The UEM (Usine d’Electricité de Metz – an electricity producer and distributor) has just installed a new supervision system that it uses to remote control all its networks from 225 kV to low voltage.

One of the special features of this system, which is also and most importantly one of its strengths, is the integration of all functions necessary for operators of very high to very low voltage electrical networks, in real time or off-line, from remote operation to local control, within a single graphic and functional environment and based on a single and consistent data base. Its extreme ease of use makes it a powerful tool easily controlled by operators.

The purpose of this report is in particular to present the study method used in this system. The term “study method” actually denotes a work environment in which all real time supervisor control functions exist (choice of images, navigation, selection of objects, access to information in the database, dynamic coloring of the network, etc.). There are other functions specific to the simulation, namely network calculation (loadflow and short circuit power), quality management, maintenance management, training and practice for dispatchers.

The most remarkable of these functions are the network calculation and quality management. Important facts are:

**In general**

- the study method operates on a non-real time version of the database, such that any manipulation made using this method has no effect on the real time.
- Network photos, in other words instantaneous records of the real state of the network at time t, are used. The photo may be taken automatically (either after an event and/or cyclically) and/or manually.

**About the network calculation**

The network calculation function applies to all voltage levels (from transmission to distribution) and regardless of the network structure (radial or grid).

The operator has to make two choices before starting any calculations:
- the representation, in other words the network portion (that may be the complete network) on which he wants to work
- modeling of loads to be selected, for the selected representation level.

Results are restored in reports and graphically (access to values and particular coloring of network elements depending on the observed constraints).

**About the quality management**

Quality management is composed of two modules:
- quality as seen by the customer, that consists of counting power failures at each node, from the 225 kV to the low voltage output, and eventually customer by customer.
- the quality as seen from the network, including the input of incidents causing power failures, their causes, sources of failures and any aggravating factors.

Therefore the operator can use these two modules to:
- easily and precisely monitor quality criteria (standard and specific),
- demonstrate weak points in the network taking each network portion separately and each structure separately, to obtain operating experience for use by entities responsible for planning (renewal / investment / selective maintenance).
1. INTRODUCTION

The UEM (Usine d'Electricité de Metz – an electricity producer and distributor) has just installed a new supervision system that it uses to remote control all its networks from 225 kV to low voltage.

One of the special features of this system lies in the fact that all functions useful to the electricity distribution company, such as maintenance management, management of supply quality, planning, training of dispatchers are based on the remote control system within a single and consistent data model. The man-machine interface is also unique, which is the reason for its exceptional ease of use and assurance of good control over the tool.

This presentation introduces mainly the study method that groups previously mentioned functions and particularly quality management and the network calculation.

2. GENERAL PRESENTATION OF THE STUDY METHOD

The study method is a work environment containing all real time supervisor control functions (choice of images, navigation, selection of objects, access to information in the database, dynamic coloring of the network, etc.). There are also functions specific to the simulation, in other words network calculation (loadflow and short circuit power), quality management, maintenance management and training of dispatchers. Note that study method operates on a non-real time version of the database, such that any manipulations made using this method have no effect on real time.

The study method uses network photos, in other words instantaneous records of the real state of the network at time t. The Lynx system can take different types of photos:
- manual photos made at the request of the operator
- automatic photos made by the system when specific key events occur (for example following a permanent trip of a circuit breaker or if the maximum power reached by the network is exceeded), the automatic generation criterion being defined by parameters
- programmed or cyclic photos.

In the study method, the operator uses the photo in which he is interested from the archiving system before starting to do his work.

2.1. Network calculation

The network calculation function operates on all voltage levels (from transmission to distribution) regardless of the network structure (radial or grid). The following steps are involved in making a calculation:

2.1.1. CHOICE OF THE REPRESENTATION LEVEL

This option is used to determine topological contours of the network within which the simulation is to be made. For example, the operator could choose to run a load flow on the 63 kV network or on a portion of the medium voltage network, by integrating input voltage levels. The choice of network portions on which the calculation has to be run is made graphically.

This feature is used to choose the representation level and is particularly interesting for two reasons:
- on a very extensive medium voltage network, being able to select a portion of this network guarantees fast and optimum execution of the calculations (the matrix calculation of equivalent impedances may require large amounts of calculation time)
- results are more accessible since the only results printed are applicable to the selected network elements.

2.1.2. MODELING LOADS

Loads are modeled taking account of two elements:
- the level at which the network is represented, that defines the level of the network at which equivalent loads must be modeled (i.e. on 63 kV busbars, on medium voltage busbars, at distribution substations, etc.)
- rules for evaluating loads that depend on management parameters available to the distribution company.

For a given representation level, the operator can choose between several load modeling algorithms.
Note also that loads are modeled automatically and may then be modified manually.

**AUTOMATIC MODELING OF LOADS:**

 Loads are calculated starting from two data sources, remote measurements associated with the network photo (real time information captured by the system at the time that the network photo was taken) and sizing characteristics of structures, for example as the transformation power in distribution substations. One of the modeling principles is shown in the following diagram:

\[
I' = \frac{I \times P_i}{\sum_{i} P_i}
\]

where:
- \(I\) is current carried by feeder X and acquired by the central system in real time
- \(P_i\) power of the transformer installed in distribution substation \(i\)
- \(I'\) corrected current called by the substation

In fact, reality is somewhat more complex. The feeder does not necessarily contain only public distribution substations, it may also contain customer substations (industrial customers) with a specific behavior, in other words different from the behavior of distribution substations. The UEM has setup modeling algorithms that take account of the specific features of these particular substations.

More generally, we are interested in the part specific to each distribution company in that modeling depends on parameters available at the distribution company. Note that the study method was designed modularly, so that it can be used by a distribution company that can use management parameters other than those used by the UEM. In this case, the manufacturer simply needs to adapt the modeling module.

**MANUAL LOAD MANAGEMENT**

In addition to this automatic management, the operator can fix loads (active or reactive) manually, either individually or globally.

**PRODUCTION MANAGEMENT**

Production may be fixed in the same way as loads, either automatically or manually and for active or reactive loads. The regulation mode (PQ or PV) may also be chosen.

**2.1.3. Calculation**

The tool can be used to make transit calculations and short circuit power calculations. Several options are possible when carrying out a short circuit power calculation:
- choice of the short circuit type (single phase, two or three phase), etc.
- choice of the failure location
- whether or not to include loads
- failure impedance
2.1.4. Results

Results are accessible in summary tables containing all values related to the selected area, and graphically. For example, an overload on a portion of the network is displayed graphically on the screen in a specific user-definable color. Different overload stages can also be distinguished, and obviously they can be assigned a different color. A graphic display may also be produced whenever a short circuit power is exceeded at a given node, by comparison with a configurable threshold. This monitoring is done for all elements in the network, including cables, bars, circuit breakers, etc. Calculated values can also be accessed graphically on the objects concerned.

2.2. Quality management

2.2.1. General presentation

Including power cuts

The quality management software can take account of power cuts at any node in the network, as far as the low voltage feeder from MV/LV substations (network representation limit at the moment). Eventually, when the low voltage network is included (by importing data from the MIS), it will be possible to count power failures individually as far as the final customer.

Power cuts can be included in two different ways:
- counting by time and by number, with a link with the incident that caused the fault
- counting according to the rules of the Emeraude contract, with management and monitoring of contractual thresholds not to be exceeded (particularly monitoring of long and short power failures).

2.2.2. Management principles

In the study method, an operator replays the chronology of the operations done for each incident (including the chronology of network automation), as follows:

Starting from a network photo, in principle corresponding to a photo taken automatically by the system after a trip, the operator inputs all changes in the position of the control device, and the corresponding time-date (hh, mn, ss, ms). When the chronology is replayed, a calculation algorithm scans the network topology and assigns time and numbers of cutoffs at each node as far as an LV feeder. A second calculation algorithm immediately interprets these power failures as defined in the Emeraude contract. Thus for Emeraude customers, the history of power failures and incidents can be displayed simply by looking at the transformation substation that supplies power to the customer. The same principle is used for an LV feeder. When the chronology is entered into the system, the system can replay it step by step, associated with a graphic display (dynamic coloring of the network) in order to display the incidence of each maneuver.

Note: The UEM has chosen to replay the chronology of incidents since it appears very difficult to automate this management for several reasons:
- one incident does not necessarily correspond to a single power failure. Therefore generation of an incident sheet cannot automatically be associated with the appearance of a power failure.
- when a failure occurs, the agent working in the field does not inform the dispatcher of the operations that he performs in the field in real time. Therefore, some additional input will have to be made afterwards in any case.