NUCLEAR POWER PLANTS

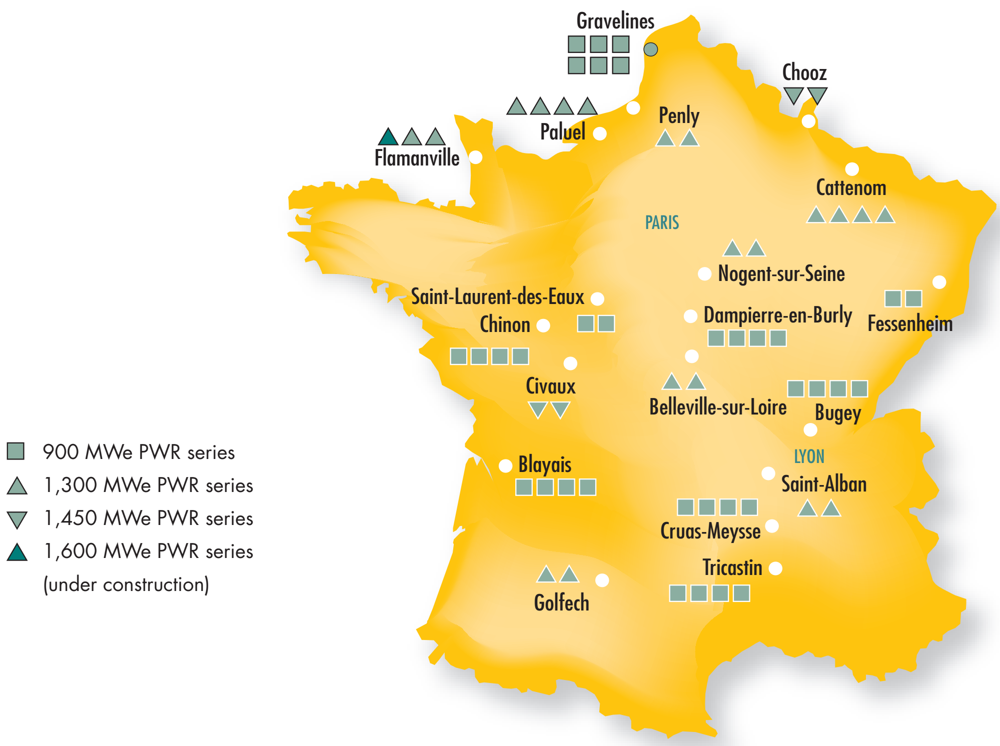
CHAPTER 12

Regulating nuclear power plants (NPPs) is ASN's historical mission. The reactors in these plants, used to produce electricity, lie at the heart of the nuclear industry in France. Many other nuclear installations 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. The reactors are currently operated by *Électricité de France* (EDF), which calls on the services of some 500 companies employing around 20,000 people for reactor maintenance. The standardisation of French plants, with a large number of technically similar reactors, justifies the generic presentation in this chapter.

Based on its extensive experience, ASN requires the highest of standards for regulating NPPs and adapts the standards continuously in the light of new knowledge. Ensuring control and regulation of the reactors, both operating currently and planned for the future, is the daily task of around 200 members of ASN staff working in the Nuclear Power Plant Department (DCN) and the Nuclear Pressure Equipment Department (DEP), and of the staff of the regional divisions. ASN also has the support of some 200 experts from the Institute for Radiation Protection and Nuclear Safety (IRSN). The ASN Commission meets regularly with the CEO of EDF to discuss nuclear safety and radiation protection issues. To be more effective, ASN has developed an integrated vision of control and regulation that covers not only the design of new installations, modifications, integration of feedback on events or complex maintenance problems but also, via the expertise its inspectors have built up, human and organisational factors of radiation protection and safety of workers, as well as the application of labour legislation. Lastly, ASN completes its judgement by examining the links between safety and competitiveness. This integrated approach allows ASN to develop a finer appreciation and determine its position each year with regard to the current status of nuclear safety and radiation protection in NPPs.

1 OVERVIEW OF NUCLEAR POWER PLANTS

Location of the nuclear power reactors in France



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 1,300 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 1,450 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 have been introduced as design and construction of plants have developed.

The CPY reactors differ from the Bugey and Fessenheim reactors (CP0) in building design and the addition of an intermediate cooling system between that used for containment spraying in the event of an accident and that containing heat sink water, along with more flexible operation.

The design of the 1,300 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.

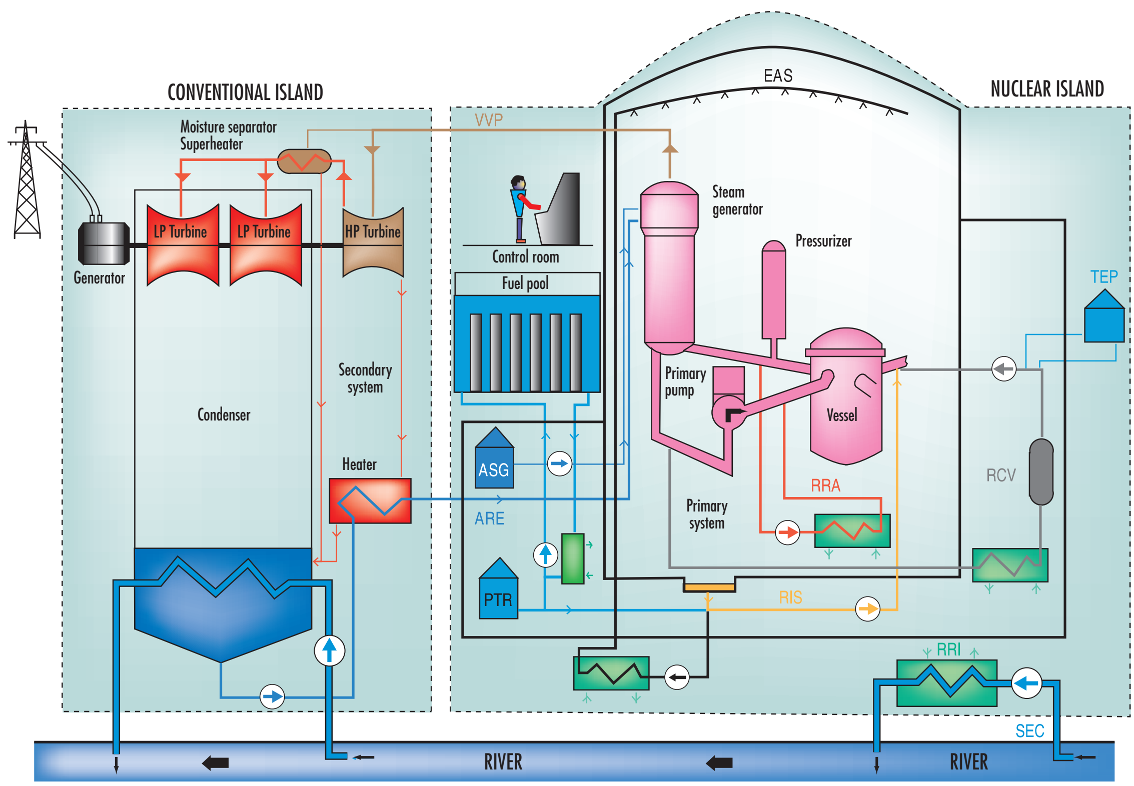
Moreover, the reactor containment consists of a double concrete-walled structure, instead of the single wall with steel liner design as with the 900 MWe reactors.

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

The N4 reactors differ from the previous reactor series in the design of their steam generators (more compact) and of their primary coolant pumps, as well as in the computerisation of the control room.

Lastly, an EPR type 1,600 MWe pressurised water reactor is being built at Flamanville, a site already housing two 1,300 MWe reactors.

Block diagram of a pressurised water reactor



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, which 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 or a river or with an atmospheric cooling system.

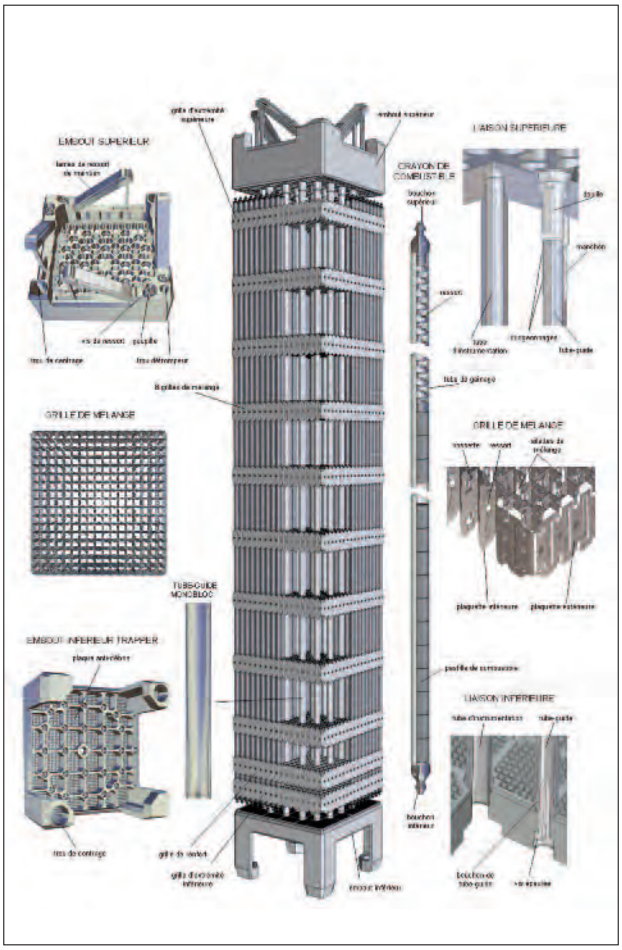
Each reactor comprises a nuclear island, a conventional island, water intake and discharge infrastructures and possibly a cooling tower.

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 generator 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 (VVP) as well as the building housing the fuel storage pool (BK). This building, which adjoins the reactor building, is used for storage of fuel assemblies before and during unit outages and for cooling of the unloaded fuel (one third or one quarter of the fuel is replaced every 12 to 18 months, depending on the reactor model). The fuel is kept immersed in a pool, where the water acts as a radiological barrier. The water in the pool contains about 2,500 ppm of boric acid, to continue to neutralise the neutrons emitted by the nuclei of the fissile elements, although they are too few in number to maintain nuclear fission. Moreover, each fuel element is placed inside a metal cell, both the design of which and its distance from the others prevents critical mass from being reached. The pool is cooled by the reactor cavity and spent fuel pool cooling and treatment system (PTR).

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

The safety of pressurised water reactors, built around the concept of defence in depth, involves a series of independent barriers, for which the safety analysis must demonstrate the effectiveness in normal and accident operating situations. There are generally three of these barriers, making up an assembly 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|5) for the third barrier.



Pressurised water reactor fuel assembly

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) contained in metal tubes, referred to as the "cladding", grouped 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 assemblies 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 control rod assemblies under the effects of gravity triggers automatic reactor trip;
- the concentration of boron (which absorbs neutrons) in the primary system water is adjusted during operation as the fissile material in the fuel becomes depleted.

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).

The MOX fuel is produced by the AREVA MÉLOX plant. 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 those 900 MWe reactors for which the decree authorising their creation (the DAC) authorises use of MOX: i.e. 22 reactors.

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 duration of an operating cycle;
– 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, for 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 consists, principally, of a closed loop through which water runs in liquid form in one part and as steam in the other part. The steam produced in the steam generators is partly expanded in a high-pressure turbine and then passes through moisture separator-reheaters 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.

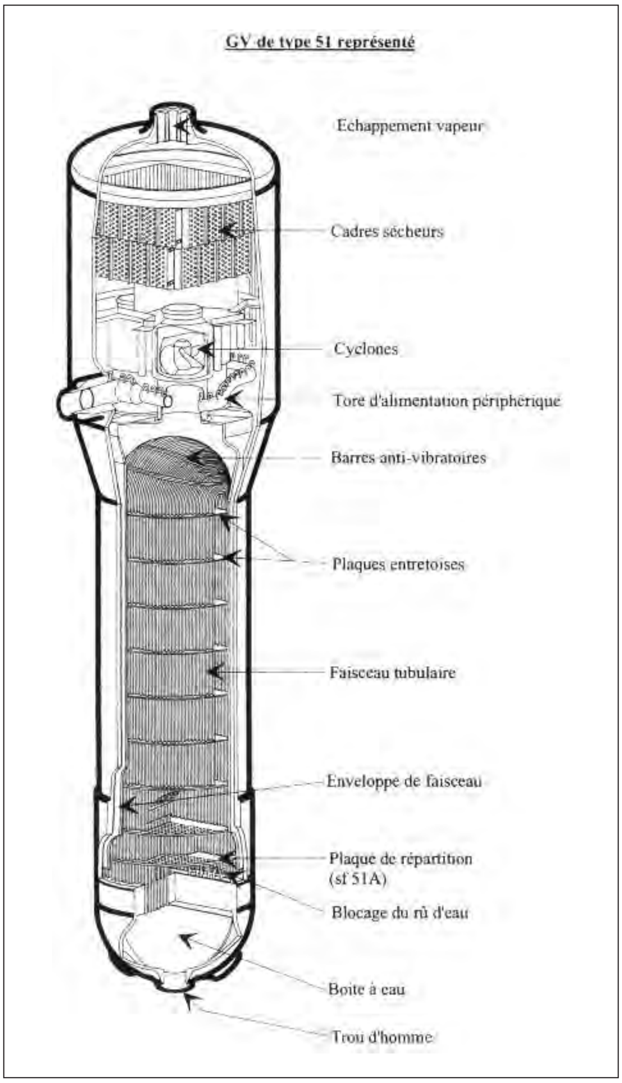
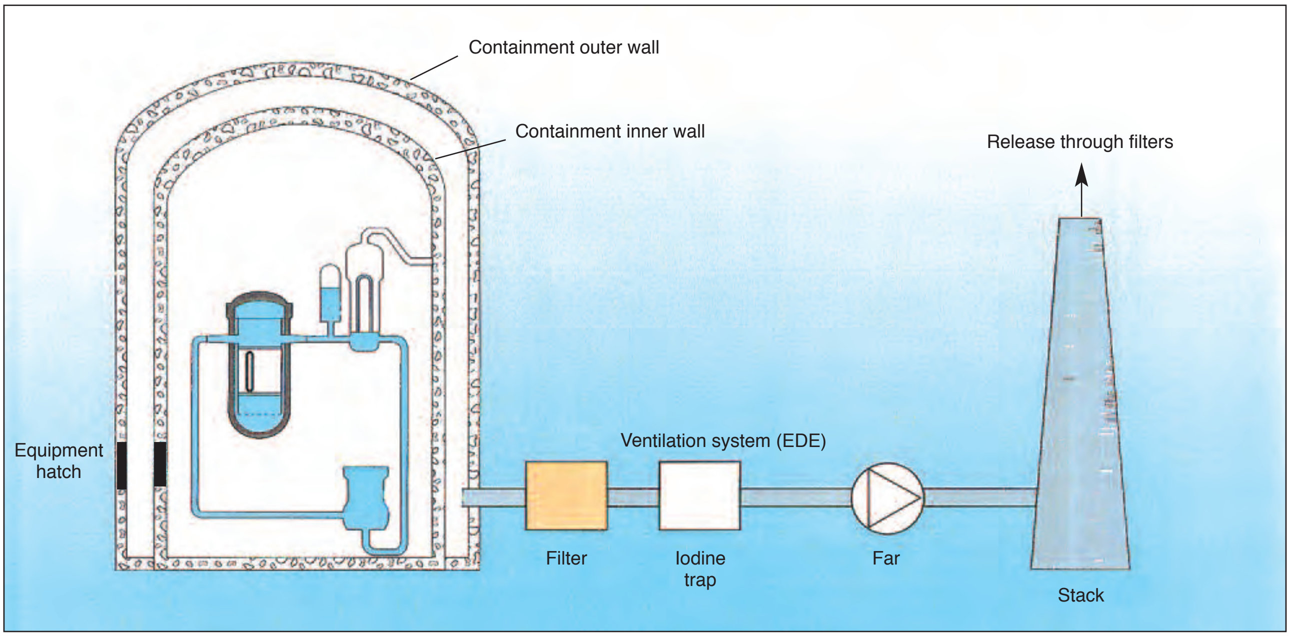


Diagram of a steam generator

1|1|4 Cooling systems

The purpose of the cooling systems is to condense the steam coming from the secondary system turbine. To do this they comprise a condenser, a heat exchanger consisting of thousands of tubes in which cold water pumped from an outside source (river, sea) circulates. When the steam comes into contact with the tubes it condenses and can be returned in liquid form to the steam generators (see point 1|1|3).

Depending on the source of the cold water circulating in the condenser, the condensers are traditionally made either of brass (for river water) or of titanium or stainless steel (for seawater). Henceforth, during renovation, the brass condensers will be replaced by stainless steel or titanium ones, thereby reducing the amounts of metals released as a result of wear (brass being the source of copper and zinc releases). However, unlike brass condensers, the renovated units do not constitute



Containment of a 1,300 MWe reactor

a toxic environment for micro-organisms and are therefore places where amoeba, potentially pathogenic micro-organisms, can develop. This can be prevented by use of biocides or other means of disinfection, e.g. ultraviolet radiation.

The cooling system water heated in the condenser is then discharged to the natural environment (open circuit) or, when the river flow is too low or heating too great in relation to the sensitivity of the environment, cooled in a cooling tower (closed or semi-closed circuit).

The conditions inside NPP's cooling towers are such that the potentially pathogenic micro-organism legionella can develop and can be propagated in the 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.).

1|1|5 Reactor containment building

The PWR containment building has two functions:
– protection of the reactor against external hazards;
– containment and consequently protection of the public and the environment against the radioactive products liable to be dispersed outside the primary system in the event of an accident; the containments were therefore designed to withstand the temperature and pressure levels that could be reached in an accident situation and to retain satisfactory leaktightness in these conditions.

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;

View of the concrete shell of the Flamanville NPP reactor building

– 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|6 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 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).

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).

1|1|7 Other safety-related systems

The other systems necessary for reactor operation and important for safety 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. This is the role of the Nuclear Engineering Department (DIN) and its engineering centres (for a detailed presentation, see *www.edf.com*).

The operator, represented by the Nuclear Production Division (DPN) 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.

ASN contacts

During the course of its regulatory activities, ASN has relations primarily with the DPN for the reactors in service and with the DIN for new reactors and for discharges. More specifically, the DPN head office departments are ASN's contacts in dealing with generic aspects affecting all the reactors in service. For questions specific to the safety of an individual reactor, ASN directly contacts the management of the NPP concerned. With regard to matters regarding equipment design and the corresponding design studies, ASN's primary contact is the DIN. The DIN is also ASN's primary contact for subjects regarding the periodic safety reviews, for instance via its specialised engineering departments. Matters concerning fuels and fuel management are also discussed with a third division responsible for these questions: the Nuclear Fuels Division (DCN).

1|2|2 ASN review 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.

Document conformity review by the ASN inspectors during the Chooz in-depth inspection – July 2010

These are first and foremost the general operating rules (RGE) applicable to the reactors in operation. They describe the operating conditions, transforming the initial hypotheses and the conclusions of the safety studies taken from the safety analysis report into operating rules.

The RGE comprise several chapters, of 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 to maintain or restore the basic safety functions (reactivity control, cooling, containment of radioactive substances) and to return the reactor to a safe condition.
– Chapter IX defines the programmes of checks and periodic tests run on the safety-relaed equipment and systems, 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 establishes the programme of physical tests for the reactor core that allow monitoring of the reactor in the restart and operating phases.

Secondly, there are documents describing the in-service monitoring and maintenance actions required on the equipment. On the basis of the manufacturer's recommendations, EDF has defined periodic inspection programmes for the components, or preventive maintenance programmes (see point 3|2|1), based on knowledge of the potential equipment failures. Their implementation, particularly in the case of pressure equipment, requires use of non-destructive testing methods (radiography, ultrasound, eddy current, dye penetrant, etc.) entrusted to specially qualified staff.

1|2|3 ASN 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, the conformity of the reactor outage programme with the applicable reference system. ASN will give its opinion on this programme;

Monitoring of the steam generator replacement work on the occasion of the 3rd ten-yearly inspection of the Fessenheim NPP – September 2011

– 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 either authorises reactor restart, or not;
– after criticality, the results of all tests carried out during the outage and after restart.

2 THE MAJOR NUCLEAR SAFETY AND RADIATION PROTECTION ISSUES

Over and above the issues brought to light by the accident at the Fukushima Daiichi nuclear power plant, the following subjects remain major topics with respect to nuclear safety.

2|1 Human and organisational factors

2|1|1 Workers

Depending on the number of reactors (2 to 6), the numbers of men and women working each day on operating a nuclear power plant varies from 800 to 2,000. The workforce consists of EDF staff and permanent outside contractors, split between various functions:
– operation: 50%;
– maintenance: 20%;
– administration and support: 30%.

Using self-evaluation during a training session on a teaching site

In addition, large numbers of service providers and subcontractors participate in maintenance and in specific operations scheduled during reactor outages. Depending on the type of outage, the number of additional participants can represent from 300 to 2,700 people.

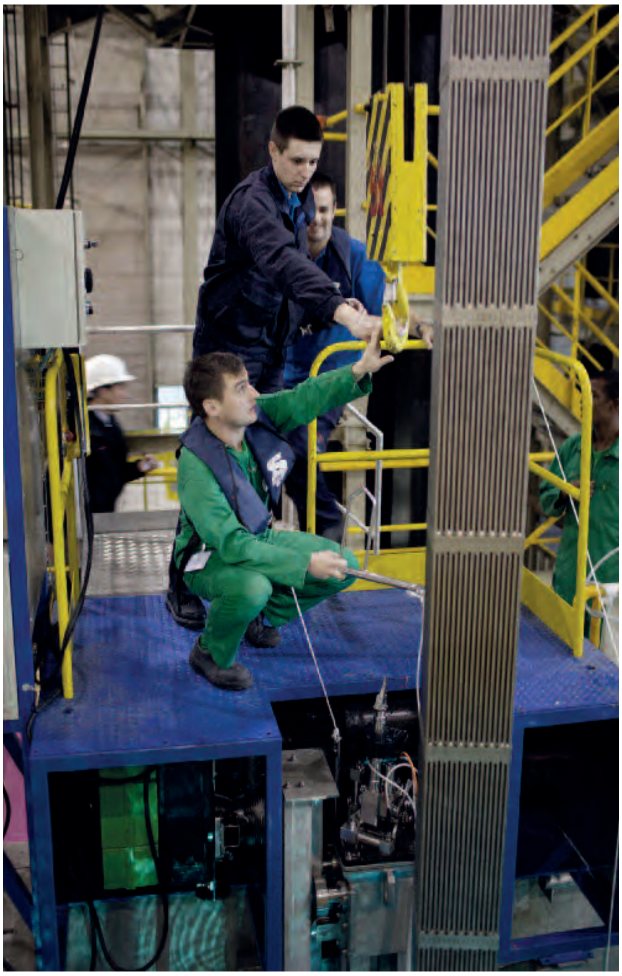
These workers are exposed on the one hand to risks common to all industries (for example, falling from heights, tripping over obstacles), and on the other to the risks linked to the use of ionising radiation.

Exposure to ionising radiation in a nuclear power reactor is due primarily to activation products and, to a lesser extent, the fission products present in the fuel. All types of radiation are present (neutrons, α, β and γ) and the risk of exposure can be either external or internal. In practice, more than 90% of the doses come from external exposure to β and γ radiation, caused by erosion and corrosion phenomena.

Eighty per cent of the doses received by workers are related to maintenance operations performed during reactor outages. In 2011, these doses were distributed over a workforce of around 45,000 people, including EDF staff, contractors and subcontractors, as shown in graphics 2, 3 and 4 below (see point 6|1|3). Monitoring of application of labour-related legislation in NPPs is addressed in point 4|2.

2|1|2 Nuclear safety as related to organisational and human factors

The contribution of man and organisations to the safety of nuclear facilities is a decisive factor in all steps of the plant lifecycle (design, commissioning, operation, maintenance, surveillance, decommissioning). ASN therefore focuses on the conditions which are favourable or prejudicial to a positive contribution by the operator and worker groups to the safety of the NPPs. All aspects of the working situation and organisation with an influence on the activity of the individuals working in an NPP are of interest to ASN as organisational and human factors (OHF) influencing safety.



Handling in the NPP operators training centre (CETIC) in Chalon-sur-Saône

The aspects considered relate to the individual and to the organisation in which he or she works, to technical arrangements and, more broadly, to the working environments (e.g., levels of heat, noise or light in the workplace, worker groups), in which the individual interacts. The variability in the characteristics of the workers (for instance, their level of vigilance which differs depending on the time of day, the level of expertise which varies according to the seniority in the post) and in the situations encountered (for example, an unexpected failure, labour tensions) explains that they constantly have to adapt their procedures so that they can perform their work efficiently. This performance must be achieved at an acceptable cost to the operators (for instance in terms of fatigue or stress) who must also benefit from it (for instance the feeling of a job well done, recognition by both peers and the hierarchy, development of new skills). Performance does not actually reflect the human cost and an operating situation achieved at very high cost to the operators is a potential source of risks: a slight variation in the working context, the group or how the work is organised, can be enough to bring down performance.

Areas for integration of OHF

ASN is counting on integration of the OHF compatible with the safety issues identified by the licensee, in the following fields of activity:

– engineering activities during design of a new installation or modification of an existing one;
– activities carried out during the operation of existing NPPs throughout their period of operation;
– activities involved in collating experience feedback from the design, construction and operation of the reactors, in particular analysis of the OHF-related causes of significant safety, radiation protection or environmental protection events and the corresponding lessons to be learned.

ASN requirements

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 to be put into place by the operator to manage quality-related activities.

ASN asks the licensee to set up a safety management system able to maintain and continuously improve safety, for instance through the development of a safety culture. ASN considers that safety management must become a part of the company's general management system in order to guarantee the priority given to safety and to the other interests protected by the TSN Act, such as radiation protection and environmental protection.

Control of safety rests on the ability of the licensee's management system to ensure that the appropriate skills and adequate resources are available. 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 this qualification must be based on justification of the skills required for the particular task, through training and professional experience.

ASN oversight

ASN oversight of OHF is based primarily on inspections carried out on the steps taken by the licensee to improve the way OHF are integrated into all phases of the lifecycle of an NPP. The inspections carried out by ASN concern the work done by the operators, but also the working conditions and the means made available to the operators in order to perform the work. More specifically, the quality and implementation of the EDF jobs, skills, training and qualifications management system are checked. The same applies to the resources, skills and methodology used for implementing the OHF approach. Finally, ASN checks the EDF safety management system, which must provide a framework and support for the decisions and actions which either directly or indirectly concern safety issues.

In addition to the inspections, ASN oversight is based on the evaluations it requests from IRSN and the Advisory Committee for nuclear reactors (GPR). For example, the GPR will be asked for its opinion on the management of safety and radiation protection during reactor outages.

Discussions between the ASN inspectors and the staff of the Fessenheim NPP during the 3rd ten-yearly inspection - September 2011

2|1|3 Management of subcontracted activities

The maintenance of French reactors is to a large extent subcontracted by EDF to outside contractors, with the total workforce representing about 20,000 employees. The use of subcontracting is driven by the need for outside expertise or a desire to reduce costs.

A system of prior contractor qualification was put into place by EDF. It is based on an evaluation of the technical know-how and quality organisation of the subcontractor companies and is formally written up in the "progress and sustainable development charter" signed by EDF and its main contractors. In addition, according to the order of 10 August 1984, the licensee is required to monitor its contractors' activities, or have them monitored, and use operating experience feedback for a continuous assessment of their ability to retain their qualification. Finally, the licensee must ensure the availability of a sufficient number of contractors with the expertise needed to perform the maintenance operations required to ensure safety.

ASN's expectations

ASN considers that the use of subcontracting is an industrial decision that lies with the licensee, but that this decision must not compromise the level of technical expertise that has to be retained by the nuclear licensee. ASN considers that poorly managed subcontracting is liable to lead to poor quality of work and have a negative impact on the safety of the facility and the radiation protection of the workers involved. Consequences such as these could result from the use of staff without the required skill levels, insufficient monitoring of the contractors by the licensee, degraded working conditions and so on.

ASN stressed the need for the order of 7 February 2012 to tighten up the conditions surrounding the use of subcontracting for safety-related activities.

ASN regulation

ASN carries out inspections on the conditions in which subcontracting takes place. ASN in particular checks EDF's implementation of and compliance with a process to ensure the quality of the activities subcontracted: the choice of contractors, monitoring, integration of experience feedback and adequacy of the resources for the volume of work to be done. ASN also pays close attention to worker protection, for instance compliance with health and safety rules and working and rest times, and checks the legality of the service contracts, in particular assessing the independence of the contractor from the ordering customer (absence of subordination and of supply of tools or equipment). The inspections on this topic are carried out in the nuclear power plants in operation and also within the various engineering departments responsible for the design studies of the Flamanville 3 reactor (see point 2|4|2).

In addition to the inspections, ASN oversight is based on the evaluations it requests from IRSN and the Advisory Committee for nuclear reactors (GPR). For example, the GPR was asked for its opinion on the topic of management of subcontracting.

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 must cultivate a questioning attitude whereby it takes the initiative to look for anomalies. The root causes of anomalies may be diverse: design problems, errors during construction, discrepancies introduced during maintenance operations, deterioration due to ageing, etc. ASN considers that periodic inspections and searches for anomalies carried out continuously by licensees play an important role in maintaining an acceptable level of safety.

Systematic verification: conformity checks

EDF carries out periodic safety reviews on the nuclear reactors every ten years (see point 2|2|3). EDF thus 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 deviations (INES scale level 1 and higher) by means of ASN's website. An upstream system was created to ensure that ASN is

Contractors working on replacing the N4 transformer in the Civaux NPP – July 2009

specifically informed of any deviations 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 deviation 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 deviation. 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 deviation which significantly impairs safety must be corrected rapidly, even if the remedial measures entail a large volume of work or shutdown of the reactor. 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 deviation. 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 deviation is present is considered to be unacceptable and if there is no appropriate remedial measure. Conversely, the time allowed for correction of a less severe deviation 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 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 NPPs. Criteria for such notification have been established 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.

ASN carries out local and national examinations of all significant events reported (the report for 2011 appears in point 6|1|5). 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.

TO BE NOTED IN 2011

Examination of operating experience feedback for the period 2006-2008

On 13th and 20th January 2011, the Advisory Committee for reactors (GPR) met to examine the notable findings for the period 2006-2008 concerning significant radiation protection, environment and reactor safety events, more particularly the deviations encountered on the steam generators (SG), the management of special systems and resources (DMP) and temporary facility modifications (MTI), post-maintenance qualification of facilities and administrative lockouts.

Following this examination, ASN considers:
• that with regard to the safety of the reactors in operation, the analyses performed and the steps taken by EDF in the light of experience feedback are satisfactory. However, the safety of the reactors in operation could be significantly improved if EDF were to pay greater attention to preparation of the maintenance and the pertinence of the maintenance schedule.
• that with regard to radiation protection, examination of experience feedback from the operation of the nuclear reactors in service for the period 2006-2008 confirms that EDF has continued to make progress, for instance in the field of gamma radiography inspections.

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 to conduct a detailed, in-depth examination of the condition of the facilities, to check that they are in conformity with the applicable baseline safety requirements. Its aim is also to improve the level of safety in the facilities. The requirements applicable to the existing facilities are therefore compared with those to be met by the most recent facilities, and the improvements which could reasonably be implemented are proposed by the licensee. 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 facility but also to improve it.

The review process

The periodic safety review comprises a number of successive steps.

1) The conformity check: this consists in comparing the condition of the installation with the applicable safety requirements and regulations including, notably, the authorisation creation decree and ASN's requirements. This step ensures that changes to the installation and its operation, as a result of modifications or ageing, comply with applicable regulations and do not compromise the installation's 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 review: this aims to appraise the installation's safety and to improve it in terms 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.

After consulting the GPR when necessary, ASN rules on the list of topics chosen for safety reassessment, during the phase referred to as the periodic safety review orientation. Following these reassessments, a batch of modifications to improve safety is defined. They will be deployed during the reactor ten-yearly outage.

3) Implementation of the improvements emerging from the safety review

The ten-yearly inspections are ideal opportunities to implement the modifications resulting from the periodic safety review, in particular those modifications based on the safety reassessment studies. 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.

4) Submission by the licensee of a review conclusions report: following the ten-yearly outage inspection, the licensee sends ASN a periodic safety review conclusions report. In this report, the licensee states its position on the regulatory conformity of its facility as well as on the modifications made to remedy deviations observed or to improve the safety of the facility. The review report contains information provided for in Article 24 of Decree no.2007-1557 of 2 November 2007, as amended.

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

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

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 has not identified any element that would compromise EDF's ability to control the safety of the 900 MWe reactors over that period. 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.

Generic significant safety event notified on 16 February 2011 concerning the emergency diesel generator sets for the 900 MWe plant series

On 22 October 2010, a periodic test carried out at the Le Blayais NPP revealed a failure of an emergency generator set. The analysis initiated by EDF and its supplier, which was forwarded to ASN, showed faster than expected deterioration of the connecting rod bushings, which are mechanical components designed to minimise friction between the moving parts of the diesel engines.

On the French NPPs, 27 electricity generating sets are equipped with bushings of the same type and liable to be affected by the same defect.

The emergency diesel generator sets supply the reactor's safety systems if the electricity supply from the national grid is interrupted. Each nuclear reactor is equipped with two emergency generator sets. In addition, a further electricity generator set is available for all the reactors of a given site. Each of these generators is able to supply the systems needed to ensure the safety of the reactor when shut down.

The corrective action plan presented by EDF comprises the installation of new bushings, the adoption of a new operating procedure for the generator sets concerned and enhanced monitoring and maintenance.
Based on the analysis performed by its technical support organisation, ASN asked EDF to:
- *carry out complementary tests and inspections;*
- *maintain enhanced monitoring of the emergency generator sets;*
- *justify certain choices made for the immediate rectification of this failure;*
- *check the condition of the connecting rod bushings sampled from emergency generator sets.*

ASN also asked EDF to continue to look for the root causes of this deviation, taking account of the experience feedback from the assessment performed on the emergency generator sets on the sites of Bugey, Tricastin and Saint-Alban. Finally, ASN asked for additional justifications concerning the reinforcement of the reliability of the electrical power supplies initiated by EDF.

In the longer term, EDF must provide a permanent solution for this deviation and thus initiate the design of connecting rod bushings which no longer comprise such defects and which will have to be qualified.

On all the EDF sites, other than Tricastin, where this type of bushing is installed (Blayais, Bugey, Chinon, Cruas, Dampierre, Gravelines and Saint-Laurent), each reactor has at least one electricity generator set, either its own or a general site set, equipped with bushings of another brand and which are unaffected by this defect. On these sites, the deviation was thus rated 1 on the INES scale by ASN.

However, the deviation was rated by ASN as a level 2 incident on the INES scale for reactors 3 and 4 on the Tricastin site, because the two electricity generator sets and the additional generator set common to all the site's reactors, are equipped with these same vulnerable bushings.

However, this generic assessment does not take account of any specific features of individual reactors. ASN therefore rules 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 in the reactor's safety review report (see point 5 | 6 for ASN's 2011 position statements).

The periodic safety review concerning the second ten-yearly outages for the 1,300 MWe reactors

In 2006, ASN declared itself to be in favour of continued operation of the 1,300 MWe reactors up to their third ten-yearly inspections, provided that the modifications decided on during this review were effectively implemented. The improvements arising from this safety review will be integrated by 2014, on the occasion of the second ten-yearly outage inspections (see point 5 | 6).

The periodic safety review concerning the third ten-yearly outages for the 1,300 MWe reactors

In 2010, ASN established the outline for the safety review associated with the third ten-yearly outages for the 1,300 MWe reactors. In 2015, reactor 2 in the Paluel NPP will be the first to undergo a third ten-yearly outage. ASN will ensure that this periodic safety review, the first to have been prepared after the TSN Act, is in strict compliance with the requirements of the Act.

The periodic safety review concerning the first ten-yearly outage for the 1,450 MWe reactors

In 2008, ASN ruled on the provisions of the first periodic safety review for the 1,450 MW reactors, which in particular concerns the level 1 probabilistic safety studies and the hazards studies. The first ten-yearly outage inspections for these reactors began in 2009 and are at present continuing (see point 5 | 6).

The implications and issues of continued reactor operations beyond 40 years

In the future, the reactors operating at present will run alongside reactors of the EPR type or their equivalent, designed for a significantly higher level of safety. This raises the question of the acceptability of continued operation of reactors beyond 40 years when there is an available technology that is safer.

There are two objectives: firstly, to demonstrate the absolute conformity of the reactors with the applicable regulations. This problem includes the question of managing ageing and equipment obsolescence. Secondly, a re-evaluation of the safety level in the light of the safety required of EPR type reactors or their equivalent is necessary, with proposals for significant and relevant improvements to the reactors. R&D work in France and elsewhere is already indicating approaches that could lead to answers, and improvements that would provide significant reductions in radioactive releases in the event of a severe accident are being studied.

For ASN, the continued operation of the reactors beyond forty years, can only be envisaged if it is associated with a proactive and ambitious programme for improved safety that is in line with the safety objectives adopted for new reactors and with best international practice.

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 of the incorporation of operating experience feedback.

The decree of 2 November 2007 clarified the requirements concerning implementation of changes by EDF and their review by ASN. In 2011, the equipment change notifications received by ASN were primarily aimed at improving reactor safety and correcting deviations.

Documentary modifications are also subject tor 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 modifications are presented in points 3|1|1, 3|1|2 and 3|2|4.

2|3 Integration of nuclear power plant (NPP) ageing

Like all industrial installations, NPPs are subject to ageing. ASN ensures that, in line with its general operating and maintenance strategy, EDF takes account of age-related phenomena in order to maintain a satisfactory level of safety throughout the installation lifetime.

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 2011, the average age of the reactors, calculated from the date of initial reactor criticality, was as follows:
– 29 years for the thirty-four 900 MWe reactors;
– 23 years for the twenty 1,300 MWe reactors;
– 13 years for the four 1,450 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 some reactor components was based on a predetermined operating period, for reasons of the cost of their replacement but also, and indeed more so, because of the need for radiation protection of the workers who would have to carry out 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 accident 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).

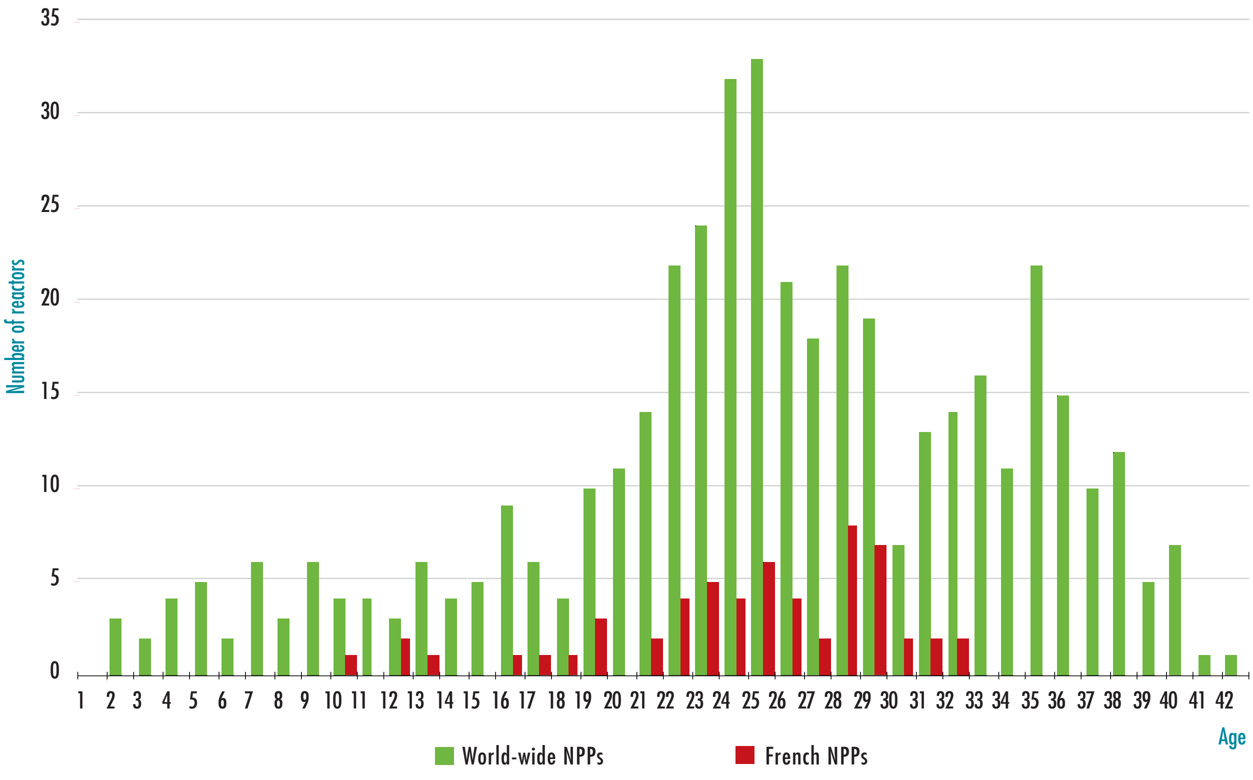
Deterioration of replaceable items

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

Some equipment, before being installed in the nuclear power plants, undergoes "qualification"; this is a process designed to ensure that the equipment is able to perform its functions in all the situations in which it is required, notably in accident conditions. 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

Graph 1: age breakdown of the reactors in operation worldwide in 2009 (Source IAEA, March 2009 and CEA, Elecnuc 2008 edition)



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, 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.

1) Consideration of ageing in design: 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 kinetics of known or presumed deterioration processes.

2) Surveillance and anticipation of ageing phenomena: ageing related phenomena other than those allowed for in the design may occur during operation. 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.

3) Repair, modification or replacement of equipment likely to be affected: this type of action has to be planned in advance, given the procurement lead-times for new components, the operation preparation time, the risk of obsolescence of certain components and the loss of staff technical skills.

2|3|4 Examination of extended operation

From a strictly regulatory standpoint, in France there is no limit on the time that an NPP is authorised to operate. Conversely, Article 29 of the TSN Act requires licensees to review the safety of their installations every 10 years (see point 2|2|3). The safety review is an opportunity for an in-depth examination of the effects of ageing on the equipment.

For the reactors going through their third ten-yearly inspections, an ageing analysis must therefore be performed for all degradation mechanisms that could affect the safety-related components. Control of ageing must be demonstrated, relying on operating experience feedback, the maintenance provisions and the possibility of either repairing or replacing the components. On the occasion of the third ten-yearly inspection of each reactor, this analysis leads to the production of a file clearing the reactor for continued operation.

Furthermore, with a view to continued reactor operations beyond 40 years, ageing management and equipment obsolescence become key issues. Ambitious proposals are therefore expected of EDF. These proposals will be submitted to the GPR in early 2012 at a meeting to discuss the study programme to be launched by EDF with a view to continued reactor operation beyond 40 years (see point 2|2|3).

2|4 EPR reactors

The EPR reactor is a pressurised water reactor based on an "evolution" in design in relation to the reactors currently in service in France, enabling it to comply with stricter safety objectives.

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 1,650 MWe EPR type reactor on the Flamanville NPP site, which already houses two 1,300 MWe reactors. This project was subsequently referred to as Flamanville 3.

In December 2010, EDF submitted another creation authorisation application to the Ministers for nuclear safety, for an EPR type reactor on the Penly site, which is also already home to two 1,300 MWe reactors. The work done by ASN on this creation authorisation application is specified in point 5|3. This project was subsequently referred to as Penly 3.

With regard to Flamanville 3, the Government authorised its creation by Decree 2007-534 of 10 April 2007, following ASN's favourable opinion, subsequent to the inquiry 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 Flamanville 3 reactor in September 2007. The first pouring of concrete for the buildings in the nuclear island began in December 2007. Since then, the civil engineering (structural) work has continued and, for certain buildings, such as the pumping station or the buildings housing the emergency diesel generators, it is now completed. Installation of the first components (tanks, pipes, electrical cables and cabinets, etc.) is continuing. In parallel with the construction work on the Flamanville site, manufacture of the pressure equipment, in particular that of the primary systems (vessel, pressuriser, pumps, valves, pipes, etc.) and secondary systems (steam generators, valves, pipes, etc.) is in progress in the manufacturers' facilities. In the summer of 2011, EDF announced that it was planning commissioning of Flamanville 3 in 2016.

General view of the Flamanville 3 EPR construction site – August 2011

TO BE NOTED IN 2011

Examination of the accident study methods: case of the MTC 3D method

With a view to examining the Flamanville 3 reactor commissioning application, ASN reviews the methods used to produce the design studies for a number of accident transients liable to occur on the reactor. Some of these methods differ significantly from those hitherto used for the reactors in operation.

A new method, called MTC 3D, was therefore developed by EDF to study the steam line break (SLB) transients. This new method reuses the main steps of the current method used for the reactors in operation, but with three-dimensional core models.

In April 2010, after close examination by IRSN, ASN considered that:

- *the MTC 3D method could be used to study the SLB transient with operation of the reactor coolant pumps, provided that account was taken of the requests concerning validation of the calculation software required by the method and that an inter-comparison was made of the results of various software;*
- *application of this method to the SLB transients with reactor coolant pumps shutdown could not be accepted as-is, because the modelling choices made by EDF in these situations were not sufficiently representative of the physical phenomena involved.*

EDF then transmitted additional information, which was reviewed by ASN and its technical support organisation.

On 7 July 2011, considering that the additional data were not sufficient to be able to accept application of the method to SLB transients with reactor coolant pumps shutdown, ASN asked EDF to provide further details on this point or to look for other ways of performing the SLB transients study.

2|4|1 The steps up to commissioning of the Flamanville 3 reactor

Pursuant to the decree of 2 November 2007 (see point 3|1|3 of chapter 3), introducing nuclear fuel into the perimeter of the NPP and 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 and 6 months before introducing fuel into the BNI perimeter of Flamanville 3, send ASN a file comprising the safety analysis report, the general operating rules, a study of the NPP's 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 jointly initiated an advance review of the following, to prepare for examination of the commissioning application file:
- the technical baseline reference standards necessary for demonstration of safety and for finalising the detailed reactor design;
- the detailed design of some safety-related systems presented in the safety report;
- certain elements forming part of or guiding compilation of the commissioning request file.

In parallel with this advance technical examination, ASN also checked and monitored the construction of the facility.

EPR fuel building spent fuel pool formwork panels – November 2010

Advance review of required documents

In 2011, ASN and IRSN continued (accident studies (see box)) and sometimes concluded (baseline safety standards concerning the risk of fire or on-site explosion for example) the examinations under way since 2007.

ASN reminded EDF that the detailed design of the systems and equipment installed in Flamanville were dependent on certain subjects, such as the accident studies or the I&C architecture. The Advisory Committee for nuclear reactors was thus consulted on the I&C architecture (see box in point 5|2).

Finally, the characteristics of the Flamanville 3 reactor were examined within the more general context of the complementary safety assessments initiated in the wake of the accident on the Fukushima Daiichi nuclear power plant in Japan (see point 5|1).

2|4|2 Construction oversight in 2011

For ASN there are numerous construction oversight issues relating to the Flamanville 3 reactor. They concern:

– ensuring that construction supervision complies with the new regulatory framework established by the TSN Act;
– checking the quality of construction in a manner commensurate with the safety, radiation protection and environmental protection issues, in order to be able to rule on the quality of the construction and its ability to meet the defined requirements;
– building on the experience acquired by each party concerned during the construction of this new reactor.

To do this, in addition to the usual means (inspections, etc.), ASN has established requirements for the DAC application concerning the design and construction of Flamanville 3 and for the operation of the 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, erection and testing of structures, systems and components, either on the construction site or on the manufacturers' premises.

This oversight also covers control of the risks relating to construction activities on the nearby BNIs (Flamanville 1 and 2 reactors) and for the environment. As the subject is a nuclear power reactor, ASN is also responsible for occupational health and safety inspection duties on the construction site. In addition, ASN oversees the manufacture of pressure equipment that will form part of the primary and secondary systems and of the nuclear steam supply system. ASN action in this field in 2011 is described in point 5|2.

Oversight of nuclear pressure equipment manufacture

Nuclear pressure equipment (ESPN) is primarily pressure equipment specifically designed to operate in nuclear facilities. This for example includes the reactor vessel, steam generators, or piping. This equipment plays an important role in the safety of nuclear facilities, because it involves a three-fold risk in the event of failure: that linked to the energy released, owing to the pressure it contains, the risk of radioactive releases and the risk that its failure could generate a nuclear accident or prevent it from being brought under control. The regulations applicable to ESPN therefore stand at the crossroads between those applying to conventional pressure equipment and those applying to the safety of nuclear facilities. They are an integral part of the nuclear safety rules. ASN considers that the ESPN manufacturers must guarantee a particularly high level of quality for this equipment. 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).

Within this framework, ASN or inspecting organisations approved by it, evaluate compliance with regulatory requirements for each item of pressure equipment for the EPR reactor.

Start of the roofing work ending the civil engineering activities for the pumping station – April 2011

View of the south diesel building – August 2011

Oversight by ASN and its approved organisations comes into play at different stages of the design and manufacture of nuclear pressure equipment. It takes the form of examination of the technical documentation for each item of equipment and of inspections in the manufacturers' facilities as well as those of their suppliers and subcontractors. Four organisations are currently approved by ASN to evaluate ESPN conformity, one of which is situated abroad: APAVE, ASAP, Bureau Véritas and AIB Vinçotte International.

2|4|3 Cooperation with foreign nuclear regulators

To be able to share experience with other nuclear safety regulators, ASN engages in numerous technical exchanges with its foreign counterparts on the subjects of oversight of the operation, 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 2011, ASN and IRSN participated in bilateral meetings on these subjects with a number of foreign nuclear safety regulators: Finland, India, United Kingdom and China.

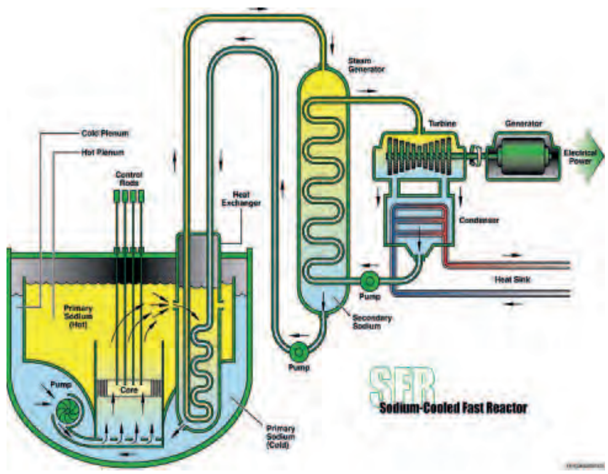
Owing to the EPR reactor construction projects at Olkiluoto in Finland and Flamanville in France, ASN and IRSN in 2004 set up enhanced cooperation with the Finnish nuclear regulator (STUK). This enhanced cooperation resulted in a number of technical meetings being held in January and May 2011, with visits to the Olkiluoto 3 and Flamanville 3 construction sites, to look at civil engineering and mechanical erection work.

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

Towards multinational cooperation

Some international bodies such as the NEA and WENRA also provide opportunities for exchanges on practices and lessons learned from overseeing reactor construction.

ASN is also a member of the Nuclear Energy Agency's Multinational Design Evaluation Programme (MDEP) (NEA, see point 2|4 of chapter 7) devoted to evaluating the design of new reactors. In 2011, ASN thus took part in the following work:
– thematic meetings and telephone conferences by the EPR detailed design working group. With the support of IRSN, ASN in particular took part in the work dealing with severe accidents, I&C, probabilistic safety studies, modelling of accidents and transients, technical specifications and on-site hazards. The plenary group also met once in May. A part of this meeting was open to the designers and future licensees (AREVA, EDF and other firms) to discuss the steps taken by these stakeholders to share their experience, the main differences between the



Schematic diagram of a sodium-cooled fast reactor

proposed designs and the steps taken to integrate the implications of the Fukushima accident. The next meeting of this plenary group is scheduled for January 2012 in Finland;
– two meetings of the technical codes and standards group. One of the meetings of this working group was opened to the various organisations in charge of developing codes and standards and involved in the comparison work launched by this working group;
– two meetings of the supplier inspection practices group.

Furthermore, in addition to the work on the EPR, a database was set up under the NEA framework recording the anomalies and discrepancies observed in recent or ongoing construction. Based on the deviations observed on Flamanville 3, ASN contributes to this database. 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

CEA, in partnership with EDF and AREVA has, since 2000, been involved in looking at the development of the fourth generation[1] of nuclear reactors ("GEN IV"), notably through international cooperation within the framework of the Generation IV International Forum (GIF). The forum was initiated in 2000 by the US Department of Energy and brings together 13 members that include research and industrial organisations from the nuclear countries around the world. The aim of the forum is to pool R&D work and to keep open the choice of possibilities for industrial development from amongst the following six selected technologies:
• SFR: sodium-cooled fast reactor;
• GFR: gas-cooled fast reactor;
• HTR/VHTR: gas-cooled high temperature (850°C) and very high temperature (1,000°C) fast reactors;
• LFR: lead-cooled fast reactor;
• MSR: molten salt reactor;
• SCWR: supercritical water reactor.

For those promoting them, the main issue for fourth generation reactors is to ensure the sustainable development of nuclear energy by making better use of resources, by minimising waste (ability to burn plutonium and to produce it from uranium-238, ability to transmute minor actinides such as americium and curium) and by offering better risk control regarding safety, proliferation and terrorism. There is a wide consensus on these objectives amongst GIF's members. The industrial deployment of fourth generation reactors in France is being envisaged no earlier than the middle of the century. It will require prior creation of a prototype, for which the planned commissioning date is set at 2020 by the Act of 28 June 2006 on the sustainable management of radioactive materials and waste.

With this both medium- and long-term view, ASN wishes, at a stage well upstream of the regulatory procedure, to monitor the development of fourth generation reactors by French industry and the associated safety concerns – in the same way as with development of the EPR – so as to be in a position, at the appropriate time, to establish the safety objectives for these future reactors.

ASN underlines the importance it attaches to the safety justification of the plant technology chosen as compared with the others adopted by the GIF. In this context and on the basis of documents transmitted by CEA, AREVA and EDF in 2009 and 2010 at its request, ASN approached the Advisory Committee for nuclear reactors (GPR), and those responsible for plants (GPU) and waste (GPD), for their opinion on:
– the different technologies available for the fourth generation of reactors, for instance with respect to the reinforcement and the protection of the interests mentioned in I of article 28 of the TSN Act, as compared with the third-generation EPR type reactors, and the possibilities with regard to the separation and transmutation of long-lived radioactive elements, as mentioned by the planning Act of 28th June 2006 on the sustainable management of radioactive materials and waste. This step aims to present the advantages and drawbacks of each of the above-mentioned technologies, given their current state of development;
– experience feedback from the sodium-cooled fast reactors (particularly Phenix and Superphenix (RNR-Na)) and the fuel cycle associated with this technology, as well as the R&D orientations of this technology if SFR reactors were once again to be operated in France.

At the same time, CEA in 2010 initiated studies into a prototype sodium-cooled fast reactor (SFR) with the ASTRID project[2]. For CEA, this project forms part of the preparation of fourth generation reactors. Technical meetings were held in 2011 between ASN, IRSN and CEA. These meetings were held ahead of transmission of a safety orientations file, which, according to CEA, should be sent in 2012, and the safety options file (DOS) which, again according to CEA, will be

1. "4th generation" reactors as opposed to the reactors currently available to renew the installed base of so-called "3rd generation" reactors (this name itself being by comparison with the present installed base of second
2. Advanced Sodium Technological Reactor for Industrial Demonstration

drafted in 2014 on the occasion of the facility preliminary design, or well ahead of submission of the BNI creation authorisation application. Before the project starts, the main purpose of these meetings is to check that safety issues are correctly taken into account.

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 corium-concrete interaction, the phenomena of vapour or hydrogen explosions, 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.

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 installations: for example, EDF's wish to improve nuclear fuel performance has, in particular, generated work on uranium oxide ceramics, fuel assembly cladding materials and 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.

3 NUCLEAR SAFETY

3|1 Operation and control

3|1|1 Operation under normal conditions: ensuring compliance with baseline safety standards and authorising changes to documents

Changing technical operating specifications (STE)

Chapter III of the general operating rules (RGE) represents the reactor technical operating specifications (STE) (see point 1|2|2).

EDF may be required to modify the STEs to take account of its operating experience feedback, improve the safety of its installations, improve economic performance or incorporate the consequences of equipment 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 these modifications, with the technical assistance of IRSN, and may approve them, possibly subject to implementation of complementary 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 report 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

ASN inspection of the control room during the ten-yearly inspection of the Tricastin NPP – May 2009

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 one to be applied. These operating documents are drafted on the basis of incident and accident operating rules, as presented in chapter VI of the RGE. ASN must be notified of any use or modification of these documents.

ASN examines the modifications of these operating rules and, notably, approves application of the files relating to reactor safety review. Some modifications to the APE procedures are the result of equipment modifications that will be incorporated during the ten-yearly outages, while others are the result of operating experience feedback or a response to ASN requests for improved safety.

To prepare the review of the commissioning application for the Flamanville EPR, the principles of operation in incident or accident conditions, which will be contained in the general operating rules relative to a safety incident or accident, will be subject to advance review.

Regular inspections are organised on the subject of incident and accident operation. During these inspections, particular attention is paid to examination of management of the operating documents of Chapter VI of the RGE, to management of special equipment used for accident operation and to training of operating staff.

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. In such a highly hypothetical situation, various steps are taken to allow the operators, supported by emergency teams, to preserve the containment so as to minimise the consequences of the accident. The emergency teams may in particular use the severe accident management guidelines (SAMG).

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 in maintaining the conformity of an installation 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 make 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 consequences.

ASN considers that the methods for optimisation of the maintenance programmes for safety-related equipment are acceptable. Giving precedence to equipment monitoring, these methods reduce the risks relating to operations on equipment and limit the dose received by operators. However, ASN has reminded EDF that the methods may lead to a failure to detect a new or unforeseen fault, and has therefore asked EDF that their deployment be accompanied by continued systematic periodic inspections for certain items of equipment. ASN has also reminded EDF of the necessity of questioning the validity of the pilot equipment approach in the event of discovery of deterioration or in the case of repairs that could call into question the uniformity of a family of 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 and thus only concern areas in which no known deterioration is likely. ASN has 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.

In 2010, EDF announced to ASN its intention to move in the near future towards a new maintenance doctrine, AP913. This methodology was developed in 2001 by the Institute of Nuclear Power Operations (INPO) working with American licensees. ASN intends to analyse the conditions for implementation of this approach on the EDF nuclear reactor fleet.

3|2|2 Examining the qualification of scientific applications

The computer software used for the safety cases are subject to the requirements of the order of 10 August 1984. One of the key requirements is qualification, which consists in ensuring that all software concerned can be used in complete confidence within a specific field.

In 2011, ASN continued with its examination of the qualification of the software to be used for the EPR reactor safety studies. ASN has also decided to start work on drafting guidelines aimed at defining the principles and methods to be used for the qualification review of the computer software 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 they are used for the first time, undergo qualification by an entity of proven competence and independence.

The role of this entity, called the Qualification Commission (accredited by COFRAC since 2001), is to evaluate the representativeness both of the models used for the demonstration and of 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

Ultrasonic inspection of a weld join

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, 90 applications have been qualified by the in-service inspection programmes. New applications are currently undergoing development and qualification to address new requirements, especially concerning the Flamanville 3 reactor, for which forty-one applications must be qualified for the pre-service inspection.

Owing to the radiological risks linked to gamma radiography, ultrasound applications are preferred over radiography applications.

3|2|4 Authorising periodic test programmes

In order to check the correct operation of safety-related equipment 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 RGE. These periodic checks make it possible to decide on the ability of an equipment item or a system to fulfil its role with regard to the design safety objectives assigned to it.

ASN is called on regularly to decide on the modification notifications for the periodic test programmes and reviews the design of periodic tests for the EPR.

3|3 Fuel

3|3|1 Controlling fuel management changes

In order to enhance the availability and performance of reactors in operation, EDF, together with the nuclear fuel industry, researches and develops improvements to fuels and their use in the reactor; this is known as "fuel management" (for more information on this concept, see point 1|1|2).

ASN ensures that each new mode of fuel management 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, when major changes were made to the fuel management mode, fuel use has been regulated by an ASN decision comprising technical prescriptions.

3|3|2 Monitoring fuel status in the reactor

Fuel behaviour is an essential element of the safety case for the core in normal or accident condition operation and its reliability is of prime importance. The leaktightness of the fuel rods, of which there are several tens of thousands in each core and which constitute the first confinement barrier, are therefore the subject of particular attention. During normal operation, leaktightness is monitored by EDF by means of continuous measurement of the activity of radioelements in the primary system. A rise in this activity above predetermined thresholds is a sign of a loss of fuel assembly tightness. If the activity level becomes too high, application of the RGE leads to reactor shutdown before the end of the normal cycle. During this shutdown, EDF must look for and identify the assemblies containing leaky rods, which must not then be reloaded. These assemblies must be

TO BE NOTED IN 2011

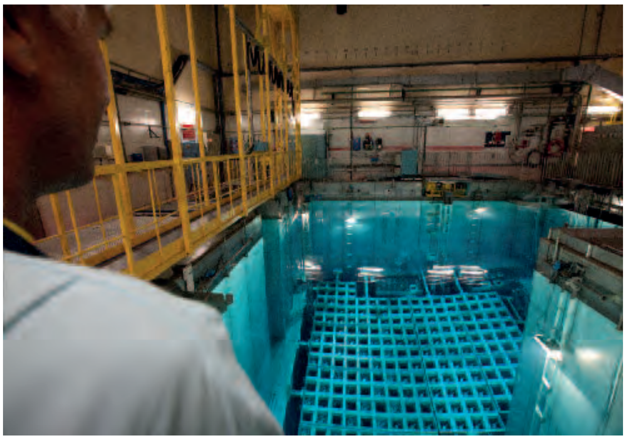
Review of fuel operating experience feedback

On 23rd June 2011, the Advisory Committee for nuclear reactors met at the request of ASN to review experience feedback concerning fuel, including the control rod clusters, for the period between 2003 and 2009.

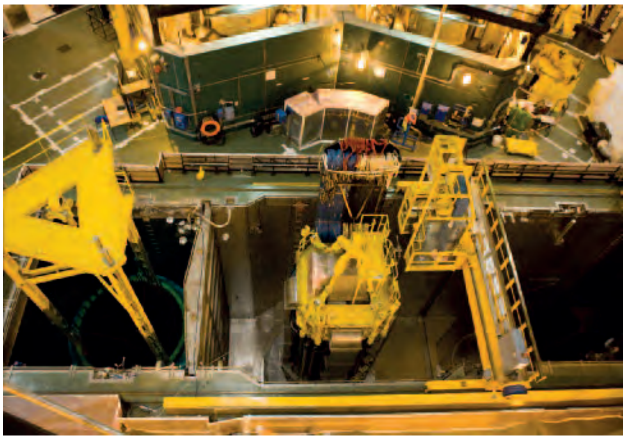
The Advisory Committee more particularly examined questions concerning:
- *operating incidents linked to fuel and control rods,*
- *the safety case for mixed cores, that is cores loaded with assemblies of different types,*
- *the reassessment of the Zircaloy 4 corrosion model and the impact of the reassessed corrosion thickness on the safety demonstration,*
- *the safety demonstration provided for new fuel loads.*

The period 2003-2009 was marked by increased diversification of the types of fuel assemblies used in the EDF reactors, leading to more widespread use of Westinghouse fuel assemblies in addition to the AREVA fuel assemblies, to the use of new cladding materials and to the greater presence of mixed cores in the 900 MWe and 1,300 MWe reactors.

ASN considers that EDF has taken satisfactory account of experience feedback concerning the behaviour of the fuel assembles and control rod clusters during the period 2003-2009. However, ASN does believe that the safety demonstration prior to use of the fuel assemblies in the cores must be supplemented, in particular for the mixed cores.



Fuel building pool in the Bugey NPP



View of the fuel handling pool for unit 2 of the Belleville-sur-Loire NPP during the ten-yearly inspection – June 2009

repaired by replacement of the leaky rods before they could possibly be reused.

ASN ensures that EDF analyses the causes of the leaks observed and that it implements means to examine leaking rods to determine the cause of the failure and to remedy this as soon as possible. Failure may be due to an incompatibility between the design and manufacture of the assemblies and the loads actually sustained or to the presence of foreign bodies in the primary system which could damage the cladding. Preventive and remedial measures may therefore affect the design of assemblies or their manufacture, or the reactor operating conditions. Furthermore, the conditions of handling of assemblies, the loading and unloading of the core and the prevention of foreign bodies in the systems and pits are also the subject of operating requirements, some of which contribute to the safety case and with which EDF's compliance is verified by ASN. ASN also conducts inspections to ensure that EDF carries out adequate monitoring of fuel assembly suppliers in order to guarantee that assembly design and manufacture comply with the rules established. Lastly, ASN calls on the GPR periodically with regard to lessons learned from operating feedback on fuel.

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. Monitoring of the operation of these systems is regulated by the order of 10 November 1999, mentioned in point 3|6 of chapter 3.

3|4|1 Monitoring and checking the 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 numerous non-destructive tests, pressurised hydrotesting and verification of the good condition and correct operation of the over-pressure protection accessories. Post-maintenance testing of the primary system is performed during the ten-yearly outages. During the course of 2011, nine main primary systems underwent periodic post-maintenance qualification. This concerned the reactors of Cattenom 3, Bugey 4 and 5, Dampierre 1, Penly 1, Civaux 1, Tricastin 2, Gravelines 1 and Fessenheim 2.

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

Several parts of a pressurised water reactor are made from nickel-based alloys:steam generator s tubes, steam generators partition plate, primary side coating of the steam generators tubesheet, vessel closure head adapters, vessel bottom-mounted instrumentation penetrations, vessel internals lower guide support welds, steam generators 1,300 drains 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

ASN inspection of a steam generator weld during hydrotesting of the primary system of the Cattenom NPP

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. In addition, the SGs are the subject of a major replacement programme (see point 3|4|4).

In 2004, cracks attributed to stress corrosion were observed on an SG partition plate separating the hot leg from the cold leg, for circulation of primary fluid in the lower part of the SG. 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 Inconel 600 zones, to take account of this damage. All the SGs equipped with an Inconel 600 alloy partition plate will thus be checked before the reactor third ten-yearly outage inspections.

The checks carried out in 2011 on the SG partition plates revealed no further signs of stress corrosion cracking. At the end of 2011, 10 SG partition plates were affected by stress corrosion and are being particularly closely monitored. To date, these monitoring checks have shown no significant variation in the stress corrosion indications.

In September 2011, cracks attributed to stress corrosion were discovered on a bottom mounted instrumentation penetration on Gravelines reactor 1. This was the first time that this type of damage had been observed on a French reactor. (see point 5|7).

3|4|3 Checking reactor vessel strength

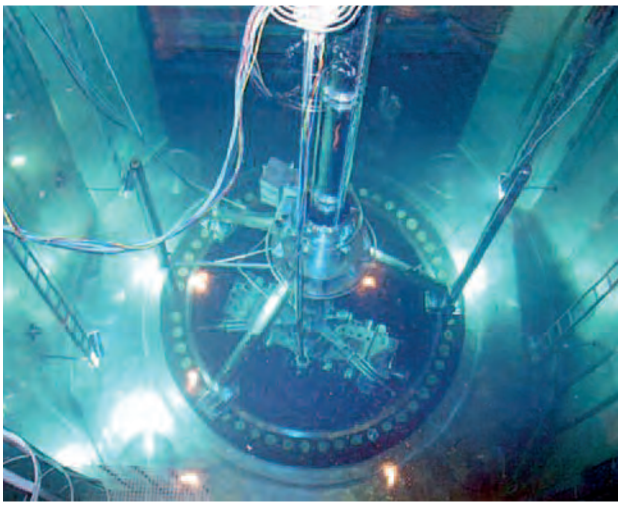
The reactor vessel is one of the essential components of a PWR. This component, 14 m high and 4 m in diameter, with a thickness of 20 cm (for the 900 MWe reactors), contains the reactor core and its instrumentation. The 300 t vessel is entirely filled with water in normal operation and can withstand a pressure of 155 bar at a temperature of 300°C.

Regular and accurate 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 this component is not included in the safety studies; this is one of the reasons why all steps must be taken, right from the design stages, to ensure its strength throughout the reactor's operational life.

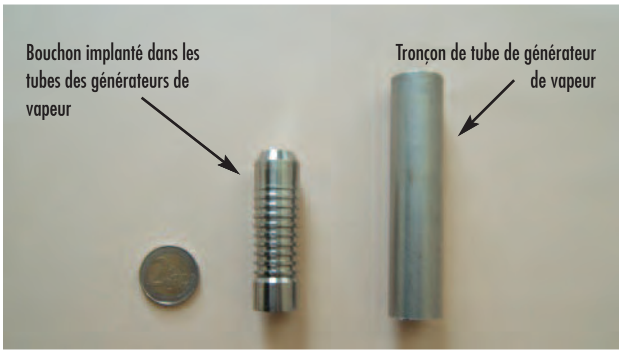
In normal operation, the vessel's metal slowly becomes brittle, under the effect of the neutrons from the fission reaction in the core. This embrittlement makes the vessel particularly sensitive to pressurised thermal shocks or to sudden pressure surges when cold. This sensitivity is also aggravated when defects are present, which is the case of some of the 900 MWe reactor vessels that have 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 programme was introduced to monitor the effects of irradiation: test specimens of the same metal as the reactor vessel were placed inside the reactor. Some of these are regularly removed by EDF 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 specimen capsules located near the core receive more neutrons than the metal of the reactor vessel;
– periodic checks verify that there are no defects or, in the case of vessels containing manufacturing defects, check that they are not getting worse.

ASN carries out regular examination of the documents on vessel in-service behaviour forwarded to it by EDF, so as to ensure that



In-service vessel inspection machine in an inspection situation the demonstration provided by EDF regarding vessel in-service behaviour is sufficiently conservative and that it complies with regulations. Thus the document concerning the in-service behaviour of the 900 MWe reactor vessels for the ten years following their third ten-yearly outage inspections was presented to the Advisory Committee for nuclear pressure equipment in June 2010. ASN declared itself to be in favour of operating these vessels for the period concerned, provided that EDF complies with a number of requests and submits additional data. ASN is at present examining the first answers supplied by EDF on this matter and is preparing to examine the file concerning the in-service strength of the 1,300 MWe reactor vessels beyond their third ten-yearly outage inspections



Mechanical plug inserted at the ends of the steam generator tubes

3|4|4 Monitoring steam generator maintenance and replacement

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 3,500 to 5,600 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.

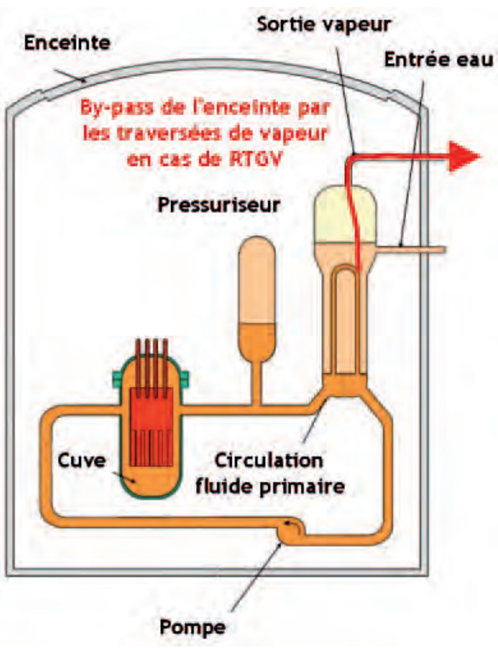
Integrity of the steam generator tube bundles is a major safety issue, since deterioration of a bundle can cause leaks from the primary to the secondary system. Furthermore, a break in one of the bundle tubes (SGTB) would lead to bypassing of the reactor containment, which is the third confinement barrier. Steam generator tubes are subject to several types of deterioration such as corrosion or wear.

The steam generators are the subject of a special in-service monitoring programme, established by EDF, reviewed periodically and examined by ASN. After inspection, tubes that are too badly damaged are plugged to remove them from service.

Chemical cleaning of steam generators

The iron contained in the NPP secondary system feedwater system builds up in the SGs and forms layers of magnetite on the tubes and on the surfaces of the internals. The layer of deposits that forms on the tubes reduces the heat exchange capacity. By narrowing or plugging the foliate water channels, the deposits also affect the flow on the tube support plates and prevent the free circulation of the water-steam mixture, thus creating a risk of damage to the tubes and SG internals (loads on the internals during certain transients, tube vibration, etc.) and can degrade the operation of the SG (water inventory, fluctuations, etc.). To prevent or minimise such effects, some of the deposits that have built up can be eliminated by remedial or preventive chemical cleaning. Conditioning of the secondary system with a higher pH is also a means of minimising metal deposits.

After deploying remedial processes to restore the operation of the SGs degraded by these deposits, the last two operations being in 2011, EDF has now adopted a strategy involving



By-pass of the concrete containment in the event of an SG tube rupture (SGTR) accident

Installation of equipment for chemical cleaning of the steam generators

Inspection of an SG weld during the 3rd ten-yearly inspection on the Fessenheim NPP – September 2011

regular use of preventive processes. This strategy must contribute to maintaining a satisfactory level of SG cleanness.

Steam generator replacement

Since the 1990s, EDF has been running a programme (RGV) to replace the SGs in which the tube bundles are the most seriously damaged, for instance those made of inconel 600 and not heat treated (600 MA). The RGV campaign for the 900 MWe plant series with a tube bundle made of 600 MA will be completed in 2014 with the RGV on Blayais 3. The SGs in the 900 MWe reactors initially equipped with this type of steam generator will thus have been replaced.

Over and above these replacements scheduled for no later than the third ten-yearly outage inspection, EDF is already preparing to replace the SGs for the 900 and 1,300 MWe plants in which the tube bundle is made of heat-treated nickel-based alloy (600 TT), owing to the high proportion of cracking in the transition zone. The first RGV for the 900 MWe plant series is that of Cruas 4 in 2014, to be followed by Cruas 1 in 2015 and Gravelines 5 and 6 in 2016. For the 1,300 MWe plant series, the first scheduled is Paluel 2 in 2015, to be followed by Flamanville 1 and Paluel 3 in 2017 and Flamanville 2 in 2018, the others being programmed between VD3 and VD4.

An inspection is also systematically performed by ASN on each steam generator replacement.

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 in the inner containment.

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 1,300 MWe and 1,450 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 counter this phenomenon, EDF implemented a repair programme using a resin liner, in order to restore the leaktightness of the most severely affected areas. Work was therefore carried out on all twenty-four reactors concerned.

Finally, a GPR meeting is planned for late 2012 to look at the issues of 1,300 MWe and 1450 MWe reactor containment, in particular in the run-up to the third ten-yearly outage inspections for the 1,300 MWe reactors.

Containment of a Fessenheim NPP reactor building

3|6 Application of pressure equipment rules and regulations

Owing to the energy that it could release in the event of failure, irrespective 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.

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

The equipment items in this category liable to emit radioactive releases in the event of a failure are called nuclear pressure vessels and are regulated by the order of 12 December 2005. In addition to the requirements applicable to conventional pressure equipment and existing texts covering reactor primary and secondary systems, this order imposes additional in-service inspection requirements on nuclear pressure equipment that came into force on 22 January 2011. In 2011, ASN continued its analysis of the dossiers and guidelines drawn up by the licensees to define their methods for monitoring and repair of nuclear pressure equipment. This work also involved the third-party inspection bodies approved by ASN, which carry out the regulation checks on this equipment on its behalf. These requirements will allow greater in-service monitoring of the nuclear pressure equipment installed in the NPPs.

Application of the section regarding in-service monitoring also entails consultation with all the stakeholders in order to produce guidelines for implementation of this order, which should be issued in 2012.

ASN is also responsible for 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 2011 include audits and monitoring visits of the NPP inspection departments. These departments, under the responsibility of the licensees, are tasked with carrying out inspections to ensure the safety of pressure vessels. However, EDF has decided that these departments will initially only deal with non-nuclear pressure equipment. Their competence could be extended to nuclear pressure equipment, once the requirements associated with this equipment, especially those corresponding to its safety roles, have been correctly defined. Of the 2011 audits, that performed at Saint-Alban led to the withdrawal of the approval of this department, owing both to the inadequate staffing levels for its required duties and its persistant lack of recognition by the management, observed since the previous audit. The loss of approval of the inspection department means that it could no longer define the nature and frequency of the equipment periodic inspections. Consequently, EDF had to carry out advance checks on its equipment.

View of a seismic monitoring device (accelerometer) installed in an NPP

3|7 Ensuring hazard protection

ASN strives to constantly strengthen the baseline safety standards designed to protect the NPPs against hazards. In addition to this approach, and as part of the CSAs, EDF required an evaluation of the ability of the NPPs to withstand situations going beyond these baseline standards (see point 5 | 1).

3|7|1 Prevention of seismic risks

Buildings and equipment important 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, based on historical and scientific data. The rules for dealing with the seismic risk are reviewed regularly in order to take account of new knowledge and are applied on a case by case basis during the safety reviews. Although there is not a particularly strong seismic risk in France, this topic is the subject of considerable effort on the part of EDF and of 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 on seismic calculations for civil engineering structures was reviewed and published in 2006 in the form of guidelines (Guide no.2/01 of 26 May 2006) for the inclusion of the seismic risk in the design of civil engineering structures for surface BNIs except for radioactive waste long term repositories). It is the result of several years of work by experts in the seismic engineering field. For surface BNIs and based on NPP data, this text defines the 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.

ASN also takes part in a working group set up by the General Directorate for the Prevention of Risks (DGPR), which includes 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.

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 to 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 completion 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 1,300 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 is able to guarantee the resistance of these reactors to the earthquakes reassessed in accordance with RFS 2001-01, subject to additional justification that the turbine hall does not constitute a hazard for the electrical building and for the reactor safeguard auxiliaries of the P'4 plant series.

To prepare for the next seismic design reviews (forty year review for the 900 MWe reactors and thirty years for the 1,300 MWe reactors), a working group was set up, including EDF, IRSN and ASN, to study the reference earthquakes to be considered. For the 1,300 MWe reactors, EDF sent ASN a technical notice proposing to update the seismic levels to be considered for the safety review associated with the third ten-yearly outages. ASN asked EDF to explain the elements taken into account in the implementation of RFS 2001-01 concerning the uncertainties linked to the methodology. EDF is required to propose and initiate a programme of work to this effect. Every six months, EDF is also required to report on the progress of the R&D programme engaged with other partners.

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 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, failure of on-site water storage tanks 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 protection of the sites have been defined. In October 2007, EDF completed the

Aerial view of Le Blayais NPP, on the right bank of the Gironde estuary

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 their recommendations 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 site. 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 off-site structures not belonging to EDF, in particular with regard to the Cruas-Meysse and Tricastin nuclear power plants. Evaluating the robustness, the monitoring and the maintenance of such structures entails taking action governed by a decision-making process that involves the concession-holders for the structures, the public authorities and EDF. 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.

Since then, for the Cruas-Meysse and Tricastin NPPs, a convention was signed in 2011 between EDF and the Compagnie nationale du Rhône (CNR) concerning the countermeasures to be deployed.

At the same time, a working group of experts (in particular from IRSN), licensees' representatives and ASN undertook a review of RFS I.2.e on integration of the flooding risk. The new guide for BNI protection against the flooding risk will concern the choice of hazards liable to lead to flooding of the site, the methods for characterising them all and the flooding risk design and protection principles. This draft guide from the working group was the subject of consultation in 2010. The remarks received were discussed at review meetings in 2011 in preparation for GPR and GPU meetings in 2012. ASN plans to publish this new guide in 2012.

3|7|3 Preventing heatwave and drought risks

The heatwave in the summer of 2003 had considerable consequences for the environment of the NPPs: some water courses saw a reduction in flow rate and significant warming. However, this water is the heat sink for some of the NPPs, which need it for cooling purposes. The heatwave also resulted in increased air temperatures, causing a temperature increase within the NPPs. The rise in the air temperature raises the question of the correct short to medium-term operation of certain heat-sensitive equipment items. During this period of heatwave and drought some physical limits that had hitherto been applied to NPP design or imposed by the RGE were reached.

EDF therefore proposed a set of "intense heatwave" baseline requirements examining and reassessing the operation of installations under more severe conditions than those envisaged in the design, applying higher hypothetical air and water temperatures. EDF proposed a version of these requirements for the 900 MWe reactors and a version for the 1,450 MWe reactors. The requirements for the 1300 MWe reactors will be forwarded for the safety review associated with the reactors' third ten-yearly outages. In 2009, ASN adopted an initial stance concerning the baseline safety requirements for the 900 MWe reactors. With the help of its technical support organisation, ASN is currently examining EDF's responses to the comments and requests for additional information issued in 2009, as well as the hardware modifications leading to a permanent strengthening of the robustness of the reactors to extreme heat. ASN will reach a decision on these new elements by early 2012.

At the same time, the deployment of certain improvements and the implementation of operating practices to optimise the cooling capacity of the equipment and increase the resistance of the equipment sensitive to high temperatures began in 2004 at the most vulnerable sites and is being extended to all sites according to an optimised calendar.

ASN takes part in the national heatwave watch and EDF has initiated an in-house climate monitoring process in order to anticipate climate changes which could compromise the hypotheses adopted in the "extreme heat" baseline safety standards. As part of the safety review associated with the third ten-yearly outages of the 1,300 MWe reactors, ASN will give its judgement on the adequacy of the organisation put in place by EDF to observe climate trends and to ensure the validity of the hypotheses used in the baseline requirements.

3|7|4 Taking account of the fire risk

The fire risk in nuclear power plants is handled using the principle of defence in depth, based on three levels: installation 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 types and quantities of combustible materials in the NPPS – whether present permanently or temporarily – remain below the hypothetical levels used in the sectoring design;
– 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.

ASN checks that the fire risk is taken into account in the NPPs, notably through an analysis of the licensee's baseline safety standards, monitoring of significant event notifications made by the licensees and inspections performed on the sites.

In 2011, ASN and its technical support organisation, IRSN, concluded their review of the baseline safety requirements for protection against the risk of on-site fire in the Flamanville 3 EPR.

ASN also looked at the steps being taken by EDF following the deviations that occurred in 2011 on the NPPs in service, in particular with regard to the problem of fire sectorisation breaks.

Finally, ASN carried out inspections on fire risk management, in particular with respect to the electrical power transformers connecting the plant to the national electricity grid.

3|7|5 Checking that the explosion risk has been considered

Amongst the accidents that could occur in an NPP, explosion represents a major potential risk. Explosions 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.

ASN checks the prevention and monitoring measures taken with regard to the risk of explosion. It in particular ensures that this risk is included in EDF's baseline safety requirements and organisation.

ASN closely monitors implementation by EDF of the provisions of the prescriptions concerning management of the explosion risk as laid out in decision 2008-DC-0118 of 13 November 2008. These provisions can be organisational (creation of an organisation designed to guarantee compliance with the explosion risk regulations, examination of the conformity of all the explosive fluid lines and in-depth review of integration of the explosion risks) or material (replacement of lines carrying hydrogen, etc.).

In 2011, ASN and its technical support organisation, IRSN, also examined the baseline safety requirements for protection against the risk of on-site explosion for the EPR during the advance examination of the Flamanville 3 reactor commissioning application.

Finally, ASN ensures compliance with the “explosive atmospheres” (ATEX) regulations with respect to occupational worker protection. The ASN inspectors check the effectiveness and pertinence of EDF’s organisation for management of the ATEX risk, during their on-site inspections.

Fire service training exercise on the Civaux NPP

4 RADIATION PROTECTION, PROTECTION OF WORKERS AND THE ENVIRONMENT

4|1 Oversight of occupational radiation protection

One of the duties of ASN concerning basic nuclear installations, as stipulated by article 4 of the TSN Act[1], is to check compliance with the regulations relative to protection of workers liable to be exposed to ionising radiation in NPPs. In this context, ASN's responsibility extends to all workers on the sites, the staff of EDF and of service providers throughout the service life of an installation.

4|1|1 Oversight of radiation protection in operating NPPs

Radiation protection in operating NPPs is subject to control by ASN in two main ways:
– by carrying out inspections: These inspections can be carried out:
  • focusing specifically on radiation protection, scheduled once or twice per year and per site;
  • during reactor outages;
  • subsequent to incidents involving exposure to ionising radiation;
  • in the head office departments responsible for radiation protection doctrine.
– by examination of the files relative to occupational radiation protection. This examination can be performed with IRSN and can concern:
  • significant radiation protection event notifications provided by EDF;
  • maintenance or modification files with national implications, produced under the responsibility of EDF;
  • documents produced by EDF concerning the implementation of radiation protection regulations.

In addition, ASN provides EDF with an annual presentation of its evaluation of the status of radiation protection in the operating NPPs. This annual report allows comparison of ASN's assessment with that of the licensee, in order to identify possible areas of progress.

Finally, meetings are also held periodically to review the progress of technical or organisational projects under study or to be implemented in the NPPs.

4|1|2 Radiation protection requirements for NPPs in the construction phase

When examining the files relative to new reactors, and in particular to the EPR, ASN has asked EDF to learn lessons from the operating nuclear installations in France and from similar technology installations operating in other countries, with a view to reducing the collective dose as far as reasonably achievable.

To this end, ASN, working with IRSN, examines the design and construction procedures intended to reduce the collective dose and the individual doses of the most exposed workers.

ASN also carries out radiation protection inspections for workers on construction sites, especially during non-destructive testing using radioactive sources (see point 6|1|3).

4|2 Oversight of application of labour legislation in NPPs

Pursuant to Article 57 of the TSN Act and the Labour Code (Article R 8111-11), ASN is responsible for labour 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 checked on a coordinated basis by ASN. These checks concern the construction, operation and decommissioning of NPPs.

The main duties of the ASN officers in charge of labour inspection 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, their representatives and the employers and to take part in meetings of the committee for health, safety and working conditions (CHSCT);
– to inform ASN of any shortcomings or abuses not covered by labour legislation and of the situation in the establishments inspected.

General view of the Bugey NPP

3. The 13 June 2006 Act on transparency and security in the nuclear field.

Water intake and discharge structures on the Loire river for the Dampierre en Burly NPP

This means that some 20,000 EDF employees and as many contractor employees, either permanent or on temporary work sites (for reactor maintenance outages for example), are covered by ASN's labour inspection duties at the 19 operating NPPs, at the 9 reactors being decommissioned and at the Flamanville reactor construction site.

As of 31 December 2011, ASN had 12 labour inspectors performing labour inspection duties, including 3 full-time, allocated to the regional divisions and working closely with the sites, plus a central director coordinating the network of labour inspectors and handling interfacing with the Ministry for Labour. Coordination with the General Directorate for Labour of the Ministry for Labour was thus the subject of a cooperation agreement signed on 1 March 2011. In the regions, this agreement is implemented locally through regional agreements signed by the ASN divisions and the Regional Directorate for Enterprises, Competition, Consumption, Work and Employment (DIRECCTE).

Finally, since 2009, the links between the labour inspection measures taken and the other NPP monitoring and inspection activities have been consolidated in order to achieve the integrated view of control sought by ASN.

4|3 Controlling the environmental and health impacts of NPPs

4|3|1 Reviewing discharge requirements

Act 2006-686 of 13 June 2006, and in particular its Article 29, gives ASN the competence to define the prescriptions concerning water intake and discharges by basic nuclear installations (see point 3|1|3 of chapter 3).

Where NPPs are concerned, ASN's objective is a review of most of the existing discharge requirements in order to attain better harmonisation between the different sites. The new discharge requirements now take the form of two decisions:
– the first of these, subject to approval by the ministers responsible for nuclear safety, sets the discharge limits;
– the second defines the prescriptions concerning discharges, intake and consumption of water.

ASN applies the following principles when requests for a discharge permit renewal or modification are received:
– with regard to radioactive discharges, ASN is tending to lower the regulation limits. ASN sets new limits based on experience feedback concerning actual discharges, while taking account of any unforeseen circumstances that could arise from routine operation of the reactors;
– for non-radioactive substances, ASN has decided to establish discharge requirements for substances that were not previously regulated, in order to control virtually all of the discharges and to adopt an approach that is more in line with heightened awareness of environmental issues.

ASN sets discharge limits as low as possible, in the light of current technical knowledge and the economic situation, ensuring at the same time that they do not have significant impacts on people or on the environment, while allowing the installation to operate normally.

Lastly, it should be noted that technological progress has made it possible to alter limits and decision thresholds, guaranteeing better determination of actual discharges (see point 6|1|5).

TO BE NOTED

Radiological impact of discharges

The calculated radiological impact of the maximum discharges given in the EDF licence applications for the most exposed population group, still remains well within the dosimetric limit acceptable for the public (1 mSv/year).

The annual effective dose delivered to the population reference group (group subject to maximum radiological impact) that appears in the EDF effluent discharge and water intake licence applications is thus estimated at from a few microsieverts to several tens of microsieverts per year, depending on the particular site.

For example, the annual effective dose, including all exposure routes and all radionuclides, corresponding to the limit values requested by EDF for renewal of the licences for the Dampierre NPP, was evaluated at 2 microsieverts per year.

4|3|2 Oversight of waste management

Management of the radioactive waste produced by the NPPs operated by EDF is covered by the general framework for management of waste from BNIs, presented in Chapter 16 of this report. ASN ensures consistency between the management of waste from NPPs and of that from other BNIs. For this type of waste, and for non-radioactive wastes, ASN has the licensee's study reference documents, as required by regulations, described in Chapter 3, point 3|5|1.

The baseline documents cover the following themes:
– a review of the existing situation, recapitulating the different wastes generated and their quantities;
– waste management procedures;
– organisation of waste transport;
– waste zoning;
– the status of current disposal options.

Each site sends ASN the details of the waste it generates annually, indicating the chosen disposal routes, an analysis of trends in comparison with previous years, a report on any discrepancies observed and on the functioning and organisation of the site for waste management, as well as any unusual occurrences. The outlook is also addressed. EDF currently classifies its waste as process waste, maintenance waste and other waste, distinguishing between waste from controlled areas and others. Meetings are held regularly between the licensee and ASN to allow exchanges of information and views regarding waste and its management, especially via annual reports.

These elements and the regulations constitute the basis ASN uses to regulate management of waste by EDF. During inspections, inspectors review the organisation of sites in terms of waste management and various other points such as the handling of anomalies, and visit areas where waste is stored temporarily or treated.

4|3|3 Increasing protection against other risks and forms of pollutions

Controlling the bacterial risk

The cooling towers (see point 1|1|4) function by means of circulation of water, with cooling in an air flow, and are therefore particularly favourable to the development of legionella.

To strengthen prevention of the risk of legionella arising from cooling tower operation (see point 1|1|4) ASN, together with the General Directorate for Health (DGS), required in 2005 that EDF comply with new maximum legionella concentration limits in the cooling systems and introduced installation surveillance requirements.

In 2008, ASN called upon the French Agency for Environmental and Occupational Safety (AFSSET) to better ascertain the health and environmental risks surrounding this issue. On the basis of opinions given by AFSSET, ASN requested that EDF develop and implement preventive or remedial means to reduce the risk arising from micro-organisms, whilst also seeking to minimise the discharges of chemicals resulting from biocidal treatments. Because in some reactors, the legionella concentrations are still above the shutdown threshold in force for ICPEs, implemented following the outbreak of legionnaire's disease in Harnes in late 2003 (10^5 colony forming units per litre of water), ASN is closely monitoring the progress of the action plan, asking EDF to explore all alternative solutions for regular chemical treatments and all methods and techniques able, as applicable, to attenuate the impact of these treatments. By examining files and carrying out field inspections, ASN verifies the progress and the results of actions to combat legionella.

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 systems other than the secondary system cooling systems (air-conditioning, etc.), application of the current requirements on installations classified for environmental purposes (ICPE) is requested.

UNDERSTAND

5 CURRENT STATUS OF NUCLEAR SAFETY AND RADIATION PROTECTION

5|1 The NPPs inspection campaign and the complementary safety assessments following the Fukushima accident

Following the nuclear accident in Fukushima, ASN considered that a complementary safety assessment (CSA) of the French civil nuclear facilities with respect to the type of events which led to the Fukushima accident, should be initiated. The CSAs are the response to the requests made by the Prime Minister on 23 March 2011 and the European Council on 24 and 25 March 2011. ASN also carried out a series of inspections targeting the issues identified by experience feedback from the Fukushima accident.

Targeted inspections

These inspections, carried out on all the nuclear facilities felt to be high-priority, comprised field checks on the conformity of the licensee's equipment and organisation with the existing baseline safety standards.

The topics covered by these inspections were as follows:
– protection against off-site hazards, in particular seismic resistance and protection against flooding,
– loss of heat sinks,
– loss of electrical power supplies,
– operational management of radiological emergencies.

19 inspections were carried out between June and October 2011 by teams comprising several ASN inspectors accompanied by the IRSN. This inspection campaign represented 74 days of inspection. For each site, this took the form of in-depth inspections lasting several days, allowing spot-checks to be run on all the topics mentioned above.

The inspections revealed that the five subjects targeted by the programme were not always in conformity with the existing baseline safety standards. The main measures to be implemented by EDF are summarised below.

1. Concerning the seismic topic, ASN considers that the inspections revealed shortcomings on several sites and that on the whole progress is needed on all the sites. It is important to carry out exercises simulating an earthquake so that the planned procedures can be implemented and the staff are prepared for this type of situation. ASN also considers that greater account must be taken of the "seismic interaction" problem in the day to day operation of the units. Finally, EDF will have to ensure compliance with RFS I.3.b concerning seismic instrumentation, for instance with regard to the staff's familiarity with the equipment, its upkeep and its calibration. Overall, ASN considers that the subject requires permanent vigilance on the part of EDF, to prevent the potential implications of this hazard being gradually forgotten during the day to day operation of the reactors.

2. With regard to the topic of flooding, the conclusions of the inspections vary from site to site. ASN considers that the organisation in place to manage the flooding risk is satisfactory and meets its expectations. However, ASN considers that the management of volumetric protection has to be improved on several sites. ASN also considers that EDF should define and carry out exercises to test the equipment and teams in this type of situation and take account of the experience feedback from these exercises. Finally, ASN considers that progress is required on the following topics:
– rigorous application by the sites of the special operating rules in the event of flooding;
– monitoring of meteorological, high water and tidal parameters;
– the schedule for the work decided on as a result of the experience feedback from the partial flooding of the Le Blayais site in 1999;
– management of the mobile pumping resources.

3. ASN considers that the heat sink requires particular vigilance. Its vulnerability was highlighted by the recent events of heat sink clogging and partial loss at Cruas-Meysse and at Fessenheim in December 2009, which led EDF to initiate an action plan to increase its robustness. ASN asked EDF to conduct a design review of all its heat sinks. ASN will ask EDF for detailed conclusions of this site-by-site design review, along with a plan of action with completion dates.

The inspections carried out by ASN in 2011 found that the general state of the facilities was generally satisfactory, although there are a number of deviations on certain sites. As a general rule, rigorous operation and maintenance, equipment and structure condition monitoring, and exhaustive application of national directives, are areas for improvement on numerous sites. On many sites, maintenance of the SEC system needs to be improved.

4. With regard to electrical power supplies, the inspectors felt that the EDF sites were on the whole satisfactory but could be improved, especially concerning the following points:
– rigorous operating and maintenance documents (filling out of operational documents, updating of maintenance programmes);

ASN inspection of the Cruas NPP pumping station

– physical condition of certain equipment used for storage of fuel oil (piping corrosion, ingress of water);
– management of fluids required by the electricity generator sets (periodic analyses);
– periodic checks associated with the combustion turbine (TAC) on certain sites.

5. Accident situation operations can be improved. The PUI organisation adopted by the sites is satisfactory. ASN considers that EDF needs to improve its management of the fall-back centres and certain agreements concluded with off-site organisations.

Complementary Safety Assessments

On 5 May 2011, ASN instructed EDF to carry out complementary safety assessments on the robustness of the facilities when faced with exceptional situations such as those which led to the Fukushima accident. They complement the safety approach adopted permanently by the facilities.

On 15 September 2011, EDF submitted one file per plant, in accordance with the methodology approved by ASN. These files were discussed at a meeting of the Advisory Committees for reactors and for laboratories and plants on 8, 9 and 10 November 2011.

Following the complementary safety assessments on the nuclear power reactors, ASN considers that the safety of these reactors is such that none of them needs to be immediately shut down. At the same time, ASN considers that their continued operation does however require that their robustness to extreme situations be increased beyond their existing safety margins, as rapidly as possible.

Therefore:
• **ASN will be requiring the creation of a "hard core" of material and organisational measures** able to manage basic safety functions in extreme situations, for all the facilities addressed in the CSA report. Before 30 June 2012, the licensees must submit to ASN the content and the specifications of the "hard core" for their specific facilities.
• **As of this year, ASN will be requiring gradual implementation of the "Nuclear Rapid Intervention Force (FARN)"** proposed by EDF, a national emergency arrangement combining specialised teams and equipment, able to **intervene in less than 24 hours on a site affected by an accident**.
• **ASN will be requiring the implementation of reinforced measures to reduce the risk of "uncovering" of the fuel** in the fuel pools in the various facilities.
• **ASN will be requiring the performance of feasibility studies for additional measures to protect underground and surface waters in the event of a severe accident** in the NPPs or the La Hague facilities.

To do this, ASN will be issuing a series of prescriptions requiring that EDF implement these measures.

ASN considers that social, organisational and human factors are a key element of safety. ASN **will therefore remain attentive to renewal of the licensees' workforce and skills.** ASN in particular considers that monitoring of the subcontractors working in the nuclear facilities must not be delegated by the licensee when this concerns safety-related activities.

The order stipulating the general rules concerning basic nuclear installations, prepared by ASN together with the ministries responsible for nuclear safety, was also signed on 7 February 2012. ASN considers that it will make a significant contribution to improving safety.

Finally, on the basis of the detailed experience feedback from the Fukushima accident, ASN **will be reinforcing the baseline safety standards for the nuclear facilities,** in particular with regard to the "seismic", "flooding" and "risks linked to other industrial activities" aspects.

TO BE NOTED IN 2011

Complementary Safety Assessments

The key steps in the process are as follows:
- *3 May 2011: favourable opinion from the HCTISN concerning the CSA draft specifications.*
- *5 May 2011: 12 decisions by the ASN Commission asking the various nuclear facility licensees to produce a "complementary safety assessment" (CSA) report complying with precise specifications.*
- *1 June 2011: each licensee sends ASN a note presenting the methodology adopted for the complementary safety assessment of its facilities, as well as the organisation adopted in order to meet the stipulated completion dates.*
- *19 July 2011: ASN issues a position statement on the methodology notes presented by the licensees.*
- *15 September 2011: the licensees send ASN their complementary safety assessments for the high-priority facilities.*
- *4 November 2011: IRSN sends ASN its analysis of the complementary safety assessment reports forwarded by the licensees.*
- *8 to 10 November 2011: meeting of the Advisory Committees with submission of their opinion on the licensee reports to ASN.*
- *3 January 2012: ASN submits its report and its opinion on the CSAs to the Prime Minister, who forwards it to the European Commission.*
- *January to April 2012: European level peer reviews of the national reports.*
- *End April 2012: review and approval by ENSREG of the report on the European peer review conclusions.*
- *28 -29 June 2012: presentation by the European commission to the European Council of its report on the stress tests.*

5|2 Monitoring of the construction of the EPR Flamanville 3 reactor

Detailed design review for Flamanville 3

The detailed design review is carried out by ASN with the technical support of IRSN on the basis of a documentary review. In 2011, ASN and IRSN mainly continued their examination of the installation's control and instrumentation system (see box) and civil engineering, and initiated examination of the detailed design of some systems that are important for reactor safety, focusing on innovative systems and those involved in reactor protection and safeguard or in maintaining the three safety functions.

In addition to the detailed design technical review carried out with the support of IRSN, ASN in 2011 conducted nine inspections in the engineering departments in charge of carrying them out and of monitoring manufacturing at the suppliers. ASN thus checked implementation in the project management system of the requirements of the order of 10 August 1984. These checks in particular concerned the requirements relating to the management and monitoring of contractors, the identification and management of quality-related activities, management of deviations and management of experience feedback. One of these inspections was an in-depth inspection of the conformity of the Flamanville 3 design and construction work subcontracted by EDF to AREVA. (see box p. 354). Furthermore, some of the contractor management inspections were performed at the manufacturers' premises.

Oversight of construction activities on the FA3 NPP

With IRSN's support, ASN performed 25 inspections on the construction site in 2011. These in particular concerned the following technical topics:
– civil engineering, including activities relating to the construction of the inner containment wall, the reactor and fuel building pools, the corium catcher and the airplane crash shell;
– the mechanical assembly activities, including initial pipe welding (see box p. 354) and the tank fabrication activities;
– electrical system assembly activities;
– non-destructive testing and occupational radiation protection;
– the organisation and management of safety on the construction site and within the operating team for the future Flamanville 3 nuclear reactor;
– the impact of the construction site on the safety of the Flamanville 1 and 2 reactors.
– the environmental impact of the construction site.

More specifically, in 2011, ASN paid particular attention to the following subjects:
– installation of a pre-stressing system for the reactor inner containment wall. Since 2008, ASN has been informed of a number of positioning anomalies with portions of pre-stressing ducting. In June 2011, ASN considered that the repetitive nature of these anomalies indicated a lack of preparation, competence and safety culture among the workers concerned and shortcomings in the monitoring of its subcontractors by EDF. On 23 June 2011, ASN therefore asked EDF to suspend concreting work on the inner containment wall and to present an action plan designed to avoid any further anomaly with the positioning of the pre-stressing cable ducts. In the following days, EDF presented its action plan and in particular the steps taken to improve the competence of the teams in charge of installing the pre-stressing cable ducts and the monitoring of these teams.
  On 1 July 2011, considering that the steps taken by EDF were such as to allow correct performance of the pre-stressing cable duct installation activities, ASN authorised EDF to resume concreting work on the inner containment wall. An unannounced ASN inspection was made to check implementation of the EDF action plan, its findings being that the technical and organisational measures were satisfactory.
– concreting of very high structures with a high rebar density. In July 2011, EDF informed ASN that it had discovered honeycombing in certain walls of the pools in the reactor and fuel buildings. The concrete walls thus comprise local concentrations of aggregate and a lack of cement, which requires repair. Over and above processing of occasional anomalies, for which repairs were already programmed, and at the request of ASN, EDF initiated additional training, reinforced the preparation of the activities by including more detailed risk analyses, and reinforced the inspections. ASN will carry out inspections on this topic in the near future, in order to check compliance with these additional requirements.

Occupational health and safety inspection on the FA3 reactor construction site

ASN has been responsible for labour inspectorate duties since the creation authorisation decree was signed. On 24 January and 11 June 2011, the Flamanville 3 construction site was marked by two fatal accidents. The exact circumstances of these accidents, involving falls from height, although completely unrelated, led to a detailed inquiry by the ASN labour inspectors. They forwarded their conclusions to the public prosecutor's office.

The other action taken in 2011 consisted in:
– carrying out safety checks on the construction site;
– conducting inquiries into the accidents that occurred on the construction site;
– participating in meetings of the Inter-firm Health, Safety and Working Conditions Committee (CISSCT) and the departmental anti-fraud operational committee (CODAF);
– answering direct requests from the employees.

In 2011, the ASN labour inspectors in particular checked compliance with the provisions of the Labour Code by the contractors working on the construction site, with regard to the conditions of assignment of foreign workers, the notification of labour accidents and the risks involved in contractors working alongside each other.

Oversight of nuclear pressure equipment manufacture

During the course of 2011, ASN continued with its evaluation of the conformity of the EPR reactor's primary and secondary system equipment (vessel, reactor coolant pumps, control rod drive mechanisms, pressuriser, steam generators, as well as some of the pipes, valves and cocks), with the assistance of the

IRWST pool for the SIS system before sheeting

approved third-party inspection bodies it specifically mandated for the performance of conformity assessment. Manufacturing has already begun on all the major equipment items and most types of valve. In addition to the review of the technical documentation concerning the design and manufacture of ESPN, ASN and the approved third-party inspection bodies performed more than 400 inspections to check the manufacture of this equipment, corresponding to being present for more than 700 days in the plants of the manufacturer AREVA NP, and its suppliers and their subcontractors. In early 2012, initial assembly of the ESPN making up the NSSS will begin on the Flamanville site.

5|3 Examination of the Penly 3 creation authorisation decree

At the end of 2010, EDF submitted a creation authorisation application to the Ministers for Nuclear Safety, for an EPR type reactor on the Penly site, pursuant to article 29 of Act 2006-686 of 13 June 2006, as amended, on transparency and security in the nuclear field. These ministers asked the ASN for its opinion on the acceptability of the various elements of the dossier, detailed in article 8 of decree 2077-1557 of 2 November 2007.

ASN, with the support of the IRSN, examined the dossier submitted by EDF. Their conclusion was that additional data were needed for a detailed technical examination to be carried out. These additional data requests primarily concern the preliminary safety report, the risk management study and the impact assessment.

Within its scope of competence, the environmental authority also issued an opinion on 13 April 2011. This is available under reference no.2011-06, at the following web address: *www.cgedd.developpement-durable.gouv.fr.*

ASN validation of the instrumentation and control (I&C) architecture

I&C of the Flamanville 3 EPR reactor comprises two platforms:
- *the Téléperm XS platform, specifically developed for the nuclear industry and dedicated to reactor protection functions in incident or accident situations;*
- *the SPPA T2000 platform, of "conventional industrial" origin, is used for normal reactor operations and for certain reactor protection functions in incident or accident situations.*

In response to the ASN request in a letter dated 9 July 2010, EDF presented an alternative design to that initially envisaged. These new design provisions for example consist in grouping within a "hard core" system certain safety functions hitherto not installed on the Téléperm XS platform. These measures make it possible to deal with total loss of the SPPA T2000 platform combined with certain accident situations.

At the same time, together with the designers and manufacturers concerned, EDF deployed significant efforts to prove that certain safety functions could be installed on the SPPA T2000 platform.

At the request of ASN and on the basis of an analysis performed by the IRSN, the Advisory Committee for nuclear reactors (GPR) examined these elements at its session of 16th June 2011. The GPR considered that the answers provided by EDF were on the whole satisfactory. ASN will shortly be issuing a position statement on this subject. The GPR opinion and the ASN position statement, like all those issued by ASN following consultation of the GPR, will be made public on www.asn.fr.

UNDERSTAND

In-depth inspection of the conformity of the Flamanville 3 design and construction work subcontracted by EDF to AREVA

A team consisting of ten inspectors from ASN, four staff members from the Institute for Radiation Protection and Nuclear Safety (IRSN) and one observer from the British nuclear safety regulator (ONR) carried out an in-depth inspection of design and construction work on the Flamanville EPR reactor, on 1st March and on 9th and 10th May 2011.

This inspection was carried out to check implementation of the provisions of the order of 10th August 1984 (referred to as the "quality order") on these activities, entrusted to AREVA by EDF. EDF, the licensee of the Flamanville EPR reactor, is responsible for the safety of its facilities. EDF must therefore define and implement the necessary measures to comply with the requirements laid out in the order.

These inspections took the form of document reviews, visits to the workshops of the subcontractors and interviews with employees of both EDF and its subcontractors. Inspections were held at the AREVA premises and at those of some of its subcontractors. They concerned:
- *the performance of studies to demonstrate the safety of the facility (accident design studies);*
- *the manufacture of components of particular importance for safety, such as the accumulators of the safety injection system (SIS) or components specific to the EPR reactor, such as the filters located in the IRWST (SIS system pool), the SIS and EVU systems (reactor building ultimate heat removal system in a severe accident situation), or the reactor vessel internals;*
- *the manufacture of items considered to be "conventional" with respect to the NPPs in operation (flow restrictors, diaphragms or electrical cables).*

Following this in-depth inspection, the inspectors concluded that the measures taken were appropriate and meet the requirements set in the "quality order". They also observed that these measures were applied throughout the subcontracting chain. However a number of weak points were identified and led the inspectors to ask EDF to ensure that no irreversible steps were taken for the DN500 venturis of the steam generators feedwater flow control system (ARE), the IRWST filters and the SIS accumulators, before the quality of construction of these items, which are essential to the safety of the facilities, has been demonstrated. Other deviations were also observed: these concern the identification of activities important for the safety of the facilities, the definition of requirements and prior conditions for performance of these activities and their monitoring by EDF.

ASN oversight of work by AREVA NP to guarantee the conformity of the Flamanville EPR reactor vessel head

AREVA NP informed ASN that two major quality deviations had been detected during manufacture of the vessel head for the Flamanville 3 EPR reactor. The processing of these deviations led AREVA NP in July 2011 to propose a wide-ranging repair solution to ASN, involving complete performance of several steps in the vessel head manufacturing process a second time.

The deviations concerned:
- *first of all, in autumn 2010, detection of a large number of defects in the welds on the vessel head, at the adapters. This deviation was made available on www.asn.fr in April 2011;*
- *secondly, in June 2011, during repair operations to correct the previous deviation, detection of insufficient thickness in the buttering metal layer located under these welds.*

Owing to their small size, most of the defects observed in the welds on the adapters were not particularly detrimental, but their large number indicates a problem with the welding process, which justifies repeating the welds with particular precautions. However, welds may have been made on an insufficient buttering thickness, which may have created cracks in the vessel head, under the buttering. A detailed inspection of the condition of the base metal under the butterings concerned, followed by their repair, was thus necessary.

ASN asked AREVA NP for a detailed analysis of the potential risks involved in these large-scale repair operations and for the proposal of special measures to guarantee the final quality of the vessel head. After examining the response and the opinion of the Advisory Committee for nuclear pressure equipment, ASN agreed that AREVA NP could proceed with repair of the vessel head, with enhanced monitoring by ASN and APAVE.

Prior to the performance of each step in the repair process, AREVA NP must demonstrate that all necessary steps have been taken to manage the risks and guarantee that any deviation or drift will be detected. In any case, this vessel head may only be installed on the Flamanville 3 EPR reactor if expressly declared by ASN as conforming with the technical requirements of the regulations. ASN will rule on the acceptability of the vessel head once all the manufacturing operations are completed.

Even though it had already updated its dossier in the summer of 2011, EDF stated in October 2011 that further additional amendments were needed, in particular before it could be submitted to the public inquiry. This position was consistent with ASN's assessment of the version of the dossier it examined in the summer of 2011.

ASN will resume its examination of EDF's application on receipt of the announced amendments, so that it can issue an opinion on the creation authorisation for this reactor.

5|4 Examination of the safety options for the ATMEA 1 reactor project

The ATMEA company, a joint venture formed between AREVA (France) and Mitsubishi Heavy Industries (MHI, Japan), approached ASN for a review of the safety features[4] for a new pressurised water reactor known as ATMEA 1. According to ATMEA, this medium power reactor (1,100 MWe) is mainly intended for export.

ASN responded favourably to ATMEA's request and in 2010 signed an agreement specifying this review.

This safety options review, performed with the support of the Institute for Radiation Protection and Nuclear Safety (IRSN), aimed to assess whether the safety options are in conformity with the French regulations and related texts (RFS, etc.) currently in force. It was carried out in conditions similar to those which would be used if the ATMEA 1 reactor were to be built in France. This review was started in 2010 and continued in 2011, via consultations with the Advisory Committee for nuclear reactors (GPR) and its Advisory Committee for "nuclear pressure equipment" (GPESPN). Five GPR sessions and one GPESPN session were thus devoted to examining the safety options for the ATMEA 1 reactor.

ASN made the conclusions of this review process public in early 2012. ASN considered that the safety features for the ATMEA 1 reactor are on the whole satisfactory and in conformity with the French requirements.

At the detailed design stage, the ATMEA company will need to be particularly vigilant with regard to optimisation of occupational exposure to ionising radiation, to the steps necessary for the "practical elimination" of certain accidents or the preclusion of breaks in certain pipes and, of course, the continued integration of the lessons learned from the accident which struck the Fukushima Daiichi nuclear power plant (Japan).

The safety features review will also allow ASN, if necessary, to assist the regulators in the countries building the reactors.

5|5 Modification of the Le Blayais 3-4 creation authorisation decree

Application for authorisation to use MOX fuel in reactors 3 and 4 of the Le Blayais NPP

MOX (mixed oxide) fuel is a fuel that contains plutonium oxide and depleted uranium oxide. Using it in reactors is a means of recycling a part of the spent fuel from the NPPs. It can thus replace the enriched uranium based fuel in the 900 MWe plants; this requires making a number of technical modifications to the reactors (for example adding extra control rod clusters).

As part of the process to recycle spent fuel, EDF on 29 April 2010 requested authorisation to use MOX fuel in Le Blayais reactors 3 and 4. At present, twenty-two 900 MWe reactors in France (including reactors 1 and 2 at Le Blayais) have already received this authorisation.

As the creation authorisation decree (DAC) for reactors 3 and 4 at Le Blayais makes no provision for the use of fuel containing plutonium, a modification of this decree is necessary.

Pursuant to Article 31 of decree 2007-1557 of 2nd November 2007 concerning basic nuclear installations and the control, in terms of nuclear safety, of the transport of radioactive materials, the DAC modification procedure is similar to that used for the creation of a new BNI. Within its area of competence, ASN thus examines the form and content of the application on behalf of the Ministers responsible for nuclear safety.

Once ASN had the application file completed and corrected, the environmental authority issued its opinion on 20 July 2011.

View of Le Blayais NPP

4. The safety features file, compiled by the operator, is used to present ASN with the main characteristics and general design choices made in terms of safety. The file, prepared in the reactor preliminary design phase, presents, notably:
– the safety objectives for the reactor;
– the safety approach applied in design;
– the overall description of the reactor and of the processes and systems used;
– the operating conditions envisaged as well as key parameters of the installation;
– accidents and attacks considered in design, and methods for dealing with these.
This step is specified in article 6 of decree 2007-1557 of 2nd November 2007.

This document is available under reference no.2011-31, at the following web address: *www.cgedd.developpement-durable.gouv.fr*. The public inquiry was held from 14 November to 14 December 2011.

5|6 Continued operation of the nuclear power plants

The licensee of a nuclear facility must conduct a periodic safety review of its facility every ten years (see point 2|3|4).

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

On 4 November 2010, following the third ten-yearly outage inspection of Tricastin NPP reactor 1, ASN ruled on the reactor's conformity with the applicable safety requirements and on the conditions necessary for continued operation for a period of up to 40 years. In addition, on 27 May 2011, an ASN decision set new technical requirements for the reactor, in order to take account of more recent safety standards and the latest technical advances.

On 4 July 2011, ASN ruled on the continued operation of the Fessenheim 1 reactor following its third ten-yearly outage inspection. ASN considered that, subject to the forthcoming conclusions of the complementary safety assessments (CSA) initiated following the Fukushima accident and in the light of the results of the third periodic safety review, this reactor was suitable for operation for a further ten years after this third periodic safety review, provided that a list of requirements was followed, in particular the two key specifications below:
- reinforce the reactor basemat before 30 June 2013, to increase its corium resistance in the event of a severe accident with vessel melt-through;
- before 31 December 2012, implement emergency technical measures for long-term removal of residual heat in the event of loss of the heat sink.

In 2012, ASN will rule on the conditions for continued operation of the next 900 MWe reactors undergoing their third ten-yearly outage inspection.

The two production units of the Fessenheim NPP

The periodic safety review concerning the third ten-yearly outages for the 1,300 MWe reactors

After the Belleville 1 and Nogent 2 reactors in 2010, the Penly 1 and Cattenom 3 reactors in 2011 integrated the improvements resulting from the periodic safety review linked to their second ten-yearly outage inspections.

The periodic safety review concerning the third ten-yearly outages for the 1,450 MWe reactors

After the Chooz reactors in 2009 and 2010, Civaux reactor 1 in 2011 integrated the modifications resulting from the periodic safety review performed on the occasion of its first ten-yearly outage inspection. As for the 900 and 1,300 MWe reactors, ASN will send the ministers responsible for nuclear safety its decision regarding the continued operation of each of these reactors, after reviewing the conclusions report submitted by EDF.

5|7 Notable findings relating to oversight of pressure equipment

Cracks detected in the bottom-mounted instrumentation penetrations on Gravelines 1

The bottom-mounted instrumentation (BMI) penetrations are used for the insertion of core instrumentation. The BMI examination on Gravelines reactor 1 during the 3 ten-yearly outage inspection revealed cracking of one penetration (also see point 3|4|2). These longitudinal branching cracks were detected using an ultrasounds inspection process. They are apparent on the inner side, are 40 mm length and run through virtually the entire thickness. They apparently propagated from manufacturing defects detected during inspections in 2001.

EDF implemented a repair solution consisting in plugging the BMI penetration by means of a removable plug. This solution enables the BMI penetration to be isolated from all contact with the reactor coolant fluid, thus preventing subsequent evolution of the defect. At the request of ASN, EDF also installed a humidity detection system in the penetration concerned.

ASN considered that these steps would allow safe operation of the reactor for the coming cycle but nonetheless informed EDF that processing of this matter beyond such a period would require detailed examination, in particular of the means for replacing and monitoring the penetration. ASN also asked EDF to reinforce the monitoring of the penetrations on its other reactors.

5|8 Notable findings relating to occupational health and safety inspections

Monitoring of health and safety regulations

ASN's main labour inspectorate activity in 2011 was monitoring of the implementation of the regulations concerning health and safety in the workplace. Workers in NPPs are not only exposed to risks relating to the "nuclear" aspects of their activity, but also to "conventional" risks such as those from electrical installations, pressure equipment, chemicals, explosion (in hydrogen systems), asphyxiation (from nitrogen), working at height or handling of heavy loads.

In 2011, labour inspection activities covered the following areas:
– systematic inquiries in the event of serious occupational accidents, in particular the three fatal accidents that occurred in 2011. In these latter cases, the labour inspectors found deviations from the regulations concerning working equipment;
– particularly close monitoring of construction site activities, with attention to lifting work which generates a large percentage of accidents, as well as the risks linked to several contractors working alongside each other;
– activities involving the use of carcinogenic, mutagenic or reprotoxic chemical products, asbestos removal, as well as the presence of lead. EDF and its contractors were urged to take measures complying with the prevention principles: first of all, eliminate the risk, or limit worker exposure to these products, or find less dangerous alternative products;
– the performance of work inside the reactor containment while the reactor is at power, both in terms of exposure to ionising radiation and heat and in terms of stress;
– participation in the campaign by the Ministry for Labour concerning road accident risks, in particular for subcontractor maintenance staff required to travel around the entire country.

The regular presence of inspectors on the hygiene, safety and working conditions committees (CHSCT), allows the inspectors to follow the activity of these bodies and to be regularly informed about relevant subjects, notably concerning occupational accidents and stress risk factors.

Monitoring working hours

ASN's labour inspectors carried out inspections on compliance with regulations on working hours as well as on daily and weekly rest periods specifically during reactor shutdown for maintenance. In 2011, albeit to a lesser extent than in previous years, they again observed deviations concerning compliance with the maximum daily and weekly working hours and rest periods. The infringements observed relate to periods of high activity (maintenance during reactor outage). A policy of advance preparation of the work to be done during reactor outages was encouraged, jointly with the Ministry for Labour and in consultation with the staff representatives, so that EDF can plan ahead and request the necessary waivers in strict compliance with the provisions of the Labour Code.

On 9 June 2011, the magistrate's court of Montélimar sentenced the director of the Tricastin NPP to 8 fines of 500 € each, for "employment of staff without complying with the minimum daily rest requirement", the events having taken place between 1 March 2009 and 30 September 2009, as recorded in the report from the ASN labour inspector. This decision reminds EDF of its obligations to comply with the maximum working hours in a nuclear power plant, both to protect worker safety and for broader reasons of nuclear safety.

Subcontracting

Detailed investigations have been carried out into the use of contractors, for instance in the service sector. Inquiries were also held on the Flamanville 3 site, concerning services contracted out to foreign contractors. The goal was to ensure application of the minimum wage rules enshrined in the collective agreements applicable in France and the application of employment rules.

Finally, the labour inspectors took part in 12 inspections jointly with the nuclear safety inspectors, to look at the quality of the work done by the contractors.

Other areas

The labour inspectors were required to examine subjects raised by the staff representative bodies, primarily to settle disputes over the CHSCT's right of alert concerning a serious and imminent danger.

The labour inspectors also participate in joint work within the operational committee for the prevention of illegal labour (CODAF) led by the Public prosecutor's office, especially where the EPR construction site is concerned.

Penal procedures

ASN's labour inspectorate issued six notifications of violation on the NPPs to the relevant jurisdictions. Three of these related to violations that led to fatal occupational accidents.

5|9 Notable findings relating to radiation protection of personnel

In-depth radiation protection review

From 6 to 14 June 2011, ASN carried out an in-depth review on conformity with the radiation protection regulations by the four NPPs in the Loire Valley and on the interfacing between these NPPs and the EDF head office departments. Seven ASN radiation protection inspectors carried out this inspection, with the assistance of two experts from the Institute for Radiation Protection and Nuclear Safety (IRSN).

They were divided into three teams and in parallel examined several radiation protection related topics (the organisation and management of radiation protection, utilisation of the ALARA approach, radiological cleanness, worker monitoring, management of radioactive sources, etc.).

The inspectors found that the radiation protection organisation defined and implemented on the four NPPs is on the whole satisfactory. However, it was clear that efforts are still needed in deploying the organisation selected by EDF to all the reactors in operation, for instance with regard to its impact on resources, as well as on deployment in the field of experience feedback and good radiation protection practices.

5. The ALARA (As Low As Reasonabely Achievable) approach implements one of the radiation protection principles enshrined in the Public Health Code, that is the optimisation principle, whereby any justified exposure must be carried out at the lowest possible dosimetric cost.

Periodic review of EDF's radiation protection actions

In 2004, following consultation of the Advisory Committee for reactors (GPR) on the state of occupational radiation protection in the French NPPs, ASN asked EDF to improve its organisation, by monitoring the areas for progress identified by the GPR. Since then, ASN has periodically carried out an overall assessment of the radiation protection results and practices in the NPPs. Any requests it issues are then the result of its analysis of significant radiation protection events, technical review of the files produced by EDF (modification files, etc.) and inspections carried out during the period in question.

In this respect, in 2007, ASN issued a letter to which EDF's answers were considered to be on the whole satisfactory. In 2011, ASN once again carried out an official assessment and issued requests for renewed impetus with regard to the ALARA approach at EDF and to the "radiation protection culture" and management of contamination at source.

Examination of the Flamanville 3 EPR file

With regard to radiation protection, ASN is also continuing to examine the EPR commissioning process, in particular concerning activities where radiological issues are of great importance and the "two rooms" concept, which involves a new area in the reactor building enabling certain maintenance operations to be carried out while the reactor is operating. The general examination of the EPR reactor is presented in point 2 | 4 of this chapter.

5 | 10 Notable findings relating to the environmental impacts of NPPs and discharges

Review of discharge requirements

In 2011, ASN completed its examination of the effluent discharge and water intake files concerning the NPPs of Dampierre, Civaux and Cruas-Meysse:

– Dampierre: Effluent discharges and water intake on the site are now regulated by ASN decisions 2011-DC-0210 and 2011-DC-0211, dated 3 March 2011 and published in the ASN official bulletin on its website. Decision 2011-DC-0210 setting the environmental discharge limits was approved by the order of 6 May 2011 from the ministers responsible for nuclear safety and radiation protection.
– Civaux: the decisions regulating effluent discharges and water intake were updated by ASN modifying decisions 2011-DC-0233 and 2011-DC-0234 of 5 July 2011 and published in the ASN official bulletin on its website. Decision 2011-DC-0233 setting the environmental discharge limits was approved by the order of 2 August 2011 from the ministers responsible for nuclear safety and radiation protection.
– Cruas-Meysse: the order of 7 November 2003 regulating effluent discharges and water intake was temporarily modified owing to the climatic conditions in the spring and summer of 2011 by ASN decision 2011-DC-0237 of 28 July 2011. This decision temporarily set new effluent discharge requirements.

Experience feedback from the SOCATRI event

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 circuits and ultimate retention systems that could contain toxic, radioactive, inflammable, corrosive or explosive (TRICE) 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 implemented in 2009.

ASN analysed the conclusions of this programme and the national summary presented by EDF, along with the environmental events that have occurred on the NPPs since 2008 and the conclusions of its environmental inspections, in order to determine areas in which EDF could still make improvements.

ASN issued a number of requests in a letter dated 1 March 2011, for instance concerning the need to consider all the products liable to cause water and soil pollution, in the same way as the "TRICE" products, the need to reconsider the means of monitoring groundwater and the importance of integrating this experience feedback when building new reactors.

EDF answered the ASN requests in a letter which is currently being analysed.

6 ASSESSMENTS

Reactors in operation

6|1 Evaluating the head office departments and overall performance of NPPs

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

Evaluation is based on the results of checks carried out by ASN in 2011, 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 2011, ASN conducted 493 inspections in the nuclear power plants in service and in EDF head offices.

The general assessment represents ASN's view of the year 2011 and acts as a guideline for ASN regulation and inspection actions for 2012.

6|1|1 Evaluating nuclear safety

Reactor operations

The documents needed for operation are on the whole satisfactorily managed. They cover the various phases of operation and give a good representation of the actual status of the facility. Anomalies in application of the rules for periodic testing are less numerous than in previous years.

Management of operating personnel training and authorisations is on the whole satisfactory. However, improvements are expected with respect to training of the shift crews.

Improving the rigorousness of operations remains a key priority for EDF. However, ASN did observe a slight deterioration in this area in 2011. ASN considers that the efforts made on this subject in recent years must be continued.

Efforts were made by EDF in 2011 to identify, manage and remove "particular equipment and devices" and temporary modifications that have remained in place on reactors for several years. These efforts should be continued.

Conversely, preparation for servicing work remains a weak point once again this year. Although ASN notes the beneficial effects of implementation of practices to improve reliability, these remain under-exploited and the shift crew managers do not have the time needed to correctly fulfil their duties, especially during reactor outages. As in 2010, oversight of the control room operators needs to be improved, to be able to detect any operating problems as early as possible.

The interfaces between operating and maintenance or testing personnel are often the source of anomalies, resulting from communication errors or misunderstandings. Actions to improve this situation must be identified and implemented.

As in 2010, ASN noted some progress in the management of equipment lock-outs, but numerous deviations persisted in this area in 2011, as well as with respect to line connection of systems. There is a lack of rigour and oversight where these operations are concerned.

Finally, rigorous application of the operating baseline safety requirements and management of temporary operating instructions is deteriorating and improvements are required.

Emergency and fire situations

ASN considers that EDF's management of emergency situations is satisfactory. Relations between ASN and EDF at national level have been strengthened in recent years, notably via meetings and discussions concerning the new baseline safety standards for EDF's on-site emergency plans (PUI). These new PUI are currently being deployed to the sites, with the aim of having them implemented on all sites by 15th November 2012.

During the course of 2011, the inspections conducted on the topic of emergency management showed that the PUI organisation adopted by the sites is satisfactory. However, the sites must improve a certain number of points, including management of the fall-back premises and certain agreements concluded with external organisations.

Even if a number of improvements were observed in 2011, ASN considers that the emergency response organisation in the event of an ammonia release, implemented on sites with a monochloramine treatment facility, is still not satisfactory and is not operational on most of the sites concerned.

Through its inspections in 2011, ASN noted that there was overall progress in the field of fire-fighting, even if there are discrepancies between sites. However, the situation with respect to fire loads and the conformity of fire sectors has not improved. In this respect, ASN considers that the anomalies affecting the availability of certain fire dampers (isolating devices contributing to compartmentalisation of buildings in the event of a fire) need to be corrected. Efforts also still need to be made in the drafting and utilisation of fire permits. Finally, ASN is remaining attentive to the deployment on the sites of corrective measures or improvements following experience feedback concerning the transformer fires in 2010 and 2011.

Maintenance activities

With regard to maintenance, ASN observed that in the past, EDF had not sufficiently anticipated certain problems nor taken sufficient account of international experience feedback, which led EDF to review its strategy, now focused on preventive measures, for example preventive chemical cleaning of the steam generators and the steam generator replacement policy. However, ASN noted that this forward planning approach was not adopted for all the problems.

ASN notes that the areas made of Inconel 600 type alloy are susceptible to certain corrosion phenomena (see point 3⎪4⎪2), damage that has been observable for several years. However, EDF has not really anticipated the appearance of such defects on the bottom-mounted instrumentation penetrations made of the same material. Today, EDF still does not have a process for repairing or replacing these penetrations that is qualified and accepted by ASN (see point 5⎪7).

Regarding the implementation of the maintenance policy on sites, ASN feels that EDF must be careful to ensure that adequate human and material resources are available.

Where implementation of maintenance methods on the sites is concerned, ASN considers that there is room for improvement in EDF's situation and that some recurring shortcomings remain:
– the maintenance baseline standards documents are in a state of continual flux in a variety of forms. The resulting complexity is a factor that aggravates the persistent delays in integration observed on all NPPs and tends to lead to disparate requirements;
– the quality of risk analysis in the preparation of maintenance operations remains unsatisfactory. It needs to be significantly improved on virtually all sites. Management of spare parts should also be improved;
– lastly, the quality of maintenance operations also requires greater consideration of human factors in the preparation stages of these operations.

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 believes that EDF should address the problem of obsolescence with regard to some items of equipment. In addition, EDF must reinforce the way it manages the way the qualification of equipment is maintained for accident conditions, whether during preventive maintenance operations or when replacing equipment. ASN notes that in 2011, EDF launched an action plan for management of the requirements regarding qualification of equipment and spare parts for accident conditions; ASN will closely monitor effective implementation. Overall, ASN considers that EDF must continue its efforts to qualify equipment and manage obsolescence.

The first barrier

ASN considers that in 2011, the situation regarding the first barrier is on the whole satisfactory but could be improved. The long-term actions undertaken by EDF have still not restored optimum status for the first barrier and, in 2011, ASN once again observed leaks in fuel assemblies, damaged support grids and the presence of numerous foreign bodies in the primary system.

In 2011, loss of leaktightness on RFA fuel assemblies in some 900 MWe reactors was associated with fretting of these 900 MWe RFA fuel assemblies which are of an old design without spacer grid. The design modifications made to these assemblies would seem to indicate gradual disappearance of these leakage sources. The number of these assemblies present in the reactors will fall in 2012 and will be insignificant within a few years.

ASN also considers that EDF needs to step up its efforts to reduce foreign bodies in the systems. The measures taken by EDF since 2008 continued in 2011, but implementation could be further improved.

Finally, EDF needs to continue to make progress in applying maintenance programmes for fuel handling equipment, which can be the cause of fuel assembly damage.

Pressure equipment and the second barrier

ASN considers that the situation of the fleet regarding pressure equipment is deteriorating. The main reasons for this deterioration are insufficient assimilation of the ESPN regulations applicable since January 2011, for instance failure to draft equipment maintenance and monitoring programmes (POES) sufficiently far in advance.

ASN also noted that several events that occurred on pressure equipment in 2011 reflect a lack of rigour in the preparation and performance of maintenance operations and in the operating conditions:
– presence of foreign materials accidentally introduced into the steam generator tube bundles during maintenance operations;
– damage to the flange and vessel head of several vessels when refitting the vessel head after reactor outages;
– insufficiently thorough preparation of certain equipment pressure tests, leading to the observation of parasitic leakage during the preparation for or performance of the test;
– occurrence of several "pressure hammer" type dynamic transients at reactor restart, highlighting equipment deviations or failure to abide by the operating instructions: these transients led to unanticipated loadings of certain equipment items.

Finally, ASN observed the appearance of signs indicating a fall in the quality of the work done by the recognised inspection departments (SIR), responsible for ensuring that each site implements the regulations concerning pressure equipment. ASN considers that in certain cases, these problems can be partly attributed to the fact that the SIR does not have enough staff to handle the duties assigned to it. The difficulties observed with certain SIR led in May 2011 to the decision by the *Préfet* of the Isère *département*, on the advice of ASN, not to renew its recognition of the inspection department on the Saint-Alban site.

The third barrier and the containment

As in previous years, it is considered that the condition of the containment, in particular the third barrier and its components, could be improved in 2011. ASN in particular notes that the number of events concerning the containment remained stable.

The results of ten-year testing of the reactor containments conducted in 2011 all complied with the criteria established in the operating rules. The results of the containment test on Bugey reactor 5, which meet the criteria set by the operating rules, are nonetheless not as satisfactory as those of the previous test 10 years ago. The licensee has undertaken to conduct checks to detect the origin of the rise in the containment leak rate and perform an additional test in 5 years time.

With regard to the 1,300 and 1,450 MWe reactors, EDF presents technical solutions to ASN to guarantee the long-term tightness performance of the containments, despite their ageing. The analysis of these proposals will be presented to the Advisory Committee for nuclear reactors as of 2012.

6|1|2 Evaluating human and organisational measures

Integrating organisational and human factors (OHF) into operating activities

ASN considers that the specific actions taken to improve the integration of OHF into operations, and how this is organised, differ from one site to another. The organisation set up by EDF to integrate human factors makes provision for a position as a "human factors" (HF) consultant for two reactors. ASN notes satisfactory professional training of the HF consultants, who generally come from the field. On the other hand, ASN has in recent years observed that the resources made available to the HF consultants are inadequate. It was for instance noted that the HF consultant post sometimes remained vacant on certain sites. In addition to the HF consultants, some sites have a network of HF correspondents within the technical sections, but they are often only allowed to devote very limited amounts of time to this function. Moreover, on most sites, the members of the HF correspondents network rarely receive any training. ASN therefore considers that the position of the HF consultants and correspondents in the site organisation must continue to be improved, so that the OHF viewpoint can continue to become increasingly firmly anchored in the management system.

ASN notes the considerable efforts made by EDF to develop implementation of practices to improve the reliability of operations within the framework of the national "human performance" project and considers that it must be continued. The managers are thus reinforcing their presence in the field, even if these field visits sometimes tend to be more to check the condition of the facilities as part of the "obtain exemplary condition of facilities (OEEI)" project, rather than to observe working situations, as proposed in the "human performance" project. ASN also specifies that application of the "human performance" project by the sites should not be to the detriment of other measures specific to the sites to improve the consideration given to "HOF" aspects during operation and of safety management on the sites, but should be considered to be complementary. Even on sites where reliability improvement practices are well-integrated into the usual practices of the workers, there are still "human" or "organisational" components in the errors responsible for the occurrence of significant events.

Finally, ASN observed that HF measures primarily aim to disseminate and implement managerial policies and requirements, but as yet pay too little attention to improved assimilation of the realities in the field by the site management.

Analysis of experience feedback from the OHF viewpoint

The HF consultants are not always incorporated into the experience feedback analysis process. They sometimes support the various disciplines, usually at their request, to help them analyse an event from the human factors standpoint. ASN considers that the HF consultants must be more naturally and systematically consulted by the site management when analysing events. When the technical sections comprise networks of human factors correspondents, they are sometimes involved in analysing events. However, there is a still a problem with the effective follow-up by the HF consultant of the action taken following the findings of the event analyses.

Working conditions

Once again in 2011, on several NPPs, ASN found numerous inadequacies concerning operational documents and the human-machine interfaces. ASN was thus able to observe equipment poorly suited to the tasks to be performed, cramped premises, inappropriate, incomplete or relatively inaccessible documents, marking defects, signs that are hard to read and which may sometimes have led to significant events.

ASN emphasises the fact that ergonomic problems adversely affect operatives' activities since the conditions under which they work and the calm atmosphere they should enjoy are jeopardised by the constraints of organisation of work, changes in planning and problems of coordination between sites that cause delays or postponement of activities. ASN observed several situations generating workload for the operators, leading to a risk to their health and a potential source of safety risks.

Management of skills and qualifications

The skills and qualifications management in place on the sites is satisfactory and the management processes well documented and coherent. Inadequacies on certain sites are however still being found by ASN during the inspections, concerning the forward planning of jobs and skills management (GPEC) so as to be able to prepare for renewal of skills. Failure to anticipate large scale departures from certain disciplines was therefore observed on a few sites. The relative balance observable hitherto could be jeopardised by a significant transition between generations and the high levels of work required as a result of the CSAs.

Training programmes are generally implemented satisfactorily and the establishment of "academies" for the different professional disciplines is highlighted as a strong point for the training of newcomers to the sites. Deviations are however still found during inspections or following significant events, in particular in the fields of transport of radioactive materials, radiation protection and environmental protection. In general, ASN observed that staff professionalisation logs were well kept and found few errors in operating staff qualifications.

Incorporating HOF when modifying reactors in operation

In the engineering centres, the OHF integration organisation defined and implemented would appear to be satisfactory. In the centres inspected, the inspectors therefore found a well-structured and documented action plan and an organisation in place, for instance with the creation of an SOH committee and the appointment of an SOH coordinator.

Evaluating arrangements concerning contractors in the operational activities

With regard to the process for selection of contractors for awarding of contracts, whether in terms of buying policy (for example, possible use of criteria unrelated to price, increase in the average duration of on-site maintenance contracts, etc.), or the qualification system, the inspections revealed no significant anomalies. ASN does however consider that EDF needs to begin to look again at its industrial maintenance and contracting policy, in particular with respect to the adequacy of the industrial fabric for meeting the industrial needs required to ensure the safety of the facilities, and to maintaining the in-house skills needed for essentially subcontracted activities.

With regard to the monitoring of subcontracted activities, ASN considered that EDF has ceased to make any further progress in contractor monitoring since 2009. Significant and repeated deviations have been observed, on the one hand in EDF monitoring of the contractors (tier 1) and on the other in contractor monitoring of the subcontractors (tier 2 or higher). The inspections thus revealed that EDF monitoring of the contractors was sometimes non-existent, in particular during workload peaks. Similarly, the inspections revealed that there were gaps in EDF verification of contractor monitoring of the subcontractors, which was sometimes absent altogether. The quality of the monitoring programmes, designed to ensure the traceability of the monitoring actions (check points and other measures) differs from site to site. Finally, EDF needs to check that the resources allocated to monitoring, in terms of both quantity and quality, are adequate to the activities subcontracted. ASN thus considers that the monitoring of the activities performed by the contractors and subcontractors needs to be rapidly improved and reinforced, in the light of the implications of these activities for safety, radiation protection and environmental protection.

However there is still room for improvement in the organisation of work and the working conditions of the contractor staff. As in the previous years, ASN observed that the material resources made available to the contractors are frequently insufficient or inappropriate which, in certain cases, may have led to a deterioration in the quality of the work and the working conditions, with respect to safety and radiation protection. Furthermore, the life of the contractor staff on the sites is not always made easier, for example, by unsatisfactory conditions on certain sites (for example, cloakrooms with no working showers, no heating in certain premises, etc.). The preliminary check-out meetings, which must be systematic and, prior to any work being done, ensure that the resources available for the work are compatible with the specified requirements, are not always effective enough. Finally, the minimum period of 4 months for placing of orders is not always met, even if certain sites are taking steps to keep the contractor companies informed, at least verbally, of the volume of activity envisaged.

6|1|3 Evaluating and analysing radiation protection

In 2011, ASN carried out twenty-nine specific inspections on the subject of radiation protection, five of which were part of an in-depth review of how the four NPPs on the banks of the Loire integrate radiation protection and the interface between these NPPs and the EDF head office departments (see graphs 2, 3 and 4).

In the light of the various ASN findings during these inspections and the analyses of significant radiation protection events, ASN considers that the radiation protection results of the NPPs in operation have been improved but could be better.

Generally speaking, ASN considers that the radiation protection organisation defined and implemented by the NPPs is on the whole satisfactory.

ASN in particular notes that the industrial radiography operations are well prepared and that the efforts made by EDF since 2010 to give renewed impetus to the ALARA approach on the sites have been maintained.

ASN does however note that the collective dosimetry per reactor rose in 2011 because of a large number of reactor ten-yearly outage inspections. The volume of maintenance work will remain high and may even increase in the coming years. ASN therefore considers that during the future reactor outages, ASN must enhance its efforts to continue to optimise collective and individual dosimetry.

ASN also observes that the prohibited areas access process could still be further improved: accidental entry or failure to lockout prohibited areas are still observed.

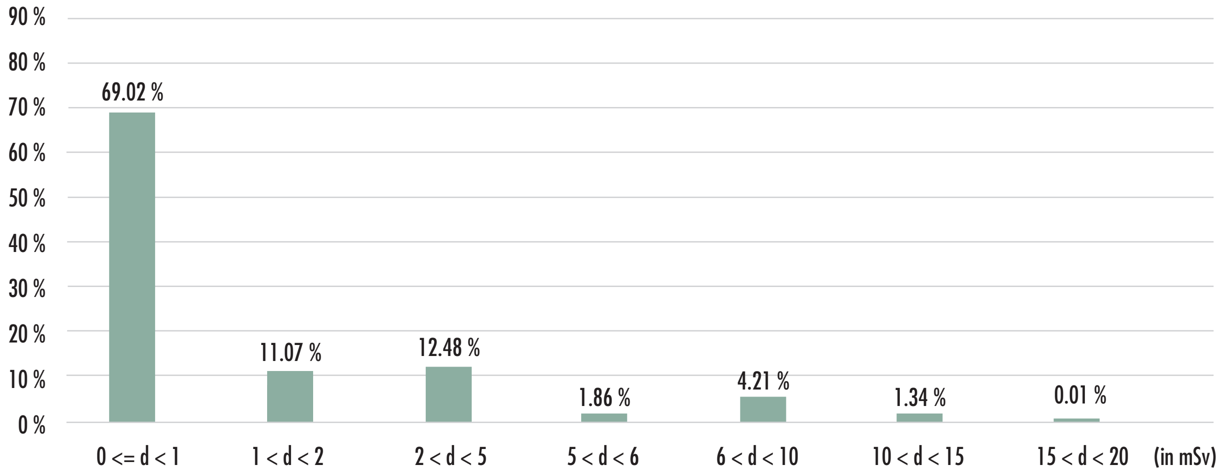
Finally, ASN recalls that EDF needs to improve the quality and the integration of risk analyses, its management of contamination in controlled areas, monitoring of application of radiation protection rules, adequate staffing levels of the radiation protection department present in the field and deployment of experience feedback and good practices to the intervention personnel.

6|1|4 Evaluating health and safety, professional relations and the quality of employment in the nuclear power plants

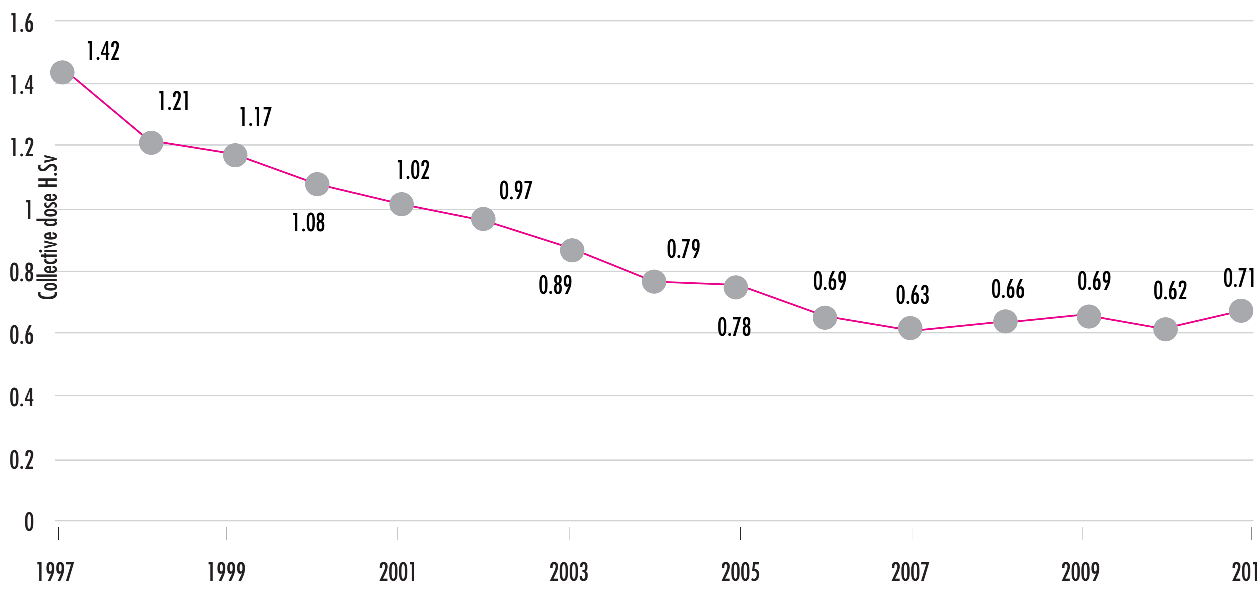
In 2011, the ASN labour inspectorate carried out 580 interventions during the course of about 256 days of inspection in the field, on nuclear power plants under construction, in operation or undergoing decommissioning. It made 1,258 observations and sent six reports to the public prosecutor's offices concerned.

In the field of worker health and safety, the ASN labour inspectorate observed a disparity between EDF workers and subcontractor workers, most of whom work on construction sites and carry out maintenance work, and are more exposed to conventional risks: the frequency of occupational accidents (number of accidents with time off work per million hours of work) for 2011 for all the reactors, was 3.5 for EDF and 4.2 for the subcontractors. However, it should be pointed out that the gap between these frequencies has tended to shrink in recent years (significant drop in the frequency at the subcontractors)

Graph 2: breakdown of the population per dose range over the year 2011 (EDF data)



Graph 3: mean collective dose per reactor (EDF data)



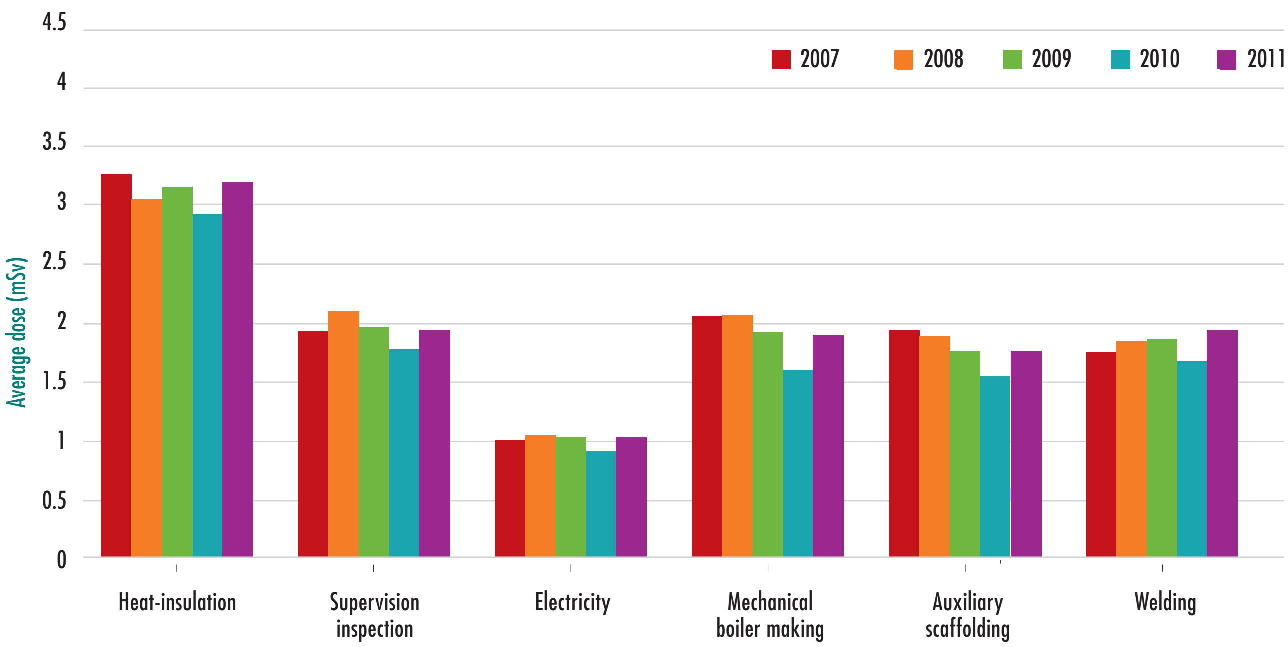
and that these results, which are comparable to those of activities in the service sector, are significantly lower than the average observed in the industry. The ASN labour inspectorate observed noteworthy initiatives on subjects such as lifting or entry into the reactor building with the reactor at power, but considers it essential that EDF develop its occupational risk prevention policy as applicable to work by employees of outside contractors and the prevention plans stipulated by the regulations.

Similarly, in terms of employment, ASN observes differences between EDF employees and those of the subcontractors. It draws the attention of EDF to situations potentially involving abusive subcontracting and illegal loaning of labour, in particular when the services to be performed are inadequately defined with respect to duration or in the event of unforeseen circumstances.

With regard to the evaluation of psycho-social risks (stress), ASN is pleased to note that EDF has begun a nationwide initiative to comply with the regulations. Occasionally and on a limited number of sites, situations resulting from the level of stress generated may be the origin of risks to the level of safety of the facilities and the health of workers.

On the EPR construction site, ASN regrets the inadequate level of safety coordination and supervisory staff given the complexity of the present and future activities, as well as violations with regard to under-notification of occupational

Graph 4: evolution of mean individual dose according to categories of workers involved in reactor maintenance (EDF data)



accidents and concealed work, or following occupational accidents.

With respect to professional relations, the ASN labour inspectorate notes that the institutions representative of the personnel function correctly on the whole, but does however note significant differences across the fleet, with social dialogue sometimes being extremely difficult. Numerous CHSCT use their right of alert in the event of severe and imminent danger during periods of tension: ASN considers that this measure should be reserved for dangerous situations and that EDF does not take sufficient account of alerts and feedback concerning the social climate.

During reactor outages, the working plan adopted to meet the completion deadlines regularly leads to all the sites exceeding the maximum working hours and failing to comply with the rest periods. The ASN labour inspectorate repeatedly observed this type of situation, already notified in formal reports.

Maintenance in the reactor building on the Flamanville site during the reactor 2 outage

Although EDF has made significant efforts to rectify the situation in 2011, by implementing regulation administrative authorisation procedures, its policy must consider all the staff, including the management.

Generally speaking, the situation of the NPPs as seen by the ASN labour inspectorate is felt to be heterogeneous and all aspects could be improved.

6|1|5 Evaluating and analysing environmental protection measures

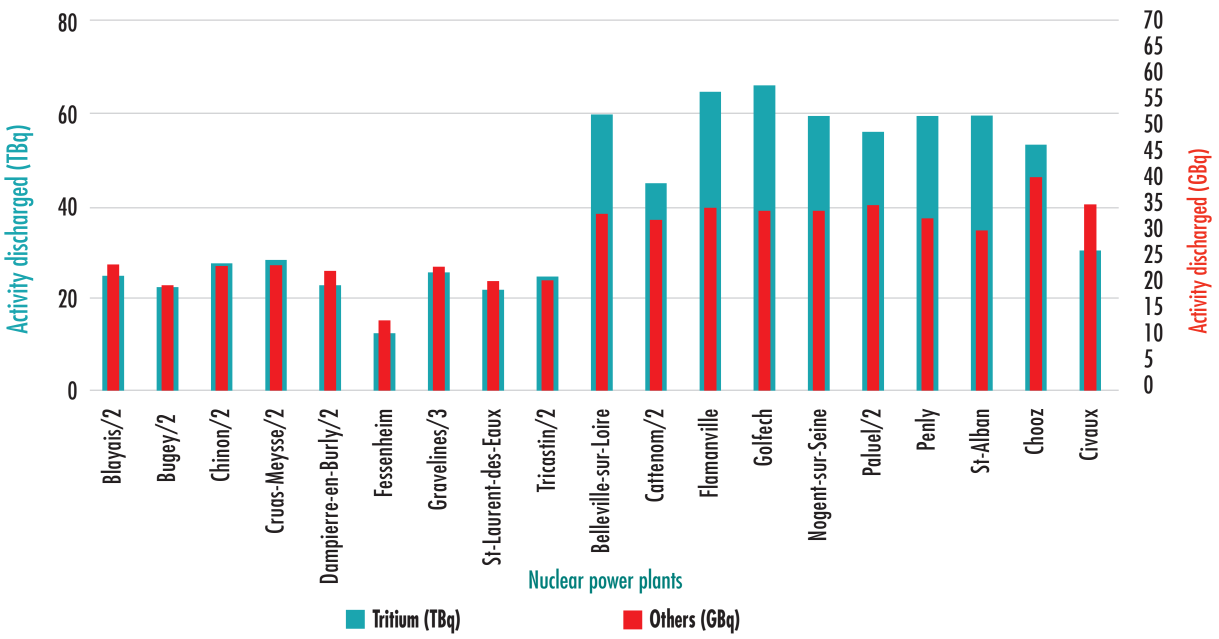
Despite positive moves already noted in 2010 by ASN and a satisfactory environmental organisation on most of the sites, ASN still observes numerous deviations on all the NPPs in operation and performance could be further improved.

In fact, deviations in compliance of installations, in implementation of corrective actions and in monitoring of contractors' activities were all highlighted this year. Furthermore, ASN inspectors observed several discrepancies in the application of the discharge orders and the amended order of 31 December 1999[6], as well as anomalies in the management of waste.

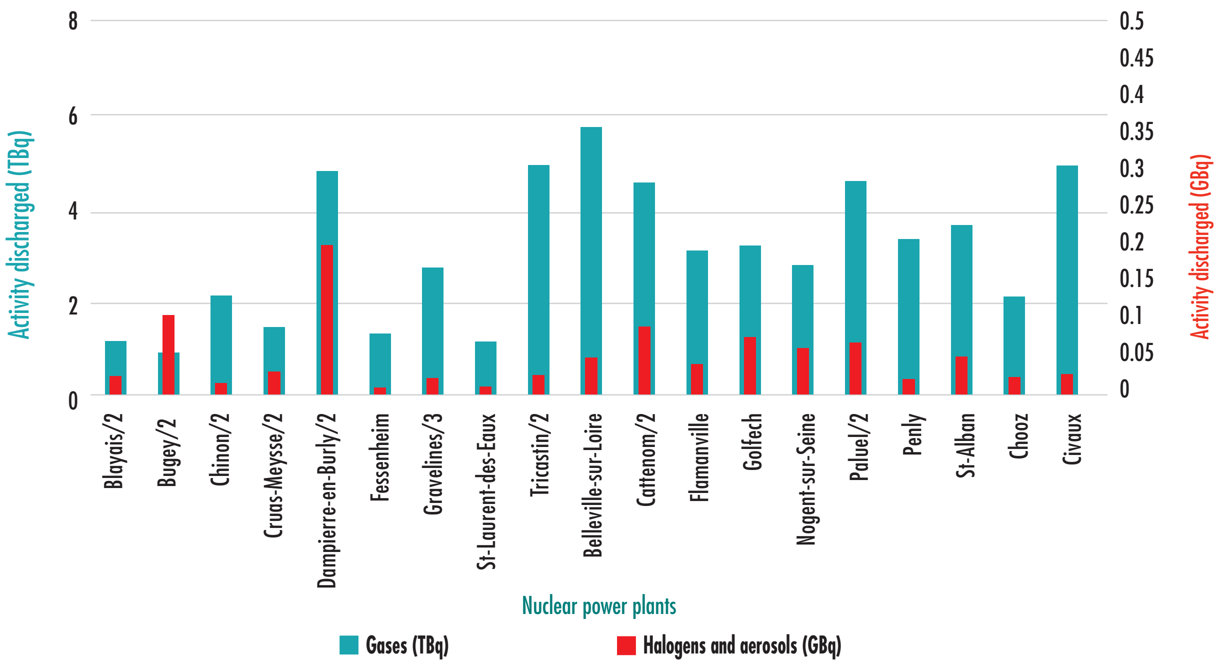
ASN also notes that the steps taken by EDF to improve management of the chiller units does not enable the coolant fluid discharges to atmosphere to be eliminated.

6. The order of 31 December 1999 stipulating the general technical regulations designed to prevent and mitigate the harmful effects and external hazards resulting from operation of basic nuclear installations.

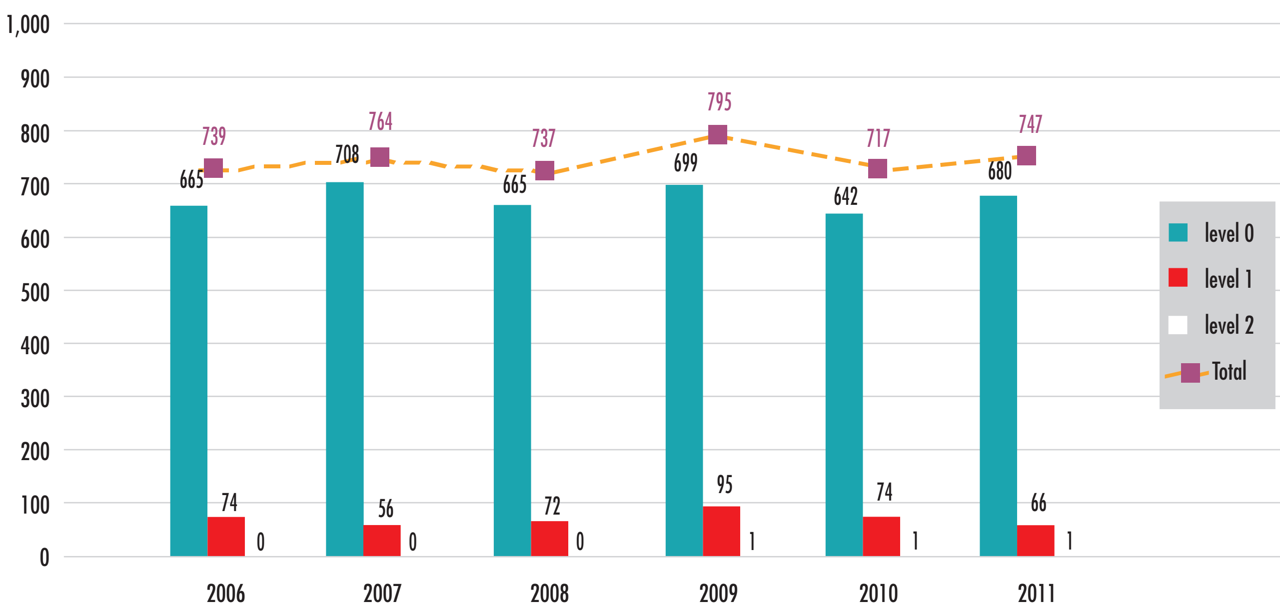
Graph 5: liquid radioactive discharges for the NPPs in 2011



Graph 6: gaseous radioactive discharges for the NPPs in 2011



Graph 7: evolution of the number of significant events rated on the INES scale in EDF nuclear power plants from 2006 to 2011



Radioactive release values

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

The 2011 results concerning radioactive effluent discharges are presented in graphs 5 and 6. Graph 5, ”liquid radioactive discharges”, presents the 2011 discharges of liquid tritium and others (carbon-14, iodine-131, nickel-63 and other beta and gamma emitting radionuclides) per pair of reactors. Graph 6, “gaseous radioactive discharges”, presents the 2011 discharges of gases (carbon-14, tritium and rare gases) as well as halogens and aerosols (iodines and other beta and gamma emitting radionuclides) per pair of reactors.

6|1|6 Analysing statistics on significant events

Significant events in 2011

Under the rules on notification of significant events in the areas of safety, radiation protection and the environment, in 2011 EDF reported 639 significant safety events (ESS), 91 significant radiation protection events (ESR) and 115 significant environmental events (ESE) (involving neither nuclear safety nor radiation protection). 747 events were rated on the INES scale.

Graph 7 shows the trends in the number of significant events reported by EDF and rated on the INES scale since 2006.

Graph 8 shows the trends since 2006 in the number of significant events per area concerned by the notification (ESS, ESR and ESE).

The number of ESS declared increased by about 3% over 2010 and a generic ESS was rated level 2 on the INES scale (see box in point 2|2|2).

The number of ESR is stable in relation to 2010 but down overall since 2007. This is mainly due to continuous improvement in the resources used for protection against ionising radiation. As the body responsible for radiation protection in the NPPs, EDF must oversee the protection and the maintaining of a safety culture amongst its staff as well as amongst contractors’ staff.

The number of ESE is up on last year and remains high in relation to other years. Protection of the environment must remain a central concern for EDF.

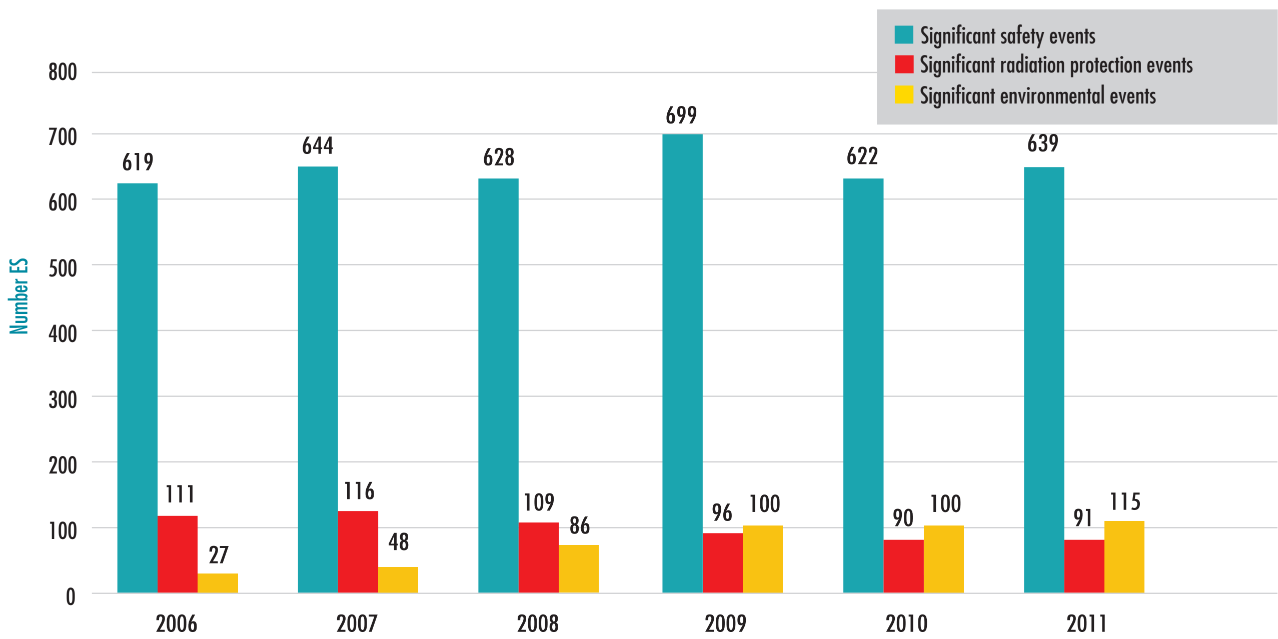
Graph 9 shows the average number of significant events in 2011, rated at levels 0 and 1 on the INES scale, and per standardised plant series. The slightly higher average for the N4 series is mainly due to the fact that reactor outages were more numerous for this series in 2011. The increased amount of maintenance and activity during the outage periods generally contributes to a rise in the number of events.

6|2 Evaluation of each site

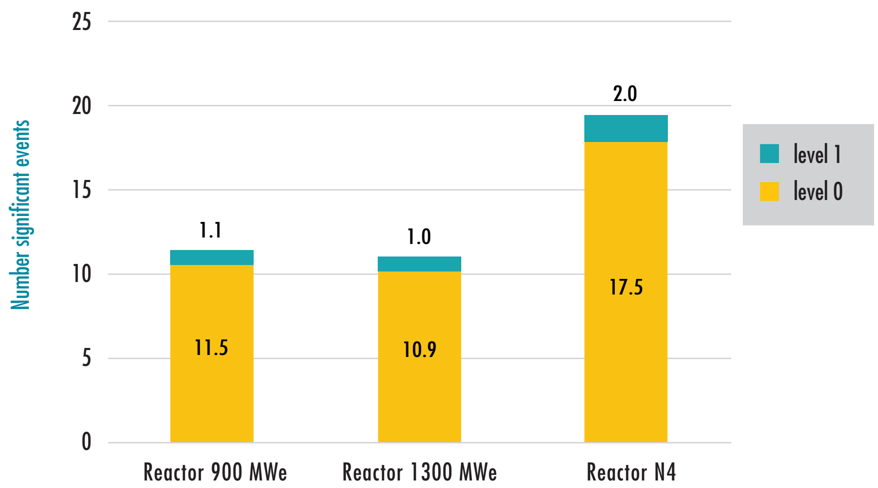
Belleville-sur-Loire

ASN considers that the performance of the Belleville-sur-Loire site is on the whole in line with the general assessment of EDF’s nuclear safety, radiation protection and environmental protection. It considers that on the whole, the safety progress made in 2011 must be continued, in particular with regard to operation of the facilities and the rigorous attitude to maintenance work. With regard to radiation protection, the site

Graph 8: evolution of the number of significant events per domain in EDF nuclear power plants from 2006 to 2011



Graph 9: mean number of significant events rated on the INES scale in EDF NPPs per type of reactor and per year, for 2011



has implemented a number of action plans designed to reinforce the protection measures. These measures were deployed during the outage of reactor 1, during which fuel rod leaks were detected.

Finally, in the field of environmental protection, ASN notes that the performance of the site must progress further, despite the significant measures taken in recent years. The application of the requirements applying to facilities liable to have an impact on the environment must be more rigorous.

During the course of the ASN inspection on the Belleville site as part of the Fukushima experience feedback process, one particular observation was that even if the planned organisation for preventing the risk of flooding appears to be satisfactory, it should nonetheless be tested by means of exercises. With regard to earthquakes, the organisation must also be consolidated by experience feedback from the performance of complete exercises.

Blayais

ASN considers that the nuclear safety and radiation protection performance of the Blayais site on the whole matches ASN's general assessment of EDF, and that the radiation protection performance stands out positively. This is because ASN considers that the site has shown rigour in this area, particularly in the management of controlled areas and dosimetry.

ASN considers that the site must be more rigorous in the preparation, performance and inspection of operating and maintenance activities. Consequently, application of the reliability enhancement practices must be improved.

Finally, despite improved control of discharges, the site must be more rigorous in the tracking and maintenance of the equipment that contributes to environmental protection and monitoring, in order to guarantee compliance with the regulatory requirements.

Following the inspections carried out in response to the Fukushima accident, the overall impression is satisfactory with regard to the "flooding", "cooling – loss of heat sink" and "emergency response organisation and resources" topics. However, the way the "seismic" risk is covered needs to be improved.

Bugey

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

With regard to nuclear safety, ASN notes that in 2011, the quality of operations on the Bugey site showed signs of weakness, as in 2010. ASN in particular considers that significant improvements must be made with respect to lock-out, circuit configuration and compliance with technical operating specifications.

In 2011, the site had to deal with a considerable reactor outage workload, in particular comprising the third ten-yearly inspections for reactors 4 and 5, which lasted 5 and 6 months respectively. The restart of reactor 5 was disrupted by a number of operational incidents related to system configuration deviations delaying reactor production restart by a month.

With regard to radiation protection, ASN notes a slight improvement in the dosimetry of the staff working on the site.

In terms of environmental protection, ASN considers that the site needs to make progress in waste management.

Generally speaking, ASN hopes to see significant progress on the Bugey site in 2012, in terms of operational rigor, following two years marked by large-scale works programmes.

The inspection carried out from 19 to 21 September 2011 following the Fukushima nuclear accident, on the topics of "earthquake", "flooding", "electrical power supplies", "heat sink", "cooling", "on-site emergency plan" and "operational management of emergency situations", proved to be on the whole satisfactory.

Cattenom

ASN considers that the nuclear safety, radiation protection and environmental protection performance of the Cattenom NPP is, on the whole, in line with ASN's general assessment of EDF's performance. ASN in particular considers that occupational radiation protection is improving thanks to the steps taken by the site.

ASN considers that the site is well-prepared for emergency situations. During the site inspection conducted by ASN from 2 to 5 August 2011 to take account of the experience feedback from Fukushima, the management of mobile emergency equipment was found to be satisfactory and the exercises showed good forward planning on the part of those involved. This inspection left a satisfactory impression overall with regard to all the other subjects inspected.

In November 2011, the IAEA carried out a operational safety review (OSART mission) of the Cattenom NPP, the second on the site after that of 1994, which confirmed ASN's opinion of the site.

Chinon

ASN considers that the environmental protection performance of the Chinon NPP is on the whole in line with ASN's general assessment of EDF but that the site's nuclear safety and radiation protection performance need to be improved.

ASN considers that, unlike the rest of the fleet, the Chinon site has made no progress in radiation protection and several significant events and inspection findings have revealed shortcomings in intervention preparation. On several occasions, ASN observed inconsistencies in the limited stay area access permits and in the work site documents. Moreover, the lack of stringency in the performance of operations and in application of the baseline requirements and operating procedures is a point that could be improved. In this respect, a proactive action plan was implemented by the site's management.

During the ASN inspection on the Chinon site, in the presence of two members of the CLI, to take account of experience feedback from Fukushima, prevention of the consequences of and organisation of the response to an earthquake appeared to be tenuous, particularly with respect to the documentation. Heat sink management appeared to be satisfactory. Moreover, the perimeter of the "flooding" exercises needs to be extended, for example to include several reactors.

Chooz

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

ASN considers that the Chooz site stands out with regard to compliance with the regulations on pressure equipment, especially concerning the main primary and secondary systems.

However, ASN believes that the Chooz site must remain attentive to fuel assembly deformation phenomena.

ASN considers that environmental protection performance is below that of its general assessment of the EDF fleet. The Chooz site must in particular exercise greater stringency in monitoring and operating its air cooling tower monochloramine treatment facility and, more generally, the way it considers the risks linked to the use of chemical products.

Following the inspections carried out in response to the Fukushima accident, in the presence of members of the CLI and the Belgian safety regulator, ASN considers that the Chooz NPP needs to improve the organisation of its response to an earthquake. The other topics left a satisfactory impression overall.

Civaux

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

With regard to nuclear safety, ASN notes that certain improvements are required in the preparation and reliability of interventions on the site. It also observes recurrent conformity deviations on earthquake-qualified equipment.

Furthermore, ASN notes that the collective dosimetry remains low despite the numerous work programmes conducted during the 10-year inspection. It nevertheless expects to see improvements in the conditions of implementation of the EVEREST initiative (entry into controlled areas wearing standard working overalls).

ASN considers that the site must remain vigilant in the management of its discharges during low water periods.

Although the inspection carried out following the Fukushima accident did not reveal any major deviations from the applicable baseline requirements in the fields concerned, ASN considers that the Civaux NPP must improve the organisation of its response to an earthquake.

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's performance.

With regard to nuclear safety, the site must continue the efforts made to improve the stringency of operations, in particular by reinforcing its practices to improve reliability during interventions.

With regard to radiation protection, the site once again presented widely contrasting results in 2011: although the gamma radiography inspection results were satisfactory, control of access to limited stay areas needs to be reinforced. ASN also considers that the radiological cleanness of the site needs to be improved.

With regard to environmental protection, ASN once again in 2011 observed that greater account needs to be taken of environmental issues resulting from modifications to the facilities.

In 2011, ASN observed a considerable deterioration in occupational safety conditions and expects tangible measures in this respect in 2012.

Finally, in the light of the delays observed in the training plans, ASN considers that the Cruas-Meysse site needs to improve its skills management processes. Furthermore, monitoring of the contractors working on the site needs to be significantly reinforced.

The inspection carried out from 19 to 21 October 2011 following the Fukushima nuclear accident, on the topics of "earthquake", "electrical power supplies", "heat sink", "cooling", "on-site emergency plan" and "operational management of emergency situations", proved to be on the whole satisfactory.

The extent to which the flooding risk is taken into account by the Cruas-Meysse site does however need to be reinforced.

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's performance.

However, the efforts made to improve the stringency of operations must be continued. In 2011, quality deviations in the preparation for and performance of maintenance operations were also detected.

With regard to occupational safety and radiation protection, breaches of the regulations were once again observed. However, ASN did note the good results achieved by the site and the drop in the number of significant radiation protection events.

The site still stands out in its management of the impact of the facilities on the environment. Optimisation of chemical and radioactive discharges continued in parallel with the use of new discharge and intake licenses.

During the course of the inspection carried out following the Fukushima accident, management of the flooding risk appeared to be on the whole satisfactory. However, the monitoring of nuclear island protection against water ingress does not conform to the applicable rules. Moreover, management of the seismic risk by the Dampierre NPP did not appear to be satisfactory.

Fessenheim

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

During the course of a particularly busy 2011, in particular with the third ten-yearly inspection of reactor 2 and the corresponding outage of reactor 1, ASN observes progress in the maintenance of the facilities and monitoring of the contractors. The licensee took account of the experience feedback from the previous outages.

ASN notes that a considerable amount of equipment was replaced in order to improve the condition of the facilities. Compliance with the technical prescriptions issued by ASN following the third ten-yearly outage inspection of reactor 1 will help raise the level of safety, so that continued operation of this reactor up to 40 years could be envisaged.

However, ASN considers that occupational worker protection is not improving, despite the proposed action plan following ASN's findings in 2010.

Finally, the inspection carried out by ASN from 27 to 30 September 2011 following the Fukushima accident left a highly satisfactory impression with respect to all the topics inspected.

Flamanville

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

ASN considers that the site must continue its efforts in terms of organisation and safety culture. ASN observes significant progress in dealing with the backlog of maintenance work and improving the condition of the facilities. The site must achieve progress in managing reactor outages with respect to reactivity and anticipating technical subjects with safety implications.

The "Fukushima experience feedback" inspection is satisfactory with respect to four of the five topics inspected (management of emergency situations, flooding, electrical power supplies and cooling), but the site needs to improve the way it deal with the "earthquake" topic.

Golfech

ASN considers that the nuclear safety performance of the Golfech NPP is on the whole in line with ASN's general assessment of EDF and that the site's environmental protection and radiation protection performance stand out positively with respect to ASN's general assessment of EDF.

ASN considers that the site must be more rigorous in the preparation, performance and second-level inspection of control operations and in the monitoring of maintenance activities performed by outside contractors. Furthermore, ASN considers that integration of the seismic risk and emergency situation management need to be improved.

ASN notes that the site continues the good radiation protection performance it has displayed for several years now, and ensures satisfactory contamination management in the controlled areas.

Following the "Fukushima experience feedback" inspection, ASN is on the whole satisfied with the electrical power supplies and satisfied with heat sink management.

Gravelines

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

However, ASN considers that the site must progress in the stringency of both the detection and analysis of significant safety events and the maintenance and operation of the reactors. ASN for example asked the licensee to rapidly rectify the deviations on certain equipment items contributing to reactor cooling and which could be affected in the event of an earthquake.

In 2011, EDF initiated the programme of the third ten-yearly outage inspections for the Gravelines NPP. ASN is currently reviewing the results of the checks carried out on reactor 1. The checks highlighted cracking on a reactor vessel bottom-mounted instrumentation penetration, which is the first occurrence of this type for the French NPP fleet (see point 5 | 7).

As part of the Fukushima experience feedback process, the ASN inspection of the Gravelines site, in the presence of members of the CLI, highlighted areas for improvement in the earthquake resistance of certain equipment items and protection against the risk of flooding of the facilities.

ASN notes positive moves by EDF to take account of industrial hazards in the site environment. These efforts should be continued.

2011 was also marked by a fatal occupational accident which occurred when work was being carried out at height.

Nogent-sur-Seine

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

ASN observes that in the Nogent NPP, operational stringency is no longer progressing. 2011 was marked by errors in reading the facility operating rules and failures in the management of equipment lock-outs. ASN also considers that the dissemination of experience feedback among the operating teams needs to be improved.

ASN also considers that contractor monitoring during reactor outages could be better, in terms of both overall management and the resources allocated in the field.

With regard to the environment, ASN considers that efforts were made in 2011, although the progress achieved would seem to be tenuous. Most of the persistent shortcomings concern liquid effluent containers.

The inspections carried out following the Fukushima accident left a satisfactory impression overall. A number of deviations still need to be corrected, mainly concerning the topics of earthquake and flooding.

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's performance.

ASN nonetheless considers that several significant event notifications issue by the site reveal a deterioration in the stringency of operation and maintenance. These deviations reflect inadequacies in the monitoring of activities, the safety culture of the staff and the preparation of interventions involving reactor operations, in particular during the transient shutdown and restart phases.

The topics examined during the "Fukushima experience feedback" inspection are on the whole covered satisfactorily.

ASN considers that the site needs to improve the monitoring and maintenance of the chiller units in the light of the recurring releases of coolant fluids.

Penly

ASN considers that the Penly NPP's nuclear safety performance stands out positively in relation to ASN's general assessment of EDF's performance and that its results for protection of the environment and for radiation protection are on the whole in line with ASN's general assessment of EDF's performance.

The site is continuing the positive developments of previous years and ASN's inspection did not reveal any particular difficulty in the areas of nuclear safety, radiation protection or protection of the environment.

The "Fukushima experience feedback" inspection is satisfactory, but the "earthquake" issue needs to be better addressed.

In the last quarter, reactor 1 underwent its second ten-yearly outage inspection, including regulation hydrotesting of the main primary system and the containment tightness test.

Saint-Alban

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

In 2011, ASN observed that the fundamental requirements issued by EDF at a national level were not being correctly implemented by the site and that the delay built up over the past 3 years in this area is not being made up. ASN also considers that the activation of the independent safety entity and the consideration given to its analyses and recommendations by the site's main decision-making bodies are insufficient.

Concerning the monitoring of pressure equipment, the *Préfet* of the Isère, on the advice of ASN, decided not to renew the approval of the site's inspection department in 2011.

Where radiation protection is concerned, ASN considers that the site's overall performance is in line with ASN's general assessment of EDF's performance. Although access to limited stay and prohibited areas is satisfactory, control of contamination on the worksites during reactor outages needs to be improved.

With regard to environmental protection, ASN considers that the site is under-performing with respect to ASN's general assessment of EDF, as the site for example lacks rigor in its operation of installations classified on environmental protection grounds.

Generally speaking, ASN considers that the Saint-Alban site rapidly needs to take proactive, tangible measures on a scale commensurate with the nature of the problems it has identified.

The inspection carried out from 27 to 29 June 2011 following the Fukushima nuclear accident, on the topics of "earthquake", "flooding", "electrical power supplies", "heat sink", "cooling" and "on-site emergency plan", proved to be on the whole satisfactory. The Saint-Alban site's organisation of operational management of emergency situations nonetheless needs to be reinforced.

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's performance.

However, in terms of safety, ASN considers that the site needs to continue its efforts to remedy the various weak points identified since 2010. In particular, improvements are still needed regarding the quality of the technical checks and the preparation and coordination of the various interventions.

With respect to radiation protection, ASN considers that the site stands out positively concerning its implementation of the EDF baseline standards. ASN also underlines the implementation of complementary requirements in this field by the site. Finally, although the site confirms its progress in terms of management of the radiological cleanness of the work sites, the inspections have shown that the radiation protection culture of the workers involved could still be improved.

During the ASN inspection of the Saint-Laurent site, in the presence of two members of the CLI and with regard to integrating experience feedback from Fukushima, one particular finding was that certain parts of some of the documents concerning the flood risk needed to be completed. It was considered that the organisation set up to analyse and utilise the recordings characterising an earthquake, to evaluate the level of an earthquake and to implement the appropriate measures could be better.

Tricastin

ASN considers that the Tricastin site stands out positively with regard to its nuclear safety performance in relation to ASN's general assessment of EDF's performance.

ASN does however consider that progress needs to be made in the activation of the independent safety entity and in the quality of the risk analyses associated with requests for temporary waivers to the general operating rules.

Where radiation protection is concerned, ASN considers that the site's overall performance is in line with ASN's general assessment of EDF's performance. Progress is however still needed concerning the regulation checks on radiation protection measuring instruments.

With regard to environmental protection, ASN in 2011 observed deviations concerning compliance with its decisions relative to the operation of site equipment, in particular including installations classified on environmental protection grounds. In 2012, ASN also expects significant progress in responsiveness when an anomaly is detected.

In 2011, ASN noted an improvement in the occupational safety results, which were found to be clearly inadequate in 2010. ASN however considers that site progress in this area remains tenuous.

Finally, ASN notes that in February 2011, Tricastin notified an event rated 2 on the INES scale concerning the premature wear of certain parts of the diesel emergency generator sets.

The inspection, carried out from 3 to 5 October 2011 following the Fukushima nuclear accident, on the topics of "earthquake", "flooding", "electrical power supplies", "heat sink", "cooling" and "on-site emergency plan", proved to be on the whole satisfactory. The Tricastin site's organisation of the operational management of emergency situations nonetheless needs to be reinforced.

New reactors

6|3 Evaluating EPR Flamanville 3 reactor construction

Quality management associated with construction activities on the Flamanville 3 site

Following the inspections carried out in 2011 and the review of the deviations notified by EDF, ASN considers that EDF's organisation on the Flamanville 3 construction site is on the whole satisfactory. ASN in particular notes that the action plan initially implemented to guarantee the quality of welding of the liner has gradually been extended to cover other welding activities on safety-related equipment and has produced satisfactory results so far. ASN has a positive opinion of the quality of the technical exchanges during the inspections.

ASN does however note that some of the more complex civil engineering activities led to a higher number of repairs and anomalies than the more routine activities. These deviations were in particular due to shortcomings in the risk analysis of these activities, a lack of safety culture on the part of the workers involved and shortcomings in EDF's monitoring of these activities. ASN considers that EDF was able to provide satisfactory answers and evidence in response to ASN's requests. ASN does however also consider that EDF must ensure that all the action plans implemented on the construction site at ASN's request following deviations, are particularly closely monitored so that the actions defined are maintained on a long-term basis, to ensure the quality of the construction of the EPR reactor.

Quality management associated with design and manufacturing activities in the workshops of the structure, system and component suppliers

During its inspections, ASN observed that the organisation put into place in the various EDF departments, whether for engineering or the teams in charge of monitoring the activities performed by its contractors, was on the whole satisfactory and showed signs of improvement with respect to previous years. Anomalies were nonetheless observed relating to identification of quality-related activities and errors in the traceability of monitoring actions carried out by EDF. Based on ASN observations in 2010, EDF took various steps: overall review of quality-related activities, action plan to improve monitoring of the design office to which EDF entrusts the detailed civil engineering design and manufacturing studies for the systems and components not used in the construction of the NSSS, and analysis of experience feedback about the organisation put into place for examination and centralisation of deviations and technical code waivers. EDF has undertaken to present a summary of these measures to ASN in the very near future.

Moreover, in the light of the conditions in which certain system and component manufacturing operations are initiated by the subcontractors, ASN considers that EDF will need to make considerable efforts to demonstrate that the equipment manufactured meets the requirements of the safety demonstration. This subject is dealt with in more detail as part of management of the follow-up to the in-depth inspection of activities subcontracted to AREVA (see point 5|2 of chapter 12).

Organisational and human factors

ASN sought the opinion of the advisory committee for reactors (GPR) regarding the principles of organisation and the human resources planned by EDF for operation of the Flamanville EPR reactor. The results of EDF's first test campaigns on a simulator in 2010 are inconclusive with regard to some of the essential elements of the safety demonstration and will be supplemented by another campaign.

During its 2011 inspections, ASN also checked the training and safety culture awareness-raising measures from which the construction site workers benefited. ASN considers that care must be given to ensuring that the workers are aware of the importance of the quality of construction and the steps that contribute to this quality, for example when technically particularly demanding. On two occasions in 2011, ASN thus asked EDF to improve the training and awareness-raising measures from which the workers benefited.

EPR simulator

7 OUTLOOK

With regard to NPPs, ASN's regulatory and inspection duties in 2012 will be primarily concerned with the subjects presented below:

7|1 Regulation of the EPR and actions relating to new reactors

Regulation of the EPR reactor

Surveillance of construction of the Flamanville 3 EPR will continue until authorisation for commissioning of the installation. EDF at present anticipates initial operation at rated power in 2016. Between now and then, ASN will be continuing its monitoring of occupational accident risk prevention, EDF's surveillance of the quality of construction, both for the work done on the site and for the manufacturing work done by EDF suppliers and the manufacturing of nuclear pressure equipment. At the same time, ASN will be continuing its advance review of certain elements of the commissioning application file, together with the Advisory committee for reactors and, for the reactors in operation, will examine the hard core requested by ASN further to the complementary safety assessments. ASN will develop the regulation tools necessary for managing the preparation and inspection of the facility start-up tests and the final review of the commissioning authorisation application file. ASN will carry out these steps jointly with its counterparts also involved in the project.

Other actions relating to new reactors

Subsequent to the statement by WENRA published in November 2010 on the safety objectives for new reactors, ASN will contribute to actions aiming to promote these objectives in the worldwide thinking on these subjects initiated by the IAEA or within the MDEP framework. Moreover, ASN will continue to work within WENRA on the development of common positions on subjects resulting from these safety objectives and that warrant clarification.

7|2 Labour inspection

ASN will ensure that labour inspection officers are regularly present in the field, in particular for construction and maintenance site activities.

Following the deviations observed on the sites since 2009 with regard to the maximum working hours overruns and the insufficient rest periods, but also EDF's 2011 implementation of a policy of early planning of working hours during reactor outages, ASN will be particularly attentive to tangible measures affecting working hours, in particular for the management. It will continue its inspections in this area to evaluate the undertakings, assess their actual implementation and penalise any deviations observed.

ASN will focus on implementing the measures defined in the 2012 action plan from the Ministry for Labour concerning labour inspection duties, as well as in the national occupational health and safety plan, by emphasising health and safety, quality of employment, social dialogue and combating illegal labour. In the second half of the year, it will be taking part in the European campaign to prevent stress-related risks.

Finally, with a view to developing an integrated view of safety, the ASN labour inspectors will be associated and coordinated with other ASN regulation and monitoring actions, for example in the field of subcontracted maintenance.

7|3 Radiation protection and protection of the environment

Radiation protection

ASN expects of EDF that it strengthen its radiation protection policy with, notably, better preparation of interventions and progress in controlling contamination at source.

The Authority will be attentive to compliance on these different aspects in the files it will be examining, and during on-site inspections. Following on from the wide-ranging inspection carried out in 2011 on the four Loire Valley sites (Belleville-sur-Loire, Dampierre, Saint-Laurent-des-Eaux and Chinon), ASN will carry out further in-depth inspections in order to continue with its detailed assessment of the radiation protection measures taken by EDF.

Environmental Protection

In 2012, once it has received the files from EDF, ASN will begin its review of the effluent discharge and water intake license renewal files for the Bugey and then Fessenheim sites, the provisions of these licenses being currently specified in relatively old orders. ASN will ensure that the discharge limits are set for these two sites according to the best available techniques and taking account of experience feedback from the NPPs in operation.

ASN will continue to review the effluent discharge and water intake modification files for Cruas-Meysse and Belleville and will begin those of Saint-Alban, Cattenom and Paluel.

It will continue to work with the licensee to optimise discharges, in accordance with the measures decided on following the meeting of the Advisory Committee for reactors in 2006 concerning the management of radioactive effluents and chemical effluents associated with the French NPPs in operation. ASN will continue to review the files concerning steam generator cleaning, management of cleaning effluents and the fate of the used generators.

It will also devote efforts in the field to checking that the measures envisaged by EDF to tackle legionnaire's disease, but also to reduce coolant fluid emissions and to replace chiller units, are actually implemented on the sites.

Finally, ASN will continue to ensure that account is taken of the experience feedback from the SOCATRI and FBFC events, by analysing the further steps taken by EDF and by means of targeted inspections.

7|4 Hazard prevention

Preventing fires and explosions

ASN will check compliance with the requirements concerning management of the fire and explosion risks in the files it will be reviewing and in its site inspections.

With regard to checking integration of the fire risk, ASN will be particularly attentive to the steps taken by EDF with regard to management of fire sectoring and management of fire loads.

With regard to the explosion risk, ASN will for example be carrying out inspections to continue to monitor the steps taken by EDF following the ASN decision concerning management of the risk of NPP on-site explosions (decision 2008-DC-0118 of 13 November 2008), as well as compliance with the requirements of the regulations concerning occupational safety in an explosive atmosphere (ATEX).

Flood prevention

In 2012, ASN will submit the draft guidelines on protection of BNIs against external flooding to the advisory committees for reactors, laboratories and plants. These draft guidelines were produced by a working group which, between 2006 and 2009, brought together ASN, IRSN, the nuclear industry licensees and experts from the field of hydrology. Public consultation on this project was organised in 2010.

7|5 1,300 MWe and 1,450 MWe reactor containment

A GPR meeting is planned for late 2012 to look at the issues of the 1,300 MWe and 1,450 MWe reactor containment, in particular in the run-up to the third ten-yearly outage inspections for the 1,300 MWe reactors. The GPR will in particular examine the double-wall containment, the double-wall containment internal ventilation system, the containment penetrations, the containment extensions and the corresponding bypass risks, as well as the behaviour of the auxiliary buildings.

7|6 Review of safety associated with ten-yearly outages

In 2012, ASN will attentively continue its examination of the safety reviews of NPPs that are associated with the ten-yearly outages. ASN considers this step to be crucial in gaining a precise understanding of the condition of the reactors, but also for continuously improving the safety of the facilities. One year after the end of each ten-yearly inspection, ASN will issue its opinion on the ability of each reactor to continue to operate and, as necessary, will specify the technical requirements needed to manage and monitor this continued operation. In 2012, ASN will make its position known following the third ten-yearly inspections of Bugey reactors 2, 4 and 5, Dampierre 1 and Tricastin 2.

7|7 Continuing operation beyond 40 years

As EDF has indicated its desire to extend the operating life of its reactors up to 60 years, ASN will pursue its examination of the possible conditions for extension of their operation. In 2012, following a meeting of the GPR concerning the programme of study and work proposed by EDF with a view to extending reactor operations, ASN will make its position known. For ASN, extension of reactor operations beyond forty years can only be envisaged if it is associated with a proactive and far-reaching programme for improved safety that is in line with the safety objectives adopted for new reactors and with best international practice.

7|8 Complementary safety assessments following the Fukushima accident

ASN will issue technical requirements to EDF as a result of its analysis of the complementary safety assessments. The purpose of these requirements will be to cover all the technical topics resulting from the analysis of the Fukushima accident, for example with regard to the robustness of the facilities to earthquake and flooding, to loss of electrical sources or heat sink, severe accident management, consideration of human and organisational factors and subcontracting.

In addition, the action taken further to the 2011 inspections in response to this accident will be checked in 2012, either as part of the normal programme of ASN inspections, or during the course of specific inspections.

ASN will draw the conclusions of the ongoing European peer-reviews, in which it is a participant and one objective of which is to compare the requirements stipulated by the safety regulators or the measures proposed by the foreign licensees.

It will take part in international experience feedback on the subject, paying particular attention to understanding of the accident, management of the operations to regain control of the facility, decommissioning and decontaminating the facility and making it safe.

ASN will make modifications to its programme to update the baseline safety requirements applicable to the design of new nuclear facilities, but also, as part of the periodic safety reviews, for the facilities currently in operation.

ASN will contribute to the expression of R&D requirements to be added in the medium term to the applicable baseline safety requirements for the prevention of this type of accident and to improvements in the understanding of severe accidents and post-accident management.