BUT, CAN WE AFFORD THE CURRENT LEVEL OF RISK? A NEW MODEL FOR A NEW AGE.

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ABSTRACT

In this paper we review the practices that we use in ENDESA to make compatible the scarcity of resources that we have, as a consequence of the current regulation, and the high demands of the society for the quality of the service.

We propose a method in three steps which achieves a successful result with a reasonable level of investment and expenses.

INTRODUCTION

Nowadays, we can find a lot of people giving their opinion about the performances and behavior of the quality of the service.

There is a general opinion in the society, that the level of quality should be better.

But on the other hand, we have continuous pressures from the regulators and the customers to cut the prices of the service and, consequently, the total cost.

The traditional point of view of the electrical engineer was to analyze all the risk of the network (or at least the simple risk as N-1 criteria) and develop enough elements as the failure of one element doesn't affect the continuity to the end users.

The scarcity of resources, the environmental difficulties to develop new installation, and the increases of the demand, have provoked that the traditional point of view should change to have a new vision of the network.

In all the industries, the level of security that you have in your system increases in opposite sense to the level of your knowledge.

"The more knowledge, the less security".

To achieve a better level of knowledge, we need to give intelligence to the network, improving the information and communication systems. All of this is the base of the intelligrid project.

Now we can't afford the cover of all the possible risks. We should wonder: what if..?, with what frequency and what will be the consequences of this contingency (How long?).

In ENDESA, we have developed a solution that is based on three levers:

- **Risk analysis** (Contingency studies).
- **Reliability behavior**. Real performance of all individual elements, and the impact of each of these in the total quality (This analysis is called MICRO PLAN)
- **Management crisis**. What will be the operation of the network that we should make after the contingency? This plan contains the changes in the configuration of the charges and the material and resources that we should have prepared to recover the network as soon as possible.

The combination of these three levers, gives us the possibility to accept some situations of risk, saving a lot of money, and improving the quality of service at the same time.

RISK ANALYSIS.

The Risk analysis is the most conventional tool that the electric utilities have ever used to assure the quality of the service. The analysis consists to make a simulation of the behavior of the system, under some scenarios of demand (how and where), generators (how, where, and what technology) and network.

In each combination of these factors, the planner studies if the system has enough capacity for each scenario, in normal contingency and with failure of each element of the system.

This analysis, which from a theoretical point of view is impeccable, has several problems:

1. The analysis only considers the single failure.
2. It doesn't take into consideration the probability of occurrence (rate of failure) of each element. We

should take into consideration that the rate of failure of the different elements of the network could have a probability one hundred times bigger. In Table 1, we can find the rate of failure of some common elements of the network, where we can see these differences.

3. It doesn't take into account the time to restore the normal state of the system (how much time you need to repair the failure?). Although this information does not contribute to the size of the problem, the impact that the incident can have on society (and the media of course) will depend on the duration of the blackout, and subsequently the time to repair the failure.

Elemento de la red	Carga característica (MW)	Tamaño característico	Tasa de fallos característica (fallos/por unidad)	Afectación esperada por incidente (MW/ elemento-año)
Línea AT	80	100 km	0,05	**4,0**
Transforma	20	1 ud	0,14	**2,7**
Línea MT	3	17 km	0,08	**0,2**

Table 1. Probability to lose 1 MW due to the failure of one element of the network.

In spite of the problems that this analysis has, if after this we can assure that the system can work under the failure of each element, then the level of confidence of the technical managers of the company will be very high, and they will be very happy and sleep well….

… But the financial managers of the same company will sleep badly. The quantity of resources that the companies need to assure the correct run of the network under each contingency, and for any level of demand and generations, normally is dramatically high.

The current trend in the major part of the countries is to try to reduce the price of the electricity, normally changing, for the Regulators, the rules of play. These pressures from the Regulator should have an answer in the level of investment and expenses of the companies, and also in the profit that the companies give to their share holders.

RELIABILITY BEHAVIOR

As we can see above, the quantity of financial resources that we will need to assure the robustness of the system, will be too much for the current level of incomes of the electric utilities.

The conclusion that we can achieve could be that we should remain with certain level of risk, but the analysis of the main incidents that we have in our network, shows us that there are a lot of incidents with important impacts in the market, that are due to a very small components of the network. The frequency of these failures, and the cost to replace or supervise these components, with an extra maintenance, is the base of the MICRO program that we are applying in ENDESA.

To do this, we have used the Failure Mode and Effects Analysis (FMEA) that is a method that examines potential failures in products or processes. It may be used to evaluate risk management priorities for mitigating known vulnerabilities.

FMEA helps select solutions that reduce the impacts of risks from a systems failure (fault). The method consists in building a hazard tree to locate possible mistakes.

The basic process is to take a description of the parts of a system, and list the consequences if each part fails. In most formal systems, the consequences are then evaluated by three criteria and associated risk indices:

- severity (S),
- probability of occurrence (P)
- inability of detection (D)

Each index ranges from 1 (lowest risk) to 10 (highest risk). The overall risk of each failure is called Risk Priority Number (RPN) or Gravity, and the product of Severity (S), Probability (P), and Detection (D) rankings: $RPN = S \times P \times D$.

To develop this technique to the network components, we have created a data base with the characteristics of all the failures that we have had in the last years. For each incident, we have recorded information of the elements affected, the level of charge and the history of the maintenance.

For each element, we study what could be the root causes of the failure, and what we can do to avoid it. In the first step, we have selected fifty components of the substations, with one hundred and twenty six different causes of failure. We have made a merit order list, based on the level of Risk Priority Number or Gravity. In Table 2, we can see what element is responsible for the network mistake. In Table 3, we can see what the roots causes of each incident are.

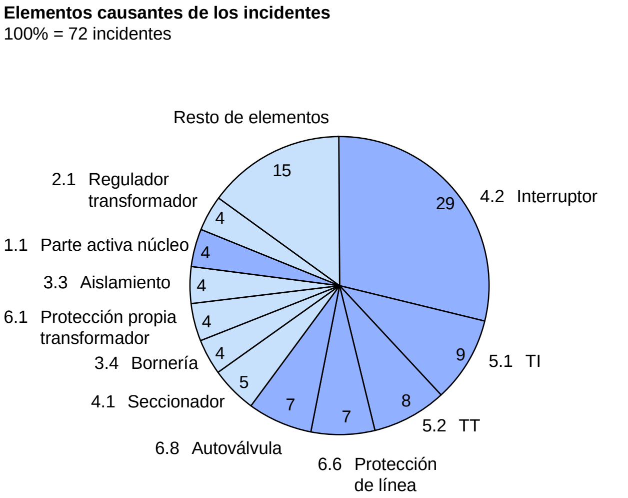

Table 2. Elements responsible of the incidents

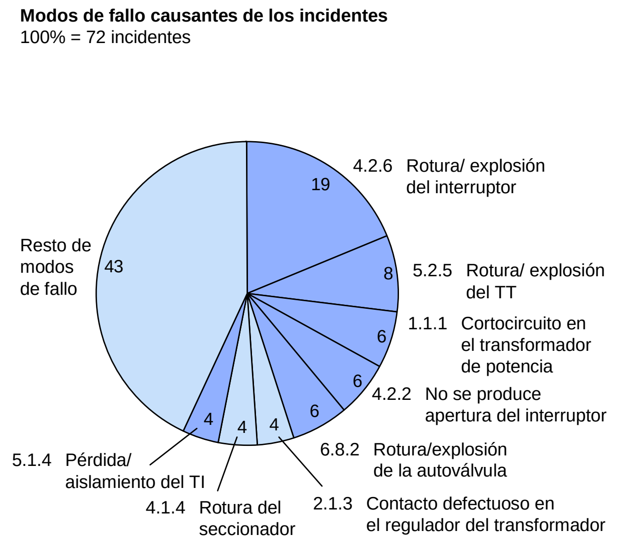

Table 3. Roots causes of the incidents

The conclusion of these two tables is that the element which affects more the existence of the incident, are the switches, and the worse failure explosion or breakage.

For each root causes, we propose a portfolio of solutions, and we select the most efficient plan, in order to avoid the consequences of this failure. As product of this analysis, we define the budget of MICRO plan. The contribution expected is the improvement of the reliability of the network, that until now we are achieving.

MANAGEMENT CRISIS

After the contingency analysis and after reducing the probability of failure, with the implementation of MICRO plan, we find a lot of elements in the network whose failure will provoke the loss of an important or sensitive part of the market (for example, 50.000 customers in an urban area). This situation will be temporary (if we are developing the definitive solution, but the time to finish it is very long) or permanent (if the quantity of resources that we need is to much to eliminate the risk, or if the probability of occurrence is very reduced)

For these elements, we need to know the answer of some questions:

1. Where are the elements of risk?
2. What will be the market affected if the element fails?
3. What operations (changes in the network configuration) should we make to reduce the impact?
4. Where are the components to replace the elements failure?

With the answer of these questions, we can have a map of risk (at least of the high risk mistakes). Starting with the geographical distribution of the risk, we define the possible actions that we should take, if the contingency will happen. To make the time to recover the service shorter, we create some stores of strategic material. The localization of the stores and the quantity of material is defined to be a maximum of two hours between the start of the contingency and the arrival of the material at the place of the failure.

The material that there are in the stores are:

1. Portable substation.
2. Multi voltage Transformer (HV/MV).
3. Small portable generators (LV).
4. Self erected HV tower.

With this plan we want to achieve recovery of the service in less than six hours in all cases.

CONCLUSIONS.

The current level of incomes of the electric utilities, and the opposition of the society, doesn't permit us to have a network without risk. On the other hand, society doesn't allow us to have a bad quality of service, in particular in the urban areas.

To solve these two problems (scarcity of resources and demands of society), we have developed in ENDESA a plan focus for the big incidents. We are studying the way to improve the reliability of the critical assets at the minimum cost, and to recover the service in a short time, while we develop the necessary infrastructure.