. In 2009, EDF completed its waste management framework, which now has to be put into practice by the NPPs. ASN observed the efforts made by EDF in terms of packaging and removal in order to reduce the quantities of waste stored and will now ensure that the waste removal process continues and the waste management framework is implemented in the field.

Waste with no disposal solution
A certain amount of waste from contaminating areas (monitored areas, controlled areas) such as batteries, electronic devices, etc., currently has no disposal solution.
Most of this waste was produced a long time in the past. Improvements in routing this waste to conventional or nuclear disposal facilities and in waste classification has minimised the production of some of this waste, in particular batteries and LED lighting.

ASN asked EDF to draw up an inventory of the types of waste concerned for the plants in operation and estimate the quantities present on NPPs as compared with the storage capacities. EDF worked with ANDRA to draw up the acceptance files. This collaboration should continue in 2010.

Finally, as the quantity of electronic waste is bound to increase, given the greater use of electronic equipment, hardware and components, ASN asked EDF to initiate the necessary investigations to estimate future waste quantities.

4 | 4 Increasing protection against other risks and forms of pollution

4 | 4 | 1 Controlling the microbiological risk

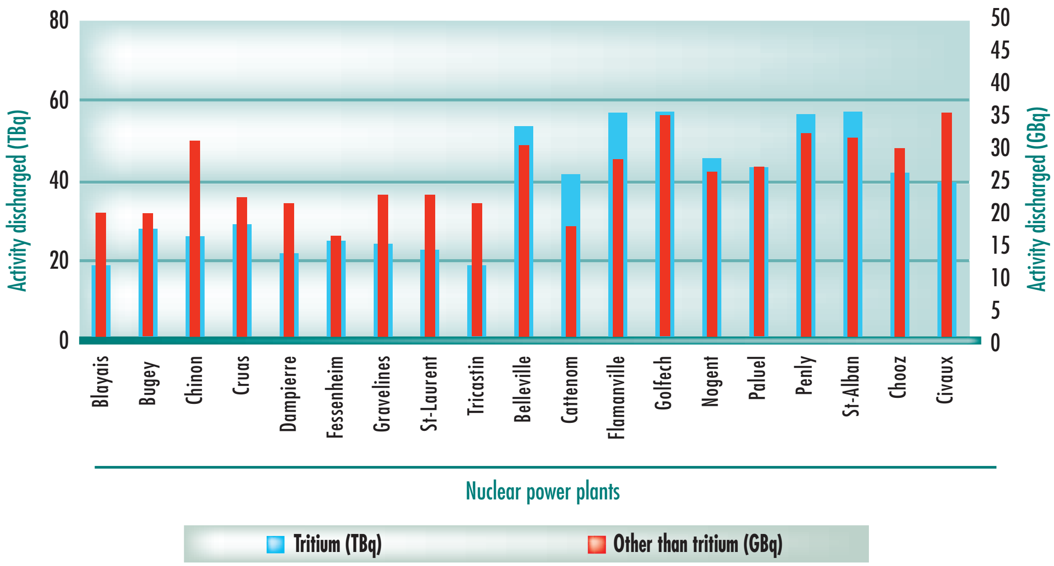
Management of the bacteriological risk in NPPs is a health issue, owing to the severity of the potential infections, but also an environmental one, given the impacts of the discharges resulting from biocidal treatment (capable of destroying micro-organisms).

Amoebae
As stated in point 1|1|1, the condenser is a heat exchanger used to cool the secondary systems. The older exchangers are made of brass while the more recent ones are made of stainless steel or titanium, because they lead to fewer metal releases through wear than brass (the origin of the copper and zinc releases).

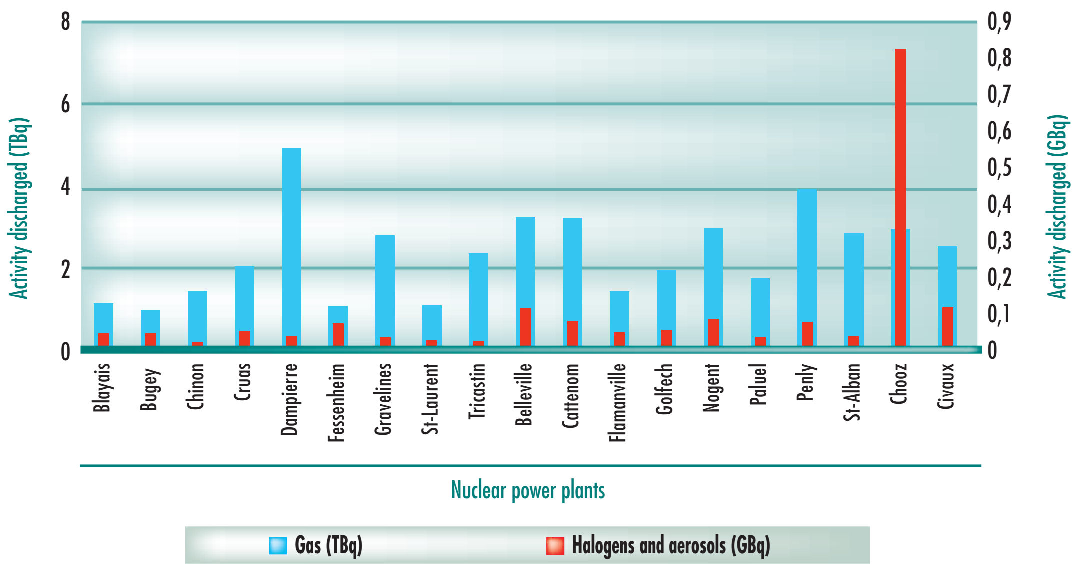
Amoebae, which are micro-organisms that can be pathogenic, do not develop in circuits fitted with brass condensers, owing to the toxicity of copper for them, but can develop in the renovated exchangers.

In order to comply with the limit value set by the health authorities, the NPPs at Bugey, Chooz, Dampierre-en-Burly, Golfech and Nogent-sur-Seine carry out biocidal treatment with monochloramine. Use of this chemical compound, which is frequently employed in water treatment, leads to discharges of chemical substances (chlorinated and nitrogenated compounds). These discharges are regulated by requirements issued by the authorities. The Civaux NPP uses another technique involving UV radiation to disinfect the discharged cooling water because the Vienne river into which the discharge flows is more susceptible to chemical treatment discharges. In 2009, no

Graph 8: liquid radioactive discharges (2009)



Graph 9: gaseous radioactive discharges (2009)



instance of the pathogenic amoeba concentration being exceeded downstream of the NPPs was observed.

However, an excessive concentration of pathogenic amoeba was observed in August 2009 downstream of the Saint-Laurent-des-Eaux NPP, which does not yet use monochloramine treatment. The site used a different type of treatment (known as “massive chlorination”) to bring the level back below the concentration limit value set by the health authorities.

EDF is also conducting a study programme, described in detail below, to look for alternative solutions to chemical treatment.

Legionella

Legionella are micro-organisms which can be pathogenic. They can develop in NPP cooling towers, which offer conditions propitious to the development of bacteria and their dispersal in the plume of steam they discharge.

The legionella concentrations in secondary system cooling systems of NPPs with cooling towers are variable and depend on a variety of factors (time of the year, scaling, quality of make-up water, use of anti-amoeba treatment, etc.). They can reach up to several hundred thousand colony forming units per litre (CFU/l – indicating the number of micro-organisms per unit of volume), or even more than a million for those plants not using treatment: Belleville-sur-Loire, Cattenom, Cruas-Meysse, Dampierre-en-Burly (reactors 2 and 4) and Saint-Laurent-des-Eaux. They remain less than one hundred thousand CFU/l at Bugey, Chooz, Civaux, Dampierre-en-Burly (reactors 1 and 3), Golfech, Nogent-sur-Seine and Chinon, the last NPP equipped with a monochloramine treatment station.

To enhance legionella risk prevention, ASN together with the General Directorate for Health (DGS) in 2005 required that EDF comply with maximum legionella concentration limits in the cooling systems, along with installation surveillance requirements. ASN observes that the limits it set are adhered to by all NPPs. Moreover, to date, no cluster of legionella cases has been attributed to a large cooling tower on a NPP.

Jointly with DGS and DGPR, ASN contacted the French Agency for Environmental and Occupational Health Safety (AFSSET) for its opinion on the evaluation of the health and environmental risks associated with the presence of legionella in the cooling systems of NPPs, in order to obtain a clearer assessment of the studies conducted by EDF and the general risk prevention and surveillance strategy.

Two opinions were forwarded by AFSSET in 2006 and 2007. After being critical of the approach and measures adopted by EDF in 2006, AFSSET considered that the action plan proposed by EDF at the end of 2007 contained significant improvements. It did however consider that EDF needs to continue its efforts with respect to risk analysis, tightening up the surveillance plans, improving inspection procedures and evaluating additional solutions.

In 2008, based on the AFSSET conclusions, ASN asked EDF:
– to keep the colonisation levels as low as reasonably achievable;
– to intensify the surveillance of its facilities and improve the robustness of its microbiological monitoring practices;
– to optimise the treatments used in order to control any contamination peaks and take account of the particularities of each site;
– to look for alternative solutions to biocidal treatment;
– to contribute to the epidemiological surveys carried out by InVS and AFSSET.

In its action plan, revised following the AFSSET opinions and built around enhanced surveillance of the NPPs, EDF defines preventive and remedial measures to be implemented, while seeking to minimise the chemical

Aerial view of the Dampierre-en-Burly NPP with its four production units discharges resulting from the treatment processes employed. The general approach proposed by EDF concerns both control of the resources already available and a search for alternative solutions.

In the action taken by EDF since the summer of 2008, ASN has observed considerable efforts to manage the risks related to the development of legionella. It did however urge EDF to step up its search for alternative solutions, in order to minimise chemical discharges and thereby limit the environmental impact.

In 2009, this search led to treatment tests on the make-up water of "pilot" installations on the Belleville and Cattenom NPPs. This alternative solution consists in treating the cooling systems make-up water by settling, flocculation and decarbonation, in order to limit system fouling and scaling, which are propitious to the proliferation of micro-organisms. The operating experience feedback from the make-up water treatment tests carried out in 2009 should enable EDF to reach a decision on the feasibility of a "large-scale" solution and fine-tune its overall legionella treatment strategy for the large cooling towers in 2010.

4 | 4 | 2 Preventing accidental water pollution

Following the July 2008 events in the BNIs operated by SOCATRI (in Tricastin) and by FBFC (in Romans-sur-Isère) respectively, ASN asked EDF to check the condition of all the retention systems that could contain toxic, radioactive, flammable, corrosive or explosive fluids and to carry out any necessary repairs as rapidly as possible. In response to this request, EDF drafted a verification programme at the end of 2008, which was carried out in 2009. The progress of this programme was presented in a quarterly report for each of the NPPs and EDF intends to complete all checks by 31 December 2009.

Hydrocarbons were released into the environment on several occasions in 2008 leading to accidental pollution of the Loire river close to the Chinon NPP and of the Rhone river near the Bugey NPP. In late 2008, initial analysis of these events revealed malfunctions in some of the oil removers (equipment used to separate oil and water in non-radioactive effluents) and in the associated alarm systems. In November 2008, ASN therefore sent EDF a letter asking it to check all the oil removers and associated alarm systems in the NPPs and to learn the lessons from experience feedback from these events. In early 2009, EDF completed its checks on this equipment and forwarded a summary to ASN. Anomalies were detected on certain oil remover level sensors and once they were replaced, satisfactory operation was restored. The inventory carried out also revealed differences in oil remover operating and maintenance procedures, so EDF has taken steps to improve this situation.

4 | 4 | 3 Noise limitation

With regard to noise pollution, the impact of the NPPs is regulated by the above-mentioned order of 31 December 1999. This order limits the noise caused by the NPPs, referred to as the "sound emergence", in other words the difference between the ambient noise level when the NPP is operating and the residual noise level when the NPP is stopped. As an example, this difference should not exceed 3 dB (A) at night.

In 2001 and 2002, EDF took noise measurements on all the NPPs and a study revealed conformity of ten sites and nonconformity of the other nine (Belleville-sur-Loire, Bugey, Chinon, Civaux, Dampierre-en-Burly, Golfech, Nogent-sur-Seine, Penly and Saint-Laurent-des-Eaux). The main noise sources identified were the cooling towers, the turbine halls, the BAN stacks and the transformers.

Legionella concentration levels in the large NPP cooling towers

The legionella concentrations not to be exceeded in the secondary system cooling systems are 5.10^6 CFU/l for NPPs with large cooling towers (about 150 m high), and 5.10^5 CFU/l for the Chinon NPP with its smaller cooling towers (28 m). For the systems other the secondary systems cooling system (air-conditioning for example), implementation of the requirements in force for ICPEs is requested (lower limits for ICPE cooling towers).

Since 2005, the Chinon nuclear power plant has been equipped with a monochloramine legionella treatment unit. This NPP, which required updating of the discharge and water intake licence, enables the licensee to meet the maximum legionella concentration level set by ASN.

For the other power plants which do not use specific treatment, the value of 5.10^6 CFU/l is met by means of the preventive measures usually employed by EDF to limit the development of biofilm and the formation of scale in its systems.

Emissions of ozone-depleting substances

In order to meet both industrial and service requirements, NPPs operate chillers. The technology used in these units involves a refrigerant fluid which is vaporised and condensed to allow heat transfer. Utilisation of these refrigerants is covered by a number of regulatory texts, including European regulation 2037/2000, which aims to limit the production, marketing and utilisation of substances which deplete the ozone layer, and decree 2007-737 of 7 May 2007 concerning certain refrigerant fluids and containing requirements regarding information of the Government representative if a leak or degassing operation is detected.

In 2008, the criteria for ASN notification of emissions of refrigerant fluids were changed and in early 2009 ASN asked EDF to conduct an inventory and analysis of all refrigerant losses in 2008. This analysis concerned 100 refrigerant losses, ranging from a few kilograms to more than 400 kilograms. These losses were apparently primarily due to equipment faults.

EDF stated that it had started work on drafting good practice guides and carrying out analyses of these losses on certain types of chiller units. 2009 was nonetheless once again marked by numerous refrigerant loss notifications.

In 2010, ASN will be closely monitoring the steps taken by EDF, in particular those concerning good practices and chiller inspections. ASN will also ensure that the replacement of the chillers on the 900 MWe reactors takes place correctly.

In response, EDF defined an overall treatment approach based on sound-proofing studies. These studies showed that ensuring strict conformity by the nine plants was not possible in acceptable technical and economic conditions, or would imply drawbacks, for example in terms of safety or health.

EDF therefore oriented its strategy along three main lines:
– reduction and if possible elimination of the main noise frequencies;
– priority given to industrial noise sources;
– whenever possible, no aggravation of the situation if the NPPs are modified.

Furthermore, for NPPs with cooling towers or a river weir, EDF considered that the detrimental effect generated by the noise of falling water in these works is less than that from noise of an industrial nature.

Following the additional measurements conducted by EDF in 2005, ASN in 2006 concluded that EDF's overall approach is acceptable and that the sound emergence of the sites obtained by incorporating falling water type noise into the residual noise is a good indicator of the performance achieved. ASN at the same time reviewed EDF's justification documents in order to adopt a stance on each of the NPPs identified as being non-compliant.

In 2009, EDF continued to study the envisaged modifications. Before starting work on the sites in question, scheduled for 2010, EDF has begun to draw up the modification notification files to be sent to ASN concerning the work in question. Once the work has been completed, EDF will carry out acoustic measurements to check the effectiveness of the solutions adopted.

5 ASSESSMENT

5|1 Assessing the head office departments and overall NPP performance

The following general assessment gives a thematic summary of ASN's evaluation of the head office departments and the safety performance of the EDF NPPs, in other words in terms of nuclear safety, radiation protection and the environment.

This evaluation is itself based on the results of checks carried out by ASN in 2009, particularly through inspections, oversight of reactor outages and analysis of how EDF handles significant events, as well as on the extent to which the inspectors are familiar with the NPPs they inspect. In 2009, ASN conducted 492 inspections in the nuclear power plants in service and in EDF head offices.

The general assessment represents ASN's view of the year 2009 and acts as a guideline for ASN regulation and inspection actions for 2010.

5|1|1 Assessing nuclear safety

Reactor operations

The operating documents are on the whole well managed, cover the various operating phases and offer a particularly accurate picture of the actual status of the installation. Management of personnel training and qualifications remains satisfactory, despite a number of minor anomalies detected during the course of inspections.

Improved operational stringency remains a key priority for the NPPs and head office departments. ASN considers that the efforts made on this subject in recent years must be continued. Progress in this area was observed on some sites in 2009.

However, despite the steps taken in some NPPs or the existence of formal procedures, preparation for maintenance work remains a weak point.

The number of incorrect interpretations of the concept of equipment availability, particularly after carrying out periodic tests, and the number of failures to comply with the STE, rose once again in 2009. Some of these interpretations are indicative of inadequate staff familiarity with chapters 3 and 9 of the GOR.

Finally, involvement by the shift crew hierarchy in the field would once again seem to be down in 2009. Periods involving a heavy work load remain hard to manage.

The situation also remains unsatisfactory in a number of fields. This is the case with management of particular equipment and resources (DMP), management of temporary operating instructions, compliance with the requirements of Articles 8 and 9 of the order of 10 August 1984 and strict application of the operating reference systems. Areas for improvement must be defined or specified in greater detail.

Emergency situations

ASN considers that EDF's preparedness for managing emergency situations is satisfactory. National relations have been strengthened over the last two years, allowing for easier exchange of information. The operating experience feedback acquired over the years, but also the diversity of situations encountered, have led EDF to take a fresh look at its documentary reference system concerning on-site emergency plans. ASN is regularly informed about this work, which also falls within the new regulatory structure being gradually implemented by ASN.

The national emergency response organisation was triggered by EDF four times in 2009: at the Le Blayais NPP during the storms of 24 January 2009 and 9 February 2009, at the Cruas NPP on 2 December 2009 owing to the blockage of the water intake feeding the reactor cooling system by a massive influx of plant debris carried by the Rhone river and at the Fessenheim NPP on 27 December 2009 following a partial reduction in cooling systems flow caused by plant debris. EDF managed the situation well in each case, but will nonetheless have to learn lessons from these situations.

The organisation for the emergency response to the release of ammonia, set up on the sites with a monochloramine treatment facility, is not considered by ASN to be fully satisfactory and will need to be improved, taking account of ASN's requests.

This type of risk will eventually be included in the emergency response part of the on-site emergency plan.

Through inspections in 2009, ASN observed progress in fire-fighting, although there is still room for improvement, in particular with regard to performance of the duties and the actions of the response teams (operational nature of the role and duties of the emergency response supervisor in particular). There are however two positive points: since 2009, the response teams are deployed as soon as the fire is detected rather than following confirmation of the fire, and a professional fire-fighter has now been seconded to each NPP.

Maintenance activities and subcontractors

ASN considers that EDF needs to improve its management of maintenance activities, as some points are constantly recurring. The maintenance framework is in a state of permanent change, introducing a level of complexity that aggravates the persistent delays in integration observed on all NPPs and tending to accentuate differences in the requirements.

The quality of the risk analyses in the preparation of maintenance work and their assimilation by those involved, remains unsatisfactory. It needs to be significantly improved in virtually all the NPPs. Spare parts management must also be improved, as these spares are not always available or sometimes do not have all the required characteristics.

ASN observes that EDF failed to anticipate certain problems sufficiently far in advance and did not take sufficient account of international operating experience feedback, which means that it is now required to carry out delicate, large-scale corrective maintenance on the steam generators in order to guarantee their safety.

With regard to the performance of maintenance work, ASN notes that some operations, carried out by EDF or its contractors, were marred by quality defects, that EDF must do more to prevent. Improving the quality of maintenance also entails greater consideration being given to human and organisational factors in the preparation stages.

Most maintenance activities on NPPs are entrusted to contractors selected on the basis of a qualification and evaluation system. ASN believes that the principle of this system is satisfactory, but that EDF needs to reassess its industrial maintenance policy and its use of contractors, as it considers that EDF is no longer making progress in its monitoring of contractors. ASN in particular notes a deterioration in field monitoring of the activities carried out by the contractors and considers that this needs to be rapidly improved and intensified. EDF must therefore check the adequacy of the quantity and quality of the resources allocated to monitoring of the activities subcontracted and take account of the safety, radiation protection and environmental protection issues involved in these activities.

As in previous years, ASN also noted that material resources are sometimes insufficient or inappropriate, which in some cases led to degraded contractor working conditions in terms of safety and radiation protection.

The methods used by EDF to optimise the maintenance programmes for the equipment important for safety are acceptable. However, it must ensure that the human and material (spares) resources deployed are commensurate with the objectives set by this policy.

EDF's involvement in maintenance is considerable, in particular owing to the significant industrial and financial stakes involved. With regard to the continued operation of the oldest reactors, it is essential for maintenance to be compatible with the ageing of the equipment. The obsolescence of certain equipment must be taken into account.

Equipment condition

Equipment maintenance and replacement programmes, the safety review process and correction of conformity anomalies identified contribute to keeping NPP equipment in a generally satisfactory condition. However, ASN observes that EDF did not anticipate certain problems far enough in advance, meaning that it now has to carry out delicate, large-scale maintenance work on the steam generators, in order to guarantee their safety.

ASN considers that the quality of the EDF operating documents for performance of the periodic tests is improving. However there are still problems with meeting the deadlines for performance of periodic tests on equipment important for safety, and with the lack of stringency in the definition and adequacy of the post-maintenance testing of equipment following the maintenance work. ASN considers that EDF needs to improve the preparation and oversight of these operations and enhance the competence of the preparation staff in order to minimise the persistent confusion between the objectives set for the periodic tests and those set for the post-maintenance qualification tests.

Pressure equipment

ASN considers that EDF is continuing to make progress in management of pressure equipment and that in the short-term all NPP inspection departments will be recognised. ASN notes that the situation is satisfactory in an increasing numbers of NPPs and believes that EDF needs to correctly staff these departments if they are to carry out their duties on the basis of exhaustive inspection plans.

The first barrier

ASN considers that in 2009 the situation regarding the first barrier is on the whole satisfactory but that there is room for improvement on several points, in particular the quality of its operation.

In 2009, as in 2008, the problems encountered on the first barrier are mainly tightness defects occurring during the cycle on a small number of M5 alloy or RFA 900 design fuel assemblies, plus damage to the support grids, leading to loose parts migrating through the primary system.

ASN considers that EDF has taken satisfactory steps to identify and minimise the risk of a fuel packaging dropping, in particular through the implementation of harmonised maintenance procedures and increasingly reliable handling equipment.

However, ASN did observe that fuel assembly blockage incidents occurred in 2009 at Gravelines and Tricastin (see point 3|3|3).

Finally, EDF needs to make significant progress in implementation of the fuel handling equipment maintenance programmes because this equipment can be the cause of damage to the fuel assemblies inserted into the core.

The second barrier

ASN considers that EDF needs to make progress in terms of ensuring CPP and CSP integrity.

Further damage linked to poorly characterised corrosion or to cracks with new characteristics was discovered in 2009 on a number of steam generators, such as those in the Bugey 3 and Fessenheim 2 reactors. This damage comes on top of the defects already detected in the past. ASN considers that EDF did not anticipate enough when programming some of the steam generator inspection, maintenance or replacement activities.

The clogged steam generator chemical cleaning strategy is a positive point. The use of chemical cleaning of the clogged steam generators on the Cattenom 1 and 3 and Chinon B3 reactors was satisfactory. The removal of copper from Chinon steam generator 2 did not prove to be as effective as planned. The process needs to be further improved because numerous problems occurred while it was being carried out.

The replacement of the steam generators on Le Blayais 1 took place in good conditions, despite the defects encountered on the new steam generator tube bundles.

With regard to the anomalies with installation of the mechanical plugs in the steam generators and following a further event detected on Paluel 3, EDF took steps in 2009 to:
– understand the origin of the anomalies encountered;
– evaluate the risk of the plugs shifting;
– define inspection criteria for subsequent plug installation when the installation curves are not available.

The third barrier

This point gives an assessment of the reactor containment, which concerns the third barrier, its extension and the containment of the peripheral buildings.

There is considered to be room for improvement in the condition of the third barrier and its components. Although it is not damaged, the incidents notified this year are indicative of a lack of operational stringency, a fact that was already observed in 2008, albeit to a lesser extent.

Even if the head office departments today offer effective monitoring of the generic problems concerning the containment and raised at the latest GPR meetings, national and local action is required in order to improve implementation of the containment requirements and increase personnel awareness on this subject.

With regard to a particular point concerning the results of the containment tests on the 1300 and 1450 MWe reactors, EDF must present ASN with technical solutions to guarantee containment tightness despite ageing.

5|1|2 Assessing radiation protection

After falling for several years, the dosimetric results from the NPPs in operation show a rise that can be explained by technical and organisational problems. Even if the dosimetric results remain satisfactory, ASN considers that vigilance must be maintained with regard to dose optimisation during reactor outages and concerning the management of contamination at source.

The national action plans defined and implemented by EDF to improve radiation protection are consistent with the diagnosis of the situation. Local implementation of these action plans is methodical and is bearing fruit, particularly with regard to management of radiographic exposure.

In 2009, ASN conducted specific inspections on the control of contamination on those NPPs (Golfech, Civaux, Cattenom) which had adopted the EVEREST approach (entry into limited access areas wearing ordinary work overalls). The inspections revealed a few anomalies which need to be addressed before this approach can be systematically adopted.

ASN observed problems in having the radiation protection approach assimilated by all the players in an NPP and noted that there was no improvement in the attitude of the participants, which may have been a factor in the occurrence of incidents.

ASN therefore considers that the action plans must be continued, even reinforced, in particular when they deal with skills enhancement, especially those of the contractors responsible for radiation protection duties or inspection in the field. The "radiation protection" culture of the parties involved must be further improved and efforts are needed in defining the responsibilities of the various radiation protection players. Finally, there is still room for progress in controlling contamination at source, in the quality and implementation of risk and optimisation analyses, in monitoring of application of the radiation protection rules on the work sites, especially involving adequate signage of hot areas and hot-spots.

5|1|3 Assessing environmental protection measures

ASN considers that EDF's situation in 2009 with regard to environmental protection, particularly with respect to non-radioactive discharges, had on the whole worsened. At the end of 2008, ASN's suspension or refusal to grant approval for EDF in-house laboratories in charge of environmental radioactivity measurements, already showed that EDF was insufficiently attentive to environmental concerns (see chapter 4, point 4|3|3).

As in 2008, ASN observed that EDF's involvement and the impetus of the actions initiated varied widely according to the topic. With regard to equipment maintenance, refrigerant fluid checks but also, more broadly, all environmental protection problems (compliance with regulations and other technical requirements applicable to NPP installations, availability of discharge and environment monitoring equipment, uncontrolled releases), EDF will need to take immediate action, at the very least to allow a rapid return to a satisfactory situation, followed by longer term measures to maintain, or even improve the level obtained after a satisfactory situation has been restored.

Although the environmental organisation of the NPPs is clearly defined, a rising number of anomalies was detected on many of them in 2009. Anomalies with regard to installation conformity, maintenance, contractor or organisational monitoring were brought to light this year. Furthermore, several anomalies concerning compliance with the discharge orders were notified by EDF to ASN. Some of these anomalies (in particular discharges of copper and zinc from Belleville and total nitrogen from Chooz) are persisting and are the subject of discharge license modification files, currently being examined.

5|1|4 Analysing human and organisational measures

ASN considers that the organisation defined by EDF for dealing appropriately with safety and radiation protection issues must be implemented more rigorously by the NPPs. Generally speaking, ASN regularly observes significant anomalies in implementation by the NPPs of the organisations specified at the national level, for example in maintenance or in contractor monitoring.

The NPPs set themselves improvement targets in the various safety, radiation protection, environment and worker safety fields.

However, in the field of safety, these objectives must be defined in a more realistic way.

In the field of radiation protection, the progress made in radiological cleanness means that the NPPs can now implement the EVEREST approach (entry into limited access areas wearing ordinary work overalls) and set more ambitious targets for this aspect.

The roles and responsibilities within the departments are defined in organisation circulars but are sometimes hard to actually apply to the activities carried out. ASN can see no change in relation to previous years in activity preparation, which is felt to be too frequently inadequate. In general, the hierarchy is more present in the field, but its supervision of the actual activities is sometimes insufficient.

ASN considers that the skills management system and NPP operating personnel qualifications are implemented satisfactorily, and that the creation of training work sites and skills academies for new recruits are positive points that should be underlined. However, as in 2008, ASN considers that the staff training, in particular of the contractors, could be improved in the radiation protection and environment fields. The hierarchy is still experiencing difficulties in carrying out the observations in the field that are necessary to assess the skills actually used by the personnel.

Manning levels are generally speaking appropriate. However, ASN once again noted an excessive workload on the staff. As in 2008, monitoring of the work done by the contractors is an activity that is sometimes under-staffed.

ASN is of the opinion that the conditions in which operation and maintenance work is carried out is not always satisfactory. In the field of maintenance, the use of material resources such as scaffolding, tools and protective equipment in poor condition is worrying, as is the lack or poor management of spare parts. The provision of equipment to the contractors by the NPPs is felt to be highly unsatisfactory.

As in 2008, ASN once again observed many ergonomic problems concerning documents, equipment, hardware and fitting out of premises. In general, the significant event analyses do not give enough weight to the ergonomic causes related to the workplace, or fail to adequately identify the consequences in terms of analysis and corrective action.

Generally speaking, ASN observes that the preparation, performance or monitoring of activities are sometimes penalised by unfavourable conditions, in particular during reactor outages.

Finally, ASN notes that the local action plans are supplemented by a large number of national projects and action plans. These projects and action plans are all designed to meet important improvement goals and are carefully drafted by the various EDF entities, whether national or local. However, it is often the same people who have to implement them in the field. Irrespective of the workload this generates, EDF should pay greater attention to the consequences of interaction between these projects

5 | 1 | 5 Analysing operating experience feedback

In general, the organisation set up by the licensee in the NPPs to handle operating experience feedback is satisfactory. There is a formal structure and the feedback is analysed and utilised. Information is efficiently shared between the local and national levels within EDF. For example, the steps taken in 2008 and 2009 led to a visible reduction in the number of reactor scrams.

However, ASN considers that EDF needs to improve the quality and detail of the analyses conducted, as this is often insufficient. The 2009 occurrence of a fuel assembly blockage incident in Tricastin that was identical to one that happened the previous year clearly illustrates this point. Consequently, the way in which lessons are learned from these analyses and the remedial action taken could therefore be improved.

ASN also notes that communication between ASN and the NPPs could also be improved. The time taken to send in the formal notifications frequently exceeds two days and ASN sometimes has to modify the event ratings proposed by the licensees.

5 | 2 Individual site assessments

Belleville-sur-Loire

ASN considers that the Belleville-sur-Loire is under-performing in terms of environmental protection and that the site's performance regarding nuclear safety and radiation protection is on the whole in line with ASN's general assessment of EDF performance.

ASN notes a significant improvement on the site regarding operational stringency. Paralleling confirmation of the positive trend in anomaly detection observed in 2008, analysis and processing of these anomalies has also progressed. However, and although the total number of significant events fell significantly in 2009, maintenance of the installations and their restart conditions could be improved and these activities are the reason for most of the anomalies during the course of the year.

Finally, ASN points out the absence of progress on the NPP in 2009 in the field of environmental protection. The many anomalies noted during the scheduled or reactive environmental inspections lead ASN to question the effectiveness of the plant's undertakings with regard to the upgrading and operation of installations liable to have an impact on the environment.

Le Blayais

ASN considers that the nuclear safety, radiation protection and environmental protection performance of the Le Blayais NPP is on the whole in line with ASN's general assessment of EDF performance.

ASN underlines the good management of the unexpected technical events encountered in 2009, linked to the winter storms and unscheduled reactor outages. It also believes that the NPP was rigorous in its radiation protection duties, particularly in management of the limited access areas and optimisation of dosimetry.

However, with respect to the environment, ASN observed a number of violations of the discharge licence, linked mainly to recurring equipment malfunctions.

Finally, ASN considers that the quality of maintenance and its monitoring is down on previous years and that progress is needed in this field.

Bugey

ASN considers that the nuclear safety performance of the Bugey NPP stands out in relation to ASN's general assessment of EDF performance, even if ASN did in 2009 observe a slight deterioration in terms of maintenance and operation. The NPP considerably improved prevention of reactor scrams. It must nonetheless make further progress in conforming to the operating technical specifications.

In the field of radiation protection and radiological cleanness, ASN considers that the performance of the Bugey NPP is in line with ASN's general assessment of EDF performance. ASN saw no significant progress and is expecting results during the outages scheduled for 2010.

With respect to the environment, ASN considers that the performance of the Bugey site is in line with ASN's general assessment of EDF performance. The environment culture is not sufficiently inculcated into the various departments, even if ASN did note the commitment of the environment department.

Finally, ASN observed a tense social climate on the plant in 2009, complicating outage management, and is expecting results from the heavy schedule of outages in 2010.

Cattenom

ASN considers that the nuclear safety, environmental protection and radiation protection performance of the Cattenom NPP is on the whole in line with ASN's general assessment of EDF performance.

In 2009, ASN observed that the NPP had made progress in preparing for and carrying out maintenance work. However, ASN believes improvements are once again needed this year in contractor monitoring.

With regard to environmental protection, the NPP implemented several action plans designed to improve anticipation and mitigation of its non-radioactive discharges into the environment. Water treatment tests are thus in progress to reduce the level of legionella in the cooling towers.

However, in 2009, ASN observed a certain let-up in radiation protection, even though the site appeared to be a driving force in this field last year. Although no workers were actually contaminated, ASN observed numerous anomalies. ASN considers that the licensee must establish precise operating experience feedback in this field and take appropriate measures.

Chinon

ASN considers that the Chinon NPP is under-performing in terms of nuclear safety and that the site's radiation protection and environmental performance is on the whole in line with ASN's general assessment of EDF.

In 2009, ASN observed a deterioration in the stringency of reactor operation, characterised by a large number of significant operating events, in particular reactor scrams, authorised range excursions, administrative lock-outs and system alignment errors. ASN believes that the site needs to make progress in its compliance with the general operating rules.

ASN considers that the Chinon NPP deals correctly with environmental protection matters. However, ASN observed numerous anomalies in the field concerning conformity with the requirements for facilities liable to have an impact on the environment.

Chooz

ASN considers that the Chooz B NPP's nuclear safety, radiation protection, maintenance and environmental performance are on the whole in line with ASN's general assessment of EDF performance.

However, this performance was not as good as in previous years and ASN believes that progress is required with regard to operating stringency, in particular by further developing the inclusion of human and organisational factors into operations.

The Chooz NPP stands out in the quality of the integrity of its second barrier, particularly the condition of its steam generators which are relatively recent and little subject to clogging.

With regard to the environment, the Chooz NPP made progress in 2009, mainly by reacting to the anomalies found in 2008 on the availability of the multi-parameter stations of the solid effluent treatment system, although other malfunctions persist.

Civaux

ASN considers that the Civaux NPP's radiation protection performance stands out and that its nuclear safety and environmental protection results are on the whole in line with ASN's general assessment of EDF performance.

ASN observes that the plant is still experiencing problems with certain operating activities, such as periodic tests, owing to a lack of monitoring. It also considers that the analysis of the loss of integrity of the fuel assemblies detected during two reactor outages needs to be taken further.

ASN considers that the NPP's radiation protection results stand out, in particular through implementation of the EVEREST approach (entry into limited access areas wearing ordinary work overalls). Efforts must nonetheless be continued to ensure that this approach continues in the future.

Finally, ASN believes that the plant must improve its monitoring of equipment participating in environmental protection.

Cruas-Meysse

ASN considers that the nuclear safety, radiation protection and environmental protection performance of the Cruas-Meysse NPP is on the whole in line with ASN's general assessment of EDF performance.

ASN notes that in 2009, the plant continued its efforts to deploy a nuclear safety improvement plan, the results of which – although still too recent to be truly robust – indicate a move in the right direction.

In the field of radiation protection, ASN considers that a significant improvement is needed in radiological cleanness as well as clear signposting of the conditions for access to the work sites.

With regard to environmental protection, ASN observes that the plant is deficient in stringent implementation of the requirements applicable to installations representing a risk for the environment.

Finally, ASN notes that in December 2009, the plant notified an incident rated level 2 on the INES scale, following complete loss of the reactor 4 heat sink as a result of the massive influx of plant matter from the Rhone river.

Dampierre-en-Burly

ASN considers that the nuclear safety, radiation protection and environmental protection performance of the Dampierre-en-Burly NPP is on the whole in line with ASN's general assessment of EDF performance.

However, loss of cladding tightness has been regularly observed during the past three years on a number of fuel rods, without the cause having yet been clearly established. With regard to monitoring of the maintenance contractors, numerous anomalies were brought to light in 2009, by both ASN and the licensee. ASN therefore considers that these two topics must be priorities for the plant in 2010.

Concerning radiation protection of workers, ASN notes that there has been no improvement in the way this risk is incorporated into working practices. Finally, operating and equipment maintenance deficiencies once again led to refrigerant leaks.

Fessenheim

ASN considers that the Fessenheim NPP has made progress in many fields and that its nuclear safety, environmental protection and radiation protection performance is on the whole satisfactory and in line with ASN's general assessment of EDF performance. In particular with regard to operating stringency, the Fessenheim plant's performance is now back on a par with the average of the NPPs in service.

ASN observes that the steps taken by the plant as part of its action plan are beginning to produce tangible results in the field. The operating personnel are in particular more comfortable with the operating documentation, which was updated. ASN considers that these efforts must be continued.

However, ASN does believe that the NPP needs to remain vigilant with regard to the maintenance of its installations, monitoring of its contractors and radiation protection of its workers.

Flamanville

ASN considers that the Flamanville NPP's environmental protection and radiation protection performance is on the whole in line with ASN's general assessment of EDF performance and that, as in 2008 and despite a degree of progress, it is under-performing in terms of nuclear safety with respect to ASN's general assessment of EDF.

The rigorous operation and maintenance plan set up has enabled the plant to achieve progress on certain points. However, this improvement process still depends on the unexpected operating and maintenance events encountered by the plant and which were again numerous in 2009, whether in terms of significant events, unscheduled outages or outage extensions. It must therefore continue to make efforts in this area.

ASN notes a clear improvement in waste management during reactor outages, particularly zero-stock management of the waste produced and greater control of the calorific potential.

Golfech

ASN considers that the Golfech NPP stands out with regard to its nuclear safety, radiation protection and environmental performance in relation to ASN's general assessment of EDF.

In 2009, ASN observed satisfactory management of operation and maintenance, which will have to be confirmed in 2010, in particular during the two refuelling outages.

With regard to radiation protection, the Golfech NPP stands out, in particular through implementation of the EVEREST approach (entry into limited access areas wearing ordinary work overalls), which confirmed its good results and is acting as a driving force for progress.

With regard to the environment, ASN notes the plant's proactive approach to controlling its chemical discharges. It will however need to maintain these efforts in order to comply with the technical requirements applicable to non-nuclear facilities.

Gravelines

ASN considers that the Gravelines NPP stands out with regard to nuclear safety, following the rigorous operation action plan implemented in the second half of 2007 and still in force. The NPP's radiation protection and environmental protection performance is on the whole in line with ASN's general assessment of EDF.

ASN considers that the plant has made progress in contractor monitoring and has boosted the presence of the hierarchy in the field.

However, ASN believes that following the significant event involving fuel assembly blockage on reactor 1 in August 2009, the NPP needs to improve the remedial measures taken as a result of operating experience feedback.

Given the size of the Gravelines NPP and its location in a dense industrial environment, ASN considers that the plant needs to reinforce the means for dealing with environmental protection issues.

Nogent-sur-Seine

ASN considers that the nuclear safety and radiation protection performance of the Nogent-sur-Seine NPP is on the whole in line with ASN's general assessment of EDF performance.

ASN considers that the NPP's results are satisfactory with regard to pressure equipment and the environment.

ASN is nonetheless expecting significant improvements in containment and in the quality of the associated periodic inspections. Similarly, the monitoring of corrective measures is not rigorous enough, especially in the civil engineering field. The deadlines for remedial measures defined following significant events or ASN inspections are often exceeded.

Worksite inspections revealed deficiencies in radiological cleanness, site security, waste removal and fire-fighting in the effluent treatment building.

Paluel

ASN considers that the nuclear safety, radiation protection and environmental protection performance of the Paluel NPP is on the whole in line with ASN's general assessment of EDF performance.

ASN monitored the implementation of an operating stringency plan for the Paluel NPP in order to comply with the equipment maintenance, post-maintenance qualification and NPP operating stringency quality requirements. The main points of this plan adequately cover the areas for progress identified by ASN in recent years. Significant action has been taken and encouraging results are appearing, despite a relatively high number of significant safety events. ASN considers that the plant management must continue in this direction in order to further improve the NPP's safety results.

ASN believes that the major investments made on the installations have had a positive impact on environmental protection, radiation protection and safety.

Penly

ASN considers that the Penly NPP stands out with regard to nuclear safety performance and that its performance in the field of radiation protection and environmental protection is on the whole in line with ASN's general assessment of EDF performance.

ASN considers that the NPP has made progress in its preparation for maintenance and operation work.

ASN considers that the NPP needs to make progress in the field of environmental protection and remain vigilant with regard to radiation protection, especially during reactor outages.

Finally, although the quality of processing of the files related to pressure equipment monitoring is satisfactory, ASN believes that the organisation of the recognized inspection department must be consolidated, so that it can retain its skills in full.

Saint-Alban

ASN considers that the Saint-Alban NPP is under-performing in terms of overall performance in relation to ASN's general assessment of EDF performance.

With regard to nuclear safety, the NPP failed in 2009 to convincingly remedy the anomalies detected by ASN and showed recurring weaknesses in its monitoring of reactor operations.

In the radiation protection field, the results worsened and the NPP in particular achieved mediocre performance during the reactor 1 maintenance and refuelling outage.

ASN identified persistent shortcomings in environmental protection. Although ASN observes that liquid and gaseous discharges on the whole remain in line with the regulation limit values, it considers that significant progress needs to be made on certain NPP facilities for which there are environmental stakes.

Finally, ASN observes that the NPP has improved its management of radioactive materials transport, an area in which it has regularly been deficient for several years.

Saint-Laurent-des-Eaux

ASN considers that the nuclear safety, radiation protection and environmental protection performance of the Saint Laurent des Eaux NPP is on the whole in line with ASN's general assessment of EDF performance.

However, ASN did note that in 2009 several significant events revealed a lack of stringency in control room monitoring and deficiencies in preparation for maintenance involving reactor operation, in particular during shutdown and restart transition phases, excluding refuelling outages.

In terms of radiation protection, the NPP will in 2010 need to confirm the progress it has made with management of radiological cleanness on the worksites, noted during the second reactor outage in 2009. In the light of the inspections carried out on the NPP in 2009, ASN found a large number of working situations in which the participants demonstrated a lack of radiation protection culture.

Tricastin

ASN considers that the nuclear safety, radiation protection and environmental protection performance of the Tricastin NPP is on the whole in line with ASN's general assessment of EDF performance. With regard to nuclear safety, ASN however notes that four of the eight level 1 events notified by the NPP reveal operating stringency deficiencies. At a time when the site is attempting to improve its production competitiveness, these incidents reflect insufficient involvement by the management in oversight of the periodic tests and strict compliance with the general operating rules.

ASN in particular believes that following the recurrence of the fuel assembly blockage event on reactor 2, the plant needs to implement rigorous and effective monitoring of the fuel assembly positions during refuelling operations.

ASN however notes that the maintenance programme for the third ten-yearly outage of reactor 1 was correctly implemented.

Finally, with regard to the environment, ASN considers that the NPP needs to continue with its efforts to limit its environmental impact.

6 OUTLOOK

With regard to NPPs, the areas in which ASN will be working and carrying out its regulatory and inspection duties will be primarily determined by the following aspects:

Regulation of the EPR reactor

The oversight of construction of the FA3 reactor, involving spot checks proportionate to the safety issues, will continue until the NPP receives commissioning authorisation. As the civil engineering and systems erection activities reach their peak, ASN intends to continue its monitoring of industrial accident risk prevention and of EDF supervision of the quality of the work done, in particular through equipment tests.

At the same time, ASN will also be continuing with an early review of certain aspects of the commissioning application file, in particular the accident study methods and the NPP control principles. The organisation principles proposed by EDF for the shift crew for the new reactor were considered to be acceptable by ASN but the crew organisation will have to be validated by means of the simulator tests scheduled for 2010. On this point, ASN will ask the GPR for its opinion.

ASN will also be attentive to EDF's answers to the letter sent out in October 2009 concerning the I&C system, asking it to make changes to the design of the system and to provide additional safety justifications.

Furthermore, ASN will begin to review the conditions for the creation of an EPR reactor in Penly announced by the Government, once the application has been submitted by the future licensee.

Development of technical regulations consistent with European best practices

In 2010, ASN will continue to focus on bilateral and multilateral international cooperation in order to compare its practices with those of its foreign counterparts and to promote sharing between experts, in particular with regard to operating experience feedback on the design and construction of new reactors.

Following the January 2008 adoption by the seventeen member countries of WENRA of a finalised version of safety reference levels for the reactors in operation in Europe, ASN will in particular continue to concentrate on the new harmonisation work started by WENRA concerning the safety objectives for the new reactors.

With regard to the reference levels adopted by the European members of WENRA in 2008, ASN will aim to make a proposal to the Government in 2010 for their transcription into a coherent set of regulatory (ministerial orders, ASN decisions) and other texts (ASN guides).

This effort to develop regulations and to give a formal framework to French safety policy concerning power generating reactors also corresponds to ASN's aim of preparing for the possible arrival in France of a new NPP licensee in addition to EDF, the incumbent public licensee.

Regulation of the NPPs in operation

ASN considers that if the reactors are to be kept in good condition then EDF will need to continue its maintenance efforts. Managing NPP ageing demands extensive replacement or maintenance work which must, owing to the scale of the work, be planned and prepared well in advance. The significant extension to the reactor outage times in 2009 reflects both the scale of these operations but also the large volumes of maintenance that become necessary, to guarantee that the installations are in a satisfactory condition, if these operations are not planned well enough in advance. ASN also considers that EDF must continue its efforts to improve the stringency of operation, especially in preparation for maintenance work, the quality of the maintenance performed by EDF or its contractors, and monitoring of these contractors.

Monitoring and maintenance work carried out by EDF on the steam generators

ASN will check that the monitoring and maintenance carried out by EDF on the steam generators in the NPPs guarantee a satisfactory level of safety, as new forms of damage can appear. Identifying these new damage mechanisms requires adaptation of the maintenance provisions, that will be examined by ASN. ASN therefore remains vigilant and will be attentive to the results of the wide-ranging inspection and appraisal programmes that are essential in order to be able to rule on the status of this equipment before it is returned to service.

Environmental Protection

With regard to environmental protection, ASN expects action on the part of EDF to ensure a rapid return to a satisfactory situation, especially with regard to the maintenance of equipment contributing to protection of the environment, compliance with discharge licence orders and monitoring and supervision of refrigerants. ASN will also examine the results of the experiments carried out by EDF as part of its fight against legionella and the lessons that can be learned from this for all the NPPs in operation.

The periodic safety reviews

Through conformity checks, a permanent search for anomalies by its engineering departments and the tests and checks carried out during the ten-yearly outages, EDF is attentive to the possibility of generic risks, which are inherent in a standardised population of NPPs. EDF takes advantage of this standardisation in making operating experience feedback between the reactors more efficient and effective. It is important for EDF to continue to take steps to improve safety still further. To do this, the periodic safety reviews are key opportunities for working with ASN.

In 2010 the GPR will review the orientations being envisaged for the periodic safety reviews of the 1300 MWe reactors associated with the third ten-yearly outages. EDF also initiated a safety review of N4 reactors and presented its conclusions to ASN in 2009. In 2010, ASN will issue a decision on the adequacy of this review for the coming ten years.

Operating period

The third ten-yearly outages for the 900 MWe reactors began in 2009, on the Fessenheim 1 and Tricastin 1 reactors in particular. ASN considers this to be a fundamental step in obtaining a precise picture of the condition of the reactors and in analysing EDF's ability to continue to operate them. One year after the end of each third ten-yearly outage of the 900 MWe reactors, ASN will issue its opinion on the conformity of each NPP with the requirements of the applicable safety requirements and the conditions for its continued operation.

With regard to EDF's aim of extending the operating life of its NPPs beyond 40 years, ASN considers that this extension could only be contemplated if associated with a proactive and ambitious safety programme. This programme will improve the safety of the installations by an order of magnitude far greater than the continuous improvements resulting from the periodic safety reviews and consistent with the safety objectives identified for the new reactors. In 2010, with the support of IRSN and the GPR, ASN will start work to assess the methodology proposed by EDF to justify operation of the reactors beyond 40 years. ASN will continue to examine the conditions for continued operation of the reactors currently in service for longer than 40 years and will place this work in an international context.

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