

MINIMIZING IMPACT

Plant safety and network



Measuring the depth of the reservoir at the Fond-de-France dam in the Alps. EDF's Aquatic Environment Service team contributed to safety at the facility.

EDF makes safety an absolute priority. Systematic controls, ongoing improvement of processes and facilities and the fostering of a safety culture among teams, are all part of this policy.

REVISED NUCLEAR SAFETY LEGISLATION

The French TSN law of June 13, 2006 on nuclear transparency and safety revises the legal framework governing the entire active life of nuclear power plants and establishes an independent nuclear safety authority (*Autorité de Sûreté Nucléaire* – ASN) to control and sanction operators. The law guarantees the transparency of information regarding health and environmental impact, organizes citizen access to the information, reinforces the role of consultative bodies and local information commissions, and increases the penal and civil responsibility of operators.

EDF mobilized its units to conform to the new framework. They must provide any citizen who requests it with information

on safety and radioprotection (without jeopardizing security or divulging industrial or commercial secrets), establish an annual public report on safety and radioprotection of their facility which must be open to assessment by the CLIs.

NUCLEAR SAFETY AND RADIOPROTECTION: 2006 RESULTS

EDF's safety performance continues to improve. In 2006, the number of automatic reactor shutdowns, triggered in the event of an anomaly, was 0.89 per unit per year for 7,000 hours of criticality, down from 0.93 in 2005.

Significant safety events (SSE) have remained within average over recent years: 1.04 per year and per unit. In 2006 no SSE reached a level 2 (on a scale of 7 by increasing order of seriousness as defined by the International Nuclear Event Scale - INES). Reinforcement against the risk of flooding was completed at the Bugey, Dampierre and Belleville plants. Similar works are being planned for St Alban, Cruas and Tricastin.

Radioprotection has also improved: no annual dose over 18 milliSieverts (legal limit 20 mSv) was recorded for any worker. 17 workers presented personal cumulative doses over 16mSv over a 12 month period, down from 29 in 2005. The most exposed (thermal insulators, welders, mechanics and logistics personnel) benefit from individual monitoring. The collective dose, at 0.69 Man-Sieverts/unit, is a marked improvement over 2005 (0.78).

An innovative way to evacuate floodwaters

The "piano key" system for evacuating floodwaters built in 2006 on the Goulours dam was designed by EDF R&D and NGO Hydrocoop. Simpler and less costly than a traditional system, this design can be installed on the top of EDF's concrete dams and usual flow increased fourfold compared with a standard spillway.

A MAJOR RENOVATION PROGRAM

The first of the six STEP 2010 management project priorities, aimed at securing progress already achieved and at further improving performance, is nuclear safety. While human performance continues to improve and a safety culture is assimilated, EDF is also launching a major investment and maintenance "housekeeping" program over five years. The program, which involves several hundred million euros, aims to bring – and keep – power plant facilities up to the very best international standards: paint, lighting, signing, roofing and curbing corrosion, especially near the sea.

A PROGRAM TO IMPROVE HYDRO SAFETY

Hydro safety is also a matter of public security. In 2006, there were only 39 hydro safety significant events (compared with 59 in 2005) with a seriousness index > 1, but nine incidents affected people instead of four in 2005). Following the assessment launched in 2005 to identify risk of failure by relative to the type of materials, EDF started the SuPerHydro project to reinforce safety in its French hydro fleet, increasingly called up in response to market adjustment and peak consumption. SuPerHydro represents an investment in maintenance of €500 million overall between 2007 and 2011. This amount, combined with planned annual investment (between €60 and €70 million/year) will cover all the safety improvements identified by the assessment. Work began in 2006 on the Tuilières plant, where one incident with human impact was recorded, and the Pragnères plant. SuPerHydro teams will consolidate safety at the facilities while improving their performance and availability.

This year, as in the past, the communication campaign *Sécurité en aval des barrages* has increased awareness of potential risk to tourists, fishermen and kayakers.

Saint-Laurent-des-Eaux reviewed by the IAEA

Fourteen international experts mandated by the International Atomic Energy Agency assessed safety at the St-Laurent-des-Eaux nuclear plant based on a reference system that integrates best practice worldwide. The report resulting from this Osart¹ inspection will be published on the ASN website (www.asn.fr) and a follow-up review will be conducted by the IAEA in 2008. IAEA and WANO² experts also conducted a post Osart visit of Blayais, Peer Reviews of St. Alban, Nogent, Flamanville and Gravelines, at the same time as internal assessments were being carried out by EDF at Nogent, Cattenom and Flamanville.

1. Operational safety assessment review team.
2. World Association of Nuclear Power Operators.

Extreme Weather Network Plan

EDF's extreme weather plan relies on a diagnosis of network weak points and aims to drastically reduce customer inconvenience: over 30,000 km of high voltage lines will be buried.

INVESTMENT IN NETWORK SECURITY

As part of the Public Service Agreement, EDF has committed to improving the security of electricity supply. Investment in the network increased by 6% in 2006. ●

▶ Radiation protection
Sharp improvement
in 2006 EDF SA
collective dose
0.69
Man-Sieverts/unit
(0.78 in 2005)

MINIMIZING IMPACT

Radioactive waste mana

EDF is responsible for managing the waste of its nuclear plants and bears all the cost involved in processing as well as management by Andra. The company ensures the deconstruction of plants shut down and makes provisions to this effect. The kWh price reflects this.

SAFE SOLUTIONS FOR ALL WASTE

EDF's waste management is organized around four major areas: limiting the quantity of waste at its source, sorting it by type and level of radioactivity, isolating from contact with humans and the environment, giving precedence to reprocessing and recycling of spent fuel.

Very low level waste (VLL) results from the dismantling of facilities (rubble and scrap iron) and is permanently stocked at Andra's storage center in Morvilliers, France. Shipping to the center was reduced in 2006 (7,967 t, down from 8,429 t in 2005) as was storage in the dedicated areas of the plants.

Low to intermediate level short-lived waste LIL/SL results from operations and maintenance (filters, tools, gloves etc.) In 2006, the total volume transported to the Andra's surface storage center in Soulaines reached 6,798 m³, down from with 8,303 m³ in 2005.

Intermediate long-lived waste (fuel hulls, end-fittings and miscellaneous technological waste) is compacted and processed in stainless steel containers at the Areva processing facility in La Hague.

High level long-lived waste, resulting from processing of spent fuel, is vitrified. Vitrification is a very high quality, low volume form of processing used for under 1% of total waste volume and concentrating over 96% of its radioactivity. The final destination of this long-lived waste, currently stored in La Hague, was the object of a public debate organized by the CNDP from September 2005 through January 2006 and of a law voted in June 2006.

SAFER TRANSPORTATION

Each year, EDF transports radioactive materials some 5,000 times. This transportation is increasingly sound: out of 165 transfers of spent fuel in 2006, only three deviations were recorded, compared with ten in 2005. None of these occurred in areas accessible to the public during transportation.

DISMANTLING OF DECOMMISSIONED PLANTS

The dismantling of decommissioned nuclear plants in France is continuing according to plan. The Brennilis active fuel building was decommissioned and will be

WASTE CATEGORY	TYPE	TOTAL ANNUAL VOLUME OF WASTE PROCESSED (M ³) PERCENTAGE OF TOTAL VOLUME PRODUCED	MASS OF PRIMARY WASTE IN GRAMS PER MWH	MASS OF PRIMARY WASTE ¹ IN GRAMS PER INHABITANT AND PER YEAR
High level and intermediate level long-lived waste (HL/LL and IL/LL)	From spent fuel processing HL/LL: more than 1 billion Bq/g IL/LL: more than 1 million Bq/g	360 m ³ • 4.6% of total volume (0.2% for HL/LL; 4.4% for IL/LL)	1	7
Low level short-lived and low level long-lived waste (LL/SL and LL/IL), and Intermediate level short-lived waste (IL/SL)	From maintenance and operations (protective wear) Less than 1 million Bq/g	6,000 m ³ • 81.4% of total volume (4.6% for LL/LL; 76.8% for LL/SL and LL/LL)	10	70
Very low level waste (VLL)	From deconstruction (rubble...) Less than 100 Bq/g	1,000 m ³ • 14% of total volume	2.4	17

1. Primary waste: waste that has not yet been processed.

demolished. The transfer of the Creys-Malville assemblies to the spent fuel pit for preparation and storage is complete. As for Chooz A, the preparatory works upstream of full dismantling are finished.

THE NEW LEGAL FRAMEWORK

The French Law of June 28, 2006 provides for a national radioactive materials and waste plan for all sources and all types of radioactive waste. The law endorses three management procedures, and specifies timelines and conditions for industrial application: reduction of the quantity and level of radioactivity through treatment and processing; surface or sub-surface storage of reduced waste and radioactive materials awaiting treatment; for final waste that is not surface storable, the progressive implementation of reversible storage deep in the earth.

At the same time, the law provides for the pursuit of research on the separation and transmutation of waste and the creation of temporary surface storage facilities.

The law also reinforces economic incentive to areas that accept storage facilities, bearing out the approach taken by the Bure laboratory with its development program for the Haute-Marne and Meuse departments (details page 53). ●



▲ Experimental tunnels at Andra's underground research laboratory in Meuse / Haute-Marne, east of Paris.



The transmutation solution

Under study in Marcoule, France, transmutation, which requires the development of Generation 4 nuclear reactors, takes recycling of fuel and the reduction of final waste to another level. Research is continuing in liaison with the Generation 4 program, which expects to bring on stream a prototype around 2020.

Reversible deep geological disposal

Since 1994, research conducted in France by Andra at the Bure laboratory are demonstrating the feasibility of reversible geological disposal in a compact layer of clay that has been stable for 155 million years and that is capable of trapping radioactive substances over long periods. The study will require another ten years to complete, after which the site will be selected and the public consultative process will begin before opening. A law will lay down the conditions of reversibility of storage. The creation of a repository could be authorized as of 2015 and operations begun in 2025.

▶ **Less than 1%**
of overall volume
accounts for
more than
96% of
radioactivity

● MINIMIZING IMPACT

● Conventional waste and

The Group endeavors to protect the natural environment, notably by recycling waste. It is seeking to reclaim the grounds of former industrial sites and limit effluents produced by its plants.

CONVENTIONAL WASTE: IMPROVED TRACKING, RE-USE PROGRESSING

The total production of conventional waste for EDF SA was 138,126 tonnes (2005 figure, national waste statements are based on the previous financial year). Non-hazardous waste amounted to 74,119 tonnes, of which 84% was recycled. Power plants accounted for 88,000 tonnes of this waste and distribution nearly 50,000, of which 30,000 tonnes of concrete pylons were recycled in public works. EDF added to its waste management policy by adopting, in March 2006, a three-year action plan aimed at increasing the proportion of recycled waste, and especially at reducing the impact of certain kinds of hazardous waste. EDF is developing methodological tools such as its OGIDE software, launched in 2006 for a rollout in all EDF SA entities at the end of 2007. The software will simplify real time management of conventional waste and consolidation of internal and regulatory statements, such as the statement required under European regulations.

In Italy, Edison too is rolling out new inventorying methods. In 2005, 57% of the 16,000 tonnes of waste generated by the company's activities was re-used.

WHEN BY-PRODUCTS BECOME RAW MATERIALS

EDF contributes to thinking on industrial ecology, which aims at saving precious resources by recycling the by-products of its activities. EDF has cemented partnerships with the concrete industry and public works sector which use the gypsum and ash from EDF's coal-fired plants as raw material. EDF was thereby able to dispose of 600,000 to 800,000 tonnes of ash produced annually and reduce stored ash to 9 Mt by the end of 2006 thanks to recycling rates of 20 to 50% of ash produced. Like Edison at its facility in Tarento, Italy, EDF recycles some of the gas produced by the steel industry.

In an effort to further develop industrial ecology, the company uses the Editerr data base to help identify potential for synergy between input/output flows of EDF sites and those of other nearby industries. Editerr is also made available to industrial and local authority customers.

In Poland, Ersa is developing a project to recover some 150,000 tonnes of coal per year from slag heaps as of 2008.

SOIL REMEDIATION

EDF determines soil contamination based on past studies that are sometimes completed by further sampling and analysis. When there appears to be a risk, an in-depth diagnosis and detailed risk assessment are carried out before reclaiming the land for its future function. All operating sites at risk of soil contamination are subject to an ISO 14001 certified Environmental Management System (EMS).

Some of the land now occupied by EDF has been contaminated by hydrocarbons or heavy metals. Of the data gathered by the Group, 473 potentially contaminated and 64 proven contaminated industrial and service sites were identified for EDF SA excluding EGD and ERD. This inventory is being carried out among the subsidiaries and affiliates. Thirty or so contaminated sites, especially former gas factories, are undergoing remediation while others require further research.

Management of hazardous substances

A European Restrictions on Hazardous Substances (RoHS) Directive obliges owners of devices containing concentrations of PCB (polychlorinated biphenyl) of over 500 ppm to have disposed of them or removed their lead content by December 31, 2010. EDF, which owns over 450,000 PCB devices, has identified the transformers that fall under the directive and drawn up an action plan for disposing of them or removing their lead content by the deadline. This action plan has already been communicated to the French Ministry of Environment and Sustainable Development.



pollution reduction

Atmospheric emissions Acidification

Trend in Group SO₂ emissions over three years

(in g/kWh)	2004	2005	2006
EDF Group	0.46	0.39	0.36
EDF Group in Europe	0.46	0.36	0.31
EDF SA	0.18	0.17	0.15
EDF Energy	4.05	2.12	1.18
EnBW	0.18	0.16	0.14

In Italy, Edison is recycling gas produced by steelmakers.

REDUCTION OF EMISSIONS AND EFFLUENTS

In France, EDF has installed new anti-pollution devices on its fossil-fired plants. At Havre 4, the first French power plant equipped with a catalytic denitrification system, nitrogen oxide (NO_x) emissions were cut fivefold, with an advance of nearly ten years on the limits set by the EUs combustion plant directive. In recent plants, the DeSO_x technique captures 90% of sulfur oxide (SO_x) in flue gas in the chimney. At Vazzio in Corsica and Bellefontaine in Martinique, treatment of flue gas is operational.

Among subsidiaries and affiliates, by the end of 2007, all of the boilers at EDF Energy's West Burton plant will be equipped with a flue gas desulfurization (FGD) system. EDF Energy relies on low sulfur coal for boilers that are not yet equipped. As a result, in 2006, concentrations of SO₂ never surpassed 200 ppb (compared with 91 cases in

2003, 5 in 2004 and 3 in 2005). In Poland, ERSAs has begun equipping the Rybnik plant with an FGD. It already replaced a dust remover, bringing emissions below the 50 mg/Nm³ threshold. Reduction of NO_x emissions is under study. Kogeneracja adapted its facilities to used low sulfur coal. In China, EDF participated in installing desulfurization units on all three SZPC¹ (19.6% EDF-owned) coal-fired plants. This should reduce SO₂ emissions at the Shiheng 2 plant by 16,500 t and bring them below the maximum threshold authorized in China (400 mg/Nm³). The system will be operational in Laibin in 2009. ●

▶ **84%**
of waste recycled

1. Shandong Zhonghua Power Company.



EDF Médiathèque — Philippe ERANIAN

Preventive monitoring of fluid-filled cables

Old underground fluid-filled high voltage cables still supply large cities. In 2006, EDF R&D successfully tested a method for detecting possible oil seepage from the cables. For its part, EDF Energy digitally mapped the environment (ground water, etc.) of its fluid-filled cables to identify and assess risk all along the lines. At the end of 2006, a cable circuit in an area identified as high-risk was replaced. The Environment Agency has acknowledged the utility of this mapping tool.

● MINIMIZING IMPACT

● Biodiversity and nature



EDF Médiathèque – Philippe ERANIAN

EDF's industrial activity can lead to disruption of ecosystems. Managing water resources, indispensable for hydro generation and thermal plants, is a priority. The Group is constantly alert to the need to limit its environmental footprint and protect biodiversity.

MANAGING CHANGING TRENDS IN WATER TEMPERATURES

EDF is researching the potential impact of global warming on its generation facilities and on consumption. Model simulations quantify future trends in temperature and river flow in France (the Rhone and the Loire in particular), which are determining factors for hydroelectricity, for cooling, and for generation output in thermal plants in compliance with legal thresholds governing the warming of water. EDF engineers are designing ways to adapt existing and future plants to take into the medium and long-term forecasts made by EDF R&D.

PREPARING FOR THE ENACTMENT OF THE FRENCH LAW ON WATER

In 2006, as part of the EU's Water Framework Directive of 2000 (WFD),

which aims for a healthy ecological state of surface waters by 2015, EDF R&D teams fully reviewed the implications of the directive for 25 thermal plants. Backing their arguments with a long series of data drawn from the hydro-biological monitoring of plant and animal life surrounding power plants, EDF contributed to increasing the accuracy of the official criteria that define the biological state of a watercourse. The French law on water, adopted December 30, 2006, aims, in particular, at establishing the tools needed to meet the targets set out in the WFD, and introduces new rules to improve the ecological quality and local management of water. If these rules in some ways constitute new constraints for EDF, they are flexible enough to reconcile the protection of nature and the requirements of hydroelectric power.



conservation

A BIODIVERSITY POLICY

The Group's thermal and hydro plants have an impact on aquatic life, while distribution and transmission networks, as well as construction works and facilities can affect plant and animal life and in general, terrestrial biotopes. On the other hand, some sites actually provide protected areas or areas for the restoration of biodiversity.

The Group's environmental management system (EMS) includes a biodiversity policy redefined in 2006. The policy aims to intensify undertakings in this area, many underway for a long time, and focuses on three areas:

- further understanding natural surroundings, impact assessment and reporting;
- protecting and restoring the natural environments where EDF is active;
- informing, educating, raising awareness.

For the last twenty years, plant and animal life near the nuclear plants in France has been monitored closely. With regard to hydropower, during this same period, EDF has built 80 fish ladders with proven results recorded by the associations that have been monitoring them (Logrami, Migado and Migradour). The company has also determined optimal flows and improved its understanding of impact due to sluicing, which can be adjusted when necessary.

LOCAL COMMITMENTS IN FRANCE

About 80% of hydro plants, 63% of nuclear plants and 36% of fossil-fired plants are located within 500 meters of a Natura 2000 site. EDF conducts impact studies for projects submitted for authorization (concession renewal, water runoff) and has already signed a first agreement with Natura 2000. As part of their impact studies, hydro units include information on the habitats as outlined by the Natura 2000 habitat registers.

Our commitment to biodiversity is made concrete through multiple projects carried



Managing July's heatwave thanks to anticipation and swift action

The month of July 2006 was the hottest France has known since 1950. Between river temperatures which rose rapidly and lasting drought, generation capacity in nuclear and fossil-fired plants had to be curbed (10,000 MW) while at the same time consumption of electricity rose due to refrigeration and air-conditioning.

EDF's extreme weather plan, drawn up after the heatwave of 2003, was rolled out along with all of the mechanisms planned to ensure balanced activated supply and demand: programmed temporary shutdowns, responsiveness on the part of industrial customers and foreign counter-parties and purchases on the wholesale market. The Group's crisis organization was mobilized, staying in constant touch with the government. On July 22, a decree relative to thermal effluents under exceptional circumstances authorized the running of nuclear plants under certain conditions. It was not used. The conditional running of the fossil-fired plants at Cordemais and Aramon went into effect for one day only, July 27, at Aramon, in order to meet national balance.

Like a fish in water...

The Gamsheim fish ladder will permit the salmon's return to a new section of the Rhine. Since March 2006, more than 30,000 fish of various species have made it over the dam. Designed with an area where visitors can observe the fish under water, it is being used by local authorities to develop tourism.

out with local and national partners: upkeep or restoration of natural areas near the company's industrial sites, public awareness campaigns, participation on the birdlife committee of the French birding association, *Ligue de protection des oiseaux*. The EDF Foundation is pursuing its partnership with the Nicolas Hulot Foundation and in 2006 renewed its partnership with the Nature Reserves of France. In 2006, there was an experimental nation wide educational program on biodiversity. The Hydro-ecology conference organized by EDF in October 2006 on biodiversity in aquatic ecosystems attracted a large number of biodiversity experts in France. ●

▶ **80** fish ladders built on French dams over the past 20 years

