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French Power System Reliability Report 2008	
Indice 1	27 pages

Summary:

The reliability of the French power system was fully under control in 2008, despite the power outage in the eastern part of the Provence–Alpes–Côte d'Azur region on November 3rd, which had been dreaded for several years, since it had not been possible to set up a structurally adequate network. Pursuant to a consultation meeting, the reinforcement solution proposed by RTE was approved by the Minister of Energy, boding well for greater reliability in future.

Based on the observations presented in this 2008 Report, RTE's Power System Reliability Audit Mission considers that no new recommendations are needed beyond those expressed in previous reliability reports and during reliability audits.

The publication of this yearly report is in keeping with RTE's goal to promote the follow-up over time of the evolution of reliability in its various aspects. RTE thus aims to contribute to the development of reliability culture, by encouraging an improved assessment by the different players (both RTE and network users) of the role they play in building reliability, and by advocating the taking into account of reliability and benchmarking in the European organisations of Transmission System Operators.

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1 Brief overview of the evolution of the internal and external environment

The 2007 reliability report had both encouraged readers to be wary of favourable climatic conditions masking threats and hailed positive evolutions fostering improved reliability. 2008 proves that this was not simply idle talk.

The first point was illustrated on November 3rd by the power outage in the eastern part of the Provence–Alpes–Côte d'Azur region (PACA) during a thunderstorm. The consultation initiated following this incident, which had been dreaded for some time due to difficulties in correcting the grid's structural fragility in this area, led to selecting an approach to improve security of supply there (§2.4).

There were also new evolutions in 2008:

- 42 TSOs created the association ENTSO-E (European Network of Transmission System Operators for Electricity) to reinforce cooperation in key fields directly concerning reliability (§3.2).
- The UCTE (Union for the Coordination of Transmission of Electricity), pursuing the review of its reference guide to draw lessons for the European incident on November 4th 2006, put three main directives up for public consultation. At the same time, it is moving forward in the verification of the application of its rules, and, in its aim to move towards audits, voluntary site visits have started (§3.2).
- RTE and its Belgian counterpart ELIA created the Coreso coordination centre as part of a determined effort to reinforce reliability on a European level (§8.1); similar initiatives were commenced in other areas.
- In France in 2008, the ERDF (public electricity distribution system operator) was created, and RTE was awarded the Public Transmission System concession (RPT), via a law that reiterates the standard clauses in the decree dated 23 December 2006 (cf. 2006 reliability report).

This 2008 report will address the main changes concerning reliability.

2 Operating situations encountered

Controlling power system reliability is especially difficult when the operating situations encountered are not easy to deal with. However, these situations themselves depend on the measures taken to control reliability and it is therefore useful to examine them.

2.1 Climatic conditions

With an average temperature 0.4°C higher than normal, 2008 was the 20th hottest year since 1900. January, February and May were quite mild, while average temperatures were below normal in September and December. There were episodes of sticky snow in April and December that did not, however, definitively trip any 400 and 225 kV lines.

2.2 Supply / demand balance management

French national electricity load increased by 2.9% to 494.5 TWh. Maximum load was reached on 15 December with 84,426 MW, compared with the 2007 maximum of 88,960 MW reached on 17 December 2007.

Power System Operating Reliability

Power system operating reliability (in brief: system reliability) is defined in France as the ability to:

- ensure the normal operation of the power system;
- limit the number of incidents and avoid major incidents;
- limit the consequences of major incidents when they do occur.

System reliability lies at the core of the responsibilities entrusted under the Act of 10 February 2000 to RTE, the French Transmission System Operator.

Readers wishing to further their knowledge of the principles are invited to refer to the *Memento of Power System Reliability*, available in French and English on the website www.rte-france.com.

The decrease in the export balance of contractual exchanges (46.6 TWh) is in line with the downward trend recorded since 2003, excepting 2006. The cumulated volume of export and import transactions grew by 5.1% to 116.2 TWh. The intraday market at the borders continues to grow and now represents 3.6% of the contractual exchanges at the borders. French generation output grew by 0.8% compared with 2007, reaching 549.1 TWh. Wind power continued to progress to reach 5.6 TWh or +37.4%. Generation from other renewable energy sources other than hydropower increased by 6.6% and represented 4.0 TWh (essentially biomass).

The deviations between actual figures at peak period and the forecasts viewed the day before remained below 1500 MW in winter and 750 MW in summer in 82.3% of the cases versus 84.2% in 2007 (with regard to a minimum objective of 80%). Two ESS (Significant System Event - cf. §5.3) were declared at level A for a deviation (slightly) higher than 3000 MW.

Operating margins

We will first examine how the operating margins were set up during the year in keeping with the reliability rules and institutional mechanisms, by basing ourselves on the measures that RTE uses, in compliance with legislation, to set up the necessary capacity margins using the bids made by power producers. RTE monitors the margins available in real time and, in case the volume falls below the specified level, restores the margin.

Whenever possible, the margin is restored while using the normal means of balancing and respecting the economic precedence of the bids. If this is not sufficient, RTE calls upon the additional bids received after sending a *Balancing Mechanism* degraded mode message, the Constraint Management and Balancing Service of IFA (cross-channel direct current link with Great Britain) and the

contracts concluded with the other TSOs. Then RTE may resort to exceptional measures, which can only be used when the margin is lower than or equal to zero, starting with the exceptional balancing bids. Should the normal and exceptional measures no longer suffice to ensure system reliability, RTE may have to resort to emergency means: 5% drop of the MV voltage set point, load shedding, reduction of exchanges at all borders, etc.

The load peak, a sensitive time of the day, was passed while respecting the requisite 1500 MW margin at the 15-minute time period, except on 24 days as opposed to 8 in 2007.

In 2008, there was a significant increase in the number of ESS relative to a critical situation due to insufficient margin or to the activation of an alert message on the *Balancing Mechanism* on the actual day or day ahead, with 56 ESS 0 and 1 ESS A (versus 24 ESS 0 in 2007, and 36 in 2006).

Operating Margins and Reliability Rules

The reliability rules recommend:

- a minimum margin that can be brought on line in less than fifteen minutes and which is higher than 1500 MW; it is sized so as to make up at any time for the outage of the largest connected generating set;
- a minimum margin with a longer time range (time span margin), the required volume of which increases from fifteen minutes up to a period of eight hours.

Whenever these conditions are not met, a "critical situation" S command is emitted by RTE.

Balancing Mechanism

French law stipulates that producers must submit reserve power proposals for the balancing of their programmes. This has been carried out since 2003 through the *Balancing Mechanism*, which permits RTE to share the means held by the players (producers, consumers or traders) in the form of a permanent and open system and the players to make optimum use of their withdrawal capacity or generation flexibility. On the basis of price-volume offers, RTE carries out the necessary balancing operations by ranking the proposals according to their bidding price until its need is met.

Measures have been set up in case of insufficiency:

- for time periods over 8h, RTE sends out an "alert message" calling for additional bids;
- for time periods under 8h, a "degraded mode message" permits RTE to mobilise, apart from additional bids, exceptional bids and means not offered for balancing.

The number of ESS concerning alert messages on the Balancing Mechanism on the actual day or day ahead came to 26 (5 in 2007, 11 in 2006). 11 cases were accompanied with a “critical situation” due to insufficient margin command, compared with none in 2007 and 8 in 2006.

For the first time, difficulties in obtaining sufficient margin to cope with decreasing load led to ESS 0, with 12 cases. In the spring, they were due to reduced hydropower availability, and in August, to the low flexibility of the generating units configuration.

For usual margin (i.e. to cope with increasing load), there were 38 ESS (including one A) linked to the sending of critical situation due to insufficient margin commands as opposed to 19 in 2007 and 32 in 2006. This higher number is essentially due to reduced hydropower facility availability, to variations in exchange programmes due to time changes, and to the increase in day ahead generation balance deficits.

The months the most impacted were June, July and December with seven commands each, followed by April and November (4 commands each) and October (5 commands). 24% of the cases corresponded to an insufficiency for a period of fifteen minutes, 26% for a period of two hours and 50% for a period of over two hours. 23 commands were accompanied by a “Balancing Mechanism degraded mode” message.

RTE has launched actions to re-examine the margin evaluation and monitoring processes and has set up a margin-monitoring observatory. A margin audit is included in the 2009 reliability audit programme.

Primary and secondary reserves of power frequency control (f/P)

An ESS A was declared on December 1 for a 50 MW primary reserve shortage between 21:00 and 22:00, due to the inability to perfectly reassign control reserves between generating sets during a generation strike. The shortage must be compared to the 625 MW of primary reserve to be constituted by RTE in application of the UCTE rule.

Frequency stability

The observation of frequency control is also instructive, even if, here, one goes beyond the sole framework of French responsibility, because of the European synchronous interconnection. Since 2001, reliability reports have drawn attention to the unexpected frequency deviations observed on the European interconnected grid, which are proving to be significant in terms of what is stipulated by the application of the UCTE rules. The following table, established using the CdP Prod tool (cf. §5.4), indicates the number of frequency deviation occurrences higher than 100 and 150 MHz with respect to the reference frequency.

	2005	2006	2007	2008
F-Fref > +100 MHz	106	202	82	191
F-Fref < - 100 MHz	59	150	73	91
F-Fref > +150 MHz	0	1	0	0
F-Fref < - 150 MHz	0	1	0	0

“Safeguard” and “Critical Situation” Commands

Under exceptional conditions, the rules that are normally applied may be suspended and/or supplemented by the sending of “safeguard commands” by RTE. The latter must be interpreted and executed without discussion and delay, provided that they do not contravene the obligations for the security of people and property. They are intended for RTE Units, as well as the power network users whose action is necessary to overcome the situation encountered.

Among them, “critical situation warning” commands are transmitted upon a security margin reduction, with a generation margin option, or low voltages, or substantial flows.

Depending on the situation, other safeguard commands may be sent, such as “voltage alert”, “emergency drop or increase”, “5% drop of the MV voltage set point”, etc.

Primary and Secondary Frequency Controls

Following any contingency affecting the balance between generation and consumption, together with the effective participation of all the partners of the synchronous interconnection, primary control ensures the automatic and immediate restoration of balance. Rules are laid down by UCTE so that this action keeps the frequency within defined limits.

Subsequently, the secondary control of the partner causing the disturbance automatically cancels the almost stationary deviation of the frequency compared with the reference frequency, as well as the deviations compared with the exchange programmes between the different UCTE control zones.

When compared with 2006, the year 2008 presented an appreciable drop in frequency deviations, similarly to 2007, but mild weather conditions during these two years must be taken into account. The largest deviations were not related to the tripping of generating sets on which the sizing of the UCTE primary reserve is based, but to variations in cross-border exchange schedules, by the effect of tariff orders in the interconnected countries, as well as to the sudden changes in the composition of the generating set program (sudden stop in hydro generation, for example).

RTE strived to push forward actions to improve frequency control, both internally and with other producers operating generating sets in France, as well as with foreign TSOs. The ad hoc *Frequency Quality Investigation (FQI) working group* submitted its recommendations in 2008 (cf. §8.1). UCTE had put the group in charge of giving an opinion on the frequency quality required to at all times avoid the risk of frequency collapse, of taking inventory of the means available to the TSOs to deal with frequency deviations, of analysing the application of the UCTE reference guide and proposing the required changes.

Voltage stability

If we judge by the ESS declared in this field, voltage stability was less tense in 2008. In western France, however, lasting concerns led to an adjustment in the voltage collapse risk management methods in association with the national dispatching centre, in order to take into account regional specificities; the feasibility of an automatic system that can be activated for limited periods and that can automatically reduce load via load shedding to avoid any major incidents was also examined. In the South-East, the period from December 17 to 19 during which we had to order a 5% decrease in MV twice, shows that we can quickly reach tense situations with high levels of consumption, especially if there is also a generation contingency. In the South-West, the blocking PLCs of the transformer on-load tap changers were called upon several times to manage power flows with Spain, which, because of their size and geographic imbalance, can lead to major voltage variations.

The national dispatching centre declared 4 level-A ESS, as opposed to 16 in 2007 and 20 in 2006, due to voltage problems that affected the 400 kV grid. The breakdown is as follows:

- 1 “voltage alert” command, compared with 12 in 2007 and 13 in 2006. It occurred on October 29 in the Normandy-Paris region and was accompanied by a critical situation command with the “low voltage” option for the West, North-East and East regions.
- 3 other critical situation commands with the “low voltage” option (12 in 2007 and 9 in 2006) in January; they concerned the Normandy-Paris and North-East regions (3 times), the East (once). These commands are sent for preventive purposes and so are not equivalent to the “voltage alert” commands in terms of expressing reliability degradation.

2.3 Operation of interconnections

As concerns energy exchanges with foreign countries, management mechanisms are organised as set out in previous yearly reliability reports. In particular, they call for exchange capacity reductions to be made, if necessary, to reconcile reliability and the market. It is therefore instructive to follow up the effects of these mechanisms over the years.

As in previous years, the operation of neighbouring European or even non-bordering systems had repercussions in France. On several occasions, the exchange capacity with neighbouring countries had to be reduced

With respect to England, sporadic reductions occurred every month of this year, due to various problems concerning the IFA direct current link between the two countries. These problems gave rise to 26 ESS 0 (24 in 2007).

Sporadic reductions of exchange capacity with Spain occurred in February, May, October, November and December. The longest situation occurred from November 24 to December 2, due to the fall of a phase cable on the 225 kV inter-connection line between Pragnères – Biescas, on the Spanish side. Moreover, the middle of the month of May was marked by very high flows on the 400 kV Argia – Cantegrit interconnection line, due in particular to a geographic generation imbalance in Spain.

Concerning Germany, the 225 kV Saint Avold - Ensdorf interconnection line was again affected by 20-minute overload alarms in October, but much less than in 2007.

Exports to Italy were reduced on several occasions, in application of the trilateral procedure agreed upon between RTE, Swissgrid and TERNA (in July, August, November...) or the pentilateral procedure that also involves Austrian and Slovenian TSOs (in January, May, June, July, August, November and December). Three particular events occurred: from May 29 to June 8, pursuant to damage on the Villarodin – Venaus interconnection link caused by the dislodging of a transmission tower on the French side due to floods; from August 18 to 29, during the scheduled safety shutdown of the 400 kV Albertville – Rondissone double-circuit interconnection line; December 16, 26 & 27 due to damage on the Italian side on an overhead earth wire on the Albertville – Rondissone line. In 2008, there were no numerous and recurrent 20 and 10 minute momentary overloads on the Trinité Victor - Menton – Camporosso interconnection line as there had been in the previous two years.

The TSOs from France, Belgium, The Netherlands, Germany and Luxemburg created a joint company in 2008 to manage common cross-border services: the CASC-CWE (Capacity Allocation Service Company for the Central West-European Electricity market). It is to act as a single-window entity in charge of organizing and managing auctions concerning year and month transmission capacity allocations at the borders between the five countries, based on standardized systems and rules. It proceeded in November with its first common auction of year and month capacities.

2.4 Management of internal congestion

The most sensitive parts of the French grid were once again the South-East and West.

In the South-East, on November 3, we saw the materialization of the concerns that we have had for several years now with regard to the region's structural situation as an electrical peninsula and the cancellation in 2006 by the Conseil d'Etat (Council of State) of the declaration of public interest of the Boutre - Broc Carros line project. During thunderstorms, the 400 kV Néoules – Réaltor line, which connects the surroundings of Marseille and Toulon and supplies the subjacent 225 kV grid, went down and a 1500 MW power failure affected 1.5 million customers in the Var and the Alpes Maritimes. The incident was ranked a level C ESS. Other noteworthy difficulties arose during the year, and although the weather conditions remained mild, the South-East region dispatching centre had to issue 17 critical situation commands (corresponding to 3 ESS A and 14 ESS 0) to which must be added two ESS A critical situation commands issued by the national dispatching centre for the reliability of the 400 kV grid in the region.

On December 1, during a supply reliability meeting for eastern PACA chaired by the Minister of Energy, a decision was made to adopt a solution proposed by RTE, consisting in reinforcing the 225 kV grid so as to have available sufficient recovery capacity in case of damage or fire on the main 400 kV line. It will be supported by a "safety net" made up of existing links and new links to be created, while a phase-shifting transformer will be installed on the existing line between France and Italy to control flows and to be able to reverse them if necessary. This reinforcement of the grid must be accompanied by the development of local production and by the reaching of ambitious electricity demand control objectives.

The other very sensitive region is Brittany, which similarly to PACA, depends on a single 400 kV axis. In 2008, there was an almost identical level of ESS A and ESS 0 as in the previous year; nevertheless, a situation analysis shows that grid operation is increasingly difficult. This is partly due to the growth in local consumption, with for example a 1000 MW increase in load peak between the winter of 2007/2008 and the previous winter. In 2008, this factor was combined with a substantial deterioration in producer performances in terms of reactive power, long breakdowns on high-power generating sets, and growing restrictions on the flexible use of combustion turbines.

2.5 Contingencies affecting the transmission facilities

The transmission facilities sustained 10,872 short-circuits, an increase of 4.8% compared with 2007 which had been a favourable year with 10,376 cases (versus 11,227 in 2006 and 10,308 in 2005).

98.8% of the short-circuits occurred on lines, 3.4% took place during automatic or manual recoveries upon fault occurrence, and 1.2% affected equipment in a break assembly, at the transformation, busbar or compensation level. Among the short-circuits excluding recovery upon fault occurrence, 52.4% were caused by lightning (versus 54.8% in 2007 and 65% in 2006), 2.7% by wind and storms (2.4% in 2007), 3.8% by frost and sticky snow (2.1% in 2007), and 1.5% due to equipment breakdowns (like 2007); undetermined causes represented 36.2% versus 35.7% in 2007; the remainder are due to miscellaneous causes (contact with animals or heavy vehicles and equipment, etc.).

In 2008, 1.5% of lightning impacts caused a short-circuit on the RPT facilities (RPT: French acronym for Public Transmission System) versus 1.4% in 2007. This is the highest rate since 2000 and yet, 2008 with 0.65 impacts per km², was the year with the lowest number of lightning strikes in France since we began compiling our statistics 15 years ago.

15 simultaneous faults on 400 kV double-circuit lines were recorded in 2008 for 10 in 2007.

The number of short-circuits per 100 km of overhead line was 2.5 for the 400 kV grid and 8.3 for the 225 kV grid, versus respectively 2.5 and 8.6 in 2007.

A short-circuit on the 400 kV grid was due to contact with vegetation despite efforts made by RTE via its tree pruning policy to avoid this type of contingency, which had been one of the factors causing the major incidents that affected North America, Switzerland and Italy in 2003. It gave rise to a flash audit (cf. §9.2).

Regional reports indicate that a small number of lines accumulate a significant proportion of the 400 kV short-circuits, that we see them from year to year, and that they are old structures not equipped with overhead earth wires (or only partially equipped).

3 Evolution of the reliability reference guide

3.1 External reference guide: directives, laws, decrees, etc.

In Europe

Following the presentation by the European Commission, on 19 September 2007, of a series of legislative proposals aimed at reforming the internal electricity market, talks continued between the Member States to reach a compromise. As the Ministers of Energy managed to reach a global political agreement, the adoption of a third law seemed possible during the first half of 2009 (it was adopted on 22 April 2009).

The European Commission also made proposals in 2008 for a new directive on renewable energies, aiming in particular at setting objectives for electricity generation in the Member States.

In France

The Official Journal published:

- On 25 April, decree n° 2008-386 of 23 April 2008 concerning general technical design and operation recommendations for the connection of generating facilities to public electricity networks;
- on 25 April, the order of 23 April 2008 relative to the technical design and operation requirements for the connection of an electrical generation facility to the public transmission system;
- on 25 April, the order of 23 April 2008 relative to the technical design and operation requirements for the connection of an electrical generation facility to the low or medium voltage public transmission system;
- On 25 October, decree n° 2008-1087 of 23 October 2008 concerning the publication of the cooperation agreement on electrical interconnection between the Government of the French Republic and the Government of the Kingdom of Spain, signed in Saragossa on 27 June 2008.

Among the other bills issued linked to reliability, mention may be made of the order of 17 November 2008 laying down the purchasing conditions for electricity generated by wind power facilities.

On 30 October 2008, the Minister of State in charge of energy signed the third amendment to the agreement of 27 November 1958 awarding to RTE EDF Transport SA the concession for the public transmission system (RPT).

Previous system reliability reports had mentioned the drafting of RTE's Technical Reference Guide, undertaken after work on the grid code conducted in 2000 and 2001 within CURTE (*Comité des Usagers du Réseau de Transport d'Electricité* – Transmission System Users' Committee) and the evolution of this Technical Reference Guide to the "Reference Technical Documentation" (RTD) mentioned in article 35 of RPT concession specifications. RTE posted on its site a first version of the RTD on 15 May, following consultation carried out within the framework of CURTE.

3.2 ETSO, UCTE, ENTSO-E

ETSO presented in a report its views of a model capable of being a reference for continuous active cross-border exchange markets on an intraday basis, aiming to encourage self-balancing to market actors in order to minimize imbalances and the balancing required in real time. ETSO members published a new set of data based on TSO files on the ETSOVista platform (on line since late 2006) to make available data concerning physical flows, exchange programs and inter-connection auctions. The platform now presents, in a transparent way, a dozen types of data supplied by more than thirty TSOs.

ETSO published a new report on generation adequacy prospects for the period 2010-2020, in cooperation with the associations UCTE, NORDEL, UKTSOA, ATSOI and BALTSO. It concludes that adequacy should be satisfactory since most of the regions have identified the need to commission new generating facilities to meet growing demand and to replace existing facilities.

UCTE, which finalized the first complete version of its new recommendations reference guide (*Operation Handbook*), with the publication of the last chapter (*policy P8 Operational Training*) concerning operator training, has proceeded with the review of three chapters, whose drafts were posted on their site in November for public consultation. These P1, P2 and P3 policies, whose current applicable versions date back to 2004, deal with load-frequency control, scheduling and accounting of international exchanges, and operational reliability. They are organized on three levels: *definitions*, *standards* and *guidelines*, the application of the *standard* level being mandatory.

Previous system reliability reports have explained how, since 2006, UCTE has been ensuring on an annual basis that TSOs are complying with its rules via the *Compliance Monitoring and enforcement Process* (CMP) by reporting any non-compliances. In 2008, the monitoring campaign focused on compliance with key rules, including regional coordination and the exchange of information between TSOs. The assertions of compliance with the rules, still made by the TSOs in the form of a self-declaration, must now be backed up by a list of applicable internal documents. New advances have been made with the first two on-site verifications made on a volunteer basis with the TSOs. They were carried out at TenneT and Vattenfall and focused on sixteen rules examined in the framework of policies P3-P4-P5, under the angle of bilateral relations.

Among the other UCTE achievements in 2008, we would like to highlight the publication of a position paper on the performance levels to be met by generating sets, a generation adequacy review for 2008-2020, the final report of the FQI Group on frequency quality (cf. §8.1), and the organization of a seminar on compliance with operating rules in association with the European Commission, the Council of European Regulators CEER¹, NORDEL, UKTSOA and the NERC². The UCTE has also finalized its feasibility study on synchronous inter-connection of the UCTE network and the electrical system in Eastern Europe (UPS/IPS)³, started in 2004. It concludes that though there are apparently no major technical obstacles, the connection of two such extensive synchronous systems, which would be a global first and a real challenge, must be considered as a long-term option, as it presents risks of technically complex oscillations. A medium term solution could consist in a coupling using direct current technologies.

Finally, a major event took place in 2008 with the December meeting in Brussels of 42 TSOs from 34 European countries to create a new association ENTSO-E (European Network of Transmission System Operators for Electricity), which would be up and running before mid-2009. The role of ENTSO-E is to reinforce cooperation between TSOs in key fields, such as the elaboration of grid codes concerning the technical aspects and operation of the market, the coordination of the operation and development of the European transmission network, and research activities. The activities of the existing European TSO associations – in particular UCTE and ETSO – were to be transferred to ENTSO-E before mid-2009.

UCTE, ETSO, and ENTSO-E

The Union for the Coordination of Transmission of Electricity (UCTE), created in 1951, coordinates the interests of 29 Transmission System Operators in 24 European countries, with the objective of ensuring the reliability of the interconnected power system. UCTE lays down the rules to be complied with by the interconnected partners for this guarantee. The UCTE interconnected network supplies 430 million people.

ETSO (Association of European Transmission System Operators), created in 1999, represents 36 Transmission System Operators in 28 countries of the European Union, Norway and Switzerland. It defines the principles for establishing the rules for access to the networks harmonised at the European level.

ENTSO-E (European Network of Transmission System Operators for Electricity), created in late 2008, will take over all of the activities of the European TSO associations, and in particular UCTE and ETSO.

3 sites:
www.ucte.org, www.etso-net.org, www.entsoe.eu

¹ Council of European Energy Regulators

² North-American Electric Reliability Corporation

³ Including the networks of the following countries: Lithuania, Latvia, Estonia, Russia, Byelorussia, Ukraine, Moldavia, Georgia, Azerbaijan, Kazakhstan, Uzbekistan, Tadzikistan, Kirghizia and Mongolia

3.3 Contracting contributing to reliability

Pursuant to the regulatory texts issued in April concerning the connection of generating sets, consultation initiated with producers led to the publication of standard technical and financial proposal frameworks, connection agreements with associated performance commitment agreements, and operation & control agreements.

Following the posting on the RTE website of the contract describing the conditions for producer participation in the system services for 2008-2010, the corresponding contracts were signed by RTE with the producers concerned. Changes were made with respect to previous conditions. They particularly concerned improved control of the primary power frequency characteristic, the introduction of generation programme compliance monitoring, the verification of generating set participation in "Coordinated Secondary Voltage Control" (RSCT), payment conditions for generating set operation in synchronous compensation mode, rules for imposing penalties due to non-compliance with power frequency control recommendations, and the possibility of producers exchanging reserves on an intraday basis. Deduction and penalty terms were initiated for the system services remuneration contract with CNR in 2008, as this was already previously the case with EDF.

As concerns network restoration and voltage recovery to power plants, the contract signed in 2006 with the Producer EDF was prolonged.

Pursuant to preparation work carried out in 2007, commitments in terms of power system reliability were contracted between RTE and EDF. They are a complement to the Joint Rules for the Development and Replacement of Delivery Point Substations and, in particular, focus on actions during exceptional situations, safeguard commands, defence plans, network restoration following a major incident, operator skills, equipment inspection and feedback. They were also signed on a regional basis with the Local Distribution Companies whose control systems interface with the RTE safeguard system.

A report on load shedding methods between RTE and the distributors was established and has been deployed on a regional level. Replacing old EDF documents, it describes the load shedding plan, the technical load shedding methods and their implementation, the tools and their tests, the preservation of staff skills, and the feedback that must be given on an annual basis and after every load shedding action.

On completion of the consultation initiated in late 2007 by RTE to dispose of 1,000 MW of rapid power reserves available within 13 minutes and 500 MW of additional power reserves available within 30 minutes, a firm three-year contract was signed with EDF starting 1 April 2008.

3.4 RTE internal reference guide

With respect to the System Operation Reference Guide, documents were implemented or published concerning: in-operation control of voltage risks that may affect the reliability of the 400 kV network, the preventive use of safeguarding means to protect against the risk of voltage collapse, the reference functions for the 400 kV PLCs, internal RTE load shedding organization, validation methods for the RTE facility telecontrol chain, alarm management for the Regional Control System (SRC), the configuration of operating information in the regional dispatching centres' control systems, diagrams used by the operators in the dispatching centres for control and operational planning, and training courses for scheduling and programming control.

RTE System Operation Reference Guide

The power system operating policy formally expresses the principles followed in operation at RTE, from operational planning to real-time control and operational feedback. It serves as a reference framework for drawing up instructions, which are operational handbooks that can be used directly by RTE's operating personnel.

As for the Transmission Operation Reference Guide, we noted the implementation of texts concerning the sizing and operation of underground lines and the updating of the automatic reclosing policy.

In 2008, we also saw the implementation of common reference guides for operators of the power system and transmission facilities, in particular with respect to the list of strategic and sensitive facilities, the servicing of protections based on ring opening upon loss of synchronism (DRS), operation in day and night operating conditions of permanent maximum admissible intensity (IMAP), changes to the transformer on-load tap changer blocking policy, and the taking into account of the substation withstand to short-circuit currents during operation.

4 Evolution of measures contributing to reliability in the equipment field

4.1 Intrinsic performances of components

4.1.1 Generating sets

The number of renewable energies generating units continues to grow.

At the end of 2008, wind power represented 3,300 MW of installed capacity compared with 2,500 MW at the end of 2007, ranking France fifth on a European level. The objectives set by the French State through its Pluriannual Investment Programme (*Programmation pluriannuelle des investissements* – PPI) are to reach at least 17,000 MW in 2015. In 2008, the monthly load factor for the installations was extremely variable due to intermittent winds, ranging from 10% to 37% for an average yearly value of 23%.

In 2008, we also started to see the development of solar cell or photovoltaic generation, with an installed capacity connected to the grid reaching 48 MW at the end of 2008.

Following a call for tender for generating facilities using biomass, the MEEDDAT (French Ministry of Ecology, Energy, Sustainable Development and the Sea) selected 22 projects within the framework of the Environmental Forum, representing a total capacity of 314 MW, spread out over eleven regions. They should be commissioned before 2010.

New generating sets with significant unit capacity must also be reported, with:

- the connection of a 451 MW gas combined cycle generating set to the Richier power plant in the Bouches du Rhône;
- end of the voluntary pluriannual shutdown status of unit n°1 in Porcheville (600 MW) and unit n°1 in Aramon (700 MW).
- industrial commissioning near Paris of combustion turbines to cope with periods of extreme load peaks, with a 125 MW turbine in Vitry-Arrighi and two 185 MW turbines in Vaires sur Marne;
- the connection of two wind farms, one in 225 kV and the other in 63 kV, representing 190 MW installed capacity.

For existing generating sets, a major point to be considered is the success rate of the islanding operations (i.e. disconnection to house load), in view of their importance when having to cope with a possible network restoration following a major incident. The performance levels are sufficient as regards the rate required to apply the policy of restoring the network by the main structures. Nine scheduled tests were carried out, of which eight were successful, and there were three unscheduled islanding operations of which two were successful. This led to an overall success rate of 83% (94% in 2007, 88% in 2006, 81% in 2005). On the basis of a sliding average over the last four years, the overall success rate was 86% for a total of 66 islanding operations (86% in 2007 and 2006, 88% in 2005).

As concerns the periodic testing of voltage recovery scenarios, the 2008 results benefited from the effectiveness of the Grid Restoration and Voltage Recovery Steering Committee that followed the application of the contract signed between RTE and EDF on this topic. The committee plays an essential role with respect to sharing between stakeholders and problem solving. Hence, the performance of attempted tests improved, as did the test scheduling. 24 tests were attempted, of which 19 in the scheduled period, representing a 79% schedule compliance rate instead of 38% in 2007. 20 tests were successful, of which one after rescheduling, two failed and six were cancelled. Overall, the voltage recovery test success rate can be characterised in two ways:

- defined as the ratio between the number of successful and attempted tests, it is 83% (79% in 2007, 95% in 2006); this rate is interesting with regard to what might happen in the case of a widespread incident;
- defined as the ratio between successful and initially scheduled tests, it is 69% (46% in 2007, 86% in 2006); this calculation mode allows one to include aborted scheduled tests, with regard to which a close watch must be kept so as to maintain an adequate periodicity of tests for each voltage scenario and for each target generation site.

There was significant progress made in 2008, with the validation of a new scenario that eliminates a common mode existing between several scenarios. This is in line with the recommendations of the "Control of voltage recovery and islanding operation tests" reliability audit in 2006.

4.1.2 Protection systems, operation PLC's, instrumentation and control

With respect to 400 kV protection plans (1975, 1983 and 1986 plans), there were 66 low voltage anomalies that had an impact on high voltage equipment, compared with 53 in 2007 and 47 in 2006. They resulted in 30 inadvertent circuit-breaker openings, including 27 due to electric fault occurrences, 2 non-closings, and 14 late openings and they gave rise to 22 ESS 0 and 1 ESS A. We noted an increase in anomalies due to electric faults (51 versus 39 in 2007), while the number of electric faults that impacted the 400 kV network with 525 occurrences has remained fairly stable since 2004.

37 of the 66 anomalies were brought about by technical causes, of which 18 were due to equipment breakdowns, 2 to functional causes, and 17 to telecommunication systems, which represents a strong increase (9 in 2007 and 2 in 2006) with disturbances mainly on the microwave relay links during storms and on power line carrier links.

With 10 occurrences, the number of anomalies due to human causes is close to the 2007 figure.

Similarly to 2007, we noted 17 anomalies due to unknown causes; 13 remain unsolved and are mainly due to equipment behaviour that was not possible to reproduce.

The digitisation of substation instrumentation and control systems continued. This year marked the beginning of the implementation of the "ELECTRE d" generation of equipment for the substations interfacing between high and medium voltage, with the commissioning of the first five "forerunner" substations and then five experimental substations with a wider scope of services.

In accordance with the changes in the policy for blocking HV/HV transformer on-load tap changers, and based on dynamic studies carried out within the framework of the "Voltage Control" project, measures were taken so that the blocking of HV1 transformers now takes place on tapping under use in the priority areas of the West, South-East and Normandy-Paris regions, in addition to the South-West where this is already the case. This policy will be rolled out in the other regions before winter 2009.

4.1.3 Automatic frequency and voltage controls

The deployment of the RST-N system, which concerns the renovation of Secondary Voltage Control, should have been completed in a few areas equipped with hydropower units in the South-West region but was pushed back until 2009 because it was not possible to set up the IT gateway required to integrate the hydropower plants.

In the West, where the "Coordinated Secondary Voltage Control" (RSCT) is used to take into account the interactions between voltage regulation zones, the integration of unit 3 at Cordemais into the RSCT was completed in late 2008 after a test campaign. Within the framework of the renovation of RSCT via the RSCT-NA project, decided in 2006, the testing of the new equipment situated near the substations was started.

4.1.4 Transmission facilities

In 2008, several 400 kV facilities were commissioned:

- The Yvelines-Ouest substation, near Rambouillet, to secure supply to the southwest part of the Paris region;
- The Biançon substation in the Var to reinforce supply in the western part of the Alpes-Maritimes;
- the Vigy – Marlenheim line, between Metz and Strasbourg, which by replacing the old 225 kV line, reinforces transmission capacities in eastern France. It also enables a better voltage plan to be applied in Alsace and to therefore reduce the risk of the low voltage events that have regularly occurred since 2005.

In the 2007 report, we mentioned that studies were being carried out to install overhead line cables featuring low thermal expansion, of the "Aluminium Conductor Steel Supported" (ACSS) type, to increase line transmission capacity in back-up mode, while maintaining a very significant proportion of the existing towers. Work to replace the conductors began on the 400 KV double-circuit line between Tamareau and Tavel. The needs in terms of low thermal expansion conductors were established for the period 2009-2014. As these cables are a limited resource, a decision had to be made to smooth out peak needs in 2012. RTE launched a call for tender in June 2008.

An experimental monitoring system was installed on a 225 kV line in view of making available to dispatchers real time information on authorised transmission capacity taking into account local weather conditions.

RTE and its British counterpart National Grid awarded a contract to Areva T&D to improve the reliability and availability of the IFA 2000 direct current link; it essentially focuses on the replacement of conversion equipment that dates back to 1986.

4.1.5 Control systems

Behaviour of the National Control System (SNC) can be characterised by:

- the total unscheduled unavailability for the SNC of zero minutes (versus 3h00min in 2007);
- the outage time of the power frequency control level signal transmission (RSFP) from the SNC of 16h (versus 20h49min in 2007); in this case, means are provided for to transmit the level signal by using the ASN (French acronym for National Mimic Board). The total level signal transmission outage time (for the combined outage of the SNC and ASN) was just a few seconds (14min in 2007), thanks to proper operation of the switchover mechanism.

2008 saw the beginnings in the regions of the Regional Control System (SRC), used for grid control at the regional level, which replaces the SIRC (Regional Control Information Processing System) tool that had been set up in the early 1980s. It was implemented for standard operation in the Lille dispatching centre and under supervised operation in the Saint Quentin en Yvelines, Marseille and Nancy dispatching centres before being rolled out into the other regional dispatching centres in 2009. Work is also continuing to add new advanced grid reliability analysis and voltage control functions to the SRC software.

RTE launched the IPES project (Integration of Wind Energy into the Power System) in 2007, to specifically take into account wind generation, which is rapidly developing, into the control and the operational planning of the power system. The main objectives for 2008 were reached. An experimental visualisation platform was deployed in all of the control and operational planning departments of the national and regional dispatching centres. It makes it possible to locate and visualize the characteristics of the wind farms. Pursuant to a contract signed by RTE and ERDF concerning the observability of wind generation, the telemetering of power supplied by the wind generators into the distribution network was progressively transferred to this platform and the rate of observability of the MV wind farms reached 75% in late 2008. At the end of the year, following a European call for tender, RTE selected AREVA to supply an industrial system to monitor wind generation to be commissioned in 2009.

The PCCP project (Production Centralized Control Point) was launched in view of transferring to the producers RTE's current responsibilities with regard to generation scheduling and balancing in day ahead, intraday and real time. The day ahead stage was successfully transferred in 2008: the production entities (EDP) must now receive their programme from their Programming Manager and no longer from RTE.

The replacement of control equipment undertaken by the Producer EDF continued actively in 2008 in the framework of the ARCHIPROD project. It affects equipment at RTE, in particular

The French Telecontrol System

The size and complexity of the French power system warrant a hierarchical organisation of the monitoring and command functions that imply four control levels:

- a national level, ensured by the National Power Control Centre (CNES);
- a regional level, ensured by the Regional Power Control Units (URSE);
- a monitoring and control grouping level, ensured by Area Transmission Control Centre computerised operation desks (PEXI) for transmission facilities, in addition to the centralised command points of network users (e.g. producers, distributors, consumers);
- a local level, represented by the power facilities themselves (transmission substations, generation).

These control levels are interconnected by the "Security Network", a telecommunications network dedicated to operation, which permits the operators to exchange commands and data under all circumstances and notably in emergency situations where public means of communication may be saturated.

Security Telecommunication Systems

Their aim is to constitute a Security Network based on a dedicated telecommunications infrastructure, permitting the conveyance of all the information (voice, data) required for telecontrol.

These systems ensure the following functions:

- the transmission of the telecontrol data of all Remote Terminal Units (PA) and of a limited number of telephone conversations between main transmission substations and area transmission control centres;
- the transmission of telecontrol data and telephone conversations between area transmission control centres and regional dispatching centres;
- the transmission of telecontrol data and telephone conversations between power plants and regional dispatching centres;
- the transmission by radio of telephone conversations between mobile land crews and their base.

RTE networks develop according to the opportunities provided by new technologies, with a view to increasingly enhanced reliability and security, by giving the greatest importance to sharing the possibilities provided by these technologies.

the Security and Alert System (SAS), the transmission of secondary voltage control and power frequency control levels, remote data feedback and the transmission of control telephone communications. Most of the regions have noted improvements with a decrease in ESS concerning control facilities (SAS in particular).

For several years now, RTE has been running the ROSE project, which consists in modernising the *Security Network* by digitising it and further equipping it with optical fibre telecommunication cables, installed on the company's transmission structures, to accommodate high-level applications ensuring reliability: teleprotection, with priority to line differential protection, telecontrol and telephony security.

In 2008, the fibre optic network installed within the framework of the ROSE project grew by 1,636 km and 1,550 km remain to be installed by 2011, for a total of 8,700 km.

Twenty-nine 400 kV line differential protections were migrated over to the ROSE system in 2008. At the end of the year, of a total of one hundred and eighty eight 400 kV links equipped with differential protections, there were only 49 left to migrate over to the ROSE system by replacing the existing microwave relay links or pilot cables. The migration should be finished in 2011.

4.1.6 Load/ Consumption

Following a call for tender opened to industrial consumers connected to the public transmission system, RTE selected six proposals to test during a one year period a load withdrawal system, for a withdrawable load of at least 10 MW.

In Brittany, RTE started the experimental Ecowatt system to encourage private customers to limit their consumption during peak periods. The ADEME, the Brittany Region, the French State and ERDF are partners for this operation that is based on a dedicated website.

4.2 **Structure of the system and its design rules**

The law has entrusted RTE with carrying out a forecast report of the electricity supply-demand balance every two years. It is one of the elements on which the Minister of Energy and the public authorities base themselves to define the Pluriannual Investment Programme (PPI).

In 2008, RTE proceeded to update, for a 5-year period, its third forecast report of the electricity supply-demand balance in France, issued in 2007. The security of supply of electricity in France continues to appear reasonably ensured, and the supply-demand balance criteria is complied with until 2013 but with very low margins for this criteria, dropping as far as zero margin for the winters of 2009-2010 and 2012-2013.

The transmission network development policy has until now been very marked by the structural context and the founding principles that governed its drafting over thirty years ago, while we must now increasingly take into account the management of uncertainties and new flow distributions (in particular with the development of decentralized generation). RTE has therefore initiated a project to propose a new network development policy, to propose technical targets and development strategies, and to design flexible instruments and methods.

4.3 **Other material measures contributing to operation**

In 2004, RTE started the "Industrial Facilities" programme whose aim is to improve the knowledge and maintenance of the company's facilities. It brings together diverse applications describing the facilities and equipment (Infoligne, Infocâble, Infoposte), organising maintenance (SAM: French acronym for Maintenance Assistance System), planning maintenance (SPORT: French acronym for Planning System for Operations on the Public Transmission System), and analysing the costs (GCP: French acronym for Control Contracts Management). One year after its first implementation in the North-East region, the

coordinated deployment of new program applications was completed in all of the Units concerned in 2008.

Initiated after the storms of 1999, the enhanced mechanical security programme for the grid is continuing. Increased resources were allocated to complete the programme in 2017. At the end of 2008, 4,266 anti-cascade towers were installed out of a total of 6,139 towers and 8,660 km of secured lines were installed out of a total of 48,754 km.

5 Evolution of measures contributing to reliability in the organizational and human domain

5.1 Reliability culture, management of the Human Factor, Training

The Human Factor

As shown in the annual regional reliability reports, the Human Factor remains an important topic of interest and activity in the regional centres, in its different locally managed forms (APACH⁴ or other approaches), based on the experience acquired. In order to ensure the sustainability of these approaches, RTE's Training Centre has drafted training specifications concerning the Human Factor approach in a group work environment.

Training

With respect to centralized training in power system operation, a new module on wind power generation was included in the dispatcher skills maintenance program.

The deployment of new tools in the regions gave rise to two new training programs, one for dispatchers on the SRC control tool and the other in operational planning on the SPORT tool. Several regions have set up common training modules for the operators of the power system and of transmission facilities on the topic of dialogue management during manoeuvres and incidents. They necessitate the training simulators used by these operators, SIDERAL (used for dispatcher training) and SIMAC (simulation of the local monitoring and control tool PEXI⁵ for agents in the Area Transmission Control Centres).

Reliability Culture

RTE continued its awareness raising actions concerning reliability for external companies through seminars entitled "Ensuring reliability together", one of whose strong points is to bring together all of the players in the same setting (producers and distributors especially). However, we noted quite a contrast between regions where the seminars were very popular (Rhône-Alpes-Auvergne, South-East...) and others where the sessions were difficult to organize (South-West...) in the same conditions and with the same training content.

5.2 ISO 9001 certification – management system

System reliability benefits from the measures set up by RTE for its management system (which has earned it ISO 9001 V2000 quality certification) through several macro-processes: connecting to the public transmission network, withdrawing and delivering electricity, providing access to interconnections, providing balancing services, developing and maintaining the network, ensuring the balance of flows, ensuring the supply-demand balance and compensating for system losses, and managing RTE. The next ISO certification renewal entails an external audit scheduled in 2009.

⁴ Amélioration des Performances Associées aux Causes Humaines (Improved Performance Levels Linked to Human Causes)

⁵ Computerized Operation Desk

5.3 Feedback (organisation of feedback, evolution of the ESS scale)

The ESS (Significant System Events) classification scale, used to ensure feedback on the reliability of the French power system, has remained stable with respect to the last version applied by RTE on 1 January 2004.

First steps were taken in 2008 towards the monitoring of events affecting the European interconnected network, via the application of a joint incident classification scale by RTE, which was a major instigator, and the other TSOs in the CWE zone (Central Western Europe: France, Germany, Belgium, The Netherlands and Luxembourg). Similar to the scale used in France by RTE, the classification is organized according to six domains: network, generation, distribution, system operation, control facilities, reliability degradation. A regular report on the application of this ranking is drawn up by the CSM Committee (Congestion Security Management), appointed by the countries that signed the memorandum of understanding in 2007 (cf. 2007 reliability report).

ESS (Significant System Events)

Events providing information concerning the reliability of the power system are detected by RTE on the basis of pre-set criteria, grouped in a "Classification scale of *Significant System Events* (ESS)".

The classification scale serves to rank the events according to their rightful level of importance with regard to reliability by placing them on a gravity scale consisting of seven levels. Level 0 is assigned to events having a low effect on reliability, but which should be memorised; levels A to F correspond to incidents of growing seriousness up to a general nationwide incident.

The ranking methodology is based on the combined assessment of gravity according to two types of input:

- an input records the occurrence of basic concrete events affecting an operation function, in a certain number of domains (transmission network, generation, system operation, control facilities, distribution);
- an input marks the level of degradation of the system operation.

5.4 Performance monitoring

According to the systems services participation contract for 2008 to 2010, the performances monitored by the CdP Prod tool are the following:

- In the frequency / power domain: generating set supply of the expected primary reserve and its maintenance for 15 min during a frequency excursion, conformity with schedule for generating set participation in primary control (reserve, static gain) and secondary control, the correct scheduling of the contribution to primary and secondary control, and the response times to these control requests.
- In the voltage / reactive power domain: availability of the totality of the contracted domain, participation in secondary voltage control, time and speed of response to the control requests.

All of the regions have applied the generation unit performance monitoring with its associated technical and financial aspects.

Monitoring the Performance of Generating Facilities

As mentioned in 2001 during discussions with users on the grid code within the scope of CURTE, generating facilities, when connected to the Public Transmission System, may be subject to performance monitoring.

The purpose of this monitoring, carried out in such a way as not to bring about an increased amount of work nor overly high expenses for the users and RTE, is to preserve the Public Transmission System operating conditions for the benefit of everyone and for system reliability.

The intended principle is for the performances to be checked at the delivery point of the facility, when such monitoring is enough to be able to ensure that performances are in keeping with the required results.

Monitoring serves to check the behaviour of generating facilities with respect to power frequency control (droop, contribution, etc.), as well as voltage control, via the situation of the operating point of the generating set in the Voltage/Reactive Power diagram (U/Q).

Performance monitoring for distributors is not quite so structured as it is for producers and progress needs to be made on this point, as was already recommended in the conclusion of the 2006 reliability report. The following was however achieved:

- a precise inventory of the MV capacitors with ERDF, for a better control of reactive power;
- application tests of the command to lower the MV voltage set point by 5%;
- a survey on the distribution of load shedding steps to verify compliance with the rule concerning the 20% of sheddable power per step;
- tests to check the application of the command to block the MV/HV on-load tap changers issued via the SAS.

A test showed the absence of the blocking of MV on-load tap changers due to an error in the configuration of the SAS equipment in the Regional Control Agencies concerned, which led to the declaration of an ESS A on December 23.

5.5 Crisis organisation

In consultation with the public authorities, in 2008, no national level load shedding crisis drills were conducted, in order to prepare for the first ever joint exercise with another transmission system operator in early 2009. Contacts are underway with ELIA to this end.

Within the framework of maintaining operational conditions in the ORTEC plan, each regional Unit checks that its crisis action plan is in readiness twice a year, and a national or regional crisis simulation drill is conducted every two years. The last national drill was conducted in October 2007. Among the regional drills, one was conducted for the Rhône-Alpes-Auvergne region simulating the failure of a dam, and another in the North-East region, simulating a fire in a substation autotransformer followed by a long power outage.

Moreover, several crisis cells were activated in real conditions. Hence, given the urgency to re-establish secure supply on the Italian side after a tower on the 400 kV Venaus – Villarodin link was swept away in a flood on March 30, RTE brought into play exceptional resources to repair the link, and a Priority Intervention Group was activated to find a solution for the outage.

5.6 Other organizational measures contributing to reliability

To draw the best from the existing grid, RTE is endeavouring to operate lines as close as possible to their transmission capacities, as defined by the Permanent Maximum Admissible Intensity (IMAP) and Overload Intensities (IS). The IMAP and IS of a line depend on both the characteristics of the conductor and on the weather conditions (temperature, sunshine, wind) that vary considerably between day and night. Consequently, RTE began to study a principle called "IMAP Day / Night" to be able to benefit from possible increases in night time IS and IMAP, when the operation of the power system requires it, while guaranteeing the safety of people and equipment.

More generally, as shown by the reliability reports drawn up since 2001, the power system on the French level but also the European level is having to deal with new structural challenges, such as the increase in difficulties to build new transmission structures, operation

ORTEC Plan

The ORTEC plan (Organisation RTE de Crise) was set up by RTE following the storms that struck France in late December 1999. It lays down the measures to be taken and the organisation to be adopted, both at the national and regional levels, whenever a crisis situation is declared by RTE.

Apart from setting in place the human resources and necessary technical skills, ORTEC calls for the implementation of communication actions needed to cope with a crisis. Whenever necessary, crisis cells can be convened at short notice in all the Units and at the Management level of RTE.

In addition, Priority Intervention Groups (Groupes d'Intervention Prioritaires - GIP) have been set up in each of the Transmission Infrastructure Division Units. Their main purpose is to make sure that seriously damaged power lines which are of particular importance for power system reliability are back in operation within five days

that is increasingly at the limits, the development of cross-border exchanges and decentralized production. In order to anticipate these evolutions and to find the appropriate solutions, RTE is pursuing the Operation 2010 project, which is based on analyses and shared practices, as well as the development of initiatives rendered possible by new technical solutions and IT tools.

6 Lessons drawn from the year's events

6.1 Lessons drawn from the ESS and from their analysis

The number of significant system events (ESS) ranked above or equal to A decreased by 7% with respect to 2007 but included an ESS C while there had not been one since 2005. For the first time, the number of ESS in “distribution” exceeded the number in “generation”. Their breakdown per scale level and domain is listed below.

ESS	2005	2006	2007	2008
A	65	45	41	37
B	4	4	2	2
C	1	0	0	1
D	0	1	0	0
E	0	0	0	0
F	0	0	0	0
Total ≥ A	70	50	43	40

ESS ≥ A	2005	2006	2007	2008
Network	9	6	8	13
System operation	34	36	23	17
Control facilities	18	3	5	7
Generation	6	4	5	1
Distribution	3	1	2	2
Total ≥ A	70	50	43	40

The C-level ESS concerns the outage in the eastern PACA region on 3 November.

The two B-level ESS concern:

- A double busbar fault caused in a 400 kV substation by the explosion of a current transformer and normally cleared by the busbar differential protection;
- non-compliance with the N-k reliability rule and the sending of a “voltage alert” command, following the combination of the safety shutdown of a 400 kV line, a higher than planned load increase and the outage of a generating set.

In addition, 1135 0-level ESS were declared. Their declaration is encouraged because it is invaluable to improve feedback even though they have little effect on reliability⁶, and to carry out theme analyses according to the guidelines of RTE's National Feedback Committee (CNREX).

Thus, in 2008, the CNREX examined an ESS 0 declared just after the commissioning of the new 400 kV Vigy - Saint-Avoid line, for the detection of a faulty database configuration that led to inconsistencies between the representations available in the regional and national dispatching centres. Improvement actions were taken to avoid any similar incidents.

⁶ Thus, any unexpected tripping of a generating set and any tripping of a 400 kV line are declared as 0-level ESS, whereas such contingencies are covered by compliance with operating rule N-k

The regions also examine the ESS 0. For example, in 2008, when examining the occurrences pertaining to “control facilities”, most of them noted a decrease in those concerning the SAS. Their analysis attributed this improvement to the architecture and equipment renewal operations carried out over the last few years and which led to a marked improvement in the functioning of the control systems and the elimination of obsolete equipment. There was a positive impact noted in 2008 regarding the deployment of the ARCHIPROD project.

6.2 Feedback other than ESS

RTE and its DSE and DTE divisions analyse problems that are not confined to ESS occurrences at both the regional and national levels (in particular within the scope of the CNREX and the Transmission Technical Committee).

The CNREX addressed the question of identifying the causes of short-circuits with undetermined origins. Actions were undertaken in coordination with the national and regional levels to significantly reduce the occurrences. The comparison of statistical studies performed using the SIQUAEL application (Electricity Quality Information System) with information derived from the operational teams indicates that factors leading to insulator string flashovers, when avifauna activity and humidity levels are at maximum level, are largely responsible for these occurrences. To test this theory, experiments involving equipping three lines with measuring devices were initiated. In parallel, other actions were undertaken including the drafting of a line inspection guide to better identify causes, the equipping of lines with fault locators and improved collection of information in SIQUAEL.

The analysis of the clearance by protections and PLCs of the 525 short-circuits sustained by the 400 kV grid provides an indication of the trend concerning protection plan efficiency. 83.3% of the short-circuits were cleared in less than 100 ms (2007: 85.9%, 2006: 88.5%), and 93.1% in less than 150 ms (2007: 96.5%, 2006: 98.0%). The lower performance level is partly attributed to anomalies on the teleprotection systems.

For all of the 365 lines at 400 kV, the unscheduled outage rate was 0.15% and the scheduled outage rate 1.6%. Among these 400 kV facilities are 171 so-called “sensitive” links, the unscheduled absence of which in real time leads to significant difficulties for the power system, and for which RTE implements appropriate measures (reinforced maintenance plan, constitution of complete repair packages, facility inspection undertaken without delay even outside business hours in case of definitive tripping, etc.); for these links, the unscheduled outage rate was 0.12%. There are also sixty-six 400 kV lines that are considered “strategic” and whose absence during operation leads to difficulties such that we must propose measures to reduce their safety shutdown needs. Their scheduled outage rate was 2.32%. This value, which was paradoxically poorer than that of all of the 400 kV links, can be partly explained by the effect of the long-term safety shutdown of the 400 kV Montezic – Rueyres line to enable a producer to work on its facilities.

Moreover, the contracts signed between RTE and the Producer EDF with respect to reliability are followed up by a specific entity. Among the topics examined in 2008 are frequency analyses, tight margin situations, the application of the contract concerning network restoration and voltage recovery to power plants, the ESS concerning generating sets and those having affected generation.

6.3 Noteworthy facts concerning other power systems

Few major incidents were reported in 2008:

- As of 9 January, South Africa had to organise daily rotating load shedding to avoid blackouts. This was due to a very serious shortage of electricity that required the government to declare a national state of emergency on 25 January.
- In January and February, China was hit by a cold wave the likes of which it had not seen for fifty years. It led to the outage of VHV lines and coal-fired power plants cutting supply off to 17 provinces.
- On 26 February, three million Florida residents were deprived of electricity due to a series of events: a short-circuit in the Flagami substation, which was poorly cleared, led to the outage of two lines and several power plants. Then a series of cascading trippings caused a blackout in the southern part of the state. Florida Power & Light declared that a human error was the cause of the poor clearing of the short-circuit: an operator had disarmed two levels of protection when working on the substation. The incident caused oscillations between the interconnected zones in the Eastern United States.
- On 27 May, automatic frequency load shedding deprived 600,000 British customers of electricity at 11:37, after the loss of the Longannet generating facility, followed two minutes later by the tripping of the Sizewell B plant; frequency had dropped to 48.79 Hz. During the afternoon, seven other generating sets once again tripped.
- On 29 May, half of Venezuela was affected by a power outage following a forest fire that caused the tripping of a transmission line conveying energy from the Guri hydropower plant, one of the world's largest with 10,300 MW of capacity. Two other tripping incidents on this same line once again cut off power supply to several million Venezuelans on September 1 and October 19.
- In mid-September, millions of Texans were deprived of electricity for several days after hurricane Ike.

After 4 years of work, the longest submarine HV cable connection between Norway and the Netherlands was commissioned: the Norned connection is 580 km long and has a transmission capacity of 700 MW.

7 Reliability-related indicators

7.1 CRE chart of key indicators

The CRE, in its "RTE Business Report", follows up indicators in various domains. In 2005, the CRE and RTE had defined new indicators related to reliability, concerning the setting up of system services by those in charge of programming. They concern the following in particular for each quarterly reference period:

- the number of generating set failures and performance deviations (and associated financial repercussions) for primary and secondary power frequency control (f/P), as well as for primary and secondary voltage control;
- the number of generating sets located in sensitive areas with regard to reactive power that were unavailable for primary and secondary voltage controls;
- the number of outages of the generating set synchronous compensation function.

These indicators were followed up throughout the year for the EDF and SNET entities in charge of scheduling.

7.2 RTE internal indicators

The present yearly report shows that system reliability concerns extremely varied fields and a great many players. A number of indicators set up by RTE as part of the Quality programme deal with system reliability, including the following examples:

- number of vegetation-related faults,

- unscheduled outage of 400 kV facilities,
- number of ESS concerning “network” + “control facilities” \geq A,
- inaccessibility rate of Artère telecontrol network sites,
- number of human failures caused by transmission facility operators,
- number of A and B-level ESS over 12 months continuously,
- number of ESS of a level higher than or equal to C,
- declaration of 0-level ESS,
- rate of telemetering and teleindication outages,
- number of human errors caused by power system operators,
- rate of ESS related to the supply-demand balance process,
- power frequency control behaviour,
- quality of consumption forecasting.

7.3 Indicators for external communication on reliability

In keeping with the recommendations of the 2003 Reliability Report, validated by the RTE Executive Committee, the indicator to be used for external communication concerning reliability expresses the number of ESS for levels A to F, i.e. for 2008: 1 C, 2 B and 37 A. However, a few figures cannot account for the reliability level, and ESS declaration, although it is extremely valuable, only accounts for incidents and not improvements. It is therefore the yearly Reliability Report which must be used in a privileged way for external communication on reliability, insofar as it gives an account, in coherence with the power system reliability policy, of all the important aspects of operating reliability, and of the role that each one plays in building reliability

8 Progress actions under way

8.1 Actions with the partners concerned (TSOs, Users, etc.)

As in previous years, mention is made here of current and active cooperation with partners in Europe or on other continents, to improve reliability analyses, provide feedback concerning major incidents, and adapt preventive and curative measures in the face of incidents. RTE also sells its services in these fields, which call matters into question and therefore result in progress.

The 2007 reliability report related the signing of a memorandum of understanding by the Pentilateral Forum of the CWE region (Central Western Europe, i.e. France, Germany & Benelux). Progress was made on the planned work: joint auctions, precise definition of market coupling that will take place in the first stage, forecast report... Moreover, in this area, RTE and the Belgian TSO ELIA founded Coreso in 2008. It is a joint subsidiary whose role is to develop coordination via the management of flows crossing the CWE region, to set up a stronger information sharing system, and to perform network reliability analyses for the global CWE mesh. National Grid and Vattenfall Europe Transmission have expressed interest in joining this initiative.

Following the incident of 4 November 2006, RTE, TERNA, EON and ELIA decided to organise peer-to-peer reviews of their measures and organisations to cope with incidents. In 2008, the first exercise took place in each of the TSOs, based on the questionnaires prepared in 2007, to examine the application of policies P1, P3 and P5 of the UCTE Operation Handbook. The jointly established final report underscores that this first campaign was a good opportunity to identify best practices and to challenge procedures and methods under the attentive eye of other partners and that it should be able to contribute in future to directing the current self-evaluation practices used by UCTE towards an audit approach.

The Frequency Quality Investigation (FQI) ad hoc group, that UCTE had assigned to analyse the frequency problems observed on the European network and to propose the required solutions, completed their work in 2008. RTE actively participated in the actions launched following the recommendations of the 2005 audit on frequency deviations and power frequency control reserves. The recommendations of the FQI group to the TSOs concerned, in particular, precautions to take during time changes, with the setting up of rules to respect a maximum generation gradient, and the coordination with producers to avoid drastic changes in generation scheduling for their facilities.

Within the framework of the actions carried out by the "Very Large Operators" Club (VLPGO), which concerns the operators of systems with an installed capacity of over 50,000 MW (cf. previous reports), the task force controlled by RTE on incentive mechanisms to promote new generation capacities has completed its work.

In the field of statistical tools for network analysis, RTE launched a project in conjunction with its Belgian counterpart ELIA on probabilistic analysis methods used in grid development studies. ELIA therefore acquired the ASSESS platform to test the contribution of the methods on real in-house studies.

In the framework of the application of policy P8 "Operational Training" of the UCTE reference guide, RTE's national dispatching centre pursued joint training actions with Terna operators, and joint training actions with all of the bordering TSOs were set up.

RTE and its Spanish counterpart REE began to work together to better share their respective issues following operating problems reported in feedback and by operators: voltage management, appropriation and sharing of day ahead constraints, sharing information, manual voltage recovery, etc.

In-depth work was initiated with the other TSOs and the European Commission to define the organization prospects for European R&D.

Within the scope of European projects after Pégase, which had been selected by the European Commission in 2007 to develop new grid simulation models, RTE contributed in 2008 to the launching of the Safewind Project to design a new forecasting model for wind generation.

8.2 Main lines of research

Ensuring power system operating reliability means knowing how to identify the risks against which one wants to protect oneself and to take the necessary measures in good time. Feedback, although it is invaluable, does not suffice, because major incidents are seldom similar to those that occurred before them. RTE therefore has to be able to anticipate new power system operating conditions and to lead research actions.

Among the many fields concerned, mention should be made of the following points for 2008, in addition to those already mentioned above:

- In the field of load forecasting, in which a lot of work has already been successfully carried out since the creation of RTE, studies are being performed on the use of new techniques and to re-examine forecasting methods for different geographic scales and time scales.
- As regards new renewable energy generation technologies and their integration into the power system:
 - . for photovoltaic generation, the analysis of its characteristics in terms of connection and its long term impact on the power system;

- . for wind power, in addition to the IPES project already mentioned, the design of an operational forecasting model, the integration of wind generator modelling in the various dynamic tools, the study of solutions to be implemented for the connection of off-shore installations, and the impact on margins to be taken into account in supply-demand balance.
- For production margins, in addition to the point just raised, work at different time scales on increasing and decreasing margins, and studies to set up indicators for monitoring margins.
- With respect to generating set performance monitoring, the creation of a “CdP Infra” prototype to be able to identify deviations in a time scale closer to daily real time, while current diagnoses using the “CdP Prod” tool can only be obtained based on measurements available on the network several days later.
- As for voltage control, work was undertaken on a new blocking policy for transformer on-load tap changers, the management of reactive power at the RPT / RPD interface, the potential interest of a load-shedding PLC on low voltage criteria, collapse risk assessment criteria, the coordination of voltage thresholds for PLCs for Centralized Capacitor Manoeuvring (ACMC) and Static Var compensators (SVC).
- For the implementation of the “flow-based” method, which is defined in the memorandum of understanding signed in 2007 as the reference method for representing the network limits in the CWE zone with respect to the management of interconnections, the proposal and the evaluation of a detailed flow-based parameter method were made.
- The launching of the Convergence project to benefit from improved continuity between grid development studies and operational safety studies; first versions were installed in the Eastern Region dispatching centre and in the national dispatching centre.

9 RTE regulation and monitoring system

9.1 Reliability audit programme

Reliability audits are carried out at the request of RTE management within the framework of the internal audit measures set up within the company to ensure that its policies are complied with, to assist it in pinpointing and correcting any organisational weaknesses, and to advise management. These audits are performed according to periodical programming, which may be supplemented by other management requests, referred to as "flash" audits.

The actions engaged by RTE pursuant to these audits, as well as to the recommendations in the annual reliability reports, are monitored by the Power System Reliability Audit Mission on behalf of RTE's Executive Committee.

In 2008, three reliability audits were completed on the following topics:

- power / frequency and voltage / reactive power system services and their control;
- monitoring of the reliability performance commitments of producers (excluding system services), distributors and telecommunications operators;
- secondary voltage control.

9.2 Reliability audits

Audit on “f/P & U/Q system services and their control”

System services are the services provided by RTE based on elementary contributions essentially coming from generating sets, which are required for power transmission on the grid while ensuring operating reliability. The system services dealt with in this reliability audit are the services set up by RTE to ensure frequency, active power, voltage and reactive power control on the public transmission system (RPT). The control of these system services

is based on legislation and contracts governing the supply of elementary contributions from generating sets.

The audit focused on one hand, on the control conditions for power / frequency and voltage / reactive power system services, and on the other hand, their control. The following were more specifically analysed: the application and evolution of the reference guide, the checking of the aptitude of the generating sets to contribute to system services during connection and in operation, the constitution of the elementary contributions supplied by the generating sets, the application of the reliability performance commitment monitoring policy, the means, methods and tools used to ensure the conformity of the services provided by the generating sets, the constitution of system services by RTE, the application of sanctions and corrective actions, progress actions, relations with network users, feedback, activity coordination group, training, the role of teams, the management of activities and the functioning of the processes.

Audit on “monitoring of reliability performance commitments” (excluding system services)

RTE has contractual agreements concerning reliability performance commitments with certain producers, distributors and suppliers such as telecommunications operators. The 2002 reliability audit concerning the functioning of reliability feedback, as well as other annual reliability audits, recommended that careful attention be paid to the rigorous monitoring of performance commitments contracted with users of the public transmission system (RPT) and telecommunications operators. A “Policy for monitoring the performance commitments applied to the users of the RPT” was signed by the RTE’s CEO on 1 March 2005. In accordance with the legislation and contracts signed by RTE, it aims at monitoring user compliance with performance commitments, and implementing a rigorous internal and external organization so as to carry out the planned verifications and to sanction the non-compliance with requirements in an adapted and gradual way.

The “monitoring of reliability performance commitments” audit focused on the identification of expected performances in terms of reliability requirements (excluding system services that were dealt with in the reliability audit above), the completeness and relevance of the reference guides, the contractual expression of performances, commitment monitoring, dealing with non-compliance, feedback and activity management.

Audit on “Secondary voltage control”

The aim of secondary voltage control (RST) is to coordinate the actions of the primary voltage regulators of the generating sets. The RST system, which was the first automated system for this type of control, was widely used in the 1980’s. Its principle is based on the selection of control zones that must be independent of each other, and on the sending of a same “level” of control signal on the primary regulators of the generating sets to reach an intended voltage in a node called the pilot point, chosen to be representative of this zone. There are 35 secondary control zones in France. In the West, a specific system called RSCT was set up in the 1990’s that is capable of taking into account interactions between the secondary control zones in this region. A generalized deployment of the RST-N system took place in 2006 in the regions. RST-N involved the renovation of the RST system. RTE also decided, for the West region, to renew RSCT in the framework of the RSCT-NA project. The 2005 and 2006 reliability reports had underscored the growing difficulties with respect to voltage control that an increasing number of regions are having to deal with. In late 2006, RTE launched the national “Voltage Control” project.

The audit on secondary voltage control carried out in 2008 focused on the reference guides used, voltage control operating conditions, maintenance of equipment in operational

conditions and their upgrading, conditions for adding new generating sets, feedback and skills.

Flash audit on a “vegetation incident on the 400 kV Mambelin – Sierentz line”

Tripping incidents due to contact with trees occurred on the 400 kV Mambelin - Sierentz line on June 6 and June 8. Since avoiding short-circuits on the 400 kV grid due to contact with vegetation is an important stake for RTE, a flash audit was ordered to identify the reasons for which this requirement was not locally respected.

The audit focused on the knowledge, management conditions and implementation of the tree pruning policy in the unit concerned, the conditions in which the operators managed these events, the organization and responsibilities, the monitoring of purchasing services, the activity coordination group, the sharing of experience and the way reliability is approached by the vegetation management teams.

Feedback from the “Champagnier PLC”

The generation units in the Grand Maison hydropower station were tripped on July 23 due to the unexpected functioning of a PLC during a maintenance operation. The Reliability Audit Mission was asked to produce feedback, which it did via an audit procedure and by making the connection with the reliability audit that it had carried out on specific operation PLCs in 2007. In addition to the sequence of events of the incident, it analysed the methods used to assess needs and design the PLCs, their testing, the skills of the operators and the contracting.

10 Conclusion and recommendations

French power system reliability was once again controlled in satisfactory conditions in 2008, despite the fact that there was a power outage in the East of the PACA region on November 3, which had been dreaded for several years since it had not been possible to set up a structurally adequate network. The consultation following the incident led to the adoption of the solution proposed by RTE, which bodes well for greater reliability in the future.

Based on the other observations presented in the various chapters of this 2008 System Reliability Report, RTE's Power System Reliability Audit Mission considers that no new recommendations are needed beyond those expressed in previous annual reliability reports and during reliability audits.

The careful attention paid by RTE to the challenges of reliability, since its creation, encourages the National Power System Reliability Inspector, author of the annual power system reliability reports since 2001, to be confident in RTE's ability to ensure reliability at the very moment that he is taking his retirement and passing on the baton to his successor.

For further information about the principles on which the annual System Reliability Report is drawn up, please consult the following IEEE paper:

Jean-Michel TESSERON

"Mission: Reliability - Auditing and Reporting on Power System Reliability"

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