“Nuclear Safety: Our Overriding Priority”

EDF Group Report 2014

In response to FTSE4Good Nuclear Criteria

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1. EDF GROUP

EDF is the world's leading nuclear energy company, and operates across all electricity business sectors. EDF holds substantial positions in several major countries worldwide. Key facts and figures in 2013:

- 654 TWh generated worldwide,
- 39.1 million customers worldwide,
- 116 g CO2/kWh generated,
- 160,000 employees worldwide,
- €75.5 billion in revenue.

EDF Group places sustainability at the core of its corporate strategy and has adopted 9 commitments responding to three priority challenges:

- The environment: Tackling climate change and protecting biodiversity:

  1. Remain the lowest carbon emitter among the major European energy companies, especially electric utilities
  2. Adapt our fleet and our customer offers to promote climate protection.
  3. Reduce our environmental impact, especially on biodiversity.

- Social responsibility: Improving access to energy and developing close links with local communities:

  4. Promote access to energy and energy efficiency.
  5. Develop and sustain links with local communities where we work.
  6. Support education on major energy issues.

- Governance: Contributing to the debate on sustainable development through dialogue, information, and communication:

  7. Continue to implement strategies based on the values we share with all our employees and stakeholders.
  8. Regularly report on our corporate social responsibility initiatives and results.
  9. Contribute to the debate on sustainable development at both a national and international level.

These commitments are detailed in a position statement jointly signed by all CEOs of EDF Group companies:

CHANGER L'ÉNERGIE ENSEMBLE

En tant qu'énergéticiens, nous avons le souci d'une croissance responsable et nous sommes conscients de notre impact sur l'environnement. Nous avons le devoir de nous mobiliser pour préserver la planète et relever le défi du changement climatique, tout en conciliant la sécurité de notre approvisionnement énergétique, la sûreté de nos installations et des offres d'énergie accessibles et compétitives.
Nous sommes convaincus qu'il existe un lien fort entre énergie et environnement et que l'électricité faiblement carbonée peut contribuer à résoudre la crise climatique.
Notre Groupe, qui dispose déjà d'un parc important d'installations de production faiblement carbonées (hydroélectricité, nucléaire, éolien, nouvelles énergies renouvelables), s'engage à rester le moins émetteur de CO_2 des grands énergéticiens européens.
Les différentes sociétés qui le composent, développent un lien étroit avec les territoires dans lesquels elles opèrent, et agissent pour :

- combiner croissance durable et gestion responsable de l'entreprise, en s'appuyant sur le partage de valeurs communes ;
- réduire les émissions de gaz à effet de serre dans la durée et développer les énergies renouvelables, grâce à des technologies rentables et des investissements soutenus ;
- promouvoir l'éco-efficacité énergétique par une gamme toujours plus large de produits et de services destinés aux entreprises et aux particuliers.

Présidents et Dirigeants des différentes sociétés du Groupe, nous nous engageons en faveur d'une politique de développement durable partagée, qui s'articule autour de trois grands enjeux :

- un enjeu environnemental : la lutte contre le changement climatique et la préservation de la biodiversité ;
- un enjeu sociétal : l'accès à l'énergie et la proximité avec les territoires ;
- un enjeu de gouvernance : la contribution au débat sur le développement durable à travers le dialogue, le partage d'information et la communication.

Nous partageons avec nos salariés une conscience toujours accrue de ces enjeux.
Cette vision commune doit servir notre développement partout où nous sommes présents.

Nous mobiliserons tous nos efforts afin de respecter cet engagement.

Henri PROGLIO, Président-Directeur Général, Groupe EDF
Vincent DE RIVAZ, Directeur Général, EDF Energy
Umberto QUADRINO, Président-Directeur Général, Edison
Hans-Peter VILLIS, Président du Directoire, EnBW
John RITTENHOUSE, Directeur Général, EDF Trading
Didier GUENIN, Directeur Général, Électricité de Strasbourg
Patrick LUCCIONI, Président-Directeur Général, Fenice
Jean-Yves GUIGNARD, Président du Conseil d'Administration, FIGLEC
Nicolas KATCHAROV, Président, BE ZRt
Jacques PITHOIS, Président, DEMASZ
David CORCHIA, Directeur Général, EDF Énergies Nouvelles
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Patrick SIMON, Président, Norte Fluminense
Pierre CHAZERAIN, Président du Conseil d'Administration, SSE

01 GROUPE EDF_Politique développement durable
GROUPE EDF_Politique développement durable 02

Figure 1: EDF commitment "Leading the Energy Change"

2. NUCLEAR ASSETS OF EDF GROUP

EDF owns nuclear facilities in three continents:

- in France, where the parent company owns and operates 58 reactors and is building a new one using the most advanced technology - the European Pressurised Water Reactor (EPR)
- in the UK, where EDF Energy owns (jointly with its minority shareholding partner Centrica, 20% stake) and operates 15 reactors. It also has plans to build four new EPRs.
- in the USA, where CENG, the joint venture between Exelon and EDF, owns and operates five reactors.

EDF also owns other assets in several nuclear companies, without operational responsibilities. The performance of these assets results from the operating companies and is therefore not consolidated into the results of EDF Group, in line with international accounting regulations. These assets are as follows:

- Tihange 1 in Belgium: EDF has a 50% investment (owned by EDF Belgium) in the plant but Electrabel is the sole operator of the plant[1].
- Taishan in China where TNPJVC, the joint company held by China General Nuclear Power Group (51%), Yudean (19%) and EDF (30%), will own and operate two new EPR reactors currently under construction.

[1] Signature of a General Agreement on 16 December 1996. EDF contributes 50% to all operational expenses and capital investments during operation and post-operation (following final shutdown), but not to decommissioning itself.

EDF also owns stakeholdings in companies in Belgium and Switzerland:

- In Belgium EDF owns 63.5% of EDF Luminus which owns 10% of the investment of Tihange 2-3 and Doel 3-4. EDF Luminus has no operational involvement or responsibility in those plants which are fully operated by Electrabel.
- In Switzerland EDF owns 25.1% of ALPIQ which owns 40% of Kernkraftwerk Gösgen-Däniken AG which is the operating company of Gösgen power plant, and 32.4% of Leibstadt AG which is the operating company of Leibstadt plant. ALPIQ has no involvement or responsibility in the operation of Gösgen and Leibstadt NPP.

EDF also holds nuclear power service contracts, mainly for technical assistance, e.g. in China or South Africa.

2.1 EDF SA

EDF SA owns and operates in France the largest nuclear fleet in the world, built by the Group as architect-engineer. The nuclear fleet includes 58 reactors with three different power levels (900MWe, 1300MWe and 1450MWe).

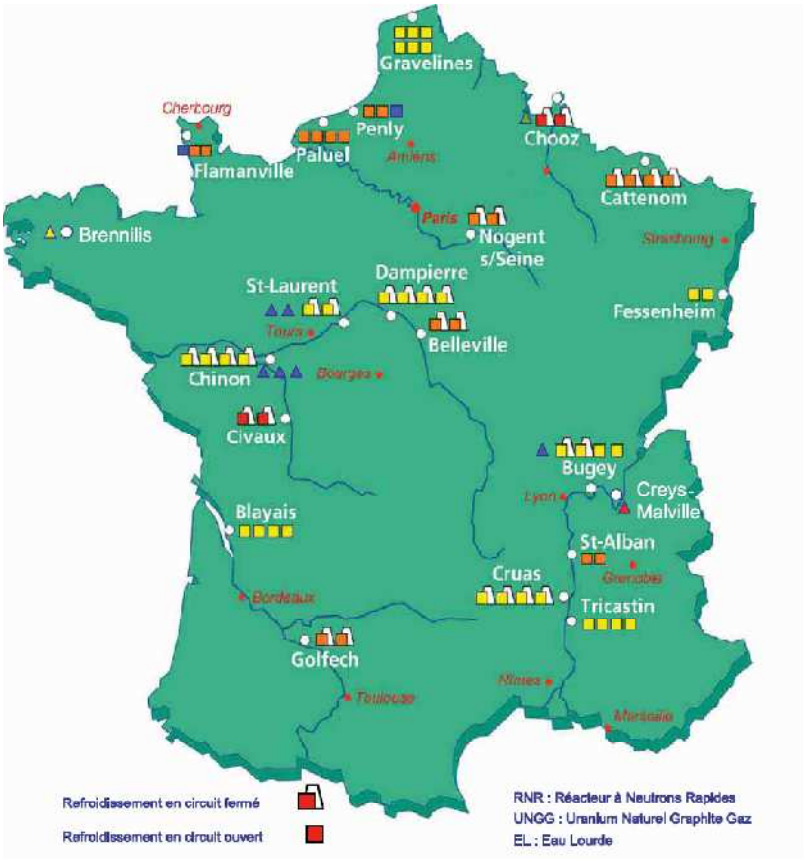


Figure 2: Map of French nuclear power plants

REACTORS IN OPERATION

SITE	Number of reactors	TYPE	POWER (MW)	COMMISSIONING YEAR
Fessenheim	2	CP0-PWR	880	1977
Bugey	4	CP0-PWR	2 x 910-2 x 880	1978-79
Dampierre	4	CP1-PWR	890	1980-81
Gravelines	4	CP1-PWR	910	1980-81
Gravelines	6	CP1-PWR	910	1984-85
Tricastin	4	CP1-PWR	915	1980-81
Blayais	4	CP1-PWR	910	1981-83
St Laurent B	2	CP2-PWR	915	1981
Chinon B	4	CP2-PWR	905	1982-87
Cruas	4	CP2-PWR	915	1983-84
Paluel	4	P4-PWR	1330	1984-86
Flamanville	2	P4-PWR	1330	1985-86
St Alban	2	P4-PWR	1335	1985-86
Cattenom	4	P'4-PWR	1300	1986-91
Belleville	2	P'4-PWR	1310	1987-88
Nogent	2	P'4-PWR	1310	1987-88
Golfech	2	P'4-PWR	1310	1990-93
Penly	2	P'4-PWR	1330	1990-92
Chooz B	2	N4-PWR	1500	1996-97
Civaux	2	N4-PWR	1495	1997-99

EPR UNDER CONSTRUCTION, our third generation reactor

EDF SA is currently building a new 1,600 MW EPR at the Flamanville site. The EPR, a pressurised water reactor (PWR), belongs to the latest and third generation of nuclear reactors. It will be safer, more powerful, and more environmentally friendly than its predecessors. Due to its "evolutionary design", the EPR incorporates the full experience feedback compiled by its designers and by French and German operators over more than thirty years.

The EPR has a capacity of 1630 MW and will consume 17% less fuel due to a more efficient core and higher output efficiency.

EDF has set ambitious environmental targets for the EPR, leading to a series of measures intended to further mitigate the impacts of a power plant on the environment. In normal operating conditions, radioactive and chemical discharges ([2]) will be at least 30% lower per MWh generated. In addition, the higher combustion rate and the core design will reduce by around 30% the amount of radioactive waste versus the current 1300 MW reactors.

In 2013, a major milestone in the construction was reached with the dome installation in July. The project entered an intensive phase of electro-mechanical assemblies, in particular with the installation and gradual commissioning of electricity supply and the control/command cabinets for the nuclear island.

Filing of Flamanville 3's final commissioning request with the Nuclear Safety Authority is scheduled for the second half of 2014 and synchronisation of Flamanville 3 to the grid is planned in 2016.

[2] Excluding tritium and carbon 14, which will be released in quantities equivalent to existing plants (proportionately to energy produced)

REACTORS UNDER DECOMMISSIONING:

EDF SA is currently decommissioning 9 reactors:

Site	Number of reactors	Type of Reactor	Power (MW)	Commissioning year	Final Shutdown Year
Brennilis	1	Heavy water Reactor	70	1967	1985
Chooz A	1	REP	305	1967	1991
Creys-Malville	1	FBR	1200	1986	1998
Chinon	3	UNGG	70 210 370	1963 1965 1966	1973 1985 1990
St Laurent	2	UNGG	500 530	1969 1971	1990 1992
Bugey	1	UNGG	540	1972	1994

EDF SA also owns the nuclear subsidiary Socodei which operates Centraco, a facility treating and conditioning low level radioactive waste. Centraco, located in the town of Codolet (Gard), treats waste metals in its melting plant and combustible waste in its incinerator.

Regulatory context

TSN Law: EDF SA's nuclear activities in France are subject to the legislation of **13 June 2006,** concerning Transparency and Security in the Nuclear field ("TSN Law", now codified in the **Environment Code Books I and V**). The legislation includes three pillars:

- **An institutional pillar**, with the creation of the Nuclear Safety Authority (ASN, *Autorité de Sûreté Nucléaire*), an independent administrative authority.
- **A pillar related to public information** and transparency, with the legislative confirmation of the High Committee for Transparency and Information on Nuclear Safety, and Local Information Commissions in the vicinity of each nuclear facility. Each facility has the legal obligation to draft and publish an annual report describing the measures taken in terms of nuclear safety, radiation protection and the environment. These documents are available for consultation on the EDF web-site[3].
- **A procedural pillar** specifying the authorisation regime applicable to basic nuclear facilities throughout their life span, from design to decommissioning.

The legislation is completed with the **Decree of 2 November 2007** which provides further requirements to the latter pillar. The Decree defines the terms and conditions for the permitting process which includes a safety report describing:

- the measures adopted to mitigate the risks and limit the consequences of any accident,
- an assessment of the impacts of the plant on the environment and human health,
- a decommissioning plan,
- and a risk control and management analysis for all types of hazards.

The TSN law does not set a limit on service life but requires a safety review of the plant every ten years. After the 10-year inspection of each reactor, the ASN issues an opinion for the continuation of

[3] http://energie.edf.com/nucleaire/carte-des-centrales-nucleaires-45738.html

operation for a new 10-year period. If needed, the ASN adopts complementary requirements, in particular the conditions for water offtake, liquid and gaseous discharges and their associated limits.

The INB Ordinance adopted by the Government on 7 February 2012 sets the general regulations for "basic nuclear facilities" ("*installations nucléaires de base*", or INB). Among other, this so-called "INB Ordinance" incorporates into French law a number of regulations responding to the problems raised by the Fukushima accident.

The INB Ordinance extends the scope of previously applicable regulatory provisions to environmental protection and mitigation of nuisances.

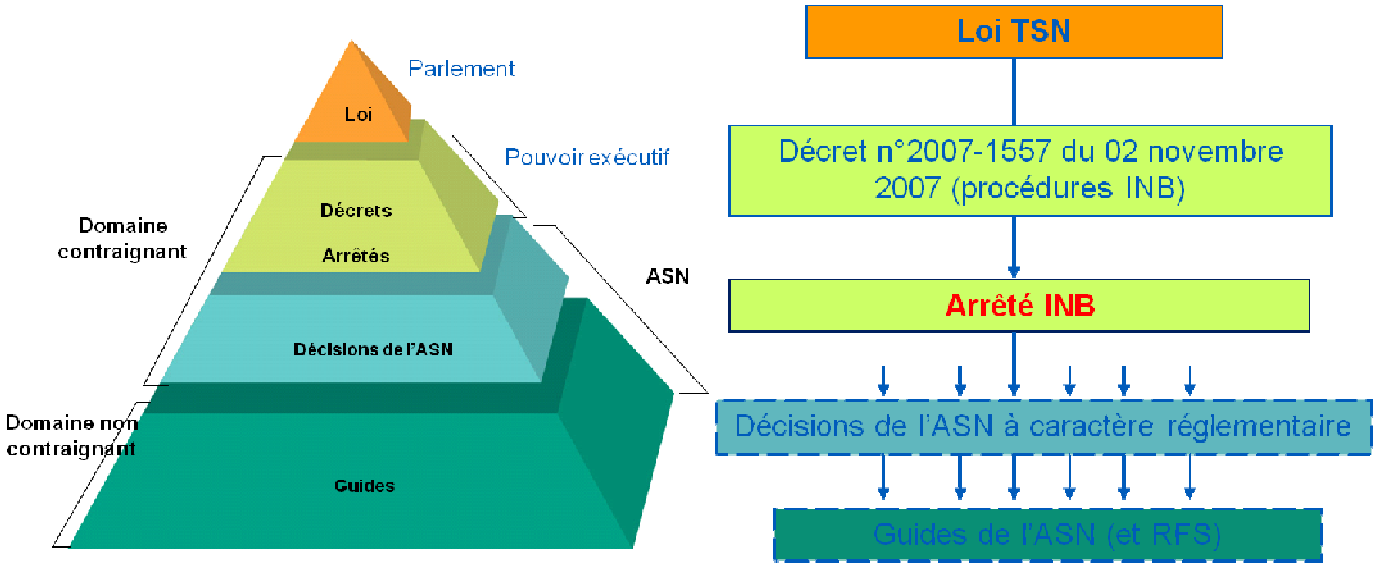
The INB Ordinance came into force on 1 July 2013.

The **final shutdown and decommissioning** of a nuclear facility are authorised by decree enacted by the Ministers in charge of nuclear safety; on that basis, the ASN can define specific requirements.

EDF SA's business is subject to French regulations on handling, storage and long-term management of **nuclear waste**. EDF is legally responsible and liable for the nuclear waste resulting from its operations. In France, radioactive waste management is handled by the National Agency for Radioactive Waste Management (ANDRA), an industrial and commercial public entity created by the French law of 30 December 1991.

Regarding **radiation protection regulations**, all nuclear activities involving a risk of human exposure to ionising radiations are subject to the oversight of the State authorities. French regulations (Code of Public Health and Code of Labour) comply with the European Directives of 1996 and 1997 which set the maximum exposure by the general public at 1 mSv per year and impose a limit on exposure of workers at 20 mSv for 12 consecutive months[4].

Figure 3: French regulatory pyramid



2.2 EDF ENERGY

EDF Energy is one of the UK's largest energy companies and its largest producer of low-carbon electricity. It generates around 25% of the UK's electricity and employs around 15,000 people. It

[4] For more details on regulations , see the EDF Reference Document

supplies electricity and gas to around 5.5 million residential and business customers and is the UK's biggest supplier of electricity by volume.

The company is organised into the following business units:

- The Generation business is responsible for the safe reliable operation of 8 nuclear power plants (15 reactors, 9,600 MW), 2 coal power plants (8 units, 4,000 MW), 1 gas power station (3 units, 1,300 MW), gas storage facilities and renewable energy sources (~500 MW) in the UK with a total installed capacity of circa 16 GW.
- The Customers business includes residential and business customers, energy services, smart metering and optimisation.
- Nuclear New Build is tasked with the delivery of the new generation of nuclear plants in line with EDF's global programme of producing safe, affordable, reliable, low-carbon production of electricity in the UK.

EDF Energy holds 80% of Lake Acquisitions Limited (the other 20% is held by Centrica) which owns the eight nuclear power stations (15 reactors under commercial operation) of former British Energy. The acquisition process was completed in 2009.

NNB Holding Company Limited, another division of EDF Energy, aims to build four EPRs in the UK. On 21st October 2013, the UK Government and EDF Group reached commercial agreement on the key terms of a proposed investment contract for the Hinkley Point C nuclear power station in Somerset. EDF Group expects to make a final investment decision on the project in 2014. Letters of Intent have been signed with potential investment partners in the project, including two Chinese companies. EDF Group is expected to take a 45-50% equity stake with AREVA 10%, and China General Nuclear Corporation (CGN) and China National Nuclear Corporation (CNNC) sharing a 30-40% stake.

The nuclear fleet includes 15 reactors with two technologies (14 AGR and 1 PWR).

REACTORS IN OPERATION

SITE	NUMBER OF REACTORS	TYPE OF REACTOR	POWER (MW)	COMMISSIONING YEAR	SCHEDULED DATE OF DECOMMISSIONING([5])
Hunterston B	2	AGR	960	1976	2023
Hinkley Point B	2	AGR	945	1976	2023
Hartlepool	2	AGR	1180	1983	2019
Heysham 1	2	AGR	1155	1983	2019
Dungeness B	2	AGR	1040	1983	2018
Heysham 2	2	AGR	1220	1988	2023
Torness	2	AGR	1185	1988	2023
Sizewell B	1	PWR	1198	1995	2035

[5] Based on currently agreed accounting lives; one of EDF Energy's expectations is to extend the lifetimes of its nuclear power plants where it is technically and economically viable to do safely

Figure 4: EDF Energy nuclear power plants

In December 2012, EDF Energy announced the formal operating life extensions of Hinkley Point B and Hunterston B by seven years to 2023 consistent with its target to achieve an additional seven years on average across the Advanced Gas-Cooled Reactor ("AGR") plants and 20 years for Sizewell B. In EDF Group's results from February 2014, EDF announced that EDF Energy now expects to achieve a ten year life extension for Dungeness B to 2028, subject to receiving the necessary approvals anticipated by the end of 2014 (EDF 2013 full year results press release, February 2014). The announcement also stated that:

"EDF Energy plans to extend the operating life of the Dungeness B nuclear plant by ten years, until 2028. Based on expected life extensions, all seven AGR stations and the Sizewell B PWR station will be operating in 2023 when Hinkley Point C is due to be commissioned if a final investment decision is taken in 2014."

EDF Energy has no nuclear facility under decommissioning. In the UK, decommissioning of nuclear facilities is overseen by the NDA (Nuclear Decommissioning Authority), an independent regulatory authority. The NDA also supervises the management of nuclear waste.

Regulatory context

Each nuclear power station is subject to a Nuclear Site Licence, which is issued by the Office for Nuclear Regulation (ONR). The licence has 36 conditions, which govern all aspects of safe operation of the station. The ONR monitors the performance of the power station operator, and appoints a site inspector for each station. All changes to the plant or to its operating rules that could affect nuclear safety significantly are subject to scrutiny by the ONR and may require their consent..

In the following text, the provided information about the governance of nuclear safety and waste is for the nuclear part of EDF Energy's Generation business only. Unless specified, this information does not apply to the Nuclear New Build project (NNB Generation Company Limited) given the current stage of development of the project.

Figure 5: Public information at EDF Energy

2.3 CENG

Constellation Energy Nuclear Group, LLC (CENG) was formed in December 1999 and reorganised as a joint venture in November 2009. CENG is 50.01 percent owned by Exelon Generation and 49.99 percent owned by Electricité de France. EDF acquired its ownership interest in CENG in November 2009. Prior to this date, CENG was a wholly-owned subsidiary of Constellation Energy Group (CEG). In March 2012, Exelon and CEG merged, which resulted in Exelon taken over CEG's 50.01 percent interest in CENG. CENG is managed day to day by its senior executive management team and implements a set of practices, programmes and processes that are distinct from Exelon Generation or EDF. CENG is overseen and governed by a 10-member Board of Directors, including 5 appointed by Exelon Generation and 5 by EDF. The approval of both owners is required before CENG may take certain significant actions. The CENG Chairman of the Board, who is appointed by Exelon Generation, has the ability to exercise a controlling vote.

On 29 July 2013, Exelon and EDF announced that the two companies would work together to transfer the operating licence of the 5 CENG reactors to Exelon and begin a process of integrating the operations of the CENG plants into Exelon Generation. In the new consolidated organisation, Exelon will continue to own 50.01 percent stake and EDF will continue to own 49.99 percent stake. EDF will continue a governance role through the CENG Board of Directors.

Upon closing of the transaction in 2014 (the Agreement being contingent on approval by the US Nuclear Regulatory Commission), Exelon will take full responsibility of the operational management of CENG's nuclear facilities. EDF will retain all of its governance rights with respect to CENG (other than the right to designate any Officer of the Company) but will be removed from third-party legal liability for nuclear operations.

REACTORS IN OPERATION

SITE	NUMBER OF REACTORS	TYPE OF REACTOR	POWER (MW)	COMMISSIONING YEAR	SCHEDULED DATE OF DECOMMISSIONING
Calvert Cliffs 1	Maryland	PWR	878 MW	1975	2034
Calvert Cliffs 2	Maryland	PWR	872 MW	1977	2036
Nine Mile Point 1	New York	BWR	620 MW	1970	2029
Nine Mile Point 2	New York	BWR	1280 MW	1988	2046
Ginna	New York	PWR	581 MW	1970	2029

Note: Nine Mile Point 2 increased its power capacity by around 140MWe in 2012.

CENG has no nuclear facility under decommissioning.

Regulatory context

In the USA, the quality and safe operation of the nuclear fleet are monitored by the Nuclear Regulatory Commission (NRC) which delivers the licence to build and operate, establishes the rules and controls their strict compliance, through inspections and with the help of a site representative (US NRC Resident Inspector). The NRC regularly assesses safety performances and publishes all corresponding reports. CENG's nuclear business is undertaken in a predictable regulatory environment. Licences are initially granted for 40 years of operation. They can be extended by additional 20-year periods, provided that the operators commit to adequate monitoring of the key components and structures of their plants. All CENG units have applied for the extension of their licence from 40 to 60 years, and they have all been granted.

In addition, the Institute of Nuclear Power Operations (INPO), created after the Three Mile Island accident of 1979, aims to promote operational excellence through safety assessments, peer-reviews and support activities. The INPO assesses all sites every two years and also publishes a rating (used by insurance companies); it is also the prescriber and the controller of training processes for staff in charge of plant operation and maintenance, and delivers accreditations for training programmes every 4 years.

The Electrical Power Research Institute (EPRI) provides substantial technical support to American nuclear operators, due to research in laboratories and experience feedback from the operators.

EDF Group has been a permanent member of INPO and EPRI for many years and has seconded liaison engineers to INPO in Atlanta and to EPRI in Palo Alto and Charlotte.

2.4 TNPJVC

EDF owns a 30% equity stake in Taishan Nuclear Power Joint Venture Company limited (TNPJVC), created to build and operate two EPR reactors in Taishan, in the southern province of Guangdong (China). China Guangdong Nuclear Power Company (CGNPC) owns the majority of the equity interest in TNPJVC in line with PRC law. For the first time EDF Group is an investor in nuclear power generation in China[6].

Following the building permit award, the concrete slab for the reactor building floor of Unit 1 was poured in October 2009, and in April 2010 at Unit 2. Welding of the Unit 1 primary circuit was completed in late 2012 and water was first circulated into this circuit and in the reactor vessel in late 2013, a major milestone in the assembly of electromechanical equipment marking the launch of the

[6] EDF also has assistance service contracts with CGN at Daya-Bay and Ling-Ao, but without any operating responsibility

start-up trials. Civil engineering works are in the finalising stage at Unit 2 where activities will shortly switch over to the assembly of electro-mechanical equipment.

Regulatory context

The design, equipment manufacturing, construction, commissioning, start-up testing and operation of nuclear facilities in China are governed by a broad corpus of regulations inspired by IAEA guidelines and by French and US regulatory practices.

The National Nuclear Safety Administration ("NNSA") is the nuclear authority in charge of controlling nuclear facilities at all stages of construction and operation, and keeps inspectors permanently on the sites.

The commissioning authorisation for the Taishan reactors will be delivered by the NNSA following a control process similar to the process applicable in France, covering all checks and controls during construction, analysis of start-up test results, and approval of the final safety report. This final safety report must demonstrate proof of compliance with Chinese regulations.

3. SAFETY AND RADIOLOGICAL PROTECTION

3.1 SAFETY POLICY AND IMPLEMENTATION AT EDF GROUP

3.1.1 Definition

Nuclear Safety relates to all technical and organisation provisions made relative to the design, construction, operation, shut-down and decommissioning of nuclear facilities, and transport of radioactive substances, adopted to prevent incidents and accidents or to mitigate their effects (source: ASN France).

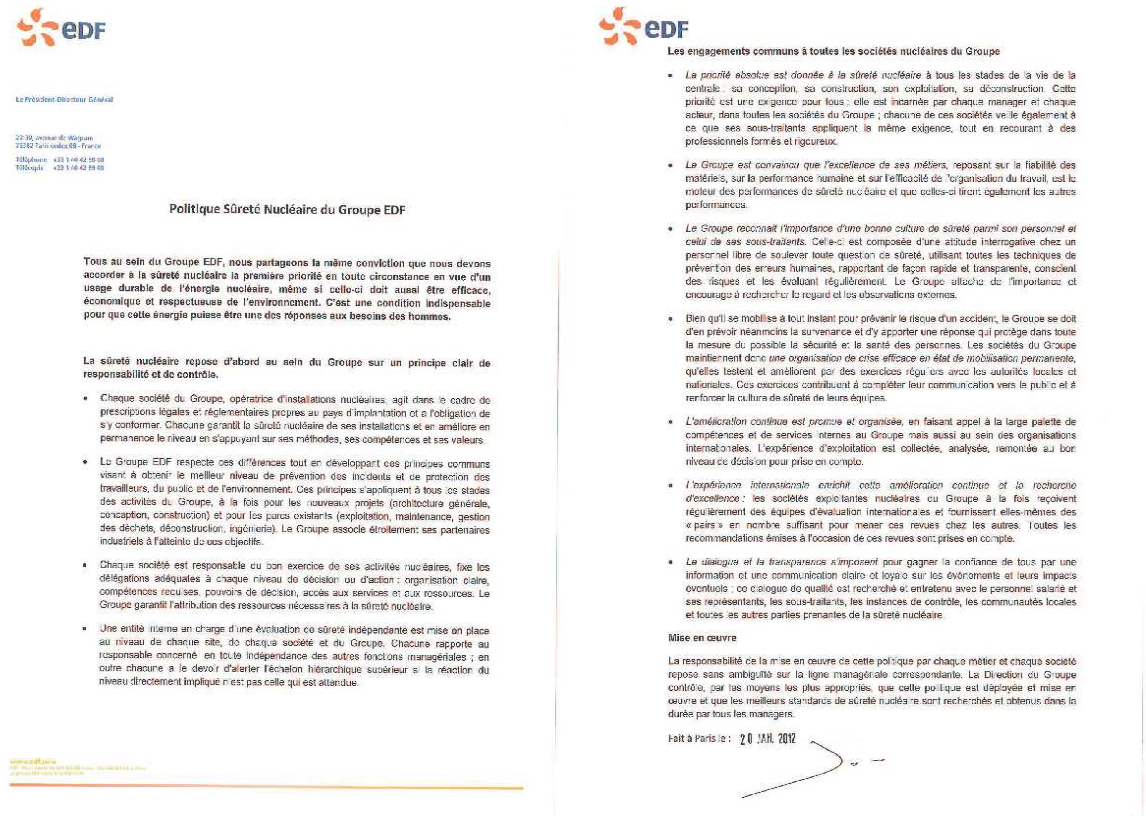
3.1.2 EDF Group Policy

On 20/01/2012, the EDF Chairman & CEO approved and signed the “Nuclear Safety Policy” of EDF Group, based on the following conviction:

“*At EDF Group, we all share the same vision that nuclear safety is the overriding priority in the sustainable use of nuclear energy, recognising that nuclear energy also needs to be efficient, affordable and environmentally friendly. It is an indispensable prerequisite when providing energy to humanity.*”

The Nuclear Safety policy of EDF Group can be consulted on this website:
http://activites.edf.com/fichiers/fckeditor/Policy_de_surete_nucleaire_Groupe_EDF.pdf or
http://businesses.edf.com/fichiers/fckeditor/Commun/En_Direct_Centrales/Nucleaire/General/Publications/edf_group_nuclear_safety_policy_20012012.pdf.

In his letter dated 06/02/2012, the Chairman & CEO of EDF has asked the senior executives and managers to “*turn nuclear safety into the key pillar of their engagement and share it with all teams*”.



Politique Sûreté Nucléaire du Groupe EDF

Tous au sein du Groupe EDF, nous partageons la même conviction que nous devons accorder à la sûreté nucléaire la première priorité en toute circonstance en vue d'un usage durable de l'énergie nucléaire, même si celle-ci doit aussi être efficace, économique et respectueuse de l'environnement. C'est une condition indispensable pour que cette énergie puisse être une des réponses aux besoins des hommes.

La sûreté nucléaire repose d'abord au sein du Groupe sur un principe clair de responsabilité et de contrôle.

- Chaque société du Groupe, opératrice d'installations nucléaires, agit dans le cadre de prescriptions légales et réglementaires propres au pays d'implantation et a l'obligation de s'y conformer. Chacune garantit la sûreté nucléaire de ses installations et en améliore en permanence le niveau en s'appuyant sur ses méthodes, ses compétences et ses valeurs.
- Le Groupe EDF respecte ces différences tout en développant ces principes communs visant à obtenir le meilleur niveau de prévention des incidents et de protection des travailleurs, du public et de l'environnement. Ces principes s'appliquent à tous les stades des activités du Groupe, à la fois pour les nouveaux projets (architecture générale, conception, construction) et pour les parcs existants (exploitation, maintenance, gestion des déchets, déconstruction, ingénierie). Le Groupe associe étroitement ses partenaires industriels à l'atteinte de ces objectifs.
- Chaque société est responsable du bon exercice de ses activités nucléaires, fixe les délégations adéquates à chaque niveau de décision ou d'action : organisation claire, compétences requises, pouvoirs de décision, accès aux services et aux ressources. Le Groupe garantit l'attribution des ressources nécessaires à la sûreté nucléaire.
- Une entité interne en charge d'une évaluation de sûreté indépendante est mise en place au niveau de chaque site, de chaque société et du Groupe. Chacune rapporte au responsable concerné en toute indépendance des autres fonctions managériales ; en outre chacune a le devoir d'alerter l'échelon hiérarchique supérieur si la réaction du niveau directement impliqué n'est pas celle qui est attendue.

Les engagements communs à toutes les sociétés nucléaires du Groupe

- *La priorité absolue est donnée à la sûreté nucléaire* à tous les stades de la vie de la centrale : sa conception, sa construction, son exploitation, sa déconstruction. Cette priorité est une exigence pour tous ; elle est incarnée par chaque manager et chaque acteur, dans toutes les sociétés du Groupe ; chacune de ces sociétés veille également à ce que ses sous-traitants appliquent la même exigence, tout en recourant à des professionnels formés et rigoureux.
- *Le Groupe est convaincu que l'excellence de ses métiers*, reposant sur la fiabilité des matériels, sur la performance humaine et sur l'efficacité de l'organisation du travail, est le moteur des performances de sûreté nucléaire et que celles-ci tirent également les autres performances.
- *Le Groupe reconnaît l'importance d'une bonne culture de sûreté parmi son personnel et celui de ses sous-traitants.* Celle-ci est composée d'une attitude interrogative chez un personnel libre de soulever toute question de sûreté, utilisant toutes les techniques de prévention des erreurs humaines, rapportant de façon rapide et transparente, conscient des risques et les évaluant régulièrement. Le Groupe attache de l'importance et encourage à rechercher le regard et les observations externes.
- Bien qu'il se mobilise à tout instant pour prévenir le risque d'un accident, le Groupe se doit d'en prévoir néanmoins la survenance et d'y apporter une réponse qui protège dans toute la mesure du possible la sécurité et la santé des personnes. Les sociétés du Groupe maintiennent donc *une organisation de crise efficace en état de mobilisation permanente*, qu'elles testent et améliorent par des exercices réguliers avec les autorités locales et nationales. Ces exercices contribuent à compléter leur communication vers le public et à renforcer la culture de sûreté de leurs équipes.
- *L'amélioration continue est promue et organisée*, en faisant appel à la large palette de compétences et de services internes au Groupe mais aussi au sein des organisations internationales. L'expérience d'exploitation est collectée, analysée, remontée au bon niveau de décision pour prise en compte.
- *L'expérience internationale enrichit cette amélioration continue et la recherche d'excellence :* les sociétés exploitantes nucléaires du Groupe à la fois reçoivent régulièrement des équipes d'évaluation internationales et fournissent elles-mêmes des « pairs » en nombre suffisant pour mener ces revues chez les autres. Toutes les recommandations émises à l'occasion de ces revues sont prises en compte.
- *Le dialogue et la transparence s'imposent* pour gagner la confiance de tous par une information et une communication claire et loyale sur les événements et leurs impacts éventuels ; ce dialogue de qualité est recherché et entretenu avec le personnel salarié et ses représentants, les sous-traitants, les instances de contrôle, les communautés locales et toutes les autres parties prenantes de la sûreté nucléaire.

Mise en œuvre

La responsabilité de la mise en œuvre de cette politique par chaque métier et chaque société repose sans ambiguïté sur la ligne managériale correspondante. La Direction du Groupe contrôle, par les moyens les plus appropriés, que cette politique est déployée et mise en œuvre et que les meilleurs standards de sûreté nucléaire sont recherchés et obtenus dans la durée par tous les managers.

Fait à Paris le : 20 JAN. 2012

Figure 6: EDF Group Nuclear Safety policy

3.1.3 Policy implementation

After having built its own fleet of reactors and thus accumulated a triple experience as designer and architect-assembler, operator and dismantler, EDF made a number of acquisitions in existing and reputable nuclear companies.

Each EDF Group company had previously put in place its own nuclear safety policy and management system in line with their national regulatory context. Beyond strict compliance with national laws and regulations, each company strives for excellence in their activities and has implemented long-term adapted programmes to continuously improve their safety performance; each company leverages its own skills and expertise, and benefits from national and international support.

The aim of EDF Group is therefore to encourage this attitude and reinforce it by making use of all possible synergies within the Group in the framework of its common Nuclear Safety policy.

Continuous improvement in nuclear safety at EDF Group level is built on three pillars, chosen and implemented in a manner consistent with international guidelines (IAEA SF-1 and GS-R-3, INSAG 4 on safety culture, INSAG 13 on safety management, INSAG 18 on change management) and best practices.

Due to the special nature of nuclear safety, EDF has had in place for many years a dedicated, highly-skilled team in charge of enforcing the safety policy across the Group, headed by the **Inspector General for Nuclear Safety and Radiation Protection** (GINSR), directly reporting to the CEO of EDF Group, and to the **Nuclear Safety Council (CSN)**.

Following the international development of nuclear activities, EDF is progressively extending the scope and the roles of the Inspector General and of the CSN, now opened to representatives from

EDF Energy and EDF Inc.[7]. Today, the GINSR Inspector carries out safety assessments and controls across the Group[8]. With his team of senior experts, he verifies that safety practices remain effective and consistent with regulatory requirements and public expectations, as well as to the company's policy. He verifies that safety behaviours and culture are consistent all over the Group. He alerts corporate executives as necessary and submits recommendations. He produces an annual report submitted to the French Nuclear Safety Authority and publicly available (on web site). His recommendations are used as appropriate by the CEO and sent annually to the relevant corporate executives.

For issues apart from nuclear safety, EDF has a "Group Audit" function in place with authority on internal audits based on all resources available with the Group, EDF SA and its subsidiaries.

The **governance of each nuclear company** is adapted to the Group's stake ownership and to the national regulatory context. Via its representation on various boards and committees, EDF has access to the necessary information and analyses, complemented by the assessments of the GINSR, and can therefore require or promote safety improvements.

At **EDF SA**, the overall compliance with regulations and the Group safety policy and the safety management are assessed at each level of the organisation (company, business line, generation site).

- At company level, the Nuclear Safety Council, of which the GINSR is the secretary, is composed of all corporate executives of the parent company and reports directly to the EDF Chairman.
- At Division level, the Operational Nuclear Safety Committee (CSNE) reports to the directors of the Nuclear Generation Division (DPN). Similarly, the Design Safety Review Committee (CSNC) reports to the directors of Nuclear Engineering Division.
- At power plant level, a Safety Technical Committee (GTS) reports to the plant director. An independent control line of safety engineers and experts continuously assess the safety of facilities and organisation, and reports to this GTS committee.

At **EDF Energy**, the Group Board, EDF Energy Nuclear Generation Group Ltd, is responsible for the management monitoring of EDF Energy Nuclear Generation Ltd (the Licensee Board), the business unit which holds the Nuclear Site Licence. Several representatives of EDF (senior executives from the Nuclear Generation and Engineering Divisions) are members of the Group board. Inside EDF Energy Generation, Nuclear Safety Committees are constituted in compliance with the Nuclear Site Licences. These Committees are consulted regularly for their consideration and advice on matters of nuclear safety. EDF IGSNR has observed the Committees in operation.

At **CENG**, the NSOC (Nuclear Safety and Operations Committee) is one of the Board's committees dedicated to nuclear safety: it reviews the safety performance of each power plant and at corporate level. EDF has two members sitting on the NSOC (equally to Exelon). At each nuclear site, the NSRB (Nuclear Safety Review Board) monitors the management of safety; various external experts participate in the NSRB alongside the site representatives.

The NSRB meets three times a year at each site. The NSRB is chaired by an independent individual who meets with the company's Board of Directors every year to submit and discuss his assessment report.

TNPJVC published its safety policy in 2011, containing guidelines on responsibility, management, control and independent assessment that are consistent with EDF Group's Safety Policy. Some

[7] EDF head office in Chevy Chase, MD, where some executives are members of CENG board

[8] These assessment visits can take place only in the **operating** nuclear companies where EDF has control (if specified in shareholder agreement in the case of minority share); in other companies, the GINSR can make visits with the authorisation of the operator in the framework of experience sharing

sixty EDF expatriate employees work in various departments of TNPJVC: safety/quality, engineering, procurement, construction, testing, operation and maintenance, finance, audit.

3.2 INCIDENTS AND EVENTS

3.2.1 Policy

The most harmful consequences arising from nuclear facilities originate from the loss of control over a nuclear reactor core cooling, the nuclear chain reaction, or uncontrolled radioactive discharges, which constitute the three key safety functions that are secured and verified on a permanent basis.

EDF Group aims to reduce the likelihood of such losses of control to the lowest possible level, and takes all necessary measures in order to:

- Prevent the occurrence of failures or abnormal conditions that could lead to such a loss of control;
- Prevent the escalation of any such failures or abnormal conditions that do occur and mitigate their external consequences;
- Prevent the loss of confinement or the discharge of radioactive substances outside the facilities.

3.2.2 Implementation principles

The primary means of preventing and mitigating the consequences of accidents is the concept of **'in-depth defence'**. In-depth defence is implemented primarily through the combination of a number of consecutive and independent levels of protection: some of them can replace others in case of failure and would prevent any harm caused to people or to the environment.

In line with this fundamental IAEA principle and with local regulations, EDF Group companies have all put in place local processes to detect[9] and prevent such failures/events[10] of any origin (human or technical), in order to mitigate them and leverage experience feedback to prevent their reoccurrence. These processes consist of:

- Identifying conditions that have or could have an adverse effect on the performance of equipment, programmes, or organisations
- Ensuring necessary immediate actions are implemented to place plant/situation in a safe and stable condition
- Reporting the condition to a technical supervisor or to the control-room, as appropriate, including immediate corrective actions already taken
- Promptly initiating an in-depth analysis, together with sufficient information so that the condition can be properly evaluated for operability and compliance with safety rules.

The conditions and limits necessary for safe operation of the facilities are described in the **Operating Technical Specifications (*Spécifications Techniques d'Exploitation* (STE))**, or the licence conditions, validated by the national safety authority. These specifications may be more or less detailed, depending on the way risk analysis may be used in real time and in conjunction. In France, STEs specify in detail the list of actions to be implemented in case of anomaly or failure on safety-sensitive equipment components; probabilistic risk analysis methods are not used as a complement to real-time analysis[11]. Conversely, probabilistic risk analysis is used more commonly in

[9] The detection and self-report of errors by their authors are promoted and recognised as a positive contribution to safety; on the contrary, the fact of hiding an error is a fault in the safety culture and is subject to disciplinary sanctions

[10] In safety culture terminology, an "event" does not necessarily have a direct consequence on equipment or a direct impact on the facilities. It can simply involve weakened defence lines, including organisational, with no material consequence.

[11] The required response was determined based on probabilistic risk assessments when the STEs were established

the USA, for instance in case of simple or combined anomalies of safety-sensitive equipment. Both approaches are internationally recognised as effective.

The **incident or accident management procedures** used to restore the facilities in safe conditions have been widely improved everywhere since the accident of Three Miles Island which highlighted the difficulty of making a correct diagnosis of normal status and inferring the appropriate corrective actions. An extensive international experience feedback programme has been implemented. Several major milestones have been achieved and currently all French procedures are status-oriented procedures, used by both operators and safety engineers. These evolutions are closely framed by licensing and regulatory requirements, and validated by safety authorities in cooperation with nuclear operators and after numerous simulator qualification tests. All operators and operational managers are regularly trained on full-scale simulators to be well prepared to face any accident situation. In some training sessions, severe accidents caused by multiple failures beyond design-basis are simulated to prepare the operational staff to face highly complex situations.

3.2.3 EDF SA

In France, based on its continuous safety assessment of its fleet and its experience feedback programme, **EDF SA** leverages a series of safety **indicators and assessment tools** to select and monitor the best improvement programmes or projects launched to correct weaknesses and seek world-class excellence.

The indicators are derived from best international practices in the nuclear power industry, which enables EDF SA to benchmark itself regularly against the best-in-class global operators[12].

In an effort to structure all improvement measures implemented at EDF SA level and in each power plant, EDF SA established the so-called “Generation 2020” project in 2011, based on a analysis of the current and future context: safety shall progress continuously, significant capital investments are to be made in the next 15 years, the renewal of the staff with the retirement of the generation who pioneering nuclear power.

The Generation 2020 project is intended to structure the measures to be implemented according to three key priorities:

- Securing the reliability of equipment: handle it with the utmost care,
- Securing the reliability of organisations: anticipate precisely the preparation of activities,
- Constantly reinforcing professional skills: challenge professionalism constantly to do the right thing from the onset.

The project was broadly disseminating across all DPN team with a top-down approach. The DPN division sets the course, the business units define and formalise their own road-map for 2015 based on a site-wide project.

3.2.4 EDF Energy

Specifically for incidents and events, **EDF Energy** also undertakes the following processes:

- The continuous improvement model which is based on the INPO excellence model and is enshrined in company processes. Issues and emerging trends are identified and analyzed; solution options are studied, prioritised and implemented through business processes.
- The Corrective Action Programme (CAP) which is used to identify, document, evaluate, and trend undesirable conditions (problems) and to take actions to correct problems and their causes. The aim is to proactively identify sub standard conditions and practices at a local, low consequence level and take positive action to prevent more significant consequence events arising and adverse trends developing.

12 E.g. the indicators used by EDF SA are also used by WANO and INPO.

- The Operating Experience processes cover the reviewing, screening and disseminating of internal and external experience (nuclear sector and high hazard industries) for applicability of lessons learned to specific EDF Energy Generation facilities.

For more details on EDF Energy processes and systems for incidents and events, see "*Our journey towards zero harm*"[13].

3.2.5 CENG

CENG has established 6 "Fleet Initiatives" which are identified and defined below:

- Nuclear Safety and Security: CENG drives for proactive elimination of vulnerabilities in nuclear safety and physical plant security. CENG accomplishes this through improvements in cyber security, emergency planning, fire protection systems, environmental performance, and Fukushima lessons learned.
- Personnel Safety Excellence: CENG drives for fundamental improvements in industrial and radiological safety. CENG accomplishes this through improvements in hazard recognition, mitigation and elimination; employee engagement; leadership support; and source term reduction.
- Operational Excellence: CENG drives for excellence in nuclear safety, human performance and reliability of generation facilities. CENG accomplishes this through improvements in Operations fundamentals, INPO Performance index, refuelling outage performance, human performance and risk management.
- Performance Improvement: CENG drives for improved prevention, detection and correction of operational problems. CENG accomplishes this through improvements in the Corrective Action Programme (CAP) relying on internal experience feedback, self-assessment and trending; and by leveraging external experience feedback.
- Equipment Reliability: CENG drives excellence in generation reliability and operational quality. CENG accomplishes this through improvements in performance monitoring, maintenance strategies, work management, and productivity.
- Organisational Effectiveness: CENG drives achievements of CENG's strategic goals through effective leadership and alignment. CENG accomplishes this through improvements in leadership, internal communications, training effectiveness, and everyone's commitment to seek the best fleet performance.

3.3 Unplanned outages

3.3.1 Policy

In the context of unplanned outages, special attention is afforded to reactor tripping events. A significant number of automatic reactor trips will generate pressure and temperature transients on components and structures that may be detrimental to the long term operation of the plant, requiring additional inspections and maintenance; unplanned shutdowns for maintenance or repair may increase worker radiation doses and volumes of liquid and gaseous wastes. Consequently EDF Group is committed to their reduction and eventual elimination in order to promote Nuclear Safety, Radiation Protection and Public Safety performance.

3.3.2 Implementation principles

EDF Group's companies have adopted international best practices in this field. The international standards and performance criteria defined by INPO (Institute of Nuclear Power Operations) and WANO (World Association of Nuclear Operators) constitute the fundamentals used by EDF.

13 http://www.edfenergy.com/about-us/energy-generation/nuclear-generation/documents/EDF-Energy-NuclearGeneration-Our-Journey-Towards-Zero-Harm.pdf

EDF however complies with different practices recommended by nuclear safety authorities and national requirements: in some countries reactor operators are required to anticipate the automatic protection (this is the case in USA and UK) by undertaking a “manual scram”; in others the operator is required to let automatic protections to do their job. The various approaches will influence the indicators differently.

Each company regularly defines and implements specific action plans depending on its own strengths and weaknesses highlighted during their safety reviews.

3.3.3 EDF SA

EDF SA’s current action plans are focused on three priorities, in line with the above-mentioned Generation 2020 programme:

- Improve reliability of organisations: the situations most likely to cause a scram are identified in activity planning, detailed risk assessments are carried out and responses put in place.
- Improve human performance: working methods intended to counter the previously mentioned risk situations are part and parcel of the practices promoted in the EDF programme “Improve Human Performance”.
- Improve the reliability of equipment: every material failure at the origin of a scram is analysed, corrected and incorporated into the continuous improvement loop of the AP 913 project.

3.3.4 EDF Energy

At **EDF Energy**, in accordance with worldwide industry accepted best practices, the implementation of a rigorous process-based approach to plant operational management is considered to be the most effective and robust means to ensure sustainably high safety and environmental performance including avoidance of Unplanned Shutdowns. Some of the most important processes are:

- Work Management and outage management
- Equipment Reliability
- Nuclear Professionalism (human error prevention) and behaviours for success

EDF Energy Generation has implemented Work Management best practices following the Institute of Nuclear Power Operations (INPO) guideline AP-928. Achievements in 2013 on outage management included an excellent Zero Harm record with no reportable nuclear, environmental or industrial safety events during outages. An average of 90% of pre outage milestones were achieved; the best ever performance to date. Statutory and interim outage programmes had the lowest recorded over-runs. However, scope remains to improve off load refuelling outages. Plans for 2014 include: long term station and fleet plans; outage preparations; outage execution (including off load re-fuelling outages); managing major threats and opportunities; supplier interactions and culture change. The aim of the outage management programme in 2014 is to reduce outage durations from the existing outage programmes that are scheduled to run between 2014 and 2018 and to maintain outage durations at this lower threshold going forward

EDF Energy is implementing plans for Equipment Reliability best practices following the INPO guideline AP-913. A new methodology (aligned with INPO) for calculating Equipment Reliability (ER) was introduced in 2013. Results showed a steady and sustained improvement throughout the year and out-turned on target. Plans for 2014 include: improving systems’ safety and reliability performance; developing performance monitoring; fostering cross functional working to deliver safety and reliability improvements; focusing, together, on the most important plant and equipment and managing performance for lifetime. The impact of this work will be to improve the ER Index score across the fleet which will make a telling contribution to the annual unplanned capability loss factor rate being reduced in 2014.

The Nuclear Professionalism programme, which includes both human performance and nuclear safety culture components, is in place throughout EDF Energy Generation. This programme focuses on minimising the frequency and consequences of human errors through training, effective use of human error prevention tools, performance coaching and the identification and reduction of organisational weaknesses through investigations into events, incidents, near misses and performance trending of sub standard conditions. On the behaviours for success programme in 2013, EDF Energy continued to improve leadership behaviours at all levels across the organisation which in turn supported the delivery of good generation results and excellent safety results. Plans for 2014 include introduction and embedding of a new 4'I's (Inspiration, Inclusion, Integrity, Impact) model. The 4'I's concepts will be applied to how we develop our leaders, conduct appraisals, build personal development plans and how we coach in the field through Nuclear Professionalism. By adopting the 4'I's model it will bring clarity and simplicity to how EDF Energy describes the leadership behaviours that underpin how high levels of performance are achieved. Additionally, the successful delivery of the 2014 talent development plans will further boost the creation of a resilient talent pool that is capable of sustaining the safe, reliable operation of plant and processes long into the future.

3.3.5 CENG

At **CENG**, operational excellence is one of the strategic priorities on which the teams are focusing to achieve safe, reliable and predictable power generation. CENG has implemented INPO guidelines like AP 928 (Maintenance Activities Process) or AP 913 (Equipment reliability). These measures include:

- Generation performance positioning CENG in the top quartile of reliability in the INPO model based on availability figures,
- Best performance of unit inspection shut-downs in terms of duration and efficiency of planned maintenance operations, and of controls to ensure proper management of plant life span,
- Excellence of the continuous improvement system (detection and anticipation of incidents, incorporation of internal and external operational experience feedback, implementation of robust training programmes).

CENG had experienced a reduction in its availability factor in 2012 due to the exceptionally long (but planned) refuelling outage at Calvert Cliffs (maintenance operations on pressuriser) and at Nine Mile Point 2 (extended power up-rate project), as well as a series of unplanned forced outages at Nine Mile Point. The refuelling outage campaign for 2013 was more favourable, with only two shorter planned outages at Calvert Cliffs and Nine Mile Point.

CENG also benefited from the initiative aimed at reducing unplanned forced outages, with a focus on Equipment Reliability and the conduct of Maintenance. Forced loss rate has dropped significantly under 2% and the availability factor of the CENG fleet exceeded 94% in 2013.

3.4 Nuclear safety assessments

3.4.1 Definition

A "nuclear safety assessment" is a general process used widely in the nuclear industry to identify and to evaluate the efficiency and effectiveness of all provisions implemented for nuclear safety; it is used in numerous situations, from design to decommissioning, through the management of operations and many other activities. The assessed items can address safety issues, means and provisions for impact prevention and mitigation, or provisions for control and monitoring. A nuclear safety assessment frequently includes a risk assessment of various hazards generated by the facility/activity itself or by external hazards. These two notions of safety assessment and risk assessment are closely linked and it is difficult to present them separately.

3.4.2 Policy

As noted in the section about the Group's nuclear safety policy, EDF Group companies operating nuclear power plants are individually responsible for the safety of their facilities and for any impact on their personnel and the public. Their goal is to reduce the risks arising from normal operation or from any nuclear accident due to internal or external causes (e.g. floods, earthquakes, storms, climate change, fires, loss of coolant, power failures...) to an acceptable level in line with international standards and corporate expectations. The Group promotes the use of safety assessment and risk analyses in the broadest possible range of situations. The Nuclear Engineering Division is fully involved in this process.

3.4.3 Routine safety assessments

In day-to-day operation, each EDF Group nuclear company has put in place a **safety assessment** process; it is a key point for efficient organisation and management (inspired by GS-R-3 and INSAG 13 of IAEA) , as well as one of the fundamentals of a good safety culture (inspired by INSAG 4).

As nuclear safety is the result of all measures taken to protect people and the environment against the release of radioactive material, the principle of successive barriers is applied for this purpose: fuel cladding, reactor cooling circuit and containment vessel. To prevent any failure of the barriers or mitigate the consequences, the three following safety functions must be maintained continuously: control of core reactivity, control of fuel cooling and control of the containment of radioactive materials.

The day-to-day safety analysis during operation consists of regular monitoring of the efficiency of these barriers and safety functions; it combines self-assessment by operators, internal control by operation supervisors and independent verification by a safety-dedicated function (safety engineers and safety-quality auditors). The process is applied in every domain of work (operation, maintenance, periodic testing). Systematic benchmarking of the results from verification safety tests with those carried out by other plant operators is a very effective way to maintain a high level of safety as well as a good way to sustain the right challenging attitude and identify any malfunctions. These safety assessments play a dominant role during daily meetings where operational managers and engineers reiterate the safety requirements and ensure compliance.

Figure 7: Daily safety dialogue in the control room

3.4.4 Day-to-day implementation at EDF SA

At **EDF SA**, several safety management tools have been developed and generally extended over several years to facilitate and encourage managers and workers to carry out relevant safety assessments and prevent mistakes. These tools include:

- Risk analysis: identifying the plausible scenarios which might lead to a wrong result or degradation of the plant conditions, and setting up the appropriate measures to prevent and manage the identified risks.
- Self-assessment: a structured and objective comparison performed by an entity (work team or department) in order to benchmark its working methods against defined requirements and identify potential improvements.
- Self-diagnosis: a reciprocal questioning process between engineers who carry out complementary tasks (for developing individual and team effectiveness).
- Because the right arbitration between nuclear safety and other performance factors is an essential issue, the Observatories on Safety, Radioprotection, Availability & Environment (OSRDE) analyse in each power plant the quality of the decision-making process and propose actions to improve it and guarantee compliance with rules in any circumstances.
- External inspections and audits are performed by international teams of organisations such as the IAEA (with its OSART missions) and WANO (Peer-Reviews and Follow-ups) (see below).

3.4.5 Day-to-day implementation at EDF Energy

At **EDF Energy**, the company's vision and associated strategic objectives are implemented through a defined organisational structure and 36 interlocking processes. For each process there is an identified champion in the business who owns the process definition and documentation and is charged with its continuous improvement. The whole is underpinned by the values, standards and expectations that should inform and permeate all activities throughout the company.

Based on these standards, the processes include all the elements necessary to manage and control nuclear power plants safely and efficiently. Alongside the processes for specific technical activities there are processes for securing sufficient suitably qualified and experienced staff (including training), for improving human performance and nuclear safety culture, for implementing and monitoring governance procedures, for ensuring adherence to regulations, for securing independent assessment of our activities, for investigating departures from expected plant and personnel behaviour and preventing their recurrence (CAP – the Corrective Action Programme) and for driving improvement in all aspects of performance.

As you would expect for a high-hazard industry there is a particular emphasis on oversight to monitor performance and conformity to both the internal standards and external regulations. EDF Energy operates a multi-layer model with increasingly independent oversight being exercised through:

- Management accountability - the exercise of leadership;
- In-process oversight through self checking, peer checking and self assessment as part of its internal controls process;
- Functional oversight – review and audit by company experts; these include fleet managers and Delivery Teams, who use the Governance, Oversight, Support and Perform (GOSP) model;
- Independent internal oversight from its Safety and Regulation Division who reports to the Board independently of the operating arm of the company, Quality Department, Internal Audit and IGSN.
- External oversight from its Nuclear Safety Committees and the Training Standards and Accreditation Boards with their external members, from peer evaluations by teams from other utilities and WANO/INPO, from standards accreditation bodies, e.g. Lloyds Register Quality Assurance, and from the Government's Office for Nuclear Regulation.

Specifically for safety assessments at EDF Energy, as part of its adequate arrangements to comply with nuclear site licence requirements, there are the following processes:

- The Maintain Design Integrity process ensures that the design intent is met and that, where changes are made to the design, this is done in a controlled manner
- The Modification Process (nuclear site licence condition 22) is used to control changes to the plant and/or safety case against deterministic and probabilistic nuclear safety principles.
- The Technical Governance process ensures that appropriate engineering policies, codes and standards are provided and applied.
- The Periodic Safety Review (nuclear site licence condition 15) process is a periodic holistic review of the condition of the plant and of any changes to standards.

For more information about processes and systems at EDF Energy, please consult the on-line document *"Our journey towards zero harm"*.

3.4.6 Day-to-day implementation at CENG

At **CENG**, safety management is carried out in real time, with safety assessments being a full-fledged component of operational processes.

CENG has set up a monitoring system to assess the performance of its nuclear sites, with oversight at central level to reinforce performance. Management Review Meetings (MRM) and Integrated Performance Assessment (IPA) reviews are carried out. An executive committee oversees the major projects.

Independent oversight is handled by the QPA department (Quality Performance Assesment) via the following four main activities:

- Performance assessments at site and central levels,
- Audits of compliance with 10 CFR 50, in particular compliance with Technical Specifications and licence requirements,
- Independent inspections of ongoing work sites for compliance with the requirements of 10 CFR 50
- External supervision of nuclear safety by NSRB (Nuclear Safety Review Board).

3.4.7 Overall safety assessments

At the highest management levels of organisations (power plants and companies), regular assessment of the organisation's efficiency and management is a process developed and promoted across EDF Group, while leveraging support from the major international institutions.

3.4.8 Overall safety assessments at EDF SA

At **EDF SA**, an annual safety performance review is carried out by the plant (or engineering unit) manager, leading to an annual safety report presenting the safety status of the plant (or engineering unit) and containing:

- A diagnosis of the management,
- A detailed analysis based on the safety review results, main indicators, main safety events of operations (regardless of the significance level), and technical status of the facilities,
- The safety action plan.

Some elements are used to prepare the safety section of the published annual report which is presented to the Local Information Commission and broadly disseminated.

The Overall Excellence Assessment process (OEA) carried out by the Nuclear Inspection Department at DPN is an EDF-specific process that was put in place over 20 years ago, and has been continuously improved since then. Its aim is to assess the level of nuclear safety,

radioprotection and environmental safety based on a comparison between actual plant performance and the reference guidelines established by the DPN division, and to issue recommendations to the management line in order to further improve the safety level. An OEA covers the following areas: general housekeeping, operation, maintenance, local engineering, technical support, radiological protection, fire protection, environment and chemistry, and safety management, plus decommissioning management if appropriate.

All of these processes have been extended in depth and breadth to help the DPN division define priority orientations for constantly enhancing nuclear safety management and improving the overall performance of the fleet.

3.4.9 Overall safety assessments at EDF Energy

At **EDF Energy**, performance on nuclear safety, radiological protection and operations is reported monthly to the Safety and Oversight and the Operations Performance Delivery Teams, these are key governance bodies within Generation, and to the Generation Executive Team and the Licensee Board. In addition, quarterly reports on the safety state of the plant and processes through use of results, analysis, insights and oversight are presented to the Licensee Board and the EDF Energy Nuclear Generation Group Ltd Board.

EDF Energy also undertakes internal self-assessments of all its 36 company processes annually as part of the Internal Controls process. In addition, self-assessments are conducted on a risk-informed basis across several other processes to ensure that gaps to excellence are identified and actions implemented to ensure continuous improvement of performance.

External assessments are undertaken regularly by WANO and learning is also taken on board through industry benchmarking.

3.4.10 Overall safety assessments at CENG

CENG uses performance assessments to determine its current-state performance, as well as to define performance targets consistent with the best benchmarks of the industrial sector.

CENG's internal assessment processes include quarterly Management Review Meetings (MRM), monthly targeted Touch Point MRMs, structured reviews of Key Performance Indicators (KPI), Quality and Performance Assessments (QPA), audits and self-assessments of the sites. An Integrated Performance Assessment Process (IPA) is used to synthesise all the data and analyses from internal assessments into an objective performance overview. The output of the IPA drives performance gap closure through continuous improvement, governance and oversight, and training activities.

INPO conducts periodic evaluations of each nuclear plant (once every two years, with a mid-term follow-up visit) and also ensures that training programs in all technical fields (Operations, Maintenance, etc.) meet industry standards through accreditation boards.

3.4.11 Contribution to international organisations

The involvement of engineers and managers from EDF Group nuclear companies in international organisations is a valuable way to learn more in terms of safety management and more broadly to develop their open-mindedness to the best practices in the industry.

One of the paths to international exchanges is training: several dozens of EDF managers participated in 2011 in seminars organised by the INPO Training Academy and in WNA University Sessions.

EDF's contribution to the WANO Peer Reviews and Technical Support Missions (TSM) involved nearly 100 managers in 2011. More than 120 others were also involved in WANO technical seminars. The Group aims to involve more and more staff members in international actions, beyond

the permanent secondment of 25 executives at WANO and 3 at INPO, EPRI and IAEA. These participations allow for better leveraging the experience feedback and sharing of the reports published by these organisations.

At **EDF SA**, the results from external safety assessments are incorporated into the management loop, and external assessments take place nearly every year at all sites:

- a WANO peer-review takes place every 4 years on each EDF nuclear site in France,
- an IAEA OSART takes place each year at one of EDF's 19 power plants,
- and every 4 years, each power plant undergoes an Overall Excellence Assessment carried out (for the portion related to nuclear safety, radiation protection and environment) by the Nuclear Inspectorate Department of the Nuclear Generation Division (DPN).

This means that each plant is subjected nearly every year[14] to an external safety assessment which provides an external vision and a set of recommendations fuelled by international experience.

At EDF Energy, WANO Peer Reviews are held at each of its nuclear power plants on a 3 (max 4) year frequency with an interim follow-up visit to review progress. The Company therefore typically receives 2 or 3 peer reviews per year with a similar number of follow-up visits. Corporate peer reviews are also held periodically.

Each peer review has two primary outputs:

- A report which identifies areas for improvements (AFIs) which describe gaps between current performance and excellence. These are supported by factual evidence and an analysis of the causes which underlie performance gaps.
- Since 2010, a separate report which reviews station progress in addressing WANO Significant Operating Experience Reports (SOERs) recommendations.

During follow up visits, WANO assesses progress made by plants in addressing AFIs identified during the previous Peer Review.

In conjunction with WANO, INPO and IAEA, EDF Energy also provides support to, and is supported by, technical support missions, self assessments, operating experience feedback, benchmarking, workshops and seminars, performance indicators and secondments.

Seven workstreams have been established to address the AFIs observed by WANO in the 2012 Corporate Peer Review of EDF Energy. These are: organisation and personal behaviours; governance, strategy and business planning; independent/external oversight; functional oversight; significant operating experience reports; loss reduction and the equipment reliability programme.

The EDF Group Nuclear Engineering Division (DIN) provides support to EDF SA and EDF Group in a number of areas, in particular:

- Expertise and design of the new generation of reactors, including technical progress in safety and environment areas (studies on Generation 3 and Generation 4)
- Construction of new plants and new projects; e.g. EDF has put in place a dedicated organisation to leverage experience and benefit from the consistency between all EPR projects (Finland with AREVA, in France, UK and China), including relationships with safety authorities concerned by these projects, and also experience gained during construction and initial commissioning tests.
- Support to existing fleets in operation whenever needed (e.g. to find and implement solutions when failures occur or to replace main components in the case of lifespan extension) including relevant relationships with safety authorities.

[14] Taking into account the post peer-reviews and post-OSARTs

- Assessment and review of safety within periodic 10-year safety reassessments or through feedback generated by significant events and accidents, including updated assessments of natural risks (e.g. 400 engineers have been involved in safety assessments and reinforcement studies following the Fukushima accident)
- Decommissioning studies (within the licensing process and during actual dismantling operations).

3.5 Risk Assessment

3.5.1 Policy

The nuclear safety case on reactors includes at the minimum risk assessments of:

- Plant-based intrinsic faults, e.g. loss of coolant, loss of power…
- Internal hazards e.g. steam pipe rupture, fire…
- External hazards, e.g. climate conditions, flooding, earthquakes…

There is a legal requirement in general regulations for risks to be ALARP ("As Low As Reasonably Practicable"). Some countries impose a maximum risk level (e.g. probability of core meltdown). The responsibility to conduct thorough and in-depth risk analyses is fully recognised by the Group which uses the process as a fundamental tool to continuously reinforce the safety standards in its nuclear power plants.

3.5.2 Implementation

Risk management, a full-fledged operating process

For many years EDF Group has pursued a policy of managing its operational, financial and organisational risks. In 2003, the Group decided to implement an overall process for managing and controlling its risks and reinforcing existing plans, in particular by creating the corporate Risk Management Division (RMD, *Direction de Contrôle des Risques Groupe* or DCRG). The objectives of the management and control policy are to identify and rank the risks in all domains to gain increasingly firm control over them, under the responsibility of operational management; this policy enables corporate officers, directors and the Group's governance bodies to have a consolidated and regularly updated view of the major risks and their level of control. DCRG, jointly with the Internal Audit Department, implements an annual programme of audits on a large range of issues, linked to the previous risk ranking.

That approach is put in place in each division and company of the Group. At EDF SA Nuclear Generation Division, the approach is applied to nearly[15] all processes and projects. Each risk is identified and assessed, and relevant mitigation actions are undertaken.

Periodic safety assessment in nuclear plants including risk analysis

The nuclear power plants were designed and built to the best state-of-the-art technologies, and based on national and international standards and guidelines; at the time of commissioning, a Safety Report was a single document summarising all requirements and provisions included in the safety case. The power plants are expected to operate for a number of decades, during which these requirements have changed and will change. In addition, there are numerous changes made to facilities and procedures at each plant, each of which is separately documented even if it only constitutes a minor change in the safety case.

The entire safety case, including risk assessments of plant-based, internal and external hazards, is therefore reviewed at regular intervals against current national and international standards which set industry best practices, e.g. IAEA. The review also encompasses operating experience gained

[15] 17 among 22 processes and projects of DPN

within the company or the entire nuclear industry (e.g. following TMI, Chernobyl and Fukushima) and through global high-hazard industry events. The review process, which is referred to as a Periodic Safety Review (PSR), is carried out at intervals of approximately 10 years[16] under the oversight of safety authorities. These reviews may identify shortfalls with respect to currently applicable guidelines. All reasonably practicable improvements identified by the review are implemented to bring the plants in line with the current guidelines. In the UK, the review is submitted to Office for Nuclear Regulation (ONR) for their consideration and, if appropriate, agreement to any proposed changes to the Safety Report. In France, the safety improvement scope targeted by the ASN is previously established and is the basis for the ASN to deliver its opinion and the eventual complementary requirements in order to support the operation of the unit for a further 10 years. This process enables the oldest plants to be compliant with or close to the current guidelines applied to the most recent reactors.

In the USA, risks are addressed both through the regulator (NRC) and the reactor operator. The NRC's Reactor Oversight Process (ROP) assesses plant performance continuously through use of performance indicators and inspections which are based on risks of impact on public health and safety. Performance indicators include availability of key safety-sensitive systems and unplanned reactor scrams. Inspections include detailed evaluations of the design, maintenance, and operation of risk significant structures, systems, and components once every three years. Performance indicators that do not meet the minimum expected criteria and any significant gaps resulting from inspections require a detailed response to the NRC. The NRC's assessment of performance is provided to each reactor operator once every 6 months for subsequent action.

In addition to the regulator, each reactor operator assesses risks on a daily basis with probabilistic assessment tools and consideration of industry operating experience. This ensures that activities are planned and coordinated to minimise unavailability of key equipment components. Plant improvements are also identified (e.g. modifications, procedure changes) based on probabilistic studies, and implemented as appropriate to further reduce any residual risks.

3.6 Emergency Preparedness

Within the previously-described general framework of risk management, EDF-DCRG (corporate Risk Management Division) is specifically in charge of emergency preparedness and crisis management organisation at Group level, while each nuclear division and company in the Group remains responsible for its own internal crisis organisation. Drills are organised regularly (in relation or not with safety authorities) and provide an opportunity for benchmarking and experience sharing between the companies.

In France, in the event of an accident, an emergency organisation is in place to limit impacts on the environment and populations. To ensure both the safety of the facilities and the protection of populations, the system relies on two closely coordinated plans, designed for both local and national use. These are the Internal Emergency Plan (*Plan d'Urgence Interne*, or "PUI"), prepared by EDF and the Special Intervention Plan (*Plan Particulier d'Intervention*, or "PPI"), prepared by French *prefectures* in collaboration with the French state and EDF. These plans take into account all possible events (internal and external events, malicious acts, etc[17]). The efficiency and relevance of the system for warning, informing and protecting populations is regularly tested through accident simulation exercises, which make it possible not only to ensure the correct operation of the crisis plan, but also to improve it, in particular, by clarifying roles and validating all of the required material

[16] In France and UK

[17] Examples of events: internal -> Electrical losses, fire, industrial safety, etc. External -> earthquakes, storms, floods, malicious acts, etc.

and human resources (decision-making process, centralised technical support, communication capacity, anticipation ability, etc).

Each year, approximately 100 emergency exercises are conducted over the entire French nuclear fleet, i.e. approximately one every three days. Approximately 10 drills take place at national level, under the oversight of the ASN and involve EDF and the public authorities, in particular the prefectures. As one of the lessons learned after the first drills, stable iodine tablets have been pre-distributed in a perimeter of approximately 10 kilometres in order to better protect children against exposure to radioactive iodine in case of accident. As a lesson learned from the Fukushima accident, national assistance systems were reinforced with additional technical and human resources planned in situ to respond to a crisis.

Figure 8: Crisis preparedness drill

At the nuclear fleet level of **EDF Energy**, Emergency Plans are practiced regularly. Within Generation, each shift is exercised at least once per year, and one in-depth exercise is required to demonstrate to ONR the adequacy of the on-site emergency arrangements at each power station. These 'Level 1' exercises are witnessed by the ONR and focus on the actions of the operator. Emergency services are invited to participate to provide a mutual learning opportunity and to add realism to the on-site actions.

Level 2 and 3 exercises are aimed at the operation and testing of the off-site emergency plans. Level 2 exercises primarily test the local off-site plan for each station every three years. These exercises enable those agencies with a responsibility in the response to exercise and review their arrangements.

Annually one of the national programme of Level 2 exercises is selected for the purposes of testing the national level response plan. In addition to the Level 2 activities, this involves the setting up of the Nuclear Emergency Briefing Room in Whitehall, or the Scottish Government Emergency Room.

Regulatory exercises are also required to satisfy the nuclear security regulations and the transport of radioactive material.

In addition to the regulatory exercises, sites have tested various aspects of the emergency plans during approximately 100 shift exercise and training drills. The lessons from all exercises have been shared across the fleet and used in revising emergency plans and future exercise programme.

During 2012 and 2013, some additional key activities in the emergency preparedness area included:

- Provision of further detailed emergency arrangements to support beyond design-base accidents and integration of the post Fukushima recommendations. Proof of concept exercises have been held to test the new extended arrangements, including deployment of back up equipment.

- Increased focus on the alignment of the safety and security response arrangements for the industry and the fleet.
- National forums such as Nuclear Emergency Planning Liaison Group (NEPLG) and Nuclear Emergency Arrangements Forum (NEAF) have made significant changes to structure and governance. EDF Energy has consistently attended the Department of Energy and Climate Change's (DECC) new National Strategic Framework; this is the governance framework for the national emergency response capability.
- Review by International Atomic Energy Agency (IAEA) and ONR on increased extendibility planning and potential increases in Detailed Emergency Planning Zone (DEPZ's).
- Following the decision to include emergency preparedness in Peer Reviews there has been increased focus on World Association of Nuclear Operators (WANO) internal and external activities.

In the USA, nuclear power facilities were designed and built to safely withstand a wide range of natural hazards and other severe events, and are staffed with highly trained, federally licenced operators. The operational teams have received training in emergency preparedness and crisis management, in the context of an emergency plan designed to minimise external impacts via multiple layers of protection. An effective emergency response is the product of mutually supportive planning and preparedness actions coordinated among all stakeholders: local, state and federal agencies, and any private or public institutions that provide emergency services.

US federal law requires nuclear operating companies to create an on-site emergency response plan for their nuclear energy facilities and to ensure that emergency preparedness plans are in place to protect the public. The US Nuclear Regulatory Commission approves on-site plans, while approval of off-site plans is coordinated between the NRC and the Federal Emergency Management Agency (FEMA). These plans must be approved for a plant to obtain and retain an operating licence from the NRC.

Emergency plans for nuclear energy facilities continually evolve. This includes incorporating lessons learned from the terrorist attacks on September 11, 2011. The plans can be implemented during a wide range of severe natural events or security-related events.

A 10-mile emergency planning zone (EPZ) is delimited to protect communities near the facility from radiation exposure in the event of an accident.

A 50-mile zone is delimited within which food products, livestock and water would be monitored to protect the public from radiological exposure through consumption of contaminated foodstuffs.

Within the 10-mile EPZ, the main, immediate protective actions for the public include instructions for sheltering or evacuation. The slow pace at which an event may unfold – over several hours or days – provides enough time for orderly sheltering or evacuation, if necessary. Supplemental protective actions within this zone might include the distribution of stable iodine tablets to protect the thyroid gland from radioactive iodine. Within the 50-mile zone, the federal and state governments may monitor and test all food and water supplies that could potentially become contaminated and remove from public consumption any foodstuff found to be unsafe.

While both zones were established for planning and preparedness purposes, state government response directors have the discretion to designate specific protective actions beyond these zones, if needed.

The NRC conducts inspections of the CENG emergency plans annually. CENG conducts continuing training of its emergency response organisation as well as drills and simulation exercises to test abilities at least four times per year at each site. Every two years at each site, the NRC, FEMA, and the state authorities participate in integrated exercises to evaluate coordination between CENG and government agencies during an emergency.

3.7 Adaptation to Climate Change

As a part of its Sustainable Development Policy, **an overall climate change adaptation strategy was adopted** by EDF Group in 2010. The strategy aims to compile in a consistent way all the works, actions, studies and research to be implemented across the entire Group in order to identify all activities impacted by climate change, and all means and processes conducive to reinforcing our robustness and resilience to extreme climatic phenomena. We recognise that we have to adapt our existing industrial facilities and networks to ensure they will remain safe and operational over several decades throughout their life cycle. This strategy includes all studies and modifications done or to be done on nuclear facilities related to the major risk sensitivities, such as:

- robustness of our power supplies, based on lessons from experience after the storms of 1999 and the Fukushima accident,
- robustness of our plants during heat waves: after hot summers in 2003 and 2006, a specific programme of modifications called "*Hot Conditions*" was launched at all French power plants, with a short-term plan already implemented, and a medium/long term plan integrated into periodic safety reviews,
- robustness against flooding: after the flooding of Blayais nuclear site in 1999, a safety review was launched for all nuclear facilities, taking into account higher water levels and all combinations of effects; some protections have been raised at French sites (both riverside and seaside sites); this programme pre-empted the post-Fukushima review and will merge with it,
- management of water resources: EDF laboratories have been working closely with climate and meteorology experts to better forecast the availability of water resources for our hydropower and fossil-fuel plants (including nuclear plants). Special organisations are already in place to manage water and better coordinate all water users during low-water periods (in order to prioritise low-flow augmentation or reduce power generation during critical periods). Studies are ongoing to find less sensitive cooling systems and upgrade the regulations on heat discharges to adapt them to observed and future climate conditions.

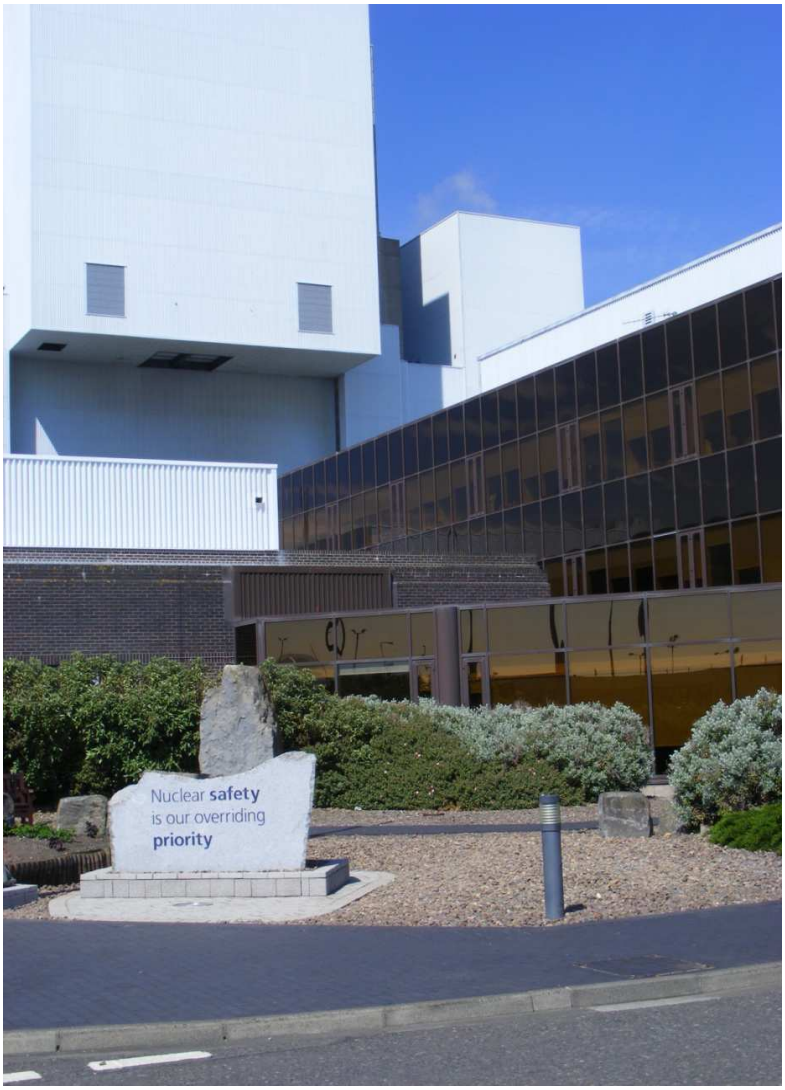


Figure 9: Nuclear Safety, our overriding priority

3.8 Lessons learned from the Fukushima accident

Following the Fukushima accident, the associations representing the nuclear safety authorities (IAEA, WENRA, ENSREG ...) asked the operators to test the capacity of their reactors to cope with extreme events such as Maximum Credible Accidents (MCA). Since 2011, each nuclear operator has conducted an assessment of its reactors to assess their robustness against the kinds of risk highlighted by the Fukushima accident (external hazards including earthquakes and floods).

The method followed by each of the operators is determined by the requirements set by the relevant regulator of the country (France ASN, UK ONR, U.S. NRC). The actions taken thus depend on the requirements and improvements required by these assessments.

In the context of transparency in the nuclear industry, the improvements are described in documents or Web-sites accessible to the general public:

- "EDF Energy Nuclear Generation : Our journey towards zero harm" for UK[18];
- "Renforcement de la sûreté : EDF s'engage" for France ;
- NRC WEB site: www.nrc.gov/ for US.

[18] http://www.edfenergy.com/about-us/energy-generation/nuclear-generation/documents/EDF-Energy-NuclearGeneration-Our-Journey-Towards-Zero-Harm.pdf

EDF SA:

In 2011 at the request of the ASN, EDF conducted a series of stress tests (*Evaluations complémentaires de sûreté*, or ECS) involving a meticulous and comprehensive review of all safety systems and their robustness against extreme events. Based on the findings of these stress tests, the ASN confirmed the satisfactory safety status of the EDF SA nuclear power facilities and recognized their robustness against extreme events.

The French Nuclear Safety Authority nevertheless required EDF to further upgrade the safety level of its power plants and their ability to withstand even the most extreme situations, and to complete this work within the shortest possible time.

EDF defined and initiated an upgrading programme in all of its power plants as early as 2011. This programme is described in detail in the publicly available document entitled "*Renforcement de la sureté: EDF s'engage*" and is scheduled to continue from 2015 up to 2030.

EDF Energy:

It is recognised that there are certain extreme fault conditions for which there is no specific design provision - these are termed "beyond design basis" faults. There are also unlikely combinations, or sequences, associated with design basis faults that fall into this category. Such situations have been analysed to confirm that there are large margins available within the design basis fault studies. In particular, it has been shown that there are no "cliff edges" which would result in the fuel safety limits being exceeded in the majority of beyond design basis situations analysed. Therefore even though specific studies have not been carried out for all possible events, scoping studies have shown the plants to be capable of maintaining safe conditions.

It is very difficult to provide detailed instructions to the Reactor Desk Operator covering all of the different extreme situations which could conceivably arise, however unlikely. The types of actions which would be most beneficial in these remote circumstances have nevertheless been considered, and this has resulted in the issue of two sets of additional instructions known as Symptom Based Emergency Response Guidelines (SBERGs) and Severe Accident Guidlines (SAG):

- The SBERGs give advice in a developing fault situation, for which the normal operating instructions are not valid. This advice focuses on the symptoms of the fault rather than on specific failures in any one plant system. The SBERGs supply guidance on the most appropriate actions which would be needed to preserve and reinforce the critical safety functions, such as reactor cooling.
- The SAGs advise on the management of the reactor after a severe fault. They focus on actions to establish the critical safety functions and to minimise the release of radioactivity from the core and plant.

The emergency preparedness arrangements at EDF Energy have been extended to include beyond design basis events. The exercises also include practising use of SBERGs and SAGs.

CENG :

The US industry and CENG in particular have re-examined the seismic ground motions at their sites, as part of the post-Fukushima lessons learned project and in line with the resolution of Generic Issue GI-199, ensuring plants meet design bases through walkdowns (2012) and by establishing new Ground Motion Response Spectra (GMRS). For the three CENG sites, the new GMRS are either bounded by the Design Basis Earthquake (DBE) or by the Review Level Earthquake (RLE) used in seismic margin assessment (SMA) performed in the 1990s, pointing to the fact that the seismic risk at the three CENG stations remains low and appropriately accounted for.

CENG has maintained a focus on the protection of the installations against external events, in particular against flooding, with improved flooding barriers and mitigating strategies at Calvert Cliffs

and Nine Mile Point. Leak tightness of roofs is monitored and strengthened when warranted. Switchyards are periodically monitored when exposed to high winds and resistance of the Calvert Cliffs emergency diesels to high winds is also increased. CENG continues to implement an annual readiness program to ensure stations can cope with extreme temperatures in winter and summer time periods. These recent actions are in line with the efforts initiated in the 1990s as part of the Individual Plant Examination for External Events program (IPEEE).

3.9 Radiation Exposure (to workers and the general public)

3.9.1 Definition

Radiation or radiological protection means the protection against ionising radiations, i.e. all rules, procedures and means of prevention and monitoring intended to prevent or mitigate the harmful effects of ionising radiations on individuals, whether directly or directly, including harmful impacts on the environment.

3.9.2 Overview on the regulatory context

In Europe, the current legislation (Euratom Directives 96/29) is inspired by the publications of ICRP (International Commission on Radiological Protection), a non-governmental institution establishing radioprotection recommendations based on scientific fundamentals. All national regulations (including the French and British laws) based on the European regulation integrate the following three fundamental principles of Radiation Protection:

- *Justification* principle: no practice involving a risk of exposure to ionising radiations shall be adopted unless its introduction produces a positive net benefit on populations as a whole (i.e. advantages deriving from the practice shall be greater than disadvantages).
- *Optimisation* principle: in the words of ICRP, all exposures shall be kept "As Low As Reasonably Achievable (ALARA), economic and social factors being taken into account". It means that all reasonably practicable measures to reduce radiation exposure shall be taken.
- Principle of individual dose exposure *limitation*: the dose to the individuals "*shall not exceed the limits recommended for the appropriate circumstances*". These limits are chosen and proposed by ICRP for workers and individuals of population to dose levels corresponding to a negligible risk level. French and British legislations have set the same dose limits: 1mSv per year for the public and 20 mSv per year[19] for the workers.

In the USA, Title 10 of the Code of Federal Regulations Part 20 establishes the standards for protection against ionising radiation from activities conducted under licences issued by the Nuclear Regulatory Commission. This chapter addresses control of the "*receipt, possession, use, transfer, and disposal*" of licenced material held by a "*licensee*" and prescribes that the total dose to an individual (including doses resulting from licenced and unlicenced radioactive material and from radiation sources other than background radiation) must not exceed the standards for protection against radiation prescribed in the regulations in this part. However, nothing in this part shall be construed as limiting actions that may be necessary to protect health and safety.

The licensee must control the occupational dose to individual adults to the following dose limits:

- (1) An annual limit, which is the more limiting of--
  - (i) The total effective dose equivalent being equal to 5 rems (50 mSv); or
  - (ii) The sum of the deep-dose equivalent and the committed dose equivalent to any individual organ or tissue other than the lens of the eye being equal to 50 rems (500 mSv).

[19] More precisely in French regulation: "per period of 12 consecutive months"

- (2) The annual limits to the lens of the eye, to the skin of the whole body, and to the skin of the extremities, which are:
  - (i) A lens dose equivalent of 15 rems (150 mSv), and
  - (ii) A shallow-dose equivalent of 50 rem (500 mSv) to the skin of the whole body or to the skin of any extremity.

The licensee shall use, to the extent practical, procedures and engineering controls based upon sound radiation protection principles to achieve occupational doses and doses to members of the public that are As Low As Reasonably Achievable (ALARA). ALARA means making every reasonable effort to maintain exposures to radiation as far below the dose limits in this part as is practical consistent with the purpose for which the licenced activity is undertaken, taking into account the state of technology, the economics of improvements in relation to state of technology, the economics of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations, and in relation to utilisation of nuclear energy and licenced materials in the public interest.

Each licensee shall conduct operations so that -

- (1) The total effective dose equivalent to individual members of the public from the licenced operation does not exceed 0.1 rem (1 mSv) in a year, and
- (2) The dose in any unrestricted area from external sources does not exceed 0.002 rem (0.02 mSv) in any one hour.

3.9.3 Policy

Despite differences between national regulations, the common approach of the nuclear companies of EDF Group is to ensure, at a minimum, compliance with all applicable regulations, to continuously improve our practices well beyond the requirements, to emulate nuclear industry best practices, and to cooperate with our industrial partners to achieve a common fleet standard which takes into account technical differences among plant technologies.

Each company strives to ensure that any exposure to ionising radiation is kept “as low as reasonably practicable” (ALARP) beyond the requirements, to reduce individual and collective radiation doses and protect any worker, without any distinction between company or subcontractor staff, or any person in the vicinity from exposure exceeding a statutory radiation dose limit.

At **EDF SA** level, the Council of Nuclear Safety, headed by the Inspector General, includes all corporate officers of the parent company and reports directly to the EDF CEO.

At the EDF SA Division level, the Risk Prevention Committee (CRP) reports to the executive managers of the Nuclear Generation Division (DPN). In each power plant, a Technical Group on Radioprotection and Nuclear Safety (*Groupe Technique de Sûreté Radioprotection*, or GTSR) reports to the site manager.

In 2012, a new policy was adopted at DPN reasserting the ambition of guaranteeing the health, safety and radioprotection of all EDF’s and subcontractors’ operational staff. Safety and radioprotection are essential components of operational quality, based on the conviction that workplace accidents, over-exposures to radiation and occupational illnesses are avoidable by developing a culture of prevention for all operational parties.

Moreover, regarding environmental protection more specifically, EDF Group adopted in 2009 an overarching **Sustainable Development Policy** which contains a target of “*minimising the impact of our activities on the environment by continuous improvement*”, taking into account minimising exposure to the populations.

Compliance with regulations and internal policy, along with nuclear safety management, are thus evaluated at each level of responsibility in the organisation.

3.9.4 Policy implementation measures

In order to reach their goal of continuously reinforcing the radiation protection of workers, the companies have implemented the following measures and processes among other:

- Efficient operation of the facility and all technical systems contributing to the lowest radiation level inside the plant premises (e.g. decontamination phase at the beginning of an outage in PWR plants, monitoring the cleanliness of controlled areas, implementation of protective shields...),
- Specific work preparation when operations are planned in a controlled area, with risk analysis, support and control by specialised staff,
- Specific radiological monitoring instrumentation and personal equipment provided to staff working inside controlled areas,
- Wearing personal dosimeters (possibly complemented with statutory dosimeters depending on local regulations)
- Appropriate alarm procedures for workers, crew supervisors and operating staff,
- Appropriate mandatory training and promotion of best practices (e.g. simulators and on-the-job workshops), for all workers whether company employees or sub-contractors.

Some most recently completed actions or ongoing action plans, aiming to remedy weaknesses and continuously improve the performances, include:

- **EDF SA** has implemented for some years a specific programme to prevent incidents in hazardous situations (red or orange zone entrance, radiographic tests...) based on a reference standard regularly audited by the Nuclear Inspectorate.
- Under the "*Charte de progrès*" (Progress Charter) signed with subcontractors and professional organisations, EDF implements an action plan intended to gradually reduce the number of workers exposed to more than 10 mSv per year (vs. 16 mSv/year a few years ago). The 16 mSv/yr pre-alert has thus reduced within 10 years the number of workers receiving a dose higher than 16mSv/yr (92 workers in 2001 down to 2 in 2011) and the dose was further reduced to 14mSv in 2012. Ever since it was implemented several years ago, this pre-alert process has also fostered a dialogue with subcontractors in an effort to find joint solutions to gradually reduce the doses received by these highly specialised workers and to guarantee the same quality of medical monitoring. More generally, under this joint agreement, EDF and its industrial partners afford the same priority and take the same commitment to the improvement of radioprotection and exposure prevention.
- EDF has been implementing for several years a specific programme to improve radiological cleanliness: reinforced rules during maintenance operations, additional investments in more sensitive and numerous contamination detectors, benchmarking and rating of the sites. Several power plants have adopted the so-called EVEREST approach *(**E**voluer **VER**s une **E**ntrée **S**ans **T**enue universelle)*, consisting in accessing clean zones (contamination <0.4Bq/cm²) with standard work overalls, and wearing a special protection suit in contaminated areas.
- The EDF Engineering Division conducts research to determine the best technical choices to reduce doses in future reactors (chemical conditions of reactor coolant, presence of cobalt in steam generator tube alloy and in valve stellite...)

EDF Energy has launched an instrumentation replacement programme, for installed and portable radiation and contamination instrumentation; the new equipment being more sensitive and aligned to best international standards and practices.

- EDF Energy has successfully implemented a programme of radiography inspections, as a world best practice, together with its contract radiography company.

- EDF Energy has improved radiation worker practices by training workers to a common standard in a training environment using simulated contamination. It has also laid the foundation for effective reinforcement of standards using coaching cards in the Radiation Controlled Areas (RCA). Other initiatives implemented to address worker practices include, the introduction of radiological protection coaching time in the field, RCA "meet and greet" programmes using standard question sheets, a pocket restriction policy (workers only permitted to take items required for the job into the RCA), an empty pocket policy (workers required to check personal items and pocket contents in a Small Article Monitor before exiting the RCA), RCA orientation tours for new starters and RCA Lockouts (prohibiting RCA access to workers for non-compliance with radiological protection rules).

CENG has successfully reduced the source term, improved radiation-related worker behaviours and improved its ability to control work remotely. The remarkably successful programme was launched to reduce the level of collective dose and has resulted in individual exposure being well below the mandatory limits: no worker is exposed any longer to more than 20 mSv, i.e. well below US standards and in line with its internal policy.

Regarding the minimisation of public dose exposure, the Group companies use a wide array of means and processes, from the design itself to the optimisation and control of effluents generation and treatment, to the monitoring the environment of the plant (including radio-ecological studies):

- At the design stage, the fission products contained in the reactor core are segregated from the environment by three successive barriers: the fuel rod cladding, the primary reactor coolant system and the containment enclosure. The tightness of these barriers is strictly controlled during operation; the Technical Specifications for Operation (STEs) define the acceptable limits for certain parameters used to monitor the tightness of these barriers and stipulate measures to be taken if these limits are reached. The tightness of the barriers is a fundamental parameter included in safety assessments carried out as described in § 3.3.
- Moreover, several fundamental checks are also conducted within maintenance programmes such as: non-destructive checks of each reloaded fuel assembly, resistance and tightness check of reactor coolant system, periodic tests of robustness and tightness of the containment enclosures (in addition of permanent monitoring during operation) and of all isolation devices.
- Because of the normal activation of water (PWR or BWR reactor type) or gas (AGR) used for reactor core cooling, several types of equipment ([20]) are in place to treat continuously the coolant and all liquid or gaseous effluents collected in the plant, for subsequent re-use to the greatest possible extent, and to minimise the residual radioactivity of these effluents before release into the environment. The efficient running of these equipments is strictly controlled.
- All discharge lines (ventilation shafts, drainage pipes of effluent storage reservoirs) are equipped with measurement devices; compliance with limits imposed by regulations and by STEs is strictly controlled. Regardless of their origin (Reactor Building, Fuel Building, Nuclear Auxiliary Building, Turbine hall, laundry etc.), all drainage effluents liable to be radiologically contaminated are always stored and tested before and during release.
- The residual radioactivity in the environment around nuclear sites is closely monitored through frequent and accurate analyses performed on all environmental compartments (terrestrial: grass, milk, farm products, or soils; Aquatic: water (surface and sea), groundwater, sediment, flora and fauna samples, and; Air: aerosols, rainwater, ambient gamma dose rate) from samples collected around the plants. Several arrays of beacons also monitor on an ongoing basis the ambient gamma radiation around the sites, with measurements reported to the control room. All monitoring results are reported to regulatory authorities and to the neighbouring municipal authorities.

[20] Filters, storage tanks for natural decay of gas radioactivity, evaporators, demineralisers...

- All Group nuclear companies aim to reach the best environmental performance in the industry by reducing the radioactivity released to levels “as low as reasonably achievable”. To this end, they rely on the international experience found within the Group and on contacts with international organisations. The improvements are found in a wide range of domains: operational mode, chemistry, maintenance, efficiency of treatments. Impressive improvements have been made since the first years of operations (reduction by more than ten in general, if not 100); the impact of operation is currently well below regulatory limits and is merging with natural variations of the ambient radioactivity. The good results now achieved (i.e. levels of radioactive releases in France excluding tritium and C14 are today one hundredth of levels in 1984) attest to the efforts made by EDF (more rigorous management, reduction at source, improvement of collection systems) over more than 20 years to optimise discharges and minimise their impact both on the environment and on the public. These efforts are obviously being continued to ensure that the NPPs maintain, or further improve their performance directly related to environmental protection.

3.10 Site Security

3.10.1 Policy

EDF Group recognises the value of its human and technical assets (people, facilities, fuel, information systems and knowledge) that contribute to its business and the need to protect them. Security is about protecting our physical and intellectual property, our staff and the public from any potential or actual event which could adversely affect the confidentiality, integrity or availability of our infrastructure and information as well as the personal security and safety of staff and the public. The risk of theft or non-civil misuse of nuclear fuel is fully taken into consideration by the Group companies, in strict compliance with the requirements of international organisations (IAEA, EURATOM) as complemented by national regulations.

3.10.2 Policy implementation measures

Based on a variety of threats, ranging from malicious behaviour to cyber-criminality and terrorism, there is a series of safety and security measures in place at each of our power plants in addition to the inherent physical security provided by the very robust design of the nuclear reactors and buildings. In compliance with local laws and requirements, access to nuclear power plants is strictly controlled and armed guards or security forces are deployed at all nuclear sites to complement existing security measures.

Confidentiality on the details of these measures is a key point of its effectiveness; readers of this report will understand that it is not possible to describe them in more detail. In each country of operation, the effectiveness of surveillance and protection measures is strictly controlled by dedicated administrations or by the safety authority, and by international inspectors (IAEA, EURATOM). These security measures are periodically tested, reviewed and reinforced as needed, depending on the threat and on the initial robustness of the protection (e.g. after September 11, 2011).

4. WASTE

4.1 General overview

The real or potential radiological impact of the operation of a nuclear power plant on its environment may have several forms and origins:

- As highly radioactive material are produced inside the fuel assemblies of the reactor core, the first source of radioactive waste is the fuel itself; certain radioactive materials that are

produced have a very high radioactivity and very long life. This is why the management of this fuel is of extreme importance and gives rise to two difficult choices: reprocessing the fuel or not, and final storage (nature and organisation, decision generation made by the States) of the solid waste generated (fuel assemblies themselves or ultimate waste generated by reprocessing).

- Solid waste originating from the equipment that treats and filters contaminated waters and air (filters, resins, sludge) or during maintenance (plastics, gloves and protective clothing); these waste materials are treated and encapsulated in sealed packages generally at the plant site, to limit the risk of uncontrolled radioactivity releases into the environment. Radioactivity levels and life span are much lower than in the first category of waste.
- When treated in a proper and efficient manner, liquid and gaseous effluents contain very low quantities of radioactivity and may be released into the environment in compliance of strict and controlled regulations.

4.2 Regulatory context

In France, the national strategy is to reprocess spent fuel coming from nuclear facilities (mainly in AREVA NC plant at La Hague, in Normandy) and to re-use fissile materials extracted during this reprocessing. The aim is “to reduce the quantity and the harmfulness of radioactive waste, while recycling valuable materials like uranium and plutonium”. The method for storage of nuclear waste depends on its degree of radioactivity and its nuclear activity period. In addition to some temporary storage on EDF sites, very low-level waste (VLLW) produced by EDF (for example, concrete or metal waste left over after decommissioning a nuclear power plant) is stored on an ANDRA site opened in 2003 (the “CSTFA”). Short life, low-or intermediate-level waste (SLLLW/SLILW) that is produced by EDF’s operations is stored above ground at ANDRA’s Aube storage centre (the “CFMA”). Long life, high-level waste (LLHLW) produced from the reprocessing of spent fuel is vitrified and stored temporarily and safely at the AREVA NC centre in La Hague pending the adoption of a long-term management solution (public decision expected around 2014 for a storage centre commissioned around 2025). Long life, intermediate-level waste (LLILW) (for example, from shells, nozzles, sheeting, etc.) is either cemented or compacted and confined in stainless steel drums. They are currently kept in temporary storage pending a final decision on a long-term management solution.

In France, as an operator and producer of waste, EDF SA is legally responsible for spent fuel from the moment it leaves the power plant, during its reprocessing and throughout its long-term management process; EDF assumes this responsibility in accordance with guidelines set by public authorities and under their oversight. Each year, EDF makes provisions for the back-end of the nuclear fuel cycle in France which covers the management of spent fuel and the long-term management of radioactive waste. To calculate the cost of future management of long-life, intermediate and high-level waste from the processing of spent fuel, EDF takes the assumption of deep geological waste storage, pursuant to the law of 28 June 2006 which defines deep geological waste storage as a reference solution. For long-life, low-level waste from the decommissioning of shut down graphite-gas power plants, provisions are established by EDF based on forecasts of waste production and cost assumptions for long-term storage supplied by ANDRA. The cost of removing and storing short-life intermediate and low-level waste and very low-level waste is calculated on the basis of contracts signed with ANDRA and the various carriers in charge of operating the existing Storage Centres. The costs of disposal and storage of plant dismantling waste are provisioned. Costs relating to operational waste are recognised in annual operating budgets.

The 2006 law on nuclear waste requires the Government to draw up every three years a National Plan on Management of Radioactive Materials and Waste (PNGMDR in French); under this Plan, EDF, as well as other producers of radioactive waste, disclose all the data available on the waste they store in the own facilities or sent to ANDRA. The full plan, along with a summary, is published

by the ASN on its web site[21]: information on quantities and management methods for the various radioactive waste categories is therefore available to the public.

In the UK, EDF Energy as owner operator and licensee is responsible for ensuring the safe decommissioning of all our power station sites. The company decommissioning policy, strategy and plans have evolved over a number of years and have been developed using multi- attribute decision analysis to ensure that the Best Practicable Environmental Option (BPEO) is being pursued. The strategy and plans take due consideration of the nuclear, industrial and environmental safety implications. The company policy and strategy objective of decommissioning is to return the power station sites to a state suitable for unrestricted alternative use.

It should be emphasised that EDF Energy remains responsible for the decommissioning of our existing power station sites. The responsibility for discharging all aspects of the decommissioning works and management of the associated wastes rests with EDF Energy. (The decommissioning responsibility **does not** transfer to the NDA following end of generation). The role of the NDA, as agent for UK Government/Secretary of State, is to administer the Liabilities Management Agreements, including the approval of Nuclear Liabilities Fund (NLF) payments for decommissioning and waste management.

The funding for EDF Energy Generation power station Decommissioning and waste management coming primarily from the Nuclear Liabilities Fund (NLF), but also EDF Energy/EDF Group Accounts

The decommissioning strategy, policy and plans are subject to regular review. At minimum, a 5 yearly review of the plans is undertaken. In practice, to date, the review/revision has been on a greater frequency. This commitment to review ensures the plans reflect best practice, take advantage of operating experience from ongoing decommissioning projects and remain consistent/ aligned with national and international policy, legislation and best practice. The latest submissions and approvals were made during 2013.

In the UK, radioactive waste is classified as either Lower Activity Waste (LAW), or Higher Activity Waste (HAW). LAW includes Very Low Level Waste (VLLW), Low Level Radioactive Waste (LA-LLW) and Low Level Waste (LLW). HAW includes Intermediate Level radioactive Waste (ILW) and High Level radioactive Waste (HLW).

Provided the radioactive waste meets specific criteria, each category of radioactive waste is managed as follows:

- **VLLW**: Consigned for landfill or off-site incineration.
- **LA-LLW**: Sent off site for treatment and/or disposal
- **LLW:** Sent for treatment and/or disposal
  - Volume reduction by supercompaction,
  - Recycled at a Metals Recycling Facility,
  - Volume reduced at a High Temperature Incinerator.
  - Disposal - LLW may be disposed of at the national Low Level Waste Repository (LLWR).
- **ILW**: Stored in purpose built facilities for radioactive decay and/or pending packaging for disposal. Where the capacity of plant storage facilities does not meet the volume of operational waste, the relevant waste is packaged to the anticipated requirements of a future national repository (for English plants), and placed in on-site interim storage. Scottish national policy differs in so far as ILW will be packaged in preparation for long term storage in Scotland.
- **HLW**: Under historic contractual arrangements, spent fuel from our AGRs is transported to Sellafield for reprocessing or storage. Once processed, HLW exists in the form of glass

EDF does not yet directly use these disposal routes but we are preparing to review their viability.

[21] http://www.french-nuclear-safety.fr/Information/Publications/Others-ASN-reports/French-National-Plan-for-the-Management-of-Radioactive-Materials-and-Waste-2013-2015

contained within stainless steel canisters for long term storage at Sellafield. HLW is not stored at any of our sites. Spent nuclear fuel is not currently classified as waste since it can be reprocessed to extract uranium and plutonium for re-use. However, unprocessed spent fuel will require disposal using a similar approach to ILW. At our Sizewell B PWR station, spent fuel is stored on site until a final decision is determined on how it will be disposed. We are planning to build a new facility to enable accumulation of the station's spent fuel until the end of its operational life. Currently, the government's policy for the management of spent fuel from Sizewell B (and new build) is that it will be directly consigned from on site storage to a national disposal repository. Disposal of spent fuel from Sizewell B will not occur for a number of decades. *Note: Some LAW, ILW and HLW are collectively referred to as HAW*

In the USA, in accordance with the Nuclear Waste Policy Act of 1982 (NWPA), CENG as a nuclear operator contributes to funding the spent fuel management handled by the DOE (Department of Energy). CENG pays the contributions stipulated in the NWPA to fund the cost of construction by the DOE of a federal storage for final disposal of spent fuel. Since the DOE has interrupted the Yucca Mountain project (at the request of the US administration) in 2009, it can no longer receive any spent fuel for storage in the absence of any solution for centralised storage (in spite of its contractual obligation to do so since 1998).

Consequently, and similarly to other US operators, CENG had to adopt technical measures and invest in facilities necessary to store its fuel assemblies on site until a federal storage site is made available. The related expenditures will be covered by the DOE under an agreement signed to this purpose in 2011.

In 2013, several local and federal courts have ruled on this case and required the DOE and NRC to resume their activities providing final storage of spent fuel.

4.3 POLICY

Regarding radioactive operational waste, the environmental policy of EDF Group is to reduce the generation of waste to a practicable minimum and to maintain radiation dose exposure to the workforce and to the general public from radioactive waste management operations, including transport and disposal, within legal limits and As Low As Reasonably Achievable (ALARA principle). The management of waste is focused on reducing, re-using (e.g. tools), and segregating waste for recycling in priority (in the framework of possibilities given by the local regulations). Moreover, EDF Group ambition is to contribute to the emergence of a comprehensive nuclear waste management solution in a long-term vision that is safe and socially acceptable.

This radioactive waste management policy is consistent with the Sustainable Development Policy adopted in March 2009 by EDF Group. The Group is committed to taking action to limit the impacts of its facilities and all its activities on human health and on the environment. EDF Group manages and monitors its impacts using an ISO14001-certified Environmental Management System (EMS)[22]. The EMS affords priority to safety in all hazardous activities, to compliance with existing regulations, to pollution prevention and to research in support of continuous improvement of our environmental performance.

In order to facilitate and monitor the implementation of this policy in all Group companies, EDF has put in place a Sustainable Development Committee which reports to the General Secretary of the Group and acts as the supervisory board on all environmental issues.

4.4 Radioactive Waste Management

All nuclear companies of EDF Group share the same principles for waste management, namely:

[22] The scope of EDF's EMS is the largest worldwide

- Minimising operation and maintenance waste generation at source, and use of the following waste hierarchy: “avoid, reduce, re-use, recycle, treat, package” while taking into account the limitations or bans prescribed by the regulator (re-use and recycling are in general possible within the nuclear industry, while recycling outside the industry is limited, even banned in some cases like in France)
- Segregation and streaming of waste;
- Processing by efficient use of existing treatment techniques;
- Storage, packaging and transport in accordance with applicable regulations;
- Waste radioactivity measurement and/or assessment and compliance with control procedures.

EDF Group’s main objective is to maintain radiation doses to the workforce and to the general public from radioactive waste management operations (including disposal and transport), within legal limits and As Low As Reasonably Achievable (ALARA principle). In line with this goal and in compliance with its certified EMS, EDF Group companies have put in place and regularly improve management processes such as: optimisation of waste management and treatment systems, maintenance and improvement (e.g. through training) of practices and behaviours, search for excellence by benchmarking with other operators and collaboration with international organisations and with service providers (e.g. for treatment or for recycling).

Figure 10: Waste sorting and characterisation

The safety of radioactive waste packages dispatched to specialised processing facilities or storage centres relies on the quality of waste containers (concrete, steel or lead casks), which are designed for specific types of waste and take into account various hazards during transportation. Waste shipments are governed by national and international legislation, for the purpose of protecting the public and the environment from all types of hazards. No shipment may leave a plant or be accepted at its destination without prior submission of a comprehensive inspection document.

Significant actions in the past years include:

At EDF SA, the average of radioactive liquid discharges is lower than 1% of the required limit ([23]) and has been halved in the last ten years, while the average number of solid LLW/ILW packages has not increased. This result was achieved with actions focused on “reduction at source”. EDF had previously (since 1985) cut down by a factor of 3 the volume of low- and intermediate-activity level

[23] Except for tritium and C14 which are linked to the energy produced and can’t be easily separated and treated

waste produced. Due to its reprocessing centre, CENTRACO, EDF cuts down by a factor more than 10 the volume of low activity metal waste[24].

At EDF Energy, it should be noted that, no decommissioning has yet been carried out for any of our nuclear power station sites. Power station decommissioning, following a planned end of generation, remains some years off. However, detailed baseline decommissioning plans for each of our power plants are in place. These plans have been developed over a number of years/iterations and have been formally approved by our regulators and NDA. The detailed Baseline Decommissioning Plans include sites specific detail on each individual decommissioning activity and process including the requirements to transition from an operational site to a decommissioning site following end of generation. The transition from operation to decommissioning includes consideration of the associated resourcing and training requirements.

The potential impacts of the company's operational activities on decommissioning are a key consideration. For example all engineering changes to plant or processes are formally assessed to consider the potential implications to decommissioning, decommissioning wastes and the associated liabilities. In addition, the company carries out an annual review of any potential impacts of power station operations on decommissioning and liabilities and formally reports this to the NDA within the Annual Liabilities Report: Part 1" (ALR1). The ALR1 provides a formal route for recording changes in our Generation decommissioning and waste liabilities which may have occurred over the previous financial year. Any impacts of engineering changes, operational changes and events etc, during the operational period are assessed for potential to impact on decommissioning.

At the end of 2011 we launched a new process called Sustainable Approach to Waste Management (SAWM), which aims to improve our performance whilst integrating with existing related company processes. A new fleet strategy for waste, Radioactive Waste Improvement Plan and Technical Baseline and underpinning Research and Development documents have been issued, whose requirements will be implemented across the fleet. SAWM, through the fleet strategy, will develop and manage the use of performance indicators. Fleet strategy and waste management practices are defined through a suite of Company Specifications for all waste types, for which compliance and Best Available Techniques are routinely reviewed. Consideration of the waste management hierarchy underpins these Company Specifications to ensure that waste disposal to land is always the final option. The waste management hierarchy provides a framework for preventing, minimising, treating and disposing of waste

We have developed new arrangements for the management of HAW to prepare for the packaging of ILW at Sizewell, which began in January 2014 and is continuing in 2014. The AGR plants will be incorporating the HAW management arrangements into their processes from 2014, commensurate to their current requirements.

In the USA, several initiatives have been launched to minimise the volume of solid radioactive waste generated at US nuclear sites through planning, training and communication. CENG segregate its waste (resin, filters, DAW and metals) and send it to a licenced waste processor where the optimum cost-efficient alternative (compaction/incineration/decontamination) is used to minimise the volume. The waste is then sent to a licenced waste burial facility or, as is often the case for metal waste, released for use. The exception to this is any waste that is higher than Class "C" and therefore must be stored as it is not authorised for burial.

CENG minimises liquid waste releases by limiting water usage, processing any liquid radioactive effluents, storing effluents for radioactivity decay when appropriate, and final discharge in compliance with USNRC Federal Regulation 10 CFR Part 20 not to exceed public dose limits. CENG site liquid discharges do not exceed one tenth of the federal limits.

[24] Further to an industrial accident at the Centraco melting furnace in September 2011, melting operations were interrupted and remain subject to ASN authorisation before restarting.

The annual Environmental Reports contain data on radioactive waste discharges and waste generated by CENG sites, in compliance with USNRC Regulatory Guidance 1.21. The reports are forwarded to the NRC and State authorities as required by existing licences and permits. Any discharges, spills or other environmental events are reported promptly to the appropriate oversight agencies based on predefined procedures. All reports are available for public review.

4.5 Spent Fuel

4.5.1 Policy

Our overall commitment is to play a leading role in the drive for continuous improvement in spent fuel management across the industry worldwide. Improvements target several issues, both for existing fleet and for new reactors:

- Fuel behaviour in reactor core during normal operation and in accidental situations with the aim of minimising public radiological exposure,
- Safe management of spent fuel,
- Optimisation of the fuel cycle intended to minimise the amount of fuel used per MWh generated,
- Reprocessing/recycling (whenever authorised by the Regulator and possible within the local industrial context) designed to reduce the consumption of natural resources and improve the management of long-life waste.

EDF works jointly with governments, regulators, NGOs and other stakeholders to develop and demonstrate a long-term and comprehensive radioactive waste management solution for the nuclear industry.

4.5.2 Policy implementation

Management of spent fuel

Because fuel assemblies contain the most radioactive products, our primary focus is to deliver a safe management of spent fuel.

Spent fuel is handled under carefully controlled conditions and the process is managed and operated by suitably skilled, experienced and certified personnel (trained on handling machines with model assemblies or on full simulators). Spent fuel management requirements include handling, operation of spent fuel pools and specific tools, temporary storage, loading and control of transport containers, and final dispatching organisation. All of these processes (loading, cleaning and checking of container contamination) are carried out under strictly controlled procedures to ensure safety and compliance with regulations, and under a process of continuous improvement present in all Group companies.

Fuel-cycle optimisation and behaviour of fuel assemblies

EDF works closely with fuel designers and suppliers on these two related aspects, both via research programme and experimentations with new alloys for the cladding which are more corrosion-resistant and more resilient in case of accident, and to extend the duration of the life-cycle of an assembly, by safely increasing their burn-up. These improvements need time and close cooperation with suppliers, reprocessors and safety authorities. They may have some impacts on spent fuel reprocessing and storage procedures, and therefore require finding the optimum process.

Long-term management and reprocessing

In France, EDF has made the choice of spent-fuel reprocessing and recycling of fissile materials, with the target of reducing the volume and the harmfulness of the final portion of radioactive waste.

EDF sends around 1,000 tonnes of spent fuel each year to AREVA for reprocessing at La Hague, and the recycled portion of the fresh fuel we reintroduce in reactors represents 17% of the energy generated. In order to avoid plutonium accumulation, the processing flow rate (1,000 tons/year) is consistent with the recycling capacity (number of power plants authorised to receive MOX fuel). The volume of Long Life-High Level waste (LL/HLW) generated in the reprocessing plant of La Hague each year is of 150 cubic metres. The Long Life-Intermediate Level waste (LL/ILW) generated represents 200 cubic metres per year.

In the UK all spent fuel from the AGRs is transferred off-site to Sellafield for long-term storage or reprocessing. For PWR (Sizewell B) the current long-term spent fuel management plans include a purpose built facility at Sizewell site. The spent fuel will be stored on site until national facilities are available for off-site disposal of fuel.

In the USA, as previously mentioned, spent fuel management is dictated by a law titled Nuclear Waste Policy Act of 1982 ("NWPA"). The U.S. government should have built and commissioned a federal repository for all spent fuels. This repository has however not been built yet and the issue is still under debate.

Accordingly, US operators, including CENG, are developing on-site dry storage solutions and negotiating with the DOE for the repayment of the related costs by Federal authorities. This type of storage is a safe, robust and long-term option (the NRC has confirmed a safe storage life of around 50 years for this type of solution) requiring no forced cooling.

New reactors

The new EPR reactor will have a larger core than its predecessors. Composed of 241 assemblies, its cladding will be made of new more resilient alloy. The planned cycle time will be 18 to 22 months with an average burn-up of 60 GWd/tU (compared to 45 for the existing French reactors) and the use of MOX will be possible but not yet contemplated[25].

Beyond its performance and power capability, the EPR core presents benefits in terms of waste generation. Due to its size, to the number of assemblies, to the use of neutron shields, and to the efficiency of the steam turbine, the efficiency of fuel use is 22% higher compared to a current type of PWR reactor and the generation of long-life waste is 26% lower[26]. Due to its higher activity, the impacts of spent fuel on transport, reprocessing and storage had to be assessed before its use in the reactor. These impacts have been predicted by safety institutes in France and UK to be compatible with current operating arrangements even if, in some cases, some arrangements in the current provisions are to be made (e.g. ILW packaging, cooling time in pools, requirements for final disposal...)[27].

4.6 DECOMMISSIONING AND WASTE

4.6.1 Policy

The common policy within the Group is to decommission each power plant following its permanent shutdown in compliance with local laws with the aim to return the site to a state suitable for an alternative use. In France, the only country where reactors previously operated by the Group have been permanently shut down, EDF has chosen to completely dismantle the nine first-generation reactors.

[25] See §4.1 of the Flamanville3 safety report on http://energie.edf.com/nucleaire/carte-des-centrales-nucleaires/epr-flamanville-3/publications-48527.html
[26] See §11.3.2 of the Flamanville 3 safety report
[27] See http://www.epr-reactor.co.uk/scripts/ssmod/publigen/content/templates/Show.asp?P=340&L=EN

EDF takes full financial and technical responsibility for the decommissioning of its nuclear power plants. For EDF, the issue is to demonstrate, through the decommissioning process, its full control over all steps throughout the entire life cycle of its nuclear power facilities.

4.6.2 Policy implementation

Decommissioning of nuclear power plants involves three levels, according to a classification defined by the International Atomic Energy Agency (IAEA) in 1980:

- Level 1: final shutdown of production, full fuel unloading, draining of circuits (99.9% of radioactivity is eliminated), followed by final shutdown: deconstruction and dismantling of non-nuclear facilities that are permanently decommissioned, with controlled access maintained for nuclear facility kept under permanent monitoring;
- Level 2: dismantling of non-nuclear buildings and nuclear buildings excluding the reactor building, conditioning, conditioning and evacuation of dismantling waste to specialised facilities, the containment enclosure of the building or structure containing the reactor is kept under surveillance;
- Level 3: complete dismantling of the reactor building, and removal of materials and equipment that are still radioactive; surveillance is no longer necessary; following these operations, the site may be re-used for other industrial purposes.

The baseline scenario adopted by EDF since 2001 consists in a decommissioning process without any waiting period, in compliance with French regulations providing for dismantling to be completed "*within the shortest possible time between the final shutdown of the plant operation and its dismantling*" (ref. Ordinance of 7 February 2012 stipulating general rules on Basic Nuclear Facilities).

EDF has launched the decommissioning programme of the nine reactors that have been definitely shut down (one PWR: Chooz A, one heavy-water reactor (HWR): Brennilis, one fast breeder reactor: Creys-Malville and six NUGG-type reactors in Bugey 1, Saint-Laurent A and Chinon A) by 2035, following the delay by ANDRA in commissioning the long-life LLW storage. The sites remain the property of EDF, and they will remain under its responsibility and monitoring. With regards to the other PWR power plants, certain decommissioning options, including those relating to the timeframe, have not yet been finally decided. Given its role as responsible owner, EDF will act as the contracting authority for the decommissioning.

The regulatory framework for decommissioning was renewed in 2006. It is characterised, for a given power plant, by:

- a single decree, following the ASN's opinion allowing for complete decommissioning. Three decrees were obtained in 2010: decrees for the complete dismantling of the NUGG reactors Saint Laurent A and Chinon A3 in May 2010, and the decree authorising the construction of an interim storage facility for radioactive waste in April 2010 (ICEDA)
- key milestone meetings to be held with the French ASN, integrated in a safety reference system;
- an internal authorisation procedure for the operator, independent of the operational staff and audited by the French ASN, and allowing the beginning of the work within the limits of the safety reference system authorised.

The decree to decommission Bugey 1 was published in the *Journal Officiel* on 20 November 2008.

Regarding the Brennilis site, at the end of July 2008, EDF filed a new request to the ministers in charge of nuclear safety for an authorisation to decommission. This new request followed the decision of the French Council of State of 6 June 2007 to cancel the decree authorising the reactor to be fully dismantled because the results of an impact study on the decommissioning work had not been issued publicly before the publication of the decree. The new decree authorising the next

steps of the decommissioning was published on 28 July 2011. A decree to be adopted around 2013 should authorise the complete dismantling.

A new authorisation request for full decommissioning was filed in December 2011. Since the construction works of the ICEDA centre had been interrupted further to a cancellation of the building permit in December 2011, the ASN considered that the authorisation request filed by EDF on 29 December 2011 was invalid as is. EDF SA is currently working on a new application.

The decommissioning programme of the nine plants is progressing normally, with a progress rate in excess of 50% at this time: Creys Malville = 64%, Chooz A = 62.5 % and Brennilis = 54%.

- At Chooz A, the dismantling of the primary circuit began in 2011; the four steam generators and the pressure vessel have been cut and decontaminated; two steam generators have been removed to the final storage centre; the reactor vessel will be cut starting in 2016,
- At Creys-Malville, primary sodium drainage and treatment were completed in January 2013; operations are continuing with the drainage of the remaining retention tanks, in parallel with secondary sodium treatment (completion planned in March 2014 for sodium treatment and summer 2014 for retention tank drainage),
- At Brennilis, first cutting of pipes connected to exchangers, a major milestone in the dismantling works,
- At Brennilis and Chooz A, several nuclear auxiliary buildings have been fully dismantled.

The decommissioning of EDF's nine shut-down reactors will produce approximately 1 million tonnes of primary waste materials, of which 80% are conventional waste material and none of the remaining 20% contain any high-level radioactive waste.

The following waste disposal projects are currently being implemented in addition to those already in place (very low-level waste and low-to-intermediate-level waste):

- Construction of a packaging and interim storage installation for radioactive waste (ICEDA) at the Bugey site has been launched. Construction works were interrupted in early 2012 after administrative authorities challenged the building permit. EDF has implemented measures to remedy the situation, with commissioning targeted in 2015.
- LL/LLW storage facilities (*Centre de Stockage des déchets FAVL*) provided under the law of 28 June 2006 on the long-term management of radioactive material and waste. Because the search for sites launched by ANDRA in 2008 yielded no results, and in order to allow time for consultation, the French State decided in 2010 to postpone the deadlines and asked ANDRA to propose new waste management scenarios by year-end 2012. After this study, the search for potential storage sites has restart in 2013.

In the UK radioactive wastes that arise during decommissioning will either be stored or disposed of depending on the availability of appropriate disposal routes, in accordance with UK Government and Scottish Government policies - noting that radioactive wastes will be disposed of where a disposal route exists.

The LLWR site near Drigg in Cumbria is currently available for the disposal of operational and decommissioning LLW within the constraints of its acceptance criteria and is expected to remain operational until at least 2050. It is Government intent that a National Repository (Geological Disposal Facility (GDF)) for ILW will be constructed, although it is presently not expected to be available before 2040.

EDF Energy's decommissioning plans detail the sequence for dismantling the plants and calculate the amounts of radioactive and non-radioactive material that will be created. These plans use sustainability and recycling principles to ensure materials created are stored, recycled and disposed in manner consistent with safety and environmental legislation. In this context "disposed of" reflects the strategic end point assumption for the waste when the waste has been conditioned /packaged,

emplaced within the GDF and the GDF facility is closed. For the waste strategic end point - waste disposed of to GDF - there are no alternative strategic options - this is the end state.

The inventory of materials projected for EDF Energy during decommissioning periods is contained in the latest publication of the National Inventory Statement (The 2013 UK Radioactive Waste Inventory - URN 14D037 NDA/ST/STY(14)0007 February 2014).

An EDF Energy document specifies the arrangements by which decommissioning of our power plants will be controlled to ensure compliance with all statutory and mandatory requirements. It describes the regulatory compliance (Site Licence), interface requirements and arrangements necessary for managing decommissioning at EDF Energy Generation's power plants.

Radioactive wastes will be managed in accordance with the Corporate Radioactive Waste Management Strategy and the Integrated Company Practice for Environmental Compliance and Management.

EDF Energy Generation is accredited to ISO 14001 for all of its power plants. In addition, the Sizewell B plant has attained registration to the European Eco-Management and Audit Scheme. This demonstrates that environmental concerns are fully integrated in EDF Energy's business, and within the Company there are a number of teams and specialists whose role it is to investigate and define environmental policies, strategy, standards and procedures. Others monitor the compliance against targets and provide advice on best practices to achieve them.

In the USA, decommissioning activities for commercial nuclear facilities are governed by U.S. Nuclear Regulatory Commission ("NRC") regulations 10 CFR 50.33(k), 10 CFR 50.75, and 10 CFR 50.82[28].

CENG has planned for decommissioning its facilities using the most feasible option to minimise low-level waste ("LLW"). The facilities will be placed in a "SAFSTOR" configuration ("delayed deconstruction") per NRC guidance to allow shorter lived activity to decay and then will use methods to remove the remaining contamination from the facilities. Regarding decommissioning funding assurance, CENG must submit a report to the NRC once every two years demonstrating how amounts deposited in protected trust funds will ensure that decommissioning activities will be fully funded at the appropriate time. CENG has already contracted with a Utah-based company, *EnergySOLUTIONS*, to accept the LLW. Once the LLW is removed and surveys confirm that levels are less than regulatory minimums, the NRC will then terminate the licence.

Decommissioning of nuclear plants is currently underway in France only. EDF Group will publish relevant information, including decommissioning waste figures, in an open and transparent way as other nuclear sites operated by the Group are decommissioned over time.

Enhancement of new reactor design, taking decommissioning into account

While the initial design of the past generation of reactors had not taken into account the prospect of decommissioning, it has now become a mandatory prerequisite in most countries. The design of the EPR has specifically integrated the best international state-of-the-art knowledge on these issues.

The provisions selected in the design phase aim at two targets at an acceptable cost: the reduction of collective doses for the operational staff and reduction of generated waste. The main provisions are as follows[29]:

- Use less materials that can be easily activated during operation (e.g. stellite, less cobalt in metallic alloys...)
- Implementation of shields and barriers preventing the activation of structural materials

[28] For an overview of the NRC's regulatory requirements for decommissioning activities and decommissioning funding assurance, please see: http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/decommissioning.html

[29] For more details please consult the safety report for Flamanville3 at the following address: http://energie.edf.com/nucleaire/carte-des-centrales-nucleaires/epr-flamanville-3/publications-48527.html

- Easy dismantling of equipment, areas for handling
- Circuits and premises designed specifically to prevent the accumulation of contamination and to facilitate its removal.

5. TRAINING

5.1 OVERVIEW ON HUMAN RESOURCES AND TRAINING POLICY

In EDF Group culture, economic and environmental performance is strongly linked to social performance.

Historically, EDF has always clearly expressed its ambition around both an industrial, economic and social project, that is to say a human adventure where the absolute priority is afforded to skills development.

The human resources policy of EDF is thus based on three key priorities shared by all businesses and companies within the Group:

- People development: develop the skills required for business and, at the same time, place people at the heart of the industrial project, with a recruitment policy and a dynamic training approach, relying in particular on apprenticeships,
- Set up recognition, quality of life at work, health and safety as levers driving employees' engagement to sustainable performance, fulfilling the EDF Group commitments to well-being at work, work-life balance, diversity,
- Introduce more diversity and strengthen our common culture, especially among managers and experts in order to build an integrated Group in France and on the international scale.

The EDF Group's ambition is to continue investing heavily in human resources and skills development through vocational training. The ambitious goals, the introduced innovations and the resources dedicated through the Training Agreement signed in 2010 with all Trade Unions (*Accord Defi Formation* of 10 September 2010) reflect the intensification of this effort, which must find its counterpart in improved performance for each of the Group companies. This agreement ambitions to turn skills development and renewal into a driver of the Group's expansion and to create a genuine "social ladder" for new hires (e.g. work/study apprenticeship) and throughout career paths (advancement training).

Growing needs and sustainable performance rely on skills development

EDF Group is now facing new challenges:

- The businesses and activities evolve, in line with technological, economic and environmental challenges in the energy sector, with increasingly stringent requirements (on nuclear safety in particular) and with EDF Group's ambitions for business development in France and on an international scale,
- The resumption of industrial investments in all sectors and the development of nuclear engineering activities which will dramatically increase the need for skills,
- In France, between 25 and 30% of the total EDF workforce will retire by 2015, a figure that rises 1.5 times when considering the number of maintenance and operation staff in the fields of production, engineering and distribution.

In addition, EDF intends to be acknowledged as a company committed to mitigating and controlling the environmental impacts of its business activities. Its nuclear business is most particularly concerned since the future level of requirements needs to be anticipated, under the dual oversight of public opinion and of the administrative authorities setting legal and regulatory requirements. Accordingly, EDF addresses the issue of skills renewal and upgrading for its personnel by taking into account both of these key issues essential for the acceptability of its industrial activities.

Figure 11: On-the-job training session at the “chantier-école” of Nogent-sur-Seine

A strong and sustained investment in training and apprenticeship

EDF Group, which operates in a context of high-technology professions, has always devoted a large budget to the training of its employees in support of technological or organisational changes and career paths. Every year, EDF thus spends about 8% of its budget on training. EDF Group intends to pursue this investment in vocational training (apprenticeship, professional training contracts, internal promotional training) with the necessary resources to match its ambition. EDF also benefits from tools in line with the expectations of current and future employees (e-learning, serious games, on-site training tools, the Group Intranet, edfrecrute.com Web site etc).

To anticipate and guarantee that EDF will in the long-term have the right number of employees with a high level of relevant qualification, a set of collective systems for training and upskilling has been set up, called the “*Académies des métiers*” (Business Academies). The objective is to seek excellence in operational and technical control, to integrate current and future challenges for every Division or Business Line in the up-skilling programmes and to ensure an optimal quality level. The Nuclear Engineering Business Academy focuses on the transmission of critical knowledge by senior workers, a major challenge for nuclear safety. After an assessment by the Business Academies Council (composed of corporate executives, HR and training professionals), a training proposal developed by a Division or by a Business Line and meeting the requirements receives an official "label", accompanied by recommendations for improvement.

Concurrently, EDF conducts significant recruitment programmes, especially in the fields of power generation (nuclear, hydro and thermal) to support its projects in France and on an international scale in order to meet the challenges of skills renewal.

The EDF Group intends to recognise and promote the ability of its employees to acquire, develop and maintain their skills connected with the qualifications required for business needs in order to be able to find or retain a satisfying job in their company or in any other EDF Group company. Mobility

is encouraged with appropriate means shared by the various Group companies, whenever it meets the needs of the Group's international mobility policy. EDF Group supports mobility because it enables employees to acquire new skills in different contexts, and to enrich their personal and professional experience, which is regarded as a major key to employability.

5.2 POLICY IMPLEMENTATION

The level of competency of EDF staff and its contractors is a vital issue for nuclear safety, operational safety and training is one of the major tools available to managers to maintain and improve skills. Managers choose the most relevant and efficient tool in order to meet each skills need among the various resources available for improving the skills of operators and technicians in their teams (mentoring, training, immersion, career path, etc),.

Training on activities related to nuclear safety, security, radiological protection, waste management and environmental protection must generally comply with legal requirements that may controlled in various ways, from internal assessments carried out by instructors and/or managers, up to external statutory accreditation. All processes are submitted to a quality assurance system and to external control by the ASN.

The three EDF Group nuclear companies are faced with different types of challenges:

- **EDF SA** will face numerous challenges over the coming years. After having operated the largest nuclear fleet in the world for thirty years without any major incident, EDF has to renew an entire generation of engineers and operators (numerous retirements), reinforce its operating performance and prepare the second half of the lifespan of its fleet with an expectation of 60 years. EDF has therefore established a project called "Generation 2020" where the reinforcement of workforce professionalism is one of five key programmes. Reinforcing professional skills relies on bolstered policies, organisations and resources:
  - Managers are empowered to and responsible for the skills development of their staff members, in order to define the needs close to the ground,
  - Feedback from operational experience is taken into account proactively in order to define the training needs,
  - In addition to centralised resources, the autonomy and resources of the nuclear plants are reinforced.

In addition, EDF SA has adopted a policy compliant with INPO international standards (ACAD02-001), and has added the topics of skills management and "strategic forward planning of jobs and skills":

- Skills management
- Performance improvement through training management
- Management of training processes and resources
- Initial training
- Continuous training
- Implementation of training programmes and skills assessments
- Assessment of training efficiency
- Individual involvement in training management

To support the ambitious programme for initial training, EDF has created a centralised training unit with local branches on each site; the unit comprises more than 500 instructors, a large training centre in Le Bugey with simulators, workshops and computerised tools. Another training centre will be built in Saclay, next to the new EDF research centre. Each power plant has its own full-scale operation simulator and workshops dedicated to maintenance training which is opened to sub-

contractors. These systems constitute the “Nuclear Academy”, one of the “Business Academies” put in place in the framework of the agreement signed in 2010 with trade unions intended to bolster a large training project at the entire Group scope.

All contractor employees must complete mandatory training courses matching their activities. The minimum basic programme includes several courses on the requirements of nuclear safety, security and radiological protection, waste management and environmental protection. This mandatory training is checked when entering a nuclear plant. Training includes courses in the following topics:

- “Quality and Safety” (5 days)
- “Nuclear Safety Accreditation” (1 to 3 days)
- “Risk Prevention” (5 days)
- “Advanced Radiation Protection” (6 courses of 1 to 5 days)
- A new course for executives has been recently created (9 days).

These training courses are delivered by institutions accredited by EDF and by an external certifier (CEFRI).

Training management is now one of the areas of continuous assessment of each nuclear plant by the Nuclear Generation Division (DPN); training management is also checked regularly by the ASN. By 2015, EDF Nuclear Generation Division plans to put in place an overall assessment process of skills management in each plant, comparable to the system in place at EDF Energy.

EDF Energy launched an ambitious and well-resourced programme, with the objective to respond to a difficult situation its fleet had to face in 2003-2004: resources for training were reinforced (the number of instructors and equipment at the training centre at Barnwood and on stations were increased), management of the training process was improved and put under the control of local Committees involving the top management of stations and the accreditation process was reinforced under the control of the Training Standards and Accreditation Board. The TSAB members sit in judgment of the capability and demonstrated performance of the evaluated line and training organisations to ensure nuclear personnel are being trained and qualified to perform their assigned activities safely, reliably, and efficiently. EDF Energy considers training an effective tool to improve the professional performance of individuals and, as a consequence, maintaining and improving safety, reliability and efficiency of EDF Energy’s operating nuclear power plants.

CENG has accredited training programmes in place at the 3 nuclear sites for the following job classifications:

- Senior Licenced Operators
- Licenced Reactor Operators
- Non Licenced Operators
- Shift Managers
- Shift Technical advisors
- Engineers
- Mechanics
- Electrical Technician
- Instrument and Control Technician
- Radiation Protection Technician
- Chemistry Technician

These training programmes lead to accreditation renewals every four years. They include initial qualification training of workers and annual continuing training. Accredited training is delivered during several sessions in various settings throughout the year: classroom, laboratory, on-the-job training, simulator training, dynamic learning activities, and computer based training.

Training is also provided for contract workers in the areas listed above. Contract workers are task-qualified and accredited for the specific work they will be performing.

6. REPORTING

6.1 POLICY

EDF Group as a whole promotes transparent communication and reporting on incidents and events, and on performance indicators, including safety, radiation protection and environmental protection.

Each Group company has put in place a public information process adapted to local regulations and generally reusing part of the data (most suitable for public understanding) reported to safety authorities. Since the requirements of such authorities are specific to each country, it is sometimes difficult to compare the different indicators, and therefore the various performance levels. It is also difficult to consolidate common indicators at Group level for the same reasons. Some of these indicators are included in reports or reviews that are produced regularly: Annual Activity Report, Sustainable Development Report or the annual Report of the Inspector General for Nuclear Safety and Radiological protection.

6.2 POLICY IMPLEMENTATION

Managers use these indicators as a management and progress monitoring tool, but not as an end in itself. They constitute a way to measure safety performance and its evolution. Each company uses a large number of indicators, some of which are linked to ongoing projects or processes, launched to support the improvements targeted by the prevention process and to achieve excellence. These indicators are not all reported in the following pages because they are too numerous and specific to each company and action plan.

The main differences in practices for indicators are the following:

- In some countries the reactor operator is required to anticipate automatic protections (e.g. USA and UK) by conducting a “manual scram”, while in others the operator is required to let automatic protections do their job. The two approaches give rise to differences when comparing indicators: in the USA and UK, the number of automatic scrams is thus lower than if it were to include manually anticipated scrams.
- EDF Group places sustainability as the main objective of its industrial strategy. In France, EDF generates 85% of its electricity output from CO2-free technologies (hydropower, nuclear, wind, solar). Within this energy mix, the French nuclear fleet generates around 75% of the power output. The French nuclear fleet thus provides an operational flexibility enabling EDF to monitor and “follow” the power demand throughout the day and therefore to adapt its output to consumer needs and to the output fluctuations of solar and wind power farms. Without such flexibility, EDF would be forced to use “CO2-emitting conventional/fossil-fired” facilities to follow the demand. Accordingly, EDF targets a maximum availability rate for its nuclear fleet during winter months when demand is at its highest, and the power supply requires the availability of all generation facilities. In wintertime, the availability rate of the French nuclear fleet is comparable to the best-in-class world operators.
- The practice for rating an event on the INES scale differs from one country to another; a safety authority may have stricter and more severe requirements and use specific criteria;

the French ASN has for instance defined “additional factors” that may affect the rating level of an incident (e.g. in cases when an event or failure can potentially affect several identical units)[30].

- The reactors of the EDF fleets (France, US, UK) have different technologies and therefore different designs leading to major differences in dose measurements for operators. For instance, due to their design, the AGRs in the UK fleet have 10 times lower dose exposures (WANO reference).
- In the USA, event reporting is governed by regulations 10 CFR 50.72 and 50.73, as well as by technical specifications in the plant operating licences. This reporting does not use the International Nuclear Event Scale but the INPO classification tool to rate operating events depending on their more or less significant potential impact as “noteworthy” or “significant”.
- Still in the USA, plant safety and operational performance are measured with a composite index that includes the monitoring of significant events, significant anomalies found during inspections, and the performance of some safety-sensitive systems and processes. This indicator is established on a quarterly basis for each reactor, and benchmarked against the performance of all US power plants.

6.3 Performance Results 2008-2013

The Table below lists the indicator values requested by FTSE4Good.

	Indicators	2008	2009	2010	2011	2012	2013
1	**Automatic trips per reactor for 7000h reactivity**						
	EDF SA	0,51	0,71	0,69	0,50	0,55	0,59
	EDF Energy NG	1,13	0,82	0,58	0,74	0,64	0,45
	CENG	0,00	0,17	1,02	0,70	0,70	0,34
2	**INES 1+ Events and Incidents (Clst≥1) per reactor per year**						
	EDF SA	1,15	1,17	1,17	0,91	1,55	1,19
	EDF Energy NG	1,13	0,80	0,93	1,33	1,00	0,67
	CENG	0,60	0,20	0,80	0,60	0,80	0,60
3	**Average Collective Dose (h-Sv/reactor)**						
	EDF SA	0,66	0,69	0,62	0,71	0,67	0,79
	EDF Energy NG-PWR	0,26	0,34	0,27	0,54	0,04	0,39
	EDF Energy NG-AGR	0,17	0,10	0,02	0,08	0,06	0,03
	CENG-BWR	1,51	1,18	1,88	1,22	2,27	1,28
	CENG-PWR	0,61	0,46	0,44	0,68	0,68	0,23
4	**Individual Dose (number of workers exposed to a dose over…)**						

[30] The number of events and their severity are not a direct measurement of the safety performance levels, as noted by IAEA itself

	Indicators	2008	2009	2010	2011	2012	2013
	EDF SA > 20 mSv	0	0	0	0	0	0
	EDF SA> 16 mSv	14	10	3	2	0	0
	EDF Energy > 20 mSv	0	0	0	0	0	0
	EDF Energy > 15 mSv	0	0	0	0	0	0
	CENG > 20 mSv	0	0	0	0	0	0
	CENG > 16 mSv	4	0	4	1	9	1
	Group > 20 mSv	0	0	0	0	0	0
	Group > 16 mSv	18	10	7	3	9	1
5	**Dose to the most exposed public individual mSv/year**						
	UK	0.006	0.006	0.007	0.006	0.006	0.006
	France	0.002	0.002	0.003	0.003	0.003	Nd[31]
	USA	0.072	0.117	0.104	0.14	0.04	Nd
6	**Decommissioning waste disposed of at EDF SA in metric tonnes**						
	Very Low Level		1504	1240	634	2528	1110
	Low and intermediate level, short life		227	345	477	109	568
	Sent to Centraco		237	261	278	20	187
7	**EDF SA operational waste (in m3/TWh)**						
	LLW/ILW	11.70	12.80	12.40	15.06	20.70	18.95
	HL-LLW	0.87	0.88	0.88	0.87	0.88	0.86
8	**EDF Energy operational waste (in m3)**						
	LLW		607	498	608	698	655
	ILW		170	162	161	161	178
9	**CENG operational waste (in m3)**						
	ILW			1,470	2,487	4,839	2,816
10	**Spent fuel (in tonnes of uranium)**						
	Unloaded by EDF SA	1,282	1,141	1,138	1,204	1,096	1,205

[31] 2013 results on individual doses are unavailable at the date of this report

	Indicators	2008	2009	2010	2011	2012	2013
	Disposed by EDF SA	1,179	1,102	1,140	1,199	1,075	1,099
	Unloaded by EDF Energy		208	163	211	216	177
	Disposed by EDF Energy		147	132	210	216	177
	Unloaded by CENG			90	87	120	66
	Disposed by CENG			0	0	0	0
	Group / Unloaded	1 282	1 349	1 346	1 459	1 372	1 415
	Group / Disposed	1 179	1 249	1 272	1 409	1 291	1 276

Comments about above indicators:

The “Group indicators” on fuel are consolidated indicators combining: 100% of EDF SA, 100% of EDF Energy (since 2009) and 49.99% of CENG (since 2010).

Indicators for these companies are not weight-adjusted according to EDF’s stakeholding in the companies.

These indicators are analysed and commented in several reports published by EDF:

- Annual Report of Inspector General for Nuclear Safety[32],
- Compendium of Sustainable Development Indicators[33],
- EDF Sustainable Development Report[34].

In order to ensure consistency between these various reports, the analyses and comments are not duplicated in this document.

[32] http://energie.edf.com/fichiers/fckeditor/Commun/En_Direct_Centrales/Nucleaire/Rapport_IGSN%202013.pdf
[33] http://www.edf.com/html/ra2012/pdf/EDF2012_cahierDD-2_vf.pdf
[34] http://rapport-dd-2012.edf.com/fr/accueil

Appendix: List of Acronyms

AFCEN	Association Française pour les règles de conception, de construction et de surveillance en exploitation des Chaudières Electro-Nucléaires
AFCN	Agence Fédérale de Contrôle Nucléaire (Belgium)
AGR	Advanced Gas-cooled Reactor
ALARA	As Low As Reasonably Achievable
ALARP	As Low As Reasonable Practicable
ANDRA	Agence Nationale pour la Gestion des Déchets Radioactifs (France)
ASN	Autorité de Sûreté Nucléaire (Nuclear Safety Authority, France)
BEG	British Energy Group (UK)
BWR	Boiling Water Reactor
CEFRI	Comité Français de Certification des Entreprises
CEG	Constellation Energy Group
CENG	Constellation Energy Nuclear Group
CEO	Chief Executive Officer
CGNPC	China Guangdong Nuclear Power Group
CPo, CP1, CP2	Contract Programme 0, 1 or 2
DCRG	Direction du Contrôle des Risques Groupe (EDF)
DG	Diesel Generators
DIN	Division de l'Ingénierie Nucléaire (EDF)
DOE	Department of Energy (USA)
DPI	Direction de la Production et de l'Ingénierie (EDF)
DPN	Direction de la Production Nucléaire (EDF)
EDF	Electricité de France
EDG	Emergency Diesel Generator
EGE	Evaluation Globale d'Excellence (Operational Excellence Assessment, EDF Nuclear Inspectorate)
EMS	Environmental Management System
EPR	European Pressurised Reactor
EPRI	Electrical Power Research Institute (USA)
EURATOM	European Atomic Energy Community
FARN	Force d'Action Rapide Nucléaire (Nuclear Rapid Action Force, EDF)
FBR	Fast Breeder Reactor
FEMA	Federal Emergency Management Agency
FTSE	Financial Times Stock Exchange
GDF	Geological Disposal Facility (UK)
GINSR	General Inspector for Nuclear Safety and Radiation Protection
GRS (or GSR)	General Requirement for Safety (IAEA)
GTS	Groupe Technique Sûreté (EDF)
GWd/t	Giga Watt-day per ton
HLW	High (activity) Level Waste
HR	Human Resources
HSE	Health and Safety Executive (UK)
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiological Protection
IEA	International Energy Agency
IGSNR	Inspecteur Général pour la Sûreté Nucléaire et la Radioprotection (Inspector General for Nuclear Safety & Radioprotection, France, EDF)
ILW	Intermediate Level Waste
INB	Installation Nucléaire de Base (Basic Nuclear Facility, France)
INES	International Nuclear Events Scale
INPO	Institute of Nuclear Power Operators (USA)

INSAG	International Nuclear Safety Advisory Group (IAEA)
IRSN	Institut de Radioprotection et de Sûreté Nucléaire (France)
ISFSI	Independent Spent Fuel Storage Installation (USA)
ISO	International Organization for Standardization
LL/LLW	Low Level/Long Life Waste
LLW	Low Level Waste
LLWR	Low Level Waste Repository
Loi TSN	Loi sur la Transparence et La Sûreté en matière Nucléaire (France – Law on Transparency and Nuclear Safety)
MOX	Mixed oxide
mSv	MilliSievert (= 0.001 Sievert) (= 0.1 Rem)
NEI	Nuclear Energy Institute (USA)
NEPA	National Environmental Protection Agency (China)
NLF	Nuclear Liabilities Fund (UK)
NMP	Nine Mile Point (nuclear power plant, USA)
NNSA	National Nuclear Safety Administration (China)
NPP	Nuclear Power Plant
NRC	Nuclear Regulatory Commission (USA)
NSC	Nuclear Safety Council
NSOC	Nuclear Safety Operational Committee (CENG)
NSRB	Nuclear Safety Review Board (CENG)
NUGG	Natural Uranium Graphite/Gas (reactor)
NWPA	Nuclear Waste Policy Act (USA)
OEA	Operational Excellence Assessment (EDF Nuclear Inspectorate)
ONR	Office for Nuclear Regulation (UK)
OSART	Operational Safety Assessment Review Team
PIRP	Politique Industrielle et Relations avec les Prestataires (Industrial Policy and Suppliers Relations Policy, EDF)
PNGMDR	Plan National de Gestion des Matières et Déchets Radioactifs (National Plan for Radioactive Materials and Waste, France)
PPI	Plan Particulier d'Intervention (Special Intervention Plan, France)
PSR	Periodic Safety Review
PUI	Plan d'Urgence Interne (Internal Emergency Plan, France)
PWR	Pressurised Water Reactor
RMD	Risk Management Division (EDF)
SER	Significant Event Report
SOER	Significant Operating Experience Event Report (INPO, USA)
STE	Spécifications Techniques d'Exploitation (Operational Technical Specifications, France)
TMI	Three Mile Island (USA)
TNPJVC	Taishan Nuclear Power Joint Venture Company (China)
TSAB	Training Standards Accreditation Board
TSM	Technical Support Mission (EDF)
TSN	Transparence et Sécurité Nucléaire (French law on Transparency and Nuclear Safety)
TSO	Technical Specifications during Operation (EDF)
TWh	Tera Watt-hour (= billion of KWh)
UATR	Unplanned Automatic Trip Rate
UNE	Unistar Nuclear Energy
UNGG	Uranium Naturel Graphite Gaz (France) (*see* NUGG)
USNRC	United States Nuclear Regulatory Commission
VLLW	Very Low Level Waste
WANO	World Association of Nuclear Operators
WNA	World Nuclear Association

French acronyms

AAR	Arrêt Automatique Réacteur
AFCEN	Association Française pour les règles de conception, de construction et de surveillance en exploitation des Chaudières Electro-Nucléaires
AFCN	Agence Fédérale de Contrôle Nucléaire Belge
AIEA	Agence Internationale pour l'Energie Atomique
ANDRA	Agence Nationale pour la Gestion des Déchets Radioactifs (France)
CEFRI	Comité Français de Certification des Entreprises
CIPR	Commission Internationale de Protection contre les Rayonnements
CPo, CP1, CP2	Contrat Programme 0, 1 ou 2
DCRG	Direction du Contrôle des Risques Groupe (EDF)
DIN	Division de l'Ingénierie Nucléaire
DPI	Direction de la Production et de l'Ingénierie (EDF)
DPN	Division de la Production Nucléaire (EDF)
EDF	Electricité de France
EGE	Evaluation Globale d'Excellence (Inspection Nucléaire d'EDF)
EPR	European Pressurised Reactor
EURATOM	European Atomic Energy Community
FARN	Force d'Action Rapide Nucléaire
FMA	déchets de Faible et Moyenne Activité
GTS	Groupe Technique Sûreté
GWj/t	Giga Watt-jour par tonne
IGSNR	Inspecteur Général pour la Sûreté Nucléaire et la Radioprotection
INB	Installation Nucléaire de Base
IRSN	Institut de Radioprotection et de Sûreté Nucléaire
Loi TSN	Loi sur la Transparence et La Sûreté en matière Nucléaire
mSv	MilliSievert (= 0,001 Sievert) (= 0,1 Rem)
MWh	Méga Watt-heure (= millier de kWh)
OSRDE	Observatoire Sûreté Radioprotection Disponibilité Environnement
PIRP	Policy Industrielle et Relations avec les Prestataires
PNGMDR	Plan National de Gestion des Matières et Déchets Radioactifs
PPI	Plan Particulier d'Intervention (Special Intervention Plan, France)
PUI	Plan d'Urgence Interne (Internal Emergency Plan, France)
REB	Réateur à eau Bouillante
REP	Réacteur à Eau Pressurisée
SME	Système de Management Environnemental
STE	Spécifications Techniques d'Exploitation
TFA	déchets de Très Faible Activité
TSN	Loi TSN : Transparence et Sûreté en matière Nucléaire
TWh	Téra Watt-heure (= milliard de kWh)
UNGG	Uranium Naturel Graphite Gaz (France)