

# MAINTENANCE PLANNING OF THE ELECTRICAL DISTRIBUTION SYSTEMS

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## **SUMMARY**

*This paper shows the methodology and the software developed for the Maintenance Planning of the Electrical Distribution Systems which is based in the following basic stages:*

- *The precedence over process of interventions through systems, feeders and blocks.*
- *The control process of the actions and of the budget , step by step.*
- *The analysis of the Performance and the Electrical Network correlated to the resources applied.*

## **INTRODUCTION**

This paper shows the process of the Maintenance Planning of the Electrical Distribution Systems developed and applied at Elektro since 1997.

The methodology in use contemplates mechanisms to make possible the precedence over the investments and expenses in maintenance by an optimized and systematized way considering the several technical and market parameters with the purpose of maximising the results of applied resources in the maintenance activities.

For this, it makes necessary in a first stage, to take precedence over the maintenance interventions according to the level of importance of the distribution network, considering the required quality by the assisted market, the planned enterprise profitability, the Electrical System Physical integrity preservation , as well as the involved aspects of safety.

## **PRECEDENCE OVER INTERVENTIONS**

### **Precedence over Electrical Systems**

The precedence over Interventions is done firstly in Electric Systems level.

In this level the first considered parameter is the legal aspect.

Precedence over actions to assure that the limits defined for the quality indicators established by CSPE - Commission of Public Services of Energy of the State of São Paulo be considered in order to avoid that the enterprise be fined.

The second considered parameter is to compare the Electrical Systems performance evolution as regards the

frequency average of interruptions by costumers per year (FEC) and the duration average of the interruptions by costumers per year (DEC) indicators with the established aim for them.

In this way, firstly take precedence those systems which performance as regards the annual FEC are not in accordance with the quality level aims required by the market.

For the Electrical Systems that show an adequate performance and that are in accordance with the established quality level aims is done precedence over maintenance level through periodical criteria in order to keep the performance of these Systems.

### **Precedence over Feeders**

Once the precedence over Electrical Systems is defined the next step is to identify in each System which Feeders need maintenance actions.

This process is done through analysis of the contribution of each feeder in the system, as regards its participation in the failure rate, and for the FEC and DEC quality indicators of the electrical system which they belong.

### **Precedence over Blocks**

Blocks are the network segments between two switches or between two protection equipments.

The blocks present different levels of importance in the electrical system, in accordance with their specific characteristics, especially as regards the supply tension, the position in the feeder, and geographical location.

For the precedence over the maintenance actions in the blocks it was developed an algorithm that considers three main parameters: technical, quality and economic as follow:

**Technical aspect.** It is considered in this item the relation between the occurred time the last inspection accomplished in the Block and the frequency of inspection defined in function of its importance.

For each type of block it was established its respective maximum inspection frequency as showed in the table I

**Table I**

Type	Description	Frequency
A1	Blocks 34,5 kV	=< 1 year
A2	Urban feeder blocks 13,8 kV	=< 1 year
A3	Extension rural main line blocks 13,8 kV	=< 1 year
B1	Urban Primary Branch Lines Blocks	=< 3 years
B2	Rural Primary Branch Blocks	=< 4 years
C1	Urban Secondary Transformer Blocks	=< 3 years
C2	Rural Secondary Transformer Blocks With or Without Secondary Network	=< 4 years

**Aspect of Quality.** This factor considers the performance of the main quality indicators, as much as in the medium as individual level, as regards the required quality and the failure rate evolution.

**Economic aspect.** This component considers the difference among the income and the volume of resources applied comparatively with the involved asset. These factors are considered and composed in only one index, which is used to establish the intervention priorities in the Block level .

**MAINTENANCE GLOBAL PLAN COMPOSITION**

Several actions were group together in maintenance service units, to make possible a better identification of interventions done in the network.

These units were composed in accordance with the specific objectives for what the services are intended for, having in view to search for the biggest effectiveness as possible as regards the maintenance results.

Based on this, it was established Service Units, each of them with specific objectives: for instance, rotten poles, broken cable/wire – environment action; broken pin insulator; etc.

The Maintenance Global Plan is composed from the Systems, Feeders and Prioritization over Blocks identifying the following items:

- Amount of services by unit.
- Financial Resources by unit.
- Labour and Material Resources by unit.

The service classification in units makes possible the acquisition of modular costs more adequate for the budget composition, as well as to analyse the performance through the correlation between maintenance service units and the interruption causes groups.

**CONTROL OF THE EXECUTION OF THE STAGES OF THE MAINTENANCE IN GRAPHIC BASE**

The maintenance control uses a computer system called SGD-MAN GIS, it means Distribution Management System – Maintenance Geographic Information System, which integrates in only one database geographical information from cartographic data, urban and rural register data, and network data.

Among the modules of this System, stand out:

- Division of the distribution network in segments for inspection with graphic visualization, having the surrounding segments different colours.
- Graphic visualization of the electrical network by blocks, having each block different colours.
- Attendance of the of the Maintenance Stage through the graphic visualization of the inspected segments, with open and executed maintenance order using different colours for each situation.
- Automatic Classification of the inspection priorities according to precedence over intervention with graphic visualization.
- Emission of Inspection Order on the cartographic base.
- The program prints the cartographic base with detail of the Network Distribution for point put to the defect code in each Network point.
- Emission of maintenance order where the respective amount of material and the sum of required labour are done in each point of the block
- Report of the intervention applied resources grouping together the total in the block

**BUDGETARY MANAGEMENT**

The Enterprise Budgetary Management of the Company is done through a Management System so the automatic process allows that all the managerial levels can verify at any moment the volume of foreseen , applied and available resources by item and administrative unit.

This processed happens in two modules according to the following description:

**Applied Resources Volume Control**

The basic principle used to establish the process of Budgetary Management was that the responsible Managerial Unit approves the accomplishment of Maintenance Service previously in the Maintenance Budgetary System.

In this system exists a resource control in a such way that when a volume of Maintenance Service is submitted to the approval the system verifies the availability of resources.

Thus the approval and execution of a determined enterprise is conditioned to the availability of resources in the respective item.

This module is already implanted and it is working in the company since 1997.

## Enterprise Justification Index

This index calculates the profitability of the enterprise comparing the difference between the income and the volume of resources to be applied with the involved asset. In the approval process the enterprise profitability is compared with the minimum profitability established by the company.

When the profitability of the enterprise is compatible the responsible managerial level for the enterprise approves its execution.

In case that the profitability is less than the minimum level its priority should be reviewed or submitted to the approval of the superior managerial level again.

This module was already specified and nowadays, it is in development process in the system to be implanted soon.

## PERFORMANCE ANALYSIS

As long as the Maintenance Global Plan and the deadline for the actions be established it is important that the process is controlled and the results be systematically evaluated with the objectives of assuring the execution to confirm the foreseen results and to take the necessary corrective steps either be in the implantation or in the planning criteria.

The evaluation of the results should be done through the monthly verification if the executed actions and the accomplished investments are in accordance with the established programme and deadline.

The performance analysis is done through the comparison of the indicators from the moment that the actions are concluded within the same period of the previous year.

- Applied Resources by Maintenance Services Units, as example given in Table II.
- DEC, FEC, and Failure Rate Evaluation by group of causes.

**Table II**

Maintenance Services Units	Causes	Code
10 – REPLACEMENT OF POLES	BROKEN POLES	14.8.4 E 14.8.6
	ROTTEN POLES	10.1.3 A 10.6.3
	BURNT POLES	14.8.5
15 – SERVICES IN INSULATORS	INSULATOR BROKEN PIN	14.0.6
	INSULATOR DRILLED PIN	14.0.3
	INSULATOR CRUNCHED PIN	14.0.4
	INSULATOR BROKEN DISC	14.1.6
	INSULATOR DRILLED DISC	14.1.3
	INSULATOR CRUNCHED DISC	14.1.4

## CONCLUSION

The application of a structured process Planning in the Maintenance of Electrical System Distribution becomes each time more important time, on one side in function of the significant volume of involved resources and on the other hand in reason of its strong influence in the performance of the system as regards the of supply quality indicators.

This last focus starts to have a larger meaning as the market started demanding better of supply quality levels in reason of the loads characteristics changes which processes are migrating quickly from electromechanical to microprocessed control with high automation degree. Before this situation the company restructured the Maintenance Planning and it starts its application in 1997 in a first moment through the prioritization over interventions phases and of Resources Budgetary Management.

In 1998, it was developed the second phase that contemplates the application of resources in graphic environment of the SGD-MAN GIS system which has the following main functionalities nowadays :

- Automatic Classification of the Distribution Network Blocks.
- Precedence over interventions in the blocks in accordance with the technical , quality and economic criteria.
- Emission of maintenance inspection orders for the priority blocks.
- Control of all Maintenance execution stages through pictograms which indicates the stage of the process in each block.

It is in development the third phase of the process which foreseen the application of resources in the following functions:

- Application of the Justification Index of the Maintenance Enterprises,
- Performance Analysis from the applied resources report by Service Units and occurred Interruptions by group of causes.

The organization of Maintenance Planning and Control Process using the SGD-MAN GIS system also allowed that starting from 1999 the Company began the regionalization of the Distribution Maintenance Center which is starting planning, programming and controlling the maintenance interventions in the ambit of a Regional of Distribution as a whole which consists contiguous electric systems located in an only geographical area.

The regionalization of the Maintenance Center is bringing larger effectiveness abd maintenance process control of the distribution electrical system with profits for the Company and for its Customers.

Through this process the Company is consolidating the Maintenance Planning of Distribution Electrical System searching for the optimization of pplied resources in the required profitability levels protecting the involved aspects of safety as well as practicing the supply quality levels required by the market.