A Gravity Scale for Detecting and Analyzing Events Affecting Power System Reliability

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***Abstract*—Power system reliability is at the core of the responsibilities entrusted to RTE, the French Transmission System Operator. To detect events that provide information for system reliability, RTE uses preset criteria, grouped in a "Classification Scale of Significant System Events (ESS)". These events are positioned on a scale consisting of seven levels. The document first presents the principles governing the classification of ESS. It then explains the changes that took place up to 2004, the year the scale was greatly revised, in particular to take better account of the impact of the power system's new players resulting from institutional developments in Europe. The classification scale ranking criteria are presented, as well as the analyses and processing carried out using the ESS as a basis. Finally, examples of ESS contribution to feedback and reliability audits are given.**

***Index Terms*—Human factors, management, power system reliability, risk analysis.**

I. Nomenclature

CNES	RTE National Power Control Center.
ESS	French acronym for "Significant System Event".
RTE	Transmission System Operator (TSO) in France.
URSE	RTE Regional System Unit.
UTE	RTE Regional Transmission Unit.

II. Introduction

POWER system reliability is at the core of the responsibilities entrusted under French law to RTE, France's Transmission System Operator, when it was created in 2000 [1].

Many examples show that the most industrialized countries are not safe from major incidents [2]–[6]. Reports are sometimes published to analyze how these incidents unfolded and draw useful feedback from them so as to propose improvements. This practice is not widespread, although it could interest, beyond the countries concerned by the occurred blackouts, any country wanting to examine the malfunction occurrences and see how the proposed improvements can be transposed to its power system.

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However, it is even more difficult to have at one's disposal analyses relative to operating events of lesser importance that have affected power system reliability. One of the factors explaining this situation is the difficulty of knowing how to characterize the useful events to be detected and analyzed. And yet, the detection and analysis of these events are invaluable when it comes to preventing more serious incidents [7]. This report is entirely devoted to this issue, while setting out the measures adopted in France: they consist in supporting feedback from the daily detection of typical events identified as being able to provide information for power system reliability, and referred to as "Significant System Events" (ESS). In this report, we will successively present:

— the power system operated by RTE and the measures relative to operational power system reliability;
— the background to the approach that led to adopting and developing an ESS classification scale;
— the content of the scale;
— feedback based on the ESS.

III. The Power System and Measures Relative to Operational System Reliability in France

A. RTE Power System and Organization

The power system operated by RTE features an installed capacity of over 100 000 MW and consists of hundreds of generating sets, about 100,000 kilometers of lines or cables interconnected via EHV and HV substations forming a highly meshed network, and eight power control centers (one national and seven regional ones). It is part of the European synchronous interconnection, which supplies power to 450 million people.

RTE, the French Transmission System Operator, features two main Divisions as regards operation. The System Division is responsible for power system operation. The Transmission Division is entrusted with the operation of the company's transmission facilities. These two Divisions are organized in management centers called Units.

From the standpoint of regional operational organization, RTE has seven regions, with a System Unit (URSE) and Transmission Unit (UTE) for each of them, plus the National Power Control Center (CNES), the System Unit responsible for the national operation level and national dispatching.

At the central functional level, three entities play a more particular role with regard to feedback:

— for the System Division, the Power System Operation Department (DESE);
— for the Transmission Division, the Operation Performance and Commitments Mission (MPEE);

— directly reporting to the Chief Executive Officer of RTE, the Power System Reliability Audit Mission; this is a specific team responsible for carrying out power system reliability audits and for drafting a yearly power system reliability report [1], [8].

Furthermore, RTE has obtained the ISO 9001 V2000 quality certification. As a result, operational reliability benefits from the measures that RTE has set up as part of the Quality program. A number of mapping macroprocesses describe RTE's activities: connecting to the public transmission system, delivering electricity, providing access to interconnections, ensuring balancing services, developing and maintaining the grid, ensuring flow balance, balancing supply and demand and making up for system losses, developing and maintaining the Information System.

B. Measures Relative to Operational System Reliability

A policy to control power system operation reliability has been set up in France to avoid new grid collapses. This policy, which was signed in 2003 by RTE's Chief Executive Officer [8], is based on the definition of *power system operating reliability* (or, to put it short, "*system reliability*") adopted in France, which represents "*the ability to*:

1) *ensure normal system operation*;
2) *limit the number of incidents and avoid major incidents*;
3) *limit the consequences of major incidents whenever they do occur*".

This definition is important because it includes the full scope of operation of the power system, from normal operating conditions to the most degraded operating conditions, including system restoration after any major incident.

By going beyond the framework of basic contingencies and their many potential combinations, a blackout is always characterized by some typical operating phases related to four main electromechanical phenomena: 1) overload cascade; 2) frequency collapse; 3) voltage collapse; and 4) loss of synchronism [9], [10]. They may occur one after the other, or superpose or combine throughout the incident.

Reliability in France is founded on the implementation of multiple measures, adapted to the dynamics of these four major collapse phenomena, to avert, detect and treat the malfunctions that may lead to their emergence. They are organized following a defense-in-depth concept [8], with defense lines related to three aspects [9], [10]:

— prevention and preparation;
— monitoring and action;
— ultimate mitigation measures.

IV. Background to the Setting Up of the Classification Scale and Its Developments

The ESS classification scale was built on the basis of preset detection criteria. Consistent with the above definition of system reliability, these criteria are designed to be able to characterize the different types of reliability alteration: failures in the capacity to ensure system operation under normal operating conditions, the ability to stave off contingencies ranging from minor incidents to the total collapse of the network, and the capacity to ensure service restoration following any major incident.

This scale is designed to position the events at their right level of importance with regard to reliability by placing them on a scale consisting of seven levels from A to F. Level 0 is assigned to significant events having little effect on reliability, but which should be remembered.

Historically, this methodology was finalized in several stages.

The origin of the approach goes back to the mid-eighties. The French system had just undergone profound changes, with a sustained load increase, the arrival of many high-capacity nuclear power units, and the fast development of new 400-kV double circuit lines. At the same time, there were extensive changes to regulation and protection systems: new secondary voltage control systems at regional level, highly-perfected primary speed-voltage controllers, new electronic distance protections doubled by line differential protections, installation of busbar differential protections in EHV substations.

Along with this rapid development, power system operators were confronted with new incidents. It turned out that their explanation—and the search for remedies—would require setting up specific feedback so as to be able to combine the skills of the operators, of specialists in the field of stability and more generally of power system dynamic operation, as well as of experts capable of modeling the behavior of control, regulation and protection equipment. A specific permanent working group was entrusted with identifying the "significant power system incidents" affecting both transmission systems and generating sets. This group was able in practice to deal with some twenty complex incidents per year.

It then gradually appeared that this type of feedback deserved to be transposed to less complex, but more numerous events, for which it was impossible to undertake such extensive analyses. As several members of the working group represented the operators of nuclear units, and as the INES gravity scale was already used in the world to declare incidents having affected nuclear safety, reflection was oriented toward a transposition of this principle to declare the most significant incidents that have affected French power system reliability. The first classification began to be used in 1991.

The design of the approach was also considerably marked by the principles of "system-state based control" and "defense in depth" [11], [12], the possibilities of which EDF studied to apply to the control of the French power system [13]. These principles were uppermost in the minds of those who designed the ranking scale, as well as in the course of subsequent revisions, in particular during the last one applied in 2004.

On the basis of this initial setting-up of the ESS scale, several modifications were made over time, the two major ones of which are presented here.

In 1996, an evolution was introduced, by taking into account the intrinsic gravity of the events independently of their causes and consequences, the gravity of the real and potential consequences on the power system, and aggravating factors (e.g.,: transparency faults in the declaration of ESS).

Lastly, the development set up in early 2004 introduced several profound changes, including the following:

— the ranking methodology was specified while having it based on the combined assessment of gravity according to two types of input (see next section);

— the contribution of the contracts signed between RTE and its contacts was integrated, which means being more specific about the impact on reliability of the different players (e.g., producers, distributors) connected to the grid.

V. Presentation of the ESS Classification Scale and of ESS Type Headings in Force Since Early 2004

A. Ranking Methodology

The ESS ranking methodology redefined for application in early 2004 [1] is based on the combined assessment of events according to two types of input:

— a first type of input enables to record the occurrence of listed *concrete basic events affecting an operation function* in five "*domains*": 1) network (here, it concerns the public transmission system operated by RTE); 2) generation; 3) system operation; 4) control facilities; and 5) distribution; the gravity level assigned to the thus listed basic events indicates the assessment of the extent of the hazards sustained by the system;

— the second type of input aims at marking *the level of deterioration of system operation* (here the principles of control by status and defense in depth are to be found); it is characterized either by a direct assessment of the reaching of an aggravated state of reliability, or by carrying out a defense action aimed at avoiding a deterioration of the state of reliability.

Particular arrangements of the ranking method make it possible in some cases to assign an aggravating factor to the event that occurred by assessing by means of an expert opinion the potential consequences that the same event would have had if it had been displaced in time (for example, during the load increase in the morning or at the peak hour of the same day). When the results of the expert evaluation or the analysis of the potential consequences of an event of gravity N lead to identifying an event situated in the scale at a level equal to at least $N+2$, an additional level is therefore assigned to the final ranking.

The events assigned a "letter level" (A to F) are considered as having a known impact on reliability. The events assigned level 0 are considered as having no known direct impact on reliability, but are thought to warrant a particular follow-up; their systematic recording is a factor for improving reliability, as they enable sharing of knowledge and theme-based analysis.

Events can also be recorded without corresponding to one of the explicit criteria shown in the scale, and they are therefore considered as "not ranked" (NC). They are useful because they make it possible to store types of contingencies which may have been overlooked by the scale designers, and because new types of contingencies may arise considering the development of the power system; feedback from these events is useful with a view to future revisions of the ranking scale.

B. Main Modifications Made to the Scale

A new field has just been added to those already in existence: the "distribution" domain. It groups all the reliability events stemming from distributors and consumers or from their response to RTE reliability requests, its aim being to facilitate the involvement of these players in reliability.

The criteria were also considerably reallocated depending on the fields, so that the allocation of an ESS to a domain is as representative as possible of responsibility. The purpose of this is to make the players accountable, both within and outside RTE (which facilitates the elaboration and follow-up of indicators characterizing the responsibility of those concerned).

Extensive changes were also made to the descriptions of typical events. These modifications aim mainly at refocusing the descriptions of the basic events of the first type of entry of the ranking (extent of hazards sustained by the system) by doing away with the hardware or software descriptions, which are actually only supports of general functions coming under operation (e.g., observability, control, transit), and are subject to change.

Emphasis was also placed on giving more density to all the ranking levels and in all the fields. The diagnosis was made that the former classification scale was hypertrophied for events 0 and A, and that it contained some gaps in the classification for levels C, D, and E, or even B. This is explained by history: on the one hand, it was conceptually easy to assign the most serious level (F) to an incident leading to the total outage of the French power system (such as it occurred on 19 December 1978 [2], [9], [10]); on the other hand, feedback from the most frequent ESS (ESS 0 and ESS A) had gradually given a great deal of information to come up with typical descriptions of typical events; but such feedback is much more limited in number for events as soon as level C, or even level B, are reached. Here, it was useful to rely on defense in depth and control by status to fill in the classification gaps.

An effort was also made to take into account the major changes that have had an impact on the power system since the previous scales. They concerned, among others, the Balancing Mechanism (this mechanism describes the way RTE proceeds with the generation adjustments needed to balance the load, by inter-ranking the reserve power proposals of producers according to their offering price); every endeavor was also made to take into account the rules of the Union for the Coordination of Transmission of Electricity (the UCTE association coordinates the interests of the TSOs in 23 European countries; UCTE lays down the rules that the partners have to respect to ensure the reliability of the synchronous interconnection).

Care was taken to make it "easy" to assign an event to one of the listed ESS criteria, so as to limit the loss of ESS due to ranking difficulty.

The definition of the events of the "grid" domain was also reviewed by ranking the gravity of the criteria according to the number of connections unavailable at the same time.

C. Impact of Changes

The revision was performed while assessing the impact of the changes on the continuity of the statistics and the number of ESS to be processed. The following diagnosis was made:

Concerning the impact of the modifications on the continuity of the statistics and the number of ESS to be processed, it was deemed that the changes made to the events ranked from A to F in the existing fields, given their low occurrence, will have an effect on the "connection" of past data, more particularly in the "Grid" and "System Operation" domains; the global number of

ESS ranked A and above should nevertheless not change fundamentally. Furthermore, it was felt that the introduction of a new "distributors" domain should not have a noteworthy impact either on the number of ESS ranked A and above, which has turned out to be so since the beginning of 2004.

Finally, the description of the criteria, mainly focused on the functions, aimed at facilitating the use of this scale outside the RTE framework.

D. Structure of the Gravity Scale

In a limited presentation, it is difficult to account for a highly detailed scale; for example, the number of ranking criteria is 16 for the "grid" domain, 13 for the "generation" domain, 18 for the "system operation" domain, 18 for the "control facilities" domain, 12 for the "distribution" domain, and 24 for the entry mode "system operation degradation level". Each criterion is explained by a description that may contain up to some thirty words.

Schematically, the scale structure can be illustrated in the following way, all entry modes combined:

- level A (anomaly, incident): outage of several lines, non-respect of a major commitment by a producer with regard to reliability, generation outage from 1500 to 3000 MW, non-compliance with the operating rules of the 225-kV network, insufficiency of reserve generation, partial and significant outage of control facilities, non-execution of a local safeguard action, loss of local load, low-frequency deviation;
- level B (noteworthy incident): outage of many lines, outage of interconnections with another country, generation outage of over 3000 MW in France, noncompliance with the operating rules of the 400-kV grid, substantial insufficiency of reserve generation, major outage of control facilities, nonexecution of a safeguard action covering an area, loss of load, noteworthy frequency deviation;
- level C (major incident): outage of a large number of lines, outage of more than 3000 MW on the same generation site, total outage of control facilities, non-execution of a vital safeguard action covering an area, incident at an area level;
- level D (extensive incident): outage of several EHV substations, widespread incident at the regional level;
- level E: widespread incident involving several regions;
- level F: nationwide incident.

VI. ESS-Based Feedback Method

The provisions relative to detecting and using ESS are set out in the "System Operation Reference Guide", which formally expresses the internal policy applied by RTE [1].

Any event that can be characterized by one or more items of the classification scales must be declared and recorded in a dedicated common data base.

A factual report is drawn up for any ESS and issued via the common data base. It comprises the relation of the events and all the protective measures taken or under way. On a decision by the management, the factual report is supplemented by an in-depth analytical report, which features research into the essential causes specific to RTE, the lessons learnt by the different parties concerned inside or outside RTE, the decisions for corrective or even preventive actions envisaged.

TABLE I
Number of ESS per Gravity Level and per Year

ESS	2002	2003	2004	2005
A	44	70	42	65
B	7	14	3	4
C	1	3	1	1
D	0	0	0	0
E	0	0	0	0
F	0	0	0	0
Total ≥ A	52	87	46	70

The Units (URSE, CNES, UTE) set up the organization necessary to implement and monitor the actions decided upon up to their completion.

The information recorded on the common data base is examined periodically by the URSE and CNES, as well as by the teams entrusted with feedback at the central level on behalf of the System (DESE) and Transmission (MPEE) Divisions, in order to detect repetitive events or those with generic causes for which corrective or preventive actions are necessary or seem pertinent.

This data base is therefore a strong means of providing feedback on significant events concerning system reliability. Since 1 January 2001, it already features about 6,000 ESS.

VII. Feedback Obtained Thanks to the ESS

A. Feedback Obtained Concerning the ESS

The declaration of ESS first makes it possible to follow the trend in the number and gravity of significant events, and their breakdown into classification fields.

This information is used to communicate about reliability within RTE, as well as to communicate with all those who play a role in controlling reliability (e.g., producers, distributors, regulating authorities, French Minister of Industry, European associations of transmission system operators).

Tables I and II show the trend in the number of ESS of at least level A, from 2002 to 2005 [1].

The presentation of these ESS would require a great deal of space, so the reader is invited to refer to the yearly French power system reliability reports, drawn up by RTE since 2001 [1].

About one thousand level-0 ESS are declared every year. Their declaration is invaluable to improve feedback, even if they have little effect on reliability.[1]

This also permits one to conduct theme-based analyses on the initiative of the RTE regional Units and central functional teams, such as on the abnormal operation of 400-kV disconnectors, the temporary impossibility of remote control from dispatching centers to substations, the concomitant outages of line differential protections and protection signaling facilities used by the distance protections.

[1]thus, one declares under 0-level ESS any tripping of a generating set and any tripping of a 400-kV line, whereas such a tripping is covered by compliance with the "N-k" operating rule

TABLE II
NUMBER OF ESS PER DOMAIN AND PER YEAR

ESS ≥ A	2002	2003	2004	2005
Grid	12	19	16	9
System	28	49	7	34
Control facilities	7	10	21	18
Generation	5	9	2	6
Distribution	-	-	0	3
Total ≥ A	52	87	46	70

B. Utilization of ESS For Management Indicators

Mention was made earlier on that RTE described its activities, within the scope of the Quality approach, through macroprocesses many of which concern system reliability. Steering these macroprocesses relies in particular on indicators, so it appeared worthwhile to seek the declaration of ESS as a basis to come up with indicators marking the contribution of the indicators to reliability. This has resulted in the following indicators: number of A and B-level ESS over 12 sliding months, number of ESS at a level higher than or equal to C, declaration of 0-level ESS, ESS rates linked to the supply-demand balancing process, number of ESS brought about by the Information System.

However, such an approach has its limits.

First, it is difficult to find a balance between the need to limit the number of indicators (trying to steer at an overly detailed level would mean steering nothing at all), the concern about having global indicators, but which may mean being unable to do much concretely, and indicators concerning precise sectors, but which may stand in the way of other contributions to reliability (in particular, one should avoid focusing on the only supply-demand balance).

Another limit concerns the distortion that the existence of indicators might introduce in the declaration of ESS. Several reliability audits have indeed shown that there is a not inconsiderable risk that the weight that the management gives to complying with the indicators actually leads to not favoring transparency in the declaration of ESS. To counter this risk, RTE endeavors to encourage the declaration of 0-level ESS, by setting up another type of indicator: unlike the ESS of a level higher than or equal to A, for which efforts are made to limit their occurrence, the aim here is to declare a minimum number of 0-level ESS per year.

C. Using ESS to Communicate on the Reliability Level

As is undoubtedly the case for all Transmission System Operators, RTE is sometimes faced with requests to characterize the power system reliability level by simple indications, in the form of overall figures. This is a subject which should be considered with precaution.

For RTE, if one wishes to put an estimated global figure to the reliability level, the most pertinent indicator is made up of the number of ESS recorded during the year for the levels ranging from A to F. This can be used better since 2004, because with the coming into application of the new ESS scale, the aim has been to improve taking into account the various users of the grid.

However, a few figures cannot take into account the reliability level. Although the ESS declaration is invaluable, it accounts only for incidents, and not improvements. What's more, considering the low number of corresponding events, the occurrence of ESS at B level and higher is quite uncertain over the years, and experience shows that one must not rush to conclusions about the underlying analyses over a period of several years.

That's why the *Yearly French power system reliability report (Bilan Sûreté annuel du système électrique français)*[1] is the most relevant when it comes to qualifying the reliability level, insofar as it takes into account, in accordance with the RTE *Power system reliability policy (Politique de sûreté du système électrique)*[8], all the major aspects of reliability, and of the role that each one plays in building reliability.

D. ESS, Support for Carrying Out Reliability Audits

ESS provide strong support for carrying out reliability audits [1], [8].

Upstream of the conception of the reliability audit plan selected by the RTE management, they help identify the most relevant themes in terms of risk analysis.

Then, within the scope of each audit, the System Reliability Audit Mission performs an analysis of all the ESS that have a link with the subject of the audit. These analyses are thorough and concern a highly significant number and duration.

For example, for the reliability audit on voltage control, 360 ESS over a two-year period were analyzed; for the audit on the control of the clearance time of short-circuits that have affected the 400-kV grid, 60 ESS occurrences over the space of two years were studied; for the audit on frequency deviations and load-frequency control reserves, an analysis was made of 251 ESS that occurred over two years (plus the 0-level ESS concerning the tripping of generating sets); and for the reliability audit on the control of voltage recovery and islanding tests (measures adopted in France to prepare for power system restoration after any major incident), all the events that occurred from 2000 to 2005 were able to be analyzed.

In addition to the lessons drawn from the ESS at the central and regional levels in terms of the origin and causes of malfunctions, the System Reliability Audit Mission extracts the ESS specific to the regions or teams that it meets as part of audit interviews, and compares them with the daily and weekly reports that the Transmission and System teams have drawn up over the same periods. This presents several advantages:

- it is then easier to discuss with the teams those problems they have encountered, and to thus facilitate their perception of the risks, before extending the perspective to other problems which have happened elsewhere and which they may be subject to one day;
- it is thus possible to deal with the deficiencies in detecting, ranking and analyzing the ESS;
- as all the teams know that the audit meetings will lead to dealing with the local practice of ESS, this contributes to increasing the attention paid by the teams to the quality of ESS detection and analysis.

E. Lessons Learnt From Reliability Audits With Regard to ESS

Through the extensive use of ESS, reliability audits help provide a sharp view of the way ESS detection and analysis are ensured between System and Transmission at the central, regional and transverse levels. Each of the reliability audit reports comprises an accurate report on this subject, and also analyzes the relevance of the ESS scale from the standpoint of the audit dealt with.

Furthermore, in 2002, a specific reliability audit was carried out on the topic of feedback contributing to reliability, and in particular on ESS detection and analysis; it has already been envisaged to resume this reliability audit theme in 2008.

Although it is difficult to say whether the use of ESS is at an optimal level, these analyses have already made it possible on several occasions to implement relevant developments of the ESS scale, an improved functioning of feedback on reliability, as well as an enhanced use of ESS in regional reliability reports drawn up in collaboration by the URSE and UTE, and at the national feedback units level.

There is still room for more and necessary progress:

- there continues to be too great a dissymmetry in the roles of Transmission and System operators with regard to ESS; still too often, Transmission operators tend to think that System operators have the exclusive competence when it comes to reliability;
- even though the operators say that they are firmly convinced of it, one must constantly reaffirm that the declaration and analysis of ESS is invaluable not only for the team that has been confronted with the contingency, but also for the other regional teams; this requires knowing how to explain, and to fully explain and carry out the corrective actions undertaken; the System Reliability Audit Mission has too often observed, through audits, that an ESS had been insufficiently dealt with and that there lacked explanatory elements or the conclusions of actions undertaken;
- constant care should be taken with regard to linking feedback based on ESS and on the other feedback sources; in particular, one must always avoid ESS-based feedback being perceived as entrusted to a team of specialists: this would lead to cutting these people off from the other teams, gradually depriving them of skills and legitimacy, and might make the other operators feel free of their involvement in the ESS-based feedback;
- lastly, attention should be paid so that the central level—managers, expertise functions in the System (DESE) and Transmission (MPEE), System Reliability Audit Mission functional teams—show signs indicating that the detection and analytical task of the regions is perceived at the national level, where it should be subject to attentive scrutiny and questioning.

F. Feedback on How to Get the ESS Scale to Evolve

The last feedback point that we would like to deal with concerns the way to get the classification scale to evolve. Here we can rely on the experience acquired over a period of 15 years of working with ESS, on several revisions of the ranking scale (we were able to compare the effect of the modifications with the initial intentions) and on five years of reliability audits.

To begin with, it turns out that no classification scale can undoubtedly claim to be perfect and so this factor has to be taken into account.

To give prospects for improving a classification scale, it is above all essential to gather good data and to be able to use the available elements to set up elaborate and effective feedback; this requires being able to rely on data bases that are practical to use, both to record and implement the ESS.

Generally speaking, anything that hampers the declaration of ESS should be avoided. Even if the information tool is user friendly, the best efforts and intentions may actually be ruined by a poorly designed steering indicator which will hinder the transparency of the declaration.

The same may hold true if an improper distribution of the typical event descriptions in the scale fields may put inappropriate and unjustified blame on the team that drew up the declaration.

Care should be taken with regard to consistency in the scale. Poor consistency of the ranking levels between the different domains may put a brake on those domains that will feel they have not received adequate attention. Likewise, ranking changes in the course of the various evolutions may result in the loss of legitimacy of the scale. Evolutions therefore have to be accompanied while explaining and taking full advantage of successive improvements.

One must make sure that the new proposals can be applied. At RTE, checking whether proposals are applicable is facilitated by “requirement reviews”, i.e., Quality procedures which operational Units must formally carry out when implementing any new element of the System Operation Reference Guide. In addition, at the time of the revision implemented on 1 January 2004, reflection was initiated to make sure that the new descriptions considered were not only basically relevant with regard to the treatment of reliability, but lent themselves well to an explicit characterization.

It was particularly difficult to characterize the ESS reflecting the distribution field, whereas the only observation points that the Transmission System Operator has are at the interface between the transmission and distribution networks. In some cases, it was possible to take advantage of these observable elements. In other cases, the idea of declaring certain situations had to be given up, while maintaining recourse to a ranking at a high level in the event of a more extensive change in reliability: it is therefore difficult to know in a routine situation whether the telecontrol facilities are properly used by the distribution operators to process information coming from them; on the other hand, on the occasion of a degraded situation, where the characterization of the event and the distributor’s action are shown by visible exchanges of information and orders, the failure can therefore be characterized by aggravating its ranking. This will have a dissuasive effect in a more routine situation.

To give a concrete illustration, this approach made it possible to opt for the ESS description “equipment for the reception and processing of safeguard commands found inoperable upon the transmission of a safeguard command”, in the “distribution” domain, at the A ranking level: indeed, RTE can easily identify this situation; on the contrary, the idea of using a level-0 ESS description “equipment for the reception and processing of safeguard commands inoperable” had to be given up, because RTE is not in a position to identify these more routine situations if the Distribution System Operator does not inform RTE of them.

Finally, the human factor cannot be disregarded. At the beginning of this section, we mentioned that no classification scale could claim to be perfect. Consequently, for the revision of early 2004, we rightfully sought to do away with explicit mentions of faulty equipment, and moved towards the characterization of faulty operating functions. In the light of the past two years, it is likely that more concrete form will have to be given to this concept, while maintaining its principle: in practice, it still remains difficult for dispatchers to appreciate when an operating function is weakened.

Lastly, many typical event descriptions, despite the great care taken in drawing them up, might be distorted as regards their interpretation by anyone wishing to get out of declaring an ESS that would be unpleasant for him, and, through the reliability audits conducted, we do not lack imagination in this domain either, but undoubtedly would it not be useful here to give more ideas to those who may be in need of them!

VIII. Conclusion

After some 15 years of detection, ranking and analysis, the use of ESS is considered by RTE to be an essential support to impede the routine occurrences of operating events liable to affect operational power system reliability, and thus contribute to preventing more extensive incidents.

For the future, using a long-term outlook, it would be undoubtedly worthwhile to see how this method could be transposed to other power systems, or to the vaster power system made up of the European synchronous interconnection.

To remain within the scope of the French power system, the question may be posed as to whether there is still much room for development. We'll be careful about this point, keeping in mind that we must avoid the search for the ideal classification scale turning into a quest for the Holy Grail, and take care to see that the changes still to be made to the scale do not lead to overly frequent and poorly linked revisions which could be detrimental to its legitimacy and implementation by the operators.

We would also be tempted to acknowledge that we are not perfect. The RTE "Memento of Power System Reliability" [9], [10] indeed states that the contribution of the human player to reliability must not only be considered as a factor of alteration of reliability, but also a factor of adaptation, compensation for insufficiencies, and improvement. Considering the obviousness of the operational reliability issue for power system operators, and of their concern about avoiding major incident occurrences, does this not apply to the utilization of an ESS classification scale?

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