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Regulating nuclear power plants (NPPs) is one of ASN's fundamental duties. The nuclear power generating reactors are 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 French reactors are technically similar to each other owing to the standardisation of the fleet and are today operated by *Électricité de France* (EDF). This licensee's industrial policy choices have led it to entrust a significant part of reactor maintenance work to outside contractors.

ASN requires the highest level of safety standards for regulating NPPs and adapts the standards continuously in the light of new knowledge. Controlling and regulating the reactors, both those operating currently and those planned for the future, is the daily task of around 200 members of ASN staff working in the Nuclear Power Plant Department and the Nuclear Pressure Equipment Department, 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).

ASN is developing an integrated approach to regulation that covers not only the design of new facilities, their construction, modifications, integration of feedback on events or maintenance problems but also, via the expertise its inspectors have built up, fields such as human and organisational factors, radiation protection, the environment, worker safety and the application of labour legislation. Lastly, ASN supplements its judgement by examining the links between safety and competitiveness. This integrated approach allows ASN to develop a finer appreciation and decide on its position each year with regard to the current status of nuclear safety and radiation protection in NPPs.

1 OVERVIEW OF NUCLEAR POWER PLANTS

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 (today AREVA), 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-Meysses 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.

The standardisation of the French nuclear power generating reactors has not proven to be an obstacle to the introduction of a number of technological upgrades during the design and construction of the NPPs currently in operation.

The CPY reactors differ from the CP0 series in building design and in 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.

In relation to the CPY series, the increased power of the 1,300 MWe reactors entailed a primary system with four Steam

Generators (SG) offering higher cooling capacity than on the 900 MWe reactors, which each have three steam generators. The core protection circuits and systems and the design of the buildings housing the facility have undergone significant changes, such as the reactor containment which consists of a double concrete wall instead of a single wall with a steel liner, as on the 900 MWe reactors. The P'4 reactors differ slightly from the P4 reactors, notably with regard to the fuel storage building.

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

Lastly, a 1,650 MWe type EPR pressurised water reactor is being built at Flamanville, a site which already houses two 1,300 MWe reactors.

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 power 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 reactor vessel, the reactor coolant system, the steam generators and the circuits and systems ensuring 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 these systems: primary effluent 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, used to store new and spent fuel assemblies (one third or one quarter of the fuel is replaced every 12 to 18 months depending on the reactor operating modes). The fuel is kept submerged in cells in the pool. The pool water, mixed with boric acid, on the one hand absorbs the neutrons emitted by the nuclei of the fissile elements to avoid sustaining nuclear fission and, on the other, acts as a radiological barrier.

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 operation situations and accident situations. There are generally three of these barriers, consisting of the fuel cladding (see point 1 | 1 | 2) for the first barrier, the main primary and secondary systems (see point 1 | 1 | 3) for the second barrier and the reactor building containment (see point 1 | 1 | 5) for the third barrier.

1 | 1 | 2 Core, fuel and fuel management

The reactor core consists of rods containing uranium oxide pellets or mixed uranium and plutonium oxides (fuel referred to as MOX) contained in closed metal tubes, referred to as the “cladding”, grouped into 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 reactor coolant system water enters the core from below at a temperature of about 285°C, heats as it flows up along the fuel rods and exits through the top at a temperature of about 320°C.

At the beginning of the operating cycle, the core has a considerable energy reserve. This gradually falls during the cycle, as the fissile nuclei disappear. The chain reaction, and hence the reactor power, is controlled by:

- inserting control rod assembly clusters, containing elements that absorb neutrons, to varying depths in the core. These enable the reactor to be started and stopped and its power level to be adjusted to the electrical power to be produced.

Falling of the 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 manufacturers 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.

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 which produces electricity, without 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 pump (known as the 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 secondary system water via the steam generators. The SGs are exchangers which contain from 3,500 to 5,600 tubes, depending on the model, through which the primary reactor coolant 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

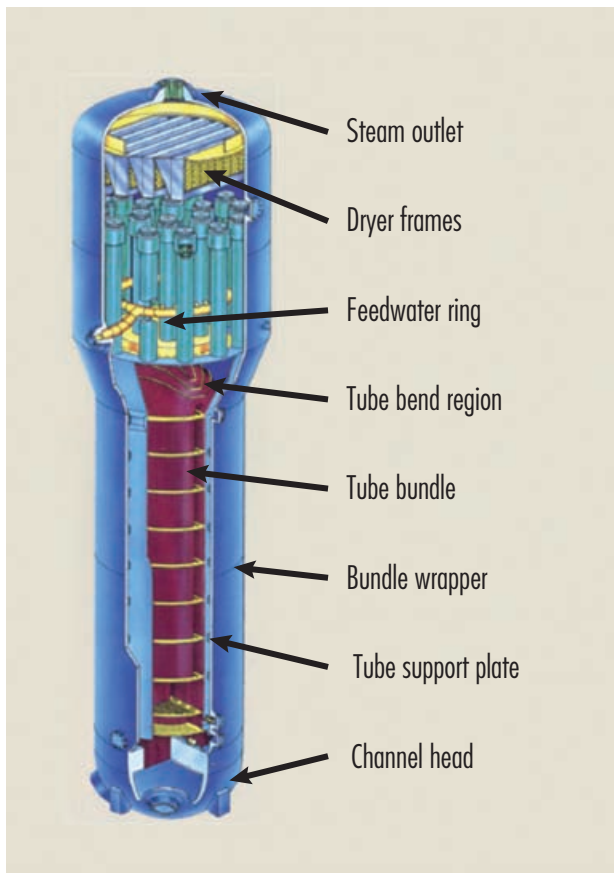


Diagram of a steam generator

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 separators before final expansion in the low-pressure turbines, from which it is then routed to the condenser. The condensed water is then heated and sent back to the steam generators by the extraction pumps relayed by feed pumps through reheaters.

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 with thousands of tubes through which cold water circulates after being taken from the external source (sea or river) or from an atmospheric cooling system. When the steam comes into contact with the tubes it condenses and can be returned in liquid form to the steam generators. 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 high in relation to the sensitivity of the environment, cooled in a cooling tower (closed or semi-closed circuit).

The cooling systems are environments favourable to the development of pathogenic micro-organisms. The use of titanium or stainless steel as construction material for riverside reactor condensers, in the place of brass, which had a natural effect on limiting the proliferation of micro-organisms, requires the use of biocidal treatment or other means of disinfection, for

example UV radiation, to prevent the proliferation of amoeba. Cooling towers contribute to the atmospheric dispersal of legionella bacterial, whose proliferation can be prevented by reinforced maintenance of the works (descaling, implementation of biocidal treatment, etc.).

1.1.5 Reactor containment building

The PWR containment building has two functions:

- protection of the reactor against external hazards;
- confinement, thereby protecting the public and the environment against radioactive products likely to be dispersed outside the primary system in the event of an accident. The containments are therefore designed to withstand the pressures and temperatures that could result from the most severe reactor loss of coolant accident and offer sufficient leaktightness in such 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 offers mechanical resistance to pressure, as well as structural integrity with regard to an external hazard. Leaktightness is ensured by a thin metal liner on the inside of the concrete wall;
- the 1,300 MWe and 1,450 MWe reactor containments, comprising two walls, an inner wall made of pre-stressed concrete and an outer wall made of reinforced concrete. Leaktightness is provided by the inner wall and the ventilation system (EDE) which in the annular space between the walls channels any radioactive fluids and fission products that could come from inside the containment as a result of an accident. Resistance to external hazards is mainly ensured by the outer wall.



Reactor buildings of the Paluel NPP

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 ensure 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 systems important for safety

The other main systems or circuits important for safety and required for reactor operation are:

- 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 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 circuit;
- the reactor cavity and spent fuel pool cooling and treatment system (PTR), used notably to remove residual heat from fuel elements stored in the fuel storage pool;
- the ventilation systems, which confine radioactive materials by depressurising the premises and filtering all discharges;
- the fire-fighting water systems;
- the I&C system, the electrical systems, etc.

2 NUCLEAR SAFETY

2|1 Reactor operation and control

2|1|1 Operation under normal conditions: ensuring compliance with baseline requirements and examining changes to documents and hardware

Changing Technical Operating Specifications (STE)

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.

This in particular concerns 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.

Chapter III of the General Operating Rules (RGE) contains reactor technical operating specifications (STE). They determine the

normal operating limits of the reactor, in particular the acceptable range of operating parameters (pressures, temperatures, 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.

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. Moreover, when EDF is required to deviate from the normal operation stipulated by the STE, during an operating phase or maintenance work, it must notify ASN of a temporary modification of the STE. ASN examines these temporary or permanent modifications, with the technical support of IRSN, and may approve them, subject if need be to the implementation of additional measures if it considers those proposed by the licensee to be inadequate.

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.

Examination of modifications made to the equipment

EDF periodically makes changes to equipment, for instance as a result of processing of deviations, periodic safety reviews or the integration of operating experience feedback.

The decree of 2nd November 2007 defines the requirements concerning implementation of changes by EDF and their review by ASN. In 2012, the equipment modification notifications received by ASN mainly concerned improvements to the safety



Check on individual training logs during an ASN inspection in the Le Blayais NPP – October 2012



ASN inspection at the Bugey NPP – May 2012

level of the reactors, correction of deviations and the implementation of equipment-related provisions as a result of the stress tests (see point 5 | 1).

Field inspections of normal operation

During NPP inspections, 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.

2 | 1 | 2 Incident or accident operations

Chapter VI of the RGE specifies what action is to be taken in the event of an incident or accident situation affecting a reactor in order to maintain or restore the fundamental safety functions (reactivity control, cooling, confinement of radioactive products). It consists of a set of reactor operating rules applicable in these situations. ASN must be notified of any modification of these documents. These rules are then implemented in the operating procedures applied by the operators to return the reactor to and keep it in a stable state.

ASN examines the modifications of which it is notified by the licensee, in particular on the occasion of the reactor periodic safety reviews. Some changes to operating procedures are the result of equipment modifications to be incorporated during the ten-yearly outages. Others are the result of operating experience feedback or are in response to ASN requests for improved safety.

Inspections on the topic of incident or accident operations are regularly performed on the sites. 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.

2 | 1 | 3 Operation in a severe accident situation

If the reactor cannot be brought to a stable condition after an incident or accident and if a series of failures leads to core degradation, the reactor is said to be entering a severe accident situation. To deal with this type of highly unlikely situation, various steps are taken to enable the operators to maintain containment integrity in order to minimise the consequences of the accident (see point 1 | 3 | 1 of chapter 5). In such situations, the operators rely on the skills of the emergency response teams set up at both local and national level. These emergency teams may in particular use the Severe Accident Management Guidelines (GIAG).

2 | 2 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,



ASN inspection of accident operations in the Le Blayais NPP (controlled area) – October 2012



Maintenance work during the Paluel NPP reactor 3 outage – June 2012

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 lasts several months and 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 as part of the periodic safety reviews (see point 4 | 3 | 4).

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 baseline requirements. ASN will give its opinion on this programme;

- during the outage - through regular briefings and inspections
 - the implementation of the programme and the handling of any unforeseen circumstances;
- 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 will either authorise reactor restart, or not;
- after the reactor restarts, the results of all tests carried out during the outage and after restart.

2|3 Maintenance and testing

2|3|1 Regulating maintenance practices

ASN considers that maintenance is an essential line of defence in preventing the occurrence of deviations and in maintaining the conformity of a facility with its baseline safety requirements.

EDF's current maintenance policy is to reinforce the competitiveness of the nuclear reactors without degrading their level of safety. This mainly involves focusing maintenance operations on those equipment items for which a failure has the greatest nuclear safety, radiation protection and environmental protection implications.

EDF has defined several methodologies, in the light of best practice from industry and from foreign NPP licensees.

Each methodology was reviewed by ASN, with the technical support of IRSN:

- reliability-based maintenance optimisation, which enables the type of maintenance required to be defined according to the safety consequences of the failure modes of a system;
- condition-based maintenance, which focuses on monitoring equipment to detect early-warning signs of a failure, is a means of limiting intrusive operations which are a source of doses for the staff and entail a risk of errors in reassembly. However, ASN has reminded EDF that this method may lead to failure to detect a new or unexpected fault, and has therefore asked EDF to back up its deployment by maintaining systematic periodic inspections for certain items of equipment;
- pilot equipment maintenance, which reduces the number of items on which maintenance is required by performing complete checks on only some of them, which are representative of the entire equipment family. ASN has also reminded EDF of the need to question the validity of this approach if deterioration is discovered or in the event of repairs that could compromise the uniformity of a family of equipment.

In 2010, EDF informed ASN of its intention to switch in the near future to a new maintenance methodology, the AP913. This methodology was developed in 2001 by the Institute of Nuclear Power Operations (INPO) working with American licensees. It leads to modification of both the format and content of the maintenance programmes for equipment important for nuclear safety, radiation protection and protection of the environment. This methodology is currently being deployed in certain EDF NPPs and is being examined by ASN with the technical assistance of IRSN.

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

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

Based on the results of the qualification, this entity, called the Qualification Commission (accredited by COFRAC since 2001), confirms that the examination method does actually meet the specified performance levels. As applicable, the aim is either to demonstrate that the inspection technique used allows detection of deterioration as described in the specifications, or to explain the performance of the method.

To date, 90 applications have been qualified by the in-service inspection programmes. Further applications are currently being developed and qualified in order to address new requirements, in particular concerning the Flamanville 3 EPR reactor, for which the 39 processes to be implemented during the pre-service inspection will be qualified by mid-2013.

Owing to the radiological risks linked to gamma radiography, ultrasound applications are preferred to radiography applications, provided that they can offer equivalent inspection performance.

2|3|3 Examining the periodic test programmes and monitoring their implementation

Any element considered to be important for nuclear safety, radiation protection or protection of the environment, undergoes periodic tests in accordance with the programmes of chapter IX of the RGE. These inspections guarantee the continuous performance of the functions assigned to these elements at qualification for the situations in which they are needed, particularly in the event of an accident.

ASN ensures that the periodic technical checks on these elements defined by the licensee are pertinent and are continuously improved.

2|4 Fuel

2|4|1 Controlling fuel management changes

In order to enhance the availability and performance of reactors in operation, EDF, together with the nuclear fuel manufacturers, researches and develops improvements to fuels and their use in the reactor; this is known as “fuel management” (see point 1|1|2).

ASN ensures that each change in fuel management is the subject of a specific reactor safety case, 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. When significant changes are made to fuel management, its implementation is dependent on a resolution being issued by the ASN Commission.



Fuel storage pool during the ten-yearly outage of production unit 3 in the Cattenom NPP – February 2011

2|4|2 Monitoring fuel integrity in the reactor

Fuel behaviour is an essential element of the safety case for the core in normal operation or accident conditions 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. Any rise in this activity level beyond predetermined thresholds is the sign of a loss in fuel assembly leaktightness. If the activity level becomes too high, application of the RGE leads to reactor shutdown before the end of the normal cycle. During shutdown, EDF must look for and identify the assemblies containing leaky rods, which must not then be reloaded.

ASN ensures that EDF looks for and analyses the causes of the loss of leaktightness observed and deploys the means for examining the defective rods in order to determine the origin of the failures and remedy it. Preventive and remedial actions may therefore concern 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 pools 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 its fuel assembly suppliers in order to guarantee that assembly design and manufacture comply with the rules established. Finally, ASN periodically calls on the Advisory Committee for nuclear reactors (GPR) concerning the lessons learned from fuel operating experience feedback.

2|5 Regulating pressure equipment

Owing to the energy that it could release in the event of failure, irrespective of the possibly hazardous nature of the fluid that would then be released, pressure equipment entails risks that

must be kept under control. Such equipment (tanks, heat exchangers, pipes, etc.) is not specific to the nuclear industry. It is found in many sectors of activity such as the chemical and oil industries, in paper making and in the refrigeration industry. It is therefore subject to regulations set by the Ministry in charge of the prevention of technological risks, which imposes the requirements with a view to guaranteeing the safe manufacture and operation of this equipment.

Nuclear Pressure Equipment (ESPN) is pressure equipment specifically designed for installation 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 entails a three-fold risk in the event of failure: the risk 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 an accident from being brought under control.

The regulations applicable to ESPN and in particular the order of 12th December 2005, take account of the regulations which apply to conventional pressure equipment and those which apply to the safety of nuclear facilities. They are an integral part of the nuclear safety rules and concern the design, the manufacture and the in-service monitoring of this equipment.

2|5|1 Monitoring the main primary and secondary systems

The Reactor Main Primary and Secondary Systems (CPP and CSP), collectively referred to as the Nuclear Steam Supply System (NSSS), are fundamental components of a reactor. They operate at high temperature and high pressure and contribute to all the fundamental safety functions: containment, cooling, reactivity control.

Surveillance of the operation of these systems is regulated by the order of 10th November 1999, mentioned in point 3|6 of chapter 3. These systems are thus the subject of close surveillance and extensive maintenance by EDF, along with intense monitoring on the part of ASN. All the surveillance programmes established by EDF for this equipment are examined by ASN, which may ask that they be supplemented.

ASN carries out inspections concerning the implementation of equipment maintenance measures, in particular during reactor outages. ASN also examines the inspection results transmitted at the end of each outage.

This equipment also undergoes periodic re-qualification every ten years, consisting of numerous non-destructive examinations of the equipment, pressurised hydrotesting and verification of the good condition and good operation of the over-pressure protection accessories. During the course of 2012, six reactors underwent periodic re-qualification of their main primary system and ten underwent requalification of the main secondary systems.

2|5|2 Monitoring of nickel-based alloy zones

Several parts of a pressurised water reactor are made from nickel-based alloys: tubes, partition plate, primary side coating of

the steam generators tubesheet, vessel closure head adapters, bottom-mounted instrumentation penetrations, vessel internals lower guide support welds, SG drains for 1,300 MWe reactors and repaired vessel nozzle areas.

The use of this type of alloy is justified by its high degree of 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. This can lead to the appearance of cracking, sometimes rapidly, as seen on the steam generator tubes in the early 1980s, or on the 1,300 MWe reactor pressuriser instrumentation taps at the end of the 1980s.

ASN asked EDF to adopt an overall monitoring and maintenance approach for the zones concerned. Several main primary system zones made of Inconel 600 alloy are thus subject to special monitoring. For each one, the in-service monitoring programme, defined and updated annually by the licensee, has to meet requirements concerning the inspection objectives and frequencies. In addition the SGs are the subject of a major replacement programme (see point 2|5|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. Consequently, all the SGs equipped with an Inconel 600 alloy partition plate are thus checked before the reactor third ten-yearly outage.

At the end of 2012, 11 SG partition plates showed signs of stress corrosion and are subject to special monitoring. 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 (PFC) on Gravelines reactor 1. The discovery of such an indication, for the first time on a French reactor vessel, led ASN to ask EDF to initiate checks on the PFCs in all the reactors. These additional checks began in 2012 and so far no similar indication has been detected.

2|5|3 Checking reactor vessel strength

The reactor vessel is one of the essential components of a PWR. This component, 14 metres high and 4 metres in diameter, with a thickness of 20 cm (for the 900 MWe reactors), contains the reactor core and its instrumentation. In normal operation, the 300 t vessel, entirely filled with water, withstands 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 upon commissioning of the first EDF reactors:

- a programme to monitor the effects of irradiation: test specimens of the same metal as the reactor vessel were placed inside the reactor. EDF regularly removes some of these 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 specimens 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 regularly examines the vessel files transmitted by EDF in order to ensure that the in-service behaviour demonstration for the vessels is sufficiently conservative and complies with the regulations. Thus the file concerning the in-service behaviour of the 900 MWe reactor vessels for the ten years following their third ten-yearly outage was presented to the Advisory Committee for nuclear pressure equipment in June 2010. ASN considered that operation of these vessels for the time considered was acceptable, provided that EDF complies with certain requests and provides additional data. ASN is at present examining the first answers provided by EDF in this file and is preparing to examine the file concerning the in-service behaviour of the 1,300 MWe reactor vessels beyond their third ten-yearly outage.

2|5|4 Monitoring steam generator maintenance and replacement

The 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 tube rupture of one of the bundle tubes (SGTR) 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.

Mechanical and 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 obstructing or clogging the foliate water channels, the deposits also affect the flow on the tube support plates and prevent free circulation of the water-steam mixture, which creates a risk of damage for the SG tubes and internals, capable of degrading overall operation of the SG.

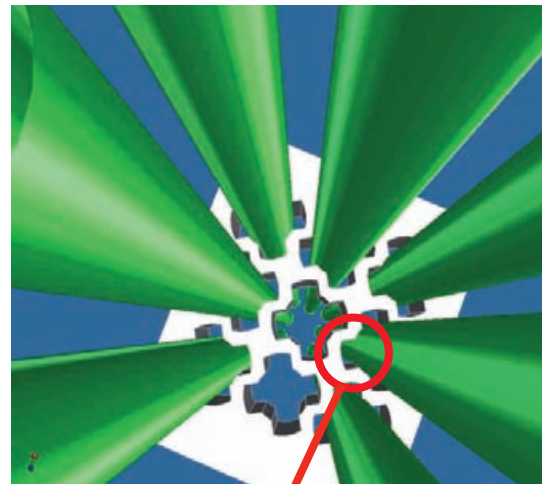


Illustration of clogging of the foliate channels on a steam generator tube support plate

To prevent or mitigate such effects, some of the deposits that have built up can be eliminated by curative or preventive chemical or mechanical cleaning. The rise in pH, which the secondary system is designed to withstand, is also a means of limiting metal deposits.

The goal of these methods is to contribute to maintaining a satisfactory level of SG cleanliness.

Replacement of steam generators

Since the 1990s, EDF has been running a programme (RGV) for priority replacement of 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, for which the tube bundle is made of 600 MA (26 reactors), will be completed in 2014 with the RGV of Blayais 3. It is continuing with the RGV for the 900 and 1,300 MWe plant series for which the tube bundle is made of heat treated inconel (600 TT). The RGV for the Inconel 600TT steam generators of the 900 and 1,300 MWe plant series will be carried out no later than the fourth ten-yearly outage owing to a high level of cracking at the base of the tubes. For the 900 MWe plant series, they will begin with Cruas 4 in 2014 and for the 1,300 MWe plant series with Paluel 2 in 2015.

ASN always carried out an inspection on the occasion of each steam generator replacement.

Incorporation of international operating experience feedback.

In 2012, a primary-secondary leak occurred on a steam generator in the San Onofre NPP (USA). The reason was premature wear of certain SG tubes. ASN made sure that EDF had examined the phenomena behind this deterioration. EDF provided data showing that the causes of this damage are not encountered on the reactors operated in France.

2|5|5 Monitoring the other reactor pressure equipment

The order of 12th December 2005 imposes specific requirements on nuclear pressure equipment, which came into force on 22nd January 2011. Application of the terms of this order implies the intervention by organisations approved by ASN, to carry out the checks required by the regulations, in addition to monitoring of the licensees. These operations include an assessment of the conformity of repaired equipment and periodic re-qualification.

ASN is also responsible for monitoring the application of the regulations concerning the operation of the non-nuclear pressure equipment in NPPs. This monitoring consists in verifying that EDF applies the provisions applicable to it. In this respect,

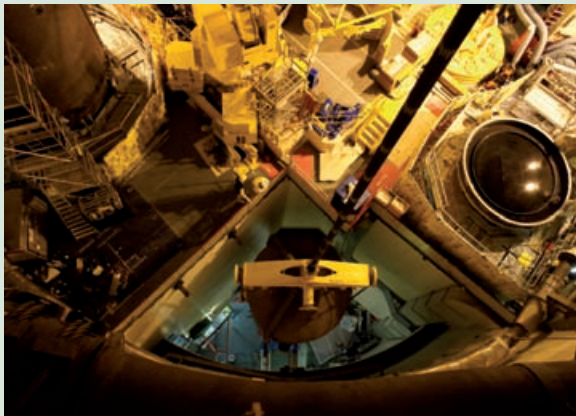
ASN in particular carries out audits and surveillance visits on the site inspection departments. These departments, under the responsibility of the licensee, are responsible for carrying out inspections to ensure the safety of pressure vessels.

2|5|6 Monitoring the manufacture of nuclear pressure equipment

Monitoring the manufacture of these items is regulated by the order of 12th December 2005 which adds extra safety, quality and ionising radiation protection requirements to the regulatory requirements applicable to the manufacture of conventional pressure equipment (decree of 13th December 1999).

ASN assesses the conformity with the regulatory requirements of each of the pressure equipment items most important for safety, known as the “level N1 nuclear pressure equipment”. This conformity assessment concerns the equipment intended for the new nuclear facilities (EPR) and the spare equipment intended for nuclear facilities already operated (replacement steam generators). For the performance of these duties, ASN can rely on the organisations that it approves. These latter can be tasked by ASN with performing some of the inspections on the N1 level equipment and are responsible for assessing conformity with the regulatory requirements applicable to

Replacement of the steam generators at Bugey 3 – 2010



Handling operation in the opening in the upper part of a twin-block steam generator



Mating of the steam generator with the reactor cooling piping on the hot leg side

Tig Orbital Narrow Gap welding operation: connection of the steam generator to the reactor cooling piping on the hot leg side



nuclear pressure equipment that is less important for safety, referred to as “level N2 or N3”.

Oversight by ASN and its approved organisations comes into play at different stages of 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. Five organisations or inspection bodies are currently approved by ASN to assess nuclear pressure equipment conformity: APAVE SA, ASAP, BUREAU VERITAS, AIB VINÇOTTE INTERNATIONAL and the EDF OIU.

2|6 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.

2|7 Protection against natural events, fire and explosions

2|7|1 Prevention of seismic risks

Although there is no particularly strong seismic risk in France, consideration of this risk is the subject of considerable efforts on the part of EDF and of sustained attention by ASN. Seismic protection measures are taken into account in the design of the facilities. They are periodically reviewed in line with changing knowledge and changes to the regulations, on the occasion of the periodic safety reviews. The design of the buildings and the equipment important for safety in the NPPs must enable them to withstand earthquakes of an intensity greater than the strongest earthquakes that have occurred in the region of the site, on the basis of historical and instrument-based knowledge, with the inclusion of significant margins.



Flamanville EPR reactor building construction site. Containment – February 2012



Aerial view of the Flamanville EPR reactor building – September 2012

Design rules

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

This RFS is supplemented by specific ASN guidelines dating from 2006 which, for surface BNIs and on the basis of the site data, define the anti-seismic design measures taken for civil engineering structures and acceptable methods for:

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

Seismic design reviews

Within the framework of the current periodic safety reviews, 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.

The studies carried out for the safety review associated with the third ten-yearly outages of the 900 MWe reactors led to the definition of equipment or structural reinforcements. After the ASN and IRSN review of the provisions proposed by EDF, their implementation began during the ten-yearly outage, in 2009 for Tricastin reactor 1 and Fessenheim reactor 1, in 2010 for Bugey reactor 2 and in 2011 for reactors 4 and 5. Bugey reactor 3 will be strengthened in 2013.

The studies carried out during the periodic safety review associated with the second ten-yearly outage of the 1,300 MWe reactors, showed that the original design guarantees the ability of these reactors to withstand earthquakes reassessed in compliance with RFS 2001-01, provided that modifications were made to prevent interactions between the electrical building and the safeguard auxiliaries for the reactors of the P4 series and the turbine hall. These modifications are implemented on the occasion of the ten-yearly outages.

Definition of the reference earthquakes to be considered during the periodic safety reviews requires a considerable amount of work. As early as 2006, ASN thus set up a working group comprising representatives from EDF, IRSN and ASN to prepare

for the next seismic reassessments (forty-year review for the 900 MWe reactors and thirty-year review for the 1,300 MWe reactors). For the periodic safety review of the 1,300 MWe reactors associated with the third ten-yearly outage, EDF proposed to ASN that the earthquake levels be updated. In 2011, ASN asked EDF to provide additional data to justify the penalising nature of the choices made to determine the earthquakes to be considered in the light of the associated uncertainties. EDF initiated a programme of work to this effect.

2|7|2 Drafting flood prevention rules

The partial flooding of the Blayais NPP in December 1999 led EDF, under ASN oversight, to reassess the safety of the NPPs against the risk of flooding, in conditions more severe than those previously considered (taking account of additional flooding causes, definition of a protection perimeter for the facilities, etc.). The measures to be taken for the reactors in the event of a rise in the water level were also reassessed. A file was produced for each NPP and works to improve the protection of the sites have been defined. In October 2007, EDF completed the work involved in the flood risk reassessment with regard to the risk of water ingress (closing off of openings after identifying possible water routes, protection of the heat sink against a large-scale arrival of debris, and so on). ASN instructed EDF to complete the remaining work (raising of walls, extension of the protected volume approach to the turbine hall, etc.) before the end of 2014.

The overall approach to take account of the risk of external flooding on the BNIs was submitted to the GPR and GPU in 2007 for their opinion. On the basis of this opinion, ASN drafted six specific requests concerning the risk of failure of a dam, systems or equipment, the risk of flooding, protection against rain and protection of the Tricastin site. A problem was raised on this occasion: the safety of certain installations with regard to external flooding depends to a large extent on the behaviour of off-site structures not belonging to EDF, in particular with regard to the Cruas-Meysses and Tricastin nuclear power plants. The assessment of robustness, of monitoring and of the upkeep of these structures requires coordination between the structure concession-holders, the public authorities and EDF. Thus, for the Cruas-Meysses and Tricastin NPPs, a convention was signed in 2011 between EDF and the *Compagnie nationale du Rhône* (CNR) concerning the countermeasures to be deployed. In its resolution 2011-DC-0227 of 27th May 2011, ASN asked EDF to improve the protection of the Tricastin site against the risk of flooding, by carrying out works on the Donzère-Mondragon hydraulic structure.

2|7|3 Preventing heatwave and drought risks

The heatwave in the summer of 2003 had significant consequences for the environment of the NPPs: some water courses saw a reduction in their 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



View of the Belleville-sur-Loire NPP during the flooding in December 2003

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 accordingly proposed “intense heatwave” baseline requirements entailing examination and reassessment of 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 references for the 900 MWe reactors and a version for the 1,300 MWe and 1,450 MWe reactors. In 2009, ASN adopted an initial position concerning the baseline safety requirements for the 900 MWe reactors. Following ASN’s investigation of the answers provided by EDF to the comments and requests for additional information issued in 2009, with the help of its technical support organisation, ASN in 2012 approved incorporation of the material modifications reinforcing the robustness of the reactors to heatwave conditions and issued a position statement on the baseline requirements used for the CPY plant series. ASN also asked EDF to take account of the experience feedback from examination of the CPY plant series baseline requirements in those for the 1,300 MWe and 1,450 MWe plant series.

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 on the most vulnerable sites and is being extended to all sites.

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 “intense heatwave” 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.

2|7|4 Checking that the fire risk has been considered

The fire risk in nuclear power plants is handled using the principle of defence in depth, based on three levels: facility design, prevention and fire-fighting.

The design rules should prevent the spread of any fire and limit its consequences. This is primarily built around:

- the principle of dividing the facility 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 premises - whether present permanently or temporarily - remain below the hypothetical levels used in designing the sectoring;
- 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 events notified by the licensee and inspections performed on the sites.

2|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 release of radioactive materials into the facility 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 these prevention and monitoring measures, paying particular attention to ensuring that the explosion risk is included in EDF’s baseline safety requirements and organisation.

ASN closely monitors EDF’s implementation of the provisions of the prescriptions concerning management of the explosion risk as laid out in resolution 2008-DC-0118 of 13th November 2008. These provisions can be organisational (setting up an organisation capable of guaranteeing compliance with the regulations concerning the explosion risk, examination of the conformity of all explosive fluid pipes and a detailed review of the extent to which explosion risks have been taken into account) or material (replacement of pipes carrying hydrogen, etc.).

Finally, ASN ensures compliance with the “explosive atmospheres” (ATEX) regulations with respect to occupational worker protection.

3 MONITORING RADIATION PROTECTION, WORKER PROTECTION AND CONTROLLING THE ENVIRONMENTAL IMPACT

3|1 Labour Law in the nuclear power plants

The nineteen nuclear power plants in operation, the eight reactors undergoing decommissioning and the EPR under construction at Flamanville are subject to ASN's labour inspectorate duties. Depending on the number of reactors (2 to 6), the workforce in an NPP varies from 800 to 2,000 (EDF and permanent contractor personnel), divided between various functions:

- plant operation: 50%;
- maintenance: 20%;
- administration and support: 30 %.

These staff are supplemented by a large number of contractors and subcontractors involved in maintenance and in the operations scheduled for the reactor outage periods. Depending on the type of outage, an additional 300 to 2,700 participants can be present.

These workers are exposed to the risks linked to ionising radiation (see point 3|2), as well as to risks common to any industry. These “conventional” risks include those relating to electrical installations, to pressure equipment, to chemical products, to hydrogen (explosion risk) and nitrogen (asphyxia) circuits, to work at height, or to the handling of heavy loads.

The health, safety, working conditions and quality of employment of the employees of EDF, its contractors or subcontractors, along with the safety of the facilities, now benefit from coordinated regulation by ASN.

As at 31st December 2012, the ASN resources for its labour inspectorate duties are:

- thirteen labour inspectors, including three working on a full-time basis, assigned to the regional divisions, working directly with the sites;
- a central labour director, responsible for managing and coordinating the network of labour inspectors and acting as the interface with the Ministry responsible for labour. Coordination with the General Directorate for Labour of the Ministry responsible for labour was thus the subject of a cooperation agreement signed on 1st March 2011 and implemented in the regions by agreements between the ASN divisions and the DIRECCTE.

ASN's radiation protection inspectors also contribute to monitoring the requirements of the Labour Code, within their own fields of competence.

Since 2009, the links between the labour inspection steps taken and the other NPP regulation activities have been consolidated in order to achieve the integrated view of regulation sought by ASN. This is in particular the case for subcontracting or for Organisational and Human Factors (OHF).



Work being carried out on a cooling tower

3|2 Personnel radiation protection

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 radiations are present (neutrons, α , β and γ) and the risk of exposure is both external and internal. In practice, more than 90% of the doses come from external exposure to β and γ radiation, caused by erosion and corrosion phenomena. Exposure is primarily linked to maintenance operations during reactor outages.

One of ASN's duties 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 concerns itself with all workers on the sites, whether the staff of EDF or of contractors, throughout the operating life of a facility.

This oversight takes two main forms:

- by carrying out inspections:
 - 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 examining files concerning the radiation protection of workers, if necessary with the technical expertise of IRSN. These examinations can concern:
 - significant radiation protection events notified by EDF;
 - design, 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 ASN's evaluation of the status of radiation protection in the operating NPPs. This annual report allows a comparison

between ASN's assessment and that of the licensee, in order to identify possible areas for progress.

Finally, periodic meetings are held to consider the progress of technical or organisational projects being studied or actually deployed in the NPPs.

3|3 Assessing the environmental and health impacts of NPPs



Collection of samples of radioactive and chemical effluents during an ASN inspection in the Bugey NPP – May 2012

3|3|1 Revising requirements concerning water intake and discharges

The Environment Code empowers ASN to define the requirements concerning BNI water intake and discharges (see point 3|3|1 of chapter 4).

ASN applies the following principles when discharge authorisation or modification applications are received:

- for radioactive discharges, ASN tends to lower the regulatory limits on the basis of operating experience feedback concerning actual discharges, while taking account of the contingencies of day-to-day reactor operation;
- for non-radioactive substances, ASN has decided to establish requirements on discharges of substances that were not formerly regulated, in order to control virtually all of the discharges and to adopt an approach designed to raise awareness of environmental issues;
- in any case, limits are set as low as possible, in the light of current technical and economic data, guaranteeing the absence of any significant impact on man and the environment, while allowing normal operation of the facility.

Finally, it should be noted that technological advances have led to improvements in metrology, enabling the actual discharges to be more accurately determined.

Radiological impact of discharges

The calculated radiological impact of the maximum discharges given in the EDF files on the most heavily exposed population group, still remains well below the allowable public dosimetric limit (1 mSv/year).

The annual effective dose delivered to the population reference group (group subject to maximum radiological impact) is thus estimated at from a few microsieverts to several tens of microsieverts per year, depending on the particular site. This exposure represents less than 0.1% of the total average dose to which the French population is exposed (see chapter 1).

3|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. For all waste, whether or not radioactive, ASN examines the baseline requirements of the licensee's waste study, as required by the regulations and as described in chapter 3, point 3|5|1.

The baseline requirements cover the following themes:

- a review of the existing situation, recapitulating the different wastes generated and their quantities;
- the waste management procedures and the 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. In compliance with the regulations, EDF carries out waste sorting at source, in particular differentiating between waste from nuclear zones and other waste. The licensee and ASN hold regular meetings to discuss waste-related matters and waste management, notably through annual inventories.

These elements and the regulations constitute the basis used by ASN to regulate management of the waste produced by EDF's NPPs. ASN carries out regular inspections, during which the inspectors review the site's waste management organisation, various points such as processing of deviations, and monitor the operation of the waste storage and processing areas.

3|3|3 Increasing protection against other risks and forms of pollution

Controlling the bacteriological risk

The cooling towers, which operate by circulation of water cooled in an air flow, are particularly favourable to the development of legionella bacteria (see point 1|1|4). To strengthen prevention of the risk of legionella arising from cooling tower operation ASN, together with the General Directorate for Health (DGS), in 2005 required that EDF comply with new maximum legionella concentration limits in

the cooling systems and introduced installation surveillance requirements.

Subsequently, on the basis of opinions submitted by ANSES, ASN asked EDF to define and implement preventive or remedial measures to reduce the risk of the proliferation of micro-organisms in the cooling circuits, while looking to minimise chemical discharges resulting from these treatments. By examining files and carrying out field inspections, ASN closely monitors the progress and the results of the steps taken to tackle legionella. Finally, ASN has begun to look at changes to these regulations to ensure consistency with the ICPE regulations (see point 5|7).

4 THE MAJOR NUCLEAR SAFETY AND RADIATION PROTECTION ISSUES

4|1 Social, organisational and human factors

4|1|1 The importance of social, organisational and human factors for nuclear safety and radiation protection

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 to NPP safety by the operators and worker groups. ASN defines Social, Organisational and Human Factors (SOHF) as being all the aspects of working situations and the organisation which will have an influence on the work done by the operators.

The elements considered concern the individual and the organisation within which he or she works, the technical arrangements and, more broadly, the working environment with which the individual interacts. The working environment for instance concerns the heat, sound or light environment of the workstation. The variability in worker characteristics (vigilance varies with the time of day, the level of expertise varies according to the seniority in the position) and in the situations encountered (unexpected failure, social tension) explains that they constantly need to adapt how they work so as to optimise effectiveness and efficiency. This performance must be achieved at an acceptable cost to the operators (in terms of fatigue or stress) and they must also benefit from it (the feeling of a job well done, recognition by both peers and the hierarchy, development of new skills). Thus, 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.

Fields for integration of social, organisational and human factors

ASN wants to see SOHF taken into account in a manner commensurate with the safety issues for the facilities and for the workers in the following areas:

- engineering activities during design of a new installation or modification of an existing one. ASN in particular wants to see design focusing on the human operator, through an iterative process comprising an analysis phase, a design phase and an evaluation phase;
- activities carried out to operate existing NPPs throughout their service life;
- activities involved in compiling and utilising operating experience feedback, which is an important function of the safety management system, during the design, construction and operation of the reactors. ASN in particular expects the licensee to analyse the root causes (often organisational) of the significant events and to identify, implement and assess the effectiveness of the corresponding corrective measures, on a long-term basis.

ASN requirements

The order of 10th August 1984 (see point 3|2|1 in chapter 3) contains requirements with which the licensee must comply in order to define, obtain and maintain the quality of its facility and its operating conditions. These requirements in particular concern the organisation to be put into place by the licensee to manage quality-related activities.

ASN asks the licensee to set up a safety management system able to maintain and continuously improve safety, notably through the development of a safety culture. ASN considers that safety management must be a part of the company's general management system, in order to guarantee the priority given to safety as well as to the other interests protected by the

TSN Act, such as radiation protection and protection of the environment.

ASN oversight

ASN oversight of SOHF relies mainly on inspection of the steps taken by the licensee to improve SOHF integration 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 implementation of the SOHF approach by EDF. Finally, ASN monitors 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. ASN also coordinates the Social, Organisational and Human Factors Steering Committee (COFSOH), which is the forum for cross-disciplinary exchanges set up to ensure progress in the three priority areas identified in the ASN opinion of 3rd January 2012 on the stress tests, that is renewal of the workforce and the skills of the licensees, the organisation of the use of subcontracting and research on these topics (see point 2 | 6 | 3 of chapter 2).

4 | 1 | 2 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. According to EDF, 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 the organisation of the subcontractor companies and is formally written up in the “progress and sustainable development charter” signed by EDF and its main contractors. The regulations require that the licensee monitor the activities performed by its contractors and continuously assess 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 at least those maintenance operations required to ensure the safety of the reactors.

ASN 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 those involved (the subcontractors are in fact exposed to a large share of the received dose on all the

reactors: see point 6 | 1 | 4). These consequences can be the result of the use of insufficiently competent personnel, insufficient monitoring of the contractors by the licensee or degraded working conditions.

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, notably 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 carrying out the service from the ordering customer (absence of subordination and lack of supply of tools or equipment). The inspections on this topic are carried out in the NPPs in operation and also within the various engineering departments responsible for the design studies of the Flamanville 3 reactor (see point 4 | 4 | 2).

In addition to the inspections, ASN oversight is based on the assessments conducted at its request by IRSN and the GPR. For example, the opinion of the GPR is requested concerning the management of EDF subcontracting of the maintenance work carried out in the NPPs.

4 | 2 Maintaining and continuously improving nuclear safety

4 | 2 | 1 Ensuring correction of deviations

The checks initiated by EDF and the systematic verifications requested by ASN lead to the detection of deviations from the defined requirements. These can have a variety of origins: design problems, construction errors, insufficient management of maintenance work, deterioration through ageing, etc. ASN considers that deviation detection, as stipulated by the BNI order of 7th February 2012, plays a key role in maintaining the level of safety in the facilities.

Ten-yearly verifications: conformity verifications

EDF carries out periodic safety reviews on the nuclear reactors every ten years (see point 4 | 3 | 4). EDF then compares the actual condition of the facilities with their applicable safety requirements and identifies any deviations. These verifications can be supplemented by a programme of additional investigations designed to check parts of the facility which are not covered by a specific preventive maintenance programme.

“Real time” verification

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

Informing ASN and the public

When a deviation is detected, the licensee is required to assess the impacts on nuclear safety, radiation protection or protection of the environment. If necessary, EDF sends ASN a significant event notification. The public is informed of the most significant deviations (INES scale level 1 and higher) by means of ASN's website. This procedure is in line with the principle of transparency with respect to ASN and the general public.

ASN's remediation requirements

ASN requires that deviations with an impact on safety be corrected as soon as possible, taking account of their degree of severity. This is why, for the most significant deviations, ASN examines the remediation procedures and deadlines proposed by EDF. To carry out this review, ASN takes into consideration the actual and potential safety consequences of the deviations. 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 continuing operation while the deviation is present is considered to be unacceptable and if there is no appropriate remedial measure. Conversely, the time to correct a less serious deviation can be increased when the particular constraints so warrant and if the safety impact is tolerable. These constraints may be the result of the time needed to prepare for remediation in conditions of complete safety. For example, for earthquake resistance deviations, one factor in assessing the urgency of the repair is the seismic level for which the equipment in question is designed. If the sole purpose is to restore a safety margin for an equipment item for which EDF is able to demonstrate the ability to withstand a severe earthquake, a longer repair time can be accepted.

4|2|2 Examination of events and operating experience feedback

The general process for incorporating operating experience feedback

Operating experience feedback is one means of maintaining conformity and continuously improving the fields of safety, radiation protection and protection of the environment. ASN therefore instructed EDF to notify it of any significant events occurring in the NPPs, using the notification criteria set accordingly in a document entitled "guidelines for notification and codification of criteria for significant events involving safety, radiation protection or the environment and applicable to BNIs and to radioactive material transport operations". 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 results for 2012 are given in point 6|1|6). For certain significant events felt to be the most noteworthy, because of their remarkable 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 in order 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.

4|3 Continued operation of the nuclear power plants

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

4|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 2012, the average age of the reactors, calculated from the date of initial reactor criticality, was as follows:

- 31 years for the thirty-four 900 MWe reactors;
- 25 years for the twenty 1,300 MWe reactors;
- 15 years for the four 1,450 MWe reactors.

4|3|2 Main factors in ageing

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

The lifetime of non-replaceable items

The non-replaceable items are closely monitored to ensure that they age as expected. This is in particular the case with the reactor vessel (see point 2|5|3) and the containment (see point 2|6).

Deterioration of replaceable items

Equipment ageing is the result of phenomena such as the wearing of mechanical parts, the hardening and cracking of polymers, the corrosion of metals, and so on. This type of deterioration must be taken into account as of the design and construction stage, as well as in a programme of monitoring and preventive maintenance and repair, or replacement if necessary (see point 4|3|3).

Equipment or component obsolescence

Some equipment, before being installed in the NPPs, 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

Significant safety event notified on 18th January 2012 concerning the cooling pipes for the Cattenom NPP spent fuel storage pools

On 18th January 2012, EDF notified ASN of the absence of a “siphon-breaker” orifice on the cooling pipes of the waste or spent fuel storage pools for Cattenom NPP reactors 2 and 3. This significant safety event, detected during an internal inspection, was rated level 2 on the INES scale, which comprises ratings from 0 to 7.

In each reactor, a pool is used to store spent fuel before it is taken away to a reprocessing facility. The fuels are kept under water and permanently cooled by a borated water circulating system (PTR system). The cooling water is injected into the bottom of the pool by a pipe.

If certain valves are incorrectly actuated or if a pipe connected to the cooling system breaks, the borated water injection pipe could siphon out the water from the pool. This situation would lead to a drop in the pool water level, potentially uncovering the fuel assemblies and damaging them. An orifice, called a “siphon-breaker” is made in this pipe near the surface of the pool, to put a stop to any initiation of siphoning.

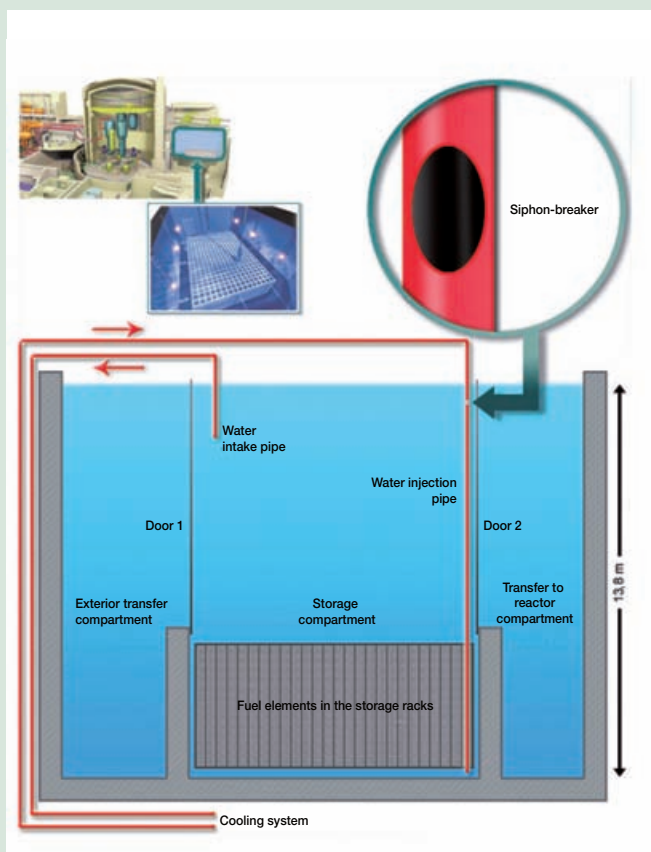
Further to the analysis of this event by ASN and IRSN, ASN asked EDF to systematically check that siphon-breakers were present on all the spent fuel storage pools of the reactors in operation.

On the reactors of the 1,300 MWe - P4 plant series, these checks revealed that the siphon-breakers fitted to the pipes of the pools at Belleville 1 and Golfech 1 had respective diameters of 15 and 17 mm, rather than an intended diameter of 20 mm; these siphon-breakers were therefore rectified. For the pipes on the pools at Nogent-sur-Seine 1 and Penly 2, EDF demonstrated that the

diameters of the siphon-breakers measured at between 19 and 20 mm were such as to enable them to perform their role in an incident situation.

For the 1,300 MWe - P4 plant series, the design of these systems is different: from the outset, the design diameter was smaller, about 10 mm. The diameters measured on the reactors concerned are in conformity with this design requirement.

Moreover, in order to increase the robustness of the facilities to situations which were not envisaged at the design stage (for example, complete rupture of a pipe), ASN asked EDF – as part of the on-going periodic safety reviews – to make provision for a siphon-breaker modification to increase the dimensions. Implementation of this modification began in 2011. Following the stress tests carried out further to the Fukushima accident, ASN asked EDF to speed up this process in order to guarantee implementation on all the reactors of all the plant series no later than March 2014.

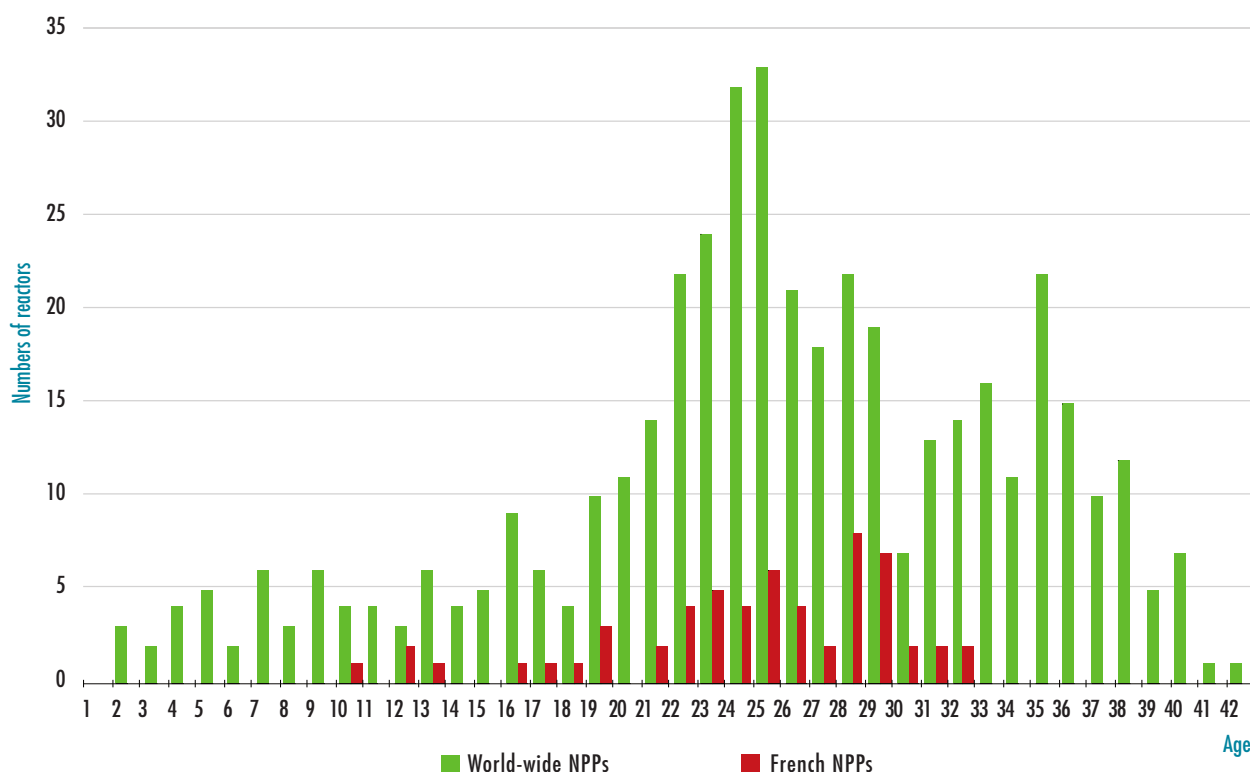


Cross-section of a fuel storage pool and a siphon-breaker

manufacturer cease to make certain components, or simply go out of business, this could create original part procurement problems for certain systems. The safety level of any new spares must then be demonstrated prior to installation. This is to

ensure that the equipment remains “qualified” with the new spare part. Given the length of this procedure, the licensee must adopt a vigorous forward-looking policy.

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



4|3|3 How EDF manages equipment ageing

EDF's "defence in depth" equipment ageing strategy is built around three lines of defence.

1) Designed-in prevention of ageing: 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 design may occur during operation. The periodic surveillance and preventive maintenance programmes, the conformity checks (see point 4|2|1) or the operating experience feedback review (see point 4|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.

4|3|4 Examination of extended operation

The texts which regulate the operation of NPPs in France specify no time limit for their authorisation to operate. However,

Article L.593-18 of the Environment Code requires licensees to review the safety of their facilities every 10 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. To do this, 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 performed on the occasion of the ten-yearly outages. The periodic safety reviews therefore constitute one of the cornerstones of safety in France, by obliging the licensee not only to maintain the level of safety of its NPP but also to improve it.

The periodic safety review is also an opportunity for an in-depth examination of the effects of ageing on the equipment. Thus, for the reactors going through their third ten-yearly outage, an ageing analysis must be performed for all degradation mechanisms that could directly or indirectly affect the components important for safety. 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 outage of each reactor, this analysis leads to the production of a file clearing the reactor for continued operation.

Furthermore, with a view to EDF's expressed goal of continued reactor operations beyond 40 years, management of ageing and

equipment obsolescence become key issues. EDF's proposals concerning the study programme to be launched were therefore submitted to the GPR at its meeting of 19th January 2012. Following this session, EDF undertook to carry out extensive studies in order to obtain a clearer understanding of ageing phenomena.

The review process

The periodic safety review process comprises several steps.

1) The conformity assessment

This consists in comparing the actual condition of the facility with the applicable safety requirements and regulations including, notably, its Authorisation Creation Decree (DAC) and ASN's requirements. This ten-yearly conformity inspection in no way relieves the licensee of its obligation to permanently guarantee the conformity of its facilities.

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 facilities in France and abroad;
- lessons learned from other facilities or equipment involving a risk.

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

3) Implementation of the improvements emerging from the safety review

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

4) Submission by the licensee of a review conclusions report

Following the ten-yearly outage, the licensee sends ASN a report containing the conclusions of the periodic safety review. 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 2007-1557 of 2nd November 2007, amended. ASN sends its analysis of the report to the Minister responsible for nuclear safety and can impose additional requirements on the licensee.

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 beyond 30 years. ASN has not identified any element that would compromise EDF's ability to manage the safety of the 900 MWe reactors until the next periodic safety review. ASN also considers that the new baseline safety requirements presented in the generic safety analysis report for the 900 MWe reactors and the installation modifications envisaged by EDF are such as to maintain and improve the overall safety level of these reactors.

However, this generic assessment does not take account of any specific features of individual reactors. ASN 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 periodic safety review report (see point 5 | 3 for ASN's position statements in 2012).

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 outage, 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 (see point 5 | 3).

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

In 2011, ASN established the outline for the safety review associated with the third ten-yearly outages for the 1,300 MWe reactors. Reactor 2 in the Paluel NPP will be the first to be subject to a third ten-yearly outage, in 2015. 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 orientations of the first periodic safety review for the 1,450 MW reactors, which in particular concerns the level 1 probabilistic safety assessments and the hazard studies. The ten-yearly outage of the 1,450 MWe reactors took place between 2009 and 2012. In 2012, ASN identified and requested generic improvements for this reactor series, that EDF will be required to implement during the course of the next few years (see point 5 | 3).

Implications of continued reactor operation beyond forty 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 safety level. 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, to reassess the safety level of the reactors in the light of that currently demanded for EPR or equivalent type reactors, with the adoption of ambitious safety improvements. R&D work in France and elsewhere is already identifying potential solutions and improvements that would provide significant reductions in radioactive releases in the event of severe accident are being studied.

For ASN, extension of reactor operation 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 international best practice.

4|4 The Flamanville EPR reactor

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 strengthened safety objectives.

After a period of about ten years during which no nuclear reactors were built in France, EDF submitted an application in May 2006 to the Ministers responsible for nuclear safety and radiation protection for the creation of a 1,650 MWe EPR type reactor, called Flamanville 3, on the Flamanville site, which already houses two 1,300 MWe reactors.

The Government authorised its creation by Decree 2007-534 of 10th April 2007, following ASN’s favourable opinion, subsequent to the inquiry conducted with the assistance of its technical support organisations.

After issue of the Creation 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, civil engineering work has continued and is now complete for certain buildings such as the pumping station or the premises housing the emergency diesel generators. 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 system (vessel, pressuriser, pumps, valves, pipes, etc.) and secondary system (steam generators, valves, pipes, etc.) is in progress in the manufacturers’ facilities. In the summer of 2011, EDF announced that it was planning to commission Flamanville 3 in 2016.

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

Pursuant to the decree of 2nd 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. In compliance with Article 20 of this same decree, the licensee must send ASN a file comprising the safety analysis report, the general operating rules, a study on facility waste management, the on-site emergency plan, the decommissioning plan and an update of the facility’s impact assessment, one year prior to the planned date of commissioning and 6 months before fuel is brought into the perimeter of the Flamanville 3 BNI.

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 references necessary for demonstration of safety and for finalising the detailed reactor design;
- the detailed design of some systems that are important for safety 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.

4|4|2 Construction oversight

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, 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 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 to 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’s main actions in this field in 2012 are described in point 5|2.

ASN inspection on the Flamanville EPR reactor construction site



Civil engineering inspection on the south diesel building – December 2012



Civil engineering inspection on the north diesel building – December 2012



Inspection of work to remove the plug between the reactor 2 seawater intake channel and that of reactor 3 – October 2012

Oversight of nuclear pressure equipment manufacture

ASN monitors the manufacture of the nuclear pressure equipment that is most important for safety, known as “level N1 equipment”. This equipment is that making up the main primary and secondary systems of the Nuclear Steam Supply System (NSSS). For the purposes of this monitoring, ASN relies on organisations that it has already approved and that it tasks with performing some of the monitoring required on the manufacture and design of this equipment.

With regard to the other pressure equipment, the approved organisations are responsible for assessing its conformity with the regulatory requirements. In this case, ASN is responsible for overall oversight of the actions of the approved organisations. ASN actions in this field in 2012 are described in point 5 | 2.

4 | 4 | 3 Cooperation with foreign nuclear regulators

To be able to share its experience with other nuclear regulators, ASN multiplies technical exchanges with its foreign counterparts on the topic of regulating the design, construction and operation 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. These relations started in 2004 with the Finnish nuclear safety regulator (STUK) with a view to the construction of EPR type reactors on the sites at Olkiluoto (Finland) and Flamanville (France). Since then, STUK and ASN have worked closely together: in 2012, this led to a technical progress meeting being held for the two projects and STUK participation in a Flamanville 3 inspection in March, followed by a technical meeting on the detailed design of the EPR I&C in November. Regular discussions between STUK and ASN also take place in order to share experience of nuclear pressure equipment manufacturing.

In addition to cooperation with STUK, ASN and IRSN took part in numerous bilateral relations in 2012 on subjects related to authorisation procedures and oversight of the construction of new reactors with foreign nuclear safety regulators: India, United Kingdom and China.



ASN inspection with the Finnish nuclear safety regulator (STUK) of the Flamanville EPR construction site – March 2012

Towards multinational cooperation

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

ASN is a member of the Multinational Design Evaluation Programme (MDEP) which evaluates the design of new reactors (see point 2 | 4 of Chapter 7). In this context, ASN took part in 2012 in the activities of the working group devoted to the detailed design of the EPR. With the support of IRSN, ASN in particular took part in the work dealing with severe accidents, I&C, probabilistic safety assessments, modelling of accidents and transients, technical specifications and on-site hazards. The group also held two plenary sessions. A part of these two meetings was open to the designers and future licensees (AREVA, EDF and other firms) to discuss steps to take account of the Fukushima accident; visits to Flamanville 3 and Olkiluoto 3 were also organised during these meetings. The next meeting of this plenary group is scheduled for January 2013.

ASN also takes part in the Working group on regulation of new reactors, which is a technical group of the Nuclear Energy Agency (NEA) Committee on Nuclear Regulatory Activities (CNRA – see point 2 | 3 of chapter 7). The corresponding work in particular led to the creation of a database of anomalies and deviations observed in recent construction projects. 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.

4|5 The reactors of the future: initiating discussions on Generation IV safety

The French Alternative Energies and Atomic Energy Commission (CEA), in partnership with EDF, has since 2000 been involved in looking at the development of the fourth generation¹ of nuclear reactors (“GEN IV”), notably 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 world’s most nuclearised countries. 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 consume plutonium and to produce it in-situ from uranium-238, ability to transmute minor actinides such as americium and curium) and by offering better risk control regarding security, proliferation and terrorism. There is a wide consensus on these objectives amongst GIF’s members. For those promoting them, the industrial deployment of the fourth generation reactors is envisaged in France no earlier than the middle of this century. It will require prior creation of a prototype, for which the planned commissioning date is set at 2020 by the Act of 28th 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, as well as the associated safety concerns - as was the case 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 the documents transmitted by CEA, AREVA and EDF in 2009 and 2010 at its request, ASN in 2012 asked the Advisory Committees for nuclear reactors (GPR), for plants (GPU) and waste (GPD) for their opinion on the range of various reactor technologies envisaged for the fourth generation, with regard to the more stringent nuclear safety, radiation protection and environmental protection objectives by comparison with the third-generation EPR type reactors, as well as with respect to the possibility of separation and transmutation of long-lived

1. The “4th generation” of reactors is identified by comparison with those reactors immediately available to replace those currently in service, known as the third generation (this term itself refers to the fact that the reactors currently in service are the second generation, for example the PWR reactors which in France replaced the gas-cooled reactors, which constituted the first generation).

radioactive elements mentioned by the programme Act of 28th June 2006 on the sustainable management of radioactive materials and waste. This step aims to present the pros and cons of each of the above-mentioned technologies, given their current state of development. The conclusions of this review will be known in late 2013.

At the same time, CEA undertook studies for a prototype SFR, as part of the ASTRID² project. For CEA, this project forms part of the preparation for the fourth generation reactors. In mid-2012, CEA sent ASN the safety orientations report (DOs) for

the ASTRID prototype. This report precedes the Safety Options Report (DOS) which CEA claims will be drafted in 2014, at the time of the facility's preliminary design, in other words well ahead of submission of the BN1 creation authorisation application. As of the beginning of the project, the main purpose of the safety orientations and options reports is to check that correct account is taken of the safety issues. The safety orientations report will thus be reviewed by the Advisory Committees, which will make their conclusions known in 2013.

2. ASTRID : Advanced Sodium Technological Reactor for Industrial Demonstration.

5 NOTABLE FINDINGS IN 2012

5|1 The NPPs inspection campaign and stress tests following the Fukushima accident

Following the nuclear accident in Fukushima, ASN considered that stress tests on the French civil nuclear facilities with respect to the type of events which led to the Fukushima accident, should be initiated. These stress tests are in response to the requests made by the Prime Minister on 23rd March 2011 and the European Council on 24th and 25th March 2011. The licensees presented the extreme situations stress tests of their facilities to ASN in September 2011. They were reviewed by the Advisory Committees for nuclear reactors (GPR) and for laboratories and plants (GPU) in November 2011. ASN published its conclusions on 3rd January 2012 and on 26th June 2012 it issued nineteen resolutions instructing EDF to take additional measures to reinforce the safety of its facilities.

In addition to the normal inspection programme, the topics addressed by the stress tests were also covered by 19 targeted inspections on the NPPs in 2011. In 2012, ASN carried out follow-up inspections to check the corrective measures requested following the inspections performed in 2011 on all the NPPs. The general impression further to these follow-up inspections is a positive one. ASN considers that the organisation defined and implemented by EDF to address the corrective action requests following the targeted inspections carried out in 2011 is on the whole satisfactory, even if there are still a number of points to be dealt with or which will require particular vigilance on the part of ASN.

Finally, the national reports produced for the stress tests were the subject of European-level peer reviews.



ASN inspectorate accompanied by a European deputy for "Commitments monitoring – Fukushima follow-up inspection", in the Civaux NPP: check on pipes and sensors in one of the plant's diesel generators – October 2012

Stress tests

Following the stress tests on the nuclear power reactors, ASN considered that the safety of these reactors is such that none of them needs to be immediately shut down. At the same time, ASN considered that their continued operation does however require that their robustness to extreme situations be increased beyond their existing safety margins, as rapidly as possible. In its nineteen resolutions of 26th June 2012, ASN more specifically required that the following measures be taken:

- **the creation of a "hardened safety core" of material and organisational measures** able to manage basic safety functions in extreme situations, for all the facilities concerned by the stress tests report. Before 30th June 2012, the licensees submitted to ASN the content and the specifications of the "hardened safety core" for each specific facility;
- **as of 2012, 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;
- **reinforced measures to reduce the risk of "uncovering"** of the fuel in the fuel pools in the various facilities;
- **performance of feasibility studies for additional measures to protect underground and surface waters in the event of a severe accident.**

At the request of ASN, EDF's proposal for the creation of a "hardened safety core" was analysed by IRSN. The results of this analysis were presented on 13th December 2012 to the GPR, which submitted its opinion to ASN.

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

Peer review of the European stress tests

The ASN report of 3rd January 2012 was transmitted by the Prime Minister to the President of the European Commission as France's report on the stress tests decided on by the European Council on 24th and 25th March 2011. The reports from the various European States were submitted to a peer review process, which ran from January to April 2012 and comprised two consecutive phases: firstly, a thematic cross-disciplinary review of all the national reports, followed by a detailed review of each one. This review mobilised some 80 experts from 24 States and the European Commission.

On 26th April 2012, the institutional group of European safety regulators ENSREG and the European Commission adopted a report on the results of the stress tests carried out on Europe's NPPs. ENSREG and the Commission praised the quality of the work done and the efforts made by all the European stakeholders to carry out this unprecedented process in the best possible conditions. ENSREG and the European Commission also underlined the progress that it will be possible to achieve in the field of nuclear safety, thanks to the stress tests report.

The ENSREG report gives a positive appreciation of the results of the stress tests carried out in France and notes the comprehensive

French and European stress tests, the key steps in the process

- 5th May 2011: 12 resolutions by the ASN Commission asking the various nuclear facility licensees to produce a stress test report complying with precise specifications
- 15th September 2011: the licensees send ASN their stress test reports for the high-priority facilities
- 8th to 10th November 2011: meeting of the Advisory Committees with submission of their opinion on the licensee reports to ASN
- 3rd January 2012: ASN submits its report on the stress tests to the Prime Minister, who forwards it to the European Commission
- January to April 2012: European level peer reviews of the national reports
- 26th April 2012: ENSREG approval of the report on the European peer review conclusions
- 26th June 2012: ASN issues nineteen resolutions imposing additional requirements applicable to all NPPs in the light of the conclusions of the stress tests
- 28th-29th June 2012: presentation by the European commission to the European Council of its report on the stress tests
- 10th-15th September 2012: fact-finding missions to follow-up the European peer review
- 13th December 2012: examination, by the Advisory Committee for reactors, of the EDF proposal for a hardened safety core of material and organisational measures to control the fundamental safety functions in extreme situations
- 21st December 2012: publication and transmission to ENSREG of the ASN national action plan following the stress tests

nature of the assessments conducted under ASN's supervision. The ENSREG report commends the wide range of improvements decided on to reinforce the safety of the French nuclear facilities beyond the existing safety margins, and notably the creation of a "hardened safety core" of measures designed to ensure performance of the fundamental safety functions in extreme situations. This report also makes a number of recommendations that ASN will be aiming to implement.

5|2 Monitoring the construction of the Flamanville 3 EPR reactor in 2012

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. This detailed design review is part of the advance examination of the future commissioning application that EDF intends to submit within the next few years, pursuant to Article 20 of decree 2007-1557. In 2012, ASN and IRSN therefore completed their examination of the design of the instrumentation and control architecture (see box) and continued with their examination of the civil engineering 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. ASN also completed its detailed design review of the elements involved in optimising radiation protection and dimensioning of the radiological protection of the reactor building.

In addition to the detailed design technical review carried out with the support of IRSN, ASN in 2012 conducted six



Overview of the EPR construction site at Flamanville – October 2012

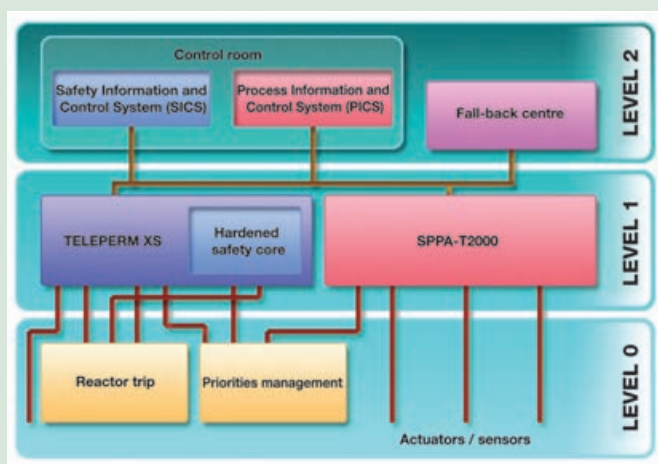
ASN validation of the instrumentation and control (I&C) architecture

The I&C of the Flamanville 3 EPR reactor comprises two platforms:

- the Télérperm 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 9th July 2010, EDF presented an alternative design to that initially envisaged. These new design provisions for example consist in grouping within a “hardened safety core” system certain safety functions hitherto not installed on the Télérperm 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 made significant efforts to prove that certain safety functions could be installed on the SPPA T2000 platform.



The Flamanville 3 EPR reactor I&C diagram

Following the analysis carried out by IRSN on these modifications and the 16th June 2011 opinion from the Advisory Committee for nuclear reactors (GPR), ASN considers that the I&C architecture of the Flamanville 3 EPR reactor proposed by EDF is able to guarantee the safety of the systems used to manage incident or accident situations and their independence from the control systems used to run the facility in normal operating conditions. EDF can thus continue to deploy this system, for which the detailed design will be analysed by ASN prior to the commissioning authorisation.



Aerial view of the Flamanville site water intake channel during admission of water to the Flamanville 3 pumping station – November 2012

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

10th August 1984, in particular concerning the requirements relating to the management and monitoring of contractors, including by means of inspections performed directly in the manufacturer's workshops, the identification and management of quality-related activities, management of deviations and management of experience feedback.

Oversight of construction activities on the Flamanville 3 site

With IRSN's support, ASN performed 18 inspections on the construction site in 2012. These in particular concerned the following technical topics:

- civil engineering, including activities relating to the construction of the inner containment wall, the core catcher and the airplane crash shell;
- the mechanical erection activities, including welding of pipes and their supports, installation of the stainless steel lining of tanks³ and pools, installation of drum screens in the pumping station, installation of the main emergency generating sets;
- erection of electrical systems, including installation of switchboards;

3. Closed tanks with stainless steel walls located in the facility's buildings.

- non-destructive testing and 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 2012, ASN paid particular attention to the following subjects:

- complex concreting activities. In July 2011, EDF informed ASN that it had discovered honeycombing in certain walls of the pools in the reactor and fuel buildings. These concrete walls thus comprise local concentrations of aggregate and a lack of cement, which requires repair. At ASN's request and beyond the processing of occasional deviations, for which repairs were already programmed, EDF initiated additional training, strengthened the preparation of the activities by including more detailed risk assessments, and reinforced the inspections, to improve the quality of the complex concreting operations. ASN conducted several inspections on this topic in 2011 and in 2012, accompanied on one of them by inspectors from the Finnish nuclear safety regulator (STUK).

In addition, in March 2012, EDF informed ASN of the presence of “empty spaces” behind the gate of the reactor building pools⁴; this partial filling with concrete results from activities that took place in the summer of 2011, before the implementation of additional measures for complex concreting work. EDF detected this defect at Flamanville through application of experience feedback from the Olkiluoto EPR reactor construction site, where a similar anomaly had already been observed. The repairs initiated by EDF were the subject of an unannounced ASN inspection on 21st August 2012 and a technical meeting on the site on 13th October 2012, notably to present the results of the first repairs. ASN will remain attentive to the final construction quality - that is to say after inspection and repair – of the Flamanville 3 reactor pools;

- welding of the tank and pool liners. Since the end of 2010, work has started on assembly of the liners of certain tanks important for safety. This in particular concerns lining of the reactor building and fuel building pools. ASN is particularly attentive to controlling these activities, to ensure that EDF demonstrates adequate manufacturing expertise.

These controls show that the organisation of EDF and of the main civil engineering contractor is satisfactory. ASN in particular observes that experience feedback from welding of this type of liner is integrated as and when difficulties are encountered. ASN will remain attentive to controlling these activities and to the final construction quality of these liners, for example by filling the tanks and pools with water to test them.

Labour inspectorate duties on the Flamanville 3 reactor construction site

The actions carried out by the ASN labour inspectors in 2012 consisted in:

- carrying out safety checks on the construction site;
- taking part in meetings of the Joint-contractors Safety and Working Conditions Committee (CIESCT) and the Committees for Health, Safety and Working Conditions (CHSCT) of the contractors;
- answering direct queries from the employees.

In 2012, 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.

In 2012, the Flamanville construction site was marked by a significant drop in the number of personnel assigned to civil engineering work. The intervention by the labour inspectorate on this subject consisted in advising the staff and employers concerned about their rights and in directing them as necessary to the relevant labour tribunal.

Monitoring the manufacture of nuclear pressure equipment for the Flamanville 3 reactor

Over the course of 2012, ASN continued to assess the conformity of the Nuclear Pressure Equipment (ESPN) for the EPR reactor primary and secondary systems (vessel, reactor coolant pumps, control rod drive mechanisms, pressuriser, steam generators, and some of the pipes and valves). Manufacturing is well advanced on all the major equipment items and under way for most types of valves. In addition to the review of the technical documentation concerning the design and manufacture of ESPN, ASN and the approved organisations specially tasked with monitoring and inspection performed more than 660 inspections to check the manufacture of this level N1 equipment, corresponding to more than 1,300 man/days of presence in the plants of the manufacturer AREVA NP, as well as its suppliers and their subcontractors. For their part, the organisations approved by ASN carried out more than 165 inspections to assess the conformity of the level N2 and N3 nuclear pressure equipment intended for the EPR reactor, which corresponds to more than 350 man/days of presence in the plants of the manufacturer AREVA NP, as well as its suppliers and their subcontractors.

5|3 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 4 | 3 | 4).

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

After ruling in 2010 on the continued operation of Tricastin reactor 1 and in 2011 on that of Fessenheim reactor 1, following their third ten-yearly outage, ASN on 10th July 2012 considered that Bugey reactor 2 was able to operate for a

4. The EPR reactor pools are divided into different compartments allowing the underwater handling and storage of fuel assemblies and vessel internals, in order to guarantee permanent cooling of the fuel assemblies and ensure radiological protection of the workers. The various pools are separated by movable structures called gates, enabling each compartment to be emptied and filled independently..



Installation of support brackets on the inner containment wall of the Flamanville 3 EPR reactor building

Manufacturing defects observed on the Flamanville 3 polar crane brackets

During an inspection on 14th December 2011, ASN was informed of a number of deviations that occurred during the manufacture of the supports of the reactor building polar crane. EDF discovered defects in the welds of these brackets in the factory before painting, then again on the Flamanville site during complementary checks. While these defects were initially discovered on a limited number of support brackets, ASN asked EDF to carry out additional checks on other supports. These additional checks revealed defects on a large number of the support brackets. EDF then informed ASN of its decision to manufacture a new batch of all the polar crane support brackets. Meetings were held between ASN, IRSN and EDF so that the licensee could present the steps taken to understand the origin of these numerous anomalies.

An inspection was carried out by ASN to check that EDF had correctly performed the steps planned to prevent defects of the same type on the new brackets. The inspectors also examined the steps taken by EDF to analyse whether other equipment intended for Flamanville 3 was affected by similar defects, which proved to be the case. EDF initiated treatment of the defects detected, sometimes returning the equipment concerned to the factory for repair.

further ten years, following its third periodic safety review. Pursuant to Article L.593-19 of the Environment Code, ASN in resolution 2012-DC-0311 of 4th December 2012 ordered EDF to comply with thirty-three new additional instructions designed to reinforce the safety of the Bugey NPP reactor 2. These instructions in particular include requirements applicable to facilities with more recent safety goals and practices.

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

After the Penly 1 and Cattenom 3 reactors in 2011, the Golfech 1 reactor in 2012 integrated the improvements resulting from the periodic safety review linked to its second ten-yearly outage.

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

After the Civaux reactor 1 in 2011, Civaux reactor 2 in 2012 integrated the modifications arising from the periodic safety review performed on the occasion of its first ten-yearly outage. As with the 900 and 1,300 MWe reactors, ASN will in 2013 rule on the continued operation of each of the reactors following examination of the conclusion reports submitted by EDF.

Continued reactor operations beyond 40 years

In 2009, EDF stated that it wished to extend the operating life of its reactors beyond 40 years. In France, the operating life of a reactor is not limited by the regulations (see point 4 | 3 | 4), but its ability to continue to operate must be periodically reviewed and its safety reassessed. In this respect, operation of a reactor beyond 40 years is a significant milestone. ASN in particular

requests that safety reassessment studies and the associated radiological objectives be considered in the light of the safety objectives applicable to new reactors, such as the EPR, in accordance with the position adopted by the WENRA association of European nuclear safety regulators.

At the request of ASN, the GPR met on 18th and 19th January 2012 to state its position on the orientations of the EDF study programme associated with the project to extend reactor operating life beyond 40 years. On the basis of the IRSN report, the GPR more particularly examined the steps taken or planned by EDF on the one hand to verify reactor conformity with the applicable baseline safety requirements and ensure that this is maintained in the future and, on the other, to improve the level of safety of existing reactors, with a view to achieving reactor operations of up to 60 years.

ASN will soon rule on the orientations of this study programme dedicated to the reactor operating life extension project.

5 | 4 Notable findings relating to oversight of pressure equipment

Detection of defects on the vessels of two reactors in Belgium

During inspections carried out in July 2012 on the reactor vessel of Doel 3 (Belgium), several thousand defects comparable to potential cracks were detected. These defects were revealed during ultrasound inspection of all of the heavily irradiated area of the vessel. This process, which is similar to that used during the ten-yearly outage of the French reactors, was used for the first time on the Doel 3 vessel, at the request of the Belgian nuclear safety regulator, AFCN.

These defects are most probably manufacturing defects. Similar checks were performed on several vessels produced by the same foundry, including those of Tihange 2 (Belgium) on which the same type of defects were observed.

ASN reviewed the situation of the French NPP reactors in the light of this event:

- the firm which manufactured the Doel 3 vessel produced no parts intended for the French NPP reactor vessels;
- in France, ASN checks the manufacture and monitors the operation of the main nuclear reactor pressure equipment, in particular the vessel. Specific monitoring of the construction of this equipment has been in place since 1974. For all the components of the French reactor vessels, checks are carried out during manufacturing in order to detect defects in the forgings;
- the performance and the results of the checks performed during manufacture to detect this type of defect were the subject of a detailed review by ASN in 1985 and 1986. Moreover, appraisals carried out in 2012 on a component scrapped owing to manufacturing defects, confirmed the ability of these checks to detect defects of the type brought to light in Doel 3 and Tihange 2;
- every ten years, ultrasound inspections are carried out on the heavily irradiated areas of the French reactor vessels in service. These checks have not yet revealed any defects of this nature.

The available information concerning the manufacturing practices in force since the early 70s in France give no indication of the presence on the French NPP reactor vessels of manufacturing defects in numbers and of dimensions similar to those discovered on the Doel reactor 3 vessel. ASN nonetheless asked EDF to carry out a detailed documentary review to confirm the correct performance of the manufacturing completion inspections. ASN also asked EDF to propose an inspection programme for certain vessels in order to further confirm the guarantees given.

5.5 Notable findings relating to occupational health and safety inspections

Monitoring of health and safety regulations

ASN's main labour inspectorate activity in 2012 was monitoring of the implementation of the regulations concerning health and safety in the workplace.

Labour inspection activities notably covered the following areas:

- 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 (CMR) chemical products, asbestos, or lead;
- the performance of work within the reactor containment while it is at power, in terms of both exposure to ionising radiation, to heat and to other conventional risks, notably steam, and in terms of the psychosocial risk;
- participation in the Ministry of Labour's campaign on psychosocial risks, in particular to ensure that they are evaluated and

taken into account in the occupational health and safety single risk assessment document (DUER), which must be kept up-to-date in each establishment;

- the ASN labour inspectors carried out a simultaneous inspection on eight NPPs concerning application of the regulations on the mandatory checks on electrical and lifting installations and, to ensure an integrated approach, on the impact of any deviations observed in the safety of the NPPs. This day of inspections enabled the inspectors to verify that the corresponding obligations were on the whole met, particularly with respect to the frequency of inspections. The inspectors nonetheless found that some premises were not visited owing to the radiological risk to the personnel responsible for the checks. The labour inspectors found disparities between the sites in the responsibility for, performance and traceability of certain conformity repair works.

Owing to their regular presence in the CHSCT, the labour inspectors are familiar with the subjects covered, notably with regard to occupational accidents. Labour accident inquiries, which are always held in the event of a severe accident, were rare in 2012 and no fatal occupational accident occurred.

Monitoring working hours

In 2012, ASN's labour inspectors continued with their inspections on compliance with regulations on working hours as well as on daily and weekly rest periods, specifically during reactor maintenance outages. For certain populations of technicians and managers required to work intensively during reactor outage periods, breaches of maximum daily and weekly working hours and rest periods are still observed. ASN notes that the policy of forward planning for the organisation of reactor outages, encouraged by ASN and the Ministry of Labour in 2011, so that EDF anticipates and requests the necessary waivers in compliance with the provisions of the Labour Code, is not uniformly implemented.

In June, ASN officially reminded EDF of the regulatory obligations regarding work and rest periods, as well as the risks to the health and safety of the operators or to the safety of the facilities that can be caused by overwork and insufficient rest. ASN also sent EDF a reminder concerning compliance with the provisions concerning work on 1st May.

Subcontracting

Detailed inquiries into the use of contractors, particularly in the service sector, continued in 2012 on several sites, in particular on the Flamanville 3 construction site with regard to the work being done by foreign contractors.

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

Current penal procedures

ASN's labour inspectorate issued eleven violation notifications on the NPPs to the relevant jurisdictions in 2012.

5|6 Notable findings relating to radiation protection of personnel

Three in-depth radiation protection inspections

During the month of April 2012, ASN carried out three in-depth inspections concerning implementation of the radiation protection regulations by the Le Blayais, Golfech and Civaux NPPs. Six ASN radiation protection inspectors, with the support of three experts from IRSN, examined several radiation protection related topics (organisation and management of radiation protection, application of the ALARA⁵ approach, radiological cleanliness, worker monitoring, management of radioactive sources, etc.) and noted that the radiation protection organisation defined and implemented on the three NPPs was on the whole satisfactory.

Gamma radiography incident of 20th March 2012 (Le Blayais NPP)

During the ten-yearly outage on Le Blayais NPP reactor 1, weld quality checks were carried out, with a GAM 120 type gamma radiography device, on a valve which had just been replaced inside the reactor building. After the check, during the night of 19th to 20th March 2012, the operators were unable to return the source to its safe position in the device, as the source had become separated from its drive cable.

The gamma radiography device was on an elevated platform, only accessible by means of a safety ladder. The congestion in the area and the dosimetric atmosphere of about 400 mGy/h at the top of the safety ladder meant that the source recovery operation was a complex one.

This incident, rated level 1 on the INES scale, is described in detail in point 4 of chapter 10.

Collective monitoring of the worker exposure risk

In 2012, ASN ruled on the ability to perform their function of the means dedicated to limiting the risk of worker internal or external collective exposure (in particular the monitors of iodine and aerosols activity in the reactor building, the gamma dose rate monitoring systems for the reactor building and fuel building pools and the vacuum valves⁶).

5|7 Notable findings relating to the environmental impacts of NPPs and discharges

Steps taken to combat micro-organisms

The renovation of the condensers (see point 1 | 1 | 4) makes it necessary to carry out biocidal treatment to limit the development of legionella bacteria and amoeba. Considering the progress made by EDF in limiting the discharges associated with

these treatments, ASN will gradually set maximum legionella colony forming limits for the cooling circuits of NPP cooling towers that are consistent with ICPE regulations. In order to prepare for this change, ASN sent a number of requests to EDF in 2012, concerning optimisation of the biocidal treatment on the NPPs located on the Loire river and the methods for rapid detection of amoeba and legionella bacteria in the micro-organisms development risk monitoring process.

Revision of discharge and water intake requirements

In 2012, ASN continued to examine the files concerning the discharge of effluents and intake of water by the NPPs at Cruas-Meysses, Belleville-sur-Loire, Cattenom and Bugey. The EDF requests for these four sites concern changes to the chemical conditioning of the secondary system, the implementation of anti-scaling treatment in the cooling systems (except in Belleville) and biocidal treatment by large-scale chlorination with controlled pH, plus biocidal treatment using monochloramine in Cattenom.

In Bugey, these requests are combined with a complete revision of the order of 7th August 1978⁷ and the future requirements will also cover discharges associated with the activities involved in the decommissioning of Bugey reactor 1 and the ICEDA facility, once it has been commissioned.

ASN also initiated a review of the files for Saint-Alban-Saint-Maurice, Saint-Laurent-des-Eaux and Fessenheim.

Risk of accidental discharges via the rainwater network

The GPR meeting of 28th May 2009 devoted to discharges and effluents from NPPs highlighted the fact that certain chemical substances, in particular phosphates, morpholine and hydrazine, were liable to be discharged via the rainwater network (SEO), even though this is not covered by the discharge requirements, nor monitored, nor counted. Following this meeting, EDF undertook to make an exhaustive inventory of the discharge routes to the SEO network for all the NPPs, before the end of 2011. In 2012, ASN issued a number of additional requests, in particular requiring EDF to take additional technical and organisational steps to prevent the overflow of substances into the SEO network for which there is no provision in the network specifications, as well as long-term provisions to physically rule out any such overflows.

Condition of retentions and prevention of pollution

ASN carried out a number of inspections to follow up the steps taken by EDF in the wake of the radioactive substance leakage incidents on the SOCATRI and FBFC sites in July 2008, and further to the event which revealed a tritium leak into the groundwater of the Civaux NPP in January 2012. ASN therefore sent EDF further improvement requests in particular for monitoring and surveillance of tanks, pipes, wells and firefighting water containment devices.

5. The ALARA (As Low As Reasonably 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.

6. Equipment used to reduce the risk of contamination inside a working area by extracting any radioactive particles emitted during the intervention.

7. Authorisation for discharge of gaseous radioactive effluents by the Bugey NPP: modification of Articles 1 to 6 of the order of 17th March 1978.

5|8 Examination of the safety options for the new ATMEA 1 reactor project

The ATMEA company, a joint venture formed by the French industrial firm AREVA and the Japanese firm Mitsubishi Heavy Industries, approached ASN in 2010 for a review of the safety options⁸ 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 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 the 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 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 break preclusion in certain pipes and, of course, the continued integration of the lessons learned from the accident which struck the Fukushima Daiichi nuclear power plant.

This safety options review will also allow ASN, if necessary, to assist the regulators in the countries in which this reactor is to be built.

8. 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 hazards considered in the design, and methods for dealing with them.

This step is specified in Article 6 of decree 2007-1557 of 2nd November 2007.

6 ASSESSMENTS

Operating reactors

6|1 Evaluating the EDF head office departments and the 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 safety, radiation protection, the environment and labour inspectorate duties.

Evaluation is based on the results of checks carried out by ASN in 2012, 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 2012, ASN carried out 457 inspections in the NPPs in operation and in the EDF head office departments, plus 281 days of labour inspection.

The following general assessment represents ASN's view of the year 2012 and acts as a guideline for ASN regulation and inspection actions for 2013.

6|1|1 Evaluating nuclear safety

Reactor operations

The documents needed for operation are on the whole satisfactorily managed. In particular, the number of deviations in the application of the periodic test rules is continuing to fall. However, the preparation and integration of changes to the general operating rules needs to be improved.

Management of operating personnel training and authorisations is on the whole satisfactory. In the same way as in 2011, improvements are still expected with respect to training of the shift crews.

Improving the rigorousness of operations remains a key priority for EDF. However, ASN observed no improvement over 2011 in this field. ASN considers that the efforts made on this subject in recent years must be continued.

Following the efforts made by EDF since 2010, the identification, management and elimination of "exceptional equipment and means" and temporary modifications which have been present on the reactor for several years, have been improved.

However, the preparation for operational interventions remains a weak point and improvements are required on this subject.

The interfaces between operating and maintenance or testing personnel are often the source of deviations, resulting from communication errors or misunderstandings. Actions to improve this situation need to be continued.

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

Finally, as in 2011, rigorous application of the operating baseline safety requirements and management of temporary operating instructions still require improvement.

Emergency situations

2012 was marked by the implementation on 15th November 2012 of the new baseline safety requirements concerning the on-site emergency plans (PUI) for the EDF sites. ASN considers that these new baseline safety requirements improve EDF's preparedness for management of emergency situations.

The inspections carried out in 2012 on the subject of emergency management showed that most of the deviations identified during the post-Fukushima inspections in 2011 had been corrected by the sites. However, the inspections performed in 2012 identified areas for improvement, notably concerning the monitoring and follow-up of exercises and corrective measures, the management of mobile emergency resources and the PPI sirens. Progress has been made in the agreements between the sites and outside organisations, including those with hospitals, but the sites must continue to make efforts because some of these agreements are still obsolete or little known.

Fire and explosion

In 2012, ASN and its technical support organisation, IRSN, concentrated in particular on the steps taken by EDF to deal with the issue of breaks in fire sectors and the management of actual situations encountered, especially the fire that broke out on a reactor coolant pump in the reactor 2 building on the Penly NPP.

ASN observes that over the past ten years, considerable resources have been deployed to improve how the fire risk is handled and the overall level has progressed. There are however still areas of inadequacy. For example, deviations in the management of breaks in fire sectors, in the issue of fire permits or in monitoring of contractor training in fire prevention, remain all too frequent. Furthermore, the management of calorific potential is improving on some sites, while being inadequate on others. With regard to interventions, fire exercises are carried out too infrequently in the controlled area and fail to take sufficient account of the complexity of potential situations (hydrogen risk, injured staff, contamination, unavailability of off-site emergency services, etc.). Finally, the in-situation exercises carried out during the inspections sometimes revealed difficulties with managing the postulated situations.

With regard to the site internal explosion risk, ASN in 2012 asked that the baseline safety requirements be strengthened in order to meet the goals set for the periodic safety reviews on the 900 MWe reactors, associated with their third ten-yearly outage and for the N4 plant series' first ten yearly outage inspection.

Maintenance activities

In the past, EDF had failed to adequately anticipate certain equipment ageing problems, nor take sufficient account of international operating experience feedback, which obliged it to

revise its strategy, now focused on preventive measures. Deployment of the AP913 maintenance method (see point 2|3|1) aims to strengthen equipment monitoring and initiate the corresponding repair work before the equipment actually fails. However, ASN observes that some problems with comparable safety implications are not anticipated to the same degree.

ASN notes that EDF does not in sufficiently good time identify the equipment important for safety for which there is a risk of obsolescence (see point 4|3|2) or which was not designed to be replaced. The spares supply and management methods also create recurring deviations. They can lead to maintenance being postponed or even to maintenance work being carried out, resulting in equipment which no longer conforms to the design or construction requirements.

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 requirements defined by EDF at the national level are constantly changing. The delays with integration are persisting on all the NPPs and are tending to result in disparate requirements;
- the files and risk assessments to be produced ahead of the maintenance work are sometimes inappropriate or incomplete. These points must be improved and EDF needs to anticipate more broadly when preparing for the reactor outage;
- lastly, the quality of maintenance operations also requires greater consideration of human factors and closer monitoring of the contractors.

ASN considers that EDF must ensure that there are adequate human and material resources for these activities.

Condition of equipment

Equipment maintenance and replacement programmes, the safety review process and correction of deviations identified contribute to keeping NPP equipment in a generally satisfactory condition.

However, ASN believes that EDF should address the problem of obsolescence of some equipment items at an earlier stage. In addition, EDF must give greater attention to the qualification of equipment 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 be closely monitoring the effective implementation of this plan.

First barrier

ASN considers that in 2012 the situation concerning the maintained integrity of the first barrier could be improved on certain points, in particular the cleanness of the work sites, to prevent foreign bodies entering the primary reactor coolant system. On this point, the situation has deteriorated slightly in relation to the previous year; ASN noted the presence of numerous foreign bodies in the primary reactor coolant system in 2012.

With regard to the integrity of the nuclear fuel cladding, the long-term steps initiated by EDF have led to a significant

reduction in the number of leaking fuel assemblies. In 2012, leaktightness defects on RFA fuel assemblies in some 900 MWe reactors was associated with vibration wear of these 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 still present in the reactors will be very small in 2013 and will be insignificant within a few years.

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 pressure equipment situation in the NPPs is satisfactory. In particular, ASN notes the following positive points:

- functioning of the recognised inspection services (see point 2|5|5) that is on the whole satisfactory, even if some sites must remain vigilant with respect to their staffing levels, to updating their documentation or to their responsiveness;
- compliance with the requirements of the order of 10th November 1999 (see point 2|5|1) and the order of 12th December 2005 (see point 2|5), despite the differences between the sites.

However, ASN considers that there are still weak points, in particular the recurrence of line connection errors which exert stresses on the pressure equipment, or “pressure hammer” type dynamic transients, insufficient preparation for certain pressure tests and the numerous clogging incidents. Failure to systematically notify ASN prior to major interventions is observed, as well as non-compliance with Article 17.3 of the decree of 13th December 1999, in that some sites prefer to maintain non-conforming equipment, without presenting adequate justification.

Concerning the guaranteed integrity of the reactor second barrier, ASN considers that EDF's situation could still be improved, even if the situation is tending to get better with the continued strategy designed to ensure that the secondary part of the steam generators is kept clean.

Third barrier and 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 2012. ASN notes that there is a slight rise in the number of events concerning the containment.

The ageing of the 900 MWe reactor containments was examined in 2005 during the periodic safety review associated with their third ten-yearly outage, in order to assess their leaktightness and mechanical strength. This examination brought to light no particular problems liable to compromise their operation for a further ten years. The results of the ten-yearly outage tests for the reactor containments have so far shown leak rates that comply with the regulations. 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 is continuing its assessment work in order to detect the cause of the rise in the containment leak rate, which is probably

attributable to a penetration and, at the request of ASN, will conduct an additional containment test in 5 years.

The results of the initial tests on the 1,450 MWe reactor containments or the first ten-yearly outage tests on the 1,300 MWe reactor containments identified a change in the leak rate from the inner wall of some of these containments. 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 areas of the wall would be liable to crack, leading to leak rates in excess of those adopted in the safety case hypotheses. 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. The tests performed during the second ten-yearly outage of the 1,300 MWe reactors and the first ten-yearly outage on the 1,450 MWe reactors all proved to be satisfactory.

An analysis of the issues linked to the 1,300 MWe and 1,450 MWe reactor containments was carried out in 2012 and the conclusions will be examined by the GPR in the run-up to the third ten-yearly outage for the 1,300 MWe reactors. A detailed assessment of certain points meant that the GPR meeting was scheduled for 2013.

6|1|2 Evaluating human and organisational measures

Provisions concerning staff and organisations in operational activities

ASN considers that the organisation and specific actions taken to improve the integration of human factors into operations differ from one site to another. The organisation set up by EDF makes provision for a “Human Factors Consultant” (CFH) position per pair of reactors. ASN notes satisfactory professional “human factors” training of the HF consultants, who generally have a technical background and come from the field. The duties of the CFH chiefly consist in taking part in the process of operating experience feedback from the site and in training the EDF or contractor staff in practices to increase the reliability of human interventions. ASN considers that the CFH duties could be extended to other organisational and human factors fields, such as participation in the skills management system or in any social, organisational and human (SOH) approaches implemented by the sites, which take account of the needs of the staff and the organisation in the light of changes to systems or modifications to certain equipment.

In addition to the HF consultants, some sites have a network of local HF correspondents within the technical sections, but the amount of time they are allowed to devote to this function is very limited and often not specified. It must be noted that these networks are often inadequately staffed and ineffective and that no improvement in these aspects has been observed for a number of years.

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 also noted that the managers are on the whole strengthening their presence in the field, even if these field visits are sometimes more to check behavioural nonconformities by the workers or the condition of the facilities, as part of the “obtain installations in exemplary condition” project (OEEL), rather than to observe working situations and detect possible improvements or areas in which worker training might be needed. 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. For ASN, the “human performance” project must not be implemented by the sites to the detriment of other site-specific improvement measures concerning safety organisation and management, or intervention conditions, but should be considered to be complementary. ASN observes that even on sites where these reliability practices are well-established, “human” or “organisational” aspects still contribute to the occurrence of significant events.

Finally, ASN considers that the HF measures adopted by EDF primarily aim to disseminate and implement managerial policies and requirements, but do not as yet contribute sufficiently to improved assimilation of the realities in the field by the site management.

Working conditions

Once again in 2012, on several NPPs, ASN found numerous inadequacies concerning equipment availability, operational documents and the human-machine interfaces. ASN for instance saw defective lighting, equipment poorly suited to the tasks to be performed (for example, a trolley used for radiographic inspections which does not fit on the pipe and is too heavy to lift, with the result being that a safety rated servomotor was used as a desk for the site documentation), tight working spaces, documents that are inappropriate (for example an operating procedure with the wrong revision index), incomplete or hard to access, marking errors, indications that are hard to read, which sometimes led to significant events. Furthermore, certain work-sites, in particular during reactor outages, are not clean enough.

ASN underlines that ergonomic problems make it harder for the staff to work, all the more so as they also have to deal with work organisation constraints, work scheduling changes and problems with worksite coordination, leading to activity delays or postponements.

As hardware modifications are mainly managed at the national level, the sites do not always have the room for manoeuvre they might require to improve the working environment when a need is identified locally. However, the following improvements were observed on two sites: when the operator is interrupted, coloured magnetic markers can be placed next to or on the device being worked on, in order to minimise the risk of error. In addition, a screen giving the main parameters to be monitored by the operators is located in the control room.

Management of skills, qualifications and training

The skills and qualifications management in place on the sites is on the whole satisfactory and the management processes well

documented and coherent. Inadequacies on certain sites are however still being found by ASN during the inspections, with regard to the forward planning of jobs and skills management. 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 stress tests.

The tutor system is on the whole implemented in the departments, even if the corresponding workload for the tutor is not always clearly documented. 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 the 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.

Analysis of the OHF viewpoint in operating experience feedback

ASN noted that the site “Human Factors Consultants” (CFH) sometimes support the technical sections, usually at their request, to help identify the root causes of events, which are most often organisational in nature. However, these CFH are not always included in the experience feedback analysis process as a whole, which includes the identification, implementation and follow-up of corrective measures taken following analysis of the event. When the technical sections comprise networks of human factors correspondents, they are sometimes involved in analysing events. ASN considers that the human factors correspondents must be more automatically and systematically consulted when analysing events.

The objectives of integrating proactive operating experience feedback, based on the “early warning signs” approach, are satisfactory. However actual implementation could be improved because on the majority of sites, the early warning signs are only picked up by the manager and not by all the workers, including the contractors. Furthermore, the processing and analysis of these early warning signs often remain limited or patchy.

Provisions concerning staff and organisations in operational reactor modification activities

The aim of the SOH approach is to transform engineering practices at EDF, to take greater account of people and organisations in the changes made to the systems and modifications to hardware and organisations, right from the outset of the design projects. ASN considers the philosophy of the SOH approach to be pertinent and important in guaranteeing the safety of the facilities and the security of the workers. In the engineering centres inspected in 2012, the inspectors found that an organisation was in place to implement the SOH approach, in particular through the appointment of an SOH coordinator and the creation of an SOH committee.

6.1.3 Evaluating health and safety, professional relations and the quality of employment in the NPPs

In 2012, the ASN labour inspectorate carried out 749 interventions during 281 days of inspection in the field, including 36 CHSCT meetings, made 1,539 observations and sent out 11 violation reports to the prosecutor’s offices concerned.

With regard to worker health and safety, the ASN labour inspectorate noted a disparity between EDF workers and those of the subcontractors. These latter, who mainly work on construction and maintenance sites, are more exposed to both conventional and radiological risks. The frequency of occupational accidents (number of accidents with time off work per million hours of work) on all the reactors, was 2.9 in 2012 (4.1 in 2011) for EDF and 5 (4.8 in 2011) for the subcontractors; these frequency levels nonetheless remain significantly lower than the averages observed in French industry. ASN considers that EDF must develop its professional risks prevention policy, for example through improved monitoring of regulatory verifications or by improving the quality and precision of the prevention plans required by the regulations concerning work by staff from outside contractors.

With regard to working and employment conditions, the ASN labour inspectorate considers that EDF needs to strengthen its “continuous improvement of working conditions” policy for all workers (for example, to improve the working conditions in the steam generators or prevent exposure to chemical and CMR risks, etc.), increase the field presence of the occupational physicians and enhance the role of the CHSCT. ASN also notes disparities between EDF and subcontractor staff in the various collective agreements (wages, travel, etc.).

EDF uses a vigilant, “best-bidder” buying policy, which should have a positive impact on the services subcontracted, but ASN drew EDF’s attention to potential or even confirmed situations (as proven by the issue of violation reports) of exploitation or illegal transfer of manpower. These findings also apply between subcontractors (“cascaded” subcontracting) especially when there are unforeseen circumstances or delays. Given the expected rise in the volume of maintenance work, this subject requires particular vigilance, notably owing to the probable and large-scale need to resort to international contractors (PSI).

On the Flamanville 3 EPR construction site, extremely difficult working conditions were observed in 2012, because they had not anticipated at the design stage, for example, finishing-sanding inside concrete ventilation ducts. At ASN’s request, the site adopted a more effective professional risks prevention policy in 2012 and is more rigorous in meeting its obligations as lead contractor in combating illegal working, especially in the context of particularly frequent use of international contractors on the site.

In terms of professional relations and with regard to all the NPPs, ASN’s labour inspectorate notes that the institutions representing the personnel on the whole function correctly, even though social dialogue is sometimes locally difficult. There were occasional strikes during the course of 2012.

The Inter-company Working Conditions and Safety Committees (CIESCT) are considered on the whole to be relatively ineffective in dealing with the working conditions of

subcontractor staff on the sites. In this respect, some situations led to labour conflicts on the sites, triggered by the staff of subcontractor companies.

During reactor outages, the working organisation adopted to meet the completion deadlines regularly leads to most of the sites exceeding the maximum working hours and failing to comply with the rest period requirements. Even if these findings only concern a small number of staff, the overshoots can be considerable. ASN in 2012 once again issued violation reports for several similar situations. EDF has made significant efforts to correct the situation and in 2011 set up administrative authorisation procedures as required by the regulations, followed in 2012 by alert systems. However, its policy must consider all the staff, including managers, who are particularly exposed. ASN considers that these situations and the corresponding working organisations must evolve further, because they can prejudice the health and the vigilance of the workers and thus potentially the safety of the facilities.

6|1|4 Evaluating and analysing radiation protection

In 2012, ASN carried out twenty-two specific inspections on the subject of radiation protection.

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 organisation defined and implemented by the NPPs is on the whole satisfactory. In particular, the collective dosimetry per reactor and individual dosimetry in particular are both down in 2012 by comparison with 2011. This reduction is partly linked to a lesser volume of maintenance work. The doses received by the workers are broken down as shown below in graphs 2, 3 and 4.

However, ASN considers that the average radiation protection situation in the NPPs could be improved on a small number of points and that there are still areas for improvement identified in recent years.

For the project to renovate the major components of the NPPs, ASN considers that in its future reactor outage campaigns, EDF must increase its efforts to limit the expected rise in collective and individual dosimetry.

ASN also notes that even though significant progress had been made in recent years, there was an increase in the number of events concerning industrial radiography operations, in particular the quality of the clear marking out of the operations area.

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, management of mobile radiation protection devices and deployment of experience feedback and best practice to the intervention personnel.

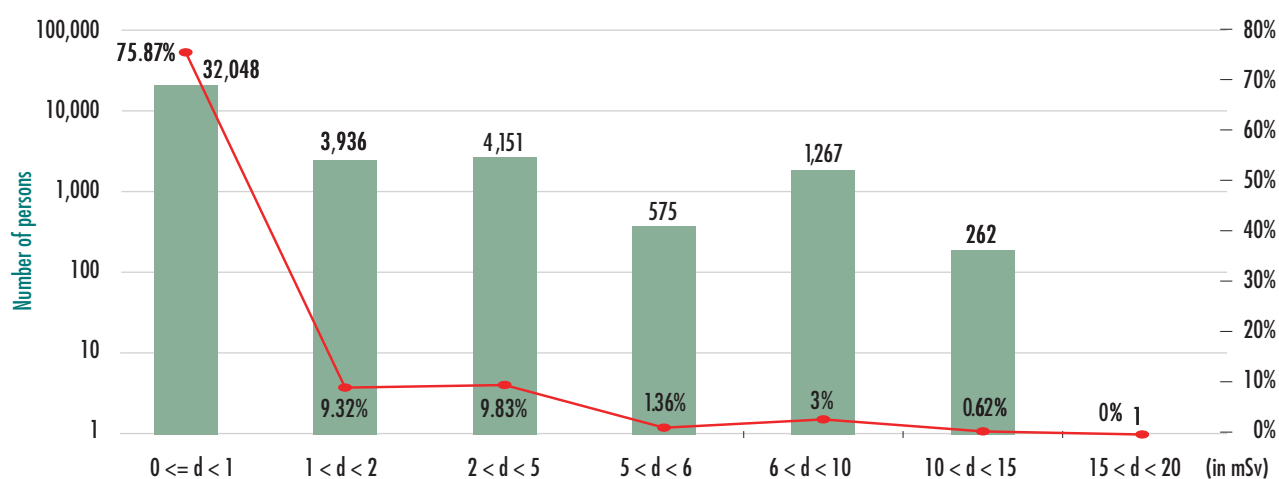
6|1|5 Evaluating and analysing environmental protection measures

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

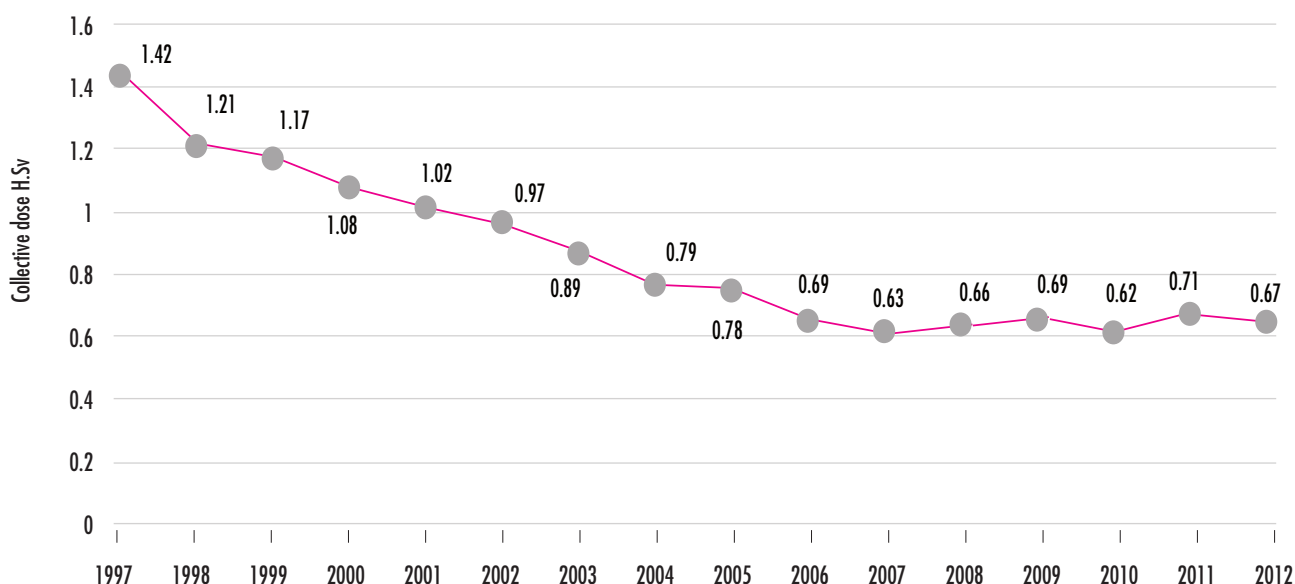
EDF does not give sufficient attention to processing of facility conformity deviations, the implementation of maintenance programmes and the updating of operational documents. Furthermore, a number of irregularities were observed by ASN in application of the specifications regulating discharges, the measures for the prevention and limitation of detrimental effects set by the order of 31st December 1999 as amended, and the management of waste.

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

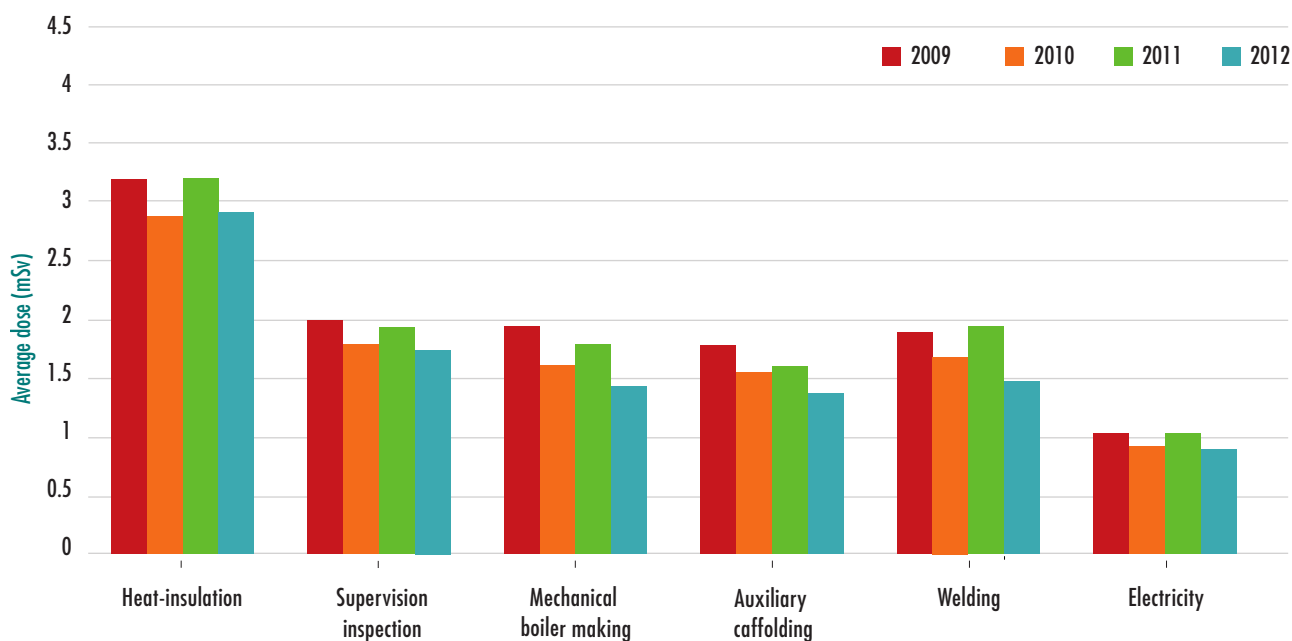
Graph 2: Breakdown of the population per dose range over the year 2012 (EDF data)



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



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



6.1.6 Analysing statistics on significant events

Significant events in 2012

Under the rules on notification of significant events in the areas of safety, radiation protection and the environment, in 2012 EDF reported 712 Significant Safety Events (ESS), 114 Significant

Radiation protection Events (ESR) and 93 Significant Environmental Events (ESE) (involving neither nuclear safety nor radiation protection).

Graph 7 shows the trends in the number of significant events reported by EDF and rated on the INES scale since 2007. 830 events were rated on the INES scale in 2012.

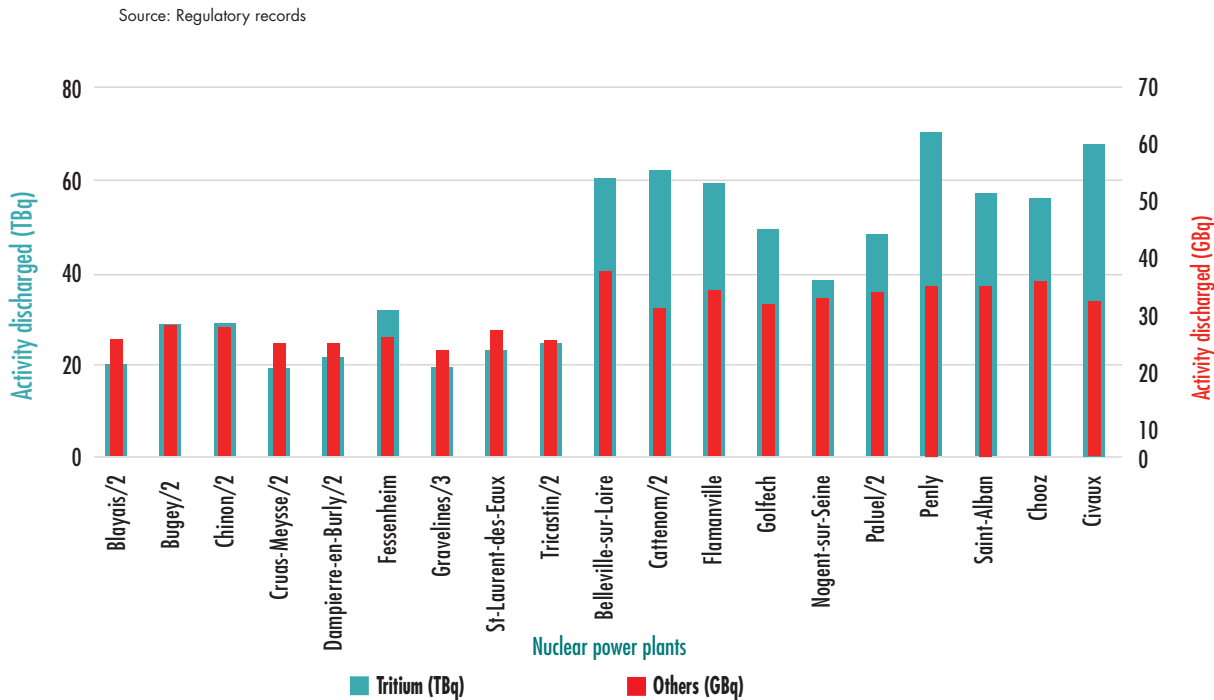
Graph 8 shows the trends since 2007 in the number of significant events per area concerned by the notification: Significant Safety Events (ESS), Significant Radiation protection Events (ESR) and Significant Environmental Events (ESE).

The number of ESS notified increased by about 10% over 2011, while remaining on the whole comparable with previous years.

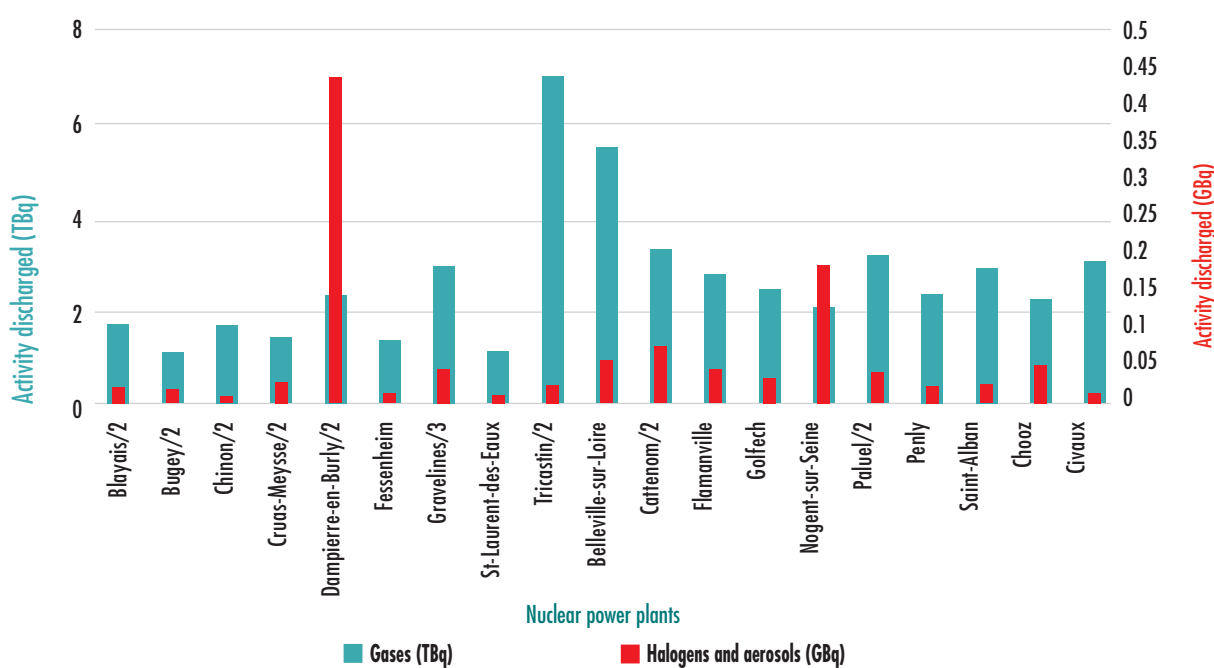
A generic ESS was rated level 2 on the INES scale (see box in point 4 | 2 | 2).

The number of ESR declared increased by about 20% over 2011. This rise is mainly due to industrial radiology operations rather than the performance of technical controls (zoning and mobile radiation protection devices). As the body responsible for

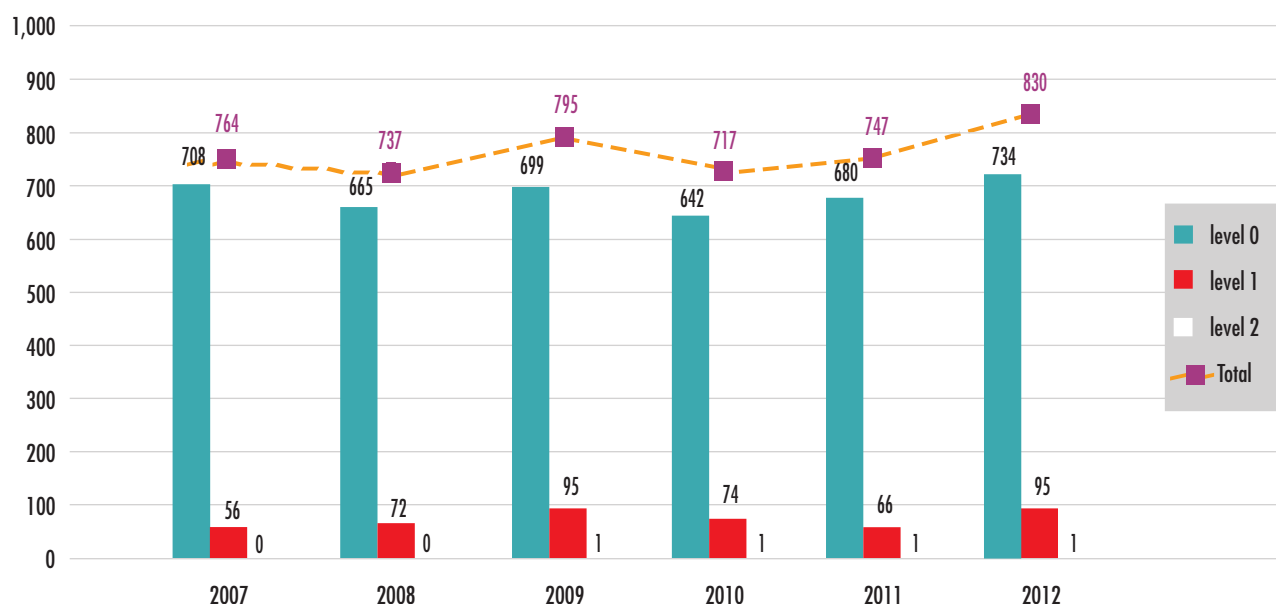
Graph 5: Liquid radioactive discharges for the NPPs in 2012



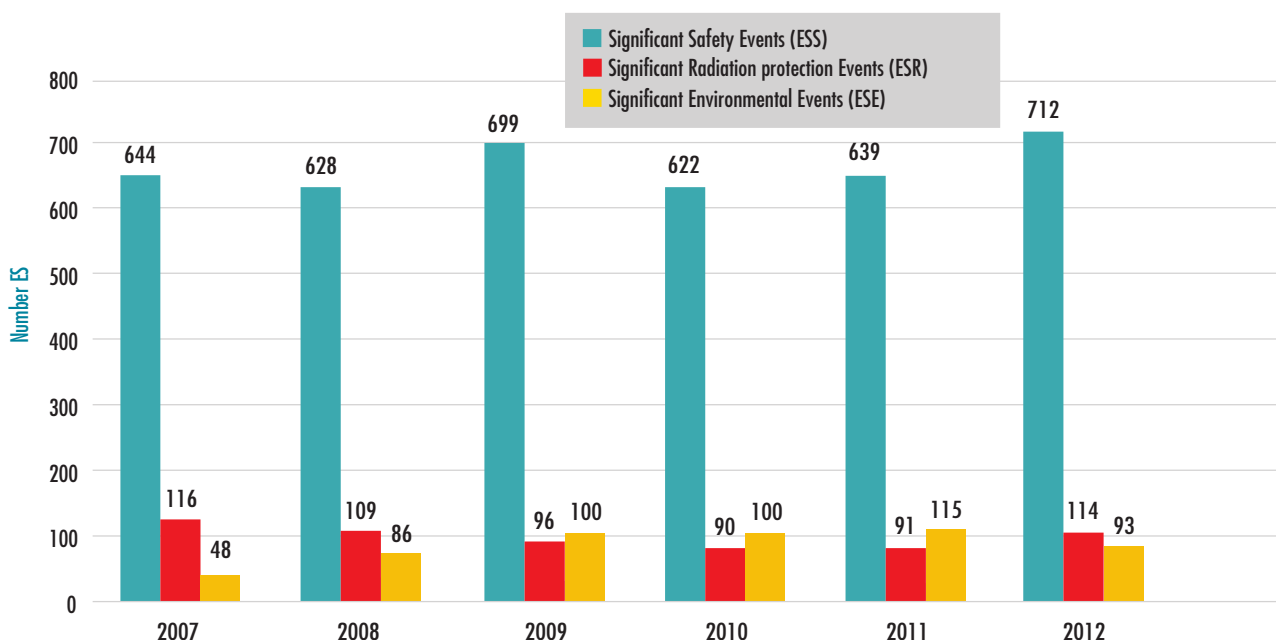
Graph 6: Gaseous radioactive discharges for the NPPs in 2012



Graph 7: Evolution of the number of significant events rated on the INES scale in EDF nuclear power plants from 2007 to 2012



Graph 8: Evolution of the number of significant events per domain in EDF nuclear power plants from 2007 to 2012

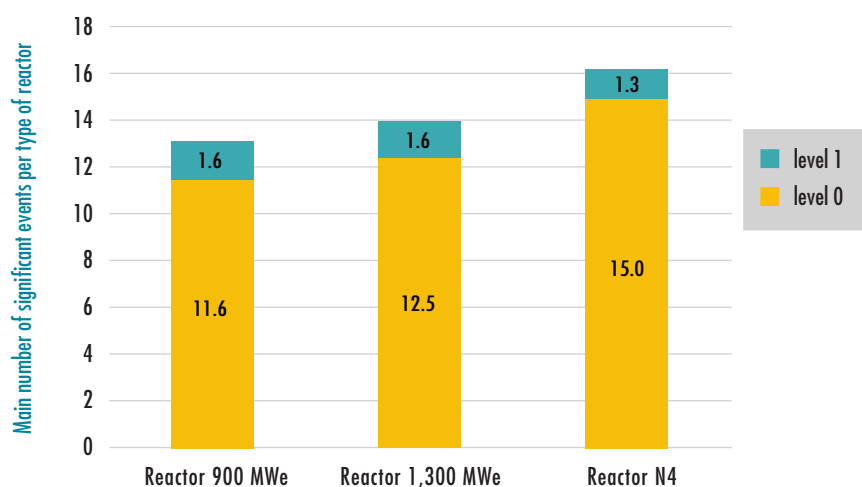


radiation protection in the NPPs, EDF must oversee the protection of and maintaining a safety culture amongst its staff as well as amongst contractors' staff.

The number of ESE is down on last year, but 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 2012, rated at levels 0 and 1 on the INES scale, for each standardised plant series. For the N4 plant series, the average number of significant events is slightly higher than for the other series; this difference being mainly due to the average volume of maintenance in 2012, which is greater on these reactors than on the other plant

Graph 9: Mean number of significant events rated on the INES scale in EDF NPPs per type of reactor and per year, for 2012



series, owing to the end of the first ten-yearly outage for the N4 plant series. The increased amount of maintenance activity during the outage periods generally contributes to a rise in the number of deviations detected.

6|2 Evaluating 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 the safety of EDF's facilities. ASN notes that the site was able to identify and implement corrective measures concerning certain operational deviations. However, the site must initiate progress in management of the periodic tests.

ASN considers that the organisation of radiation protection is on the whole satisfactory despite the persistence of deviations observed during its inspections. The site is continuing with its efforts to reduce worker exposure during maintenance operations.

With regard to the environmental impact of the facilities, ASN notes that the site falls short despite the measures taken in recent years. ASN in particular noted a lack of rigour in the operation of the conventional and potentially pathogenic waste storage facilities.

Blayais

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

It notes the good general running of the maintenance operations during reactor outages but considers that the site needs to improve the quality control of the activities performed. The

deployment of a new IT system on the site caused several organisational problems.

ASN considers that the site needs to improve how it monitors environmental requirements and how it communicates with the public authorities concerning events liable to affect the environment. Although the radiation protection organisation is robust, ASN notes a number of deviations in the oversight of gamma radiography operations and in the management of access to areas in which the dose rate is high.

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 the first half of 2012, progress was made in compliance with technical operating specifications. ASN however notes that the Bugey site was unable to consolidate this progress during the second half of 2012. Moreover, ASN notes that the Bugey site shows signs of recurring shortcomings in the preparation and performance of periodic tests or certain maintenance work.

With regard to radiation protection, ASN notes that the Bugey site has managed to maintain the progress observed in 2011 concerning the dosimetry of the staff working on the site. ASN did however note weaknesses on the Bugey site with regard to rigorous compliance with radiation protection rules for access to areas specially regulated for worker protection against ionising radiation ("orange" or "red" areas).

With regard to environmental protection, ASN considers that the Bugey site needs to continue its efforts to reduce the volumes of liquid effluents produced by the non-nuclear part of the facilities. ASN also notes that since mid-October 2012, Bugey has detected the abnormal presence of tritium in the site groundwater. In resolution 2012-DC-0172 of 31st October

2012, ASN instructed EDF to reinforce its environmental monitoring and identify the equipment which led to this abnormal presence of tritium in the groundwater.

Cattenom

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

However, it does consider that the site needs to make progress in managing unforeseen circumstances and work preparation, especially with regard to communication between the various stakeholders.

In February 2012, ASN rated level 2 on the INES scale a deviation affecting the cooling system of the spent fuel pools for reactors 2 and 3 (see 4 | 2 | 2). ASN considers that the site was responsive in dealing with ASN's requests.

The site effectively monitors environmental issues and utilises appropriate indicators, particularly concerning discharges.

The site falls short of the other NPPs in terms of worker radiation protection: radiological cleanliness is good, but certain practices in the field could be improved.

Chinon

ASN considers that in terms of nuclear safety, the Chinon NPP falls short of its general assessment of EDF. However, by means of its detailed inspections, supplemented by the in-depth inspection carried out in October 2012 on operational stringency, ASN does see improvements, even if no significant turnaround is observable.

With regard to radiation protection, ASN has observed a clear improvement since late 2011, with performance which is on the whole in-line with the general assessment of EDF. ASN considers that this positive trend, primarily driven by the department responsible for risk prevention, must be continued.

Concerning the environmental performance of the Chinon NPP, ASN considers that the site falls short. The quality and responsiveness of the deviation analyses in this field deteriorated in 2012. However, the site remains a driving force on a number of environmental subjects.

Chooz

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

The Chooz site in particular needs to make progress in its work preparation and in the quality of the risk assessments drawn up prior to the work, and must pay particular attention to the maintenance of the equipment contributing to protection of the environment.

ASN considers that the Chooz site maintains a high level of compliance with pressure equipment regulations.

Finally, ASN considers that the Chooz site has regressed in terms of operational stringency and notes a rise in line connection errors in the facilities and in planning of periodic tests.

Civaux

ASN considers that nuclear safety and radiation protection performance of the Civaux NPP stands out positively with respect to ASN's general assessment of EDF, but that it falls short in terms of nuclear and environmental protection performance.

ASN notes that good account is taken of radiation protection in work preparation and that collective dosimetry remains low despite the numerous work programmes conducted during the ten-yearly outage on reactor 2.

During the course of 2012, ASN observed a number of deviations in the application of the reactor operating rules and a number of shortcomings in the handling of maintenance files. ASN considers that the site must demonstrate greater rigour in preparing and carrying out operation and maintenance and that the monitoring of these activities needs to be improved.

ASN considers that the site must ensure more rigorous monitoring of the equipment contributing to environmental protection and surveillance.

Cruas-Meyssse

ASN considers that the nuclear safety performance of the Cruas-Meyssse site falls short of its general assessment of EDF performance. ASN in particular notes shortcomings in the management of maintenance and operation during the reactor outage phases. ASN also observes that the restart of reactor 4 was marked by the notification of seven significant safety events, three of which were rated level 1 on the INES scale, highlighting inadequacies in the line connection and system configuration activities. Considering that, EDF needs to significantly improve its results in this field. ASN issued the resolution 2012-DC-0313 on 10th July 2012, instructing the Cruas-Meyssse site to reinforce the technical checks and the performance of audits concerning line connection and system configuration operations.

Where radiation protection is concerned, ASN considers that the performance of the Cruas-Meyssse site is on the whole in line with ASN's general assessment of EDF's performance. The Cruas-Meyssse site must however improve its worksite radiological cleanliness results. Moreover, ASN noted that it was notified of six significant radiation protection events in 2012, attributable to failure to apply radiological zoning rules.

With regard to environmental protection, ASN in 2012 observed that there are still shortcomings on the Cruas-Meyssse site, as shown by the spillage of several litres of uncontaminated oil into the Rhone river on 31st October 2012.

With regard to occupational health and safety, ASN noted that the results of the Cruas-Meyssse site in 2012 were unsatisfactory, for the second year running. Even if ASN noted a slight improvement in this area in 2012, this tenuous positive trend will have to be confirmed on a long-term basis.

ASN also observes that social relations on the Cruas-Meyssse site remain difficult. The summer of 2012 was in particular marked by a strike relating to the renewal of a logistics contract, which paralysed the Cruas-Meyssse site for several weeks and disrupted the smooth running of the reactor outages.

Finally, ASN considers that in general the management of skills on the Cruas-Meyssse site needs to be improved in order to guarantee that qualifying training, in particular refresher training, is carried out in accordance with the baseline requirements in force on the site.

Dampierre-en-Burly

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

In 2012, ASN observed progress in control and maintenance operations, despite a particularly dense campaign of reactor outages. However, ASN considers that the management of the material resources required during the incident or accident operating phases needs to be significantly improved.

Concerning occupational safety and radiation protection, ASN considers that the organisation of the site is on the whole satisfactory, in particular when preparing operations with major dosimetric implications. The extent to which radiation protection issues are addressed still varies considerably and deviations from the regulations were once again observed.

With regard to the environmental impact of the facilities, the site stands out positively in relation to ASN's general assessment of EDF and environmental issues are dealt with well by the various departments.

Fessenheim

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

In this respect, ASN notes the close involvement by the EDF head office departments.

ASN considers that the Fessenheim site stands out with regard to preventive maintenance during outages and demonstrates



ASN inspection of progress of the "ultimate make-up" programme at the Fessenheim NPP – December 2012

considerable responsiveness in integrating regulatory requirements, thanks to the work done by the site, with the support of the head office departments. The performance of the work relating to the continued operation of reactor 1, within the time-frame set by ASN, improves the facility's safety level. Nonetheless, the site must make further progress on its risk assessments ahead of the interventions.

If the site is on a par with the other NPPs in terms of environmental protection, it still falls short in terms of worker radiation protection. Numerous deviations are still observed and are indicative of a lack of radiation protection culture among those involved. A remediation plan was put into place and its effectiveness will be closely monitored by ASN.

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 notes that the site is continuing its efforts to make up for a long-standing and significant delay in the processing of certain maintenance operations. However, in the light of its inspection during the reactor 1 outage and of several significant events notified in 2012, ASN considers that the Flamanville site needs to make progress in the preparation, performance and oversight of the maintenance activities. The site must also reinforce its reliability practices when carrying out the interventions in the facilities.

ASN notes that several significant radiation protection events mean that the site needs to raise the level of the radiation protection culture among the workers in the controlled area.

Golfech

ASN considers that the nuclear safety and radiation protection performance of the Golfech site is on the whole in line with ASN's general assessment of EDF, and that the radiation protection performance stands out positively.

ASN notes that the operating teams carry out satisfactory monitoring of the facilities but identifies a lack of rigour in certain operations. ASN also considers that the site needs to improve oversight of its contractors during maintenance operations, as a number of deviations were detected belatedly.

Radiation protection performance remains good, even if ASN noted a number of deviations concerning interventions in the controlled area. ASN considers that the site is insufficiently responsive in dealing with events with a potential environmental impact.

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.

However, ASN considers that the site needs to make progress in its operational rigour, the analysis of significant safety events and the quality of maintenance interventions, which are the cause of a rise in the number of significant safety events.

In 2012, EDF continued with the programme of third ten-yearly outages on the Gravelines reactors 1 and 3. ASN examined the results of the inspections carried out on reactor 1, affected by cracking of a reactor vessel bottom-mounted instrumentation penetration (see 2 | 5 | 2).

In 2012, the steps taken jointly by EDF and the licensees of high-risk facilities located nearby, helped reduce the potential risks arising from the site's industrial environment. EDF was however late in transmitting the complementary studies concerning the impact of the future methane tanker terminal.

An OSART (Operational Safety Review Team) mission was carried out on the Gravelines site by a team of 14 experts from the IAEA in November 2012 (see chapter 7).

Nogent-sur-Seine

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

As in the previous year, the site is no longer making progress in terms of stringency of operations. 2012 was marked by errors in line connection and by inadequate monitoring during the control of operations specific to the steam generators. ASN considers that this second point clearly highlights the fragility of the human resources available in the control room.

ASN considers that the site's maintenance performance, more specifically with regard to contractor monitoring, falls short of the general assessment of the EDF fleet.

With regard to the environment, ASN considers that the site is making progress. Waste management, however, could be improved.

Paluel

ASN considers that the radiation protection and environmental protection performance of the Paluel site is on the whole in line with its general assessment of EDF performance, but that nuclear safety falls short of this general assessment.

ASN observes that several significant events notified by the site, the vast majority of which were during the restart of a reactor following a maintenance outage, highlight insufficiencies in stringency, in preparation of interventions and in oversight and monitoring of maintenance activities.

ASN underlines the problems with managing three reactor outages, involving numerous technical difficulties with equipment important for safety, entailing lengthy repairs. The site must therefore make progress in this field with a view to the next ten-yearly outage.

Penly

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

Generally speaking, the site is continuing the positive developments of previous years. However, ASN considers that the site

needs to reinforce its organisational measures concerning contractor monitoring during reactor outages, particularly with regard to the resources allocated in the field.

The year was marked by the 5th April incident on reactor 2, concerning a primary coolant fluid circulating pump, which led to the scheduled outage of the reactor being brought forward and then extended until 3rd August, so that important maintenance and repair work could be performed.

Saint-Alban

After three years in which it fell short of ASN's general assessment of EDF, ASN considers that the nuclear safety performance of the Saint-Alban site was generally in line with its assessment of EDF performance. ASN in particular notes that the Saint-Alban site has improved the deployment of its independent safety organisation and reinforced the robustness of the analyses it produces. On 6th June 2012, the Director of the Saint-Alban site and the Director of the EDF nuclear generating division also presented the ASN General Directorate with the structural measures it intends to take to address ASN's findings following the in-depth inspection it carried out from 5th to 9th September 2011. Therefore, in the light of the inspections it carried out in 2012, ASN notes that even if they remain precarious, the nuclear safety results on the Saint-Alban site are on the whole improving, with the fundamental steps initiated by EDF beginning to bear fruit. ASN does however consider that this improvement needs to be continued on a long-term basis.

With regard to environmental protection, ASN considers that the performance of the Saint-Alban NPP has improved but that the site falls short of its general assessment of EDF performance. The Saint-Alban site must improve the stringency of its operation of equipment contributing to protection of the environment.

With regard to the monitoring of pressure equipment, and after deciding in 2011 not to renew its approval of Saint-Alban's inspection department, ASN carried out an audit in April 2012, during which it noted the quality of the action plan implemented by EDF to reinforce the activation and independence of this department. In the light of the conclusions of this audit, ASN sent the Prefect a proposal that the Saint-Alban site's inspection department be again approved as of 1st June 2012.

Where radiation protection is concerned, ASN considers that the Saint Alban site's overall performance is in line with ASN's general assessment of EDF's performance. In this area, the results of the Saint-Alban site differ widely: although access to specially regulated areas for worker protection against ionising radiation (limited stay and prohibited areas) is satisfactory, control of contamination on the worksites during reactor outages needs to be improved.

Saint-Laurent-des-Eaux

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

In terms of nuclear safety, ASN considers that significant progress had been made by the site on most of the weak points identified in previous years, such as technical monitoring defects. ASN nonetheless considers that particular attention must be given to the management of operating documents.

In the field of radiation protection, ASN considers that the site's organisational arrangements are on the whole satisfactory, specifically concerning the processing of deviations. ASN will check that the progress identified in 2012 concerning the consideration of radiation protection issues by the workers, will continue in 2013 during the major reactor outages campaign.

Concerning environmental protection, ASN considers that the optimisation of liquid discharges and maintenance of the facilities remain positive points on this site. However, progress is still expected concerning management of the impact of the site's water intake and effluent discharge regulations and optimisation of the monochloramine treatment process.

Tricastin

ASN considers that the nuclear safety performance of the Tricastin NPP is, on the whole, in line with ASN's general assessment of EDF's performance. However, ASN considers that the Tricastin site's performance should be significantly improved with respect to the performance of periodic tests, the post-maintenance qualification of equipment and, to a lesser extent, line connections and system configuration operations. ASN also considers that the Tricastin NPP relies too much on its head office engineering department when it submits files to ASN, without assuming its responsibility as licensee.

Where radiation protection is concerned, ASN considers that the Tricastin site's overall performance is in line with ASN's general assessment of EDF's performance.

With regard to occupational health and safety, ASN observes that the progress achieved by the Tricastin site since 2010 remains precarious and needs to be confirmed in the future.

With regard to environmental protection, ASN considers that the performance of the Tricastin site falls short of its general assessment of EDF performance. Thus, in resolution 2012-DC-0264 of 13th March 2012, ASN served the Tricastin site with formal notice to conform to the requirements concerning environmental discharges of liquid and gaseous effluents following an event involving the spillage of demineralised water containing morpholine into the rainwater network.

Finally, in its resolution 2011-DC-0227 of 27th May 2011, ASN instructed the Tricastin site to improve its protection against the risk of flooding, by carrying out works on the Donzère-Mondragon hydraulic structure. On 18th June 2012, EDF submitted an authorisation application file for the performance of these works. ASN notes that this file was not considered to be acceptable at this stage by the Government departments responsible for reviewing it, given the particularly tight performance calendar.

New reactors

6|3 Evaluating Flamanville 3 EPR reactor construction

Quality management associated with construction activities on the Flamanville 3 site

Following the inspections carried out in 2012 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 equipment important for safety and has produced satisfactory results so far. ASN specifically noted that, for the welding of the pool liners, lessons had been learned from operating experience feedback concerning the tank liner welding activities.

ASN notes that given the postponement of certain welding and concreting activities, for which considerable experience feedback had been gathered, EDF must ensure that the skills of the staff in charge of these activities is maintained. ASN also considers that EDF must remain vigilant with respect to the rigorous processing of deviations, by implementing specific methods, such as the processing of the deviation concerning the spaces behind the gate of the EPR pools. On these two points, ASN considers that EDF was able to provide satisfactory answers and evidence in response to ASN's requests.

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

During its inspections, ASN found that the organisation set up in the various EDF departments, whether engineering or the teams in charge of monitoring the activities performed by its contractors, is in line with the principles set by EDF, and that these principles are implemented more systematically than in previous years. However:

- in the past, the manufacture of many components had begun without EDF validation of the quality requirements, as a result several actions are in progress at EDF and its contractors to demonstrate that the equipment being manufactured complies with the expected technical characteristics;
- the defects discovered in early 2012 on the polar crane support brackets, even though they were already installed on the Flamanville site, led ASN to query the EDF doctrine for monitoring manufacturing in the factories. ASN considers that the defects affecting the support brackets (see point 5|2) should have been detected far earlier, in particular owing to the problems encountered by EDF in the past with the manufacture of other components using similar welding processes. ASN notes that EDF has begun a revision of its monitoring doctrine accordingly, and will pay particular attention to these changes.

Furthermore, as all the detailed design studies for the Flamanville 3 reactor have not yet been completed, EDF shall, once they are finalised, check that all elements involved in the reactor safety case are coherent.

Manufacture of pressure equipment for the Flamanville 3 EPR reactor

The order of 12th December 2005 concerning nuclear pressure equipment, known as the “ESPN order”, clarifies the key safety requirements applicable to nuclear pressure equipment (ESPN). For the equipment that is most important for safety, known as “level N1 equipment”, it requires:

- the performance of “technical qualification” intended to identify the risks of component heterogeneities in order to ensure that they have the required characteristics throughout their entire volume;
- compliance with the mechanical characteristic values specified for each type of material.

In order to meet these requirements, AREVA, which is the manufacturer of these components and the EDF supplier, has identified the zones of the components concerned by potential heterogeneities and performed mechanical tests in the areas which are not usually subject to such checks. This approach therefore led AREVA to wonder whether it was possible to achieve the mechanical properties indicated in the ESPN order throughout the entire volume of the components.

In the case of the steam isolation valves, AREVA highlighted a risk that, in the thickest part of the component, the mechanical properties might be lower than those obtained in the other zones. At the request of ASN, AREVA thus looked to optimise the manufacturing process in order to guarantee that the properties mentioned in the ESPN order are obtained.

ASN considers that the ESPN manufacturers must take care to use the best available technologies in order to guarantee the quality of the equipment in the Flamanville 3 reactor.

The nuclear steam supply system (NSSS) of the Flamanville 3 EPR reactor comprises a large number of nuclear pressure equipment items (containers under pressure, pipes, valves, safety valves). These equipment items are assembled together to form integrated and functional units. The first assembly erection operations began on the Flamanville site in November 2012.

In addition to its regular inspections of EDF, the nuclear installation licensee, ASN also examined the measures taken by AREVA, the assemblies manufacturer, to prevent the risks of the units being damaged during transport to and assembly on the site. ASN ensured that the risks of impacts, deformation, chemical pollution, corrosion, etc. are taken into account.

ASN has asked AREVA to carry out a risk assessment of these transport and on-site installation phases and to clearly identify the measures planned to reduce or eliminate these risks. At the same time, ASN had started its inspections on this subject in June 2012 on the Flamanville 3 construction site. These first AREVA on-site inspections showed that progress was still required:

- in the identification of the documents drafted by the manufacturers and defining the precautions to take to prevent equipment damage during transport and assembly;
- in the definition of and compliance with the conditions of conservation of the equipment in the buildings after their installation until they are commissioned, notably with regard to temperature and relative humidity.

In 2010 and 2011, several nonconformities were detected by AREVA NP during the manufacture of the Flamanville 3 EPR vessel head. This involved a large number of weld defects on the vessel adapters and a localised lack of thickness on the metal buttering under some of these same welds. These deviations led AREVA NP to propose large-scale repairs to ASN, the principle of which was accepted, subject to closer monitoring of the repair operations. In 2012, these EPR vessel head repair operations continued in accordance with the monitoring procedures defined by ASN. No significant deviation was detected during these operations.

6|4 Evaluating the manufacture of nuclear pressure equipment

In 2012, ASN and the approved organisations carried out:

- more than 830 inspections to check the manufacture of nuclear pressure equipment intended for the Flamanville 3 EPR reactor, representing more than 1,600 man/days in the manufacturers’ plants, as well as those of their suppliers and subcontractors,
- more than 1,600 inspections to check the manufacture of the spare steam generators intended for the NPP reactors in operation, which represented more than 3,400 man/days in the manufacturer’s plants, as well as those of their suppliers and subcontractors.

ESPN conformity assessment practices

ASN considers that, even if they do not compromise the conformity of the equipment being manufactured with the regulations, some of the practices in force up to 2012 could be improved. ASN considers that the nuclear pressure equipment manufacturers must do everything to apply the provisions specified in the conformity assessment guidelines as rapidly as possible.

ASN however notes that all the manufacturers are taking increasing note of the new regulatory requirements. It specifically notes that certain requirements have been satisfactorily assimilated by the manufacturers. Generally speaking, ASN therefore considers that in 2012, as a result of complying with the provisions of the ESPN orders for a number of years, the equipment manufacturers have reached a satisfactory level with respect to the “technical qualification” requirement. This requirement, introduced by the ESPN order and applicable only to level N1 nuclear pressure equipment, aims to identify the risks of heterogeneities in the volume of nuclear pressure equipment components, in order to ensure that they will actually have the required properties (mechanical, chemical, physical, metallurgical). It is a means of providing additional guarantees concerning the quality of the components manufactured.

In October 2012, ASN completed its conformity assessment of the first steam generator manufactured in compliance with the requirements of the ESPN order. As a result of this assessment, ASN considers that AREVA was able to acceptably demonstrate the conformity of the equipment with the provisions of the ESPN order, thanks to the efforts made during the course of 2012. ASN however considers that AREVA practices must further change in order to adapt fully to the practices introduced by this order, specifically with respect to the content of the technical documentation, in order to enhance the clarity of its baseline

requirements to ensure compliance with those of the regulations. ASN observed that the conformity assessment of these steam generators had helped to determine the procedures for drafting a part of this documentation and considers that AREVA must take account of the experience feedback from this initial application example.

Continuity of the steps taken to manage manufacturing risks

In early 2012, on the occasion of checks performed during the manufacturing process, AREVA detected defects due to the presence of hydrogen in the shells manufactured by Creusot Forge and intended for the replacement steam generators. This observation led to these shells being scrapped and to ASN requesting the cessation of manufacturing activities in order to ensure that AREVA had taken all measures to prevent the appearance of these defects. These measures were taken in addition to the checks carried out, the performance of which was not called into question.

Detailed assessments had been carried out on this phenomenon in 1980 and had led to the implementation of numerous preventive measures. ASN nonetheless found that experience feedback from several years of defect-free manufacturing resulted in a relaxation of these measures on the part of the manufacturer. ASN considers that the manufacturers must exercise vigilance to ensure that the preventive measures designed to guarantee manufacturing quality must be maintained on a long-term basis. Manufacturing was able to

resume normally after several months stoppage once the steelmaker responsible for production of the material had implemented specific surveillance and more rigorous practices.

Monitoring of organisations approved by ASN for assessment of ESPN conformity

The approved organisations play a major role in checking compliance with the regulatory requirements which apply to the design and manufacture of nuclear pressure equipment. They are directly or indirectly involved in the inspection of the manufacture of all nuclear pressure equipment, through the authorisations issued by ASN.

Further to ASN's 2012 monitoring of the approved organisations, no significant deviation liable to compromise the justification of their approval was observed. ASN however observed that certain practices, often similar to those of "conventional" equipment, were unable to take full account of certain requirements specific to nuclear pressure equipment.

ASN considers that the organisations approved for assessment of nuclear pressure equipment conformity must have appropriate procedures taking account of the quality requirements specific to the nuclear field. ASN also expects the approved organisations to have personnel with particular skills and mastering the requirements specific to the nuclear field, both for assessment of nuclear pressure equipment conformity and for in-service monitoring.

Guidelines for the assessment of nuclear pressure equipment (ESPN) conformity

The assessment of equipment conformity with the regulatory requirements entails examination of the documentation produced by the manufacturer and the performance of inspections by ASN or the inspection organisation tasked with this assessment. These practices are described in guidelines for the assessment of nuclear pressure equipment conformity, the first version of which was published in March 2009. In late 2010, ASN initiated a revision of these guidelines, specifically by identifying the points requiring clarification and the changes felt to be necessary, in the light of experience feedback from the first years of application of the ESPN order. ASN published the revised guidelines in September 2012 after consulting the Advisory Committee for nuclear pressure equipment.

The revision of these guidelines for conformity assessment and discussions with the industrial firms concerned, led ASN to note that certain conformity assessment practices were still imperfectly implemented.

- ASN recalled the need for a nuclear pressure equipment preliminary design review prior to manufacture. This review should in particular cover the choice of materials, the pre-dimensioning and the limitation of areas susceptible to certain damage phenomena, particularly fatigue. ASN considers that the nuclear pressure equipment manufacturers must continue their efforts to ensure that the technical documentation used for the performance of this review is available as early as possible before the manufacturing operations begin.

- ASN also clarified the scope of the inspections to be performed at the end of nuclear pressure equipment manufacturing in order to ensure that all applicable regulatory requirements are met. This review, called the final verification, consists of a visual examination of the equipment and a documentary check. ASN stressed the need for an exhaustive check on compliance with the applicable requirements and for the final verification being performed under the responsibility of an organisation or of the manufacturers. ASN also recalled that problems with the performance of visual checks should not lead to them being abandoned but to the definition of equivalent compensatory checks. In 2012, ASN performed several inspections concerning compliance with these rules which showed that, even if few deviations are today observed, the scope of the inspection and the complexity of the procedures involved require particular attention.

ASN also called on the nuclear pressure equipment manufacturers to exercise vigilance with regard to demonstrating that the materials used in the equipment comply with the relevant regulatory requirements. This verification implies monitoring of the materials suppliers by the manufacturers themselves.

7 OUTLOOK

With regard to NPPs, ASN's regulatory and inspection duties in 2013 will be primarily concerned with the subjects presented below.

7|1 Experience feedback from the Fukushima Daiichi accident

Following on from the actions of 2012, ASN will pay particular attention to how EDF takes account of experience feedback from the accident at the Fukushima Daiichi NPP. ASN will ensure specific monitoring of the implementation of the additional safety measures required following the stress tests and will in particular issue a position statement on EDF's proposal to implement a "hardened safety core" of material and organisational measures to control the fundamental safety functions in extreme situations.

7|2 Oversight of the EPR reactor and the associated international cooperation

Regulation of the EPR reactor

Surveillance of construction of the Flamanville 3 EPR will continue until authorisation for commissioning of the installation. Currently, EDF anticipates initial operation at rated power in 2016. Between now and then, ASN will continue its oversight of occupational accident risk prevention. ASN will also continue to check how EDF monitors the quality of the work done on the site and the manufacturing work performed off the site by its suppliers, in particular for nuclear pressure equipment. At the same time, ASN will continue with its advance review of certain parts of the required commissioning authorisation application file, especially with the help of the Advisory Committee for nuclear reactors (GPR). 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 foreign counterparts also involved in the project.

International cooperation in the field of new reactors oversight

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 finalising common positions on subjects resulting from these safety objectives and that warrant clarification.

7|3 Labour inspection

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

maintenance site activities. Further to the problems with the maximum working hours being exceeded and the inadequate rest periods observed on the sites since 2009, but also EDF's creation in 2011 of an anticipated working hours management policy for reactor outages, ASN will pay particular attention to actual measures concerning working hours, in particular for the management. It will continue its inspections in this area to evaluate EDF's commitments, assess their actual implementation and penalise any deviations observed.

ASN will make every effort to implement the measures defined in the 2013 action plan from the Ministry of Labour with regard to labour inspectorate duties, as well as in the national occupational safety plan (PNST). It will emphasise health and safety, job quality, in particular for temporary staff, social dialogue, in particular owing to the professional elections and the fight against illegal labour. On this last point, the inspections on sub-contractors will be continued in 2013, with emphasis on the activities more directly related to safety.

Finally, with a view to developing an integrated view of safety, the ASN labour inspectors will be associated with other ASN regulation and monitoring actions, with the continuation of coordinated measures in 2013, especially in the field of fire.

7|4 Radiation protection and protection of the environment

Radiation protection

Given the anticipated rise in the volume of NPP maintenance over the coming years, ASN fully expects EDF to strengthen its radiation protection policy, specifically with greater optimisation of individual and collective doses. In this respect, ASN wishes to obtain the opinion of the Advisory Committee for reactors (GPR) on certain aspects concerning the optimisation of doses during future reactor outage campaigns for the NPPs operated by EDF.

This strengthening of EDF's radiation protection policy will be given close attention by ASN when reviewing the files submitted to it and during on-site inspections. ASN will also continue with its wide-ranging inspections, such as those performed in 2011 on the four sites in Val-de-Loire (Belleville-sur-Loire, Dampierre, Saint-Laurent-des-Eaux and Chinon) and in 2012 on the Civaux, Blayais and Golfech sites.

Environmental Protection

In 2013, ASN will continue to review the files for modification of the water intake and effluent discharge licenses for the Belleville, Cattenom and Bugey sites and will begin the review of the files for the Saint-Alban, Saint-Laurent-des-Eaux and then Fessenheim sites. ASN will ensure that the discharge limits are set for these sites taking account of the best available techniques, environment protection objectives, and experience feedback from the NPPs in operation.

ASN will continue to monitor optimisation of discharges, in accordance with the measures decided on following the meeting of the Advisory Committee for reactors in 2009 concerning the management of radioactive and chemical effluents associated with the French NPPs in operation. ASN will continue to review the files concerning steam generator cleaning and the management of cleaning effluents.

It will also devote efforts in the field to checking that the measures to which EDF is committed for tackling legionella, but also to reduce coolant fluid emissions and to manage waste, are actually implemented on the sites.

Finally, ASN will continue to integrate operating experience from events at SOCATRI, FBFC and Civaux (see point 5 | 7), by checking that EDF continues to take action on the tanks and retentions and on the prevention of pollution, as well as through targeted inspections.

7|5 Management of experience feedback

Experience feedback is one of the fundamental means of identifying improvements to be made to organisational arrangements in order to strengthen how all high-risk activities are managed. On the occasion of the GPR examination of experience feedback for the years 2003 to 2005, ASN had noted that in its analysis of significant events, the licensee failed to give sufficient prominence to organisational and human factors. At ASN's request, EDF undertook to change its analysis method.

In 2012, EDF informed ASN of its intention to implement a new significant events analysis method. This is based on a search for the root causes of these events, both organisational and human, with a view to making the corrective measures to be implemented more robust. ASN will monitor the conditions of the deployment of this new method in the NPPs and its effects on the process of experience feedback management at EDF.

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

In 2013, ASN will continue to examine the periodic safety reviews on the French NPPs. ASN considers this process to be the cornerstone of the safety improvement process. Analysis of the periodic safety review is also a means of obtaining a precise snapshot of the condition of each of the reactors, partly through the results of the in-depth inspections performed during the ten-yearly outages. After the end of each ten-yearly outage, ASN will give its position on the ability of each reactor to continue to operate and will, if necessary, issue additional prescriptions concerning their operation. In 2013, ASN should in particular adopt a stance on the continued operation of the Bugey 5, Dampierre 1, Fessenheim 2, Gravelines 1, Tricastin 1, Chooz, Civaux, Saint-Alban, Nogent-sur-Seine, Cattenom 2 and 3, Belleville and Penly 1 reactors.

7|7 NPP operating lifetime

In 2010, EDF announced its intention to extend the operating life of its reactors beyond forty years. Even if management of the ageing of the facility is a necessary precondition for the continued operation of the reactors beyond forty years, this condition is not considered to be in itself sufficient by ASN. Operation of the French NPPs for such a period is only conceivable if associated with a proactive and ambitious programme of safety improvements in addition to those initiated as part of the periodic safety reviews in progress. For ASN, these improvements must aim to raise existing NPP reactor safety to levels as close as possible to the safety objectives applicable to a new reactor.

To achieve this, ASN will in 2013 rule on the study and work programme proposed by EDF with a view to extending the operating life of its reactors.

